

Paper 1

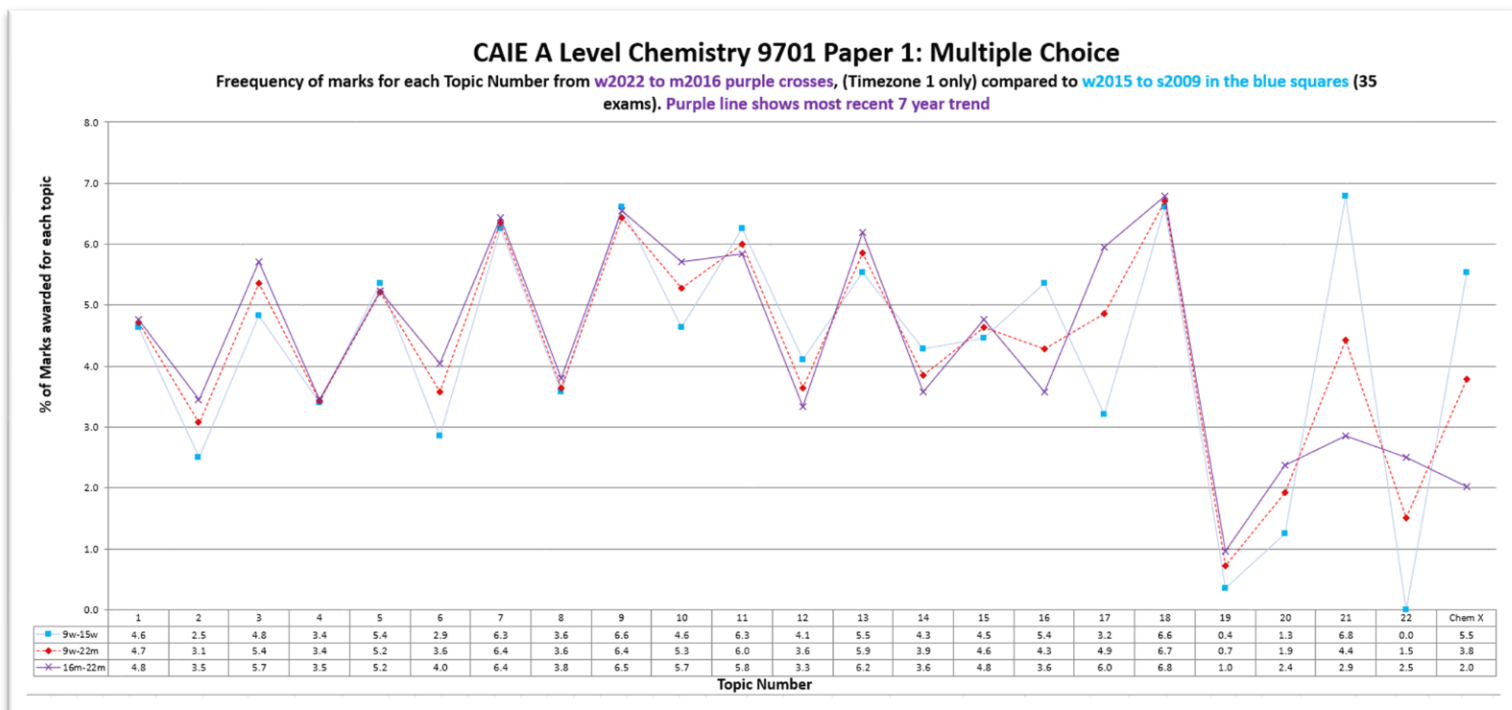
Past Exam Questions

Organised by Topic Number

Summer 2009 to Winter 2022 (35 Papers)

Name: _____

Class: _____





Contents

For and electronic version of this Work Book.....	2
Calendars and time management.....	4
Planning your days	8
Paper 1 Analysis and Graphs.....	12
Paper 1: Notes and points of interest	16
Exam Questions	17
Topic Chem 1 Q# 1	17
Topic Chem 2 Q# 67	33
Topic Chem 3 Q# 110	42
Topic Chem 4 Q# 185	63
Topic Chem 5 Q# 233	76
Topic Chem 6 Q# 306	103
Topic Chem 7 Q# 356	116
Topic Chem 8 Q# 445	146
Topic Chem 9 Q# 496	173
Topic Chem 10 Q# 586	200
Topic Chem 11 Q# 660	221
Topic Chem 12 Q# 744	245
Topic Chem 13 Q# 795	260
Topic Chem 14 Q# 877	288



Topic Chem 15 Q# 931	305
Topic Chem 16 Q# 996	326
Topic Chem 17 Q# 1056	346
Topic Chem 18 Q# 1124	368
Topic Chem 19 Q# 1218	398
Topic Chem 20 Q# 1228	402
Topic Chem 21 Q# 1255	410
Topic Chem 22 Q# 1317	433
Mark Scheme	446
Q# 1/ Chem 1	446
Q# 67/ Chem 2	447
Q# 110/ Chem 3	449
Q# 185/ Chem 4	451
Q# 233/ Chem 5	452
Q# 306/ Chem 6	455
Q# 356/ Chem 7	456
Q# 445/ Chem 8	459
Q# 496/ Chem 9	460
Q# 586/ Chem 10	463
Q# 660/ Chem 11	465
Q# 744/ Chem 12	468
Q# 795/ Chem 13	469
Q# 877/ Chem 14	472
Q# 931/ Chem 15	473
Q# 996/ Chem 16	475
Q# 1056/ Chem 17	477
Q# 1124/ Chem 18	479
Q# 1218/ Chem 19	482
Q# 1228/ Chem 20	482
Q# 1255/ Chem 21	483
Q# 1317/ Chem 22	485
2016 Data Booklet and Periodic Table	486
Important values, constants and standards (2022 and after)	499
Periodic table	500



January						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

February						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

March						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

April						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

May						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

June						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						



CAMBRIDGE
International Education

Cambridge IGCSE™
Cambridge O Level
Cambridge International AS & A Level

Cambridge Final Exam Timetable June 2024

Administrative zone 5

CAIE Chemistry 9701 A Level Chemistry Exam Timetable for Administrative Zone 5 (Time Zone 2):

Paper 1 – AS Chemistry

Tuesday 04 June

	Syllabus/Component	Code	Duration	Session
IG	Drama	0411/13	2h 30m	AM
IG	Design & Technology	0445/33	1h	AM
IG	Design & Technology	0445/43	1h	AM
IG	Design & Technology	0445/53	1h	AM
AS	Accounting (Multiple Choice)	9706/13	1h	AM

	Syllabus/Component	Code	Duration	Session
AS	Chemistry (Multiple Choice)	9701/12	1h 15m	PM

Paper 2 - AS Chemistry

Wednesday 15 May

	Syllabus/Component	Code	Duration	Session
IG	Literature in English	0475/23	1h 30m	AM
IG	Literature in English	0475/33	45m	AM
IG	Literature in English	0475/43	1h 15m	AM
OL	Literature in English	2010/23	1h 30m	AM
AL	Mathematics (Pure Mathematics 3)	9709/33	1h 50m	AM

	Syllabus/Component	Code	Duration	Session
IG	Computer Science	0478/12	1h 45m	PM
IG	French	0520/22	1h	PM
OL	Computer Science	2210/12	1h 45m	PM
OL	French	3015/02	1h	PM
AS	Chemistry	9701/22	1h 15m	PM
AL	Chemistry	9701/52	1h 15m	PM



Paper 3 - AS Chemistry

Thursday 02 May

	Syllabus/Component	Code	Duration	Session
IG	Geography	0460/13	1h 45m	AM

	Syllabus/Component	Code	Duration	Session
IG	Sanskrit	0499/22	1h 30m	PM
IG	Biology (Core)	0610/32	1h 15m	PM
IG	Biology (Extended)	0610/42	1h 15m	PM
IG	Combined Science (Core)	0653/32	1h 15m	PM
IG	Combined Science (Extended)	0653/42	1h 15m	PM
IG	Co-ordinated Sciences (Double Award) (Core)	0654/32	2h	PM
IG	Co-ordinated Sciences (Double Award) (Extended)	0654/42	2h	PM
OL	Biology	5090/22	1h 45m	PM
OL	Combined Science	5129/22	1h 45m	PM
AS	Global Perspectives & Research	9239/12	1h 30m	PM
AS	Chemistry (Practical - Advanced)	9701/33	2h	PM

Thursday 30 May

	Syllabus/Component	Code	Duration	Session
OL	Commerce	7100/23	2h	AM
AL	Sociology	9699/43	1h 45m	AM

	Syllabus/Component	Code	Duration	Session
IG	Accounting (Multiple Choice)	0452/12	1h 15m	PM
OL	Accounting (Multiple Choice)	7707/12	1h 15m	PM
AS	Law	9084/22	1h 30m	PM
AS	Chemistry (Practical - Advanced)	9701/34	2h	PM

Paper 4 (A2 Chemistry)

Wednesday 08 May

	Syllabus/Component	Code	Duration	Session
IG	Information & Communication Technology	0417/13	1h 30m	AM
IG	Global Perspectives	0457/13	1h 15m	AM
AS	Computer Science	9618/13	1h 30m	AM
AS	Information Technology	9626/13	1h 45m	AM

	Syllabus/Component	Code	Duration	Session
IG	English (as an Additional Language)	0472/22	1h	PM
IG	English (as an Additional Language)	0472/42	1h	PM
IG	First Language English (Oral Endorsement)	0500/12	2h	PM
IG	English as a Second Language (Speaking Endorsement)	0510/12	2h	PM
IG	English as a Second Language (Count-in Speaking)	0511/12	2h	PM
OL	English Language	1123/12	2h	PM
AL	Chemistry	9701/42	2h	PM
IG	Latin	0480/13	1h 30m	EV
AS	Thinking Skills	9694/23	1h 45m	EV

Paper 5 (A2 Chemistry)

Wednesday 15 May

	Syllabus/Component	Code	Duration	Session
IG	Literature in English	0475/23	1h 30m	AM
IG	Literature in English	0475/33	45m	AM
IG	Literature in English	0475/43	1h 15m	AM
OL	Literature in English	2010/23	1h 30m	AM
AL	Mathematics (Pure Mathematics 3)	9709/33	1h 50m	AM

	Syllabus/Component	Code	Duration	Session
IG	Computer Science	0478/12	1h 45m	PM
IG	French	0520/22	1h	PM
OL	Computer Science	2210/12	1h 45m	PM
OL	French	3015/02	1h	PM
AS	Chemistry	9701/22	1h 15m	PM
AL	Chemistry	9701/52	1h 15m	PM



Syllabus view (A-Z)

Cambridge International AS Level					Cambridge International AS Level				
Syllabus/Component	Code	Duration	Date	Session	Syllabus/Component	Code	Duration	Date	Session
A					I				
Accounting (Multiple Choice)	9706/13	1h	Tuesday 04 June 2024	AM	Information Technology	9626/13	1h 45m	Wednesday 08 May 2024	AM
Accounting	9706/23	1h 45m	Thursday 09 May 2024	AM	L				
B					Language & Literature in English	8695/12	2h	Monday 06 May 2024	PM
Biology (Multiple Choice)	9700/12	1h 15m	Tuesday 11 June 2024	PM	Language & Literature in English	8695/22	2h	Wednesday 01 May 2024	PM
Biology	9700/22	1h 15m	Tuesday 14 May 2024	PM	Law	9084/12	1h 30m	Tuesday 28 May 2024	PM
Biology (Practical - Advanced)	9700/33	2h	Thursday 09 May 2024	PM	Law	9084/22	1h 30m	Thursday 30 May 2024	PM
Biology (Practical - Advanced)	9700/34	2h	Tuesday 28 May 2024	PM	Literature in English	9695/12	2h	Wednesday 01 May 2024	PM
Business	9609/13	1h 15m	Monday 06 May 2024	AM	Literature in English	9695/22	2h	Monday 13 May 2024	PM
Business	9609/23	1h 30m	Friday 10 May 2024	AM	M				
C					Marine Science	9693/13	1h 45m	Friday 26 April 2024	EV
Chemistry (Multiple Choice)	9701/12	1h 15m	Tuesday 04 June 2024	PM	Marine Science	9693/23	1h 45m	Wednesday 01 May 2024	AM
Chemistry	9701/22	1h 15m	Wednesday 15 May 2024	PM	Mathematics (Pure Mathematics 1)	9709/13	1h 50m	Monday 29 April 2024	AM
Chemistry (Practical - Advanced)	9701/33	2h	Thursday 02 May 2024	PM	Mathematics (Pure Mathematics 2)	9709/23	1h 15m	Tuesday 07 May 2024	EV
Chemistry (Practical - Advanced)	9701/34	2h	Thursday 30 May 2024	PM	Mathematics (Mechanics)	9709/43	1h 15m	Tuesday 07 May 2024	AM
Chinese Language (Listening - Multiple Choice)	8238/12	1h	Monday 27 May 2024	PM	Mathematics (Probability & Statistics 1)	9709/53	1h 15m	Monday 13 May 2024	AM
Chinese Language (Multiple Choice)	8238/22	1h 30m	Wednesday 29 May 2024	PM	Media Studies	9607/22	2h	Tuesday 07 May 2024	PM
Chinese Language	8238/32	1h 30m	Friday 26 April 2024	PM	Music (Listening)	9483/13	2h	Monday 20 May 2024	AM
Computer Science	9618/13	1h 30m	Wednesday 08 May 2024	AM	P				
Computer Science	9618/23	2h	Friday 17 May 2024	AM	Physics (Multiple Choice)	9702/12	1h 15m	Thursday 06 June 2024	PM
D					Physics	9702/22	1h 15m	Thursday 16 May 2024	PM
Drama	9482/13	2h	Friday 24 May 2024	AM	Physics (Practical - Advanced)	9702/33	2h	Tuesday 30 April 2024	PM
E					Physics (Practical - Advanced)	9702/34	2h	Thursday 23 May 2024	PM
Economics (Multiple Choice)	9708/12	1h	Friday 07 June 2024	PM	Portuguese Language	8684/02	1h 45m	Tuesday 30 April 2024	EV
Economics	9708/22	2h	Friday 10 May 2024	PM	Portuguese Language	8684/03	1h 30m	Monday 20 May 2024	EV
English General Paper	8021/12	1h 15m	Thursday 25 April 2024	PM	Psychology	9990/12	1h 30m	Thursday 25 April 2024	PM
English General Paper	8021/22	1h 45m	Monday 29 April 2024	PM	Psychology	9990/22	1h 30m	Tuesday 30 April 2024	PM
English Language	9093/12	2h 15m	Friday 03 May 2024	PM	S				
English Language	9093/22	2h	Monday 06 May 2024	PM	Sociology	9699/13	1h 30m	Thursday 09 May 2024	AM
Environmental Management	8291/13	1h 45m	Friday 26 April 2024	EV	Sociology	9699/23	1h 30m	Friday 17 May 2024	AM
Environmental Management	8291/23	1h 45m	Wednesday 01 May 2024	EV	Spanish Language (Listening - Multiple Choice)	8022/13	1h	Monday 13 May 2024	AM
F					Spanish Language (Multiple Choice)	8022/23	1h 30m	Wednesday 22 May 2024	EV
French Language	8682/23	1h 45m	Wednesday 01 May 2024	AM	Spanish Language	8022/33	1h 30m	Monday 06 May 2024	EV
French Language	8682/33	1h 30m	Wednesday 29 May 2024	AM	Sport & Physical Education	8386/13	1h 45m	Friday 24 May 2024	AM
Further Mathematics	9231/13	2h	Monday 06 May 2024	AM	T				
Further Mathematics	9231/33	1h 30m	Friday 24 May 2024	AM	Thinking Skills	9694/13	1h 30m	Monday 29 April 2024	EV
Further Mathematics	9231/43	1h 30m	Wednesday 29 May 2024	AM	Thinking Skills	9694/23	1h 45m	Wednesday 08 May 2024	EV
G					Travel & Tourism	9395/13	2h	Tuesday 30 April 2024	AM
Geography (Core)	9696/12	1h 30m	Friday 03 May 2024	PM	U				
Geography (Core)	9696/22	1h 30m	Friday 17 May 2024	PM	Urdu Language	8686/02	1h 45m	Monday 29 April 2024	EV
Global Perspectives & Research	9239/12	1h 30m	Thursday 02 May 2024	PM	Urdu Language	8686/03	1h 30m	Wednesday 22 May 2024	EV
H									
History	9489/13	1h 15m	Friday 03 May 2024	AM					
History	9489/23	1h 45m	Friday 10 May 2024	AM					

Syllabus view (A-Z)

Cambridge International A Level					Cambridge International A Level				
Syllabus/Component	Code	Duration	Date	Session	Syllabus/Component	Code	Duration	Date	Session
A					L				
Accounting	9706/33	1h 30m	Tuesday 14 May 2024	AM	Law	9084/32	1h 30m	Monday 03 June 2024	PM
Accounting	9706/43	1h	Tuesday 21 May 2024	AM	Law	9084/42	1h 30m	Wednesday 05 June 2024	PM
B					Literature in English	9695/32	2h	Tuesday 21 May 2024	PM
Biology	9700/42	2h	Tuesday 07 May 2024	PM	Literature in English	9695/42	2h	Thursday 23 May 2024	PM
Biology	9700/52	1h 15m	Tuesday 14 May 2024	PM	M				
Business	9609/33	1h 45m	Thursday 16 May 2024	AM	Marine Science	9693/33	1h 45m	Monday 06 May 2024	AM
Business	9609/43	1h 15m	Monday 20 May 2024	AM	Marine Science	9693/43	1h 45m	Friday 24 May 2024	EV
C					Mathematics (Pure Mathematics 3)	9709/33	1h 50m	Wednesday 15 May 2024	AM
Chemistry	9701/42	2h	Wednesday 08 May 2024	PM	Mathematics (Probability & Statistics 2)	9709/63	1h 15m	Tuesday 07 May 2024	AM
Chemistry	9701/52	1h 15m	Wednesday 15 May 2024	PM	Media Studies	9607/42	2h	Wednesday 22 May 2024	PM
Chinese Language & Literature (Multiple Choice)	9868/12	1h 30m	Monday 27 May 2024	PM	P				
Chinese Language & Literature	9868/22	2h	Friday 26 April 2024	PM	Physics	9702/42	2h	Monday 13 May 2024	PM
Chinese Language & Literature	9868/32	2h	Monday 29 April 2024	PM	Physics	9702/52	1h 15m	Thursday 16 May 2024	PM

Organising your weeks

Week Starting	Wk #	Events	Topic Focus
11-Mar	9	<u>MONTHLY EXAM</u>	
18-Mar	10		
25-Mar	11		
1-Apr	12		
8-Apr	13		
15-Apr	14	<u>MOCK EXAM(?)</u>	
22-Apr	15		
29-Apr	16	Thur 2 nd PM Paper 33 (TZ2)	
6-May	17	Wed 8 th PM Paper 4 (TZ2)	
13-May	18	Wed 15 th PM Paper 2 (TZ2) Wed 15 th PM Paper 5 (TZ2)	
20-May	11		
27-May	12	Thur 30 th PM Paper 34 (TZ2)	
3-Jun	13	Tues 4 th PM Paper 1 (TZ2)	
10-Jun	14		
17-Jun	15		
24-Jun	16		



Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 am							
	5:30 am							
	6:00 am							
	6:30 am							
	7:00 am							
Regstn	7:25 am							
1	7:50 am							
2	8:40 am							
3	9:30 am							
4	10:20 am							
5	11:00 am							
Lunch	11:50 pm							
6	1:10 pm							
7	2:00pm							
8	2:50 pm							
9	3:40 pm							
	4:20 pm							
	5:00 pm							
	5:30 pm							
	6:00 pm							
	6:30 pm							
	7:00 pm							
	7:30 pm							
	8:00 pm							
	8:30 pm							
	9:00 pm							
	9:30 pm							
	10:00 pm							
	10:30 pm							



Planning your days – v2.0

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 am							
	5:30 am							
	6:00 am							
	6:30 am							
	7:00 am							
Regstn	7:25 am							
1	7:50 am							
2	8:40 am							
3	9:30 am							
4	10:20 am							
5	11:00 am							
Lunch	11:50 pm							
6	1:10 pm							
7	2:00pm							
8	2:50 pm							
9	3:40 pm							
	4:20 pm							
	5:00 pm							
	5:30 pm							
	6:00 pm							
	6:30 pm							
	7:00 pm							
	7:30 pm							
	8:00 pm							
	8:30 pm							
	9:00 pm							
	9:30 pm							
	10:00 pm							
	10:30 pm							



Planning your days – v3.0

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 am							
	5:30 am							
	6:00 am							
	6:30 am							
	7:00 am							
Regstn	7:25 am							
1	7:50 am							
2	8:40 am							
3	9:30 am							
4	10:20 am							
5	11:00 am							
Lunch	11:50 pm							
6	1:10 pm							
7	2:00pm							
8	2:50 pm							
9	3:40 pm							
	4:20 pm							
	5:00 pm							
	5:30 pm							
	6:00 pm							
	6:30 pm							
	7:00 pm							
	7:30 pm							
	8:00 pm							
	8:30 pm							
	9:00 pm							
	9:30 pm							
	10:00 pm							
	10:30 pm							



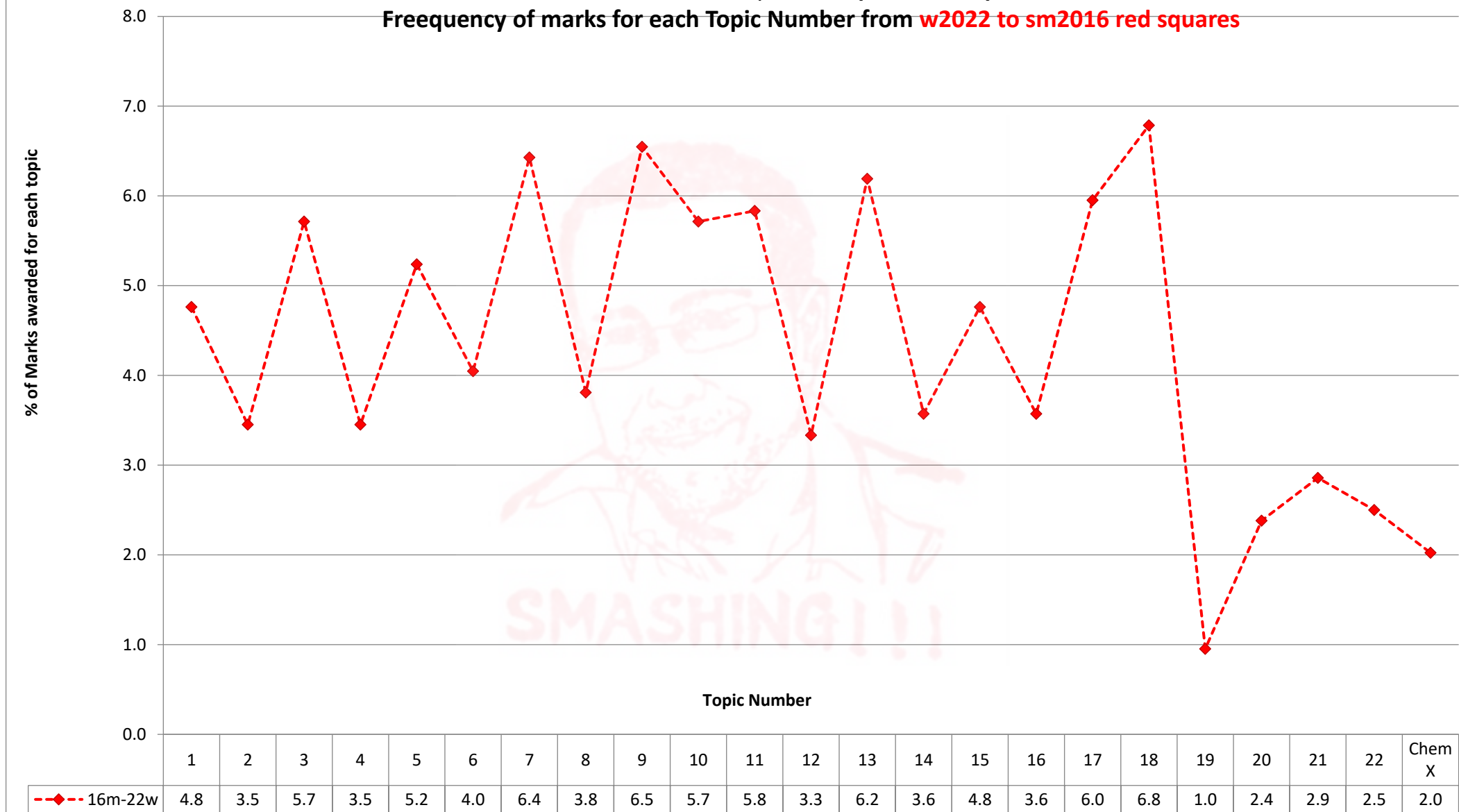
Planning your days – v4.0

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 am							
	5:30 am							
	6:00 am							
	6:30 am							
	7:00 am							
Regstn	7:25 am							
1	7:50 am							
2	8:40 am							
3	9:30 am							
4	10:20 am							
5	11:00 am							
Lunch	11:50 pm							
6	1:10 pm							
7	2:00pm							
8	2:50 pm							
9	3:40 pm							
	4:20 pm							
	5:00 pm							
	5:30 pm							
	6:00 pm							
	6:30 pm							
	7:00 pm							
	7:30 pm							
	8:00 pm							
	8:30 pm							
	9:00 pm							
	9:30 pm							
	10:00 pm							
	10:30 pm							



Paper 1 Analysis and Graphs

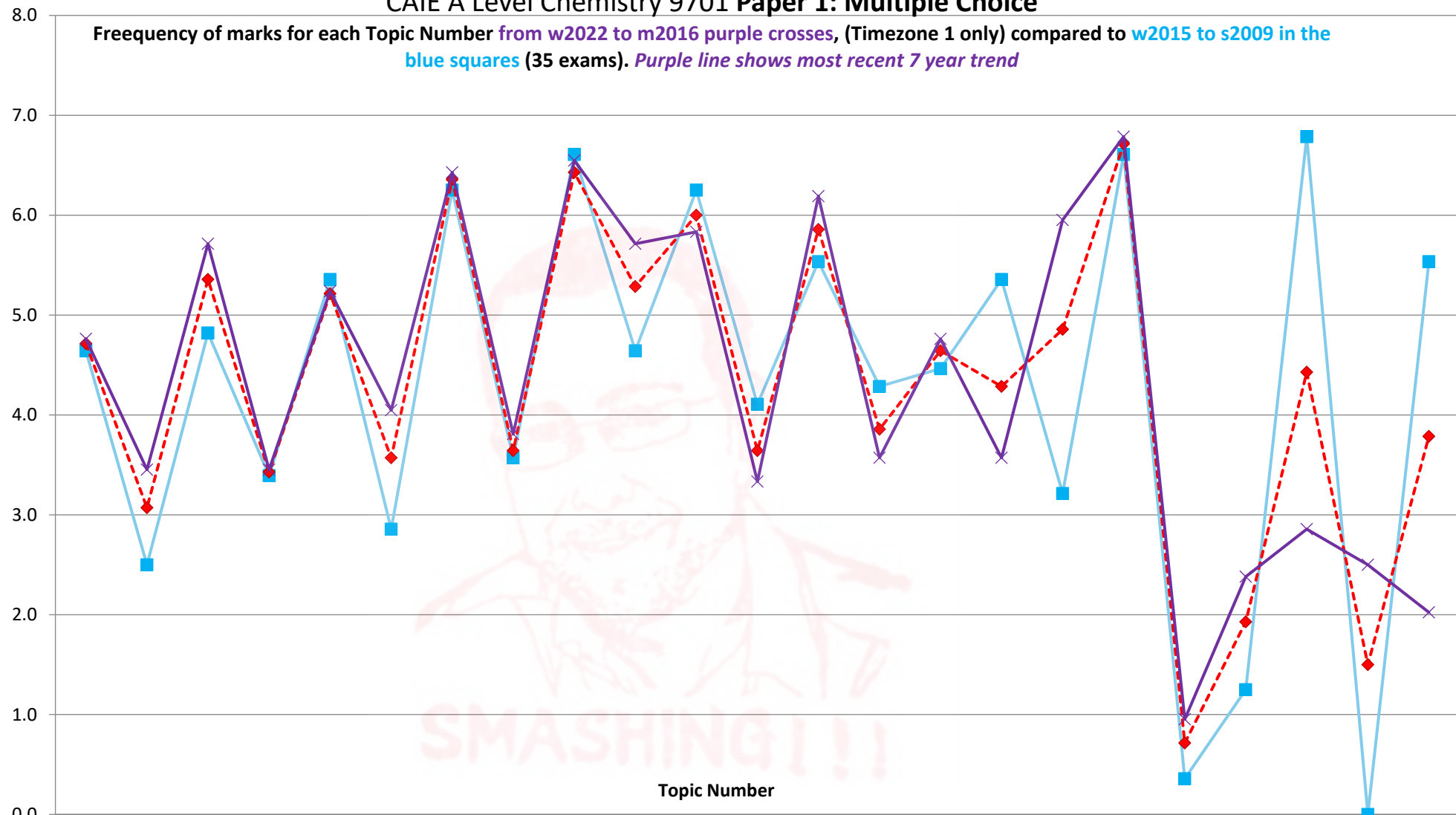
CAIE A Level Chemistry 9701 Paper 1: Multiple Choice
 Frequency of marks for each Topic Number from w2022 to sm2016 red squares



CAIE A Level Chemistry 9701 Paper 1: Multiple Choice

Freequency of marks for each Topic Number from w2022 to m2016 purple crosses, (Timezone 1 only) compared to w2015 to s2009 in the blue squares (35 exams). Purple line shows most recent 7 year trend

% of Marks awarded for each topic



Topic Number

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Chem X
9w-15w	4.6	2.5	4.8	3.4	5.4	2.9	6.3	3.6	6.6	4.6	6.3	4.1	5.5	4.3	4.5	5.4	3.2	6.6	0.4	1.3	6.8	0.0	5.5
9w-22m	4.7	3.1	5.4	3.4	5.2	3.6	6.4	3.6	6.4	5.3	6.0	3.6	5.9	3.9	4.6	4.3	4.9	6.7	0.7	1.9	4.4	1.5	3.8
16m-22m	4.8	3.5	5.7	3.5	5.2	4.0	6.4	3.8	6.5	5.7	5.8	3.3	6.2	3.6	4.8	3.6	6.0	6.8	1.0	2.4	2.9	2.5	2.0



Multiple choice frequencies across the years

Initially, there was a strong bias against making choice A to be the correct answer.

		01w P1/0	02s P1/0	02w P1/0	03s P1/0	03w P1/0	04s P1/0	04w P1/0	05s P1/0	05w P1/0	06s P1/0	06w P1/0	07s P1/0	07w P1/0	08s P1/0	08w P1/0	09s P1/0	09w P1/1	10s P1/1	10w P1/1	11s P1/1	11w P1/1	12s P1/1		
A	9.1	7	9	10	6	7	8	6	7	7	7	7	7	12	7	5	4	9	10	8	6	9	8		
B	10.1	10	11	8	8	14	10	8	11	12	13	15	8	6	6	8	10	10	10	11	12	10	12		
C	10.6	10	11	14	14	12	9	8	10	11	11	10	14	14	16	12	11	12	10	8	12	12	12		
D	10.2	13	9	8	12	7	13	18	12	10	9	8	11	8	11	15	15	9	10	13	10	9	8		
Rolling 5 year average:														7.4	7.4	7.6	7.4	7.3	7.0	7.1	7.5	7.5	7.5	7.6	7.7
A														10.9	10.7	10.3	10.1	10.1	9.7	9.7	9.9	9.9	9.9	9.6	9.4
B														10.9	11.3	11.5	11.7	11.5	11.5	11.7	11.9	11.7	11.8	11.9	12.1
C														10.8	10.6	10.5	10.8	11.1	11.8	11.5	10.7	10.8	10.8	10.8	10.8
D																									

Towards 2020 there was a consistency in the number of A, B, C and D correct answers. This pattern in format delivers even more information than a simple bias. At the end of the exam you should count the number of each of your answers, and any that have more than 10 are where you more likely have made mistakes, and the letter choice that you have selected less than 10 times could be the right answer, which would be particularly useful for students who only make a handful of mistakes.

	19m P1/2	19s P1/1	19s P1/2	19s P1/3	19w P1/1	19w P1/2	19w P1/3	20m P1/2	20s P1/1	20s P1/2	20s P1/3	20w P1/1	20w P1/2	20w P1/3	21m P1/2	21s P1/1	21s P1/2	21s P1/3	21w P1/1
A	10	10	9	9	11	11	11	10	11	10	11	10	9	10	10	10	10	10	10
B	11	9	11	10	9	8	9	10	9	10	10	10	11	10	10	10	10	10	10
C	10	11	10	11	10	12	10	10	10	11	9	11	10	11	10	10	10	10	10
D	9	10	10	10	10	9	10	10	10	9	10	9	10	9	10	10	10	10	10
Rolling 5 year average:		9.6	9.6	9.5	9.4	9.4	9.5	9.6	9.8	10.0	10.1	10.3	10.3	10.2	10.3	10.4	10.3	10.2	10.1
A	10.4	10.5	10.5	10.4	10.2	10.0	9.8	9.7	9.6	9.6	9.6	9.5	9.7	9.6	9.6	9.7	9.9	10.0	10.0
B	10.3	10.2	10.2	10.3	10.5	10.7	10.9	10.7	10.5	10.6	10.4	10.5	10.4	10.5	10.4	10.4	10.2	10.2	10.2
C	9.7	9.7	9.9	10.0	10.0	9.8	9.6	9.7	9.8	9.6	9.7	9.7	9.7	9.6	9.6	9.6	9.7	9.7	9.7
D																			



Most recently though, this has changed completely, so it is better to avoid inferring too much into how many of each letter choice you have selected. But each letter choice has at least 5 correct answers, and none have more than 15, so is some information there, but almost all students would be better off ignoring this moving forward certainly for AS chemistry, probably for all CAIE exams (the Cambridge University Entrance exam, the NSAA, which used to be run by CAIE, had a strong bias here however).

	23m P1/2	23s P1/1	23s P1/2	23s P1/3	23w P1/1	23w P1/2	23w P1/3
A	9	10	5	9	11	6	11
B	12	10	13	12	8	10	8
C	8	15	12	9	6	15	6
D	11	5	10	10	15	9	15
Rolling 5 year average:							
A	10.0	10.0	9.5	9.5	9.4	9.1	9.2
B	10.0	10.0	10.4	10.5	10.5	10.5	10.3
C	10.2	10.6	10.7	10.6	10.2	10.5	10.2
D	9.8	9.4	9.4	9.4	10.0	9.9	10.4

Section B (until 2021 winter)

This section was used for questions 31 to 40 and required you to chose a letter based on a combination of options:

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

For Section B, towards the end there was still a bias towards A (all options 1, 2 and 3) and against C (option 1 is incorrect, but 2 and 3 are correct):

	19m P1/2	19s P1/1	19s P1/2	19s P1/3	19w P1/1	19w P1/2	19w P1/3	20m P1/2	20s P1/1	20s P1/2	20s P1/3	20w P1/1	20w P1/2	20w P1/3	21m P1/2	21s P1/1	21s P1/2	21s P1/3	21w P1/1	21w P1/2	21w P1/3
A	3	3	5	4	2	3	2	3	3	4	3	4	3	4	2	4	4	3	3	3	3
B	2	2	2	3	4	3	4	2	3	2	3	3	3	3	5	2	3	2	2	2	2
C	3	3	1	1	1	2	1	3	2	2	2	1	2	1	2	1	2	3	2	3	2
D	2	2	2	2	3	2	3	2	2	2	2	2	2	2	1	3	1	2	3	2	3
	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Rolling 5 year average:																					
A	3.3	3.1	3.3	3.5	3.3	3.4	3.3	3.1	3.0	3.3	3.2	3.3	3.3	3.2	3.0	3.2	3.3	3.4	3.4	3.4	3.3
B	2.6	2.6	2.5	2.5	2.5	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.9	3.0	3.2	3.0	3.0	2.8	2.8	2.7
C	1.8	2.0	2.1	2.0	2.1	2.0	1.8	1.8	1.8	1.9	1.9	1.7	1.6	1.6	1.7	1.7	1.7	1.9	1.8	1.9	1.9
D	2.3	2.3	2.1	2.1	2.1	2.0	2.2	2.4	2.5	2.1	2.2	2.2	2.2	2.2	2.1	2.1	2.0	1.9	2.0	2.0	2.1

For this format of question, which still appears very occasionally in Paper 1 exams, the bias seems to be towards all answers are correct, and away from statements suggesting the first is incorrect.



Paper 1: Notes and points of interest

Topics tend to be placed within the exam paper in order, so topic 1 is at the start, and topic 22 would be at around question 29 to 31 (relevant to winter 2021, the last year of Section B with the choice between a combination of 3 statements), or 38 to 40 in exams 2022 and onwards. But about 10-20% of the questions are out of this order. This can be helpful when dealing with questions like those from Topic 10 Group 2, which are concerned with solubilities of salts and thermal decomposition. A harder question about unusual salts before a question about Group 17 (topic 11) can be solved by thinking of other Group 2 kinds of questions. And a harder question about unknown combustion gases after a question on Group 2 or 17 could be about Topic 12 Nitrogen and Sulfur.

Section B was last part of Paper 1 in winter 2021 (there was a bias against

A general principle used when assigning topic numbers to marks is to give the mark to the earliest topic that a student would be able to answer the question in if they were taught in sequential syllabus order. Exceptions to this general rule include names of organic molecules, especially primary, secondary and tertiary alcohols, which appears first in Topic 13 An Introduction to AS Level Organic Chemistry, but isn't really used until Topic 16 Hydroxy Compounds. So it is put in Topic 16 because that is the first time the students would normally really work with the idea. Similarly, named carbonyls would be in Topic 17 rather than Topic 13. Topic 18 has a larger representation because often a question that has a choice of answers e.g. propanol, propanal, propanone and propanoic acid, would be classed as Topic 18 even if the answer was topic 16. There is an argument for saying that a student ought to be able to find the correct answer, even if they have yet to learn enough to understand all of the options are also incorrect, though this has generally been avoided here.

Overall, very little changed in the last 15 years, though Topic 21 Organic Synthesis has become easier to separate into individual organic chemistry topics.

Also of note is Topic 19 Nitrogen Compounds rarely comes up.

Esters, especially their breakdown hydrolysis products, have a really large representation.

There is a pattern where odd topic numbers tend to be more represented until Topic 19, while even numbers were less represented until Topic 18 Carboxylic Acids and Derivatives.

A more detailed analysis might appear in the workbooks for one of the other exam papers (Paper 2, or Paper 3) in AS, but generally topics that are more common in one exam paper tend to be less common in another.

Exam Papers, their marks and their weighting towards the AS and A2 years and the A Level qualification:

Paper	% of AS or A2	% of A Level	Total (marks)	Time (min)	Time(s) / marks	mark as % AS or A2	mark as % ALL A-Level/ mark
1	31	15.5	40	75	112.5	0.78	0.39
2	46	23	60	75	75	0.77	0.38
3	23	11.5	30	120	240	0.77	0.38
4	77	38.5	100	120	72	0.77	0.39
5	23	11.5	30	75	150	0.77	0.38



Exam Questions

Topic Chem 1 Q# 1/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 For the element sulfur, which pair of ionisation energies has the largest difference between them?

- A third and fourth ionisation energies
- B fourth and fifth ionisation energies
- C fifth and sixth ionisation energies
- D sixth and seventh ionisation energies

Topic Chem 1 Q# 2/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Which statement about the electrons in a ground state carbon atom is correct?

- A Electrons are present in four different energy levels.
- B There are more electrons in p orbitals than there are in s orbitals.
- C The occupied orbital of highest energy is spherical.
- D The occupied orbital of lowest energy is spherical.

Topic Chem 3 Q# 3/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Which atom has the same number of electrons as the hydroxide ion, OH⁻?

- A F
- B Ne
- C Na
- D Mg

Topic Chem 1 Q# 4/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

- 1 Which atom has its outermost electron in an orbital of the shape shown, with principal quantum number 3?



- A sodium
- B chlorine
- C calcium
- D bromine

Topic Chem 1 Q# 5/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 What is the electronic configuration of Mg²⁺?

- A 1s² 2s² 2p⁶
- B 1s² 2s² 2p⁶ 3s²
- C 1s² 2s² 2p⁶ 3s² 3p²
- D 1s² 2s² 2p⁶ 3s² 3p⁶ 3d² 4s²

Topic Chem 1 Q# 6/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

- 1 The first ionisation energy of potassium, K, is 418 kJ mol⁻¹. The first ionisation energy of strontium, Sr, is 548 kJ mol⁻¹.

Which statement helps to explain why Sr has a greater first ionisation energy than K?

- A The charge on a Sr nucleus is greater than the charge on a K nucleus.
- B The outer electron in a Sr atom experiences greater shielding than the outer electron in a K atom.
- C The outer electron in a Sr atom experiences spin-pair repulsion.
- D The outer electron in a Sr atom is further from the nucleus than the outer electron in a K atom.

Topic Chem 1 Q# 7/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 The ion X²⁺ has the same electronic configuration as the atom Kr.

What is the electronic configuration of an atom of X?

- A [Ar] 4s² 3d¹⁰ 4p⁶
- B [Ar] 4s² 3d¹⁰ 4p⁶ 5s²
- C [Ar] 4s² 4d¹⁰ 4p⁶
- D [Ar] 4s² 4d¹⁰ 4p⁶ 5s²

Topic Chem 1 Q# 8/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Which of these elements has the highest fifth ionisation energy?

- A C
- B N
- C P
- D Si

Topic Chem Q# 9/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 Why is the first ionisation energy of oxygen less than that of nitrogen?

- A The nitrogen atom has its outer electron in a different subshell.
- B The nuclear charge on the oxygen atom is greater than that on the nitrogen atom.
- C The oxygen atom has a pair of electrons in one p orbital that repel one another.
- D There is more shielding in an oxygen atom.

Topic Chem 1 Q# 10/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 In which pair of species do both species have only one unpaired p electron?

- A Ar⁺ and C⁻
- B B and Ti⁺
- C F and Ga
- D Se⁻ and Si⁺

Topic Chem 1 Q# 11/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Where in the Periodic Table is the element that has an outer electron shell arrangement of 4s² 4p³?

	Group	Period
A	13	3
B	13	4
C	15	3
D	15	4



Topic Chem 1 Q# 12/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

- 1 The table shows the numbers of protons, neutrons and electrons in four different particles, W, X, Y, and Z.

	number of protons	number of neutrons	number of electrons
W	32	40	32
X	32	40	34
Y	32	42	32
Z	34	40	34

Which pair represents the atoms of two isotopes of the same element?

A W and Y B W and Z C X and Y D X and Z

Topic Chem 1 Q# 13/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 A single ^{32}P nucleus can be produced when a single ^{32}S nucleus joins with particle X. In the process a proton is emitted.

What is particle X?

- A a deuteron, $^2_1\text{H}^+$
B an electron
C a neutron
D a proton

Topic Chem 1 Q# 14/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

- 1 Which statement is correct?

- A Cl has a relative isotopic mass of 35.5.
B Cl_2 has a relative molecular mass of 70.
C ICl has a relative molecular mass of 162.4.
D NaCl has a relative molecular mass of 58.5.

Topic Chem 1 Q# 15/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 In which pair does each species have the same number of unpaired electrons?

- A Al and Cu^{2+}
B Ca and Cr^{3+}
C Ca and Ni^{2+}
D Fe^{3+} and O^{2-}

Topic Chem 1 Q# 16/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

- 1 What number of protons, neutrons and electrons are present in the ion $^{54}\text{Fe}^{3+}$?

	protons	neutrons	electrons
A	26	28	23
B	26	28	29
C	29	25	23
D	29	25	26

Topic Chem 1 Q# 17/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 The first ionisation energy of chlorine is greater than that of sulfur.

Which factors contribute to this?

- 1 Chlorine has more protons in its nucleus than sulfur does.
2 Chlorine has greater electron shielding than sulfur does.
3 The covalent bonds in chlorine molecules are stronger than those in sulfur molecules.

Topic Chem 1 Q# 18/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 A particular atom of germanium, Ge, has a nucleon number of 70.

Which statements about a $^{70}_{32}\text{Ge}$ atom are correct?

- 1 It has the same number of electrons as a $^{79}_{34}\text{Se}^{2+}$ ion.
2 It has the same number of neutrons as an atom of $^{68}_{30}\text{Zn}$.
3 It has half as many protons as an atom of $^{168}_{64}\text{Gd}$.

Topic Chem 1 Q# 19/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



31 An atom of calcium-48 can form a 2+ ion.

Which statements about this ion are correct?

- 1 It has 20 protons.
- 2 It has 28 neutrons.
- 3 It has 22 electrons.

Topic Chem 1 Q# 20/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 In which pairs do both species have the same number of unpaired electrons in p orbitals?

- 1 O and Cl^+
- 2 F^+ and Ga^-
- 3 N and Kr^{3+}

Topic Chem 1 Q# 21/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

33 Which statement about a 3p orbital is correct?

- A It can hold a maximum of 6 electrons.
- B It has the highest energy of the orbitals with principal quantum number 3.
- C It is at a higher energy level than a 3s orbital but has the same shape.
- D It is occupied by one electron in an isolated phosphorus atom.

Topic Chem 1 Q# 22/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Which ions contain one or more unpaired electrons?

- 1 Cu^{2+}
- 2 Mn^{3+}
- 3 V^{3+}

Topic Chem 1 Q# 23/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 The first four ionisation energies for element X are shown in the table.

ionisation energy value/ kJ mol^{-1}	1st	2nd	3rd	4th
	577	1980	2960	6190

Which ion of X is produced by removing an electron from a filled shell?

- A X^+ B X^{2+} C X^{3+} D X^{4+}

Topic Chem 1 Q# 24/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

10 Element X has a higher first ionisation energy than element Y.

Two students state what they believe is one factor that helps to explain this.

- student 1 "X has a higher first ionisation energy than Y because an atom of X has more protons in its nucleus than an atom of Y."
- student 2 "X has a higher first ionisation energy than Y because X has a smaller atomic radius than Y."

Only one of the two students is correct.

What could X and Y be?

	X	Y
A	carbon	boron
B	magnesium	aluminium
C	oxygen	nitrogen
D	oxygen	sulfur

Topic Chem 1 Q# 25/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 This question refers to isolated gaseous atoms.

In which atom are all electrons paired?

- A Ba B Br C S D Si

Topic Chem 1 Q# 26/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 Which molecule contains a nitrogen atom with sp hybridised orbitals?

- A $\text{CH}_3\text{CH}_2\text{NH}_2$ B HNO_3 C HCN D NH_3

Topic Chem 1 Q# 27/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 Drinking water may contain dissolved calcium hydrogencarbonate, $\text{Ca}(\text{HCO}_3)_2$.

How many electrons are present in a hydrogencarbonate anion?

- A 30 B 31 C 32 D 33



Topic Chem 1 Q# 28/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 The electronic configuration of the two outermost shells of an atom is $3s^2 3p^3 3d^4 4s^2$.

What is this atom?

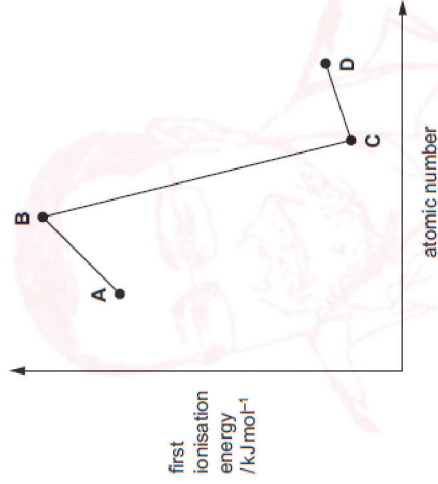
- A manganese
- B phosphorus
- C strontium
- D vanadium

Topic Chem 1 Q# 29/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 2//

- 2 The relative first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?



Topic Chem 1 Q# 30/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 Which property of an atom does **not** affect its first ionisation energy?

- A the atomic radius
- B the number of electron shells
- C the number of neutrons
- D the number of protons

Topic Chem 1 Q# 31/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 Why is the second ionisation energy of sodium larger than the second ionisation energy of magnesium?

- A The attraction between the nucleus and the outer electron is greater in Na^+ than in Mg^+ .
- B The nuclear charge of Na^+ is greater than that of Mg^+ .
- C The outer electron of Na^+ is more shielded than the outer electron of Mg^+ .
- D The outer electron of Na is in the same orbital as the outer electron of Mg.

Topic Chem 1 Q# 32/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

- 1 Which ion has the same electronic configuration as Cl^- ?

- A F^-
- B P^+
- C Sc^{3+}
- D Si^{4+}

Topic Chem 1 Q# 33/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5 The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give an isotope of a different element, ^{68}X , which can be used to detect tumours. This transformation of ^{68}Ge occurs when an electron enters the nucleus and changes a proton into a neutron.

Which statement about the composition of an atom of ^{68}X is correct?

- A It has 4 electrons in its outer p orbitals.
- B It has 13 electrons in its outer shell.
- C It has 37 neutrons.
- D Its proton number is 32.

Topic Chem 1 Q# 34/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 Sodium azide, NaN_3 is an explosive used to inflate airbags in cars when they crash. It consists of positive sodium ions and negative azide ions.

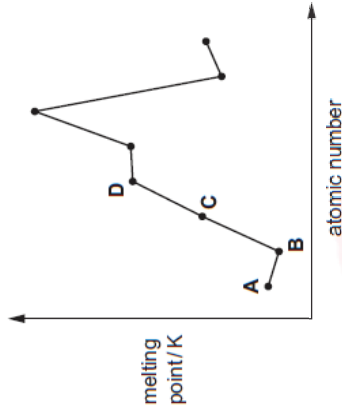
What are the numbers of electrons in the sodium ion and the azide ion?

	sodium ion	azide ion
A	10	20
B	10	22
C	12	20
D	12	22



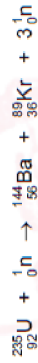
Topic Chem 1 Q# 35/ AS Chemistry/2016/m/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)
 13 The diagram shows the melting points of eight elements with consecutive atomic numbers.

Which element could be sodium?



Topic Chem 1 Q# 36/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 When nuclear reactions take place, the elements produced are different from the elements that reacted. Nuclear equations, such as the one below, are used to represent the changes that occur.



The nucleon (mass) number total is constant at 236 and the proton number total is constant at 92.

In another nuclear reaction, uranium-238 is reacted with deuterium atoms, ${}_1^2\text{H}$. An isotope of a new element, J, is formed as well as two neutrons.



What is isotope J?

A ${}_{238}^{238}\text{Np}$ B ${}_{238}^{238}\text{Pu}$ C ${}_{240}^{240}\text{Np}$ D ${}_{240}^{240}\text{Pu}$

Topic Chem 1 Q# 37/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 X is a particle with 18 electrons and 20 neutrons.

What could be the symbol of X?

- 1 ${}_{18}^{38}\text{Ar}$
- 2 ${}_{20}^{40}\text{Ca}^{2+}$
- 3 ${}_{19}^{39}\text{K}^+$

Topic Chem 1 Q# 38/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 Which species contains the smallest number of electrons?

A B^{3+} B Be^{2+} C H^- D He^+

Topic Chem 1 Q# 39/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 Which ion has both more electrons than protons and more protons than neutrons?
 $[\text{H} = {}_1^1\text{H}; \text{D} = {}_1^2\text{H}; \text{O} = {}_8^{16}\text{O}]$

A D^- B H_3O^+ C OD^- D OH^-

Topic Chem 1 Q# 40/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

2 For the element sulfur, which pair of ionisation energies has the largest difference between them?

- A third and fourth ionisation energies
- B fourth and fifth ionisation energies
- C fifth and sixth ionisation energies
- D sixth and seventh ionisation energies

Topic Chem 1 Q# 41/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Which statements about orbitals in a krypton atom are correct?

- 1 The 1s and 2s orbitals have the same energy as each other but different sizes.
- 2 The third energy level ($n=3$) has three subshells and nine orbitals.
- 3 The 3d subshell has five orbitals that have the same energy as each other in an isolated atom.

Topic Chem 1 Q# 42/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 The table gives the successive ionisation energies for an element X.

	1st	2nd	3rd	4th	5th	6th
ionisation energy/ kJ mol^{-1}	950	1800	2700	4800	6000	12300

What could be the formula of a chloride of X?

A XCl B XCl_2 C XCl_3 D XCl_4

Topic Chem 1 Q# 43/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



31 Use of the Data Booklet is relevant to this question.

The isotope ^{99}Tc is radioactive and has been found in lobsters and seaweed adjacent to nuclear fuel reprocessing plants.

Which statements are correct about an atom of ^{99}Tc ?

- 1 It has 13 more neutrons than protons.
- 2 It has 43 protons.
- 3 It has 99 nucleons.

Topic Chem 1 Q# 44/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Use of the Data Booklet is relevant to this question.

Which ions contain one or more unpaired electrons?

- 1 Cu^{2+}
- 2 Mn^{3+}
- 3 V^{3+}

Topic Chem 1 Q# 45/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 Use of the Data Booklet is relevant to this question.

Atoms of element X have six unpaired electrons.

What could be element X?

- A carbon
- B chromium
- C iron
- D selenium

Topic Chem 1 Q# 46/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 Use of the Data Booklet is relevant to this question.

In which set do all species contain the same number of electrons?

- A Co^{2+} , Co^{3+} , Co^{4+}
- B F^- , Br^- , Cl^-
- C Na^+ , Mg^{2+} , Al^{3+}
- D K_2SO_4 , K_2SeO_4 , K_2TeO_4

Topic Chem 1 Q# 47/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 X is a particle with 18 electrons and 20 neutrons.

What could be the symbol of X?

- 1 $^{38}_{18}\text{Ar}$
- 2 $^{40}_{20}\text{Ca}^{2+}$
- 3 $^{39}_{19}\text{K}^+$

Topic Chem 1 Q# 48/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 In which species are the numbers of protons, neutrons and electrons all different?

- A $^{27}_{13}\text{Al}$
- B $^{35}_{17}\text{Cl}^-$
- C $^{32}_{16}\text{S}^{2-}$
- D $^{39}_{19}\text{K}^+$

Topic Chem 1 Q# 49/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Use of the Data Booklet is relevant to this question.

Free-radicals play an important part in reactions involving the destruction of the ozone layer and the substitution of alkanes by chlorine.

Some free-radicals contain two unpaired electrons. Such species are called diradicals.

Which species are diradicals?

- 1 O
- 2 Cl
- 3 CH_3

Topic Chem 1 Q# 50/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

9 John Dalton's atomic theory, published in 1808, contained four predictions about atoms.

Which of his predictions is still considered to be correct?

- A All atoms are very small in size.
- B All the atoms of a particular element have the same mass.
- C All the atoms of one element are different in mass from all the atoms of other elements.
- D No atom can be split into simpler parts.



Topic Chem 1 Q# 51/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Use of the Data Booklet is relevant to this question.

The isotope ^{99}Tc is radioactive and has been found in lobsters and seaweed adjacent to nuclear fuel reprocessing plants.

Which statements are correct about an atom of ^{99}Tc ?

- It has 13 more neutrons than protons.
- It has 43 protons.
- It has 99 nucleons.

Topic Chem 1 Q# 52/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

2 Use of the Data Booklet is relevant to this question.

The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give a gallium isotope, ^{68}Ga , which can be used to detect tumours. This transformation of ^{68}Ge occurs when an electron enters the nucleus, changing a proton into a neutron.

Which statement about the composition of an atom of the ^{68}Ge isotope is correct?

- It has 4 electrons in its outer p subshell.
- It has 13 electrons in its outer shell.
- It has 37 neutrons.
- Its proton number is 32.

Topic Chem 1 Q# 53/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

- A chloride ion has one more occupied electron shell than a sodium ion.
- Chlorine has a higher proton number than sodium.
- Ionic radius increases regularly across the third period.
- Sodium is a metal, chlorine is a non-metal.

Topic Chem 1 Q# 54/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 The value of the second ionisation energy of calcium is 1150 kJ mol^{-1} .

Which equation correctly represents this statement?

- $\text{Ca}(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{e}^-$; $\Delta H^\ominus = +1150 \text{ kJ mol}^{-1}$
- $\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$; $\Delta H^\ominus = +1150 \text{ kJ mol}^{-1}$
- $\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$; $\Delta H^\ominus = -1150 \text{ kJ mol}^{-1}$
- $\text{Ca}(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{e}^-$; $\Delta H^\ominus = -1150 \text{ kJ mol}^{-1}$



Topic Chem 1 Q# 55/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Use of the Data Booklet is relevant to this question.

In which pairs do both species have the same number of unpaired p electrons?

- O and Cl^+
- F^+ and Ga^-
- P and Ne^+

Topic Chem 1 Q# 56/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 Which element has an equal number of electron pairs and of unpaired electrons within orbitals of principal quantum number 2?

- beryllium
- carbon
- nitrogen
- oxygen

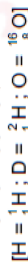
Topic Chem 1 Q# 57/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 Which equation represents the second ionisation energy of an element X?

- $\text{X}(\text{g}) \rightarrow \text{X}^{2+}(\text{g}) + 2\text{e}^-$
- $\text{X}^+(\text{g}) \rightarrow \text{X}^{2+}(\text{g}) + \text{e}^-$
- $\text{X}(\text{g}) + 2\text{e}^- \rightarrow \text{X}^{2-}(\text{g})$
- $\text{X}^-(\text{g}) + \text{e}^- \rightarrow \text{X}^{2-}(\text{g})$

Topic Chem 1 Q# 58/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

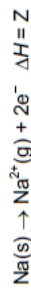
6 Which ion has more electrons than protons and more protons than neutrons?



- D^-
- H_3O^+
- OD^-
- OH^-

Topic Chem 1 Q# 59/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 Equations involving four enthalpy changes are shown.



What is the second ionisation energy of sodium?

- 2W
- X – W
- Y – W
- Z – Y



- 2 A simple ion X^+ contains eight protons.

What is the electronic configuration of X^+ ?

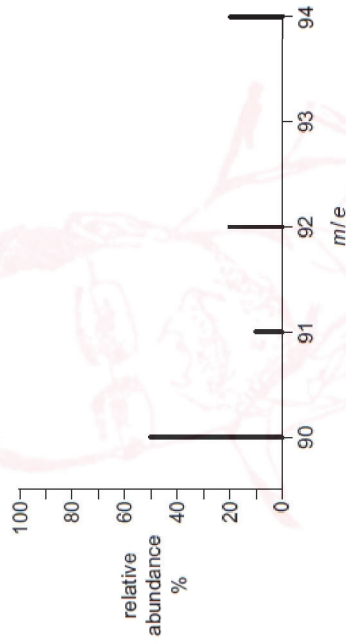
- A $1s^2 2s^1 2p^6$
 B $1s^2 2s^2 2p^3$
 C $1s^2 2s^2 2p^5$
 D $1s^2 2s^2 2p^7$

- 1 Use of the Data Booklet is relevant to this question.

What could be the proton number of an element that has three unpaired electrons in each of its atoms?

- A 5 B 13 C 15 D 21

- 1 An element X consists of four isotopes. The mass spectrum of X is shown in the diagram.

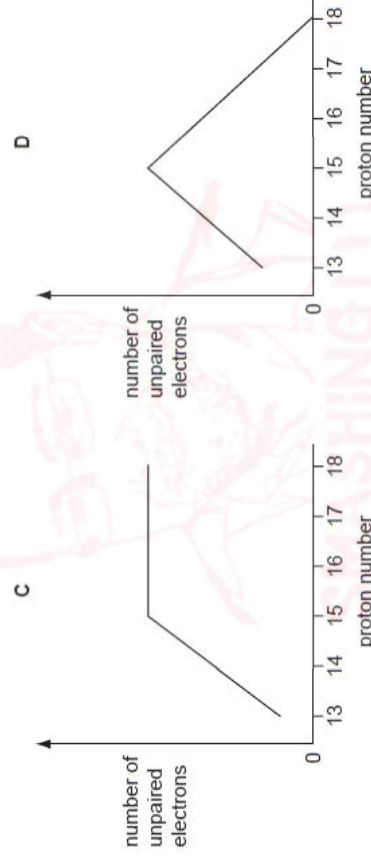
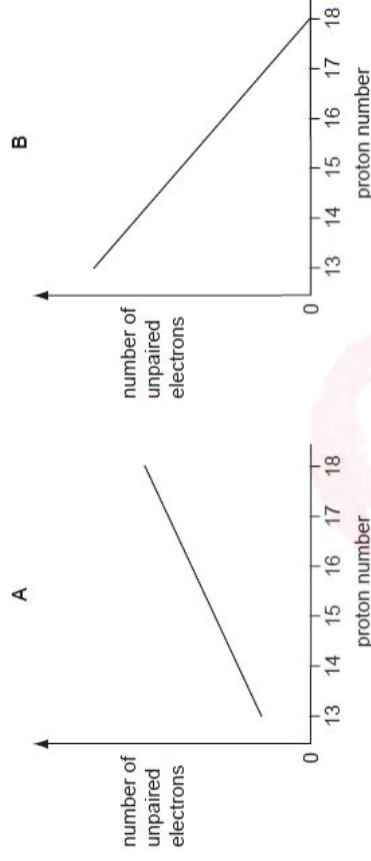


What is the relative atomic mass of X?

- A 91.00 B 91.30 C 91.75 D 92.00

- 4 Use of the Data Booklet is relevant to this question.

Which graph represents the number of unpaired p orbital electrons for atoms with proton numbers 13 to 18?



The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 On a scale in which the mass of a ^{12}C atom is 12 the relative molecular mass of a particular sample of chlorine is 72.

Which properties of the atoms in this sample are always the same?

- 1 radius
 2 nucleon number
 3 isotopic mass



Topic Chem 1 Q# 65/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

- 3 The first seven ionisation energies of an element between lithium and neon in the Periodic Table are as follows.

1310 3390 5320 7450 11000 13300 71000 kJ mol⁻¹

What is the outer electronic configuration of the element?

A 2s² B 2s²2p¹ C 2s²2p⁴ D 2s²2p⁶

Topic Chem 1 Q# 66/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

- 12 Which group of particles is in order of increasing size?

A N O F
B N³⁻ O²⁻ F⁻
C Na⁺ Mg²⁺ Al³⁺
D Na⁺ Ne F⁻

Topic Chem 2 Q# 67/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 Mixture R consists of one mole of C₃H₈ and one mole of C₄H₈.

What is the minimum number of moles of oxygen molecules needed for complete combustion of mixture R?

A 6.5 B 7 C 10 D 20

Topic Chem 2 Q# 68/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org .o)

- 1 Which sample contains the same number of the named species as the number of molecules in 35.5 g of chlorine?

A atoms in 16 g of sulfur
B atoms in 23 g of sodium
C ions in 74.5 g of potassium chloride
D molecules in 88 g of carbon dioxide

Topic Chem 2 Q# 69/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org .o)

- 4 A student reacts 1 mol of copper with concentrated nitric acid to produce 1 mol of copper(II) nitrate, 2 mol of water and substance X. No other product is formed.

Substance X does not contain copper or hydrogen.

What could be substance X?

A N₂ B N₂O C NO D NO₂

Topic Chem 2 Q# 70/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 A 3.0 g sample of Na₂CO₃ powder is stirred into 50 cm³ of 1.0 mol dm⁻³ HCl. The volume of CO₂ produced is 600 cm³.



[M_r: Na₂CO₃, 106.0]

Which volume of CO₂ is produced if 1.0 g of Na₂CO₃ powder is stirred into 50 cm³ of 1.0 mol dm⁻³ HCl under the same conditions?

A 600 cm³ B 452 cm³ C 226 cm³ D 200 cm³

Topic Chem 2 Q# 71/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

- 3 Compound X contains the elements C, H and O only.

2.00 g of X produces 4.00 g of carbon dioxide and 1.63 g of water when completely combusted.

What is the empirical formula of X?

A CHO₂ B C₂H₂O C C₂H₄O D CH₂O₂

Topic Chem 2 Q# 72/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

- 14 Which statement about atoms and molecules is correct?

A The molecular formula of a compound is the simplest whole number ratio of atoms of each element in the compound.
B One mole of any substance contains 6×10^{23} atoms.
C The relative atomic mass of an element is the ratio of the average mass of one atom of the element to the mass of an atom of carbon-12.
D The relative formula mass of a compound is the sum of the individual atomic masses of all the atoms in the formula.

Topic Chem 2 Q# 73/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 2.0 g of ammonium nitrate, NH₄NO₃, decomposes to give 0.90 g of water and a single gas.

What is the identity of the gas?

A NO B NO₂ C N₂O D N₂

Topic Chem 2 Q# 74/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 4//www.SmashingScience.org .o)

- 4 Originally, chemists thought indium oxide had the formula InO. By experiment they showed that 4.8 g of indium combined with 1.0 g of oxygen to produce 5.8 g of indium oxide. The A_r of oxygen was known to be 16.

Which value for the A_r of indium is calculated using these data?

A 38 B 77 C 115 D 154

Topic Chem 2 Q# 75/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

- 3 Substance Q is a hydrocarbon. When 1.00 g of Q is completely burned, 3.22 g of carbon dioxide is produced.

What could be the identity of Q?

A cyclohexene
B cyclopentane
C ethene
D pentane

Topic Chem 1 Q# 65/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

- 3 The first seven ionisation energies of an element between lithium and neon in the Periodic Table are as follows.

1310 3390 5320 7450 11000 13300 71000 kJ mol⁻¹

What is the outer electronic configuration of the element?

A 2s² B 2s²2p¹ C 2s²2p⁴ D 2s²2p⁶

Topic Chem 1 Q# 66/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

- 12 Which group of particles is in order of increasing size?

A N O F
B N³⁻ O²⁻ F⁻
C Na⁺ Mg²⁺ Al³⁺
D Na⁺ Ne F⁻

Topic Chem 2 Q# 67/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 Mixture R consists of one mole of C₃H₈ and one mole of C₄H₈.

What is the minimum number of moles of oxygen molecules needed for complete combustion of mixture R?

A 6.5 B 7 C 10 D 20

Topic Chem 2 Q# 68/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org .o)

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Topic Chem 2 Q# 69/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org .o)

- 4 A student reacts 1 mol of copper with concentrated nitric acid to produce 1 mol of copper(II) nitrate, 2 mol of water and substance X. No other product is formed.

Substance X does not contain copper or hydrogen.

What could be substance X?

A N₂ B N₂O C NO D NO₂

Topic Chem 2 Q# 70/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 A 3.0 g sample of Na₂CO₃ powder is stirred into 50 cm³ of 1.0 mol dm⁻³ HCl. The volume of CO₂ produced is 600 cm³.



[M_r: Na₂CO₃, 106.0]

Which volume of CO₂ is produced if 1.0 g of Na₂CO₃ powder is stirred into 50 cm³ of 1.0 mol dm⁻³ HCl under the same conditions?

A 600 cm³ B 452 cm³ C 226 cm³ D 200 cm³



Topic Chem 2 Q# 76/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Strontium metal can be extracted from strontium oxide, SrO, by reduction with aluminium. One of the possible reactions is shown.



What is the maximum mass of strontium metal that can be produced from the reduction of 100 g of strontium oxide using this reaction?

- A 41.3 g B 42.3 g C 84.6 g D 169.2 g

Topic Chem 2 Q# 77/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

- 13 6.90 g of an ammonium salt is heated with an excess of aqueous sodium hydroxide. The volume of ammonia produced, measured under room conditions, is 2.51 dm³.

Which ammonium salt is used?

- A ammonium carbonate ($M_r = 96.0$)
B ammonium chloride ($M_r = 53.5$)
C ammonium nitrate ($M_r = 80.0$)
D ammonium sulfate ($M_r = 132.1$)

Topic Chem 2 Q# 78/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

- 11 A sample of solid ammonium chloride decomposes on heating.



A total of 2.4×10^{21} molecules of gas is formed.

How many hydrogen atoms are present in the gaseous products?

- A 1.2×10^{21} B 2.4×10^{21} C 4.8×10^{21} D 9.6×10^{21}

Topic Chem 2 Q# 79/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 Sodium azide, NaN₃, decomposes as shown.



Which volume of nitrogen, measured at room temperature and pressure, will be produced by the decomposition of 150 g of sodium azide?

- A 166 dm³ B 83 dm³ C 55 dm³ D 37 dm³

Topic Chem 2 Q# 80/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Diamond is a pure form of carbon. The mass of a diamond can be measured in carats. One carat is 0.200 g of carbon.

Which expression gives the number of carats that contain 6.02×10^{23} carbon atoms?

- A 0.200×12.0
B $\frac{0.200}{12.0}$
C $\frac{12.0}{0.200}$
D $\frac{0.200}{6.02 \times 10^{23}} \times 12.0$

Topic Chem 2 Q# 81/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 A washing powder contains sodium hydrogencarbonate, NaHCO₃, as one of the ingredients.

In a titration, a solution containing 1.00 g of this washing powder requires 7.15 cm³ of 0.100 mol dm⁻³ sulfuric acid for complete reaction. The sodium hydrogencarbonate is the only ingredient that reacts with the acid.

What is the percentage by mass of sodium hydrogencarbonate in the washing powder?

- A 3.0% B 6.0% C 12.0% D 24.0%

Topic Chem 2 Q# 82/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 1.15 g of a metallic element needs 300 cm³ of oxygen for complete reaction, under room conditions, to form an oxide which contains O²⁻ ions.

What could be the identity of this metallic element?

- A calcium
B magnesium
C potassium
D sodium

Topic Chem 2 Q# 83/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

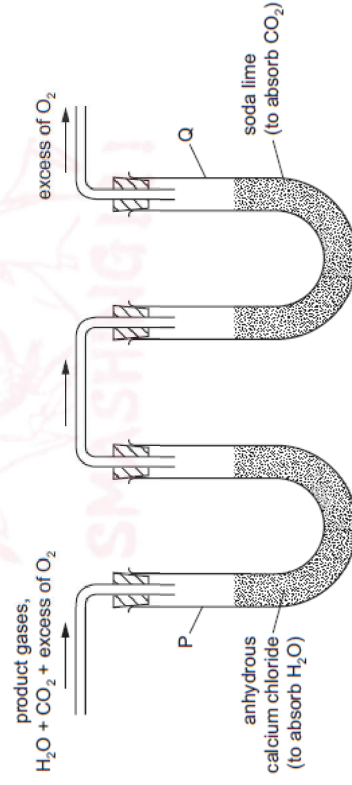
- 2 A 3.7 g sample of copper(II) carbonate is added to 25 cm³ of 2.0 mol dm⁻³ hydrochloric acid.

Which volume of gas is produced under room conditions?

- A 0.60 dm³ B 0.72 dm³ C 1.20 dm³ D 2.40 dm³

Topic Chem 2 Q# 84/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 A sample of the hydrocarbon C₈H₁₂ is completely burned in dry oxygen and the product gases are collected as shown.



The increases in mass of the collecting vessels P and Q are M_P and M_Q , respectively.

What is the ratio M_P/M_Q ?

- A 0.41 B 0.82 C 1.2 D 2.4

Topic Chem 2 Q# 76/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Strontium metal can be extracted from strontium oxide, SrO, by reduction with aluminium. One of the possible reactions is shown.



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Which ammonium salt is used?

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C ammonium nitrate ($M_r = 80.0$)
D ammonium sulfate ($M_r = 132.1$)

Topic Chem 2 Q# 78/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

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A total of 2.4×10^{21} molecules of gas is formed.

How many hydrogen atoms are present in the gaseous products?

- A 1.2×10^{21} B 2.4×10^{21} C 4.8×10^{21} D 9.6×10^{21}

Topic Chem 2 Q# 79/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

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Which volume of nitrogen, measured at room temperature and pressure, will be produced by the decomposition of 150 g of sodium azide?

- A 166 dm³ B 83 dm³ C 55 dm³ D 37 dm³

Topic Chem 2 Q# 80/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

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Which expression gives the number of carats that contain 6.02×10^{23} carbon atoms?

- A 0.200×12.0
B $\frac{0.200}{12.0}$
C $\frac{12.0}{0.200}$
D $\frac{0.200}{6.02 \times 10^{23}} \times 12.0$



Topic Chem 2 Q# 85/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Which fuel would produce the largest mass of CO₂ when 10 kg of the fuel undergo complete combustion?

- A biodiesel, C₁₇H₃₄O₂
B ethanol, C₂H₆O
C octane, C₈H₁₈
D propane, C₃H₈

Topic Chem 2 Q# 86/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5 Which mass of solid residue is obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

- A 0.70 g B 1.00 g C 1.40 g D 2.25 g

Topic Chem 2 Q# 87/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Compound Q contains 40% carbon by mass.

What could Q be?

- 1 glucose, C₆H₁₂O₆
2 starch, (C₆H₁₀O₅)_n
3 sucrose, C₁₂H₂₂O₁₁

Topic Chem 2 Q# 88/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 32//

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 A student makes sodium chloride by reacting together 0.025 mol of sodium carbonate with an excess of 0.2 mol dm⁻³ hydrochloric acid.



Which statements about the quantities of substance are correct?

- 1 600 cm³ of carbon dioxide are produced at room temperature and pressure.
2 250 cm³ of the hydrochloric acid are needed to exactly neutralise the sodium carbonate.
3 1.46 g of sodium chloride are produced.

Topic Chem 2 Q# 89/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 16//

- 16 Which fertiliser contains the greatest percentage of nitrogen by mass?

- A ammonium nitrate, NH₄NO₃
B ammonium sulfate, (NH₄)₂SO₄
C diammonium hydrogen phosphate, (NH₄)₂HPO₄
D urea, CO(NH₂)₂

Topic Chem 2 Q# 90/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 1//

- 1 Which formula represents the empirical formula of a compound?

- A C₂H₄O B C₂H₄O₂ C C₆H₁₂ D H₂O₂

Topic Chem 2 Q# 91/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 A sports medal has a total surface area of 150 cm². It was evenly coated with silver by electrolysis. Its mass increased by 0.2116 g.

How many atoms of silver were deposited per cm² on the surface of the medal?

- A 8.0 × 10¹⁸ B 1.8 × 10¹⁹ C 8.7 × 10²⁰ D 1.2 × 10²¹

Topic Chem 2 Q# 92/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 The mass spectrum of a sample of lithium shows that it contains two isotopes, ⁶Li and ⁷Li.

The isotopic abundances are shown in the table.

isotope	isotopic abundance
⁶ Li	7.42%
⁷ Li	92.58%

What is the relative atomic mass of this sample of lithium, given to three significant figures?

- A 6.07 B 6.50 C 6.90 D 6.93

Topic Chem 2 Q# 93/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Compounds J and K each contain 40% carbon by mass.

What could J and K be?

	J	K
A	a hexose, C ₆ H ₁₂ O ₆	starch, (C ₆ H ₁₀ O ₅) _n
B	a pentose, C ₅ H ₁₀ O ₅	a hexose, C ₆ H ₁₂ O ₆
C	a pentose, C ₅ H ₁₀ O ₅	sucrose, C ₁₂ H ₂₂ O ₁₁
D	starch, (C ₆ H ₁₀ O ₅) _n	sucrose, C ₁₂ H ₂₂ O ₁₁

Topic Chem 2 Q# 85/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Which fuel would produce the largest mass of CO₂ when 10 kg of the fuel undergo complete combustion?

- A biodiesel, C₁₇H₃₄O₂
B ethanol, C₂H₆O
C octane, C₈H₁₈
D propane, C₃H₈

Topic Chem 2 Q# 86/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5 Which mass of solid residue is obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

- A 0.70 g B 1.00 g C 1.40 g D 2.25 g

Topic Chem 2 Q# 87/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Compound Q contains 40% carbon by mass.

What could Q be?

- 1 glucose, C₆H₁₂O₆
2 starch, (C₆H₁₀O₅)_n
3 sucrose, C₁₂H₂₂O₁₁

Topic Chem 2 Q# 88/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 32//

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 A student makes sodium chloride by reacting together 0.025 mol of sodium carbonate with an excess of 0.2 mol dm⁻³ hydrochloric acid.



Which statements about the quantities of substance are correct?

- 1 600 cm³ of carbon dioxide are produced at room temperature and pressure.
2 250 cm³ of the hydrochloric acid are needed to exactly neutralise the sodium carbonate.
3 1.46 g of sodium chloride are produced.



Topic Chem 2 Q# 94/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 1.15 g of a metallic element needs 300 cm³ of oxygen for complete reaction, at 298 K and 1 atm pressure, to form an oxide which contains O²⁻ ions.

What could be the identity of this metallic element?

- A calcium
B magnesium
C potassium
D sodium

Topic Chem 2 Q# 95/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Tetraethyl lead, Pb(C₂H₅)₄, has been used as a petrol additive.

What is the percentage by mass of carbon in tetraethyl lead?

- A 10.2 B 14.9 C 29.7 D 32.0

Topic Chem 2 Q# 96/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

- 3 Use of the Data Booklet is relevant to this question.

The compound S₂O₇ is hydrolysed by water to produce sulfuric acid and oxygen only.

Which volume of oxygen, measured at room temperature and pressure, is evolved when 0.352 g of S₂O₇ is hydrolysed?

- A 12 cm³ B 24 cm³ C 48 cm³ D 96 cm³

Topic Chem 2 Q# 97/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6 Aluminium carbide, Al₄C₃, reacts readily with aqueous sodium hydroxide. The two products of the reaction are NaAlO₂ and a hydrocarbon. Water molecules are also involved as reactants.

What is the formula of the hydrocarbon?

- A CH₄ B C₂H₆ C C₃H₈ D C₆H₁₂

Topic Chem 2 Q# 98/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 Use of the Data Booklet is relevant to this question.

The approximate percentage composition of the atmosphere on four different planets is given in the table below.

The density of a gas may be defined as the mass of 1 dm³ of the gas measured at s.t.p.

Which mixture of gases has the greatest density?

	planet	major gases/ % by number of molecules
A	Jupiter	H ₂ 89.8, He 10.2
B	Neptune	H ₂ 80.0, He 19.0, CH ₄ 1.0
C	Saturn	H ₂ 96.3, He 3.25, CH ₄ 0.45
D	Uranus	H ₂ 82.5, He 15.2, CH ₄ 2.3

Topic Chem 2 Q# 99/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 Use of the Data Booklet is relevant to this question.

Which sodium compound contains 74.2 % by mass of sodium?

- A sodium carbonate
B sodium chloride
C sodium hydroxide
D sodium oxide

Topic Chem 2 Q# 100/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Use of the Data Booklet is relevant to this question.

1.15 g of a metallic element reacts with 300 cm³ of oxygen at 298 K and 1 atm pressure, to form an oxide which contains O²⁻ ions.

What could be the identity of the metal?

- A calcium
B magnesium
C potassium
D sodium

Topic Chem 2 Q# 101/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 Use of the Data Booklet is relevant to this question.

The reaction between aluminium powder and anhydrous barium nitrate is used as the propellant in some fireworks. The metal oxides and nitrogen are the only products.

Which volume of nitrogen, measured under room conditions, is produced when 0.783 g of anhydrous barium nitrate reacts with an excess of aluminium?

- A 46.8 cm³ B 72.0 cm³ C 93.6 cm³ D 144 cm³

Topic Chem 2 Q# 102/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

- The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



33 Use of the Data Booklet is relevant to this question.

Zinc reacts with hydrochloric acid according to the following equation.



Which statements are correct?

[All volumes are measured at room conditions.]

- 1 A 3.27 g sample of zinc reacts with an excess of hydrochloric acid to give 0.050 mol of zinc chloride.
- 2 A 6.54 g sample of zinc reacts completely with exactly 100 cm³ of 1.00 mol dm⁻³ hydrochloric acid.
- 3 A 13.08 g sample of zinc reacts with an excess of hydrochloric acid to give 9.60 dm³ of hydrogen.

Topic Chem 2 Q# 103/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 5//www.SmashingScience.org .o)

5 Use of the Data Booklet is relevant to this question.

Nickel makes up 20 % of the total mass of a coin. The coin has a mass of 10.0g.

How many nickel atoms are in the coin?

- A 2.05×10^{22} B 4.30×10^{22} C 1.03×10^{23} D 1.20×10^{24}

Topic Chem 2 Q# 104/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 12//www.SmashingScience.org .o)

12 Camphor is a white solid which was used to make the early plastic celluloid. Camphor contains the same percentage by mass of hydrogen and oxygen.

What is the molecular formula of camphor?

- A C₁₀H₁₆O₆ B C₁₀H₁₆O C C₁₀H₁₆O D C₁₀H₁₀O₂

Topic Chem 2 Q# 105/ AS Chemistry/2010/s/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

9 Which mass of gas would occupy a volume of 3 dm³ at 25 °C and 1 atmosphere pressure?

[1 mol of gas occupies 24 dm³ at 25 °C and 1 atmosphere pressure.]

- A 3.2g O₂ gas
B 5.6g N₂ gas
C 8.0g SO₂ gas
D 11.0g CO₂ gas

Topic Chem 2 Q# 106/ AS Chemistry/2010/s/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org .o)

8 Use of the Data Booklet is relevant to this question.

2.920 g of a Group II metal, X, reacts with an excess of chlorine to form 5.287 g of a compound with formula XCℓ₂.

What is metal X?

- A barium
B calcium
C magnesium
D strontium

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Page 41 of 500



Topic Chem 2 Q# 107/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 2//www.SmashingScience.org .o)

2 0.200 mol of a hydrocarbon undergo complete combustion to give 35.2 g of carbon dioxide and 14.4 g of water as the only products.

What is the molecular formula of the hydrocarbon?

- A C₂H₄ B C₂H₆ C C₄H₄ D C₄H₈

Topic Chem 2 Q# 108/ AS Chemistry/2009/s/TZ.1/Paper.1/Exam Q# 2//www.SmashingScience.org .o)

2 A household bleach contains sodium chlorate(I), NaClO, as its active ingredient. The concentration of NaClO in the bleach can be determined by reacting a known amount with aqueous hydrogen peroxide, H₂O₂.



When 25.0 cm³ of bleach is treated with an excess of aqueous H₂O₂, 0.0350 mol of oxygen gas is given off.

What is the concentration of NaClO in the bleach?

- A 8.75×10^{-4} mol dm⁻³
B 0.700 mol dm⁻³
C 0.875 mol dm⁻³
D 1.40 mol dm⁻³

Topic Chem 2 Q# 109/ AS Chemistry/2009/s/TZ.1/Paper.1/Exam Q# 1//www.SmashingScience.org .o)

1 Use of the Data Booklet is relevant to this question.

In leaded petrol there is an additive composed of lead, carbon and hydrogen only. This compound contains 29.7 % carbon and 6.19 % hydrogen by mass.

What is the value of x in the empirical formula PbC₈H_x?

- A 5 B 6 C 16 D 20

Topic Chem 3 Q# 110/ AS Chemistry/2022/w/TZ.1/Paper.1/Exam Q# 6//www.SmashingScience.org .o)

6 Which molecule has an equal number of bonding electrons and lone-pair electrons?

- A BH₃ B CO₂ C F₂O D SO₂

Topic Chem 3 Q# 111/ AS Chemistry/2022/w/TZ.1/Paper.1/Exam Q# 5//www.SmashingScience.org .o)

5 How many σ bonds are present in one H—C≡C—C(CH₃)=CH(CH₃) molecule?

- A 5 B 11 C 13 D 16

Topic Chem 3 Q# 112/ AS Chemistry/2022/s/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org .o)

8 For which pair is the boiling point of the first compound higher than the boiling point of the second compound?

- A CH₃CH₂OH and CH₃CH₂SH
B CH₃CO₂CH₃ and CH₃CH₂CO₂H
C CH₃OCH₃ and CH₃CH₂OH
D CH₃CH₂CHO and CH₃CH₂CO₂H

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Page 42 of 500



Topic Chem 3 Q# 113/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 7/ www.SmashingScience.org .o)
 7 Elements X, Y and Z are all in the first two periods of the Periodic Table.

Their Pauling electronegativity values, E_N , are shown.

element	E_N
X	1.0
Y	2.1
Z	4.0

Substances exist with formulae XZ, YZ and Z₂.

Which row puts these substances in order of increasing melting point?

	lowest melting point	→	highest melting point
A	XZ		Z ₂
B	XZ		YZ
C	Z ₂		XZ
D	Z ₂		YZ

Topic Chem 3 Q# 114/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 6/ www.SmashingScience.org .o)
 6 The boiling points of some hydrogen halides are shown.

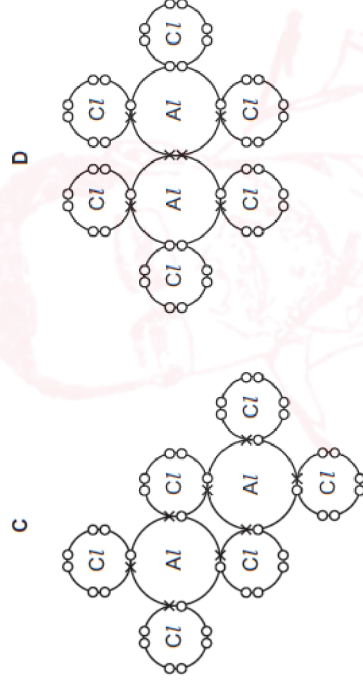
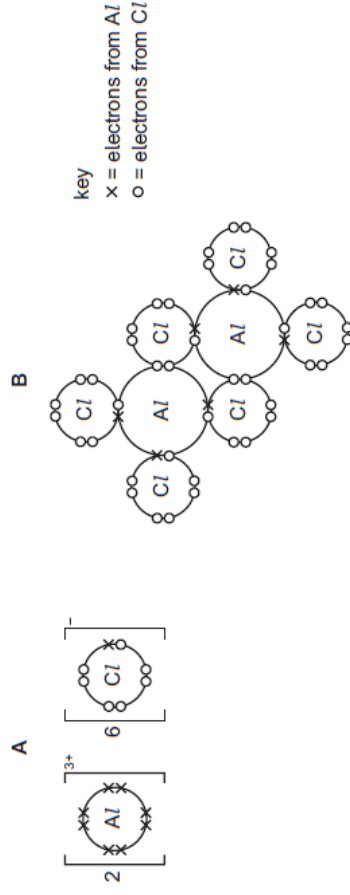
hydrogen halide	boiling point/K
H-Cl	188
H-Br	206
H-I	238

What is the explanation for the trend in boiling point for the hydrogen halides from HCl to HI?

- A The bond energies of the hydrogen halides increase from HCl to HI.
- B There is an increase in the strength of the intermolecular forces of attraction from HCl to HI.
- C The intermolecular hydrogen bonds become stronger from HCl to HI.
- D There is an increase in the bond polarity from HCl to HI.

Topic Chem 3 Q# 115/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 5/ www.SmashingScience.org .o)

5 Which dot-and-cross diagram is correct for Al₂Cl₆?



Topic Chem 3 Q# 116/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 4/ www.SmashingScience.org .o)
 4 For which molecule is the dipole moment zero?

- A CH₃Cl
- B CH₂Cl₂
- C CHCl₃
- D CCl₄

Topic Chem 3 Q# 113/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 7/ www.SmashingScience.org .o)
 7 Elements X, Y and Z are all in the first two periods of the Periodic Table.

Their Pauling electronegativity values, E_N , are shown.

element	E_N
X	1.0
Y	2.1
Z	4.0

Substances exist with formulae XZ, YZ and Z₂.

Which row puts these substances in order of increasing melting point?

	lowest melting point	→	highest melting point
A	XZ		Z ₂
B	XZ		YZ
C	Z ₂		XZ
D	Z ₂		YZ

Topic Chem 3 Q# 114/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 6/ www.SmashingScience.org .o)
 6 The boiling points of some hydrogen halides are shown.

hydrogen halide	boiling point/K
H-Cl	188
H-Br	206
H-I	238

What is the explanation for the trend in boiling point for the hydrogen halides from HCl to HI?

- A The bond energies of the hydrogen halides increase from HCl to HI.
- B There is an increase in the strength of the intermolecular forces of attraction from HCl to HI.
- C The intermolecular hydrogen bonds become stronger from HCl to HI.
- D There is an increase in the bond polarity from HCl to HI.



- 25 When ammonia, NH_3 , is dissolved in water, a small concentration of ammonium ions, NH_4^+ , is formed.

Which row is correct?

	number of electrons in one ammonium ion	change of the H—N—H angle from ammonia to the ammonium ion
A	8	decreases
B	8	increases
C	10	decreases
D	10	increases

- 5 Which type of interaction exists between water molecules and metal cations in aqueous solution?

- A dipole-dipole interactions
 B hydrogen bonds
 C ion-dipole interactions
 D ionic bonds

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 Which elements form a chloride in which both covalent bonding and coordinate (dative covalent) bonding are present?

- 1 Al
 2 Si
 3 Mg

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Which molecules contain at least one unpaired electron?

- 1 NO
 2 NO_2
 3 NH_3

- 18 Which row is correct?

	shape		bonds present	
	ammonia molecule	ammonium ion	ammonia molecule	ammonium ion
A	pyramidal	regular tetrahedral	σ	σ
B	pyramidal	regular tetrahedral	σ	π
C	regular tetrahedral	pyramidal	σ	σ
D	regular tetrahedral	pyramidal	π	σ

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Which molecules contain at least one bond angle of 120° ?

- 1 C_2H_4
 2 PF_5
 3 NCl_3

- 3 Phosphorus forms two chlorides. Phosphorus(III) chloride, PCl_3 , is a covalent liquid.

Phosphorus(V) chloride is an ionic solid. One of the ions present is $[\text{PCl}_4]^+$.

What is the shape of the PCl_3 molecule and the $[\text{PCl}_4]^+$ ion?

	PCl_3	$[\text{PCl}_4]^+$
A	pyramidal	square planar
B	pyramidal	tetrahedral
C	tetrahedral	square planar
D	trigonal planar	tetrahedral

- 5 In which substance are the only intermolecular forces temporary dipole-induced dipole attractions?

- A hydrogen chloride
 B methanol
 C octane
 D water



Topic Chem 3 Q# 125/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Which species can accept a lone pair of electrons to form a coordinate (dative covalent) bond?

- BF₃
- H⁺
- CH₃⁺

Topic Chem 3 Q# 126/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 Copper has a high melting point.

What is the reason for the high melting point of copper?

- strong attractive forces between copper atoms only
 - strong attractive forces between copper ions and delocalised electrons
 - strong attractive forces between copper ions only
 - strong attractive forces between copper atoms and delocalised electrons
- Topic Chem 3 Q# 127/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)
- 4** In which of the following, when in liquid form, are there only intermolecular forces based on temporary dipoles between the particles?

- bromine
- ethanol
- hydrogen chloride
- water

Topic Chem 3 Q# 128/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which molecules have no overall dipole moment?

- boron trifluoride
- methane
- phosphorus pentafluoride

Topic Chem 3 Q# 129/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

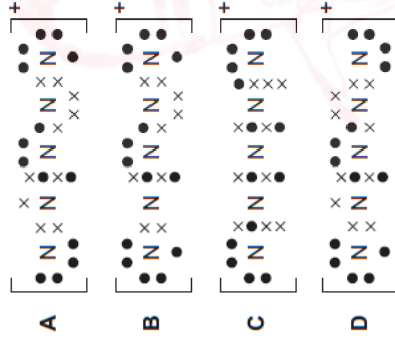
19 What is the order of increasing melting point of the three chlorides shown?

	lowest melting point	→	highest melting point
A	CCl ₄		MgCl ₂
B	MgCl ₂		PCl ₅
C	MgCl ₂		CCl ₄
D	PCl ₅		CCl ₄

Topic Chem 3 Q# 130/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

8 A stable ion N₅⁺ has been produced by research chemists.

Which structure is most likely to show the electron arrangement of this ion?



Topic Chem 3 Q# 131/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 The strong hydrogen bonding present in liquid water causes an increase in which properties?

- viscosity
- boiling point
- surface tension

Topic Chem 3 Q# 132/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 Which molecule does **not** have any 90° or 180° bond angles?

- C₂H₆
- CO₂
- PF₅
- SF₆



Topic Chem 3 Q# 133/ AS Chemistry/2019/m/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org :o)

4 Four compounds are shown.



How many of these compounds have an odd number of σ bonds?

A 1 B 2 C 3 D 4

Topic Chem 3 Q# 134/ AS Chemistry/2019/m/TZ.1/Paper.1/Exam Q# 3//www.SmashingScience.org :o)

3 Which molecule or ion contains the smallest bond angle?

A C_2H_4 B CH_3COCH_3 C NH_4^+ D NH_3

Topic Chem 3 Q# 135/ AS Chemistry/2019/s/TZ.1/Paper.1/Exam Q# 5//www.SmashingScience.org :o)





5 In which species is there a lone pair of electrons?

A CH_3 B CH_3^+ C CH_3^- D CH_4

Topic Chem 3 Q# 136/ AS Chemistry/2019/s/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org :o)

4 The outermost electron in an atom of neon occupies a particular orbital.

Which row shows the relative energy and shape of this orbital?

	energy of orbital relative to other occupied orbitals	shape of orbital
A	higher or equal	
B	higher or equal	
C	lower or equal	
D	lower or equal	

Topic Chem 3 Q# 137/ AS Chemistry/2019/s/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Four elements, W, X, Y and Z, have electronic configurations as shown.

W	X	Y	Z
2,4	2,6	2,8,2	2,8,8,1

Which formulae represent compounds that have boiling points below room temperature?

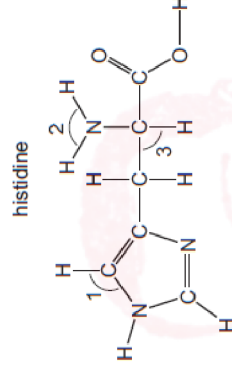
1 WX_2

2 YX

3 Z_2X

Topic Chem 3 Q# 138/ AS Chemistry/2019/m/TZ.2/Paper.1/Exam Q# 5//www.SmashingScience.org :o)

5 Histidine is an amino acid.



What are the approximate bond angles 1, 2, and 3?

	1	2	3
A	109.5	107	90
B	120	107	109.5
C	120	120	90
D	120	120	109.5

Topic Chem 3 Q# 139/ AS Chemistry/2019/m/TZ.2/Paper.1/Exam Q# 4//www.SmashingScience.org :o)

4 The eight species that follow all have covalent bonds.

In which pair do the species have different shapes from each other?

A $BeCl_2$ and CO_2

B CH_4 and NH_4^+

C NH_3 and BF_3

D SCl_2 and H_2O

Topic Chem 3 Q# 140/ AS Chemistry/2019/m/TZ.2/Paper.1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



36 Which types of bonding are present in ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$?

- 1 ionic
- 2 covalent
- 3 co-ordinate (dative covalent)

Topic Chem 3 Q# 141/ AS Chemistry/2018/m/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which molecules and ions have a bond angle of 120° ?

- 1 BF_3
- 2 CH_3^-
- 3 NH_3

Topic Chem 3 Q# 142/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 Which solid contains more than one type of bonding?

- A iodine
- B silicon dioxide
- C sodium chloride
- D zinc

Topic Chem 3 Q# 143/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 Which molecule has no overall dipole?

- A CH_3Cl
- B CH_2Cl_2
- C CHCl_3
- D CCl_4

Topic Chem 3 Q# 144/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

2 Which compound has a boiling point that is influenced by hydrogen bonding?

- A CH_3CHO
- B CH_3OCH_3
- C HCO_2CH_3
- D HCO_2H

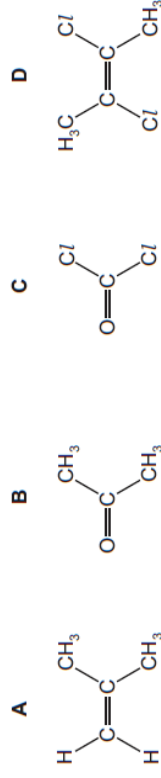
Topic Chem 3 Q# 145/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 What are the shapes of the molecules of water and boron trifluoride?

	H_2O	BF_3
A	linear	pyramidal
B	linear	trigonal
C	non-linear	pyramidal
D	non-linear	trigonal

Topic Chem 3 Q# 146/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 Which molecule has the largest overall dipole?



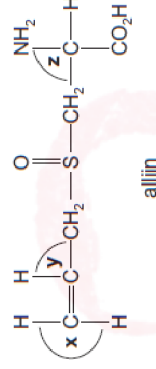
Topic Chem 3 Q# 147/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 Which molecule contains six bonding electrons?

- A C_2H_4
- B H_2S
- C NCl_3
- D SF_6

Topic Chem 3 Q# 148/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 The characteristic smell of garlic is due to alliin.



What are the approximate bond angles x, y and z in a molecule of alliin?

	x	y	z
A	90°	90°	109°
B	120°	109°	90°
C	120°	120°	109°
D	180°	109°	109°

Topic Chem 3 Q# 149/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 The boiling points of methane, ethane, propane and butane are given.

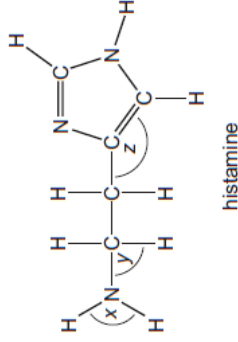
compound	CH_4	CH_3CH_3	$\text{CH}_3\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
boiling point /K	112	185	231	273

Which statement explains the increase in boiling point from methane to butane?

- A Closer packing of molecules results in stronger van der Waals' forces.
- B More covalent bonds are present and therefore more energy is required to break the bonds.
- C More electrons in the molecules results in stronger van der Waals' forces.
- D More hydrogen atoms in the molecules results in stronger hydrogen bonding.



- 6 Histamine is produced in the body to help fight infection. Its shape allows it to fit into receptors which expand blood vessels.



What are the bond angles x , y and z in histamine, from the smallest to the largest?

	smallest bond angle	largest bond angle
A	x	z
B	y	z
C	y	x
D	z	y

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 Which elements can form π bonds in their compounds?

- 1 carbon
- 2 oxygen
- 3 nitrogen

- 7 At room temperature and pressure, H_2O is a liquid and H_2S is a gas.

What is the reason for this difference?

- A O has higher first and second ionisation energies than S.
- B The covalent bond between O and H is stronger than the covalent bond between S and H.
- C There is significant hydrogen bonding between H_2O molecules but not between H_2S molecules.
- D The instantaneous dipole-induced dipole forces between H_2O molecules are stronger than the instantaneous dipole-induced dipole forces between H_2S molecules.

- 5 Dicarboxylic acid, C_2O_4 , is found in dust clouds in space. The structure of this molecule is $\text{C}=\text{C}=\text{O}$. The molecule contains no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O_4 ?

- A 1
- B 2
- C 3
- D 4

- 2 What is the correct number of bonds of each type in the $\text{Al}_2\text{C}_4\text{I}_6$ molecule?

	covalent	co-ordinate (dative covalent)
A	6	1
B	6	2
C	7	0
D	7	1

- 6 Which series shows molecules in order of increasing bond angle?

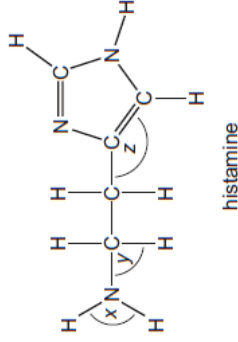
- A $\text{CH}_4 \rightarrow \text{BF}_3 \rightarrow \text{NH}_3$
- B $\text{H}_2\text{O} \rightarrow \text{CO}_2 \rightarrow \text{BF}_3$
- C $\text{NH}_3 \rightarrow \text{CH}_4 \rightarrow \text{CO}_2$
- D $\text{NH}_3 \rightarrow \text{CH}_4 \rightarrow \text{H}_2\text{O}$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Which molecules have an overall dipole moment?

- 1 carbon monoxide, CO
- 2 phosphine, PH_3
- 3 carbon dioxide, CO_2



What are the bond angles x , y and z in histamine, from the smallest to the largest?

	smallest bond angle	largest bond angle
A	x	z
B	y	z
C	y	x
D	z	y

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 Which elements can form π bonds in their compounds?

- 1 carbon
- 2 oxygen
- 3 nitrogen

- 7 At room temperature and pressure, H_2O is a liquid and H_2S is a gas.

What is the reason for this difference?

- A O has higher first and second ionisation energies than S.
- B The covalent bond between O and H is stronger than the covalent bond between S and H.
- C There is significant hydrogen bonding between H_2O molecules but not between H_2S molecules.
- D The instantaneous dipole-induced dipole forces between H_2O molecules are stronger than the instantaneous dipole-induced dipole forces between H_2S molecules.

15 Which row of the table is correct?

	shape		bonds present	
	ammonia molecule	ammonium ion	ammonia molecule	ammonium ion
A	pyramidal	regular tetrahedral	σ	σ
B	pyramidal	regular tetrahedral	σ	π
C	regular tetrahedral	pyramidal	σ	σ
D	regular tetrahedral	pyramidal	π	σ

Topic Chem 3 Q# 158/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 Nitrogen, N_2 , and carbon monoxide, CO, both have $M_r = 28$.

The boiling point of N_2 is 77K.

The boiling point of CO is 82 K.

What could be responsible for this difference in boiling points?

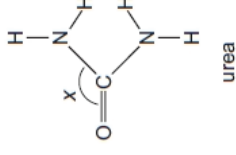
- A CO molecules have a permanent dipole, the N_2 molecules are not polar.
- B N_2 has σ and π bonding, CO has σ bonding only.
- C N_2 has a strong N=N bond, CO has a C=O bond.
- D The CO molecule has more electrons than the N_2 molecule.

Topic Chem 3 Q# 159/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Urea is a product of animal metabolism. It can also be used as a fertiliser.



The diagram shows angle x in this molecule.

Which statements about the structure of urea are correct?

- 1 Angle x is approximately 120° .
- 2 The molecule has two π bonds.
- 3 The molecule has only three lone pairs of electrons.

Topic Chem 3 Q# 160/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 The table shows the physical properties of four substances.

Which substance could be hydrogen chloride?

	melting point / $^\circ\text{C}$	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	-119	poor	poor	insoluble
B	-115	poor	poor	good
C	-50	poor	poor	poor
D	993	poor	good	good

Topic Chem 3 Q# 161/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 $AlCl_3$ vapour forms molecules with formula Al_2Cl_6 as it is cooled.

What happens to the bond angles during the change from $AlCl_3$ to Al_2Cl_6 ?

- A Some decrease, some remain the same.
- B Some increase, some remain the same.
- C They all decrease.
- D They all increase.



Topic Chem 3 Q# 162/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org .o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 P and Q are two liquid compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

How do the properties of P and Q differ?

- P has a higher surface tension than Q.
- P is less soluble in water than Q.
- P has a lower melting point than Q.

Topic Chem 3 Q# 163/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org .o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Use of the Data Booklet is relevant to this question.

When the liquid N_2F_4 is heated, it decomposes into a single product, X.

Which statements are correct?

- N–F bonds are broken during this decomposition.
- The enthalpy change when N_2F_4 decomposes into X is approximately $+160 \text{ kJ mol}^{-1}$.
- Molecules of X are non-linear.

Topic Chem 3 Q# 164/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

14 What is the order of increasing melting point of the four chlorides shown?

	lowest melting point	→	highest melting point
A	CCl_4		$MgCl_2$
B	HCl		$MgCl_2$
C	HCl		$MgCl_2$
D	$MgCl_2$		HCl

Topic Chem 3 Q# 165/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org .o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which types of bonding are present in ammonium carbonate, $(NH_4)_2CO_3$?

- ionic
- covalent
- co-ordinate (dative covalent)

Topic Chem 3 Q# 166/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org .o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Use of the Data Booklet is relevant to this question.

Carbon and nitrogen are adjacent in the Periodic Table.

Which properties do they both have?

- There is an empty 2p orbital in one atom of the element.
- The principal quantum number of the highest occupied orbital is 2.
- They form compounds in which their atoms form bonds with four other atoms.

Topic Chem 3 Q# 167/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org .o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Valence shell electron pair repulsion theory should be used to answer this question.

Which species are trigonal planar?

- BH_3
- CH_3^+
- PH_3



Topic Chem 3 Q# 168/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 The Group II metals have higher melting points than the Group I metals.

Which factors could contribute towards the higher melting points?

- There are smaller interatomic distances in the metallic lattices of the Group II metals.
- More electrons are available from each Group II metal atom for bonding the atom into the metallic lattice.
- Group II metals have a higher first ionisation energy than the corresponding Group I metal.

Topic Chem 3 Q# 169/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 How many nitrogen exist in compounds?

- bonded by a triple covalent bond
- as part of a cation
- having lost 3 electrons to form an anion

Topic Chem 3 Q# 170/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
3 Sodium borohydride, NaBH_4 , and boron trifluoride, BF_3 , are compounds of boron.

What are the shapes around boron in the borohydride ion and in boron trifluoride?

	borohydride ion	boron trifluoride
A	square planar	pyramidal
B	square planar	trigonal planar
C	tetrahedral	pyramidal
D	tetrahedral	trigonal planar

Topic Chem 3 Q# 171/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)
12 In which pair do the molecules have the same shape as each other?

- H_2O and CO_2
- H_2O and SCl_2
- NH_3 and BH_3
- SCl_2 and BeCl_2

Topic Chem 3 Q# 172/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Nitrogen and phosphorus are both in Group V of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5 .

Why is it **not** possible for nitrogen to form NCl_5 ?

- Nitrogen's outer shell can only contain eight electrons.
- Nitrogen cannot have oxidation state +5.
- Nitrogen is almost inert.

Topic Chem 3 Q# 173/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 In which species does the underlined atom have an incomplete outer shell?

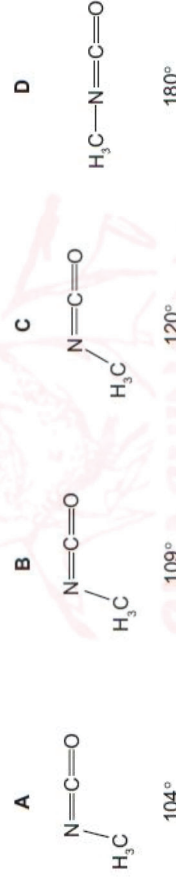


Topic Chem 3 Q# 174/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 Methyl isocyanate, CH_3NCO , is a toxic liquid which is used in the manufacture of some pesticides.

In the methyl isocyanate molecule, the sequence of atoms is $\text{H}_3\text{C}-\text{N}=\text{C}=\text{O}$.

What is the approximate angle between the bonds formed by the N atom?



Topic Chem 3 Q# 175/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Why does aluminium chloride, Al_2Cl_6 , sublime at the relatively low temperature of 180°C ?

- The intermolecular forces between the Al_2Cl_6 molecules are weak.
- The co-ordinate bonds between aluminium and chlorine are weak.
- The covalent bonds between aluminium and chlorine are weak.



Topic Chem 3 Q# 176/ AS Chemistry/2011/w/TZ.1/Paper.1/Exam Q# 13//www.SmashingScience.org :o)

13 Which element shows the greatest tendency to form some covalent compounds?

- A aluminium
 - B magnesium
 - C neon
 - D potassium
- Topic Chem 3 Q# 177/ AS Chemistry/2011/s/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org :o)
- The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which are features of the structure of metallic copper?

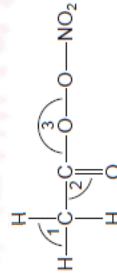
- 1 a lattice of ions
 - 2 delocalised electrons
 - 3 ionic bonds
- Topic Chem 3 Q# 178/ AS Chemistry/2011/s/TZ.1/Paper.1/Exam Q# 11//www.SmashingScience.org :o)
- 11 In which change would only van der Waals' forces have to be overcome?

- A evaporation of ethanol $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$
- B melting of ice $H_2O(s) \rightarrow H_2O(l)$
- C melting of solid carbon dioxide $CO_2(s) \rightarrow CO_2(l)$
- D solidification of butane $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

Topic Chem 3 Q# 179/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 7//www.SmashingScience.org :o)

7 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.

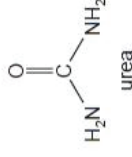


What is the correct order of the bond angles shown in ascending order (smallest first)?

- A 1 → 2 → 3
 - B 2 → 1 → 3
 - C 3 → 1 → 2
 - D 3 → 2 → 1
- Topic Chem 3 Q# 180/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 33//www.SmashingScience.org :o)
- The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Which types of intermolecular forces can exist between adjacent urea molecules?



- 1 hydrogen bonding
- 2 permanent dipole-dipole forces
- 3 temporary induced dipole-dipole forces

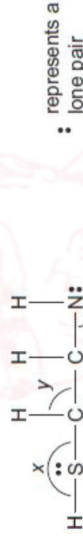
Topic Chem 3 Q# 181/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 5//www.SmashingScience.org :o)

5 Which molecule has the largest overall dipole?



Topic Chem 3 Q# 182/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org :o)

4 The antidote molecule shown can help to prevent liver damage if someone takes too many paracetamol tablets.



What is the order of decreasing size of the bond angles x, y and z?

	largest	→	smallest
A	x	y	z
B	x	z	y
C	y	z	x
D	z	y	x

Topic Chem 3 Q# 183/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

Topic Chem 3 Q# 176/ AS Chemistry/2011/w/TZ.1/Paper.1/Exam Q# 13//www.SmashingScience.org :o)

13 Which element shows the greatest tendency to form some covalent compounds?

- A aluminium
 - B magnesium
 - C neon
 - D potassium
- Topic Chem 3 Q# 177/ AS Chemistry/2011/s/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org :o)
- The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which are features of the structure of metallic copper?

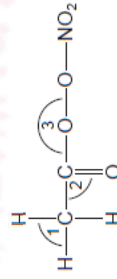
- 1 a lattice of ions
 - 2 delocalised electrons
 - 3 ionic bonds
- Topic Chem 3 Q# 178/ AS Chemistry/2011/s/TZ.1/Paper.1/Exam Q# 11//www.SmashingScience.org :o)
- 11 In which change would only van der Waals' forces have to be overcome?

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- B melting of ice $H_2O(s) \rightarrow H_2O(l)$
- C melting of solid carbon dioxide $CO_2(s) \rightarrow CO_2(l)$
- D solidification of butane $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

Topic Chem 3 Q# 179/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 7//www.SmashingScience.org :o)

7 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

- A 1 → 2 → 3
 - B 2 → 1 → 3
 - C 3 → 1 → 2
 - D 3 → 2 → 1
- Topic Chem 3 Q# 180/ AS Chemistry/2010/w/TZ.1/Paper.1/Exam Q# 33//www.SmashingScience.org :o)
- The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 32** Which physical properties are due to hydrogen bonding between water molecules?
- Water has a higher boiling point than H₂S.
 - Ice floats on water.

3 The H–O–H bond angle in water is approximately 104°.

Topic Chem 3 Q# 184/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5** Which statement explains why the boiling point of methane is higher than that of neon?
[A: H, 1; C, 12; Ne, 20]

- A molecule of methane has a greater mass than a molecule of neon.
- Molecules of methane form hydrogen bonds, but those of neon do not.
- Molecules of methane have stronger intermolecular forces than those of neon.
- The molecule of methane is polar, but that of neon is not.

Topic Chem 4 Q# 185/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7** The table shows properties of four solids held together by different types of bonding.

Which row correctly describes the properties of a solid with a giant covalent structure?

	melting point	solubility in polar solvents
A	high	insoluble
B	high	soluble
C	low	insoluble
D	low	soluble

Topic Chem 4 Q# 186/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7** 'Black powder' is a mixture of potassium nitrate, carbon and sulfur. The mixture reacts as shown.



A sealed tube containing black powder has a volume of 10.0 cm³. When all of the black powder reacts, the reaction causes a pressure of 2×10^6 Pa and a temperature of 2500 K.

The volume of the K₂CO₃ and K₂S produced can be ignored.

How many moles of KNO₃ are contained in the sealed tube?

- A** 4.81×10^{-4} **B** 9.63×10^{-4} **C** 1.93×10^{-3} **D** 9.63×10^{-1}

Topic Chem 4 Q# 187/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6** Which substance shows the greatest deviation from the properties of an ideal gas under room conditions?

- A** CO₂(g) **B** H₂(g) **C** Ne(g) **D** NH₃(g)

Topic Chem 4 Q# 188/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33** Ethylene glycol, HOCH₂CH₂OH, is used as a de-icer. It allows ice to melt at temperatures below 0 °C.

Which statements are correct?

- Ethylene glycol disrupts the extensive network of hydrogen bonds in ice.
- Ethylene glycol molecules form hydrogen bonds with other ethylene glycol molecules.
- Ethylene glycol molecules will dissolve in the water formed from the ice.

Topic Chem 4 Q# 189/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8** Which gas would behave most like an ideal gas under room conditions?

- A** helium
B nitrogen
C ammonia
D krypton

Topic Chem 4 Q# 190/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6** A solution contains 0.25 g of sulfur dioxide in 1.00 dm³ of water.

Which volume of sulfur dioxide, measured at 50 °C, and a pressure of 1×10^5 Pa, must be added to 1.00 dm³ of water to produce this solution?

- A** 0.0162 cm³ **B** 0.105 cm³ **C** 16.2 cm³ **D** 105 cm³

Topic Chem 4 Q# 191/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33** Many gases do **not** obey the general gas equation at high pressures.

Why is this?

- At higher pressures the molecules have more energy.
- At higher pressures the volume of the molecules is a larger proportion of the total volume.
- At higher pressures the molecules experience greater intermolecular forces.



Topic Chem 4 Q# 192/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 A sample of argon gas has a mass of 0.20 g, at a pressure of 100 000 Pa and a temperature of 12 °C.

Which volume does the gas occupy?

- A $1.2 \times 10^{-4} \text{ cm}^3$
B 5.0 cm^3
C 59 cm^3
D 119 cm^3

Topic Chem 4 Q# 193/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 10 cm^3 of ethane is burned in 45 cm^3 of oxygen at a pressure of 101 kPa and a temperature of 200 °C. Complete combustion takes place.

What is the total volume of gas present when the reaction is complete, measured under the same conditions?

- A 30 cm^3 B 50 cm^3 C 55 cm^3 D 60 cm^3

Topic Chem 4 Q# 194/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 Carbon exists in several different forms. Two of these forms are buckminsterfullerene and graphene. Buckminsterfullerene is a fullerene allotrope of carbon.

Which statements about buckminsterfullerene and graphene are correct?

- 1 Both have delocalised electrons.
2 Buckminsterfullerene has a giant molecular structure.
3 The carbon atoms in graphene form a tetrahedral lattice.

Topic Chem 4 Q# 195/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 1.8 g of water, heated to 227 °C in a sealed container, turns to steam with a pressure of 200 kPa.

What is the approximate volume of the container?

- A $9 \times 10^{-4} \text{ m}^3$ B $2 \times 10^{-3} \text{ m}^3$ C 2 m^3 D $8 \times 10^7 \text{ m}^3$

Topic Chem 4 Q# 196/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 Under which conditions will nitrogen behave most like an ideal gas?

	temperature	pressure
A	low	high
B	high	low
C	low	low
D	high	high

Topic Chem 4 Q# 197/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6 When an evacuated tube of volume 400 cm^3 is filled with gas at 300 K and 101 kPa, the mass of the tube increases by 0.65 g.

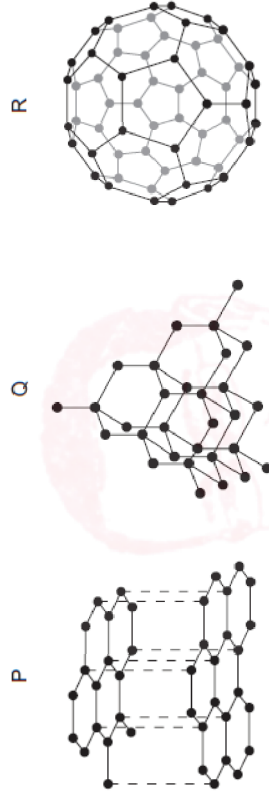
Assume the gas behaves as an ideal gas.

What could be the identity of the gas?

- A argon
B helium
C krypton
D neon

Topic Chem 4 Q# 198/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 P, Q and R represent three different structures of an element.



Which structures are giant molecular?

- A P, Q and R
B P and Q only
C P and R only
D Q and R only

Topic Chem 4 Q# 199/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6 A sample of gas occupies 240 cm^3 at 37 °C and 100 kPa.

How many moles of gas are present in the sample?

- A 9.32×10^{-6} B 9.32×10^{-3} C 0.0781 D 78.1

Topic Chem 4 Q# 200/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5 In this question you should assume methane behaves as an ideal gas.

The gas laws can be summarised in the ideal gas equation below.

$$pV = nRT$$

The volume of a sample of methane is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is $5.37 \times 10^{-3} \text{ m}^3$.

What is the mass of the sample of methane, given to two significant figures?

- A 0.0032 g B 0.018 g C 3.2 g D 18 g

Topic Chem 4 Q# 192/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

Which volume does the gas occupy?

- A $1.2 \times 10^{-4} \text{ cm}^3$
B 5.0 cm^3
C 59 cm^3
D 119 cm^3

Topic Chem 4 Q# 193/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

- 4 10 cm^3 of ethane is burned in 45 cm^3 of oxygen at a pressure of 101 kPa and a temperature of 200 °C. Complete combustion takes place.

What is the total volume of gas present when the reaction is complete, measured under the same conditions?

- A 30 cm^3 B 50 cm^3 C 55 cm^3 D 60 cm^3

Topic Chem 4 Q# 194/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 Carbon exists in several different forms. Two of these forms are buckminsterfullerene and graphene. Buckminsterfullerene is a fullerene allotrope of carbon.

Which statements about buckminsterfullerene and graphene are correct?

- 1 Both have delocalised electrons.
2 Buckminsterfullerene has a giant molecular structure.
3 The carbon atoms in graphene form a tetrahedral lattice.

Topic Chem 4 Q# 195/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 1.8 g of water, heated to 227 °C in a sealed container, turns to steam with a pressure of 200 kPa.

What is the approximate volume of the container?

- A $9 \times 10^{-4} \text{ m}^3$ B $2 \times 10^{-3} \text{ m}^3$ C 2 m^3 D $8 \times 10^7 \text{ m}^3$

Topic Chem 4 Q# 196/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 Under which conditions will nitrogen behave most like an ideal gas?

	temperature	pressure
A	low	high
B	high	low
C	low	low
D	high	high

2 What is a basic assumption of the kinetic theory, as applied to an ideal gas?

- A Collisions between gas molecules are elastic.
- B Each gas molecule occupies a finite volume.
- C Gases consist of particles that experience the force of gravity.
- D Gas molecules attract each other with weak intermolecular forces.

Topic Chem 4 Q# 202/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which statements are correct?

- 1 The hydrogen bonds in ice are more regularly arranged than in water.
- 2 The solidification of water to form ice is exothermic.
- 3 Pure water is less dense than ice.

Topic Chem 4 Q# 203/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 7//www.SmashingScience.org .o)

7 The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.960 g of oxygen gas is contained in a vessel of volume $7.00 \times 10^{-3} \text{ m}^3$ at a temperature of 30°C .

Assume that the gas behaves as an ideal gas.

What is the pressure in the vessel?

- A 1.07 kPa
- B 2.14 kPa
- C 10.8 kPa
- D 21.6 kPa

Topic Chem 4 Q# 204/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 5//

5 A fluorescent light tube has an internal volume of 400 cm^3 and an internal pressure of 200 kPa.

It is filled with 0.03 moles of an ideal gas.

What is the temperature of the gas inside the fluorescent light tube?

- A $3.21 \times 10^{-1} \text{ K}$
- B $3.21 \times 10^2 \text{ K}$
- C $3.21 \times 10^5 \text{ K}$
- D $3.21 \times 10^8 \text{ K}$



4 In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the *co-ordination number* of the sodium ions.

What are the co-ordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

	sodium ions	chloride ions
A	4	6
B	6	4
C	6	6
D	8	6

Topic Chem 4 Q# 206/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 6//www.SmashingScience.org .o)

6 Which gas sample contains the **fewest** molecules?

- A 1.00 dm³ of carbon dioxide at 27°C and 2.0 kPa
- B 1.00 dm³ of hydrogen at 100°C and 2.0 kPa
- C 1.00 dm³ of nitrogen at 300°C and 4.0 kPa
- D 1.00 dm³ of oxygen at 250°C and 3.0 kPa

Topic Chem 4 Q# 207/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 When a sample of a gas is compressed at constant temperature from 1500 kPa to 6000 kPa, its volume changes from 76.0 cm^3 to 20.5 cm^3 .

Which statements are possible explanations for this result?

- 1 The gas does not behave ideally.
- 2 The gas partially liquefies.
- 3 Some of the gas is lost from the container.



- 7 The approximate percentage composition of the atmospheres on four different planets is given in the table below.

Which mixture of gases has the greatest density?

	planet	major gases / % by number of molecules		
		H ₂	He	CH ₄
A	Jupiter	89.8	10.2	0.0
B	Neptune	80.0	19.0	1.0
C	Saturn	96.3	3.3	0.4
D	Uranus	82.5	15.2	2.3

- 2 In the ideal gas equation, $pV = nRT$, what are the units of n and T ?

	n	T
A	no units	°C
B	no units	K
C	mol	°C
D	mol	K

The responses A to D should be selected on the basis of

	A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 What are basic assumptions of the kinetic theory as applied to an ideal gas?

- Gas particles are in continuous random motion.
- Gas particles experience no intermolecular forces.
- The volume of each gas particle is zero.

- 9 An article in a science magazine contains the following statement.

'It is lighter than a feather, stronger than steel, yet incredibly flexible and more conductive than copper.'

Which form of carbon is being described?

- A buckminsterfullerene
B diamond
C graphene
D graphite

- 8 Solid carbon dioxide, CO₂, is similar to solid iodine, I₂, in its structure and properties. Carbon is in Group 14. Silica, SiO₂, is a Group 14 compound.

Which statement about solid CO₂ and solid SiO₂ is correct?

- A Both solids exist in a lattice structure.
B Both solids have a simple molecular structure.
C Both solids have atoms joined by single covalent bonds.
D Both solids change spontaneously to gas at s. t. p.

- 7 What is the volume of steam produced when 1.00 g of ice is heated to 323 °C at a pressure of 101 kPa?

- A 0.27 dm³ B 1.3 dm³ C 2.7 dm³ D 48 dm³

- 5 Some car paints contain small flakes of silica, SiO₂.

In the structure of solid SiO₂

- each silicon atom is bonded to x oxygen atoms,
- each oxygen atom is bonded to y silicon atoms,
- each bond is a z type bond.

What is the correct combination of x , y and z in these statements?

	x	y	z
A	2	1	covalent
B	2	1	ionic
C	4	2	covalent
D	4	2	ionic

- 7 The approximate percentage composition of the atmospheres on four different planets is given in the table below.

Which mixture of gases has the greatest density?

	planet	major gases / % by number of molecules		
		H ₂	He	CH ₄
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B	Neptune	80.0	19.0	1.0
C	Saturn	96.3	3.3	0.4
D	Uranus	82.5	15.2	2.3

- 2 In the ideal gas equation, $pV = nRT$, what are the units of n and T ?

	n	T
A	no units	°C
B	no units	K
C	mol	°C
D	mol	K

The responses A to D should be selected on the basis of

	A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 What are basic assumptions of the kinetic theory as applied to an ideal gas?

- Gas particles are in continuous random motion.
- Gas particles experience no intermolecular forces.
- The volume of each gas particle is zero.



- 5 Use of the Data Booklet is relevant to this question.

The gas laws can be summarised in the ideal gas equation below.

$$pV = nRT$$

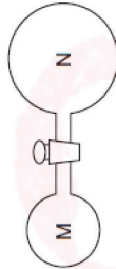
0.96 g of oxygen gas is contained in a glass vessel of volume $7.0 \times 10^{-3} \text{ m}^3$ at a temperature of 30°C .

Assume the gas behaves as an ideal gas.

What is the pressure in the vessel?

- A 1.1 kPa B 2.1 kPa C 10.8 kPa D 21.6 kPa

- 4 Two glass vessels M and N are connected by a closed valve.



M contains helium at 20°C at a pressure of $1 \times 10^5 \text{ Pa}$. N has been evacuated, and has three times the volume of M. In an experiment, the valve is opened and the temperature of the whole apparatus is raised to 100°C .

What is the final pressure in the system?

- A $3.18 \times 10^4 \text{ Pa}$
 B $4.24 \times 10^4 \text{ Pa}$
 C $1.25 \times 10^5 \text{ Pa}$
 D $5.09 \times 10^5 \text{ Pa}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 A student borrowed a friend's chemistry notes and copied out the notes in the box below.

Which statements are correct?

<p>A gas behaves less like an ideal gas when the gas</p> <p>1 is at low pressure.</p> <p>2 is at low temperature.</p> <p>3 can be easily liquefied.</p>

- 4 The table shows the physical properties of four substances.

Which substance has a giant covalent structure?

	melting point / $^\circ\text{C}$	boiling point / $^\circ\text{C}$	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	-119	39	poor	poor	insoluble
B	-115	-85	poor	poor	good
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

- 2 Use of the Data Booklet is relevant to this question.

Iodine is a black, shiny, non-metallic solid and a member of Group VII. It sublimes easily on heating to give a purple vapour.

A sample of iodine vapour of mass 6.35 g has a volume of 1.247 dm^3 when maintained at constant temperature and a pressure of $1.00 \times 10^5 \text{ Pa}$.

If iodine vapour acts as an ideal gas, what is the temperature of the iodine vapour?

- A 300 K B 600 K C 300 000 K D 600 000 K

- 9 Which would behave the least like an ideal gas at room temperature?

- A carbon dioxide
 B helium
 C hydrogen
 D nitrogen

- 10 The general gas equation can be used to calculate the M_r value of a gas.

For a sample of a gas of mass mg , which expression will give the value of M_r ?

- A $M_r = \frac{mpV}{RT}$ B $M_r = \frac{pVRT}{m}$ C $M_r = \frac{mRT}{pV}$ D $M_r = \frac{pV}{mRT}$

- 8 Some car paints contain small flakes of silica, SiO₂.

In the structure of solid SiO₂

- each silicon atom is bonded to **x** oxygen atoms,
- each oxygen atom is bonded to **y** silicon atoms,
- each bond is a **z** type bond.

What is the correct combination of **x**, **y** and **z** in this statement?

	x	y	z
A	2	1	covalent
B	2	1	ionic
C	4	2	covalent
D	4	2	ionic

- 6 Use of the Data Booklet is relevant to this question.

The volume of a sample of ammonia is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is 5.37 × 10⁻³ m³.

What is the mass of the sample of ammonia, given to two significant figures?

- A** 0.00019 g **B** 0.0034 g **C** 0.19 g **D** 3.4 g

- 8 Under which set of conditions is a gas most likely to behave ideally?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

- 6 Use of the Data Booklet is relevant to this question.

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.56 g of ethene gas is contained in a vessel at a pressure of 102 kPa and a temperature of 30 °C.

What is the volume of the vessel?

- A** 49 cm³ **B** 494 cm³ **C** 48 900 cm³ **D** 494 000 cm³

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

where each symbol has its usual meaning.

Which statements are correct?

- 1 One mole of an ideal gas occupies the same volume under the same conditions of temperature and pressure.
- 2 The density of an ideal gas at constant pressure is inversely proportional to the temperature, T .
- 3 The volume of a given mass of an ideal gas is doubled if its temperature is raised from 25 °C to 50 °C at constant pressure.

- 5 At room temperature and pressure chlorine does not behave as an ideal gas.

At which temperature and pressure would the behaviour of chlorine become more ideal?

	pressure /kPa	temperature /K
A	50	200
B	50	400
C	200	200
D	200	400



- 10 Three substances, R, S and T, have physical properties as shown.

substance	R	S	T
mp /°C	801	2852	3550
bp /°C	1413	3600	4827
electrical conductivity of solid	poor	poor	good

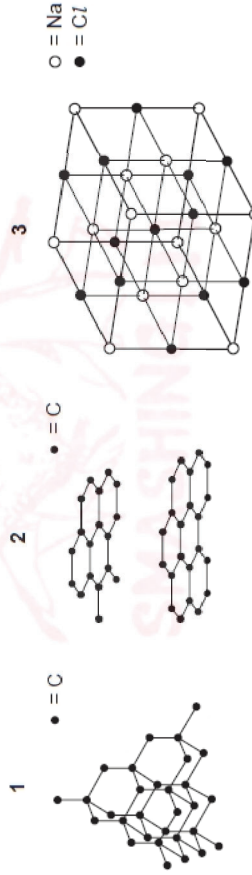
What could be the identities of R, S and T?

	R	S	T
A	MgO	NaCl	C [graphite]
B	MgO	NaCl	SiO ₂
C	NaCl	MgO	C [graphite]
D	NaCl	MgO	SiO ₂

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Which diagrams represent part of a giant molecular structure?



- 3 Which gas closely approaches ideal behaviour at room temperature and pressure?

- A ammonia
B carbon dioxide
C helium
D oxygen

- 7 A crystal of iodine produces a purple vapour when gently heated.

Which pair of statements correctly describes this process?

	type of bond broken	formula of purple species
A	covalent	I
B	covalent	I ₂
C	induced dipole-dipole	I ₂
D	permanent dipole-dipole	I ₂

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

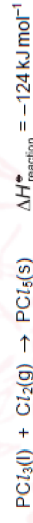
- 32 An ideal gas obeys the gas laws under all conditions of temperature and pressure.

Which of the following are true for an ideal gas?

- The molecules have negligible volume.
- There are no forces of attraction between molecules.
- The molecules have an average kinetic energy which is proportional to its absolute temperature.

- 9 The enthalpy changes of formation, ΔH_f° , of both PCl_3 and PCl_5 are exothermic.

PCl_3 reacts with chlorine.



Which pair of statements is correct?

	statement 1	statement 2
A	$\Delta H_{\text{reaction}}^\circ$ is less negative than ΔH_f° (PCl_5).	The Cl_2 bond energy is needed in calculating $\Delta H_{\text{reaction}}^\circ$ from enthalpies of formation.
B	$\Delta H_{\text{reaction}}^\circ$ is more negative than ΔH_f° (PCl_5).	The Cl_2 bond energy is needed in calculating $\Delta H_{\text{reaction}}^\circ$ from enthalpies of formation.
C	$\Delta H_{\text{reaction}}^\circ$ is less negative than ΔH_f° (PCl_5).	The Cl_2 bond energy is not needed in calculating $\Delta H_{\text{reaction}}^\circ$ from enthalpies of formation.
D	$\Delta H_{\text{reaction}}^\circ$ is more negative than ΔH_f° (PCl_5).	The Cl_2 bond energy is not needed in calculating $\Delta H_{\text{reaction}}^\circ$ from enthalpies of formation.



Topic Chem 5 Q# 234/ AS Chemistry/2022/m/TZ.1/Paper.1/Exam Q# 10//www.SmashingScience.org .o)

- 10 A student mixes 25.0 cm^3 of $0.350 \text{ mol dm}^{-3}$ sodium hydroxide solution with 25.0 cm^3 of $0.350 \text{ mol dm}^{-3}$ hydrochloric acid. The temperature increases by 2.5°C . No heat is lost to the surroundings.

The final mixture has a specific heat capacity of $4.2 \text{ J cm}^{-3} \text{ K}^{-1}$.

What is the molar enthalpy change for the reaction?

- A -150 kJ mol^{-1}
 B -60 kJ mol^{-1}
 C -30 kJ mol^{-1}
 D $-0.15 \text{ kJ mol}^{-1}$

Topic Chem 5 Q# 235/ AS Chemistry/2022/s/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

- 9 The equation for an enthalpy change is shown. The enthalpy change is Q.

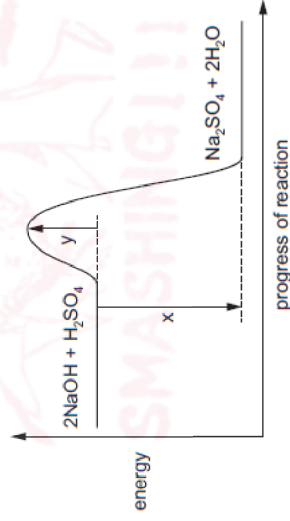


What is the correct expression to calculate Q?

- A $2 \times \Delta H_f^\circ [\text{CO}_2\text{(g)}] - 3 \times \Delta H_f^\circ [\text{H}_2\text{(g)}]$
 B $3 \times \Delta H_f^\circ [\text{H}_2\text{O(g)}] + 2 \times \Delta H_f^\circ [\text{CO}_2\text{(g)}]$
 C $2 \times \Delta H_f^\circ [\text{CO}_2\text{(g)}] - 3 \times \Delta H_f^\circ [\text{H}_2\text{(g)}]$
 D $3 \times \Delta H_f^\circ [\text{H}_2\text{O(l)}] + 2 \times \Delta H_f^\circ [\text{CO}_2\text{(g)}]$

Topic Chem 5 Q# 236/ AS Chemistry/2022/s/TZ.1/Paper.1/Exam Q# 10//www.SmashingScience.org .o)

- 10 A reaction pathway diagram for the reaction of aqueous sodium hydroxide and dilute sulfuric acid is shown.



What is the value of the enthalpy change of neutralisation, ΔH_{neut} ?

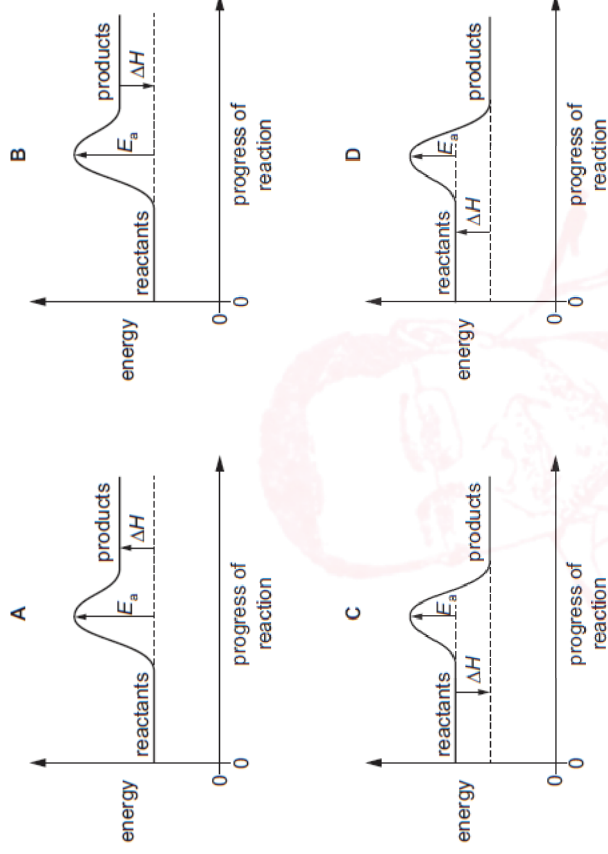
- A x
 B $x - y$
 C $\frac{x}{2}$
 D $\frac{(x - y)}{2}$

Topic Chem 5 Q# 237/ AS Chemistry/2022/m/TZ.2/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

- 9 Nitrogen monoxide is an atmospheric pollutant that is formed inside car engines by an endothermic reaction between nitrogen and oxygen.



Which diagram correctly represents the energy profile for this reaction?



Topic Chem 5 Q# 238/ AS Chemistry/2022/m/TZ.2/Paper.1/Exam Q# 8//www.SmashingScience.org .o)

- 8 The equation for reaction 1 is shown.



	$\Delta H_f^\circ / \text{kJ mol}^{-1}$
$\text{C}_6\text{H}_{12}\text{O}_6$	a
$\text{C}_2\text{H}_5\text{OH}$	b

What is the correct expression for the enthalpy change of reaction 1?

- A $a + b$
 B $a - b$
 C $a + 2b$
 D $a - 2b$



Topic Chem 5 Q# 239/ AS Chemistry/2021/m/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org .o)

8 Which equation represents the enthalpy change of atomisation of iodine?

- A $\frac{1}{2} \text{I}_2(\text{g}) \rightarrow \text{I}(\text{g})$
 B $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
 C $\frac{1}{2} \text{I}_2(\text{s}) \rightarrow \text{I}(\text{g})$
 D $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$

Topic Chem 5 Q# 240/ AS Chemistry/2021/m/TZ.1/Paper.1/Exam Q# 7//www.SmashingScience.org .o)

7 In order to determine the enthalpy of neutralisation of a strong acid and a strong alkali, 25.0 cm³ of 2.00 mol dm⁻³ sodium hydroxide is added to 25.0 cm³ of 2.00 mol dm⁻³ hydrochloric acid. The increase in temperature is 12 °C.

In a second experiment, the same method is used, but 50.0 cm³ of 2.00 mol dm⁻³ sodium hydroxide is added to 50.0 cm³ of 2.00 mol dm⁻³ hydrochloric acid.

What is the increase in temperature in the second experiment?

- A 6 °C B 12 °C C 24 °C D 48 °C

Topic Chem 5 Q# 241/ AS Chemistry/2021/s/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org .o)

4 ΔH_1^\ominus is the standard enthalpy of formation of methane.

ΔH_2^\ominus is the standard enthalpy of combustion of carbon.

ΔH_3^\ominus is the standard enthalpy of combustion of hydrogen.



Which expression is equivalent to ΔH_c^\ominus ?

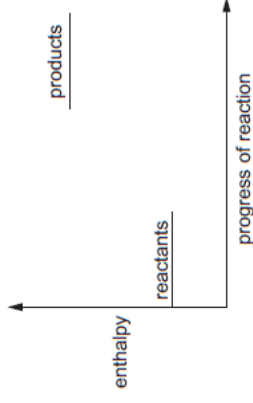
- A $\Delta H_1^\ominus - \Delta H_2^\ominus + \Delta H_3^\ominus$
 B $\Delta H_1^\ominus - 2\Delta H_3^\ominus - \Delta H_2^\ominus$
 C $\Delta H_2^\ominus - \Delta H_3^\ominus + \Delta H_1^\ominus$
 D $\Delta H_2^\ominus + 2\Delta H_3^\ominus - \Delta H_1^\ominus$

Topic Chem 5 Q# 242/ AS Chemistry/2021/s/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 The diagram shows an incomplete energy profile diagram for a reaction.

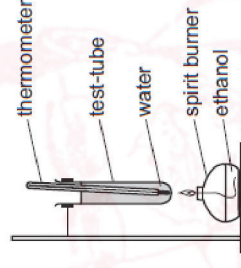


Which reactions could this diagram refer to?

- 1 $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 2 $\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$
 3 $\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}^-(\text{g}) + \text{aq}$

Topic Chem 5 Q# 243/ AS Chemistry/2021/m/TZ.2/Paper.1/Exam Q# 7//www.SmashingScience.org .o)

7 An experiment was performed to determine the enthalpy of combustion of ethanol.



The data collected are shown.

mass of water = Wg

mass of ethanol burned = Xg

temperature rise = Y°C

molar mass of ethanol = Zg mol⁻¹

specific heat capacity of water = 4.2 JK⁻¹ g⁻¹

Which expression can be used to calculate the enthalpy of combustion of ethanol in kJ mol⁻¹?

- A $\frac{-4.2WYZ}{1000X}$ B $\frac{-4.2WYX}{1000Z}$ C $\frac{-4.2XYZ}{1000W}$ D $\frac{-4.2X(Y+273)Z}{1000W}$

Topic Chem 5 Q# 239/ AS Chemistry/2021/m/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org .o)

8 Which equation represents the enthalpy change of atomisation of iodine?

- A $\frac{1}{2} \text{I}_2(\text{g}) \rightarrow \text{I}(\text{g})$
 B $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
 C $\frac{1}{2} \text{I}_2(\text{s}) \rightarrow \text{I}(\text{g})$
 D $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$

Topic Chem 5 Q# 240/ AS Chemistry/2021/m/TZ.1/Paper.1/Exam Q# 7//www.SmashingScience.org .o)

7 In order to determine the enthalpy of neutralisation of a strong acid and a strong alkali, 25.0 cm³ of 2.00 mol dm⁻³ sodium hydroxide is added to 25.0 cm³ of 2.00 mol dm⁻³ hydrochloric acid. The increase in temperature is 12 °C.

In a second experiment, the same method is used, but 50.0 cm³ of 2.00 mol dm⁻³ sodium hydroxide is added to 50.0 cm³ of 2.00 mol dm⁻³ hydrochloric acid.

What is the increase in temperature in the second experiment?

- A 6 °C B 12 °C C 24 °C D 48 °C

Topic Chem 5 Q# 241/ AS Chemistry/2021/s/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org .o)

4 ΔH_1^\ominus is the standard enthalpy of formation of methane.

ΔH_2^\ominus is the standard enthalpy of combustion of carbon.

ΔH_3^\ominus is the standard enthalpy of combustion of hydrogen.



Which expression is equivalent to ΔH_c^\ominus ?

- A $\Delta H_1^\ominus - \Delta H_2^\ominus + \Delta H_3^\ominus$
 B $\Delta H_1^\ominus - 2\Delta H_3^\ominus - \Delta H_2^\ominus$
 C $\Delta H_2^\ominus - \Delta H_3^\ominus + \Delta H_1^\ominus$
 D $\Delta H_2^\ominus + 2\Delta H_3^\ominus - \Delta H_1^\ominus$

Topic Chem 5 Q# 242/ AS Chemistry/2021/s/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

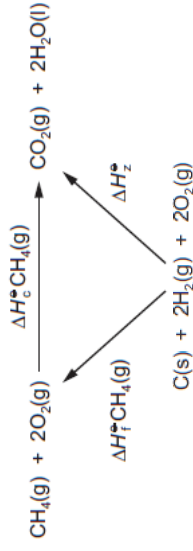
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



Topic Chem 5 Q# 244/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 An energy cycle for the combustion of methane is shown.

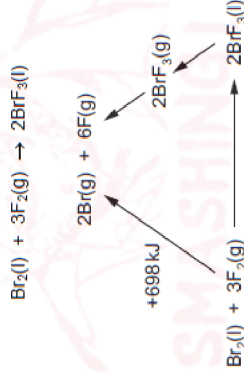


Which expressions can be used to calculate the energy change, ΔH_f° ?

- $\Delta H_f^\circ(\text{CH}_4(\text{g})) + \Delta H_c^\circ(\text{CH}_4(\text{g}))$
- $\Delta H_c^\circ(\text{C}(\text{s})) + 2\Delta H_f^\circ(\text{H}_2(\text{g}))$
- $\Delta H_c^\circ(\text{CO}(\text{g})) + 2\Delta H_f^\circ(\text{H}_2(\text{g}))$

Topic Chem 5 Q# 245/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

7 An energy cycle is drawn for the following reaction.



The standard enthalpy of formation of $\text{BrF}_3(\text{l}) = -301 \text{ kJ mol}^{-1}$.

The enthalpy change of $\text{BrF}_3(\text{l})$ to $\text{BrF}_3(\text{g})$ is $+44 \text{ kJ mol}^{-1}$.

What is the average bond energy of the Br–F bond in BrF_3 ?

- A** 152 kJ mol^{-1} **B** 202 kJ mol^{-1} **C** 304 kJ mol^{-1} **D** 404 kJ mol^{-1}

Topic Chem 5 Q# 246/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 Which pair of standard enthalpy changes are numerically equal?

- A** atomisation of $\text{CH}_4(\text{g})$ and formation of $\text{CH}_4(\text{g})$
B combustion of $\text{CH}_3\text{OH}(\text{l})$ and combustion of graphite + 2(combustion of $\text{H}_2(\text{g})$)
C combustion of graphite and formation of $\text{CO}_2(\text{g})$
D neutralisation of $\text{HCl}(\text{aq})$ with $\text{NaOH}(\text{aq})$ and formation of $\text{H}_2\text{O}(\text{l})$



Topic Chem 5 Q# 247/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which statements are correct?

- enthalpy of combustion of $\text{H}_2 =$ enthalpy of formation of H_2O
- enthalpy of formation of $\text{H}_2 = -$ (enthalpy of atomisation of H_2)
- enthalpy of solution of $\text{HCl} =$ enthalpy of hydration of H^+ + enthalpy of hydration of Cl^-

Topic Chem 5 Q# 248/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Nitrogen forms a number of oxides. Their enthalpies of formation are given.

$$\Delta H_f^\circ[\text{NO}(\text{g})] = +90 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ[\text{N}_2\text{O}(\text{g})] = +82 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ[\text{NO}_2(\text{g})] = +33 \text{ kJ mol}^{-1}$$

Which statements are correct?

- If $\text{N}_2\text{O}(\text{g})$ is oxidised by $\text{O}_2(\text{g})$ to $\text{NO}_2(\text{g})$, 16 kJ is released per mole of N_2O .
- The decomposition of $\text{N}_2\text{O}(\text{g})$ to $\text{N}_2(\text{g})$ and $\text{O}_2(\text{g})$ is exothermic.
- The reaction between NO and oxygen is exothermic.

Topic Chem 5 Q# 249/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

5 Two reactions are shown.

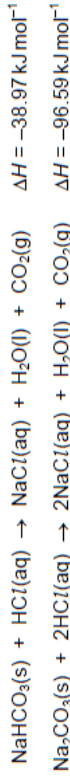


If molar amounts are used, how can the two energy changes associated with these reactions be described?

- A** enthalpy of atomisation and enthalpy of combustion
B enthalpy of atomisation and enthalpy of formation
C bond energy and enthalpy of combustion
D bond energy and enthalpy of formation



- 4 The following data are needed for this question.



On heating, sodium hydrogencarbonate decomposes as shown.



What is the enthalpy change for this decomposition?

- A $-57.62 \text{ kJ mol}^{-1}$
 B $-18.65 \text{ kJ mol}^{-1}$
 C $18.65 \text{ kJ mol}^{-1}$
 D $57.62 \text{ kJ mol}^{-1}$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 A reaction between carbon and oxygen is shown.



How can the standard enthalpy change of this reaction be described correctly?

- 1 standard enthalpy change of formation
 2 standard enthalpy change of combustion
 3 standard enthalpy change of atomisation

- 8 Sodium burns in oxygen giving out heat energy and forming the compound Na_2O . The equation for this reaction is shown.



Which statement about the reaction is correct?

- A ΔH° for the reaction is equal to twice the bond energy of the Na–O bond.
 B ΔH° for the reaction is positive.
 C The equation represents the standard enthalpy change of combustion of sodium.
 D The equation represents the standard enthalpy change of formation of sodium oxide.

- 7 The following data are needed for this question.

$$\Delta H_f^\circ(\text{N}_2\text{H}_4(\text{l})) = 50.6 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ(\text{N}_2\text{O}_4(\text{g})) = 9.2 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ(\text{H}_2\text{O}(\text{g})) = -241.8 \text{ kJ mol}^{-1}$$

Hydrazine, $\text{N}_2\text{H}_4(\text{l})$, reacts with dinitrogen tetraoxide, $\text{N}_2\text{O}_4(\text{g})$, to form nitrogen gas and water vapour.



What is the enthalpy change for this reaction?

- A $-1077.6 \text{ kJ mol}^{-1}$
 B $-856.8 \text{ kJ mol}^{-1}$
 C $-301.6 \text{ kJ mol}^{-1}$
 D $-182.0 \text{ kJ mol}^{-1}$

- 8 Two reactions and their enthalpy changes are shown.



These data can be used to calculate the enthalpy change for the reaction shown.



What is the value of X?

- A $-228.0 \text{ kJ mol}^{-1}$
 B $-123.6 \text{ kJ mol}^{-1}$
 C $+123.6 \text{ kJ mol}^{-1}$
 D $+228.0 \text{ kJ mol}^{-1}$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 Which statements about enthalpy changes are correct?

- 1 The enthalpy change of atomisation is always positive.
 2 The enthalpy change when a C–C bond is broken is positive.
 3 The enthalpy change of neutralisation of a weak acid is always negative.



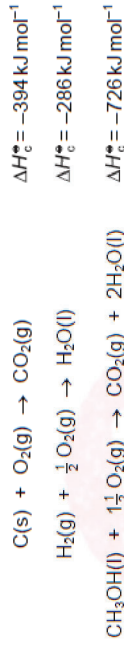
- 9 The equation for a chemical reaction is shown. All substances are in their standard states.



Which statement describes the standard enthalpy change of reaction for this reaction?

- A the enthalpy change when a total of one mole of products is produced
 B the enthalpy change when a total of one mole of reactants is reacted
 C the enthalpy change when one mole of water reacts
 D the enthalpy change when six moles of hydrogen fluoride are produced

- 8 The standard enthalpy changes of combustion of carbon, hydrogen and methanol are shown.



Which expression gives the standard enthalpy change of formation of methanol in kJ mol^{-1} ?

- A $-394 + (-286) - (-726)$
 B $-394 + (-286 \times 2) - 726$
 C $-394 + (-286 \times 2) - (-726)$
 D $-726 - (-394) - (-286 \times 2)$

- 6 A butane burner is used to heat water. The M_r of butane is 58.

- ΔH_c^\ominus of butane is $-2877 \text{ kJ mol}^{-1}$.
- 250 g of water is heated from 12°C to 100°C .
- The burner transfers 47% of the heat released from the burning fuel to the water.

Assume that the butane undergoes complete combustion and none of the water evaporates.

What is the minimum mass of butane that must be burnt?

- A 0.068 g B 1.85 g C 3.94 g D 4.48 g

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 Which statements are correct for all exothermic reactions?

- ΔH for the reaction is negative.
- On a reaction pathway diagram the products are shown lower than the reactants.
- The reaction will occur without heating.

- 7 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.



By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, ΔH_f^\ominus , of butane?

substance	$\Delta H_c^\ominus / \text{kJ mol}^{-1}$
C(s)	-394
H ₂ (g)	-286
C ₄ H ₁₀ (g)	-2877

- A $-5883 \text{ kJ mol}^{-1}$
 B -129 kJ mol^{-1}
 C $+129 \text{ kJ mol}^{-1}$
 D $+2197 \text{ kJ mol}^{-1}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 Calcium reacts with water to form calcium hydroxide and hydrogen.



The standard enthalpy change for this reaction is -414 kJ mol^{-1} .

What further information is needed in order to calculate the standard enthalpy change of formation of calcium hydroxide, $\Delta H_f^\ominus \text{Ca(OH)}_2(\text{s})$?

- ΔH_f^\ominus for H₂O(l)
- ΔH_f^\ominus for H₂(g)
- first and second ionisation energies of Ca



- 9 Hess' Law and bond energy data can be used to calculate the enthalpy change of a reaction.

Bromoethane, $\text{CH}_3\text{CH}_2\text{Br}$, can be made by reacting ethene with hydrogen bromide.



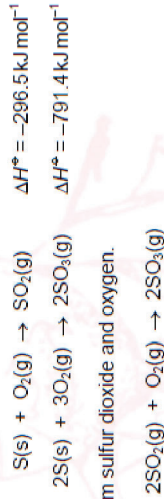
What is the enthalpy change for this reaction?

- A -674 kJ mol^{-1}
 B -64 kJ mol^{-1}
 C $+186 \text{ kJ mol}^{-1}$
 D $+346 \text{ kJ mol}^{-1}$

- 8 Which equation represents the standard enthalpy change of formation of water?

- A $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g})$
 B $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
 C $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$
 D $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$

- 8 Sulfur can be oxidised in two ways.



Sulfur trioxide can be made from sulfur dioxide and oxygen.



What is the standard enthalpy change for this reaction?

- A $-1384.4 \text{ kJ mol}^{-1}$
 B $-989.8 \text{ kJ mol}^{-1}$
 C $-494.9 \text{ kJ mol}^{-1}$
 D $-198.4 \text{ kJ mol}^{-1}$

- 11 200 g of water are at 25°C .

The water is heated to 75°C by burning 2 g of ethanol.

What is the amount of energy transferred to the water?

- A 0.418 kJ B 10.4 kJ C 41.8 kJ D 62.7 kJ

- 7 Which expression gives the standard enthalpy change of combustion of methane?

- A $\Delta H_f^\circ(\text{CH}_4) + \Delta H_f^\circ(\text{CO}_2) - 2\Delta H_f^\circ(\text{H}_2\text{O})$
 B $\Delta H_f^\circ(\text{CO}_2) + 2\Delta H_f^\circ(\text{H}_2\text{O}) + \Delta H_f^\circ(\text{CH}_4)$
 C $\Delta H_f^\circ(\text{CH}_4) + 2\Delta H_f^\circ(\text{H}_2\text{O}) - \Delta H_f^\circ(\text{CO}_2)$
 D $\Delta H_f^\circ(\text{CO}_2) + 2\Delta H_f^\circ(\text{H}_2\text{O}) - \Delta H_f^\circ(\text{CH}_4)$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 A reaction between carbon and oxygen is shown.



How can the enthalpy change of this reaction be described correctly?

- 1 enthalpy change of formation
 2 enthalpy change of combustion
 3 enthalpy change of atomisation

- 9 All the reactants and products of an exothermic reaction are gaseous.

Which statement about this reaction is correct?

- A The total bond energy of the products is less than the total bond energy of the reactants, and ΔH for the reaction is negative.
 B The total bond energy of the products is less than the total bond energy of the reactants, and ΔH for the reaction is positive.
 C The total bond energy of the products is more than the total bond energy of the reactants, and ΔH for the reaction is negative.
 D The total bond energy of the products is more than the total bond energy of the reactants, and ΔH for the reaction is positive.



Topic Chem 5 Q# 269/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 7/ www.SmashingScience.org .o)

- 7 A student mixed 25.0 cm^3 of 4.00 mol dm^{-3} hydrochloric acid with an equal volume of 4.00 mol dm^{-3} sodium hydroxide. The initial temperature of both solutions was 15.0°C . The maximum temperature recorded was 30.0°C .

Using these results, what is the enthalpy change of neutralisation of hydrochloric acid?

- A $-62.7 \text{ kJ mol}^{-1}$
B $-31.4 \text{ kJ mol}^{-1}$
C $-15.7 \text{ kJ mol}^{-1}$
D $-3.14 \text{ kJ mol}^{-1}$

Topic Chem 5 Q# 270/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 8/ www.SmashingScience.org .o)

- 8 An important reaction in the manufacture of nitric acid is the catalytic oxidation of ammonia.



For every mole of O_2 that reacts in this way, 181.8 kJ of energy are released.

A factory makes $2.50 \times 10^5 \text{ mol}$ of NO every day.

How much energy, in kJ , is released every day?

- A 3.64×10^7 B 4.55×10^7 C 5.68×10^7 D 2.27×10^8

Topic Chem 5 Q# 271/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 33/ www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

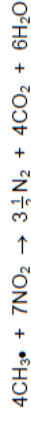
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 For which enthalpy changes is the value of ΔH always negative?

- 1 combustion
2 hydration
3 solution

Topic Chem 5 Q# 272/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 15/ www.SmashingScience.org .o)

- 15 At 550°C nitrogen dioxide reacts with unburnt hydrocarbon fragments such as $\text{CH}_3\cdot$ in the catalytic converter of a motor vehicle.



The following table lists types of energy change for this reaction and possible reasons for them.

Which row gives the energy change for this reaction and the reason for it?

	energy change of reaction	reason why the reaction is endothermic or exothermic
A	endothermic	chemical energy is converted to heat energy
B	endothermic	the $\text{N}=\text{N}$ bond energy is very high
C	exothermic	CO_2 and H_2O have large negative ΔH_f° values
D	exothermic	double bonds are broken in NO_2

Topic Chem 5 Q# 273/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 8/ www.SmashingScience.org .o)

- 8 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating. The table gives the bond energies.

bond	bond energy/ kJ mol^{-1}
$\text{P}-\text{Cl}$ (in both chlorides)	330
$\text{Cl}-\text{Cl}$	242

What is the enthalpy change for the decomposition of PCl_5 to PCl_3 and Cl_2 ?

- A -418 kJ mol^{-1}
B -88 kJ mol^{-1}
C $+88 \text{ kJ mol}^{-1}$
D $+418 \text{ kJ mol}^{-1}$

Topic Chem 5 Q# 269/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 7/ www.SmashingScience.org .o)

- 7 A student mixed 25.0 cm^3 of 4.00 mol dm^{-3} hydrochloric acid with an equal volume of 4.00 mol dm^{-3} sodium hydroxide. The initial temperature of both solutions was 15.0°C . The maximum temperature recorded was 30.0°C .

Using these results, what is the enthalpy change of neutralisation of hydrochloric acid?

- A $-62.7 \text{ kJ mol}^{-1}$
B $-31.4 \text{ kJ mol}^{-1}$
C $-15.7 \text{ kJ mol}^{-1}$
D $-3.14 \text{ kJ mol}^{-1}$

Topic Chem 5 Q# 270/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 8/ www.SmashingScience.org .o)

- 8 An important reaction in the manufacture of nitric acid is the catalytic oxidation of ammonia.



For every mole of O_2 that reacts in this way, 181.8 kJ of energy are released.

A factory makes $2.50 \times 10^5 \text{ mol}$ of NO every day.

How much energy, in kJ , is released every day?

- A 3.64×10^7 B 4.55×10^7 C 5.68×10^7 D 2.27×10^8

Topic Chem 5 Q# 271/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 33/ www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

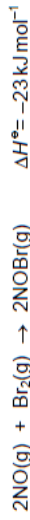
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 For which enthalpy changes is the value of ΔH always negative?

- 1 combustion
2 hydration
3 solution

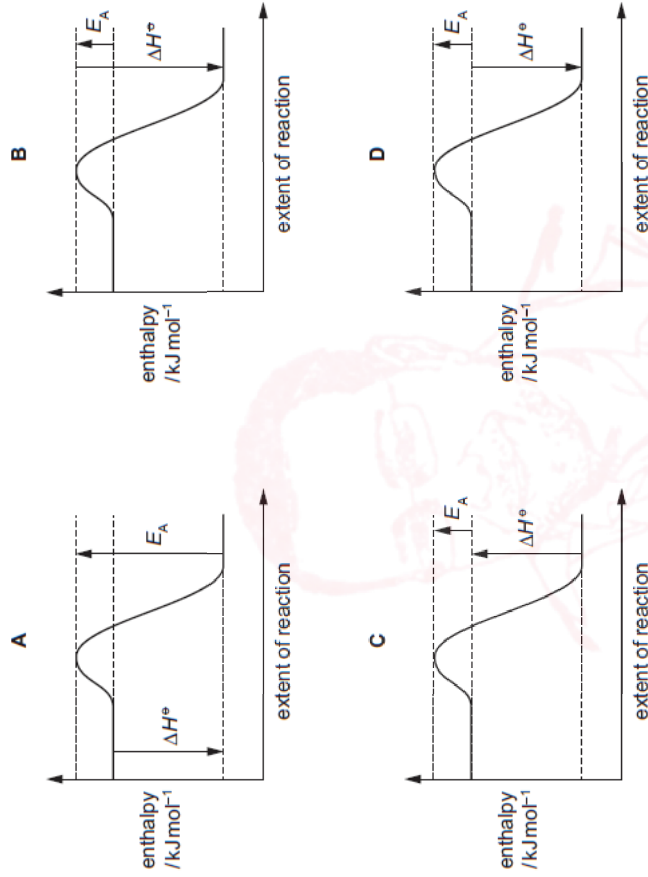


- 5 Nitric oxide, NO, and bromine vapour react together according to the following equation.



The reaction has an activation energy of +5.4 kJ mol⁻¹.

What is the correct reaction pathway diagram for this reaction?

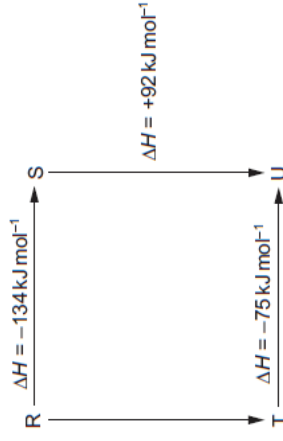


Topic Chem 5 Q# 275/ AS Chemistry/2016/m/TZ.2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 The diagram illustrates the enthalpy changes of a set of reactions



Which statements are correct?

- The enthalpy change for the transformation U → R is +42 kJ mol⁻¹.
- The enthalpy change for the transformation T → S is endothermic.
- The enthalpy change for the transformation R → T is -33 kJ mol⁻¹.

Topic Chem 5 Q# 276/ AS Chemistry/2016/m/TZ.2/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 Which equation has an enthalpy change of reaction which corresponds to the standard enthalpy change of atomisation of chlorine?

- A $\frac{1}{2} \text{Cl}_2(\text{g}) \rightarrow \text{Cl}(\text{g})$
 B $\frac{1}{2} \text{Cl}_2(\text{l}) \rightarrow \text{Cl}(\text{g})$
 C $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$
 D $\text{Cl}_2(\text{l}) \rightarrow 2\text{Cl}(\text{g})$

Topic Chem 5 Q# 277/ AS Chemistry/2015/w/TZ.1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 Use of the Data Booklet is relevant for this question.

In an experiment, the burning of 1.45 g (0.025 mol) of propanone was used to heat 100 g of water. The initial temperature of the water was 20.0 °C and the final temperature of the water was 78.0 °C.

Which experimental value for the enthalpy change of combustion for propanone can be calculated from these results?

- A -1304 kJ mol⁻¹
 B -970 kJ mol⁻¹
 C -352 kJ mol⁻¹
 D -24.2 kJ mol⁻¹



- 6 Solid sulfur consists of molecules made up of eight atoms covalently bonded together.

The bonding in sulfur dioxide is O=S=O.

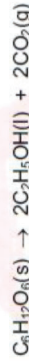
- enthalpy change of combustion of S₈, $\Delta H_c^\circ \text{S}_8(\text{s}) = -2376 \text{ kJ mol}^{-1}$
 energy required to break 1 mole S₈(s) into gaseous atoms = 2232 kJ mol^{-1}
 O=O bond enthalpy = 496 kJ mol^{-1}

Using these data, what is the value of the S=O bond enthalpy?

- A 239 kJ mol⁻¹ B 257 kJ mol⁻¹ C 319 kJ mol⁻¹ D 536 kJ mol⁻¹

- 7 The standard enthalpy changes of combustion of glucose and ethanol are given as -2820 and $-1368 \text{ kJ mol}^{-1}$ respectively.

Glucose, C₆H₁₂O₆, can be converted into ethanol.

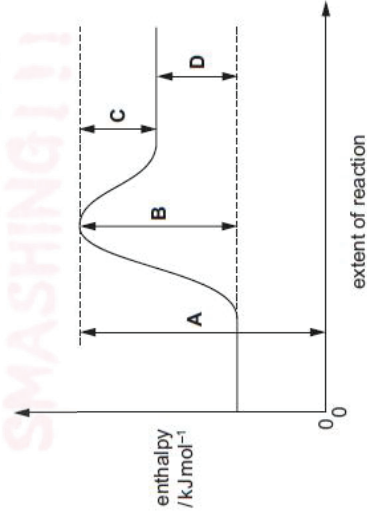


What is the standard enthalpy change for this reaction?

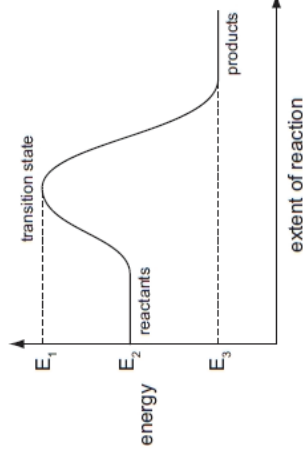
- A $-1452 \text{ kJ mol}^{-1}$
 B -84 kJ mol^{-1}
 C $+84 \text{ kJ mol}^{-1}$
 D $+1452 \text{ kJ mol}^{-1}$

- 11 The diagram shows a reaction pathway for an endothermic reaction.

Which arrow represents the activation energy for the forward reaction?



- 8 The reaction pathway diagram below illustrates the energies of the reactants, the products and the transition state of a reaction.



Which expression represents the activation energy of the forward reaction?

- A $E_1 - E_2$ B $E_2 - E_1$ C $E_2 - E_3$ D $E_3 - E_2$

- 7 In an experiment to calculate the enthalpy change of combustion of a fuel, 1.5g (0.0326 mol) of the fuel was used to heat 200g of water. The temperature of the water rose from 25°C to 55°C . The specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$.

There is significant heat loss in this experiment. Therefore, the experimental value for the enthalpy change of combustion, ΔH_c , of the fuel will be different from the theoretical value.

Using the information above, what is the experimental value for the enthalpy change of combustion, ΔH_c , of the fuel?

- A $-1410 \text{ kJ mol}^{-1}$
 B -769 kJ mol^{-1}
 C $-30.7 \text{ kJ mol}^{-1}$
 D $-16.7 \text{ kJ mol}^{-1}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



32 Use of the Data Booklet is relevant to this question.

The bond energy of the Br–O bond is 235 kJ mol⁻¹.

Which reactions are exothermic?

- 1 OH• + HBr → H₂ + BrO•
- 2 OH• + HBr → H₂O + Br•
- 3 H• + HBr → H₂ + Br•

Topic Chem 5 Q# 284/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

3 Ethanol is increasingly being used as a fuel for cars.

The standard enthalpy change of formation of carbon dioxide is -393 kJ mol⁻¹.
The standard enthalpy change of formation of water is -286 kJ mol⁻¹.
The standard enthalpy change of formation of ethanol is -277 kJ mol⁻¹.

What is the standard enthalpy change of combustion of ethanol?

- A -1921 kJ mol⁻¹
- B -1367 kJ mol⁻¹
- C -956 kJ mol⁻¹
- D -402 kJ mol⁻¹

Topic Chem 5 Q# 285/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org .o)

5 A student mixed 25.0 cm³ of 0.350 mol dm⁻³ sodium hydroxide solution with 25.0 cm³ of 0.350 mol dm⁻³ hydrochloric acid. The temperature rose by 2.50 °C. Assume that no heat was lost to the surroundings.

The final mixture had a specific heat capacity of 4.20 J cm⁻³ K⁻¹.

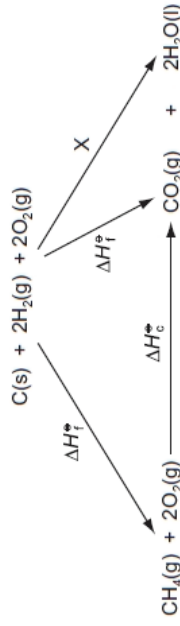
What is the molar enthalpy change for the reaction?

- A -150 kJ mol⁻¹
- B -60.0 kJ mol⁻¹
- C -30.0 kJ mol⁻¹
- D -0.150 kJ mol⁻¹

Topic Chem 5 Q# 286/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

3 Enthalpy changes that are difficult to measure directly can often be determined using Hess' Law to construct an enthalpy cycle.

Which enthalpy change is indicated by X in the enthalpy cycle shown?



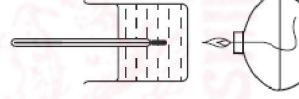
- A -4 × the enthalpy of combustion of hydrogen
- B +4 × the enthalpy of combustion of hydrogen
- C -2 × the enthalpy of formation of water
- D +2 × the enthalpy of formation of water

Topic Chem 5 Q# 287/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org .o)

11 Use of the Data Booklet is relevant to this question.

A student carried out an experiment to determine the enthalpy change for the combustion of methanol.

The following results were obtained by the student.



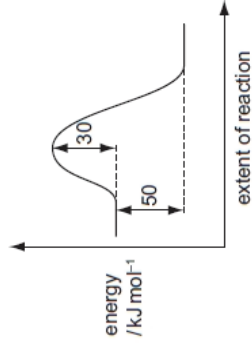
start temperature of the water	20 °C
final temperature of the water	53 °C
mass of alcohol burner before burning	259.65 g
mass of alcohol burner after burning	259.15 g
mass of glass beaker plus water	150.00 g
mass of glass beaker	50.00 g

How much of the heat energy produced by the burning of methanol went into the water?

- A 209 J
- B 13 794 J
- C 20 691 J
- D 22 154 J



- 7 The reaction pathway for a reversible reaction is shown below.



Which statement is correct?

- A The activation energy of the reverse reaction is $+80 \text{ kJ mol}^{-1}$.
 B The enthalpy change for the forward reaction is $+30 \text{ kJ mol}^{-1}$.
 C The enthalpy change for the forward reaction is $+50 \text{ kJ mol}^{-1}$.
 D The enthalpy change for the reverse reaction is $+30 \text{ kJ mol}^{-1}$.

- 12 Use of the Data Booklet is relevant to this question.

This question should be answered using bond enthalpy data. The equation for the complete combustion of methane is given below.



What is the enthalpy change of combustion of methane?

- A $-1530 \text{ kJ mol}^{-1}$
 B $-1184 \text{ kJ mol}^{-1}$
 C -770 kJ mol^{-1}
 D -688 kJ mol^{-1}

- 4 Use of the Data Booklet is relevant to this question.

A reaction which causes the presence of oxides of nitrogen in car exhausts is the formation of NO.



What is the bond energy in kJ mol^{-1} of the bond between the atoms in NO?

- A 655 B 835 C 1310 D 1670

- 11 Which process could be used to calculate the bond energy for the covalent bond X-Y by dividing its ΔH by n ?

- A $\text{XY}_n(\text{g}) \rightarrow \text{X}(\text{g}) + n\text{Y}(\text{g})$
 B $2\text{XY}_n(\text{g}) \rightarrow 2\text{XY}_{n-1}(\text{g}) + \text{Y}_2(\text{g})$
 C $\text{Y}(\text{g}) + \text{XY}_{n-1}(\text{g}) \rightarrow \text{XY}_n(\text{g})$
 D $n\text{XY}(\text{g}) \rightarrow n\text{X}(\text{g}) + \frac{n}{2}\text{Y}_2(\text{g})$

- 10 A student calculated the standard enthalpy change of formation of ethane, C_2H_6 , using a method based on standard enthalpy changes of combustion.

He used correct values for the standard enthalpy change of combustion of ethane ($-1560 \text{ kJ mol}^{-1}$) and hydrogen (-286 kJ mol^{-1}) but he used an incorrect value for the standard enthalpy change of combustion of carbon. He then performed his calculation correctly. His final answer was -158 kJ mol^{-1} .

What did he use for the standard enthalpy change of combustion of carbon?

- A $-1432 \text{ kJ mol}^{-1}$
 B -860 kJ mol^{-1}
 C -430 kJ mol^{-1}
 D -272 kJ mol^{-1}

- 7 Propanone has the molecular formula $\text{C}_3\text{H}_6\text{O}$.

The enthalpy change of combustion of hydrogen is -286 kJ mol^{-1} .

The enthalpy change of combustion of carbon is -394 kJ mol^{-1} .

The enthalpy change of combustion of propanone is $-1786 \text{ kJ mol}^{-1}$.

Using this information, what is the enthalpy change of formation of propanone?

- A $-1106 \text{ kJ mol}^{-1}$
 B -540 kJ mol^{-1}
 C -254 kJ mol^{-1}
 D $+1106 \text{ kJ mol}^{-1}$



- 3 The equation for a reaction is shown.



Which pair of descriptions is fully correct for this reaction?

	type(s) of enthalpy change	value of x
A	formation only	positive
B	formation only	negative
C	combustion, formation	positive
D	combustion, formation	negative

- 6 The standard enthalpy change for the reaction



What is the bond energy of the N-F bond?

- A -556 kJ mol^{-1}
 B -278 kJ mol^{-1}
 C $+278 \text{ kJ mol}^{-1}$
 D $+556 \text{ kJ mol}^{-1}$

- 19 Which reaction is endothermic?

- A $2\text{HBr} \rightarrow \text{H}_2 + \text{Br}_2$
 B $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
 C $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$
 D $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$

- 9 50 cm^3 of 2.50 mol dm^{-3} hydrochloric acid was placed in a polystyrene beaker of negligible heat capacity. Its temperature was recorded and then 50 cm^3 of 2.50 mol dm^{-3} NaOH at the same temperature was quickly added, with stirring. The temperature rose by 17°C .

The resulting solution may be considered to have a specific heat capacity of $4.2 \text{ J g}^{-1} \text{ K}^{-1}$.

What is an approximate value for the molar enthalpy change of neutralisation of hydrochloric acid and sodium hydroxide from this experiment?

- A $\frac{-(50 \times 4.2 \times 17)}{(0.050 \times 2.5)} \text{ J mol}^{-1}$
 B $\frac{-(50 \times 4.2 \times 17)}{(0.10 \times 2.5)} \text{ J mol}^{-1}$
 C $\frac{-(100 \times 4.2 \times 17)}{(0.050 \times 2.5)} \text{ J mol}^{-1}$
 D $\frac{-(100 \times 4.2 \times 17)}{(50 \times 2.5)} \text{ J mol}^{-1}$

- 8 The equation below represents the combination of gaseous atoms of non-metal X and of hydrogen to form gaseous X_2H_6 molecules.



The bond energy of an X-H bond is 395 kJ mol^{-1} .

What is the bond energy of an X-X bond?

- A $-405.0 \text{ kJ mol}^{-1}$
 B $-202.5 \text{ kJ mol}^{-1}$
 C $+202.5 \text{ kJ mol}^{-1}$
 D $+405.0 \text{ kJ mol}^{-1}$

- 9 In a calorimetric experiment 1.60 g of a fuel is burnt. 45% of the energy released is absorbed by 200 g of water whose temperature rises from 18°C to 66°C . The specific heat capacity of water is $4.2 \text{ J g}^{-1} \text{ K}^{-1}$.

What is the total energy released per gram of fuel burnt?

- A 25200 J B 56000 J C 89600 J D 143360 J



- 8 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.



By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, ΔH_f^\ominus , for this reaction?

compound	$\Delta H_c^\ominus/\text{kJ mol}^{-1}$
carbon	-394
hydrogen	-286
butane	-2877

- A -5883 kJ mol⁻¹
 B -129 kJ mol⁻¹
 C +129 kJ mol⁻¹
 D +2197 kJ mol⁻¹

- 5 Given the following enthalpy changes,



What is the standard enthalpy change of formation of iodine trichloride, ICl₃(s)?

- A +176 kJ mol⁻¹
 B -88 kJ mol⁻¹
 C -176 kJ mol⁻¹
 D -214 kJ mol⁻¹

- 4 Some bond energy values are listed below.

bond	bond energy /kJmol ⁻¹
C-H	410
C-Cl	340
C-C	244
Br-Br	193

These bond energy values relate to the following four reactions.



What is the order of enthalpy changes of these reactions from most negative to most positive?

- A P → Q → R → S
 B Q → R → S → P
 C R → Q → P → S
 D S → P → Q → R

- 6 The first stage in the industrial production of nitric acid from ammonia can be represented by the following equation.



Using the following standard enthalpy change of formation data, what is the value of the standard enthalpy change, ΔH_f^\ominus , for this reaction?

compound	$\Delta H_f^\ominus/\text{kJ mol}^{-1}$
NH ₃ (g)	-46.1
NO(g)	+90.3
H ₂ O(g)	-241.8

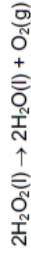
- A +905.2 kJ mol⁻¹
 B -105.4 kJ mol⁻¹
 C -905.2 kJ mol⁻¹
 D -1274.0 kJ mol⁻¹



- 8 Hydrogen peroxide slowly decomposes into water and oxygen. The enthalpy change of reaction can be calculated using standard enthalpies of formation.



Using a Hess cycle, what is the enthalpy change of reaction for this decomposition?



- A +98 kJ mol⁻¹
 B -98 kJ mol⁻¹
 C -196 kJ mol⁻¹
 D -947.2 kJ mol⁻¹

Topic Chem 5 Q# 305/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 For which reactions does the value of ΔH_f° represent both a standard enthalpy change of combustion and a standard enthalpy change of formation?

- 1 C(s) + O₂(g) → CO₂(g)
 2 2C(s) + O₂(g) → 2CO(g)
 3 CO(g) + $\frac{1}{2}$ O₂(g) → CO₂(g)

Topic Chem 6 Q# 306/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 Sodium dichromate(VI), Na₂Cr₂O₇, reacts with hydrogen peroxide, H₂O₂, producing Cr³⁺ ions, water and oxygen.

What is the correctly balanced ionic equation for this reaction?

- A Cr₂O₇²⁻ + 2H⁺ + H₂O₂ → 2Cr³⁺ + 2H₂O + 4O₂
 B Cr₂O₇²⁻ + 8H⁺ + 3H₂O₂ → 2Cr³⁺ + 7H₂O + 3O₂
 C Cr₂O₇²⁻ + 8H⁺ + 6H₂O₂ → 2Cr³⁺ + 10H₂O + 6O₂
 D Cr₂O₇²⁻ + 14H⁺ + 3H₂O₂ → 2Cr³⁺ + 7H₂O + 3O₂

Topic Chem 6 Q# 307/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

- 11 Ammonium ions are converted into nitrate ions by bacteria.

What is the change in the oxidation number of nitrogen?

- A -6 B +6 C +8 D +9

Topic Chem 6 Q# 308/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Solid sodium iodide reacts with concentrated sulfuric acid to form more than one product that contains sulfur.

What is the lowest oxidation number of sulfur in these products?

- A -2 B 0 C +4 D +6

Topic Chem 6 Q# 309/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 In the treatment of domestic water supplies, chlorine is added to water to kill bacteria. Some ClO⁻ ions are formed.

What is the change in oxidation number of chlorine when forming the ClO⁻ ion from aqueous chlorine?

- A -1 B 0 C +1 D +2

Topic Chem 6 Q# 310/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

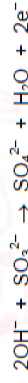
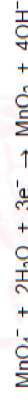
- 11 A student reacts 4 mol of ammonia with oxygen to produce an oxide of nitrogen and water only. Each nitrogen atom increases its oxidation state by 5 in the reaction.

How many moles of oxygen gas react with 4 mol of ammonia in this reaction?

- A 4 mol B 5 mol C 7 mol D 10 mol

Topic Chem 6 Q# 311/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 Two half-equations are shown.



The equation for the reaction between manganate(VII) ions and sulfite ions is shown.



Which statements are correct?

- 1 $u = x = z$
 2 Manganese is reduced to oxidation state +4.
 3 Sulfur is oxidised from oxidation state +4 to +6.

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

Topic Chem 6 Q# 312/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 Zinc atoms can be oxidised to Zn²⁺ ions by dichromate(VI) ions in acid solution. Chromium is reduced to Cr³⁺ in this reaction.

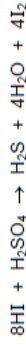
Which equation is correct?

- A Cr₂O₇²⁻ + Zn + 14H⁺ → 2Cr³⁺ + Zn²⁺ + 7H₂O
 B Cr₂O₇²⁻ + Zn + 14H⁺ → 2Cr³⁺ + 3Zn²⁺ + 7H₂O
 C Cr₂O₇²⁻ + 3Zn + 14H⁺ → 2Cr³⁺ + 3Zn²⁺ + 7H₂O
 D 2Cr₂O₇²⁻ + 3Zn + 14H⁺ → 2Cr³⁺ + 3Zn²⁺ + 7H₂O



Topic Chem 6 Q# 313/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 When hydrogen iodide is reacted with concentrated sulfuric acid, several reactions occur, including:

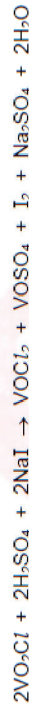


Which row gives the change in oxidation number of iodine and of sulfur in this reaction?

	change in oxidation number of iodine	change in oxidation number of sulfur
A	-1	+6
B	-1	+8
C	+1	-6
D	+1	-8

Topic Chem 6 Q# 314/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 VO_2Cl reacts with NaI under acidic conditions.



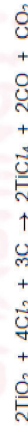
The oxidation state of Cl is -1 in VO_2Cl and in VOCl_2 .

Which row about this reaction is correct?

	vanadium	iodine
A	is oxidised	is oxidised
B	is oxidised	is reduced
C	is reduced	is oxidised
D	is reduced	is reduced

Topic Chem 6 Q# 315/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 The first stage in the chloride process for the manufacture of titanium consists of the following reaction.



What is reduced in this reaction?

- A carbon
- B chlorine
- C oxygen
- D titanium

Topic Chem 6 Q# 316/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 In which reaction does the greatest change in the oxidation number of sulfur occur?

- A $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$
- B $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$
- C $\text{SO}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2\text{S}_2\text{O}_7(\text{l})$
- D $\text{H}_2\text{S}_2\text{O}_7(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2\text{SO}_4(\text{l})$

Topic Chem 6 Q# 317/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 In this question you should use changes in oxidation numbers to balance a chemical equation.

Acidified potassium dichromate(VI) solution can oxidise a solution of V^{2+} ions. The equation for this reaction is shown.



What is the ratio $a : b$ in the correctly balanced equation?

- A 1 : 1
- B 1 : 2
- C 2 : 1
- D 4 : 1

Topic Chem 6 Q# 318/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Cobalt can form the positive ion $\text{Co}(\text{NH}_3)_4\text{Cl}_2^{2+}$.

What is the oxidation number of cobalt in this ion?

- A +1
- B +2
- C +3
- D +6

Topic Chem 6 Q# 319/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 5//www.SmashingScience.org :o)

- 5 In the redox reaction shown, how do the oxidation states of vanadium and sulfur change?



	vanadium		sulfur	
	from	to	from	to
A	+1	+3	0	-2
B	+1	+3	+4	+6
C	+5	+3	0	-2
D	+5	+3	+4	+6

Topic Chem 6 Q# 320/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 When the equation is correctly balanced, what is the value of c ?



- A 3
- B 4
- C 5
- D 6



- 9 In the chemical equation, w, x, y and z are all whole numbers.



When the equation is balanced, what are w, x and y?

	w	x	y
A	1	1	2
B	2	2	2
C	2	3	8
D	3	2	2

- 6 What is the oxidation number of sulfur in each species?

	H ₂ S	SO ₂	H ₂ SO ₃
A	-2	+4	+4
B	-2	+4	+6
C	+2	-4	+4
D	+2	-4	+6

- 9 Ethanedioic acid, HO₂CCO₂H, can be oxidised by KMnO₄ in dilute sulfuric acid. The products of this reaction are carbon dioxide, water, potassium sulfate and manganese(II) sulfate.

In this reaction each ethanedioic acid molecule loses two electrons as it is oxidised. A half-equation for this process is shown.



How many water molecules are produced when five ethanedioic acid molecules are oxidised by KMnO₄ in dilute sulfuric acid?

- A 5 B 8 C 10 D 16

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

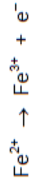
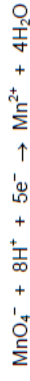
- 33 In which reactions is the underlined element or compound reduced?

- NaClO + H₂O₂ → O₂ + NaCl + H₂O
- 2NH₃ + 2Li → 2LiNH₂ + H₂
- 3CH₃CH2OH + K₂Cr₂O₇ + 4H₂SO₄ → 3CH₃CHO + Cr₂(SO₄)₃ + K₂SO₄ + 7H₂O



- 10 Acidified potassium manganate(VII) reacts with iron(II) ethanedioate, FeC₂O₄.

The reactions taking place are shown.



How many moles of iron(II) ethanedioate react with one mole of potassium manganate(VII)?

- A 0.60 B 1.67 C 2.50 D 5.00

- 8 A transition metal ion, M²⁺, reacts with acidified dichromate(VI) ions to form M³⁺ ions, Cr³⁺ ions, and H₂O.

Which equation correctly represents this reaction?

- A Cr₂O₇²⁻ + 14H⁺ + M²⁺ → 2Cr³⁺ + 7H₂O + M³⁺
 B Cr₂O₇²⁻ + 14H⁺ + 2M²⁺ → 2Cr³⁺ + 7H₂O + 2M³⁺
 C Cr₂O₇²⁻ + 14H⁺ + 3M²⁺ → 2Cr³⁺ + 7H₂O + 3M³⁺
 D Cr₂O₇²⁻ + 14H⁺ + 6M²⁺ → 2Cr³⁺ + 7H₂O + 6M³⁺

- 7 Nitric acid is known to take part in the oxidation of atmospheric sulfur dioxide. One possible reaction is shown.



Which row shows the correct changes in oxidation numbers of nitrogen and sulfur?

	nitrogen	sulfur
A	-3	+3
B	-2	+2
C	-2	+3
D	-1	+2



Topic Chem 6 Q# 328/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

14 Chlorine reacts with **cold** aqueous sodium hydroxide to produce sodium chloride, water and compound X.

Chlorine reacts with **hot** aqueous sodium hydroxide to produce sodium chloride, water and compound Y.

What are the oxidation states of chlorine in compound X and compound Y?

	X	Y
A	-1	-5
B	-1	+5
C	+1	-5
D	+1	+5

Topic Chem 6 Q# 329/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 10//www.SmashingScience.org .o)

10 Which reaction is **not** a redox reaction?

- A $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$
- B $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$
- C $SO_2 + NO_2 \rightarrow SO_3 + NO$
- D $SO_3 + H_2O \rightarrow H_2SO_4$

Topic Chem 6 Q# 330/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 6//

6 One of the reactions in a lead/acid cell is shown.



Which statement about this reaction is correct?

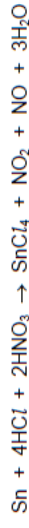
- A Lead is both oxidised and reduced.
- B Lead is neither oxidised nor reduced.
- C Lead is oxidised only.
- D Lead is reduced only.

Topic Chem 6 Q# 331/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 33//

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 One way of recovering tin from old printed circuit boards is to dissolve it in a mixture of concentrated hydrochloric acid and concentrated nitric acid. The tin dissolves because it reacts with the mixture of these concentrated acids.



Which statements about this reaction are correct?

- 1 Nitrogen is present in three different oxidation states in the reactants and products.
 - 2 The oxidation state of tin increases from 0 to +4.
 - 3 The oxidation state of chlorine remains the same.
- Topic Chem 6 Q# 332/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org .o)
- 9 When K_2MnO_4 is dissolved in water, the following reaction occurs.



What are the values of a and c in the balanced chemical equation?

	a	c
A	2	1
B	3	2
C	4	3
D	5	4

Topic Chem 6 Q# 333/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

17 When concentrated sulfuric acid reacts with sodium iodide the products include sulfur, iodine, hydrogen sulfide and sulfur dioxide.

Which statement is correct?

- A Hydrogen sulfide is the product of a reduction reaction.
- B Iodide ions are stronger oxidising agents than sulfate ions.
- C Sulfur atoms from the sulfuric acid are both oxidised and reduced.
- D Sulfur atoms from the sulfuric acid are oxidised to make sulfur dioxide.

Topic Chem 6 Q# 334/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 36//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



36 Sodium chloride and sodium iodide react with concentrated sulfuric acid.

Which statements are correct?

- 1 Sodium chloride is not oxidised by concentrated sulfuric acid.
- 2 No colour change is seen when concentrated sulfuric acid is added to sodium chloride.
- 3 Sodium iodide is oxidised by concentrated sulfuric acid.

Topic Chem 6 Q# 335/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

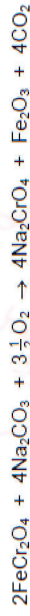
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Which of these statements are always correct?

- 1 The sum of the oxidation numbers of all the atoms in a compound is zero.
- 2 The oxidation number of sodium in a salt is positive.
- 3 The oxidation number of chlorine in a compound is negative.

Topic Chem 6 Q# 336/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

9 Sodium chromate(VI), Na_2CrO_4 , is manufactured by heating chromite, FeCr_2O_4 , with sodium carbonate in an oxidising atmosphere. Chromite contains $\text{Cr}_2\text{O}_4^{2-}$ ions.



What happens in this reaction?

- A Chromium and iron are the only elements oxidised.
- B Chromium, iron and carbon are oxidised.
- C Only chromium is oxidised.
- D Only iron is oxidised.

Topic Chem 6 Q# 337/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)

3 The reaction between acidified dichromate(VI) ions, $\text{Cr}_2\text{O}_7^{2-}$, and aqueous Fe^{2+} ions results in the dichromate(VI) ions being reduced to Cr^{3+} ions.

What is the correct equation for this reaction?

- A $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + \text{Fe}^{3+} + 7\text{H}_2\text{O}$
- B $\text{Cr}_2\text{O}_7^{2-} + 2\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 2\text{Fe}^{3+} + 7\text{H}_2\text{O}$
- C $\text{Cr}_2\text{O}_7^{2-} + 3\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{Fe}^{3+} + 7\text{H}_2\text{O}$
- D $\text{Cr}_2\text{O}_7^{2-} + 6\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$

Topic Chem 6 Q# 338/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Bromine reacts with water.



Which oxidation states of bromine are present in the equilibrium mixture?

- 1 +3
- 2 0
- 3 -1

Topic Chem 6 Q# 339/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 Which compound contains two different elements with identical oxidation states?

- A HClO
- B $\text{Mg}(\text{OH})_2$
- C Na_2SO_4
- D NH_4Cl

Topic Chem 6 Q# 340/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 The salt NaClO_3 is used as a non-selective weedkiller.

On careful heating, this reaction occurs: $4\text{NaClO}_3 \rightarrow \text{NaCl} + 3\text{NaClO}_4$.

On strong heating this reaction occurs: $\text{NaClO}_4 \rightarrow \text{NaCl} + 2\text{O}_2$.

The overall reaction is $2\text{NaClO}_3 \rightarrow 2\text{NaCl} + 3\text{O}_2$.

What do these equations show?

- 1 NaClO_3 can behave as an oxidising agent.
- 2 NaClO_3 can behave as a reducing agent.
- 3 The oxidation numbers of chlorine in the three compounds shown are +6, +8 and -1.



- 4 In oxygen difluoride, OF₂, fluorine has an oxidation number of -1. OF₂ will react with sulfur dioxide according to the following equation.

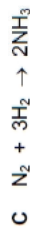


What is oxidised and what is reduced in this reaction?

	fluorine	oxygen in OF ₂	sulfur
A	oxidised	oxidised	reduced
B	oxidised	reduced	oxidised
C	reduced	oxidised	reduced
D	reduced	reduced	oxidised

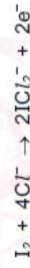
Topic Chem 6 Q# 342/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 In which reaction does hydrogen behave as an oxidising agent?



Topic Chem 6 Q# 343/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

- 3 The following half reactions occur when potassium iodate(V), KIO₃, in hydrochloric acid solution oxidises iodine to ICl₂⁻.



What is the ratio of IO₃⁻ to I₂ in the balanced chemical equation for the overall reaction?

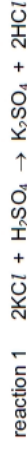
- A 1 : 1 B 1 : 2 C 1 : 4 D 2 : 1

Topic Chem 6 Q# 344/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 In which reaction does a single nitrogen atom have the greatest change in oxidation number?



- 16 Solid potassium halides react with concentrated sulfuric acid, according to the following equations.



What is the largest change in the oxidation number of sulfur in each of these reactions?

	reaction 1	reaction 2	reaction 3
A	0	0	4
B	0	2	4
C	0	2	8
D	0	4	8

Topic Chem 6 Q# 346/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org .o)

- 11 A solution of Sn²⁺ ions will reduce an acidified solution of MnO₄⁻ ions to Mn²⁺ ions. The Sn²⁺ ions are oxidised to Sn⁴⁺ ions in this reaction.

How many moles of Mn²⁺ ions are formed when a solution containing 9.5 g of SnCl₂ (M_r: 190) is added to an excess of acidified KMnO₄ solution?

- A 0.010 B 0.020 C 0.050 D 0.125

Topic Chem 6 Q# 347/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org .o)

- 1 In which reaction does an element undergo the largest change in oxidation state?



Topic Chem 6 Q# 348/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org .o)

- 10 The oxide of titanium, TiO₂, is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate, FeTiO₃.

What is the change, if any, in the oxidation number (oxidation state) of titanium in the reaction FeTiO₃ → TiO₂?

- A It is oxidised from +3 to +4.

- B It is reduced from +3 to +2.

- C It is reduced from +6 to +4.

- D There is no change in the oxidation number.



2 Use of the Data Booklet is relevant to this question.

Lead(IV) chloride will oxidise bromide ions to bromine. The Pb^{4+} ions are reduced to Pb^{2+} ions in this reaction.

If 6.980 g of lead(IV) chloride is added to an excess of sodium bromide solution, what mass of bromine would be produced?

- A 0.799g B 1.598g C 3.196g D 6.392g

2 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

In which step is the change in oxidation number (oxidation state) of nitrogen different to the changes in the other steps?



4 Sulfur dioxide, SO_2 , is added to wines to prevent oxidation of ethanol by air. To determine the amount of SO_2 , a sample of wine is titrated with iodine, I_2 . In this reaction, one mole of SO_2 is oxidised by one mole of I_2 .

What is the change in oxidation number of sulfur in this reaction?

- A +2 to +4 B +2 to +6 C +4 to +5 D +4 to +6

6 Ammonium nitrate, NH_4NO_3 , can decompose explosively when heated.



What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

- A -2, -4 B +2, +6 C +4, -6 D +4, -4

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Sodium hydrosulfide, NaSH , is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

- It contains 18 electrons.
- Three lone pairs of electrons surround the sulfur atom.
- Sulfur has an oxidation state of +2.



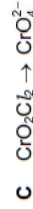
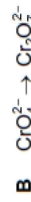
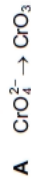
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

32 Which reactions are redox reactions?



7 Which conversion involves a reduction of chromium?



14 Ethanol is produced industrially by reacting ethene and steam.



K_p has a value of 1.8×10^{-5} and the partial pressures of the reactants at equilibrium are shown.

reactant	partial pressure /kPa
ethene	4.8×10^3
steam	2.8×10^3

Which row is correct?

	partial pressure of ethanol at equilibrium /kPa	units of K_p
A	2.42×10^2	kPa^{-1}
B	2.42×10^2	kPa
C	7.47×10^{11}	kPa^{-1}
D	7.47×10^{11}	kPa



13 In which equilibrium reaction is the position of equilibrium moved to the right-hand side by increasing the temperature and also by decreasing the pressure?

- A $\text{H}_2(\text{g}) + \text{CO}_2(\text{g}) \rightleftharpoons \text{H}_2\text{O}(\text{g}) + \text{CO}(\text{g})$ $\Delta H = 40 \text{ kJ mol}^{-1}$
 B $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ $\Delta H = 58 \text{ kJ mol}^{-1}$
 C $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ $\Delta H = -197 \text{ kJ mol}^{-1}$
 D $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ $\Delta H = -10 \text{ kJ mol}^{-1}$

14 SO_3 is manufactured from SO_2 and O_2 in the Contact process.

The reaction is exothermic.

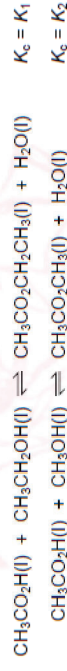
Which row shows the effect on the equilibrium yield obtained in the Contact process of increasing the temperature and of adding a vanadium(V) oxide catalyst?

	increasing the temperature	adding vanadium(V) oxide as catalyst
A	equilibrium yield decreases	equilibrium yield increases
B	equilibrium yield decreases	equilibrium yield unchanged
C	equilibrium yield increases	equilibrium yield unchanged
D	equilibrium yield increases	equilibrium yield increases

13 Ethanoic acid is mixed with ethanol.

The ethanol is contaminated with a small amount of methanol.

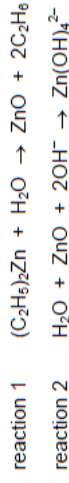
The following equilibria are established.



Which statement about the equilibrium mixture is correct?

- A Only ethyl ethanoate will be formed because there is much more ethanol present than methanol.
 B In this mixture $\frac{[\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3]}{[\text{CH}_3\text{CO}_2\text{CH}_3]} = \frac{K_1}{K_2}$.
 C Adding water to the mixture will alter the mole ratio of the two esters.
 D Adding methyl ethanoate to the mixture will increase the number of moles of ethyl ethanoate.

13 Diethylzinc, $(\text{C}_2\text{H}_5)_2\text{Zn}$, is added to $\text{NaOH}(\text{aq})$. Two reactions occur.



In these reactions, which compounds act as Brønsted–Lowry acids?

	reaction 1	reaction 2
A	$(\text{C}_2\text{H}_5)_2\text{Zn}$	H_2O
B	H_2O	H_2O
C	H_2O	ZnO
D	the reaction is not acid/base	ZnO

12 Hydrogen and iodine react to form hydrogen iodide in an exothermic reaction. The equation is shown.



A 1 m^3 reaction vessel contains H_2 , I_2 and HI gases at equilibrium. The temperature is changed such that the total pressure in the 1 m^3 vessel doubles.

What is the effect on the value of K_p and on the position of equilibrium?

	effect on the value of K_p	effect on the position of equilibrium
A	decreases	moves left
B	increases	moves right
C	no change	moves left
D	no change	no change

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



32 Iron reacts with steam to produce hydrogen and an oxide of iron.



A system containing all four substances is at equilibrium.

Which changes will decrease the mass of Fe present at equilibrium?

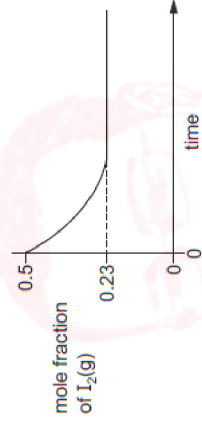
- 1 addition of steam at constant pressure
- 2 increase in overall pressure
- 3 addition of an effective catalyst

Topic Chem 7 Q# 363 / AS Chemistry/2021/m/TZ.1/Paper.1/Exam Q# 10/ /www.SmashingScience.org :o)

10 The equation shows that $\text{H}_2\text{(g)}$ and $\text{I}_2\text{(g)}$ react to form an equilibrium mixture.

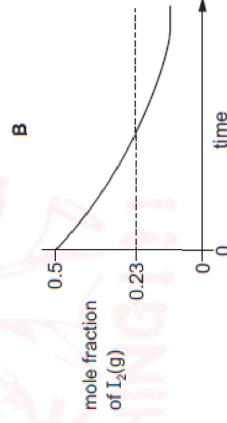
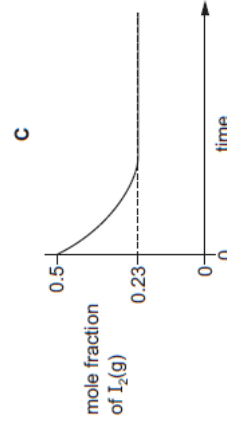
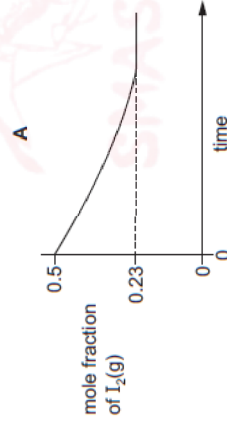


A mixture containing equal amounts of $\text{H}_2\text{(g)}$ and $\text{I}_2\text{(g)}$ is made at temperature T_1 and the composition of the mixture is monitored. A graph of the results is shown.



The experiment is repeated at a lower temperature, T_2 .

Which new graph would be obtained?



Topic Chem 7 Q# 364 / AS Chemistry/2021/s/TZ.1/Paper.1/Exam Q# 31/ /www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Ethanol combines with ethanoic acid to form ethyl ethanoate according to the following reaction.



9.2 g ethanol, 12 g ethanoic acid and 8.8 g ethyl ethanoate are mixed and allowed to stand at 298 K, until equilibrium is reached.

(M_r: C₂H₅OH, 46; CH₃CO₂H, 60; CH₃CO₂C₂H₅, 88)

The resulting equilibrium mixture is found to contain 4.8 g ethanoic acid.

The experiment is repeated at 323 K.

Which statements are correct?

- 1 There are 0.22 moles of ethyl ethanoate in the mixture at equilibrium at 298 K.
- 2 The equilibrium mixture at 323 K will contain more than 4.8 g of ethanoic acid.
- 3 If a small amount of water is added at the start of either experiment the value of K_c would not be affected.

Topic Chem 7 Q# 365 / AS Chemistry/2021/m/TZ.2/Paper.1/Exam Q# 9/ /www.SmashingScience.org :o)

9 In which reaction is water behaving as a Brønsted–Lowry base?

- A $\text{H}_2\text{O} + \text{Na} \rightarrow \text{NaOH} + \frac{1}{2}\text{H}_2$
- B $\text{H}_2\text{O} + \text{H}_3\text{PO}_4 \rightarrow \text{H}_3\text{O}^+ + \text{H}_2\text{PO}_4^-$
- C $\text{H}_2\text{O} + \text{CaO} \rightarrow \text{Ca(OH)}_2$
- D $\text{NH}_3 + [\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{NH}_4^+ + [\text{Cu}(\text{H}_2\text{O})_5(\text{OH})]^{+}$

Topic Chem 7 Q# 366 / AS Chemistry/2021/m/TZ.2/Paper.1/Exam Q# 31/ /www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 31 A sample of 17.15 mol HI(g) is in dynamic equilibrium with 2.27 mol H₂(g) and 2.84 mol I₂(g) in a volume of 1 m³ at 764 K and 141 kPa.



Two equilibrium constants, K_c and K_p , can be calculated for this mixture.

Which statements about the equilibrium constants for this mixture are correct?

- neither K_c nor K_p has any units
- $K_c = 45.6$
- $K_c > K_p$

Topic Chem 7 Q# 367/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Methanol, CH₃OH, can be produced industrially by reacting CO with H₂.



The process can be carried out at 4 × 10³ kPa and 1150 K.

Which statements about this reaction are correct?

- Increasing the temperature will increase the rate of reaction because more effective collisions will occur.
- Lowering the temperature will reduce the rate of reaction because the forward reaction is exothermic.
- Increasing the pressure will reduce the rate of reaction because there are a larger number of moles on the left-hand side of the equation.

Topic Chem 7 Q# 368/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 The units of K_c for an equilibrium reaction are mol⁻¹ dm³.

What could be the equation for the equilibrium?

- A(aq) + B(aq) ⇌ C(s) + D(aq)
- P(aq) + Q(aq) ⇌ R(aq)
- W(aq) + 2X(aq) ⇌ Y(aq) + Z(aq)

Topic Chem 7 Q# 369/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 In aqueous solution, sulfuric acid dissociates as shown.



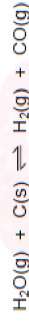
Analysis of a 2.00 mol dm⁻³ solution of H₂SO₄ found the HSO₄⁻ concentration to be 1.988 mol dm⁻³.

What is K_c ?

- 1.381 × 10⁵ dm³ mol⁻¹
- 82.34 dm² mol⁻¹
- 1.214 × 10⁻² mol dm⁻³
- 7.244 × 10⁻⁵ mol dm⁻³

Topic Chem 7 Q# 370/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

- 7 What are the units of K_p for the reaction shown?



- Pa⁻¹
- Pa
- Pa²
- no units

Topic Chem 7 Q# 371/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Carbon monoxide burns readily in oxygen to form carbon dioxide.

What does this information suggest?

- The +4 oxidation state of carbon is more stable than the +2 state.
- The standard enthalpy change of formation of carbon dioxide is more negative than the standard enthalpy change of formation of carbon monoxide.
- The value of the equilibrium constant for the reaction, 2CO(g) + O₂(g) ⇌ 2CO₂(g), is likely to be high.



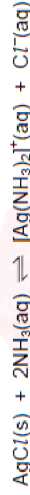
1 Ethene can be oxidised to form epoxyethane, C₂H₄O.



Which set of conditions gives the greatest yield of epoxyethane at equilibrium?

	pressure	temperature / °C
A	high	100
B	high	200
C	low	100
D	low	200

6 The equation for the reaction between silver chloride and aqueous ammonia is shown.



What are the units of K_c for this reaction?

A no units B mol⁻¹dm³ C mol dm⁻³ D mol²dm⁻⁶

15 Solid ammonium nitrate is put into a test-tube and solution X is added to it. The resulting mixture is warmed and the gas given off is tested with damp red litmus paper. The litmus paper changes colour from red to blue.

What could be the identity of X and its role in the reaction?

	identity of X	role of X
A	NaOH(aq)	proton donor
B	NaOH(aq)	proton acceptor
C	HCl(aq)	proton donor
D	HCl(aq)	proton acceptor

11 The main stage in the Contact process is an equilibrium reaction.



Which row describes the effect of the named condition on the equilibrium yield?

	presence of catalyst	high pressure	high temperature
A	no effect on yield	decreases yield	increases yield
B	no effect on yield	increases yield	decreases yield
C	increases yield	decreases yield	increases yield
D	increases yield	increases yield	decreases yield

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 The stoichiometry of a catalysed reaction is shown by the equation below.



Two experiments are carried out in which the amount of R is measured. The results are shown in the diagram.



Which changes in the conditions could explain the results shown?

- 1 A lower pressure was used in experiment 2.
- 2 A different catalyst was used in experiment 2.
- 3 Product S was continuously removed from the reaction vessel in experiment 2.

18 Which type of reaction occurs when solid ammonium sulfate is heated with an excess of sodium hydroxide solution?

- A acid-base
- B precipitation
- C redox
- D thermal decomposition

11 The reaction between sulfur dioxide and oxygen is reversible.



In an equilibrium mixture at 1000 K the sulfur dioxide concentration is 0.200 mol dm⁻³ and the oxygen concentration is 0.100 mol dm⁻³.

What is the sulfur trioxide concentration?

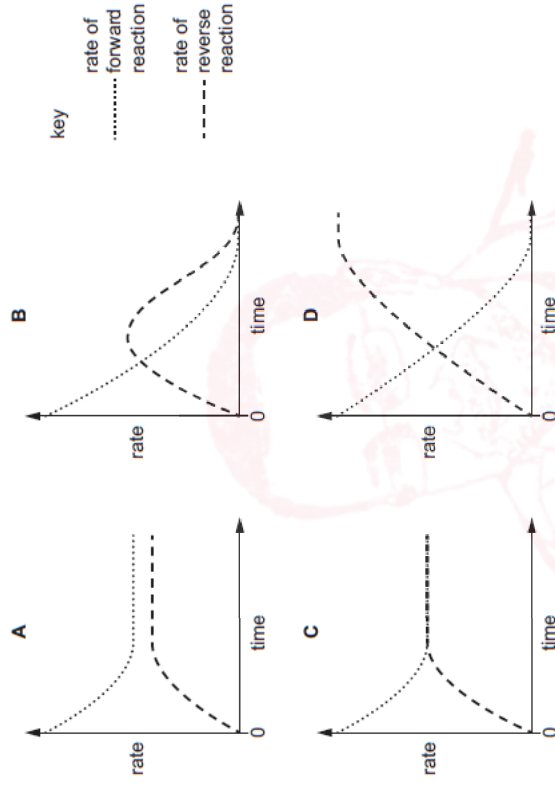
- A 1.058 mol dm⁻³
- B 1.120 mol dm⁻³
- C 2.366 mol dm⁻³
- D 5.600 mol dm⁻³

- 10 Two compounds X and Y react to produce compound Z. The reaction is reversible.



When X and Y are mixed together in a closed system a dynamic equilibrium is gradually established.

Which graph could represent the change in the rates of the forward and reverse reactions over time?



- 11 The reaction between sulfur dioxide and oxygen is reversible.



In an equilibrium mixture at 1000 K the sulfur trioxide concentration is 6.00 mol dm^{-3} .

The sulfur dioxide concentration is twice the oxygen concentration.

What is the sulfur dioxide concentration?

- A $0.175 \text{ mol dm}^{-3}$
 B $0.254 \text{ mol dm}^{-3}$
 C $0.318 \text{ mol dm}^{-3}$
 D $0.636 \text{ mol dm}^{-3}$



- 10 Hydrogen iodide gas decomposes reversibly producing iodine vapour and hydrogen.



The position of the equilibrium for this reaction may be altered by changing the external conditions.

Which row correctly describes the change in position of equilibrium?

	effect of increasing the pressure	effect of increasing the temperature
A	moves to the right	moves to the right
B	moves to the right	moves to the left
C	no change	moves to the right
D	no change	moves to the left

- 11 When copper is added to a solution of silver ions, the following equilibrium is established.



What is the concentration of silver ions at equilibrium when $[\text{Cu}^{2+}] = 0.10 \text{ mol dm}^{-3}$?

- A $5.0 \times 10^{-7} \text{ mol dm}^{-3}$
 B $5.0 \times 10^{-4} \text{ mol dm}^{-3}$
 C $1.0 \times 10^{-3} \text{ mol dm}^{-3}$
 D $1.0 \times 10^2 \text{ mol dm}^{-3}$

- 9 In this question you should assume that all gases behave ideally.

Hydrogen and iodine react reversibly in the following reaction. The system reaches dynamic equilibrium.



Which statement **must** be true for the K_p of this equilibrium to be constant?

- A The partial pressures of H_2 , I_2 and HI are equal.
 B The external pressure is constant.
 C The forward and reverse reactions have stopped.
 D The temperature is constant.



Topic Chem 7 Q# 384/ AS Chemistry/2018/m/TZ.1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 0.200 mol of sulfur dioxide and 0.200 mol of oxygen are placed in a 1.00 dm³ sealed container. The gases are allowed to react until equilibrium is reached.



At equilibrium there is 0.100 mol of SO₃ in the container.

What is the value of K_c?

- A 0.150 mol dm⁻³
B 0.800 mol dm⁻³
C 1.25 mol⁻¹ dm³
D 6.67 mol⁻¹ dm³

Topic Chem 7 Q# 385/ AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 Oxidation numbers should be used to answer this question.

A redox reaction takes place between hydroxylammonium ions, [NH₂OH]⁺, and acidified iron(III) ions, Fe³⁺. The products are iron(II) ions, Fe²⁺, H⁺ ions, water and a compound of nitrogen.

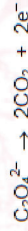
The mole ratio of reacting hydroxylammonium ions to reacting iron(III) ions is 1 : 2.

Which nitrogen-containing compound could be formed in the reaction?

- A NH₃ B N₂O C NO D NO₂

Topic Chem 7 Q# 386/ AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 Ethanedioate ions, C₂O₄²⁻, react with a suitable reagent to form CO₂. A half-equation for this reaction is shown.



Which row is correct?

	oxidation state of carbon in C ₂ O ₄ ²⁻	type of reaction
A	+3	oxidation
B	+3	reduction
C	+5	oxidation
D	+5	reduction

Topic Chem 7 Q# 387/ AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Which statements are correct when a reversible reaction is at equilibrium?

- 1 All species are at equal concentration.
2 The concentrations of all species remain constant.
3 The rate of the forward reaction equals the rate of the reverse reaction.

Topic Chem 7 Q# 388/ AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 One mole of sulfuric acid is used to make an aqueous solution. The solution contains H₂SO₄ molecules, H⁺ ions, SO₄²⁻ ions and HSO₄⁻ ions.

Which statements are correct?

- 1 The solution contains 6.02 × 10²³ sulfur atoms.
2 The solution contains an exactly equal number of H⁺ ions and HSO₄⁻ ions.
3 One mole of SO₄²⁻ ions contains two moles of electrons.

Topic Chem 7 Q# 389/ AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

- 15 In which reaction does ammonia behave as a Brønsted-Lowry base?

- A NH₃ + CH₃CH₂Br → CH₃CH₂NH₂ + HBr
B NH₃ + H₂O + CO₂ → (NH₄)HCO₃
C 2NH₃ + 2Na → 2NaNH₂ + H₂
D 4NH₃ + 3O₂ → 2N₂ + 6H₂O

Topic Chem 7 Q# 390/ AS Chemistry/2018/m/TZ.2/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6 Sodium hydroxide neutralises acid.



In a 11000 dm³ sample of an aqueous solution, the concentration of acid, [H⁺], is 1.26 × 10⁻³ mol dm⁻³.

Which mass of solid sodium hydroxide neutralises the acid?

- A 0.0214 g B 0.0504 g C 236 g D 554 g



Topic Chem 7 Q# 391/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

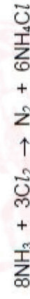
34 In which reactions does NH_3 behave as a Brønsted-Lowry acid?

- $2\text{NH}_3 \rightarrow \text{NH}_2^- + \text{NH}_4^+$
- $\text{HSO}_4^- + \text{NH}_3 \rightarrow \text{SO}_4^{2-} + \text{NH}_4^+$
- $\text{Ag}^+ + 2\text{NH}_3 \rightarrow [\text{Ag}(\text{NH}_3)_2]^+$

Topic Chem 7 Q# 392/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Ammonia and chlorine react together in the gas phase.



Which statements are correct?

- Ammonia behaves as a reducing agent.
- Ammonia behaves as a base.
- The oxidation number of hydrogen changes.

Topic Chem 7 Q# 393/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 12//www.SmashingScience.org :o)
12 Which statement about the effect of a catalyst on a reversible reaction is correct?

- The activation energy of the forward reaction stays the same.
- The composition of the equilibrium mixture stays the same.
- The rate of the backward reaction stays the same.
- The value of the equilibrium constant changes.

Topic Chem 7 Q# 394/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 11//www.SmashingScience.org :o)
11 The reaction between sulfur dioxide and oxygen is reversible.



Which conditions of pressure and temperature favour the reverse reaction?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 Q# 395/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 9//

9 Hydrogen iodide dissociates into hydrogen and iodine.



In an experiment, b mol of hydrogen iodide were put into a sealed vessel at pressure p . At equilibrium, x mol of the hydrogen iodide had dissociated.

Which expression for K_p is correct?

- A $\frac{x^2}{(b-x)^2}$ B $\frac{x^2 p^2}{(b-x)^2}$ C $\frac{x^2 p^2}{4b(b-x)}$ D $\frac{x^2}{4(b-x)^2}$

Topic Chem 7 Q# 396/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 34//
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 The following reaction takes place in a suitable solvent.



Which statements explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

- The ammonium ion acts as a proton donor.
- Na^+Cl^- is a salt.
- Ammonia is a nucleophile.



10 Methanol can be produced from hydrogen and carbon monoxide.



What is the expression for K_p for this reaction?

A $K_p = \frac{(2p_{\text{H}_2})^2 \times p_{\text{CO}}}{p_{\text{CH}_3\text{OH}}}$

B $K_p = \frac{(p_{\text{H}_2})^2 \times p_{\text{CO}}}{p_{\text{CH}_3\text{OH}}}$

C $K_p = \frac{p_{\text{CH}_3\text{OH}}}{(p_{\text{H}_2})^2 \times p_{\text{CO}}}$

D $K_p = \frac{p_{\text{CH}_3\text{OH}}}{p_{\text{CO}} \times (2p_{\text{H}_2})^2}$

8 HOC(l) is the molecule that kills bacteria when chlorine is added to water.

The following reaction produces this molecule.



Which statement about this reaction is correct?

A Chlorine is both oxidised and reduced.

B Chlorine is oxidised but not reduced.

C Hydrogen is both oxidised and reduced.

D Hydrogen is oxidised but not reduced.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Sulfur dioxide and oxygen react in the gas phase.



Which statements are correct?

1 Increasing the pressure increases the equilibrium yield of SO_3 .

2 Increasing the temperature lowers the value of the equilibrium constant K_p .

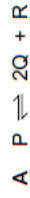
3 The presence of a vanadium(V) oxide catalyst increases the equilibrium yield of SO_3 .



3 Two moles of compound P were placed in a sealed container. The container was heated and P was partially decomposed to produce Q and R only. A dynamic equilibrium between P, Q and R was established.

At equilibrium x moles of R were present and the total number of moles present was $\left(2 + \frac{x}{2}\right)$.

What is the equation for this reversible reaction?



11 Ammonia is manufactured from nitrogen and hydrogen using the Haber process.



What is the expression for K_c for this equilibrium?

A $\frac{2[\text{NH}_3(\text{g})]}{[\text{N}_2(\text{g})] + 3[\text{H}_2(\text{g})]}$

B $\frac{2[\text{NH}_3(\text{g})]}{[\text{N}_2(\text{g})] \times 3[\text{H}_2(\text{g})]}$

C $\frac{[\text{NH}_3(\text{g})]^2}{[\text{N}_2(\text{g})] + [\text{H}_2(\text{g})]^3}$

D $\frac{[\text{NH}_3(\text{g})]^2}{[\text{N}_2(\text{g})] \times [\text{H}_2(\text{g})]^3}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 In the manufacture of sulfuric acid, the following exothermic reaction occurs.



Which changes will move the position of the equilibrium to the right?

1 increasing the pressure

2 increasing the temperature

3 using twice as much catalyst



Topic Chem 7 Q# 403/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 The table shows the partial pressures in an equilibrium mixture formed by the Haber process.

substance	partial pressure/ kPa
nitrogen	7000
hydrogen	8000
ammonia	4000



What is the numerical value of the equilibrium constant, K_p , for this reaction?

- A 4.46×10^{-9}
 B 4.76×10^{-5}
 C 7.14×10^{-5}
 D 2.24×10^8

Topic Chem 7 Q# 404/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 An aqueous solution was prepared containing a mixture of 1.0 mol of AgNO_3 and 1.0 mol of FeSO_4 in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $\text{Ag}^+(\text{aq})$ in the mixture.



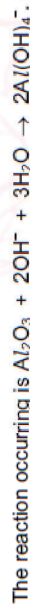
What is the numerical value of K_c ?

- A 0.62 B 1.40 C 1.62 D 2.89

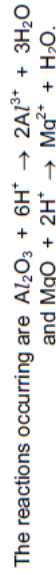
Topic Chem 7 Q# 405/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

- 6 A white powder is known to be a mixture of magnesium oxide and aluminium oxide.

100 cm^3 of 2 mol dm^{-3} $\text{NaOH}(\text{aq})$ is just sufficient to cause the aluminium oxide in x grams of the mixture to dissolve.



800 cm^3 of 2 mol dm^{-3} $\text{HCl}(\text{aq})$ is just sufficient to cause all of the oxide in x grams of the mixture to dissolve.



How many moles of each oxide are present in x grams of the mixture?

	aluminium oxide	magnesium oxide
A	0.05	0.25
B	0.05	0.50
C	0.10	0.25
D	0.10	0.50



Topic Chem 7 Q# 406/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 A piece of rock has a mass of 2.00g. It contains calcium carbonate, but no other basic substances. It neutralises exactly 36.0 cm^3 of 0.500 mol dm^{-3} hydrochloric acid.

What is the percentage of calcium carbonate in the 2.00g piece of rock?

- A 22.5% B 45.0% C 72.0% D 90.1%

Topic Chem 7 Q# 407/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 The equation for the reaction between carbon monoxide and hydrogen is shown.



What are the units of K_p for this reaction?

- A kPa B kPa^{-1} C kPa^2 D kPa^{-2}

Topic Chem 7 Q# 408/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Which statements about reversible reactions are correct?

- 1 An increase in concentration of a reactant always increases the concentration of the product.
 2 An increase in temperature always increases the rate at which the equilibrium is established.
 3 An increase in temperature always increases the concentration of the product at equilibrium.

Topic Chem 7 Q# 409/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 11//www.SmashingScience.org :o)

- 11 In an experiment, 2.00 mol of hydrogen and 3.00 mol of iodine were heated together in a sealed container and allowed to reach equilibrium at a fixed temperature. The container had a fixed volume of 1.00 dm^3 . At equilibrium, there were 2.40 mol of iodine present in the mixture.



What is the value of the equilibrium constant, K_c ?

- A 0.107 B 0.357 C 0.429 D 2.33

Topic Chem 7 Q# 410/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

- 2 Which set of conditions gives the highest yield of ammonia at equilibrium?



	catalyst	pressure	temperature
A	absent	high	low
B	absent	low	high
C	present	high	high
D	present	low	low



Topic Chem 7 Q# 411/ AS Chemistry/2015/w/TZ.1/Paper.1/Exam Q# 11//www.SmashingScience.org :o)

11 Ammonia is made by the Haber process. The reactants are nitrogen and hydrogen.



What will increase the rate of the forward reaction?

- A adding argon to the mixture but keeping the total volume constant
- B decreasing the temperature
- C increasing the total pressure by reducing the total volume at constant temperature
- D removing ammonia as it is made but keeping the total volume of the mixture the same

Topic Chem 7 Q# 412/ AS Chemistry/2015/w/TZ.1/Paper.1/Exam Q# 10//www.SmashingScience.org :o)

10 A mixture of nitrogen and hydrogen gases, at a temperature of 500K, was put into an evacuated vessel of volume 6.0 dm³. The vessel was then sealed.



The mixture was allowed to reach equilibrium. It was found that 7.2 mol of N₂ and 12.0 mol of H₂ were present in the equilibrium mixture. The value of the equilibrium constant, K_c, for this equilibrium is 6.0 × 10⁻² at 500K.

What is the concentration of ammonia present in the equilibrium mixture at 500K?

- A 0.58 mol dm⁻³
- B 0.76 mol dm⁻³
- C 3.5 mol dm⁻³
- D 27 mol dm⁻³

Topic Chem 7 Q# 413/ AS Chemistry/2015/s/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org :o)

9 One molecule of haemoglobin, Hb, can bind with four molecules of oxygen according to the following equation.



When the equilibrium concentration of O₂ is 7.6 × 10⁻⁶ mol dm⁻³, the equilibrium concentrations of Hb and Hb(O₂)₄ are equal.

What is the value of K_c for this equilibrium?

- A 3.0 × 10²⁰
- B 1.3 × 10⁵
- C 7.6 × 10⁻⁶
- D 3.3 × 10⁻²¹

Topic Chem 7 Q# 414/ AS Chemistry/2015/s/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org :o)

8 In which reaction is the underlined substance acting as a base?

- A $\text{HNO}_3 + \underline{\text{H}_2\text{SO}_4} \rightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$
- B $\text{HSiO}_3^- + \underline{\text{HCN}} \rightarrow \text{CN}^- + \text{H}_2\text{O} + \text{SiO}_2$
- C $\text{HNO}_2 + \underline{\text{HCO}_3^-} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{NO}_2^-$
- D $\text{C}_6\text{H}_5\text{O}^- + \underline{\text{CH}_2\text{ClCO}_2\text{H}} \rightarrow \text{C}_6\text{H}_5\text{OH} + \text{CH}_2\text{ClCO}_2^-$

Topic Chem 7 Q# 415/ AS Chemistry/2015/s/TZ.1/Paper.1/Exam Q# 6//www.SmashingScience.org :o)

6 One mole of phosphorus(V) chloride, PCl₅, is heated to 600K in a sealed flask of volume 1 dm³. Equilibrium is established and measurements are taken.



The experiment is repeated with one mole of phosphorus(V) chloride heated to 600K in a sealed flask of volume 2 dm³.

How will the measurements vary?

- A The equilibrium concentrations of PCl₃(g) and Cl₂(g) are higher in the second experiment.
- B The equilibrium concentration of PCl₅(g) is lower in the second experiment.
- C The equilibrium concentrations of all three gases are the same in both experiments.
- D The value of the equilibrium constant is higher in the second experiment.

Topic Chem 7 Q# 416/ AS Chemistry/2014/w/TZ.1/Paper.1/Exam Q# 15//www.SmashingScience.org :o)

15 Use of the Data Booklet is relevant to this question.

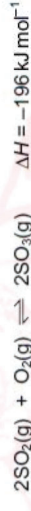
A sample of potassium oxide, K₂O, is dissolved in 250 cm³ of distilled water. 25.0 cm³ of this solution is titrated against sulfuric acid of concentration 2.00 mol dm⁻³. 15.0 cm³ of this sulfuric acid is needed for complete neutralisation.

Which mass of potassium oxide was originally dissolved in 250 cm³ of distilled water?

- A 2.83 g
- B 28.3 g
- C 47.1 g
- D 56.6 g

Topic Chem 7 Q# 417/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 7//www.SmashingScience.org :o)

7 The Contact process is used in the manufacture of sulfuric acid. The equation for the main reaction is shown below.



Which statement about this reaction is incorrect?

- A Increased pressure gives a higher yield of SO₃.
- B Increased temperature gives a higher yield of SO₃.
- C In the forward reaction the oxidation state of sulfur changes from +4 to +6.
- D Vanadium(V) oxide is used as a catalyst.

Topic Chem 7 Q# 418/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 34//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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34 The Brønsted-Lowry theory describes acid and base character.

When concentrated sulfuric acid and concentrated nitric acid are mixed, the following reactions occur.



Which species are bases in these reactions?

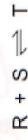
- 1 HSO_4^-
- 2 HNO_3
- 3 NO_2^+

Topic Chem 7 Q# 419/ AS Chemistry/2014/S/TZ.1/Paper.1/Exam Q# 33//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 R and S react together.



Which factors affect the rate of the forward reaction?

- 1 the activation energy of the reaction
 - 2 the enthalpy change of the reaction
 - 3 the equilibrium constant of the reaction
- Topic Chem 7 Q# 420/ AS Chemistry/2014/S/TZ.1/Paper.1/Exam Q# 18//www.SmashingScience.org .o)
- 18 Use of the Data Booklet is relevant to this question.

A chemist took 2.00 dm³ of nitrogen gas, measured under room conditions, and reacted it with a large volume of hydrogen gas, in order to produce ammonia. Only 15.0% of the nitrogen gas reacted to produce ammonia.

What mass of ammonia was formed?

- A 0.213g B 0.425g C 1.42g D 2.83g

Topic Chem 7 Q# 421/ AS Chemistry/2014/S/TZ.1/Paper.1/Exam Q# 10//www.SmashingScience.org .o)

10 The equilibrium constant, K_c , for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, is 60 at 450 °C.

What is the number of moles of hydrogen iodide in equilibrium with 2 mol of hydrogen and 0.3 mol of iodine at 450 °C?

- A $\frac{1}{100}$ B $\frac{1}{10}$ C 6 D 36

Topic Chem 7 Q# 422/ AS Chemistry/2013/W/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

9 Nitrogen reacts with hydrogen to produce ammonia.



A mixture of 2.00 mol of nitrogen, 6.00 mol of hydrogen, and 2.40 mol of ammonia is allowed to reach equilibrium in a sealed vessel of volume 1 dm³ under certain conditions. It was found that 2.32 mol of nitrogen were present in the equilibrium mixture.

What is the value of K_c under these conditions?

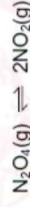
- A $\frac{(1.76)^2}{(2.32)(6.96)^3}$
- B $\frac{(1.76)^2}{(2.32)(6.32)^3}$
- C $\frac{(2.08)^2}{(2.32)(6.32)^3}$
- D $\frac{(2.40)^2}{(2.32)(6.00)^3}$

Topic Chem 7 Q# 423/ AS Chemistry/2013/W/TZ.1/Paper.1/Exam Q# 34//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 If N_2O_4 gas is placed in a sealed vessel the following equilibrium is established.



The forward reaction is endothermic.

What happens when the temperature is increased?

- 1 The equilibrium constant increases.
- 2 The partial pressure of NO_2 increases.
- 3 The activation energy is unchanged.

Topic Chem 7 Q# 424/ AS Chemistry/2013/W/TZ.1/Paper.1/Exam Q# 33//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



33 What are necessary properties of a dynamic equilibrium?

- Equal amounts of reactants and products are present.
 - Concentrations of reactants and products remain constant.
 - The rate of the forward reaction is the same as the rate of the reverse reaction.
- Topic Chem 7 Q# 425/ AS Chemistry/2013/w/TZ.1/Paper.1/Exam Q# 18//www.SmashingScience.org .o)
- 18 Transition metals and their compounds are used as catalysts.

Which row is correct?

	transition metal present in the catalyst used in the Contact process	transition metal present in the catalyst used in the Haber process
A	iron	iron
B	iron	vanadium
C	vanadium	iron
D	vanadium	vanadium

Topic Chem 7 Q# 426/ AS Chemistry/2013/s/TZ.1/Paper.1/Exam Q# 18//www.SmashingScience.org .o)

18 Sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process.

Which condition affects the value of the equilibrium constant, K_c ?

- adjusting the temperature
- increasing the pressure
- removing SO_3 from the equilibrium mixture
- using a catalyst

Topic Chem 7 Q# 427/ AS Chemistry/2012/w/TZ.1/Paper.1/Exam Q# 35//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which equations represent stages in the Contact process for manufacturing sulfuric acid?

- $\text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{SO}_3$
- $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$
- $\text{H}_2\text{SO}_3 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{SO}_4$

Topic Chem 7 Q# 428/ AS Chemistry/2012/s/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

9 Two moles of compound P were placed in a vessel. The compound P was partly decomposed by heating. A dynamic equilibrium between chemicals P, Q and R was established.

At equilibrium, x mol of R were present and the total number of moles present was $(2 + x)$.

What is the equation for this equilibrium?

- $\text{P} \rightleftharpoons 2\text{Q} + \text{R}$
- $2\text{P} \rightleftharpoons 2\text{Q} + \text{R}$
- $2\text{P} \rightleftharpoons \text{Q} + \text{R}$
- $2\text{P} \rightleftharpoons \text{Q} + 2\text{R}$

Topic Chem 7 Q# 429/ AS Chemistry/2012/s/TZ.1/Paper.1/Exam Q# 36//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 In the manufacture of sulfuric acid the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ usually takes place at 400°C and 1 atm pressure. In one industrial plant, it is decided to change the pressure to 20 atm.

What will be the consequences of this change?

- increased running costs
- an increased percentage of sulfur trioxide in the equilibrium mixture
- the rate of the backward reaction increases

Topic Chem 7 Q# 430/ AS Chemistry/2012/s/TZ.1/Paper.1/Exam Q# 2//www.SmashingScience.org .o)

2 Ammonia is manufactured by the Haber Process, in an exothermic reaction.

Assuming that the amount of catalyst remains constant, which change will **not** bring about an increase in the rate of the forward reaction?

- decreasing the size of the catalyst pieces
- increasing the pressure
- increasing the temperature
- removing the ammonia as it is formed

Topic Chem 7 Q# 431/ AS Chemistry/2011/w/TZ.1/Paper.1/Exam Q# 9//www.SmashingScience.org .o)

9 An aqueous solution was prepared containing 1.0 mol of AgNO_3 and 1.0 mol of FeSO_4 in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $\text{Ag}^+(\text{aq})$ in the mixture.



What is the numerical value of K_c ?

- 0.35
- 0.62
- 1.62
- 2.89



- 8 Sulfur dioxide is used as a preservative in wine making.

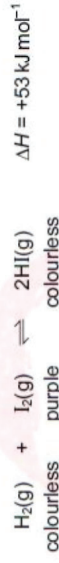
The following equations describe how sulfur dioxide dissolves.



Which statement about these two reactions is correct?

- A HSO_3^- acts as a base.
- B SO_2 acts as an oxidising agent.
- C SO_3^{2-} acts as an acid.
- D SO_3^{2-} acts as a reducing agent.

- 10 When gaseous iodine is heated with hydrogen at 450 °C, an equilibrium is established.



Which change of conditions will cause the purple colour of the equilibrium mixture to become paler?

- A decrease in pressure
- B decrease in temperature
- C increase in pressure
- D increase in temperature

- 7 In the last century the Haber process was sometimes run at pressures of 1000 atm and higher. Now it is commonly run at pressures below 100 atm.

What is the reason for this change?

- A An iron catalyst is used.
- B Maintaining the higher pressures is more expensive.
- C The equilibrium yield of ammonia is increased at lower pressures.
- D The rate of the reaction is increased at lower pressures.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Ethanol is manufactured by reacting ethene gas and steam in the presence of phosphoric(V) acid.

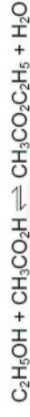


The reaction is carried out at 570K and 60atm.

What would be the consequences of carrying out the reaction at the same temperature but at a pressure of 200atm?

- 1 The manufacturing costs would increase.
- 2 The maximum yield at equilibrium would be higher.
- 3 The reaction would proceed at a faster rate.

- 10 The value of the equilibrium constant, K_c , for the reaction to form ethyl ethanoate from ethanol and ethanoic acid is 4.0 at 60 °C.



When 1.0 mol of ethanol and 1.0 mol of ethanoic acid are allowed to reach equilibrium at 60 °C, what is the number of moles of ethyl ethanoate formed?

- A $\frac{1}{3}$
- B $\frac{2}{3}$
- C $\frac{1}{4}$
- D $\frac{3}{4}$

- 7 The Haber process for the manufacture of ammonia is represented by the following equation.



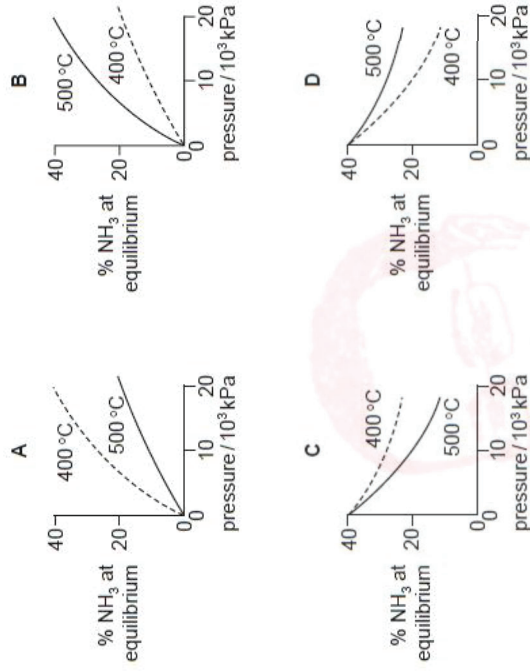
Which statement is correct about this reaction when the temperature is increased?

- A Both forward and backward rates increase.
- B The backward rate only increases.
- C The forward rate only increases.
- D There is no effect on the backward or forward rate.

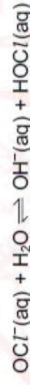


- 15 The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

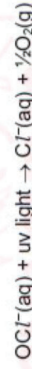
Which diagram correctly represents the two graphs?



- 11 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOCl. This reacts with water to produce HOCl molecules which kill bacteria.



In bright sunshine, the OCl⁻ ion is broken down by ultra-violet light.



Which method would maintain the highest concentration of HOCl(aq)?

- A acidify the pool water
- B add a solution of chloride ions
- C add a solution of hydroxide ions
- D bubble air through the water

- 10 The table gives the concentrations and pH values of the aqueous solutions of two compounds, X and Y. Either compound could be an acid or a base.

	X	Y
concentration	2 mol dm ⁻³	2 mol dm ⁻³
pH	6	9

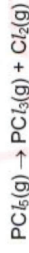
Student P concluded that X is a strong acid.

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq).

Which of the students are correct?

- A both P and Q
- B neither P nor Q
- C P only
- D Q only

- 9 PCl₅ dissociates as follows.



The extent of dissociation is 13% at 160 °C and 100% at 300 °C.

Which pair of statements about this formation of PCl₅ is correct?

	shape of PCl ₅ molecule	the reaction is
A	pyramidal	endothermic
B	pyramidal	exothermic
C	trigonal	endothermic
D	trigonal	exothermic



Topic Chem 7 Q# 442/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 8//www.SmashingScience.org :o)
8 The equilibrium



contributes to a series of reactions producing photochemical smog.

Which factors would affect the value of K_p of the above equilibrium?

	change in pressure	change in temperature	presence or absence of a catalyst
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✓
D	✗	✓	✗

Topic Chem 7 Q# 443/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 33//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 Which equilibria, in which all species are gaseous, would have equilibrium constants, K_p , with no units?

- sulfur dioxide and oxygen in equilibrium with sulfur trioxide
- hydrogen and iodine in equilibrium with hydrogen iodide
- carbon monoxide and steam in equilibrium with carbon dioxide and hydrogen

Topic Chem 7 Q# 444/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 17//www.SmashingScience.org :o)

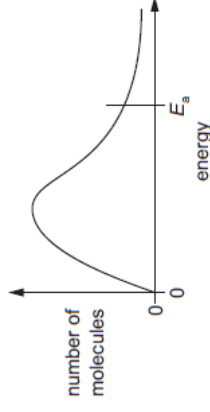
17 When sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process, which condition affects the value of the equilibrium constant, K_c ?

- adjusting the temperature
- adjusting the pressure
- using a catalyst
- removing SO_3 from the equilibrium mixture

Topic Chem 8 Q# 445/ AS Chemistry/2022/w/TZ.1/Paper.1/Exam Q# 16//www.SmashingScience.org :o)

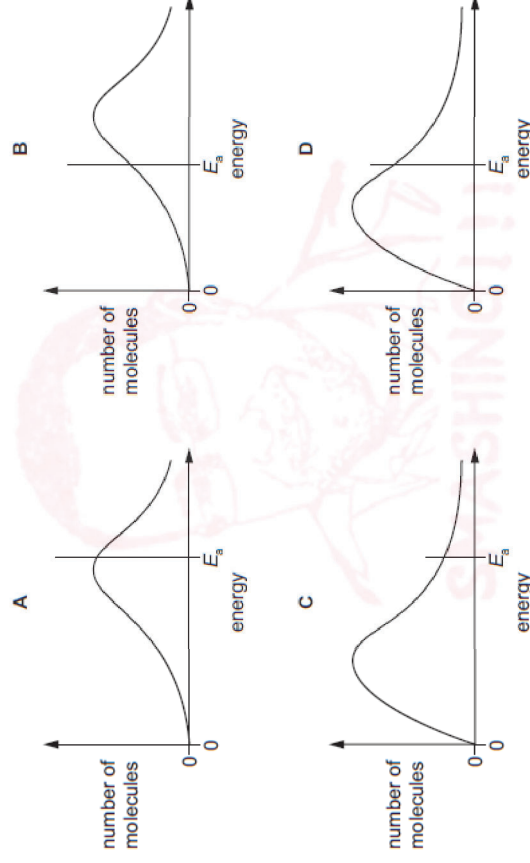
16 Measurements are made to determine the activation energy, E_a , of a reaction.

The diagram shows E_a on the Boltzmann distribution at temperature T_1 .



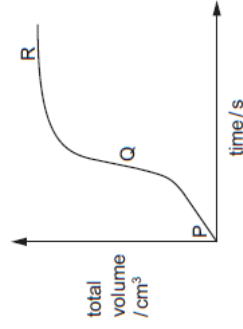
Measurements are then made at a higher temperature, T_2 .

Which diagram correctly shows the Boltzmann distribution and E_a at T_2 ?



- 15 A large excess of magnesium ribbon is added to dilute hydrochloric acid and the volume of hydrogen gas produced is measured as the reaction proceeds. The reaction is exothermic.

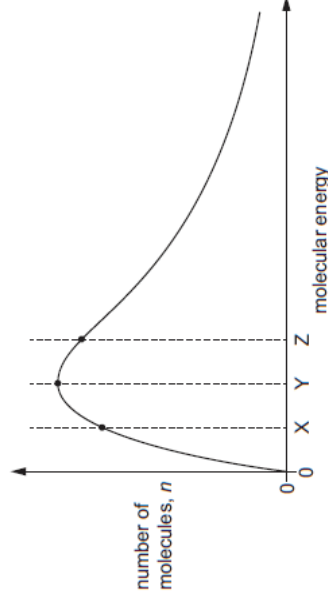
The results are shown.



Which row explains the changes in the rate of reaction between points P and Q and between points Q and R?

	between points P and Q	between points Q and R
A	the reaction temperature is increasing	the acid concentration is falling
B	the reaction temperature is increasing	the magnesium has been used up
C	magnesium's surface area is decreasing	the acid concentration is falling
D	magnesium's surface area is decreasing	the magnesium has been used up

- 15 The Boltzmann distribution for a gas at a constant temperature of 50 °C is shown.



If the temperature of the gas is **reduced** by 10 °C, the graph changes shape.

What happens to the values of n for the molecular energies X, Y and Z?

	X	Y	Z
A	higher	lower	higher
B	higher	lower	lower
C	lower	higher	lower
D	lower	lower	lower

- 16 In the reaction shown, the concentrations of both X and Y are reduced to half of their original values whilst keeping the total volume of the solution constant.



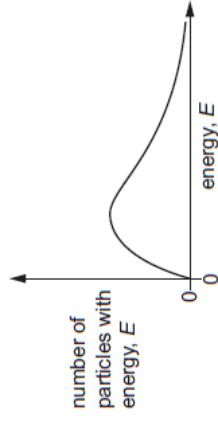
Simultaneously the temperature is increased from 288 K to 348 K.

Which prediction is definitely true?

- A A smaller proportion of collisions between particles of X and particles of Y will be successful.
- B The average kinetic energy of particles of X and particles of Y will increase.
- C The rate of the reaction will be unaffected.
- D The frequency of collisions between particles of X and particles of Y will halve.

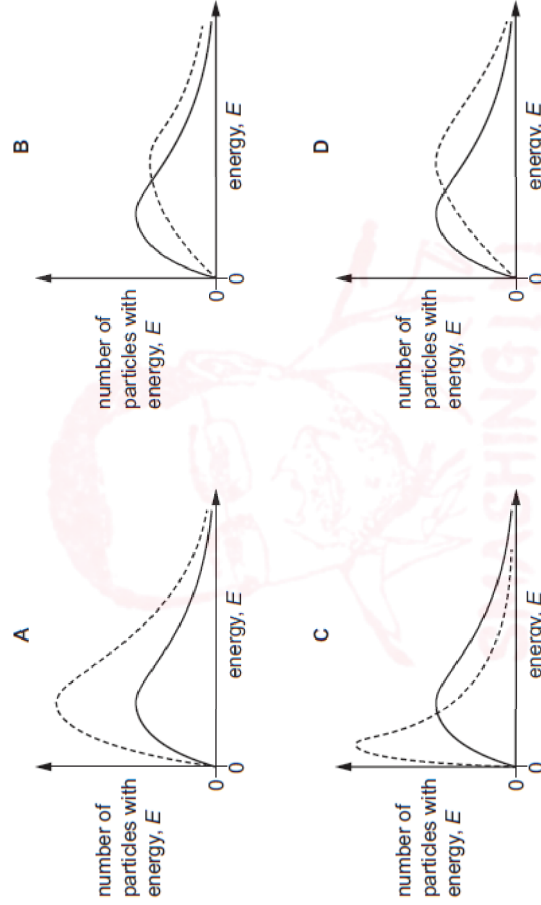


- 15 The Boltzmann distribution for one mole of a gas at temperature T is shown.



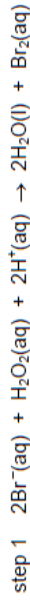
One mole of the same gas is added, and the gas remains at temperature T .

Which dotted curve shows the distribution with the added gas?



- 11 Hydrogen peroxide, H_2O_2 , decomposes to form water and oxygen.

The reaction is catalysed by bromide ions.



Which row is correct?

	type of catalyst	in step 1
A	heterogeneous	bromide ions are oxidised
B	heterogeneous	bromide ions are reduced
C	homogeneous	bromide ions are oxidised
D	homogeneous	bromide ions are reduced

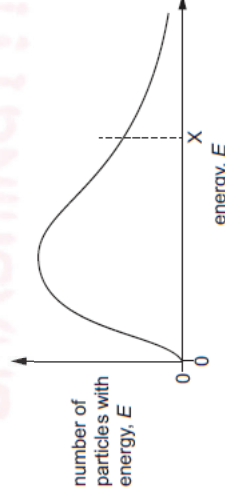
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Which changes can be used to measure the rates of chemical reactions?

- the decrease in concentration of a reactant per unit time
- the rate of appearance of a product
- the increase in total volume of gas per unit time at constant pressure

- 11 The diagram shows the Boltzmann distribution of energies for a reacting gas. For a particular reaction, the activation energy is X.

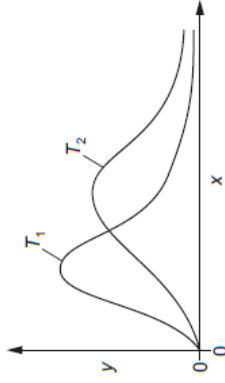


Which change to the diagram occurs if an effective catalyst is added at the same temperature?

- More particles will possess higher values of E .
- The peak will move to the left.
- The peak will move to the right.
- The value of the activation energy decreases.



- 5 The diagram shows the Boltzmann distribution for the same gas at two different temperatures, T_1 and T_2 .



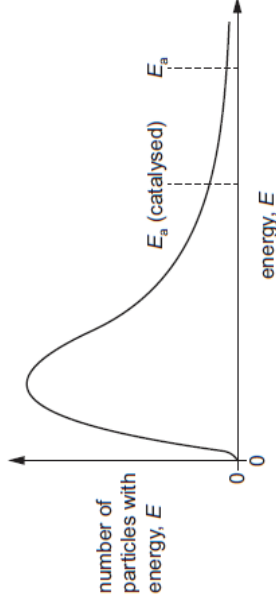
What is plotted on the y-axis and which line represents the higher temperature?

	plotted on y-axis	higher temperature
A	number of molecules	T_1
B	number of molecules	T_2
C	molecular energy	T_1
D	molecular energy	T_2

- 11 Which statement about catalysts is correct?

- A They change the reaction pathway by increasing the activation energy.
- B They increase the rate of reaction by lowering the enthalpy change of the reaction.
- C They increase the number of particles that have sufficient energy to react.
- D Heterogeneous catalysts are in the same state as the reactant.

- 11 The Boltzmann distribution curve for a gaseous mixture of ethene and hydrogen is shown. Nickel is an effective catalyst for the reaction that occurs.



How does the diagram appear if the same reaction mixture is at a higher temperature?

- A The curve is unchanged.
- B The values of both E_a (catalysed) and E_a decrease.
- C The values of both E_a (catalysed) and E_a increase.
- D The values of both E_a (catalysed) and E_a remain the same.

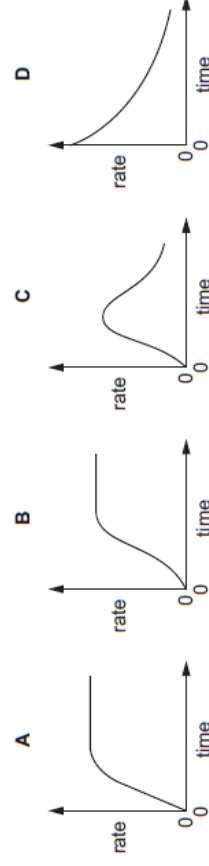
- 10 A large excess of marble chips is reacted with 25 cm^3 of 1.0 mol dm^{-3} hydrochloric acid at 40°C .

How is the result different when the reaction is repeated with 60 cm^3 of 0.5 mol dm^{-3} hydrochloric acid at 40°C ?

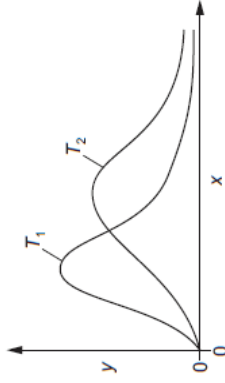
- A The reaction is faster and more of the products are made when the reaction is complete.
- B The reaction is faster and less of the products are made when the reaction is complete.
- C The reaction is slower and more of the products are made when the reaction is complete.
- D The reaction is slower and less of the products are made when the reaction is complete.

- 11 An autocatalytic reaction is a reaction in which one of the products catalyses the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?



- 5 The diagram shows the Boltzmann distribution for the same gas at two different temperatures, T_1 and T_2 .



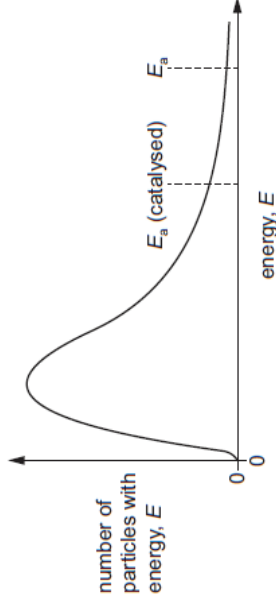
What is plotted on the y-axis and which line represents the higher temperature?

	plotted on y-axis	higher temperature
A	number of molecules	T_1
B	number of molecules	T_2
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D	molecular energy	T_2

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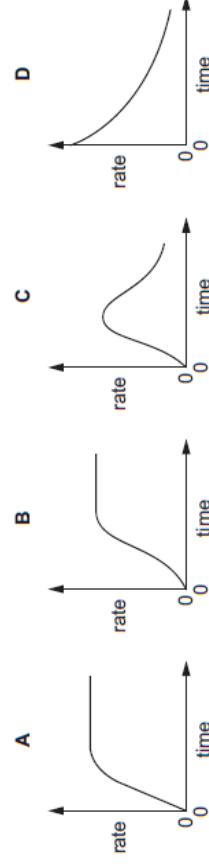
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- B The reaction is faster and less of the products are made when the reaction is complete.
- C The reaction is slower and more of the products are made when the reaction is complete.
- D The reaction is slower and less of the products are made when the reaction is complete.

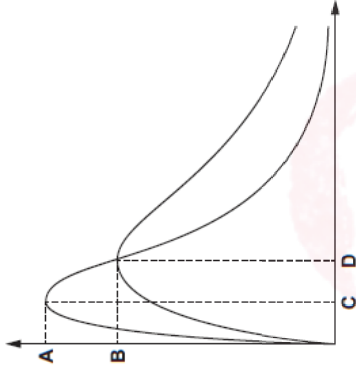
- 11 An autocatalytic reaction is a reaction in which one of the products catalyses the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?



- 6 The diagram shows the Boltzmann energy distribution curves for molecules of a sample of a gas at two different temperatures.

Which letter on the axes represents the most probable energy for molecules of the same sample of gas at the **lower** temperature?



Topic Chem 8 Q# 459/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

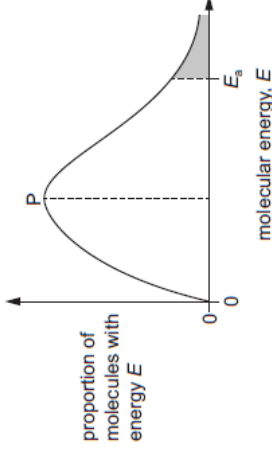
34 Hydrochloric acid reacts with zinc.



What will increase the rate of this reaction but will **not** change the Boltzmann distribution of molecular energies?

- addition of a suitable catalyst
- an increase in concentration of hydrochloric acid
- an increase in temperature of hydrochloric acid

- 1 The diagram shows the Boltzmann distribution of energies in a gas. The gas undergoes a reaction with an activation energy, E_a . The peak of the distribution is labelled P.



If the same reaction is carried out in the presence of a catalyst, which statement is correct?

- The peak P is at a lower height and the position of E_a moves to the left.
 - The peak P is at a lower height and the position of E_a moves to the right.
 - The peak P remains at the same height and the position of E_a moves to the left.
 - The peak P remains at the same height and the position of E_a moves to the right.
- Topic Chem 8 Q# 461/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
- 1 The temperature of a sample of an inert gas is increased.

What effect does this have on the number of molecules with the most probable energy and on the number of molecules with high energy?

	number of molecules with the most probable energy	number of molecules with high energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Topic Chem 8 Q# 462/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



34 Some polluting gases are removed from car exhaust fumes using a catalytic converter.

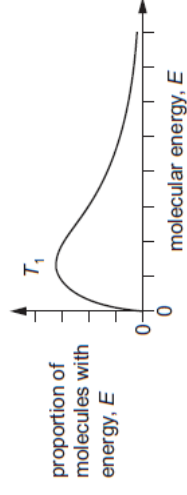
Platinum or palladium can be used as the catalyst. The reactions are faster when platinum is the catalyst than they are when palladium is the catalyst.

Which statements are correct?

- 1 Platinum acts as a heterogeneous catalyst in these reactions.
- 2 The palladium-catalysed reactions have higher activation energies than the platinum-catalysed reactions.
- 3 The platinum-catalysed reactions are more exothermic than the palladium-catalysed reactions.

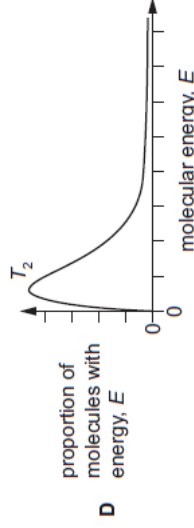
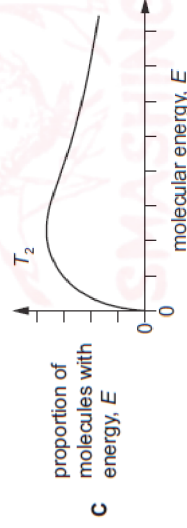
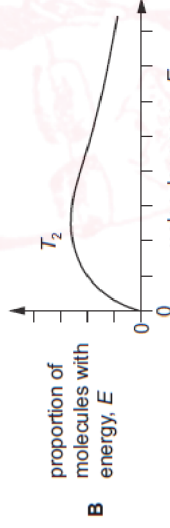
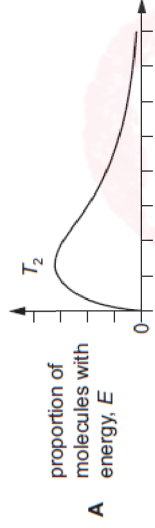
Topic Chem 8 QR 463 / AS Chemistry / 2019 / m / TZ 2 / Paper 1 / Exam Q# 1 / www.SmashingScience.org .io

1 The Boltzmann distribution is shown for a sample of gas at an initial temperature, T_1 .



The sample of gas was heated to temperature, T_2 .

What is the correct distribution for the higher temperature, T_2 ?



Topic Chem 8 Q# 464/ AS Chemistry/2018/w/TZ.1/Paper.1/Exam Q# 34//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 The factors affecting the rate of reaction between aqueous sodium thiosulfate and hydrochloric acid can be investigated. The ionic equation for the reaction is shown.



Which of the following can be used to investigate the rate of this reaction?

- change of mass
- change of appearance caused by formation of a precipitate
- change of electrical conductivity

Topic Chem 8 Q# 465/ AS Chemistry/2018/w/TZ.1/Paper.1/Exam Q# 11//www.SmashingScience.org :o)

11 Two reactions are shown.



In reaction 1, a finely powdered iron catalyst is used.

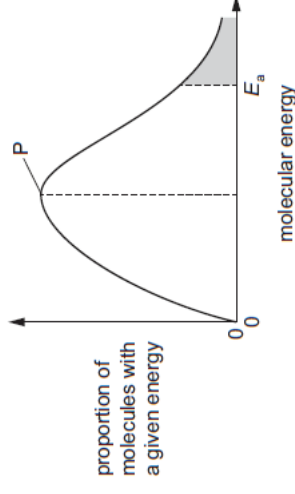
In reaction 2, a vaporised tetrachloromethane catalyst in ultraviolet light is used.

Which statement about the catalysts used is correct?

- Both reaction 1 and reaction 2 use a heterogeneous catalyst.
- Both reaction 1 and reaction 2 use a homogeneous catalyst.
- Reaction 1 uses a heterogeneous catalyst and reaction 2 uses a homogeneous catalyst.
- Reaction 1 uses a homogeneous catalyst and reaction 2 uses a heterogeneous catalyst.

Topic Chem 8 Q# 466/ AS Chemistry/2018/s/TZ.1/Paper.1/Exam Q# 4//www.SmashingScience.org :o)

4 The diagram shows the Boltzmann distribution of energies in a gas. The gas can take part in a reaction with an activation energy, E_a . The gas is maintained at a constant temperature.



Which statement is correct?

- If a catalyst is added, peak P will be lower and E_a will move to the left.
- If a catalyst is added, peak P will be lower and E_a will move to the right.
- If a catalyst is added, peak P will be the same and E_a will move to the left.
- If a catalyst is added, peak P will be the same and E_a will move to the right.

Topic Chem 8 Q# 467/ AS Chemistry/2018/s/TZ.1/Paper.1/Exam Q# 11//www.SmashingScience.org :o)

11 Hydrogen ions catalyse the hydrolysis of esters.

Which statement is correct?

- The hydrogen ions act as a heterogeneous catalyst.
- The hydrogen ions are in the same phase as the reactants.
- The hydrogen ions are used up in the reaction.
- The hydrogen ions have no effect on the activation energy of the reaction.

Topic Chem 8 Q# 468/ AS Chemistry/2017/w/TZ.1/Paper.1/Exam Q# 7//

7 Iodine and propanone react according to the following equation.



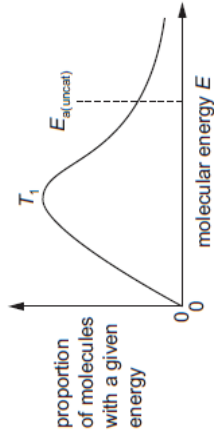
If the concentration of propanone is increased, keeping the total reaction volume constant, the rate of the reaction also increases.

What could be the reason for this?

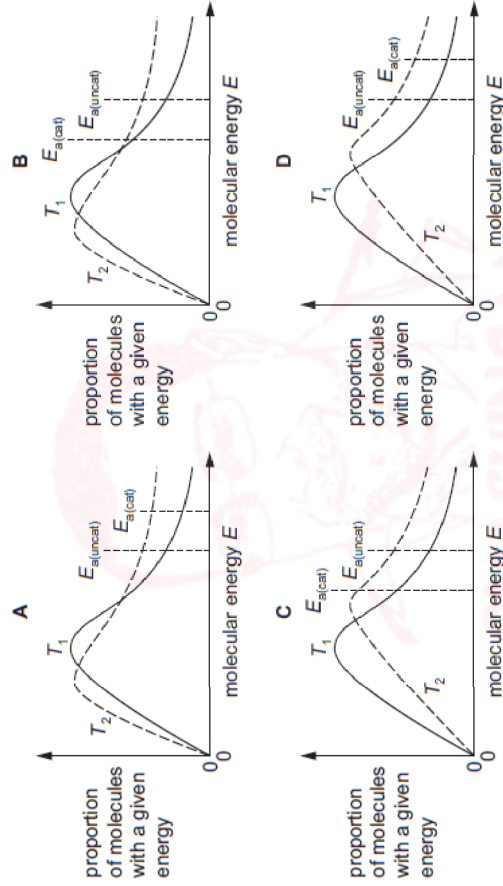
- A greater proportion of collisions is successful at the higher concentration.
- The particles are further apart at the higher concentration.
- The particles have more energy at the higher concentration.
- There are more collisions between reactant particles per second at the higher concentration.



- 10 The diagram shows the distribution of molecular energies in a sample of gas at a temperature T_1 . The activation energy for an uncatalysed reaction of this gas, $E_{a(\text{uncat})}$, is shown.



Which diagram correctly shows the new distribution and new activation energy, $E_{a(\text{cat})}$, when the temperature is increased to T_2 , and a catalyst is used that increases the rate of the reaction?



Topic Chem 8 Q# 470/ AS Chemistry/2017/1/TZ.1/Paper 1/Exam Q# 34/1/www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Which changes can be used to measure the rates of chemical reactions?

- the decrease in concentration of a reactant per unit time
- the rate of appearance of a product
- the increase in total volume per unit time at constant pressure

- 11 When 4 g of powdered calcium carbonate, $M_r = 100$, were added to 100 cm³ of 0.10 mol dm⁻³ hydrochloric acid the volume of carbon dioxide produced was recorded.

time/s	30	60	90	120	150	180	210	240
total volume of carbon dioxide given off/cm ³	40	70	88	101	110	116	120	120

Which row gives the correct explanations about these results?

	why the rate of the reaction changes with time	why the reaction stops
A	fewer collisions between reacting molecules occur	the calcium carbonate is used up
B	fewer collisions between reacting molecules occur	the hydrochloric acid is used up
C	more collisions between reacting molecules occur	the calcium carbonate is used up
D	more collisions between reacting molecules occur	the hydrochloric acid is used up

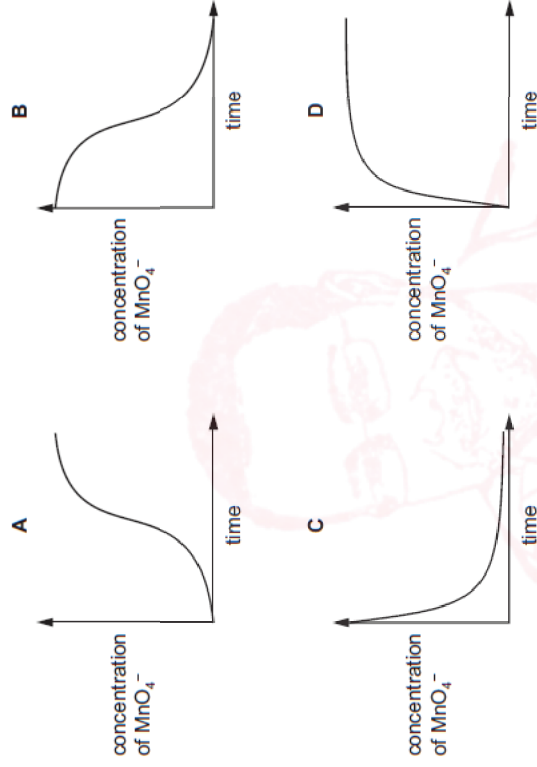


- 10 Oxidation of ethanedioate ions by acidified manganate(VII) ions is very slow at room temperature.



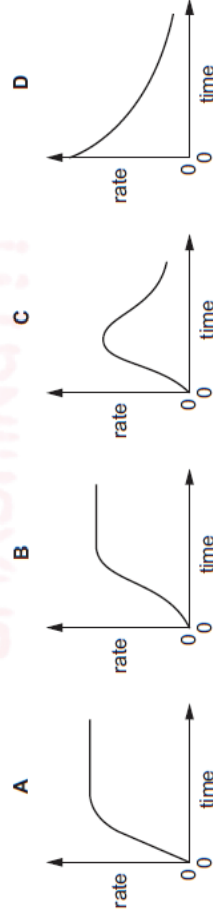
Mn^{2+} ions catalyse this reaction.

Which graph shows how the concentration of acidified manganate(VII) ions varies after ethanedioate ions are added?

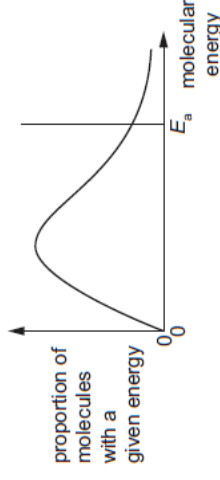


- 11 An autocatalytic reaction is a reaction in which one of the products catalyses the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?

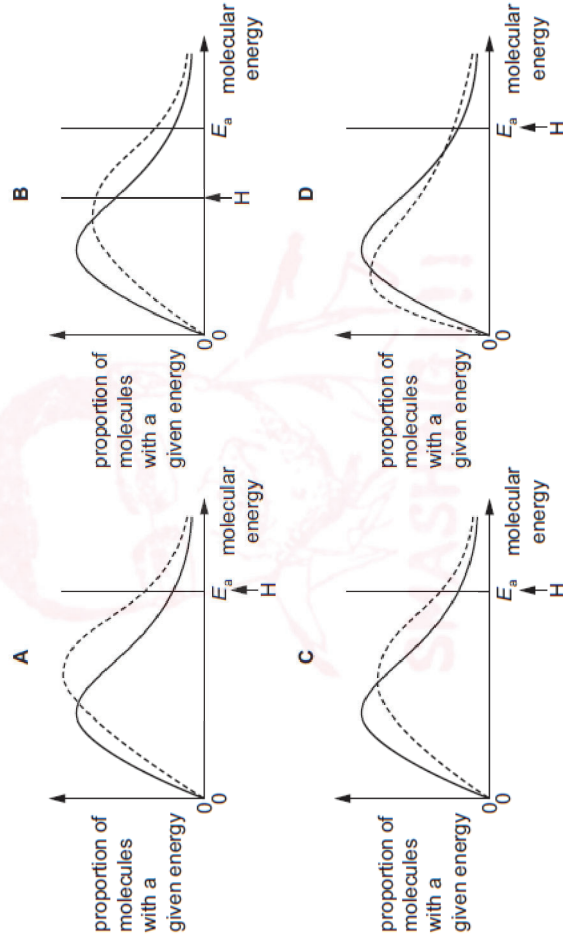


- 1 The diagram represents, for a given temperature, the Boltzmann distribution of the kinetic energies of the molecules in a mixture of two gases that react together. The activation energy for the reaction, E_a , is marked.



The dotted curves below show the Boltzmann distribution for the same reaction at a higher temperature. On these diagrams, H represents the activation energy at the higher temperature.

Which diagram is correct?



The responses **A** to **D** should be selected on the basis of

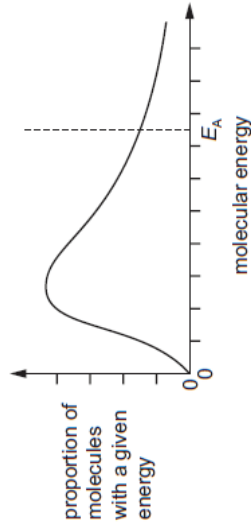
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



37 The equation shows a gas phase reaction.

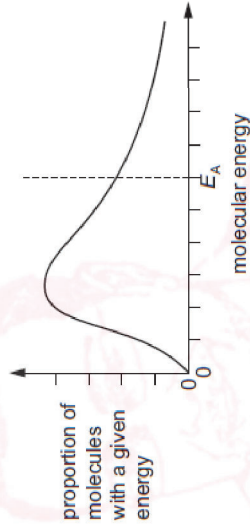


The diagram shows the Boltzmann distribution of a fixed mass of X(g) at temperature T in the absence of a catalyst. The line E_A indicates the activation energy.

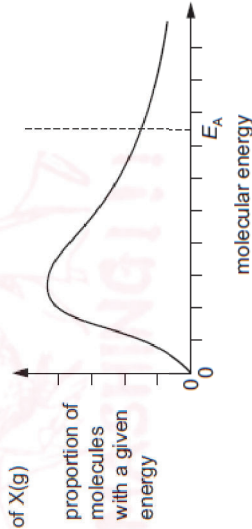


Which diagrams correctly show the effect of the following changes made separately and independently?

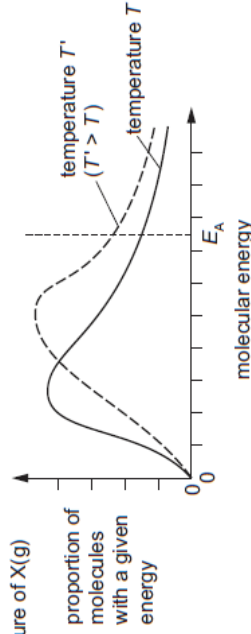
1 adding a catalyst



2 increasing the pressure of X(g)



3 increasing the temperature of X(g)



Topic Chem 8 Q# 476/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 A chemist puts a sample of dilute aqueous hydrochloric acid into beaker 1. She adds a sample of zinc and measures the rate of production of hydrogen gas.

She then puts a different sample of dilute aqueous hydrochloric acid into beaker 2. She adds a different sample of zinc and measures the rate of production of hydrogen gas.

The rate of the reaction in beaker 2 is greater than the rate of the reaction in beaker 1.

Which factors **could** help to explain this observation?

- The reaction in beaker 1 has a higher activation energy than the reaction in beaker 2.
- The zinc in beaker 1 is in larger pieces than the zinc in beaker 2.
- The acid in beaker 1 is at a lower concentration than the acid in beaker 2.

Topic Chem 8 Q# 477/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Which statements correctly describe an effect of a rise in temperature on a gas-phase reaction?

- More particles now have energies greater than the activation energy.
- The energy distribution profile changes with more particles having the most probable energy.
- The activation energy of the reaction is decreased.

Topic Chem 8 Q# 478/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

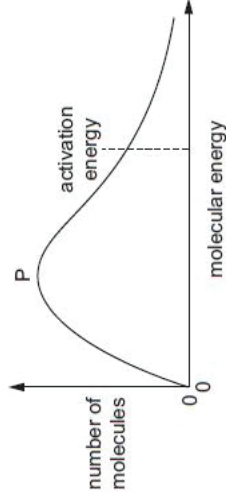
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Why does raising the pressure of a fixed mass of gaseous reactants at a constant temperature cause an increase in the rate of reaction?

- More collisions occur per second when the pressure is increased.
- More molecules have energy greater than the activation energy at the higher pressure.
- Raising the pressure lowers the activation energy.



- 1 The diagram shows a Boltzmann distribution of molecular energies for a gaseous mixture. The distribution has a peak, labelled P, on the diagram.



What happens when an effective catalyst is added to the mixture?

- A The height of the peak decreases and the activation energy moves to the right.
- B The height of the peak decreases and the activation energy moves to the left.
- C The height of the peak remains the same and the activation energy moves to the right.
- D The height of the peak remains the same and the activation energy moves to the left.

Topic Chem 8 Q# 480/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

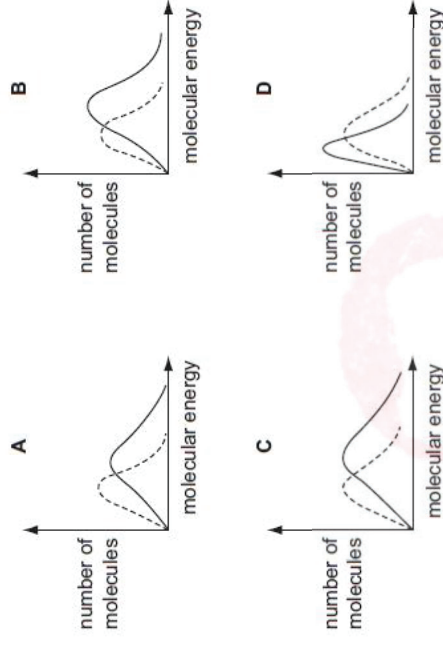
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 33 A reversible reaction is catalysed.

Which statements about the effects of the catalyst on this system are correct?

- 1 The catalyst alters the mechanism of the reaction.
- 2 The catalyst reduces the activation energy for both the forward and the backward reaction.
- 3 The catalyst alters the composition of the equilibrium mixture.

- 1 Which solid-line curve most accurately represents the distribution of molecular energies in a gas at 500K if the dotted-line curve represents the corresponding distribution for the same gas at 300K?



Topic Chem 8 Q# 482/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org :o)

- 8 When making sparkler fireworks, a mixture of barium nitrate powder with aluminium powder, water and glue is coated onto wires and allowed to dry. At this stage, the following exothermic reaction may occur.

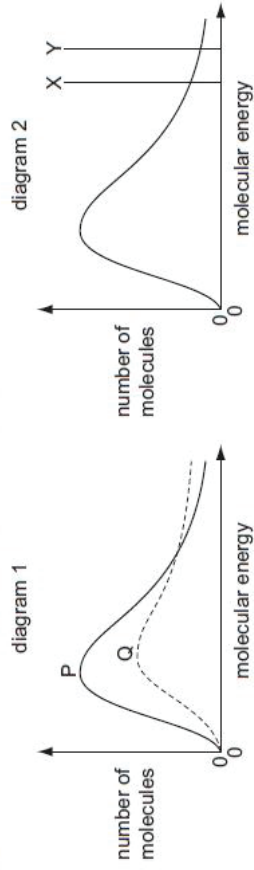


Which conditions would be best to reduce the rate of this reaction during the drying process, and would also keep the aluminium and barium nitrate unchanged?

	temperature /K	pH
A	298	7
B	298	14
C	398	7
D	398	14



11 Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve, P or Q, corresponds to a temperature higher than that of the other curve.

In diagram 2, one line, X or Y, corresponds to the activation energy in the presence of a catalyst and the other line corresponds to the activation energy of the same reaction in the absence of a catalyst.

Which combination gives the correct curve and line?

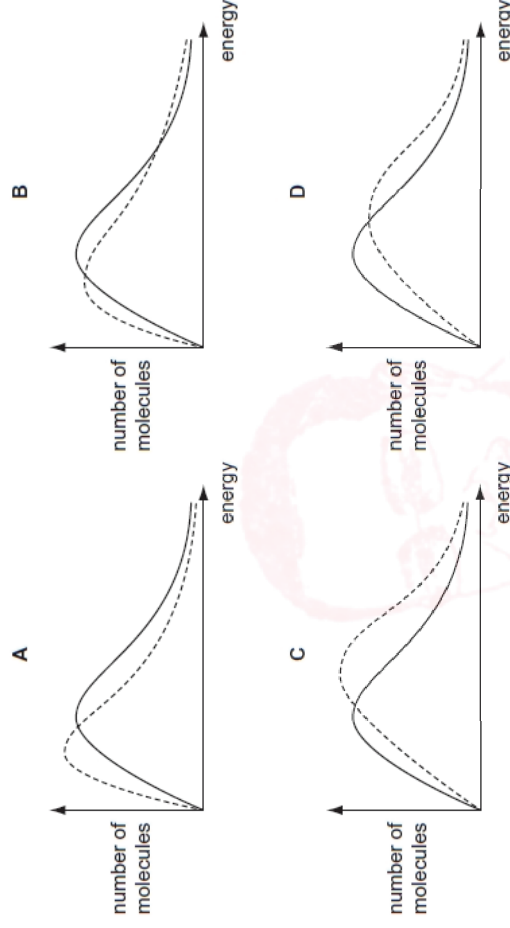
	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

6 The diagrams below show the Boltzmann distribution for air at two temperatures.

The solid line represents the distribution at -20°C .

The dotted line represents the distribution at -10°C .

Which diagram is correct?

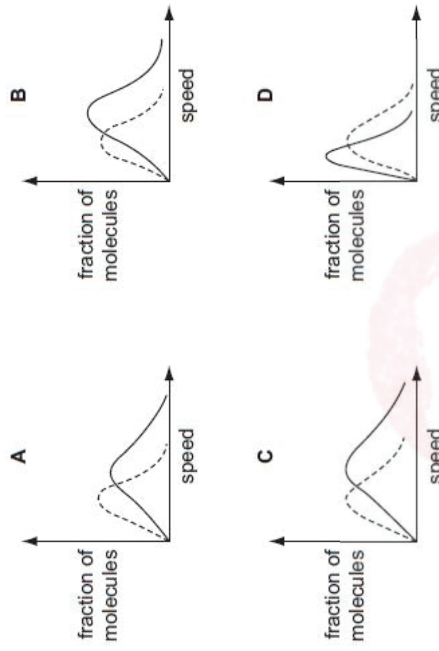


8 Why does the rate of a gaseous reaction increase when the pressure is increased at a constant temperature?

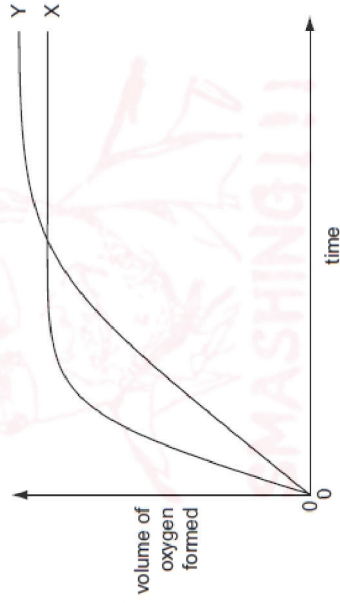
- A More particles have energy that exceeds the activation energy.
- B The particles have more space in which to move.
- C The particles move faster.
- D There are more frequent collisions between particles.



- 11 Which solid-line curve most accurately represents the distribution of molecular speeds in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?



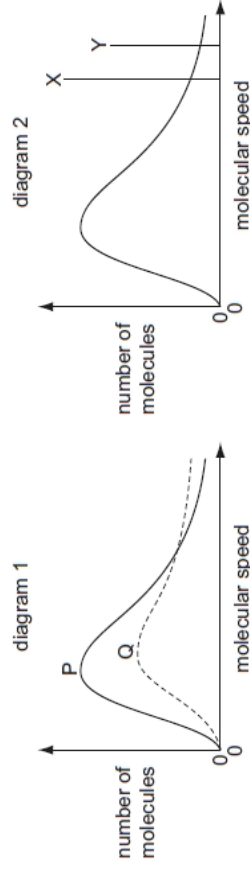
- 6 In the diagram, curve X was obtained by observing the decomposition of 100 cm³ of 1.0 mol dm⁻³ hydrogen peroxide, catalysed by manganese(IV) oxide.



Which alteration to the original experimental conditions would produce curve Y?

- A adding some 0.1 mol dm⁻³ hydrogen peroxide
- B adding water
- C lowering the temperature
- D using less manganese(IV) oxide

- 4 Different Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve P or Q corresponds to a temperature higher than that of the other curve.

In diagram 2, one line X or Y corresponds to the activation energy for a catalysed reaction and the other line corresponds to the activation energy of the same reaction when uncatalysed.

Which combination gives the correct curve and line?

	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

- 12 Hydrazine, N₂H₄, is widely used as a rocket fuel because it reacts with oxygen as shown, producing 'environmentally friendly' gases.



Despite its use as a rocket fuel, hydrazine does not burn spontaneously in oxygen.

Which statement explains why hydrazine does **not** burn spontaneously?

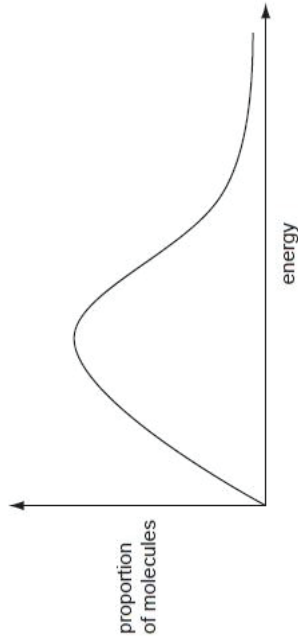
- A Hydrazine is a liquid.
- B The activation energy is too high.
- C The N≡N bond is very strong.
- D The reaction is exothermic.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



32 The diagram represents the Boltzmann distribution of molecular energies at a given temperature.



Which of the factors that affect the rate of a reaction can be explained using such a Boltzmann distribution?

- 1 increasing the concentration of reactants
- 2 increasing the temperature
- 3 the addition of a catalyst

Topic Chem 8 Q# 491/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

12 $\text{Na}_2\text{S}_2\text{O}_3$ reacts with dilute HCl to give a pale yellow precipitate. If 1 cm^3 of $0.1 \text{ mol dm}^{-3} \text{ HCl}$ is added to 10 cm^3 of $0.02 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ the precipitate forms slowly.

If the experiment is repeated with 1 cm^3 of $0.1 \text{ mol dm}^{-3} \text{ HCl}$ and 10 cm^3 of $0.05 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ the precipitate forms more quickly.

Why is this?

- A The activation energy of the reaction is lower when $0.05 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ is used.
- B The reaction proceeds by a different pathway when $0.05 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ is used.
- C The collisions between reactant particles are more violent when $0.05 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ is used.
- D The reactant particles collide more frequently when $0.05 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ is used.

Topic Chem 8 Q# 492/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Why does a mixture of hydrogen gas and bromine gas react together faster at a temperature of 500 K than it does at a temperature of 400 K ?

- 1 A higher proportion of effective collisions occurs at 500 K .
- 2 Hydrogen molecules and bromine molecules collide more frequently at 500 K .
- 3 The activation energy of the reaction is lower at 500 K .

Topic Chem 8 Q# 493/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org .o)

11 Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The depth of colour of the glass is related to the concentration of silver atoms.

The following reactions are involved.



Which statement about these reactions is correct?

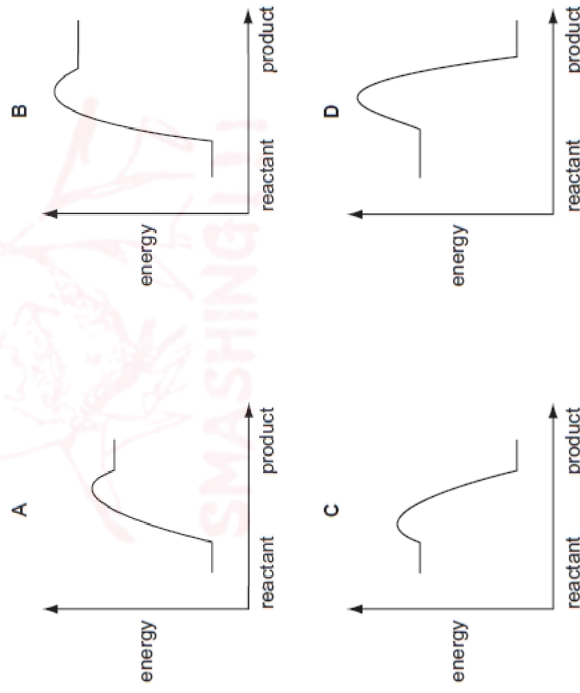
- A Cu^+ and Cu^{2+} ions act as catalysts.
- B Cu^+ ions act as an oxidising agent in reaction 2.
- C Reaction 2 is the one in which light is absorbed.
- D Ag^+ ions are oxidised in reaction 1.

Topic Chem 8 Q# 494/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org .o)

10 Four reactions of the type shown are studied at the same temperature.

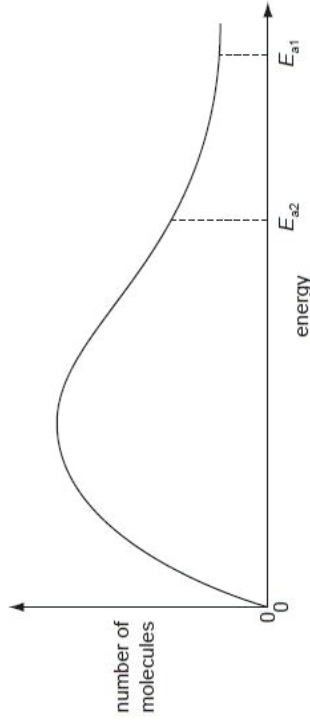


Which is the correct reaction pathway diagram for the reaction that would proceed **most rapidly** and with the **highest yield**?



Topic Chem 8 Q# 495/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org .o)

- 10 The diagram shows the Maxwell-Boltzmann energy distribution curve for molecules of a mixture of two gases at a given temperature. For a reaction to occur the molecules must collide together with sufficient energy.



E_a is the activation energy for the reaction between the gases. Of the two values shown, one is for a catalysed reaction, the other for an uncatalysed one.

Which pair of statements is correct when a catalyst is used?

A	E_{a1}	catalysed reaction fewer effective collisions	E_{a2}	uncatalysed reaction more effective collisions
B	E_{a1}	uncatalysed reaction fewer effective collisions	E_{a2}	catalysed reaction more effective collisions
C	E_{a1}	catalysed reaction more effective collisions	E_{a2}	uncatalysed reaction fewer effective collisions
D	E_{a1}	uncatalysed reaction more effective collisions	E_{a2}	catalysed reaction fewer effective collisions

Topic Chem 9 Q# 496/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org .o)

- 25 Separate 1.0 g samples of Na_2O , MgO , Al_2O_3 , SiO_2 , NaCl , MgCl_2 , Al_2Cl_6 and SiCl_4 are added to separate beakers containing water and stirred.

The number of beakers containing a white solid is Q.

An excess of $\text{NaOH}(\text{aq})$ is then added to each beaker and stirred.

The number of beakers now containing a white solid is R.

Which row is correct?

	Q	R
A	3	2
B	3	3
C	4	3
D	4	4

Topic Chem 9 Q# 497/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

- 19 The oxides BaO , CaO , MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

A BaO **B** CaO **C** MgO **D** SrO

Topic Chem 9 Q# 498/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org .o)

- 18 Which row describes the relative sizes of the ionic radii of Na^+ , Mg^{2+} and S^{2-} ?

	smallest	→	largest
A	Na^+		S^{2-}
B	Mg^{2+}		S^{2-}
C	S^{2-}		Mg^{2+}
D	S^{2-}		Na^+

Topic Chem 9 Q# 499/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

- 17 The electrical conductivities of two compounds, Y and Z, are shown.

	conductivity of the compound in the liquid state	for Y	for Z
	conductivity of the mixture obtained by adding the compound to water	good	does not conduct
		good	good

What are compounds Y and Z?

	Y	Z
A	Al_2O_3	SiCl_4
B	NaCl	Al_2O_3
C	NaCl	SiCl_4
D	SiCl_4	Al_2O_3

Topic Chem 9 Q# 500/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org .o)

- 6 Which statement about aluminium chloride is correct?

- A** Aluminium chloride has a much higher melting point than magnesium chloride due to the small size of the aluminium ion.
B Anhydrous aluminium chloride reacts vigorously with water to form a solution with a pH greater than 7.
C Each Al_2Cl_6 molecule found in aluminium chloride vapour contains two coordinate bonds.
D The bonding between aluminium and chlorine is strongly ionic due to the large difference in electronegativity.



- 23 Silicon is heated in an excess of chlorine, producing compound J.

An excess of water is added to the sample of J produced.

Which row is correct?

	structure of J	Is HCl produced when water is added to J?
A	giant molecular	no
B	giant molecular	yes
C	simple molecular	no
D	simple molecular	yes

- 19 A student reacts 0.100 mol of each of sodium, magnesium and phosphorus atoms separately with an excess of oxygen.

Which rows are correct?

	oxide	mass of oxide formed/g
1	sodium	3.10
2	magnesium	4.03
3	phosphorus	7.10

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

- 18 Which statement for the element in Period 3 and Group 13 of the Periodic Table is correct?

- A It has the highest melting point of the elements in its period.
 B It has exactly one electron in its shell with principal quantum number 3.
 C It forms an oxide that reacts with aqueous sodium hydroxide.
 D It forms a chloride that dissolves in water to give a neutral solution.

- 19 The table shows the melting points of SiO₂ and P₄O₆.

oxide	SiO ₂	P ₄ O ₆
melting point/K	1883	297

Which statement explains the difference between the melting points of SiO₂ and P₄O₆?

- A The bonding of the oxides changes from ionic to covalent.
 B The metallic character of the elements decreases across Period 3.
 C The oxidation number of the element increases from Si to P.
 D The structure changes from giant molecular to simple molecular.

- 18 The elements in Period 3 and their compounds show trends across the period from sodium to chlorine.

Which row is correct?

	electronegativity of the elements	acid/base behaviour of the oxides of the elements
A	decreases	basic → amphoteric → acidic
B	decreases	acidic → amphoteric → basic
C	increases	basic → amphoteric → acidic
D	increases	acidic → amphoteric → basic

- 17 A student investigated the chloride of a Period 3 element. This is what the student wrote down as a record.

The compound was a white crystalline solid. It dissolved easily in water to give a solution of pH 12. When placed in a test-tube and heated in a roaring Bunsen flame, the compound melted after several minutes heating.

What can be deduced from this record?

- A At least one of the recorded observations is incorrect.
 B The compound was magnesium chloride, MgCl₂.
 C The compound was phosphorus pentachloride, PCl₅.
 D The compound was sodium chloride, NaCl.

- 13 An element, Y, reacts according to the following sequence.



What could be element Y?

- A Na B Mg C Al D P

- 12 Which element requires the least number of moles of oxygen for the complete combustion of 1 mol of its atoms?

- A aluminium
 B magnesium
 C phosphorus
 D sodium

Topic Chem 9 Q# 509/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements are correct going across Period 3 from sodium to chlorine?

- The charge on the nucleus increases, pulling the electrons closer to it.
- The radius of the most common ion of each element decreases.
- The shielding caused by inner electrons decreases, so the outer electrons are pulled closer to the nucleus.

Topic Chem 9 Q# 510/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 R is an oxide of Period 3 element T. 5.00 g of R contains 2.50 g of T.

What is T?

- A magnesium
- B aluminium
- C silicon
- D sulfur

Topic Chem 9 Q# 511/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

12 Element X is in Period 3. Element X forms a solid oxide Y.

Y reacts with hot concentrated hydrochloric acid. Y reacts with hot aqueous sodium hydroxide to form a compound in which X is part of an anion.

How many p electrons does one atom of X have in its outer shell?

- A 0
- B 1
- C 2
- D 3

Topic Chem 9 Q# 512/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 A sample containing x mol of Al_2Cl_6 is dissolved in water to give solution W.

In order to precipitate all of the aluminium as its hydroxide, y mol of sodium hydroxide are required.

More of the alkali is added to re-dissolve the precipitate, giving solution Z.

Which statements are correct?

- the initial pH of solution W is below 7
- $y = 3x$
- Z contains x mol of aluminium

Topic Chem 9 Q# 513/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Which row is correct?

	statement	reason
A	The first ionisation energy of phosphorus is greater than that of magnesium.	electron is lost from a 3p orbital in both cases
B	The melting point of phosphorus is greater than that of magnesium.	phosphorus has more valence electrons than magnesium
C	The atomic radius of phosphorus is smaller than that of magnesium.	phosphorus has greater nuclear charge than magnesium
D	The electrical conductivity of phosphorus is smaller than that of magnesium.	bonding changes from ionic in magnesium to covalent in phosphorus

Topic Chem 9 Q# 514/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

12 Which observations are made when a sample of silicon chloride, $SiCl_4$, is added to a beaker of water?

- A No visible change is observed.
- B Steamy fumes and a precipitate are both observed.
- C The appearance of a precipitate is the only observation.
- D The appearance of steamy fumes is the only observation.

Topic Chem 9 Q# 515/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



36 Three test-tubes, X, Y and Z, each contain water.

- A small amount of NaCl is added to test-tube X.
- A small amount of SiCl_4 is added to test-tube Y.
- A small amount of AlCl_3 is added to test-tube Z.

After a short time, two drops of universal indicator solution are added to each test-tube.

Which statements can be correct?

- 1 The pH in test-tube X is 7.
- 2 The pH in test-tube Y is 2.
- 3 The pH in test-tube Z is 2.

Topic Chem 9 Q# 516/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 35/ www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which rows correctly show the relative electrical conductivities of the sets of three Period 3 elements?

	greatest conductivity	←	→	least conductivity
1	sodium		silicon	chlorine
2	aluminium		magnesium	phosphorus
3	sulfur		silicon	phosphorus

Topic Chem 9 Q# 517/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 12/ www.SmashingScience.org .o)

12 X and Y are two elements in Period 3 of the Periodic Table. They combine to form compound Z.

X forms a soluble acidic oxide. The oxidation number of X in this oxide is +4.

Y forms an amphoteric oxide.

What is the formula of compound Z?

A AlP B Al_2S_3 C Si_2P_5 D SiS_2

Topic Chem 9 Q# 518/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 16/ www.SmashingScience.org .o)

16 Sodium, aluminium and silicon are three elements in Period 3. Each element forms an oxide.

Which row has three correct properties of these oxides?

	sodium oxide	aluminium oxide	silicon dioxide
A	basic	basic	amphoteric
B	giant ionic	giant ionic	simple molecular
C	high melting point	low melting point	high melting point
D	reacts with water	no reaction with water	no reaction with water

Topic Chem 9 Q# 519/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 15/ www.SmashingScience.org .o)

15 Element Z has a giant structure.

The chloride of Z reacts with water to give a solution with a pH less than 5.

Which pair shows two elements which could be Z?

- A aluminium, magnesium
- B aluminium, silicon
- C phosphorus, magnesium
- D phosphorus, silicon

Topic Chem 9 Q# 520/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 36/ www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements are correct?

- 1 Aluminium chloride dissolves in water to give an acidic solution.
- 2 Magnesium chloride dissolves in water to give a solution of pH close to 7.
- 3 Sodium chloride dissolves in water to give an alkaline solution.

Topic Chem 9 Q# 521/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 31/ www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Carbon and nitrogen are adjacent in the Periodic Table.

Which properties do they both have?

- 1 There is an empty 2p orbital in each atom of the element.
- 2 The principal quantum number of the highest occupied orbital is 2.
- 3 They can form compounds in which their atoms form four bonds.



Topic Chem 9 Q# 522/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 16/www.SmashingScience.org :o)
 16 Sodium, magnesium and aluminium are three elements in Period 3 of the Periodic Table. Each element forms an oxide.

Which row is correct?

	sodium oxide	magnesium oxide	aluminium oxide
A	basic	amphoteric	amphoteric
B	giant ionic	giant ionic	simple molecular
C	high melting point	high melting point	low melting point
D	readily reacts with water	slight reaction with water	no reaction with water

Topic Chem 9 Q# 523/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 12/www.SmashingScience.org :o)

12 X and Y are oxides of different Period 3 elements.

If one mole of X is added to water, the solution formed is neutralised by exactly one mole of Y.

What could be the identities of X and Y?

	X	Y
A	P_4O_{10}	Al_2O_3
B	SO_3	Al_2O_3
C	P_4O_{10}	Na_2O
D	SO_3	Na_2O

Topic Chem 9 Q# 524/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 13/www.SmashingScience.org :o)

13 X, Y and Z are consecutive elements in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

	X	Y	Z
A	Na	Mg	Al
B	Mg	Al	Si
C	Al	Si	P
D	Si	P	S

Topic Chem 9 Q# 525/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 12/www.SmashingScience.org :o)

12 Which oxide will cause an increase in pH when added to water?

A MgO B Al_2O_3 C SiO_2 D SO_2

Topic Chem 9 Q# 526/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 35/www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which oxides, when placed in cold water for one day, will react with the water?

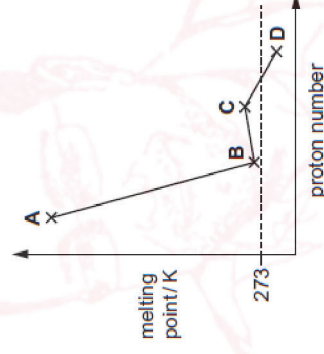
- 1 MgO
- 2 Al_2O_3
- 3 SiO_2

Topic Chem 9 Q# 527/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 13/www.SmashingScience.org :o)

13 The relative melting points of four consecutive elements in the Periodic Table are shown in the graph.

The elements all have proton numbers less than 20.

Which element is in Group 16?



Topic Chem 9 Q# 528/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 13/www.SmashingScience.org :o)

13 A solid Period 3 element, Q, is reacted with oxygen gas. Compound R is formed.

When R is added to water the pH decreases.

What could be the empirical formula of R?

A Q_2O_4 B Q_2O_5 C Q_4O_{10} D Q_5O_2

Topic Chem 9 Q# 522/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 16/www.SmashingScience.org :o)
 16 Sodium, magnesium and aluminium are three elements in Period 3 of the Periodic Table. Each element forms an oxide.

Which row is correct?

	sodium oxide	magnesium oxide	aluminium oxide
A	basic	amphoteric	amphoteric
B	giant ionic	giant ionic	simple molecular
C	high melting point	high melting point	low melting point
D	readily reacts with water	slight reaction with water	no reaction with water

Topic Chem 9 Q# 523/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 12/www.SmashingScience.org :o)

12 X and Y are oxides of different Period 3 elements.

If one mole of X is added to water, the solution formed is neutralised by exactly one mole of Y.

What could be the identities of X and Y?

	X	Y
A	P_4O_{10}	Al_2O_3
B	SO_3	Al_2O_3
C	P_4O_{10}	Na_2O
D	SO_3	Na_2O

Topic Chem 9 Q# 524/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 13/www.SmashingScience.org :o)

13 X, Y and Z are consecutive elements in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

	X	Y	Z
A	Na	Mg	Al
B	Mg	Al	Si
C	Al	Si	P
D	Si	P	S

Topic Chem 9 Q# 525/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 12/www.SmashingScience.org :o)

12 Which oxide will cause an increase in pH when added to water?

A MgO B Al_2O_3 C SiO_2 D SO_2



Topic Chem 9 Q# 529/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 X, Y and Z are elements in Period 3 of the Periodic Table. The results of some experiments carried out with compounds of these elements are shown.

element	result of adding the oxide of the element to H ₂ O(l)	result of adding the chloride of the element to H ₂ O(l)	result of adding the oxide of the element to HCl(aq)
X	no reaction	hydrolyses	forms chloride salt
Y	forms hydroxide	dissolves	forms chloride salt
Z	forms acid	hydrolyses	hydrolyses

Which statement could be correct?

- A X is Al and Y is Mg.
 B X is Si and Y is Na.
 C Y is Al and Z is P.
 D Y is Na and Z is Al.

Topic Chem 9 Q# 530/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 Which row describes the structure and bonding of SiO₂ and SiCl₄?

	SiO ₂		SiCl ₄	
	bonding	structure	bonding	structure
A	covalent	giant	covalent	giant
B	covalent	giant	covalent	simple
C	ionic	giant	covalent	giant
D	ionic	giant	covalent	simple

Topic Chem 9 Q# 531/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

- 13 X and Y are elements in Period 3 of the Periodic Table.
- The oxide of X is a solid at room temperature. This oxide has a giant structure.
 - The chloride of X does not react with water.
 - Argon is the only element in Period 3 with a lower melting point than Y.

What could be the formula of a compound formed between elements X and Y?

- A Al₂S₃ B MgS C NaCl D PCl₅

Topic Chem 9 Q# 532/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 Sodium and sulfur are burned separately in oxygen.

Each reaction has a distinctive coloured flame.

Which row is correct?

	Na + O ₂	S + O ₂
A	white	blue
B	white	yellow
C	yellow	blue
D	yellow	yellow

Topic Chem 9 Q# 533/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

- 13 Which element has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

- A boron
 B calcium
 C magnesium
 D sodium

Topic Chem 9 Q# 534/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

- 12 Silicon is heated in an excess of chlorine, producing compound J.

Excess water is added to the sample of J produced.

Which row is correct?

	structure of J	Is HCl produced when water is added to J?
A	giant molecular	no
B	giant molecular	yes
C	simple molecular	no
D	simple molecular	yes

Topic Chem 9 Q# 535/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 X, Y and Z are three elements in the third period.

- X reacts with chlorine to give a liquid product.
- Y reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 7.
- Z reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 6.

Which elements are good conductors of electricity?

- A X and Y B Y and Z C Y only D Z only



Topic Chem 9 Q# 536/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Which oxide is insoluble in aqueous sodium hydroxide?

- A MgO B Al_2O_3 C P_4O_{10} D SO_2

Topic Chem 9 Q# 537/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 13//

13 An element Y reacts according to the following sequence.



What could be element Y?

- A Al B Ca C Mg D P

Topic Chem 9 Q# 538/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 12//

12 The elements Cl, Mg, Si and S are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

	lowest melting point	→	highest melting point	
A	Cl	S	Mg	Si
B	Cl	S	Si	Mg
C	Mg	Si	S	Cl
D	Si	Mg	S	Cl

Topic Chem 9 Q# 539/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

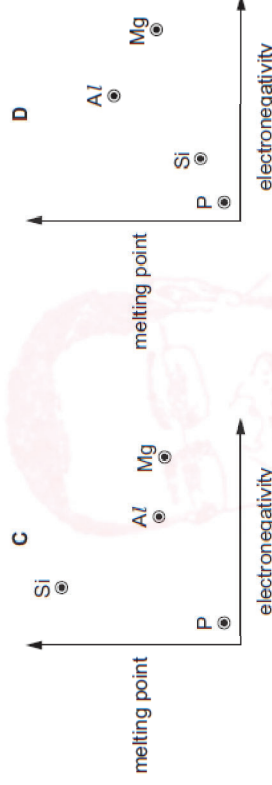
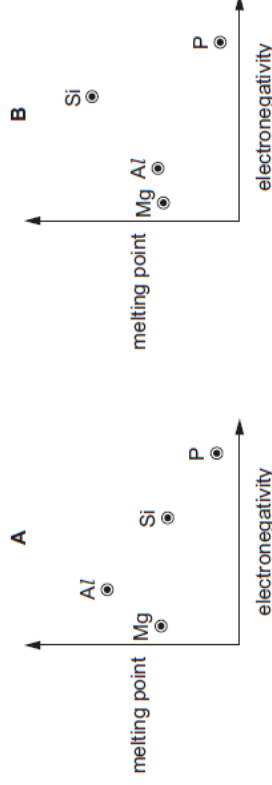
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements describe a trend in Period 3 between every pair of adjacent elements from sodium to chlorine?

- The atomic radius decreases.
- The 1st ionisation energy decreases.
- The melting point decreases.

Topic Chem 9 Q# 540/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Which graph correctly shows the relative melting points of the elements Mg, Al, Si and P plotted against their relative electronegativities?



Topic Chem 9 Q# 541/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Three test-tubes, X, Y, and Z, each contain a small amount of water.

- A small amount of NaCl is added to test-tube X.
- A small amount of $SiCl_4$ is added to test-tube Y.
- A small amount of $AlCl_3$ is added to test-tube Z.

After a short time, two drops of Universal Indicator solution are added to each test-tube.

Which observations are made?

- The indicator added to test-tube X stays green.
- The indicator added to test-tube Y turns red.
- The indicator added to test-tube Z turns red.



Topic Chem 9 Q# 542/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

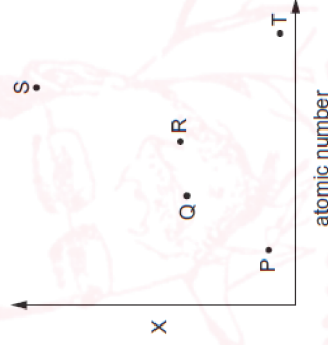
31 Nitrogen and phosphorus are both in Group 15 of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5 but nitrogen does not form NCI_5 .

Which statements help to explain this?

- Nitrogen's outer shell cannot contain more than eight electrons.
- Nitrogen cannot have an oxidation state of +5.
- Nitrogen is less electronegative than phosphorus.

Topic Chem 9 Q# 543/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 The magnitude of property X of five elements from the third period of the Periodic Table, P, Q, R, S and T is shown. P, Q, R, S and T have consecutive atomic numbers. The letters do not represent the symbols of the elements.



Which row correctly identifies property X and element R?

	property X	element R
A	electrical conductivity	Al
B	electronegativity	Si
C	melting point	Al
D	melting point	Si

Topic Chem 9 Q# 544/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

12 The electrical conductivities of two compounds, Y and Z, are shown in the table.

	Y	Z
conductivity of the compound in the liquid state	good	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good

What could compounds Y and Z be?

	Y	Z
A	Al_2O_3	$SiCl_4$
B	NaF	Al_2O_3
C	NaF	$SiCl_4$
D	$SiCl_4$	Al_2O_3

Topic Chem 9 Q# 545/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 A little water is added to each of the following compounds and the mixture warmed.

For which compounds will an acidic gas be evolved?

- aluminium chloride
- silicon tetrachloride
- phosphorous pentachloride

Topic Chem 9 Q# 546/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

12 Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

- A chloride ion has one more occupied electron shell than a sodium ion.
- Chlorine has a higher proton number than sodium.
- Ionic radius increases regularly across the third period.
- Sodium is a metal, chlorine is a non-metal.



- 13 When dealing with a spillage of metallic sodium it is important that no toxic or flammable products are formed.

Which material should be used if there is a spillage of metallic sodium?

- A dilute hydrochloric acid
- B ethanol
- C sand
- D water spray

- 12 Consecutive elements X, Y and Z are in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

- A sodium, magnesium, aluminium
- B magnesium, aluminium, silicon
- C aluminium, silicon, phosphorus
- D silicon, phosphorus, sulfur

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 32 The Group IV elements carbon, silicon and germanium can all exist in the giant molecular structure which is also found in diamond. The bond lengths in these structures are given below.

element X	C	Si	Ge
bond length X-X/nm	0.154	0.234	0.244

Why does the bond length increase down the group?

- 1 Orbital overlap decreases down the group.
- 2 Atomic radius increases down the group.
- 3 Nuclear charge increases down the group.

- 16 X is the oxide of a Period 3 element. X reacts with water to give an acidic solution.

A solution is prepared by reacting 0.100 g of X with excess water. This solution was neutralised by exactly 25.0 cm³ of 0.100 mol dm⁻³ sodium hydroxide solution.

What could be the identity of X?

- A Al₂O₃
- B MgO
- C P₄O₁₀
- D SO₃

- 15 The melting points of the Period 3 elements sodium to aluminium are shown in the table.

element	Na	Mg	Al
mp/K	371	923	932

Which factor explains the increase in melting points from sodium to aluminium?

- A the changes in first ionisation energy from sodium to aluminium
- B the increase in electronegativity from sodium to aluminium
- C the increase in the A_r of the elements from sodium to aluminium

- D the increase in the number of outer electrons in each atom from sodium to aluminium

- 14 Use of the Data Booklet is relevant to this question.

Which of the elements sodium, magnesium, aluminium, silicon, phosphorus, sulfur and chlorine

- has a lower first ionisation energy than the preceding element in the Periodic Table,
- conducts electricity and
- has a lower atomic radius than the preceding element in the Periodic Table?

- A aluminium
- B magnesium
- C phosphorus

- D sulfur

- 3 Use of the Data Booklet is relevant to this question.

1.00 g of carbon is combusted in a limited supply of pure oxygen. 0.50 g of the carbon combusts to form CO₂ and 0.50 g of the carbon combusts to form CO.

The resultant mixture of CO₂ and CO is passed through excess NaOH(aq) and the remaining gas is then dried and collected.

What is the volume of the remaining gas? (All gas volumes are measured at 25°C and 1 atmosphere pressure.)

- A 1 dm³
- B 1.5 dm³
- C 2 dm³
- D 3 dm³

Topic Chem 9 Q# 554/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org .o)

15 Use of the Data Booklet is relevant to this question.

Which diagram correctly shows the atomic radii of the elements Mg, Al, Si and P plotted against their melting points?



Topic Chem 9 Q# 555/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

14 Which observations are made when a sample of silicon chloride, SiCl_4 , is added to a beaker of water?

- A No visible changes are observed.
- B Steamy fumes and a white precipitate are both observed.
- C The appearance of a white precipitate is the only observation.
- D The appearance of steamy fumes is the only observation.

Topic Chem 9 Q# 556/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

19 Which oxide does not react with cold dilute sodium hydroxide to produce a salt?

- A Al_2O_3
- B P_4O_{10}
- C SO_2
- D SiO_2

Topic Chem 9 Q# 557/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org .o)

18 Total removal of the pollutant sulfur dioxide, SO_2 , is difficult. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are reacted with calcium hydroxide to remove the SO_2 .

What is the main product formed initially?

- A $\text{Ca}(\text{HSO}_3)_2$
- B CaS
- C CaSO_3
- D CaSO_4

Topic Chem 9 Q# 558/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

14 Use of the Data Booklet is relevant to this question.

Sir Humphrey Davy discovered boron, calcium, magnesium and sodium.

Which of these elements has the second smallest atomic radius in its group and the third lowest first ionisation energy in its period?

- A boron
- B calcium
- C magnesium
- D sodium

Topic Chem 9 Q# 559/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

13 Which property is not associated with the element sodium?

- A It can react with cold water to form hydrogen.
- B It forms a basic oxide.
- C It forms a neutral chloride.
- D It is an oxidising agent.

Topic Chem 9 Q# 560/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

12 Element X, in Period 3, has the following properties.

- Its oxide has a giant structure.
- It forms covalent bonds with chlorine.
- Its oxide will neutralise $\text{HC}l(\text{aq})$.

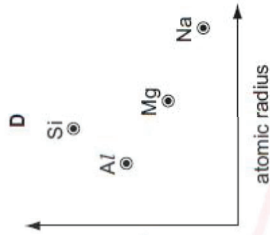
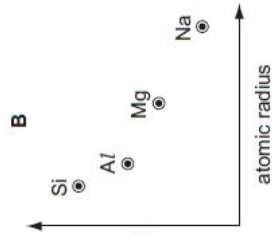
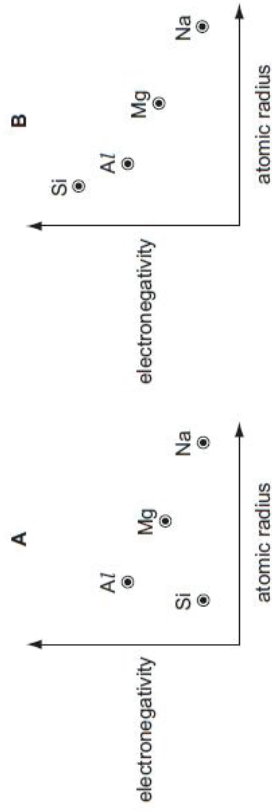
What is element X?

- A Mg
- B Al
- C Si
- D P



19 Use of the Data Booklet is relevant to this question.

Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, Al and Si?



Topic Chem 9 Q# 562/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

16 Which description of the bonding and acid/base nature of aluminium oxide is correct?

	bonding	acid / base nature
A	covalent	amphoteric
B	covalent	basic
C	ionic	amphoteric
D	ionic	basic

Topic Chem 9 Q# 563/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org .o)

15 When calcium is burnt in oxygen, what colour is the flame?

- A green
- B red
- C white
- D yellow

19 Consecutive elements X, Y and Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What could be the identities of X, Y and Z?

- A sodium, magnesium, aluminium
- B magnesium, aluminium, silicon
- C aluminium, silicon, phosphorus
- D silicon, phosphorus, sulfur

Topic Chem 9 Q# 565/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org .o)

4 Use of the Data Booklet is relevant to this question.

The elements radon (Rn), francium (Fr) and radium (Ra) have proton numbers 86, 87 and 88 respectively.

What is the order of their first ionisation energies?

	least endothermic	most endothermic
A	Fr	Rn
B	Fr	Ra
C	Ra	Rn
D	Rn	Fr

Topic Chem 9 Q# 566/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org .o)

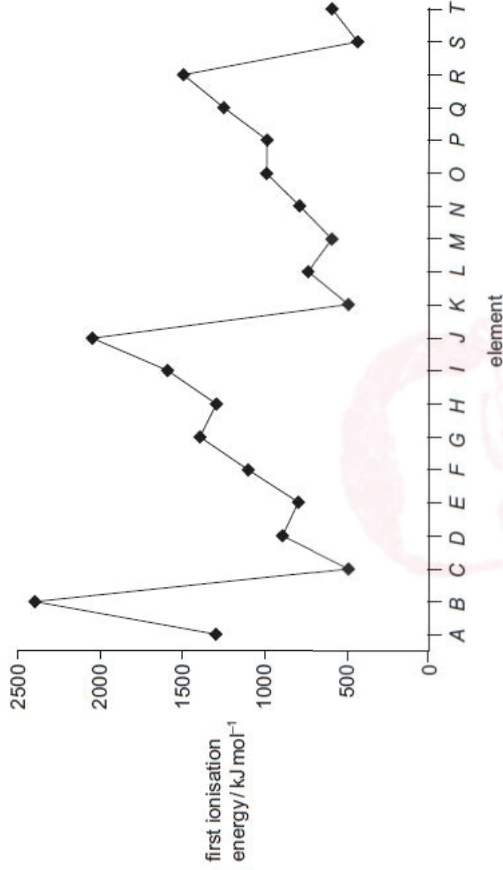
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 34 The first ionisation energies of twenty successive elements in the Periodic Table are represented in the graph.

The letters given are not the normal symbols for these elements.



Which statements about this graph are correct?

- Elements B, J and R are in Group 0 of the Periodic Table.
- Atoms of elements D and L contain two electrons in their outer shells.
- Atoms of elements G and O contain a half-filled p subshell.

Topic Chem 9 Q# 567/ AS Chemistry/2013/s/TZ.1/Paper 1/Exam Q# 2/(www.SmashingScience.org :o)

- A mixture of 10 cm³ of methane and 10 cm³ of ethane was sparked with an excess of oxygen. After cooling to room temperature, the residual gas was passed through aqueous potassium hydroxide.

All gas volumes were measured at the same temperature and pressure.

What volume of gas was absorbed by the alkali?

- A 15 cm³ B 20 cm³ C 30 cm³ D 40 cm³

Topic Chem 9 Q# 568/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 36/(www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

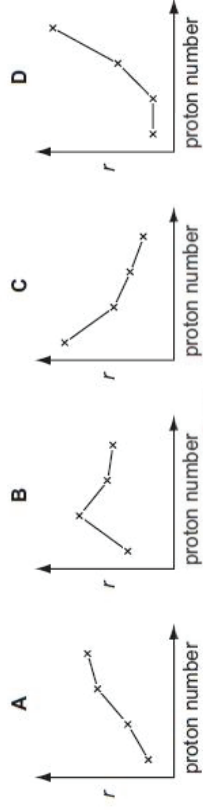
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 36 When added to water, which oxides will not cause a change in pH?

- Al₂O₃
- SiO₂
- P₄O₁₀

Topic Chem 9 Q# 569/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 19/(www.SmashingScience.org :o)

- 19 Which diagram shows the variation of the metallic radius *r* of the Group I elements, Li, Na, K and Rb, with increasing proton (atomic) number?



Topic Chem 9 Q# 570/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 18/(www.SmashingScience.org :o)

- 18 Elements X and Y are both in period three.

When the chloride of X is added to water, it reacts and a solution of pH 2 is produced.

When the chloride of Y is added to water, it dissolves and a solution of pH 7 is produced.

Which statement explains these observations?

- A Both chlorides hydrolyse in water.
 B X is phosphorus and Y is aluminium.
 C X is silicon and Y is sodium.
 D X is sodium and Y is phosphorus.

Topic Chem 9 Q# 571/ AS Chemistry/2012/s/TZ.1/Paper 1/Exam Q# 15/(www.SmashingScience.org :o)

- 15 The oxides BaO, CaO, MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

- A BaO(aq) B CaO(aq) C MgO(aq) D SrO(aq)

Topic Chem 9 Q# 572/ AS Chemistry/2011/w/TZ.1/Paper 1/Exam Q# 18/(www.SmashingScience.org :o)

- 18 Total removal of the pollutant sulfur dioxide, SO₂, is difficult, both for economic and technical reasons. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO₂.

What is the main product formed initially?

- A Ca(HSO₄)₂ B CaS C CaSO₃ D CaSO₄



Topic Chem 9 Q# 573/ AS Chemistry/2011/w/TZ.1/Paper 1/Exam Q# 1//www.SmashingScience.org .o)

- 1 Three elements, X, Y and Z, have the physical properties shown in the table.

element	melting point /°C	boiling point /°C	density /g cm ³
X	-7	59	3.12
Y	98	883	0.97
Z	649	1107	1.74

What could be the identities of X, Y and Z?

X	Y	Z
A	Br ₂	Al
B	Br ₂	Na
C	I ₂	Mg
D	I ₂	Si

Topic Chem 9 Q# 574/ AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 5//www.SmashingScience.org .o)

- 5 Which factor helps to explain why the first ionisation energies of the Group 1 elements decrease from lithium to sodium to potassium to rubidium?

- A The nuclear charge of the elements increases.
B The outer electron is in an 's' subshell.
C The repulsion between spin-paired electrons increases.
D The shielding effect of the inner shells increases.

Topic Chem 9 Q# 575/ AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 35//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 Which oxides react with water to give a solution of pH 10 or higher?

- 1 CaO
2 Na₂O
3 SrO

Topic Chem 9 Q# 576/ AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 34 Which statements are correct?

- 1 Aluminium chloride dissolves in water to give an acidic solution.
2 Magnesium chloride dissolves in water to give a slightly acidic solution.
3 Sodium chloride dissolves in water to give an alkaline solution.

Topic Chem 9 Q# 577/ AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

- 13 0.02 mol of aluminium is burned in oxygen and the product is reacted with 2.00 mol dm⁻³ hydrochloric acid.

What minimum volume of acid will be required for complete reaction?

- A 15 cm³ B 20 cm³ C 30 cm³ D 60 cm³

Topic Chem 9 Q# 578/ AS Chemistry/2010/w/TZ.1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

- 13 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

- A A phosphorus atom has one more proton in its nucleus.
B The atomic radius of a phosphorus atom is greater.
C The outer electron in a phosphorus atom is more shielded.

Topic Chem 9 Q# 579/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 2//www.SmashingScience.org .o)

- 2 Use of the Data Booklet is relevant to this question.

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic	→	most endothermic
A	Fr		Rn
B	Fr		Ra
C	Ra		Rn
D	Rn		Fr

Topic Chem 9 Q# 580/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

- 19 Two properties of non-metallic elements and their atoms are as follows.

- property 1 has an oxide that can form a strong acid in water
property 2 has no paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only



Topic Chem 9 Q# 581/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org .o)

- 18 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

- A aluminium
- B magnesium
- C phosphorus
- D sodium

Topic Chem 9 Q# 582/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

- A aluminium, silicon, phosphorus
- B magnesium, aluminium, silicon
- C silicon, phosphorus, sulfur
- D sodium, magnesium, aluminium

Topic Chem 9 Q# 583/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

- 14 The oxide and chloride of an element X are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element X?

- A sodium
- B magnesium
- C aluminium
- D phosphorus

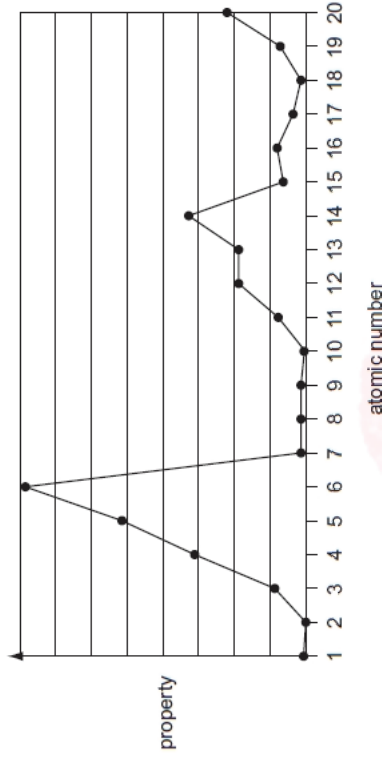
Topic Chem 9 Q# 584/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

- 13 Which statement correctly describes what happens when silicon tetrachloride is added to water?

- A The SiCl_4 dissolves to give a neutral solution only.
- B The SiCl_4 reacts to give an acidic solution only.
- C The SiCl_4 reacts to give a precipitate and an acidic solution.
- D The SiCl_4 reacts to give a precipitate and a neutral solution.

Topic Chem 9 Q# 585/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

- 12 The following graph shows the variation of a property of the first 20 elements in the Periodic Table with the atomic number of the element.



What is the property?

- A atomic radius
- B first ionisation energy
- C ionic radius
- D melting point

Topic Chem 10 Q# 586/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org .o)

- 8 The carbonate of an s-block element is reacted with an excess of hydrochloric acid.

0.833 g of the carbonate releases 200 cm^3 of gas, measured under room conditions.

What is the identity of the metal carbonate?

- A Na_2CO_3
- B K_2CO_3
- C MgCO_3
- D CaCO_3

Topic Chem 10 Q# 587/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

- 20 Which row is correct?

	the temperature needed to decompose Group 2 metal nitrates	the solubility of Group 2 sulfates
A	decreases down the group	decreases down the group
B	decreases down the group	increases down the group
C	increases down the group	increases down the group
D	increases down the group	decreases down the group

Topic Chem 9 Q# 581/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org .o)

- 18 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

- A aluminium
- B magnesium
- C phosphorus
- D sodium

Topic Chem 9 Q# 582/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

- A aluminium, silicon, phosphorus
- B magnesium, aluminium, silicon
- C silicon, phosphorus, sulfur
- D sodium, magnesium, aluminium

Topic Chem 9 Q# 583/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

- 14 The oxide and chloride of an element X are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element X?

- A sodium
- B magnesium
- C aluminium
- D phosphorus

Topic Chem 9 Q# 584/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

- 13 Which statement correctly describes what happens when silicon tetrachloride is added to water?

- A The SiCl_4 dissolves to give a neutral solution only.
- B The SiCl_4 reacts to give an acidic solution only.
- C The SiCl_4 reacts to give a precipitate and an acidic solution.
- D The SiCl_4 reacts to give a precipitate and a neutral solution.



Topic Chem 10 Q# 588/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

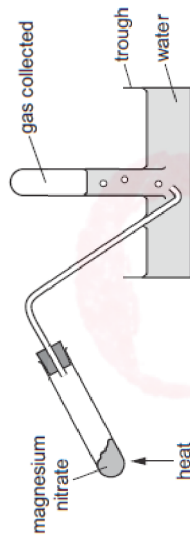
- 3 In separate experiments, 5.0 g samples of each of four s-block metals are added to an excess of water. The gas evolved is collected and its volume measured under the same conditions of temperature and pressure for each sample.

Which metal produces the largest volume of gas?

- A calcium
 B potassium
 C rubidium
 D strontium

Topic Chem 10 Q# 589/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org .o)

- 21 A sample of magnesium nitrate is heated in the apparatus shown.



The pH of the solution in the trough is measured.

The gas collected is tested with a glowing splint.

What are the results?

	pH of solution in trough	splint test
A	8	relights
B	2	relights
C	8	extinguished
D	2	extinguished

Topic Chem 10 Q# 590/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

- 20 A mixture contains magnesium carbonate and barium carbonate only. A sample of the mixture is dissolved in nitric acid to produce a solution.

How could this solution be processed into a magnesium compound and a separate barium compound?

- A Add HCl(aq), filter off the solid barium chloride.
 B Add HCl(aq), filter off the solid magnesium chloride.
 C Add H₂SO₄(aq), filter off the solid barium sulfate.
 D Add H₂SO₄(aq), filter off the solid magnesium sulfate.

Topic Chem 10 Q# 591/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 21//www.SmashingScience.org .o)

- 21 Which row gives correct comparisons between the solubilities of calcium hydroxide and barium hydroxide and the thermal stabilities of calcium carbonate and barium carbonate?

	solubility		thermal stability	
	calcium hydroxide	barium hydroxide	calcium carbonate	barium carbonate
A	higher	lower	higher	lower
B	higher	lower	lower	higher
C	lower	higher	higher	lower
D	lower	higher	lower	higher

Topic Chem 10 Q# 592/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

- 20 Equal masses of CaCO₃, Ca(NO₃)₂, BaCO₃ and Ba(NO₃)₂ are thermally decomposed. The volume of gas produced in each experiment is measured under the same conditions.

Which compound will produce the greatest volume of gas?

- A CaCO₃ B Ca(NO₃)₂ C BaCO₃ D Ba(NO₃)₂

Topic Chem 10 Q# 593/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 36 Which statements about calcium oxide are correct?

- 1 It can be reduced by heating with magnesium.
 2 It is produced when calcium nitrate is heated.
 3 It reacts with cold water.

Topic Chem 10 Q# 594/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org .o)

- 15 Anhydrous magnesium nitrate, Mg(NO₃)₂, decomposes when heated, giving a white solid and a mixture of two gases, X and Y.

Y is oxygen.

What is the ratio mass of X released, mass of Y released?

- A $\frac{1}{0.174}$ B $\frac{1}{0.267}$ C $\frac{1}{0.348}$ D $\frac{1}{3.43}$

Topic Chem 10 Q# 595/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

- 14 In which list are all three compounds soluble in water?

- A barium chloride, calcium carbonate, magnesium hydroxide
 B barium hydroxide, calcium hydroxide, strontium carbonate
 C barium chloride, barium hydroxide, magnesium sulfate
 D barium sulfate, calcium sulfate, magnesium hydroxide

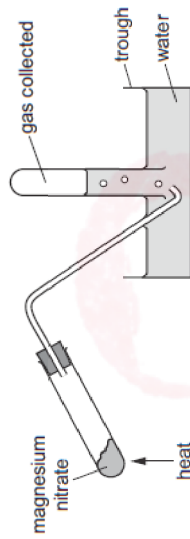
Topic Chem 10 Q# 588/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

Which metal produces the largest volume of gas?

- A calcium
 B potassium
 C rubidium
 D strontium

Topic Chem 10 Q# 589/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org .o)

- 21 A sample of magnesium nitrate is heated in the apparatus shown.



The pH of the solution in the trough is measured.

The gas collected is tested with a glowing splint.

What are the results?

	pH of solution in trough	splint test
A	8	relights
B	2	relights
C	8	extinguished
D	2	extinguished

Topic Chem 10 Q# 590/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

- 20 A mixture contains magnesium carbonate and barium carbonate only. A sample of the mixture is dissolved in nitric acid to produce a solution.

How could this solution be processed into a magnesium compound and a separate barium compound?

- A Add HCl(aq), filter off the solid barium chloride.
 B Add HCl(aq), filter off the solid magnesium chloride.
 C Add H₂SO₄(aq), filter off the solid barium sulfate.
 D Add H₂SO₄(aq), filter off the solid magnesium sulfate.



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements are correct?

- Magnesium carbonate decomposes at a lower temperature than calcium carbonate.
- Calcium hydroxide is more soluble in water than magnesium hydroxide.
- Calcium is a stronger reducing agent than magnesium.

15 Which substance will **not** be a product of the thermal decomposition of hydrated magnesium nitrate?

- dinitrogen monoxide
- magnesium oxide
- oxygen
- steam

14 Q is a mixture of a Group 2 oxide and a Group 2 sulfate. Q contains equal amounts of the two compounds.

Q is shaken with water and the resulting mixture filtered; a solid residue is obtained. There is no reaction when the solid residue is shaken with HCl(aq). Shaking the filtrate with H₂SO₄(aq) produces a white precipitate.

What could be Q?

- BaO + BaSO₄
- BaO + MgSO₄
- MgO + BaSO₄
- MgO + MgSO₄

15 An anhydrous white salt, Z, is heated strongly for 30 minutes. A mixture of gases is given off. The solid remaining in the test-tube is then dissolved in a small volume of dilute hydrochloric acid. The addition of a few drops of dilute sulfuric acid to the test-tube causes a white precipitate to form.

Which substance could be Z?

- barium carbonate
- barium nitrate
- magnesium carbonate
- magnesium nitrate

14 Which row correctly describes one property of barium and one property of barium oxide?

	observation when barium metal is added to water	pH of solution obtained when a spatula measure of BaO is added to 100 cm ³ of water
A	a few gas bubbles form on the metal surface	8
B	a few gas bubbles form on the metal surface	13
C	rapid effervescence is seen	8
D	rapid effervescence is seen	13

19 Sulfur dioxide, SO₂, reacts with calcium hydroxide in aqueous solution.

What is the main product that is first formed?

- Ca(HSO₃)₂
- CaS
- CaSO₃
- CaSO₄

18 What are the trends in the stated properties as Group 2 is descended from magnesium to barium?

	decomposition temperature of the carbonate	first ionisation energy
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

15 A student mixes pairs of chemicals together in separate test-tubes.

- excess calcium (s) + water (l)
- barium chloride (aq) + strontium hydroxide (aq)
- calcium carbonate (s) + excess hydrochloric acid (aq)
- magnesium sulfate (aq) + barium nitrate (aq)

How many of the mixtures produce a white, solid product?

- 0
- 1
- 2
- 3



- 13 This question is about two elements in Group 2, Q and R.

Three of the statements shown are correct for metal Q.

The one remaining statement is correct for metal R.

Which statement applies to R?

- A A saturated solution of the hydroxide of this metal has the higher pH value.
- B This metal has a carbonate that is used in agriculture to reduce the acidity of soil.
- C This metal has the greater atomic radius.
- D This metal reacts more quickly with cold water.

- 17 0.25 g of anhydrous magnesium nitrate is heated strongly until it completely decomposes.

What is the total volume of gas produced, measured under room conditions?

- A 40 cm³
- B 81 cm³
- C 101 cm³
- D 202 cm³

- 14 An excess of MgO is shaken with water. The resulting mixture is filtered into test-tube P.

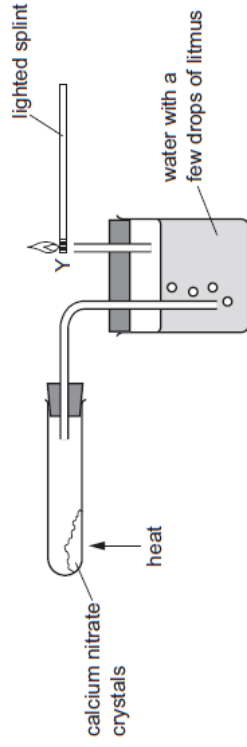
An excess of BaO is shaken with water. The resulting mixture is filtered into test-tube Q.

Which oxide reacts more readily with water and which filtrate has the lower pH?

	oxide reacts more readily with water	test-tube with filtrate of lower pH
A	BaO	P
B	BaO	Q
C	MgO	P
D	MgO	Q

- 17 A student investigates calcium nitrate crystals by heating them in the apparatus shown.

A colourless gas leaves the apparatus at Y. A flame is held to this gas.



Which observations would the student make?

	litmus solution	flame at Y
A	changes to blue	flame burns more brightly
B	changes to blue	flame goes out
C	changes to red	flame burns more brightly
D	changes to red	flame goes out

- 13 Compound Z is insoluble in water but soluble at low pH.

What could be compound Z?

- A barium carbonate
- B barium chloride
- C barium hydroxide
- D barium sulfate

- 15 Solutions P and Q each contain a different Group 2 ion at the same concentration. One contains Mg²⁺, the other contains Ba²⁺. Tests are carried out on separate 5 cm³ samples of P and Q.

test 1: add 1 cm³ of 0.1 mol dm⁻³ Na₂SO₄(aq)

test 2: add 1 cm³ of 0.1 mol dm⁻³ NaOH(aq)

What are the results of these tests?

	results in test 1	results in test 2
A	more precipitate with Ba ²⁺	more precipitate with Ba ²⁺
B	more precipitate with Ba ²⁺	more precipitate with Mg ²⁺
C	more precipitate with Mg ²⁺	more precipitate with Ba ²⁺
D	more precipitate with Mg ²⁺	more precipitate with Mg ²⁺

- 13 This question is about two elements in Group 2, Q and R.

Three of the statements shown are correct for metal Q.

The one remaining statement is correct for metal R.

Which statement applies to R?

- A A saturated solution of the hydroxide of this metal has the higher pH value.
- B This metal has a carbonate that is used in agriculture to reduce the acidity of soil.
- C This metal has the greater atomic radius.
- D This metal reacts more quickly with cold water.

- 17 0.25 g of anhydrous magnesium nitrate is heated strongly until it completely decomposes.

What is the total volume of gas produced, measured under room conditions?

- A 40 cm³
- B 81 cm³
- C 101 cm³
- D 202 cm³

- 14 An excess of MgO is shaken with water. The resulting mixture is filtered into test-tube P.

An excess of BaO is shaken with water. The resulting mixture is filtered into test-tube Q.

Which oxide reacts more readily with water and which filtrate has the lower pH?

	oxide reacts more readily with water	test-tube with filtrate of lower pH
A	BaO	P
B	BaO	Q
C	MgO	P
D	MgO	Q



Topic Chem 10 Q# 610/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 A 5.00 g sample of an anhydrous Group 2 metal nitrate loses 3.29 g in mass when heated strongly.

Which metal is present?

- A magnesium
- B calcium
- C strontium
- D barium

Topic Chem 10 Q# 611/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 36 A mixture of magnesium carbonate and magnesium nitrate is heated strongly in a hard-glass test-tube.

Which gases are formed?

- 1 carbon dioxide
- 2 nitrogen dioxide
- 3 oxygen

Topic Chem 10 Q# 612/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

- 15 Solutions of $0.1 \text{ mol dm}^{-3} \text{ Mg(NO}_3)_2$ and $0.1 \text{ mol dm}^{-3} \text{ Ba(NO}_3)_2$ separately undergo a series of reactions using pure reagents.



M, N and P are magnesium compounds.

Q, R and S are barium compounds.

How many of M, N, P, Q, R and S are white precipitates?

- A 2
- B 3
- C 4
- D 5

Topic Chem 10 Q# 613/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 Substance X reacts with water. A gas is given off and the pH of the solution increases. The solution is then reacted with sulfuric acid and a white precipitate forms.

What could be substance X?

- A barium
- B barium oxide
- C magnesium
- D magnesium oxide

Topic Chem 10 Q# 614/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

- 16 L, M and N are Group 2 metals. L reacts more vigorously with dilute hydrochloric acid than N does. M(OH)_2 is more soluble than N(OH)_2 .

What could be the identities of L, M and N?

	L	M	N
A	Ba	Ca	Sr
B	Ba	Sr	Ca
C	Ca	Ba	Sr
D	Sr	Ca	Ba

Topic Chem 10 Q# 615/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

- 15 When calcium nitrate thermally decomposes, oxygen is one of the products.

Which volume of oxygen is produced under room conditions when 0.50 mol of calcium nitrate thermally decomposes?

- A 6.0 dm^3
- B 12.0 dm^3
- C 18.0 dm^3
- D 30.0 dm^3

Topic Chem 10 Q# 616/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 Metal T reacts with water to produce a colourless solution. A white precipitate is produced when this colourless solution is mixed with aqueous sulfuric acid.

What is metal T?

- A barium
- B magnesium
- C potassium
- D sodium



Topic Chem 10 Q# 617/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)

4 5.0 g samples of the carbonates of barium, copper, lithium and magnesium are decomposed to the metal oxides and carbon dioxide.

For which compound is there the greatest loss in mass?

- A barium carbonate
- B copper(II) carbonate
- C lithium carbonate
- D magnesium carbonate

Topic Chem 10 Q# 618/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which properties increase from magnesium to barium?

- 1 ionic radius of the cation M^{2+}
- 2 screening of outermost electrons by inner shells
- 3 solubility of the hydroxides, $M(OH)_2$, in water

Topic Chem 10 Q# 619/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which reaction routes can be used to make a pure sample of barium sulfate?

- 1 Ba metal $\xrightarrow[\text{in } O_2]{\text{heat}}$ product \xrightarrow{HCl} product 2 $\xrightarrow{H_2SO_4}$ product 3 $\xrightarrow{\text{filter, wash and dry}}$
- 2 $Ba(NO_3)_2 \xrightarrow[\text{heat in air}]{\text{strong}}$ product $\xrightarrow{\text{an excess of water}}$ product 2 $\xrightarrow{H_2SO_4}$ product 3 $\xrightarrow{\text{filter, wash and dry}}$
- 3 $Ba(OH)_2 \xrightarrow{HNO_3}$ product $\xrightarrow{H_2SO_4}$ product 2 $\xrightarrow{\text{filter, wash and dry}}$

Topic Chem 10 Q# 620/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 A sample of anhydrous calcium nitrate is placed in a test-tube and heated in a roaring Bunsen flame until it decomposes. The description of the gas in the test-tube is then noted. A glowing splint is then put into the test-tube and any changes are noted.

Which observations are correct?

	description of the gas in the test-tube	result of glowing splint test
A	brown	the splint goes out
B	brown	the splint relights
C	colourless	the splint goes out
D	colourless	the splint relights

Topic Chem 10 Q# 621/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 When 3.00 g of an anhydrous nitrate of a Group 2 metal is decomposed, 1.53 g of gas is produced.

What is the nitrate compound?

- A beryllium nitrate
- B calcium nitrate
- C magnesium nitrate
- D strontium nitrate

Topic Chem 10 Q# 622/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 A solution contains both $Mg^{2+}(aq)$ and $Sr^{2+}(aq)$ at the same concentration.

The solution is divided into two equal portions. Aqueous sodium hydroxide is added dropwise to one portion. Dilute sulfuric acid is added dropwise to the other portion.

Which row is correct?

	precipitate seen first when $NaOH(aq)$ is added	precipitate seen first when $H_2SO_4(aq)$ is added
A	magnesium hydroxide	magnesium sulfate
B	magnesium hydroxide	strontium sulfate
C	strontium hydroxide	magnesium sulfate
D	strontium hydroxide	strontium sulfate

Topic Chem 10 Q# 623/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 35//

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



35 Which statements about the elements barium and calcium and their compounds are correct?

- 1 Barium nitrate decomposes at a higher temperature than calcium nitrate.
- 2 Barium hydroxide is more soluble in water than is calcium hydroxide.
- 3 Calcium is more reactive with water than is barium.

Topic Chem 10 Q# 624/ AS Chemistry/2017/m/TZ 1/Paper 1/Exam Q# 15//

15 The mineral dolomite is a mixture of magnesium carbonate and calcium carbonate.

An aqueous reagent, X, was added to a small sample of dolomite. Effervescence was seen and a white solid, Y, was formed.

What could be the correct identity of reagent X and solid Y?

	reagent X	solid Y
A	hydrochloric acid	calcium chloride
B	hydrochloric acid	magnesium chloride
C	sulfuric acid	calcium sulfate
D	sulfuric acid	magnesium sulfate

Topic Chem 10 Q# 625/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 Samples of magnesium carbonate, MgCO_3 , are placed in crucibles R and S. The sample in crucible R is heated until there is no further loss in mass, and then allowed to cool. The sample in crucible S is left unheated.

Dilute hydrochloric acid is then added to both crucibles.

On adding the dilute hydrochloric acid, which observations are correct?

	R	S
A	gas produced	gas produced
B	gas produced	no gas produced
C	no gas produced	gas produced
D	no gas produced	no gas produced

Topic Chem 10 Q# 626/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 An excess of MgO is shaken with water. The resulting mixture is filtered into test-tube X.

An excess of BaO is shaken with water. The resulting mixture is filtered into test-tube Y.

Which oxide reacts more readily with water and which filtrate has the lower pH?

	oxide reacts more readily with water	test-tube with filtrate of lower pH
A	barium oxide	X
B	barium oxide	Y
C	magnesium oxide	X
D	magnesium oxide	Y

Topic Chem 10 Q# 627/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Z is an anhydrous compound of a Group 2 element. When it is heated, Z undergoes thermal decomposition to produce two different gases. Z has relatively low thermal stability compared to other Group 2 compounds containing the same anion as Z.

What is compound Z?

- A barium carbonate
- B barium nitrate
- C magnesium carbonate
- D magnesium nitrate

Topic Chem 10 Q# 628/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 Why does barium react more rapidly with cold water than magnesium does?

- A Barium atoms are larger and form ions more easily than magnesium atoms.
- B Barium floats on the surface of the water but magnesium sinks in the water.
- C Barium hydroxide is less soluble than magnesium hydroxide.
- D The sum of the 1st and 2nd ionisation energies of barium is more than that for magnesium.

Topic Chem 10 Q# 629/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Which row of the table gives correct comparisons between the solubilities of calcium and barium hydroxide and the thermal stabilities of calcium and barium carbonate?

	solubility		thermal stability	
	calcium hydroxide	barium hydroxide	calcium carbonate	barium carbonate
A	higher	lower	higher	lower
B	higher	lower	lower	higher
C	lower	higher	higher	lower
D	lower	higher	lower	higher



Topic Chem 10 Q# 630/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Magnesium nitrate, $Mg(NO_3)_2$, will decompose when heated to give a white solid and a mixture of gases. One of the gases released is an oxide of nitrogen, X.

7.4 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

What mass of X is produced?

- A 1.5 g B 2.3 g C 3.0 g D 4.6 g

Topic Chem 10 Q# 631/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 X and Y are both Group 2 metals.

X and Y both form hydroxide compounds, but $X(OH)_2$ is more soluble in water than $Y(OH)_2$.

If a piece of metal Y is put into cold water a very slow reaction occurs, and only a very few, small hydrogen bubbles can be seen.

What could be the identities of X and Y?

	X	Y
A	barium	magnesium
B	barium	strontium
C	calcium	strontium
D	magnesium	calcium

Topic Chem 10 Q# 632/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 A sample containing 0.40 mol of calcium nitrate was decomposed by heating in a roaring Bunsen burner flame until there was no further decomposition.

What are the products of this reaction?

- 1 0.40 mol of calcium oxide
2 0.40 mol of nitrogen, $N_2(g)$
3 0.40 mol of oxygen, $O_2(g)$

Topic Chem 10 Q# 633/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 River water in a chalky agricultural area contains Ca^{2+} , Mg^{2+} , CO_3^{2-} , HCO_3^- , Cl^- and NO_3^- ions. In a water treatment plant, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated from the river water following the addition of calcium hydroxide?

- A $CaCl_2$ B $CaCO_3$ C $Ca(NO_3)_2$ D $Mg(NO_3)_2$

Topic Chem 10 Q# 634/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements concerning the Group II elements magnesium, calcium and barium are correct?

- 1 Their reactivity increases with increasing relative atomic mass.
2 The oxidation number exhibited in their stable compounds is +2.
3 On strong heating, their nitrates give off oxygen only.

Topic Chem 10 Q# 635/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Rat poison needs to be insoluble in rain water but soluble at the low pH of stomach contents.

What is a suitable barium compound to use for rat poison?

- A barium carbonate
B barium chloride
C barium hydroxide
D barium sulfate

Topic Chem 10 Q# 636/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)

12 X is a Group II metal. The carbonate of X decomposes when heated in a Bunsen flame to give carbon dioxide and a white solid residue as the only products. This white solid residue is sparingly soluble in water. Even when large amounts of the solid residue are added to water the pH of the saturated solution is less than that of limewater.

What could be the identity of X?

- A magnesium
B calcium
C strontium
D barium

Topic Chem 10 Q# 637/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



36 X is a Group II metal. It forms a sulfate which is more soluble than barium sulfate. It forms a hydroxide which is more soluble than calcium hydroxide.

What could be the identity of X?

- 1 strontium
- 2 magnesium
- 3 beryllium

Topic Chem 10 Q# 638/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 Use of the Data Booklet is relevant to this question.

Which mass of solid residue will be obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

- A 0.70 g B 1.00 g C 1.40 g D 2.25 g

Topic Chem 10 Q# 639/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 The three minerals below are obtained from mines around the world. Each one behaves as a mixture of two carbonate compounds. They can be used as fire retardants because they decompose in the heat, producing CO₂. This gas smothers the fire.

barytocalcite BaCa(CO₃)₂
 dolomite CaMg(CO₃)₂
 huntite Mg₃Ca(CO₃)₄

What is the order of effectiveness as fire retardant, from best to worst?

	best	→	worst
A	dolomite	barytocalcite	huntite
B	dolomite	huntite	barytocalcite
C	huntite	barytocalcite	dolomite
D	huntite	dolomite	barytocalcite

Topic Chem 10 Q# 640/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements about calcium oxide are correct?

- 1 It reacts with cold water.
- 2 It is produced when calcium nitrate is heated.
- 3 It can be reduced by heating with magnesium.

Topic Chem 10 Q# 641/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Group II nitrates undergo thermal decomposition according to the following equation.



Which Group II nitrate requires the highest temperature to bring about its thermal decomposition?

- A barium nitrate
- B calcium nitrate
- C magnesium nitrate
- D strontium nitrate

Topic Chem 10 Q# 642/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 When equal volumes of saturated solutions of barium hydroxide and calcium hydroxide are mixed, a white precipitate, Y, forms. The mixture is filtered and carbon dioxide is bubbled through the filtrate, producing a second white precipitate, Z.

What are Y and Z?

	Y	Z
A	Ba(OH) ₂	Ca(OH) ₂
B	Ba(OH) ₂	CaCO ₃
C	Ca(OH) ₂	BaCO ₃
D	Ca(OH) ₂	Ba(OH) ₂

Topic Chem 10 Q# 643/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 Which property increases in value going down Group II?

- A electronegativity
- B ionic radius
- C maximum oxidation number
- D second ionisation energy

Topic Chem 10 Q# 644/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 A metal, X, reacts with water to produce a colourless solution which gives a white precipitate when mixed with aqueous sulfuric acid.

What is metal X?

- A barium
- B magnesium
- C potassium
- D sodium



Topic Chem 10 Q# 645/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)
 16 Use of the Data Booklet is relevant to this question.

Magnesium nitrate, $Mg(NO_3)_2$, will decompose when heated to give a white solid and a mixture of gases. One of the gases released is an oxide of nitrogen, X.

7.4 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

What mass of X is produced?

- A 1.5g B 2.3g C 3.0g D 4.6g

Topic Chem 10 Q# 646/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)
 13 In which row of the table are all statements comparing the compounds of magnesium and barium correct?

	solubility of hydroxides		solubility of sulfates	
	solubility of magnesium hydroxide	solubility of barium hydroxide	solubility of magnesium sulfate	solubility of barium sulfate
A	higher	lower	higher	lower
B	higher	lower	lower	higher
C	lower	higher	higher	lower
D	lower	higher	lower	higher

Topic Chem 10 Q# 647/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 Use of the Data Booklet is relevant to this question.

The nitrates of beryllium, calcium, magnesium, and strontium all decompose in the same way when heated. When 2.00 g of one of these anhydrous nitrates is decomposed, 1.32 g of gas is produced.

What is the nitrate?

- A beryllium nitrate
 B calcium nitrate
 C magnesium nitrate
 D strontium nitrate

Topic Chem 10 Q# 648/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 What are the trends in the stated properties as Group II is descended from magnesium to barium?

	decomposition temperature of the carbonate	first ionisation energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Topic Chem 10 Q# 649/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)
 13 Use of the Data Booklet is relevant to this question.

When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned lime water milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.

What was the mineral?

- A aragonite, $CaCO_3$
 B artinite, $MgCO_3 \cdot Mg(OH)_2 \cdot 3H_2O$
 C baryfocalcite, $BaCO_3 \cdot CaCO_3$
 D dolomite, $CaCO_3 \cdot MgCO_3$

Topic Chem 10 Q# 650/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 Use of the Data Booklet is relevant to this question.

A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass when heated strongly.

Which metal is present?

- A magnesium
 B calcium
 C strontium
 D barium

Topic Chem 10 Q# 651/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 Use of the Data Booklet is relevant to this question.

A significant contribution to atmospheric carbon dioxide levels comes from the thermal decomposition of limestone, in the manufacture of cement and of lime for agricultural purposes.

Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.

What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?

- A 440 B 527 C 660 D 880

Topic Chem 10 Q# 652/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 Steam is passed over heated magnesium to give compound X and hydrogen.

What is **not** a property of compound X?

- A It has an M_r of 40.3.
 B It is basic.
 C It is a white solid.
 D It is very soluble in water.

Topic Chem 10 Q# 653/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org .o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Samples of calcium and barium are separately added to beakers of cold water containing a few drops of litmus solution.

Which observations will be made with **only** the calcium and **not** with the barium?

- 1 A white suspension appears in the water.
- 2 The solution turns blue.
- 3 A gas is evolved.

Topic Chem 10 Q# 654/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

19 Which property of beryllium and its compounds is typical of the elements below it in Group II?

- A Be does not react with hot water.
- B BeCl_2 is covalent.
- C $\text{Be}(\text{NO}_3)_2$ produces BeO on thermal decomposition.
- D BeO dissolves in alkalis.

Topic Chem 10 Q# 655/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

14 When magnesium nitrate, $\text{Mg}(\text{NO}_3)_2 \cdot 7\text{H}_2\text{O}$, is heated, which three gases are given off?

- A dinitrogen oxide, oxygen, water vapour
- B hydrogen, nitrogen, oxygen
- C hydrogen, nitrogen dioxide, oxygen
- D nitrogen dioxide, oxygen, water vapour

Topic Chem 10 Q# 656/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

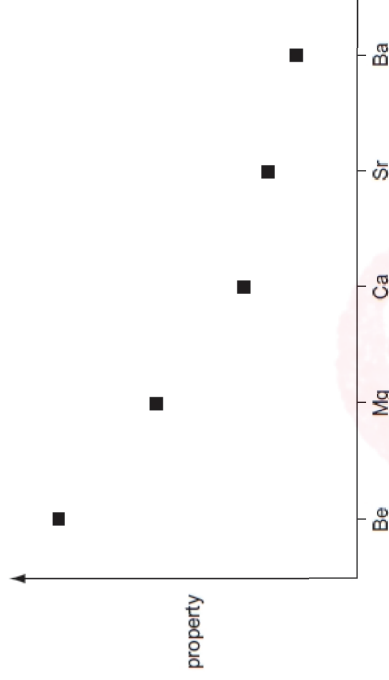
17 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?

- A reactivity with water
- B second ionisation energy
- C solubility of hydroxides
- D stability of the carbonates

Topic Chem 10 Q# 657/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org .o)

3 Use of the Data Booklet is relevant to this question.

The graph represents the variation of a property of the Group II elements.



What is this property?

- A ionic radius
- B ionisation energy
- C neutron/proton ratio
- D rate of reaction with water

Topic Chem 10 Q# 658/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org .o)

13 River water in a chalky agricultural area may contain Ca^{2+} , Mg^{2+} , CO_3^{2-} , HCO_3^- , Cl^- and NO_3^- ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated following the addition of calcium hydroxide?

- A CaCl_2
- B CaCO_3
- C $\text{Ca}(\text{NO}_3)_2$
- D $\text{Mg}(\text{NO}_3)_2$

Topic Chem 10 Q# 659/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org .o)

11 In some fireworks there is a reaction between powdered aluminium and powdered barium nitrate in which heat is evolved and an unreactive gas is produced.

What is the equation for this reaction?

- A $2\text{Al} + \text{Ba}(\text{NO}_3)_2 \rightarrow \text{Al}_2\text{O}_3 + \text{BaO} + 2\text{NO}$
- B $4\text{Al} + 4\text{Ba}(\text{NO}_3)_2 \rightarrow 2\text{Al}_2\text{O}_3 + 4\text{Ba}(\text{NO}_2)_2 + \text{O}_2$
- C $10\text{Al} + 3\text{Ba}(\text{NO}_3)_2 \rightarrow 5\text{Al}_2\text{O}_3 + 3\text{BaO} + 3\text{N}_2$
- D $10\text{Al} + 18\text{Ba}(\text{NO}_3)_2 \rightarrow 10\text{Al}(\text{NO}_3)_3 + 18\text{BaO} + 3\text{N}_2$



- 22 Chlorine is bubbled through 100 cm³ of hot 4.0 mol dm⁻³ sodium hydroxide until the reaction is complete.



Which row is correct?

	x	[Na ⁺](aq) after reaction / mol dm ⁻³
A	3	4.0
B	3	less than 4.0
C	6	4.0
D	6	less than 4.0

Topic Chem 11 Q# 661/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org .o)

- 21 Which statement about Group 17 elements and compounds is correct?

- A Sodium chloride produces chlorine when reacted with concentrated sulfuric acid.
 B Sodium chloride produces chlorine when reacted with bromine.
 C Sodium bromide produces bromine when reacted with concentrated sulfuric acid.
 D Sodium bromide produces bromine when reacted with iodine in aqueous potassium iodide.

Topic Chem 11 Q# 662/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org .o)

- 22 The results of tests performed on a white crystalline solid, X, are given in the table.

reagent and conditions	observation
X is gently heated	X sublimes
X is shaken with H ₂ O	a colourless solution, Y, forms
Y is warmed with NaOH(aq)	a gas is given off
AgNO ₃ (aq) is added to Y	a white precipitate, Z, forms
Z is shaken with NH ₃ (aq)	a colourless solution forms

What is the identity of X?

- A aluminium bromide
 B aluminium chloride
 C ammonium bromide
 D ammonium chloride
- Topic Chem 11 Q# 663/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 23//www.SmashingScience.org .o)
- 23 An excess of chlorine was bubbled into 100 cm³ of hot 6.0 mol dm⁻³ sodium hydroxide.

How many moles of sodium chloride would be produced in the reaction?

- A 0.30 B 0.50 C 0.60 D 0.72

Topic Chem 11 Q# 664/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 22//www.SmashingScience.org .o)

- 22 Which statement relating to the elements in Group 17 and their compounds is correct?

- A Bromine will reduce KI to form iodine.
 B Iodide ions react to form a white precipitate when added to silver nitrate solution.
 C Bromide ions react to form a white precipitate when added to silver nitrate solution.
 D Chlorine reacts with hydrogen to form a colourless gas.

Topic Chem 11 Q# 665/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

- 17 Z is a compound of sodium, chlorine and oxygen.

It contains 45.1% by mass of oxygen.

Z is prepared by reacting sodium hydroxide with chlorine.

Which row shows the conditions used for the reaction and the oxidation state of chlorine in Z?

	reaction conditions	oxidation state of Cl in Z
A	cold dilute NaOH	+1
B	cold dilute NaOH	+5
C	hot concentrated NaOH	+1
D	hot concentrated NaOH	+5

Topic Chem 11 Q# 666/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 In a series of nine experiments, to test the reactivity of the halogens, an aqueous solution of each halogen is added to an equal volume of an aqueous solution containing halide ions, as shown in the table.

halogen solution	halide solution		
	sodium chloride (aq)	sodium bromide (aq)	sodium iodide (aq)
chlorine (aq)	experiment 1	experiment 2	experiment 3
bromine (aq)	experiment 4	experiment 5	experiment 6
iodine (aq)	experiment 7	experiment 8	experiment 9

The nine resulting mixtures are then shaken separately with an equal volume of hexane. The nine tubes are left to stand so that the aqueous and organic solvents separate into layers.

How many test-tubes contain a purple upper hexane layer?

- A 1 B 2 C 3 D 5

Topic Chem 11 Q# 667/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

- 17 The volatility of the Group 17 elements, chlorine, bromine and iodine, decreases down the group.

What is responsible for this trend?

- A bond length in the halogen molecule
 B bond strength in the halogen molecule
 C electronegativity of the halogen atom
 D number of electrons in the halogen atom



Topic Chem 11 Q# 668/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

- 16 A 5 cm³ sample of 0.05 mol dm⁻³ sodium chloride is mixed with a 5 cm³ sample of 0.05 mol dm⁻³ potassium iodide. 10 cm³ of acidified 0.05 mol dm⁻³ silver nitrate is then added, followed by concentrated ammonia solution.

What is seen after the addition of an excess of concentrated ammonia solution?

- A a cream precipitate
- B a white precipitate
- C a yellow precipitate
- D no precipitate

Topic Chem 11 Q# 669/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 When concentrated sulfuric acid reacts with sodium iodide the products include sulfur, iodine, hydrogen sulfide and sulfur dioxide.

Which statement is correct?

- A Hydrogen sulfide is the product of a reduction reaction.
- B Iodide ions are stronger oxidising agents than sulfate ions.
- C Sulfur atoms from the sulfuric acid are both oxidised and reduced.
- D Sulfur atoms from the sulfuric acid are oxidised to make sulfur dioxide.

Topic Chem 11 Q# 670/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

- 16 Chlorine gas is reacted with aqueous sodium hydroxide. The oxidation number of chlorine changes from 0 to -1 and also from 0 to +1.

Under which conditions does this reaction occur and what is the colour of the solid silver salt with chlorine in the oxidation state -1?

	reaction conditions	colour of silver salt
A	cold, dilute alkali	white
B	cold, dilute alkali	yellow
C	hot, concentrated alkali	white
D	hot, concentrated alkali	yellow

Topic Chem 11 Q# 671/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

- 16 With which compound does concentrated sulfuric acid react both as a strong acid and as an oxidising agent?

- A magnesium carbonate
- B potassium chloride
- C sodium bromide
- D sulfur trioxide

Topic Chem 11 Q# 672/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

- 14 The electronic arrangement for atoms of four elements is given.

Which element is the strongest oxidising agent?

- A 1s²2s²2p⁵
- B 1s²2s²2p⁶3s²
- C 1s²2s²2p⁶3s²3p⁵
- D 1s²2s²2p⁶3s²3p⁶4s²

Topic Chem 11 Q# 673/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Chlorine reacts with sodium hydroxide in two different ways depending upon the temperature.



Which statements about these reactions are correct?

- 1 Reaction 2 requires a higher temperature than reaction 1.
- 2 The products of reaction 1 show chlorine in two different oxidation states.
- 3 The products of reaction 2 show oxygen in two different oxidation states.

Topic Chem 11 Q# 674/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Astatine, At, is below iodine in Group 17 of the Periodic Table.

Which statement is most likely to be correct?

- A AgAt(s) reacts with an excess of dilute aqueous ammonia to form a solution of a soluble complex.
- B Astatine and KCl(aq) react to form KAt(aq) and chlorine.
- C KAt(aq) and dilute sulfuric acid react to form HAt(g).
- D NaAt(s) and concentrated sulfuric acid react to form astatine.



Topic Chem 11 Q# 675/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)
12 A white powder is a mixture of sodium chloride and sodium iodide. It is dissolved in water in a test-tube. An excess of aqueous silver nitrate is added to the test-tube. A precipitate, X, is observed.

An excess of concentrated ammonia is then added to the test-tube containing X. After the test-tube has been shaken, a precipitate, Y, is observed.

Which statement about X or Y is correct?

- A X is a pure white colour.
- B X is pure silver iodide.
- C Y is pure silver chloride.
- D Y is yellow.

Topic Chem 11 Q# 676/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 35//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 The element astatine, At, is below iodine in Group 17 of the Periodic Table.

Which statements concerning At are likely to be correct?

- 1 It is a dark-coloured solid at room temperature.
- 2 It is a more powerful oxidising agent than iodine.
- 3 Its hydride is more thermally stable than HBr.

Topic Chem 11 Q# 677/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)
18 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

- A as an acid only
- B as an acid and oxidising agent
- C as an oxidising agent only
- D as a reducing agent only

Topic Chem 11 Q# 678/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org :o)
14 Hot aqueous sodium hydroxide reacts with chlorine.



Which statement is correct?

- A The oxidation numbers of chlorine and hydrogen both change in the reaction.
- B The oxidation numbers of chlorine in the products are -1 and $+1$.
- C If the aqueous sodium hydroxide is cold the reaction produces NaClO instead of NaClO₃.
- D Sodium undergoes disproportionation in this reaction.

Topic Chem 11 Q# 679/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements are correct?

- 1 Chloride ions are oxidised when concentrated sulfuric acid is added to NaCl(s).
- 2 A disproportionation reaction takes place when chlorine is added to cold NaOH(aq).
- 3 An acidic solution forms when chlorine is added to water.

Topic Chem 11 Q# 680/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)
17 Sodium azide, NaN₃, is dissolved in water. Acidified silver nitrate is added to the solution and a white precipitate forms. Aqueous ammonia is then added to the white precipitate.

The azide ion, N₃⁻, has similar chemical properties to the Cl⁻ ion.

Which row of the table can be predicted from this information?

	formula of white precipitate	observation on adding aqueous ammonia
A	AgN ₃	colourless solution formed
B	AgN ₃	precipitate remains
C	Ag ₃ N	colourless solution formed
D	Ag ₃ N	precipitate remains

Topic Chem 11 Q# 681/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)
16 Chlorine and bromine have different volatilities.

Which row identifies the more volatile of the two elements, and gives the correct explanation?

	identity of the more volatile element	explanation for the difference in volatility
A	bromine	instantaneous dipole-induced dipole forces are greater in bromine than they are in chlorine
B	bromine	instantaneous dipole-induced dipole forces are greater in chlorine than they are in bromine
C	chlorine	instantaneous dipole-induced dipole forces are greater in bromine than they are in chlorine
D	chlorine	instantaneous dipole-induced dipole forces are greater in chlorine than they are in bromine



Topic Chem 11 Q# 682/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)
 17 The reaction of bromine with warm NaOH(aq) produces products with the same oxidation numbers, in the same ratios, as the reaction of chlorine with hot NaOH(aq).

In one reaction between bromine and warm NaOH(aq), 30.2 g of a product containing sodium, bromine and oxygen is produced.

Which mass of NaOH has reacted?

- A 8.00 g B 10.2 g C 20.3 g D 48.0 g

Topic Chem 11 Q# 683/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Concentrated sulfuric acid is added to separate solid samples of sodium chloride, sodium bromide and sodium iodide.

With which samples does sulfuric acid act as an oxidising agent?

- A sodium chloride only
 B sodium chloride and sodium bromide
 C sodium bromide and sodium iodide
 D sodium iodide only

Topic Chem 11 Q# 684/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Under standard conditions, which statement is correct?

- A $Cl_2(aq)$ can oxidise $Br^-(aq)$.
 B $Cl_2(aq)$ can reduce $Br^-(aq)$.
 C $Cl^-(aq)$ can oxidise $Br_2(aq)$.
 D $Cl^-(aq)$ can reduce $Br_2(aq)$.

Topic Chem 11 Q# 685/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 The table shows some reactions of a white compound, G.

test	observation
silver nitrate is added to a solution of G followed by aqueous ammonia	a precipitate is formed which does not dissolve when the ammonia is added
solid G is warmed with concentrated sulfuric acid	a mixture of gases is formed including hydrogen sulfide

What could be the identity of G?

- A caesium chloride
 B lithium bromide
 C potassium sulfate
 D sodium iodide

Topic Chem 11 Q# 686/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Reaction 1: chlorine reacts with cold aqueous sodium hydroxide to form solution Z.

Reaction 2: solution Z is heated and forms $ClO_3^-(aq)$ and $Cl^-(aq)$.

Which equations represent reaction 1 and reaction 2?

- A reaction 1 $2Cl_2 + 4OH^- \rightarrow ClO_2^- + 3Cl^- + 2H_2O$
 reaction 2 $3ClO_2^- \rightarrow 2ClO_3^- + Cl^-$
 B reaction 1 $2Cl_2 + 4OH^- \rightarrow ClO_2^- + 3Cl^- + 2H_2O$
 reaction 2 $3ClO^- \rightarrow ClO_3^- + 2Cl^-$
 C reaction 1 $Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$
 reaction 2 $2ClO^- + 2OH^- \rightarrow ClO_3^- + Cl^- + H_2O$
 D reaction 1 $Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$
 reaction 2 $3ClO^- \rightarrow ClO_3^- + 2Cl^-$

Topic Chem 11 Q# 687/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Which row correctly describes the properties of the halogens as Group 17 is descended from chlorine to iodine?

	volatility	strength as oxidising agent
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Topic Chem 11 Q# 688/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Each of the three mixtures shown can result in a chemical reaction.

Which mixtures result in a redox reaction?

- 1 bromine + hydrogen
 2 sodium chloride + concentrated sulfuric acid
 3 potassium iodide + silver nitrate



- 19 Which row correctly describes one property of barium and one property of barium oxide?

	observation when barium metal is added to water	pH of solution obtained when a spatula measure of BaO is added to 100 cm ³ of water
A	a few gas bubbles form on the metal surface	8
B	a few gas bubbles form on the metal surface	13
C	rapid effervescence is seen	8
D	rapid effervescence is seen	13

- 16 Aqueous silver nitrate is added to a solution of potassium iodide.

Aqueous ammonia is then added.

What would be observed?

- A a cream precipitate that dissolves on addition of aqueous ammonia
- B a cream precipitate that does not dissolve on addition of aqueous ammonia
- C a yellow precipitate that dissolves on addition of aqueous ammonia
- D a yellow precipitate that does not dissolve on addition of aqueous ammonia

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 Chlorine reacts with hot aqueous sodium hydroxide.

Which oxidation states does chlorine show in the products of this reaction?

- 1 -1
- 2 +3
- 3 +1

- 17 Bromine is extracted from sea-water.

In the final stages of the process two redox reactions take place.



Which row is correct?

	strongest oxidising agent	weakest oxidising agent
A	Br ₂	SO ₂
B	Cl ₂	Br ₂
C	Cl ₂	SO ₂
D	SO ₂	Br ₂

- 16 The volatility of the Group 17 elements, chlorine, bromine and iodine, decreases down the group.

What is responsible for this?

- A bond length in the halogen molecule
- B bond strength in the halogen molecule
- C electronegativity of the halogen
- D number of electrons in the halogen molecule

- 19 The strengths of the covalent bonds within halogen molecules, and the van der Waals' forces between halogen molecules, vary going down Group 17 from chlorine to bromine to iodine.

Which row shows these correctly?

	strength of covalent bonds	strength of van der Waals' forces
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 18 Compound Q is a white crystalline solid which dissolves easily in water. When concentrated sulfuric acid is added to a dry sample of Q steamy white fumes are formed which, when passed through aqueous silver nitrate solution, form a white precipitate. This precipitate is soluble in dilute ammonia solution.

What could be the identity of compound Q?

- A AgCl
- B NaBr
- C NaCl
- D PbBr₂



- 17 71.0g of chlorine, Cl_2 , react with an excess of sodium hydroxide solution at a particular temperature. The reaction produces exactly 35.5g of product X.

What is product X?

- A H_2O B $NaCl$ C $NaClO$ D $NaClO_3$

Topic Chem 11 Q# 697/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 8//www.SmashingScience.org .o)

- 8 Solutions containing chlorate(I) ions are used as household bleaches and disinfectants. These solutions decompose on heating as shown.



Which oxidation state is shown by chlorine in each of these three ions?

	ClO^-	ClO_3^-	Cl^-
A	+1	+3	-1
B	-1	+3	+1
C	+1	+5	-1
D	-1	+5	+1

Topic Chem 11 Q# 698/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

- 19 Redox reactions are common in the chemistry of Group 17.

Which statement is correct?

- A Br^- ions will reduce Cl_2 but not I_2 .
 B Cl_2 will oxidise Br^- ions but not I^- ions.
 C F_2 is the weakest oxidising agent out of F_2 , Cl_2 , Br_2 and I_2 .
 D I^- ions are the weakest reducing agent out of F^- , Cl^- , Br^- and I^- .

Topic Chem 11 Q# 699/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org .o)

- 18 A solution of sodium hydroxide reacts with 3 mol of chlorine under certain conditions. The reaction produces 5 mol of sodium chloride and 1 mol of X, the only other chlorine-containing product.

What is the formula of compound X?

- A $NaClO$ B $NaClO_2$ C $NaClO_3$ D $NaClO_4$

Topic Chem 11 Q# 700/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

- 17 In an experiment, 0.600mol of chlorine gas, Cl_2 , is reacted with an excess of hot aqueous sodium hydroxide. One of the products is $NaClO_3$.

Which mass of $NaClO_3$ is formed?

- A 21.3g B 44.7g C 63.9g D 128g

Topic Chem 11 Q# 701/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

- 16 Some uses of chlorine and bromine are given.

Which is a use of bromine?

- A making bleaches for textiles and the paper industry
 B making CFCs
 C making flame retardants and fire extinguishers
 D making the polymer PVC

Topic Chem 11 Q# 702/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)

- 19 X, Y and Z represent different halogens. The table shows the results of nine experiments in which aqueous solutions of X_2 , Y_2 and Z_2 were separately added to separate aqueous solutions containing X^- , Y^- and Z^- ions.

	$X^-(aq)$	$Y^-(aq)$	$Z^-(aq)$
$X_2(aq)$	no reaction	no reaction	no reaction
$Y_2(aq)$	X_2 formed	no reaction	Z_2 formed
$Z_2(aq)$	X_2 formed	no reaction	no reaction

Which row of the following table contains the ions X^- , Y^- and Z^- in order of their decreasing strength as reducing agents?

	strongest	→	weakest
A	X^-		Z^-
B	X^-		Y^-
C	Y^-		X^-
D	Z^-		Y^-

Topic Chem 11 Q# 703/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 14//www.SmashingScience.org .o)

- 14 The properties of chlorine, bromine and their compounds are compared.

Which property is **smaller** for chlorine than for bromine?

- A bond strength of the hydrogen-halide bond
 B first ionisation energy
 C solubility of the silver halide in $NH_3(aq)$
 D strength of the van der Waals' forces between molecules of the element

Topic Chem 11 Q# 704/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



35 The element astatine, At, is below iodine in Group 17 of the Periodic Table.

Which statements concerning At are likely to be correct?

- 1 It is a dark-coloured solid at room temperature.
- 2 It is a more powerful oxidising agent than iodine.
- 3 Its hydride is thermally stable.

Topic Chem 11 Q# 705/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 The solids sodium chloride and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaCl, the products are NaHSO₄ and HCl.

With NaI, the products are NaHSO₄, HI, I₂, SO₂, H₂O, S and H₂S.

What is the best explanation for this difference in products?

- A Chloride ions will displace iodine from solution.
- B Hydrogen chloride is more volatile than hydrogen iodide.
- C Iodide ions are better reducing agents than chloride ions.

D Sulfuric acid is able to act as a dehydrating agent with NaI.

Topic Chem 11 Q# 706/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 After black and white photographic film has been developed, unreacted silver bromide is removed by reaction with sodium thiosulfate.



What is the function of the thiosulfate ion?

- A to make the silver ions soluble
- B to oxidise the silver ions
- C to reduce the bromine
- D to reduce the silver ions

Topic Chem 11 Q# 707/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Hydrogen chloride gas and hydrogen iodide gas have different thermal stabilities. The difference is due to a difference in the energies of some of the covalent bonds that are involved in the decomposition.

Which row identifies the more stable of the two compounds, and gives the correct explanation?

	identity of the more thermally stable compound	explanation for the difference in stability
A	hydrogen chloride	the C-Cl bond is stronger than the I-I bond
B	hydrogen chloride	the H-Cl bond is stronger than the H-I bond
C	hydrogen iodide	the C-I bond is stronger than the I-I bond
D	hydrogen iodide	the H-I bond is stronger than the H-Cl bond

Topic Chem 11 Q# 708/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 14//www.SmashingScience.org :o)

14 Chlorine gas is widely used to treat contaminated water.

Which species present in water when chlorine gas has been added is responsible for killing bacteria?

- A ClO₂⁻
- B Cl⁻
- C HCl
- D OCl⁻

Topic Chem 11 Q# 709/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 The addition of aqueous silver nitrate to aqueous barium chloride produces a white precipitate which dissolves in excess dilute aqueous ammonia to form a colourless solution.

The addition of excess dilute nitric acid to the colourless solution produces a white precipitate, Z.

What is Z?

- A AgCl
- B BaCl₂
- C Ba(NO₃)₂
- D NH₄NO₃

Topic Chem 11 Q# 710/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Which statement about bromine is correct?

- A Bromine is insoluble in non-polar solvents.
- B Bromine vapour is more dense than air.
- C Bromine will not vaporise significantly under normal conditions.
- D Gaseous bromine is purple.

Topic Chem 11 Q# 711/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Astatine, At, is below iodine in Group VII of the Periodic Table.

Which statement is most likely to be correct?

- A AgAt(s) reacts with excess dilute aqueous ammonia to form a solution of a soluble complex.
- B Astatine and KCl(aq) react to form KAt(aq) and chlorine.
- C KAt(aq) and dilute sulfuric acid react to form white fumes of HAt(g).
- D NaAt(s) and concentrated sulfuric acid react to form astatine.

Topic Chem 11 Q# 712/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Chlorine is widely used in water treatment plants.

Which reaction takes place when chlorine dissolves in water?

- A Cl₂ + H₂O → HCl + HClO
- B 2Cl₂ + 2H₂O → 3HCl + HClO₂
- C 3Cl₂ + 3H₂O → 5HCl + HClO₃
- D 4Cl₂ + 4H₂O → 7HCl + HClO₄



Topic Chem 11 Q# 713/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org .o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 On being heated, hydrogen iodide breaks down more quickly than hydrogen chloride.

Which statements explain this faster rate?

- 1 The H-I bond is weaker than the H-Cl bond.
- 2 The reaction of the breakdown of HI has a smaller activation energy than that of HCl.
- 3 The breakdown of HI is more exothermic than that of HCl.

Topic Chem 11 Q# 714/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org .o)

17 Under standard conditions, which statement is correct?

- A Cl^- (aq) can oxidise Br_2 (aq).
- B Cl^- (aq) can reduce Br_2 (aq).
- C Cl_2 (aq) can oxidise Br^- (aq).
- D Cl_2 (aq) can reduce Br^- (aq).

Topic Chem 11 Q# 715/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org .o)

16 Chlorine gas reacts with cold aqueous sodium hydroxide. It can also react with hot aqueous sodium hydroxide.

What are the oxidation numbers of chlorine in the products of these reactions?

	cold aqueous sodium hydroxide	hot aqueous sodium hydroxide
A	-1, +1	-1, +5
B	-1, +1	+1, +6
C	-1, +2	-1, +5
D	-1, +2	+1, +6

Topic Chem 11 Q# 716/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 A test-tube of HI gas and a test-tube of HBr gas are placed together in an environment at temperature, T.

Which combinations of observations are possible depending on the temperature, T?

- 1 A brown vapour appears in one of the test-tubes. No change is apparent in the other test-tube.
- 2 A brown vapour appears in one of the test-tubes. A purple vapour appears in the other test-tube.
- 3 No change is apparent in either test-tube.

Topic Chem 11 Q# 717/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org .o)

12 Redox reactions occur very frequently in the chemistry of Group VII.

Which statement is correct?

- A Chlorine will oxidise bromide ions but not iodide ions.
- B Fluorine is the weakest oxidising agent out of F_2 , Cl_2 , Br_2 and I_2 .
- C Iodide ions are the weakest reducing agent out of F^- , Cl^- , Br^- and I^- .
- D When chlorine reacts with water, chlorine is both oxidised and reduced.

Topic Chem 11 Q# 718/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 When a red-hot platinum wire is plunged into a test tube of hydrogen iodide, the gas is decomposed into its elements. If the experiment is repeated with hydrogen chloride, no change occurs.

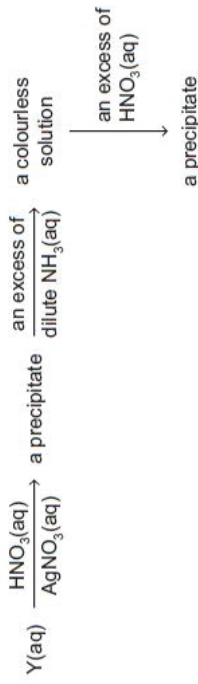
Which factors contribute to this behaviour?

- 1 the strength of the hydrogen-halogen bond
- 2 the size of the halogen atom
- 3 the standard enthalpy of formation, ΔH_f^\ominus , of each of the products of decomposition



17 Y is a salt of one of the halogens chlorine, bromine, iodine, or astatine (element 85).

The reaction scheme shows a series of reactions using a solution of Y as the starting reagent.



What could Y be?

- A sodium chloride
- B sodium bromide
- C potassium iodide
- D potassium astatide

15 Element 85, astatine, is in Group VII. Concentrated sulfuric acid is added to sodium astatide. The mixture of products includes astatine, hydrogen astatide, hydrogen sulfide, and sodium sulfate.

Which product is formed by the oxidation of one of the constituents of sodium astatide?

- A astatine
- B hydrogen astatide
- C hydrogen sulfide
- D sodium sulfate

14 What happens when iodine solution is added to a solution of sodium bromide?

- A A reaction occurs without changes in oxidation state.
- B Bromide ions are oxidised, iodine atoms are reduced.
- C Bromide ions are reduced, iodine atoms are oxidised.
- D No reaction occurs.

1 Solutions containing chlorate(I) ions are used as household bleaches and disinfectants. These solutions decompose on heating as shown.



Which oxidation state is shown by chlorine in each of these three ions?

	ClO^-	ClO_3^-	Cl^-
A	+1	+3	-1
B	-1	+3	+1
C	+1	+5	-1
D	-1	+5	+1

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 The element astatine, At, is below iodine in Group VII of the Periodic Table.

Which statements concerning At will be correct?

- 1 It is a dark-coloured solid at room temperature.
- 2 It is a more powerful oxidising agent than iodine.
- 3 Its hydride is thermally stable.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements are correct for all three halogens, chlorine, bromine and iodine?

- 1 They all form hydrides that are strong acids in aqueous solution.
- 2 They all react with aqueous sodium hydroxide to form oxo-anions.
- 3 They all require one more electron to fill the p orbitals of their outer shells.



- 18 The following two experiments are carried out with anhydrous potassium chloride and observations X and Y are made at the end of each experiment.

Concentrated sulfuric acid is added to the potassium chloride and the fumes produced are bubbled into aqueous potassium iodide solution - observation X.

The potassium chloride is dissolved in aqueous ammonia and this is then added to aqueous silver nitrate - observation Y.

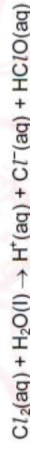
What are the observations X and Y?

	X	Y
A	brown solution	colourless solution
B	brown solution	white precipitate
C	colourless solution	colourless solution
D	colourless solution	white precipitate

- 17 What trend is observed on descending Group VII?

- A The colours of the elements become lighter.
 B The elements become more volatile.
 C The hydrides of the elements become more thermally stable.
 D The reactions of the elements with hydrogen become less vigorous.

- 16 In the treatment of domestic water supplies, chlorine is added to the water to form HClO .



The HClO reacts further to give ClO^- ions.



Both HClO and ClO^- kill bacteria by oxidation.

What is the overall change in oxidation number of chlorine when forming the ClO^- ion from the aqueous chlorine?

- A -1 B 0 C +1 D +2

- 7 When chlorine and aqueous sodium hydroxide are heated together the following overall reaction occurs.



What are the oxidation numbers for chlorine in each of the following species?

	Cl_2	NaCl	NaClO_3
A	0	+1	-5
B	+2	-1	+3
C	0	-1	+5
D	-2	+1	-3

The responses A to D should be selected on the basis of

	A	B	C	D
1, 2 and 3 are correct	1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 Which of the halide ions, chloride, bromide or iodide, acts as a reducing agent when its sodium salt reacts with concentrated sulfuric acid?

- 1 at least one of Cl^- , Br^- and I^-
 2 at least two of Cl^- , Br^- and I^-
 3 all three of Cl^- , Br^- and I^-

- 17 Why do the halogens become less volatile as Group VII is descended?

- A The halogen-halogen bond energy decreases.
 B The halogen-halogen bond length increases.
 C The number of electrons in each molecule increases.
 D The van der Waals' forces between molecules become weaker.

The responses A to D should be selected on the basis of

	A	B	C	D
1, 2 and 3 are correct	1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



36 Use of the Data Booklet is relevant to this question.

The element astatine lies below iodine in Group VII of the Periodic Table.

What will be the properties of astatine?

- 1 It forms diatomic molecules which dissociate more readily than chlorine molecules.
- 2 It reacts explosively with hydrogen.
- 3 It can oxidise iodide to iodine.

Topic Chem 11 Q# 732/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and with concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H ₂ SO ₄	colourless acidic gas formed	purple vapour formed
conc. H ₃ PO ₄	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

- A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.
- B Concentrated phosphoric acid is a stronger oxidising agent than iodine.
- C Concentrated sulfuric acid is a stronger oxidising agent than chlorine.
- D Concentrated sulfuric acid is a stronger oxidising agent than iodine.

Topic Chem 11 Q# 733/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

15 X, Y and Z represent different halogens. The table shows the results of nine experiments in which aqueous solutions of X₂, Y₂ and Z₂ were separately added to separate aqueous solutions containing X⁻, Y⁻ and Z⁻ ions.

	X ⁻ (aq)	Y ⁻ (aq)	Z ⁻ (aq)
X ₂ (aq)	no reaction	no reaction	no reaction
Y ₂ (aq)	X ₂ formed	no reaction	Z ₂ formed
Z ₂ (aq)	X ₂ formed	no reaction	no reaction

Which row in the following table contains the ions X⁻, Y⁻ and Z⁻ in order of their decreasing strength as reducing agents?

	strongest	→	weakest
A	X ⁻		Z ⁻
B	X ⁻		Y ⁻
C	Y ⁻		X ⁻
D	Z ⁻		Y ⁻

Topic Chem 11 Q# 734/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Disproportionation is the term used to describe a reaction in which a reactant is simultaneously both oxidised and reduced.

To which incomplete equations does the term disproportionation apply?

- 1 Cl₂(g) + 2OH⁻(aq) → H₂O(l) + Cl⁻(aq) +
- 2 3Cℓ₂(g) + 6OH⁻(aq) → 3H₂O(l) + ClO₃⁻(aq) +
- 3 2NO₂(g) + H₂O(l) → HNO₃(aq) +

Topic Chem 11 Q# 735/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Which statement describes the halogens chlorine, bromine and iodine?

- A Their bond energies decrease with increasing proton number.
- B Their first ionisation energies increase with increasing proton number.
- C They are all coloured gases at room temperature.
- D They are all good reducing agents.

Topic Chem 11 Q# 736/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Chile saltpetre, NaNO₃, contains sodium iodide as an impurity.

Aqueous silver nitrate is added to an aqueous solution of Chile saltpetre. Concentrated aqueous ammonia is then added.

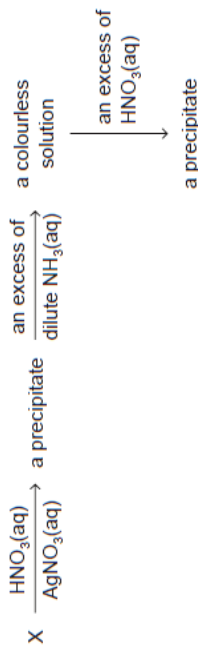
Which observations are made?

	with acidified silver nitrate	with concentrated aqueous ammonia
A	no precipitate	no further reaction
B	no precipitate	precipitate forms
C	precipitate forms	precipitate dissolves
D	precipitate forms	precipitate remains



14 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85).

The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

- A sodium chloride
- B sodium bromide
- C potassium iodide
- D potassium astatide

13 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

- A as an acid only
- B as an acid and oxidising agent
- C as an oxidising agent only
- D as a reducing agent only

The responses A to D should be selected on the basis of

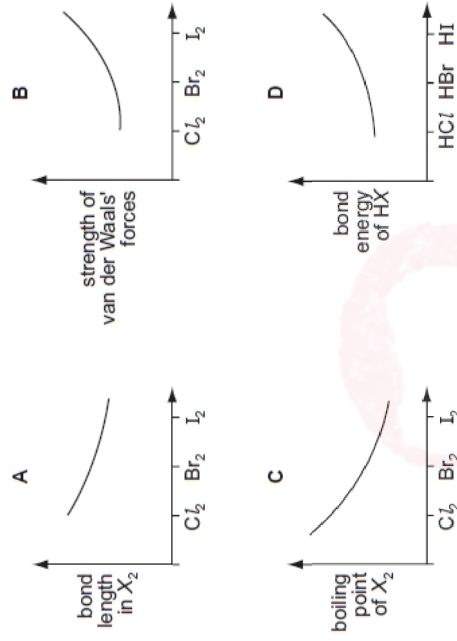
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements about the reaction of solid sodium bromide with concentrated sulfuric acid are correct?

- 1 Hydrogen bromide is a product of the reaction.
- 2 Sulfuric acid is oxidised to sulfur dioxide.
- 3 Bromide ions are reduced to bromine.

15 Which graph correctly describes a trend found in the halogen group?

[X represents a halogen atom.]



The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?

- 1 thermal stability
- 2 bond length
- 3 ease of oxidation

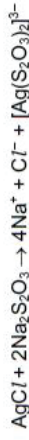
16 Which statement is most likely to be true for astatine, which is below iodine in Group VII of the Periodic Table?

- A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.
- B Potassium astatide and hot dilute sulfuric acid react to form white fumes of only hydrogen astatide.
- C Silver astatide reacts with dilute aqueous ammonia in excess to form a solution of a soluble complex.
- D Sodium astatide and hot concentrated sulfuric acid react to form astatine.



Topic Chem 11 Q# 743/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

- 15 In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unreacted silver chloride is removed by reaction with sodium thiosulfate to produce a 'fixed' negative.



What is the function of the thiosulfate ion?

- A to make the silver ions soluble
- B to oxidise the silver ions
- C to oxidise the silver metal
- D to reduce the silver ions

Topic Chem 12 Q# 744/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

- 23 Which statement about ammonia or the ammonium ion is correct?

- A Ammonia gas is produced when an aqueous solution containing the ammonium ion is reacted with a strong acid.
- B Silver iodide is soluble in a concentrated aqueous solution of ammonia.
- C The ammonium ion has the same number of electrons as a methane molecule.
- D The square planar ammonium ion contains a dative covalent bond.

Topic Chem 12 Q# 745/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

- 29 Carbon monoxide, CO, nitrogen dioxide, NO₂, and sulfur dioxide, SO₂, are all atmospheric pollutants.

Which reaction occurs in the atmosphere?

- A CO is spontaneously oxidised to CO₂.
- B NO₂ is reduced to NO by SO₂.
- C NO₂ is reduced to NO by CO.
- D SO₂ is oxidised to SO₃ by CO₂.

Topic Chem 12 Q# 746/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

- 25 Which reaction mixture produces an acidic gas?

- A aqueous ammonium nitrate and solid calcium oxide
- B calcium and aqueous hydrochloric acid
- C potassium chloride and concentrated sulfuric acid
- D sodium oxide and water

Topic Chem 12 Q# 747/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

- 24 The product of the Contact process is Z.

Which reaction or process leads to the formation of a gas that can neutralise an aqueous solution of Z?

- A atmospheric lightning
- B combustion of fuel in an internal combustion engine
- C the Haber process
- D thermal decomposition of Group 2 nitrates

Topic Chem 12 Q# 748/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 Acid rain is a dilute solution of sulfuric acid.

Which pollutant also contributes to the formation of acid rain?

- A carbon monoxide
- B carbon dioxide
- C nitrogen dioxide
- D hydrocarbons

Topic Chem 12 Q# 749/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

- 13 The gaseous products of heating a mixture of Ca(OH)₂ and NH₄Cl are passed through solid CaO. A single gaseous product, W, is collected.

A sample of W reacts with Cl₂(g) to produce two gases, X and Y.

X is an element. Y is acidic.

Y reacts with W to produce Z.

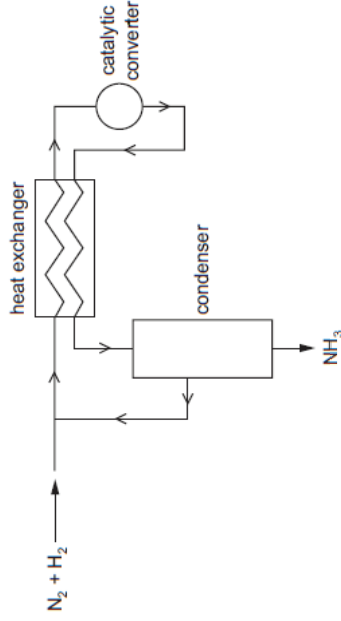
What are X and Z?

	X	Z
A	N ₂	CaCl ₂
B	N ₂	NH ₄ Cl
C	O ₂	CaCl ₂
D	O ₂	NH ₄ Cl



Topic Chem 12 Q# 750/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

- 10 The diagram represents the Haber process for the manufacture of ammonia from nitrogen and hydrogen.



What is the purpose of the heat exchanger?

- A to cool the incoming gas mixture to avoid overheating the catalyst
- B to cool the reaction products and separate the NH_3 from unused N_2 and H_2
- C to warm the incoming gas mixture and shift the equilibrium to give more NH_3
- D to warm the incoming gas mixture and speed up the reaction

Topic Chem 12 Q# 751/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 36 Nitrogen dioxide gas is produced when petrol is burned in car engines.

Which acids are made in the atmosphere as a result of this release of nitrogen dioxide into the air?

- 1 H_2SO_3
- 2 H_2SO_4
- 3 HNO_3

Topic Chem 12 Q# 752/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

- 19 Methylamine, CH_3NH_2 , has similar chemical properties to ammonia, NH_3 . Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.



A sample of methylammonium chloride is heated with aqueous sodium hydroxide.

What are the products?

- A ammonia, sodium chloride and water
- B ammonia, sodium hydrogencarbonate and sodium chloride
- C methylamine, hydrogen chloride and water
- D methylamine, sodium chloride and water

Topic Chem 12 Q# 753/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 NO , NO_2 , CO and unburnt hydrocarbons are present in the exhaust gases of internal combustion engines. When catalytic converters are used to remove these compounds from the exhaust gases, redox reactions occur.

What happens to each compound in the catalytic converter?

	NO	NO_2	CO	unburnt hydrocarbons
A	oxidised	oxidised	reduced	oxidised
B	oxidised	oxidised	oxidised	oxidised
C	reduced	reduced	oxidised	oxidised
D	reduced	reduced	reduced	reduced

Topic Chem 12 Q# 754/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Ammonia can undergo an acid–base reaction with hydrogen chloride to form ammonium chloride.

Which statement is correct?

- A The ammonium ion is basic.
- B The hydrogen atom from HCl donates a lone pair of electrons to the nitrogen atom.
- C The $\text{H}-\text{N}-\text{H}$ bond angle in ammonia is the same as the $\text{H}-\text{N}-\text{H}$ bond angle in the ammonium ion.
- D The $\text{H}-\text{N}-\text{H}$ bond angle in the ammonium ion is the same as the $\text{H}-\text{C}-\text{H}$ bond angle in methane.



Topic Chem 12 Q# 755/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 19/www.SmashingScience.org :o)

19 Which statement about nitrogen or its compounds is correct?

- A In the Haber process the temperature is kept high to give a good equilibrium yield of ammonia.
- B Nitrogen gas is unreactive because of the strong nitrogen–nitrogen double bond.
- C Nitrogen monoxide will react with carbon monoxide under suitable conditions.
- D The formula of ammonium sulfate is NH_4SO_4 .

Topic Chem 12 Q# 756/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 36/www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Nitrogen gas is unreactive, whereas oxygen gas and chlorine gas are reactive.

Which statements help to explain this difference?

- 1 The two N atoms in an N_2 molecule are held together by a very strong triple bond.
- 2 The triple bond between two N atoms is not polar. The bonds in O_2 and Cl_2 are polar.
- 3 The atoms in N_2 have a full outer shell of electrons. The atoms in O_2 and Cl_2 do not have a full outer shell of electrons.

Topic Chem 12 Q# 757/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 19/www.SmashingScience.org :o)

19 Catalytic converters are fitted in the exhaust systems of many cars.

Which gas:

- causes acid rain if it is released into the air
- is removed from car exhaust fumes by a catalytic converter?

- A carbon dioxide
- B carbon monoxide
- C hydrocarbon vapour
- D nitrogen dioxide

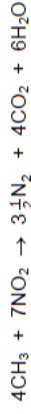
Topic Chem 12 Q# 758/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 19/www.SmashingScience.org :o)

19 Which statement is correct?

- A Ammonia reacts with alkalis to form the ammonium ion.
- B Ammonium chloride contains ionic, covalent and co-ordinate bonds.
- C The ammonium ion reacts with acids to produce ammonia.
- D The bond angle in the ammonium ion is approximately 107° .

Topic Chem 12 Q# 759/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 18/www.SmashingScience.org :o)

18 At 550°C nitrogen dioxide reacts with unburnt hydrocarbon fragments such as CH_3 in the catalytic converter of a motor vehicle.



Which row gives the energy change for this reaction and a possible reason for it?

	energy change of reaction	reason why the reaction is endothermic or exothermic
A	endothermic	chemical energy is converted to heat energy
B	endothermic	the N=N bond energy is very high
C	exothermic	CO_2 and H_2O have negative ΔH_f° values
D	exothermic	double bonds are broken in NO_2

Topic Chem 12 Q# 760/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 19/www.SmashingScience.org :o)

19 Ammonia, NH_3 , and hydrazine, NH_2NH_2 , are two compounds of nitrogen, N_2 .

Which statement is correct?

- A The N–N bond in NH_2NH_2 is polar.
- B NH_3 and NH_2NH_2 have lone pairs of electrons but N_2 does not.
- C The oxidation number of each nitrogen in NH_2NH_2 is +2.
- D The reaction of nitrogen with hydrogen has a high activation energy.

Topic Chem 12 Q# 761/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 19/www.SmashingScience.org :o)

19 Transition elements and their compounds are widely used as catalysts.

What is the identity and what is the oxidation number of the element present in the catalyst used in the Contact process?

	element	oxidation number
A	iron	0
B	iron	+3
C	vanadium	0
D	vanadium	+5

Topic Chem 12 Q# 762/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 18/www.SmashingScience.org :o)

18 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

- A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+ .
- B NH_4Cl dissociates less fully than NaCl .
- C The Na^+ and Mg^{2+} ions have the same number of electrons.
- D The NH_4^+ ion can donate a proton.



Topic Chem 12 Q# 763/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements correctly describe an oxide of nitrogen acting as an atmospheric pollutant?

- Nitrogen monoxide, NO, reacts with oxygen to form nitrogen dioxide which contributes to acid rain.
 - Nitrogen dioxide reacts with sulfur dioxide to form sulfur trioxide which reacts with water to form sulfuric acid.
 - Nitrogen oxides react with unburnt hydrocarbons in sunlight to form other pollutants.
- Topic Chem 12 Q# 764/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)
17 Oxides of nitrogen are present in the environment due to natural and man-made sources.

Which row is correct?

	natural source of nitrogen oxides	man-made source of nitrogen oxides
A	electrical discharges in the atmosphere	internal combustion engines
B	electrical discharges in the atmosphere	as a by-product of the Haber process
C	decomposition of dead plants in rivers	internal combustion engines
D	decomposition of dead plants in rivers	as a by-product of the Haber process

Topic Chem 12 Q# 765/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 When burned, sulfur forms a gaseous product X which can be oxidised to produce a gas Y.

Gas Y reacts with water to produce a product Z.

Which row correctly shows the oxidation states of sulfur in X, Y and Z?

	X	Y	Z
A	-2	+4	+4
B	-2	+4	+6
C	+4	+6	+4
D	+4	+6	+6

Topic Chem 12 Q# 766/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 36//

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements explain why nitrogen gas is unreactive?

- Nitrogen atoms are highly electronegative.
- Nitrogen molecules are non-polar.
- The triple bond between nitrogen atoms is very strong.

Topic Chem 12 Q# 767/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 X is either nitrogen or sulfur and forms pollutant oxide Y in a car engine.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen molecules.

Which statements about X, Y and Z can be correct?

- The oxidation number of X increases by two from Y to Z.
- Y has an unpaired electron in its molecule.
- Y is a polar molecule.

Topic Chem 12 Q# 768/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 13//www.SmashingScience.org :o)

13 Which reagent, when mixed with ammonium sulfate and then heated, liberates ammonia?

- aqueous bromine
- dilute hydrochloric acid
- limewater
- potassium dichromate(VI) in acidic solution

Topic Chem 12 Q# 769/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Compound T is a white crystalline solid.

When a sample of T was mixed with aqueous sodium hydroxide and heated, a pungent smelling gas was produced which turned damp red litmus paper blue. This same gas produced dense white smoke with hydrogen chloride gas.

Further testing of a solution of T with barium chloride solution produced a dense white precipitate which did not dissolve when dilute hydrochloric acid was added to the mixture.

What is the identity of compound T?

- ammonium carbonate
- ammonium sulfate
- sodium carbonate
- sodium sulfate



Topic Chem 12 Q# 770/ AS Chemistry/2016/s/TZ.1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 Which statement about the ammonia molecule and/or the ammonium ion is correct?
- A Ammonia molecules are basic because they can donate H^+ ions.
 - B Ammonium ions are basic because they can accept H^+ ions.
 - C If ammonium ions are heated with $NaOH(aq)$, ammonia molecules are formed.
 - D The bond angle in NH_4^+ is 2.5° less than the bond angle in NH_3 .

Topic Chem 12 Q# 771/ AS Chemistry/2016/m/TZ.2/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3 , are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of neutral soil.

Which row is correct?

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

Topic Chem 12 Q# 772/ AS Chemistry/2015/w/TZ.1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

- 19 Element X forms a pollutant oxide Y. Y can be further oxidised to Z. Two students made the following statements.

- Student P 'The molecule of Y contains lone pairs of electrons.'
Student Q 'The oxidation number of X increases by 1 from Y to Z.'

X could be carbon or nitrogen or sulfur.

Which student(s) made a correct statement?

- A P only
- B Q only
- C both P and Q
- D neither P nor Q

Topic Chem 12 Q# 773/ AS Chemistry/2015/s/TZ.1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 Mohr's salt is a pale green crystalline solid which is soluble in water. It contains two cations, one of which is Fe^{2+} , and one anion which is SO_4^{2-} .

The identity of the second cation was determined by heating Mohr's salt with aqueous sodium hydroxide. A colourless gas was evolved which readily dissolved in water giving an alkaline solution.

A green precipitate was also formed.

What are the identities of the gas and the precipitate?

	gas	precipitate
A	NH_3	$Fe(OH)_2$
B	NH_3	Na_2SO_4
C	SO_2	$Fe(OH)_2$
D	SO_2	Na_2SO_4

Topic Chem 12 Q# 774/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 Pollutant oxide Y, which contains non-metallic element X, is formed in a car engine.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen molecules.

X could be either nitrogen or sulfur.

Which statements about X, Y and Z can be correct?

- 1 The oxidation number of X increases by two from Y to Z.
- 2 Y has an unpaired electron in its molecule.
- 3 Y is a polar molecule.

Topic Chem 12 Q# 775/ AS Chemistry/2013/w/TZ.1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

- A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+ .
- B NH_4Cl dissociates less fully than $NaCl$.
- C The Na^+ and Mg^{2+} ions have the same number of electrons.
- D The NH_4^+ ion can donate a proton.

Topic Chem 12 Q# 770/ AS Chemistry/2016/s/TZ.1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 Which statement about the ammonia molecule and/or the ammonium ion is correct?
- A Ammonia molecules are basic because they can donate H^+ ions.
 - B Ammonium ions are basic because they can accept H^+ ions.
 - C If ammonium ions are heated with $NaOH(aq)$, ammonia molecules are formed.
 - D The bond angle in NH_4^+ is 2.5° less than the bond angle in NH_3 .

Topic Chem 12 Q# 771/ AS Chemistry/2016/m/TZ.2/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

- 17 Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3 , are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of neutral soil.

Which row is correct?

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

Topic Chem 12 Q# 772/ AS Chemistry/2015/w/TZ.1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

- 19 Element X forms a pollutant oxide Y. Y can be further oxidised to Z. Two students made the following statements.

- Student P 'The molecule of Y contains lone pairs of electrons.'
Student Q 'The oxidation number of X increases by 1 from Y to Z.'

X could be carbon or nitrogen or sulfur.

Which student(s) made a correct statement?

- A P only
- B Q only
- C both P and Q
- D neither P nor Q



Topic Chem 12 Q# 776/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 25/www.SmashingScience.org .o)
 25 One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction are non-toxic.

Which is the correct equation for the reaction?

- A $C_8H_{16} + 16NO \rightarrow 8CO + 8N_2 + 8H_2O$
 B $C_8H_{16} + 24NO \rightarrow 8CO_2 + 12N_2 + 8H_2O$
 C $C_8H_{16} + 17NO \rightarrow 8CO + 8\frac{1}{2}N_2 + 9H_2O$
 D $C_8H_{16} + 25NO \rightarrow 8CO_2 + 12\frac{1}{2}N_2 + 9H_2O$

Topic Chem 12 Q# 777/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 16/www.SmashingScience.org .o)

16 In a car engine, non-metallic element X forms a pollutant oxide Y. Y can be further oxidised to Z. Two students made the following statements.

- Student P The molecule of Y contains lone pairs of electrons.
 Student Q The oxidation number of X increases by 1 from Y to Z.

X could be carbon or nitrogen or sulfur.

Which student could be correct if X were any of these elements?

- A P only
 B Q only
 C both P and Q
 D neither P nor Q

Topic Chem 12 Q# 778/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 5/www.SmashingScience.org .o)

5 Two conversions are outlined below.



What similar feature do these two conversions have?

- A a lone pair of electrons in the product
 B change in oxidation state of an element
 C decrease in bond angle of the species involved
 D disappearance of a π bond

Topic Chem 12 Q# 779/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 34/www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 Ammonia and chlorine react in the gas phase.



Which statements are correct?

- 1 Ammonia behaves as a reducing agent.
 2 Ammonia behaves as a base.
 3 The oxidation number of the hydrogen changes

Topic Chem 12 Q# 780/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 19/www.SmashingScience.org .o)

19 Carbon monoxide, CO, nitrogen monoxide, NO, and sulfur dioxide, SO₂, may all be present in the exhaust fumes from a car engine.

Which reaction concerning these compounds occurs in the atmosphere?

- A CO is spontaneously oxidised to CO₂
 B NO₂ is reduced to NO by CO
 C NO₂ is reduced to NO by SO₂
 D SO₂ is oxidised to SO₃ by CO₂

Topic Chem 12 Q# 781/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 36/www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen.

Which statements about X, Y and Z are correct?

- 1 X forms a basic hydride.
 2 Y is a diatomic molecule.
 3 Z is a polar molecule.

Topic Chem 12 Q# 782/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 34/www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 34 A farmer spreads lime on land which has already been treated with an ammonium nitrate fertiliser.

Which reactions will occur in the treated soil?

- $\text{Ca}(\text{OH})_2 + 2\text{NH}_4^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{NH}_3 + 2\text{H}_2\text{O}$
- $\text{Ca}(\text{OH})_2 + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{H}_2\text{O}$
- $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$

Topic Chem 12 Q# 783/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 37 Which descriptions of the ammonium ion are correct?

- It contains ten electrons.
- It has a bond angle of 109.5° .
- It has only three bonding pairs of electrons.

Topic Chem 12 Q# 784/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

- 18 Nitrogen monoxide, NO, is a primary pollutant produced by petrol engines and is found in their exhaust gases.

Which reaction occurs in a catalytic converter and decreases the emission of nitrogen monoxide?

- $\text{NO}(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{C}(\text{s})$
- $\text{NO}(\text{g}) + \text{CO}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{CO}(\text{g})$
- $2\text{NO}(\text{g}) + 2\text{CO}(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{CO}_2(\text{g})$
- $2\text{NO}(\text{g}) + \text{CO}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) + \text{C}(\text{s})$

Topic Chem 12 Q# 785/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 36 Element X is a solid. It occurs as a contaminant of carbonaceous fuels.

Its oxide Y is formed in car engines.

Further oxidation of Y to Z can occur in the atmosphere.

Which statements about Y and Z are correct?

- Molecule Y has lone pairs of electrons.
- The atmospheric oxidation of Y to Z is a catalysed reaction.
- Y is a colourless gas.

Topic Chem 12 Q# 786/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 Which environmental problem is **not** made worse by the release of oxides of nitrogen from car engines?

- acidification of lakes
- corrosion of buildings
- photochemical smog
- the hole in the ozone layer

Topic Chem 12 Q# 787/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)

- 15 Ammonium sulfate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulfuric acid, nitric acid and water.

How many moles of oxygen gas are needed to oxidise completely one mole of ammonium sulfate?

- 1
- 2
- 3
- 4

Topic Chem 12 Q# 788/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 35 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with $\frac{1}{2}$ mol of gaseous oxygen.

What can X be?

- carbon
- nitrogen
- sulfur



Topic Chem 12 Q# 789/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 A farmer added lime to damp soil, followed by the nitrogenous fertiliser ammonium sulfate. A chemical reaction occurred in the soil.

Which substances were formed in this reaction?

- sulfuric acid
- calcium sulfate
- ammonia

Topic Chem 12 Q# 790/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 In an historically famous experiment Wöhler heated 'inorganic' ammonium cyanate in the absence of air. The only product of the reaction was 'organic' urea, CO(NH₂)₂. No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

- A** CNO⁻ **B** CNO²⁻ **C** CO⁻ **D** NO⁻

Topic Chem 12 Q# 791/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Most modern cars are fitted with three-way catalytic converters in the exhaust system.

Which three gases are removed by such a catalytic converter?

- carbon monoxide, hydrocarbons, nitrogen oxides
- carbon monoxide, carbon dioxide, nitrogen oxides
- carbon monoxide, nitrogen oxides, sulfur dioxide
- hydrocarbons, nitrogen oxides, sulfur dioxide

Topic Chem 12 Q# 792/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 The following reaction takes place using liquid ammonia as a solvent.



Which statements best explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

- The ammonium ion acts as a proton donor.
- Na⁺Cl⁻ is a salt.
- Ammonia is always basic.

Topic Chem 12 Q# 793/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)

18 Mohr's salt is a pale green crystalline solid which is soluble in water. It is a 'double sulfate' which contains two cations, one of which is Fe²⁺.

The identity of the second cation was determined by heating solid Mohr's salt with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution. A grey-green solid residue was also formed which was insoluble in water.

What are the identities of the gas and the solid residue?

	gas	residue
A	H ₂	FeSO ₄
B	NH ₃	Na ₂ SO ₄
C	NH ₃	Fe(OH) ₂
D	SO ₂	Fe(OH) ₂

Topic Chem 12 Q# 794/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)

17 Deposits of ammonium compounds have been discovered in areas of high atmospheric pollution.

They are believed to arise from the following reaction.



What does **not** occur in this reaction?

- acid/base neutralisation
- dative bond formation
- ionic bond formation
- oxidation/reduction

Topic Chem 13 Q# 795/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

35 Structural isomerism and stereoisomerism should be considered when answering this question.

How many isomeric compounds with molecular formula C₅H₈O₄ contain two -CO₂H groups and one C=C double bond?

- A** 5 **B** 6 **C** 7 **D** 8

Topic Chem 13 Q# 796/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 How many chiral carbon atoms are there in one molecule of 2,2,4,5-tetramethylhexan-3-ol?

- A** 1 **B** 2 **C** 3 **D** 4



Topic Chem 13 Q# 797/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

- 24 Sulfur dioxide can be catalytically oxidised by an oxide of nitrogen in the atmosphere.

Which reaction shows how the catalyst is reformed?

- A $N_2 + 2O_2 \rightleftharpoons 2NO_2$
B $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
C $N_2 + O_2 \rightarrow 2NO$
D $NO + \frac{1}{2}O_2 \rightarrow NO_2$

Topic Chem 13 Q# 798/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org .o)

- 33 17.6 g of pentan-1-ol is completely combusted.

Which volume of gaseous products is formed when measured at s.t.p.?

- A 22.4 dm³ B 24.0 dm³ C 49.3 dm³ D 52.8 dm³

Topic Chem 13 Q# 799/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

- 24 In a catalytic converter, 5.6 g of carbon monoxide react with an excess of nitrogen monoxide.

What is produced in this reaction?

- A 2.4 g of C and 6.0 g of NO₂
B 2.4 g of C and 9.2 g of NO₂
C 8.8 g of CO₂ and 1.4 g of N₂
D 8.8 g of CO₂ and 2.8 g of N₂

Topic Chem 13 Q# 800/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 39//www.SmashingScience.org .o)

- 39 The diagrams show the structures of lycopene and β -carotene.



When lycopene is converted into β -carotene, what is the gain or loss of hydrogen atoms per molecule?

- A 4 gained
B 2 gained
C no change
D 2 lost

Topic Chem 13 Q# 801/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 36//www.SmashingScience.org .o)

- 36 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

- A 7 B 8 C 9 D 10

Topic Chem 13 Q# 802/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 26//www.SmashingScience.org .o)

- 26 In this question, alkenes and cyclic alkanes should be considered.

How many structural isomers of C₄H₈ are there?

- A 3 B 4 C 5 D 6

Topic Chem 13 Q# 803/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org .o)

- 6 What is the minimum mass of oxygen required to ensure the complete combustion of 12 dm³ of propane measured under room conditions?

- A 60 g B 80 g C 120 g D 160 g

Topic Chem 13 Q# 797/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

- 24 Sulfur dioxide can be catalytically oxidised by an oxide of nitrogen in the atmosphere.

Which reaction shows how the catalyst is reformed?

- A $N_2 + 2O_2 \rightleftharpoons 2NO_2$
B $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
C $N_2 + O_2 \rightarrow 2NO$
D $NO + \frac{1}{2}O_2 \rightarrow NO_2$

Topic Chem 13 Q# 798/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org .o)

- 33 17.6 g of pentan-1-ol is completely combusted.

Which volume of gaseous products is formed when measured at s.t.p.?

- A 22.4 dm³ B 24.0 dm³ C 49.3 dm³ D 52.8 dm³

Topic Chem 13 Q# 799/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

- 24 In a catalytic converter, 5.6 g of carbon monoxide react with an excess of nitrogen monoxide.

What is produced in this reaction?

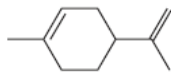
- A 2.4 g of C and 6.0 g of NO₂
B 2.4 g of C and 9.2 g of NO₂
C 8.8 g of CO₂ and 1.4 g of N₂
D 8.8 g of CO₂ and 2.8 g of N₂



Topic Chem 13 Q# 804/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Limonene is a hydrocarbon found in the rind of citrus fruits.

limonene

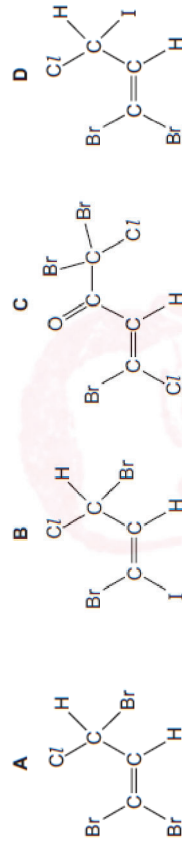


What is the molecular formula of limonene?

- A C₁₀H₁₂ B C₁₀H₁₄ C C₁₀H₁₆ D C₁₀H₁₈

Topic Chem 13 Q# 805/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Which compound could show both *cis-trans* isomerism and optical isomerism?



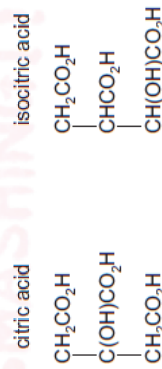
Topic Chem 13 Q# 806/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)

1 Which contains the largest number of hydrogen atoms?

- A 0.10 mol of pentane
 B 0.20 mol of but-2-ene
 C 1.00 mol of hydrogen molecules
 D 6.02×10^{23} hydrogen atoms

Topic Chem 13 Q# 807/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 The structures of citric acid and isocitric acid are shown.



How many chiral centres does each acid possess?

	citric acid	isocitric acid
A	1	1
B	1	2
C	0	1
D	0	2

Topic Chem 13 Q# 808/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

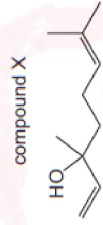
38 During the bromination of methane, the free radical CH₃• is generated. A possible termination step of this reaction is the formation of C₂H₆ by the combination of two free radicals.

What could be produced in a termination step during the bromination of propane?

- 1 CH₃CH₂CH(CH₃)CH₂CH₃
 2 CH₃CH(CH₃)CH(CH₃)₂
 3 CH₃CH₂CH₂CH(CH₃)₂

Topic Chem 13 Q# 809/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 The skeletal formula of compound X is shown.



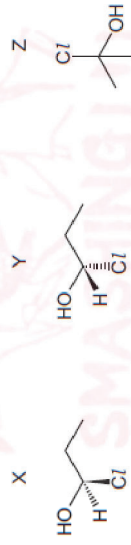
What is the molecular formula of compound X?

- A C₁₀H₁₈O B C₁₀H₂₀O C C₁₁H₂₀O D C₁₁H₂₄O

Topic Chem 13 Q# 810/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Structural and stereoisomerism should be considered when answering this question.

Compounds X, Y and Z are shown.



How many other isomers of C₃H₇ClO are there that are alcohols?

- A 2 B 3 C 4 D 5

Topic Chem 13 Q# 811/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 The definitions of many chemical terms can be illustrated by chemical equations.

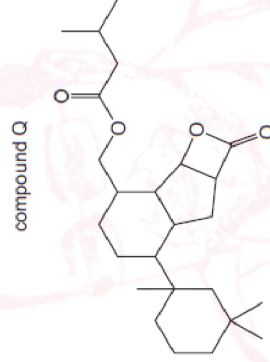
Which terms can be illustrated by an equation that includes the formation of a positive ion?

- 1 first ionisation energy
 - 2 heterolytic fission of a covalent bond
 - 3 enthalpy change of atomisation
- Topic Chem 13 Q# 812/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
- 3 When considering one molecule of ethene, which row describes both the hybridisation of the atomic orbitals in the carbon atoms and the overall bonding?

	hybridisation	bonding
A	sp^2	4 σ bonds 1 π bond
B	sp^2	5 σ bonds 1 π bond
C	sp^3	4 σ bonds 1 π bond
D	sp^3	5 σ bonds 1 π bond

Topic Chem 13 Q# 813/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 The structure of compound Q is shown.



How many chiral centres are present in a molecule of Q?

- A 4 B 5 C 6 D 7

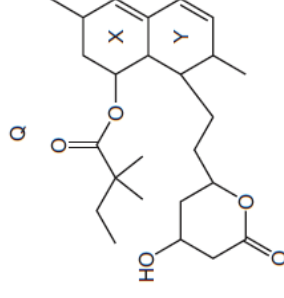
Topic Chem 13 Q# 814/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Which statement is correct?

- A 2,2-dimethylpropanoic acid is an isomer of propyl methanoate.
- B 2-methylbutan-2-ol is an isomer of hexan-3-ol.
- C 3-methylbutan-2-one is an isomer of pentanal.
- D 3,3-dimethylbutan-2-one is an isomer of pentan-3-one.

Topic Chem 13 Q# 815/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 The diagram shows the structure of compound Q.



Two of the rings, X and Y, contain a C=C bond.

Which row is correct?

	number of ester groups in one molecule of Q	description of rings X and Y
A	1	both are planar
B	1	neither is planar
C	2	both are planar
D	2	neither is planar

Topic Chem 13 Q# 816/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Structural isomerism and stereoisomerism should be considered when answering this question.

How many non-cyclic isomers have the molecular formula C_9H_{10} ?

- A 3 B 4 C 5 D 6

Topic Chem 13 Q# 817/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Which pair of compounds are functional group isomers of each other?

- A butan-1-ol and butanal
- B ethylpropanoate and pentanoic acid
- C hex-1-ene and hex-2-ene
- D propylamine and propanenitrile

Topic Chem 13 Q# 818/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

2 For which hydrocarbon are the molecular and empirical formulae the same?

- A butane
- B ethane
- C pent-1-ene
- D propane



- 5 Ethanal, CH_3CHO , ethanol, $\text{C}_2\text{H}_5\text{OH}$, and methoxymethane, CH_3OCH_3 , are three organic compounds.

Which compound has the highest boiling point and what is the interaction that causes this boiling point to be the highest?

	highest boiling point	interaction
A	methoxymethane	permanent dipole-dipole forces
B	ethanal	hydrogen bonds
C	ethanol	hydrogen bonds
D	ethanal	permanent dipole-dipole forces

Topic Chem 13 Q# 820/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 37 The structure of tiglic acid is $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)\text{CO}_2\text{H}$.

Which statements about the properties of one molecule of this acid are correct?

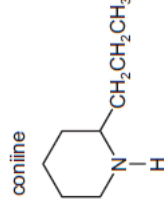
- It contains two π bonds.
- It contains four lone pairs of electrons.
- It has all its atoms in the same plane.

Topic Chem 13 Q# 821/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 Which compound is chiral?

- 1-chloro-3-methylbutane
- 2-chloro-2-methylbutane
- 2-chloro-3-methylbutane
- 3-chloropentane

- 25 The structure of coniine is shown.



Coniine can be synthesised by reacting ammonia with a dibromo compound, X.



What is the name of compound X?

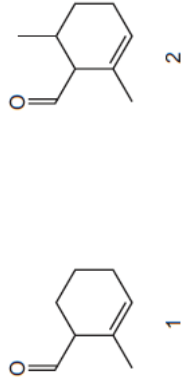
- 1,1-dibromo-2-propylcyclopentane
- 1,2-dibromo-2-propylcyclopentane
- 1,4-dibromooctane
- 1,5-dibromooctane

Topic Chem 13 Q# 823/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

- 21 Which compound has the molecular formula $\text{C}_6\text{H}_{10}\text{O}$?



20 The diagrams show two different compounds.



What is

- the total number of structural isomers, including compound 2, that could be formed by adding a second methyl group to the ring of compound 1,
- the number of π electrons in each compound?

	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 In an experiment, 10 cm^3 of an organic compound, J, in the gaseous state is reacted with an excess of oxygen. Steam, 20 cm^3 of carbon dioxide and 5 cm^3 of nitrogen are the only products.

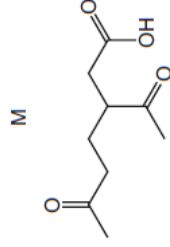
All gas volumes were measured at the same temperature and pressure.

What could be the identity of J?

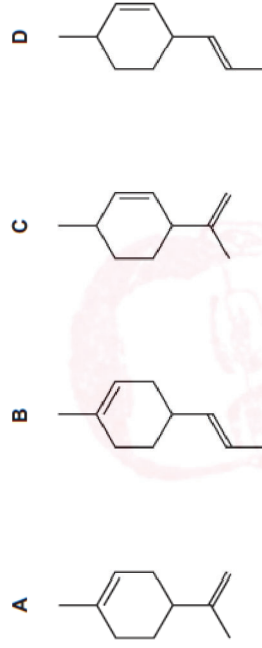
- $\text{C}_2\text{H}_6\text{N}_2$
- $\text{C}_2\text{H}_3\text{N}$
- $\text{C}_2\text{H}_7\text{N}$

21 Compound L has the molecular formula $\text{C}_{10}\text{H}_{16}$.

A sample of L reacted with an excess of hot, concentrated, acidified potassium manganate(VII). Compound M is produced.



What could be the structure of compound L?

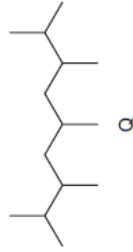


20 How many structural isomers are there of trichloropropane, $\text{C}_3\text{H}_5\text{Cl}_3$?

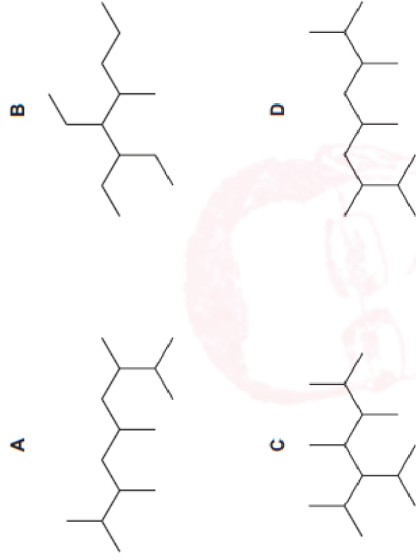
- A 3 B 4 C 5 D 6



22 A new jet fuel has been produced that is a mixture of different structural isomers of compound Q.



Which skeletal formula represents a structural isomer of Q?



21 X has the molecular formula $C_8H_{12}O$. X has a branched carbon skeleton and a secondary alcohol functional group.

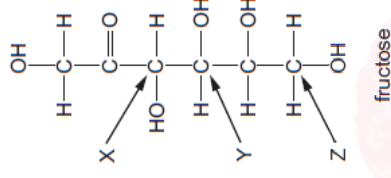
How many structural isomers fit this description of X?

- A 1 B 2 C 3 D 4

21 Which pair of alcohols are isomers of each other?

- A butan-1-ol and 2,2-dimethylpropan-1-ol
 B butan-2-ol and 2-methylpropan-2-ol
 C pentan-1-ol and 2-methylpropan-2-ol
 D propan-2-ol and 2-methylpropan-2-ol

20 Fructose is a sugar with more than one chiral centre. The fructose molecule is shown with X, Y and Z indicating three carbon atoms.



Which carbon atoms are chiral centres?

- A X, Y and Z B X and Y only C X only D Y only

20 Which types of stereoisomerism are shown by 2,4-dimethylhex-2-ene?

- A both cis-trans isomerism and optical isomerism
 B cis-trans isomerism only
 C neither cis-trans isomerism nor optical isomerism
 D optical isomerism only

The responses A to D should be selected on the basis of

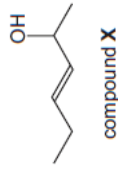
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 In which molecules do all the carbon atoms lie in the same plane?

- 1 2,3-dimethylbut-2-ene
 2 propane
 3 cyclohexane



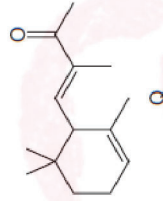
21 What is the name of compound X?



- A *trans*-2-hydroxyhex-3-ene
 B *trans*-2-hydroxyhexene
 C *trans*-5-hydroxyhex-3-ene
 D *trans*-5-hydroxyhexene

Topic Chem 13 Q# 835/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 20//

20 The structural formula of compound Q is shown.



How many stereoisomers exist with this structural formula?

- A 1 B 2 C 4 D 8

Topic Chem 13 Q# 836/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 The complete combustion of 2 moles of a straight chain alkane produces 400 dm³ of carbon dioxide measured at 301 K and 1 × 10⁵ Pa. Carbon dioxide can be assumed to behave as an ideal gas under these conditions.

What is the formula of the straight chain alkane?

- A C₈H₁₈ B C₁₀H₂₄ C C₂₀H₄₂ D C₄₀H₈₂

Topic Chem 13 Q# 837/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

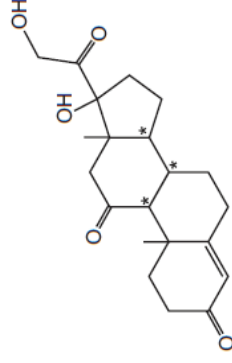
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 P and Q are a pair of *cis*-*trans* isomers.

What **must** be the same for P and Q?

- 1 their empirical formula
 2 their functional groups
 3 their skeletal formula

21 The drug cortisone has the formula shown.



In addition to those chiral centres marked by an asterisk (*), how many **other** chiral centres are present in the cortisone molecule?

- A 0 B 1 C 2 D 3

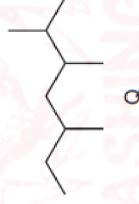
Topic Chem 13 Q# 839/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)

16 Which statement about nitrogen or its compounds is correct?

- A In the Haber process the temperature is kept high to give a good equilibrium yield of ammonia.
 B Nitrogen gas is unreactive because of the strong nitrogen-nitrogen double bond.
 C Nitrogen monoxide will react with carbon monoxide under suitable conditions.
 D The formula of ammonium sulfate is NH₄SO₄.

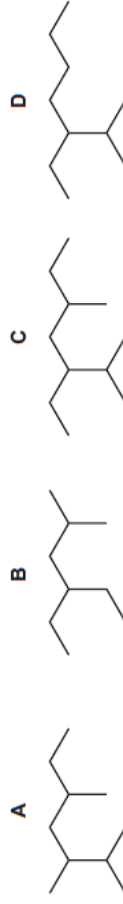
Topic Chem 13 Q# 840/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Kerosene is used as an aircraft fuel. Q is one of the molecules in kerosene and has the skeletal formula shown.

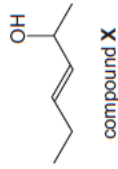


Other structural isomers of this molecule are also found in kerosene.

Which structure is a structural isomer of Q?



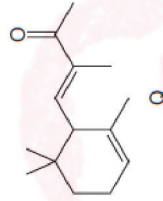
21 What is the name of compound X?



- A *trans*-2-hydroxyhex-3-ene
 B *trans*-2-hydroxyhexene
 C *trans*-5-hydroxyhex-3-ene
 D *trans*-5-hydroxyhexene

Topic Chem 13 Q# 835/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 20//

20 The structural formula of compound Q is shown.



How many stereoisomers exist with this structural formula?

- A 1 B 2 C 4 D 8

Topic Chem 13 Q# 836/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 The complete combustion of 2 moles of a straight chain alkane produces 400 dm³ of carbon dioxide measured at 301 K and 1 × 10⁵ Pa. Carbon dioxide can be assumed to behave as an ideal gas under these conditions.

What is the formula of the straight chain alkane?

- A C₈H₁₈ B C₁₀H₂₄ C C₂₀H₄₂ D C₄₀H₈₂

Topic Chem 13 Q# 837/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 P and Q are a pair of *cis*-*trans* isomers.

What **must** be the same for P and Q?

- 1 their empirical formula
 2 their functional groups
 3 their skeletal formula



Topic Chem 13 Q# 841/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org .o)
The responses **A** to **D** should be selected on the basis of

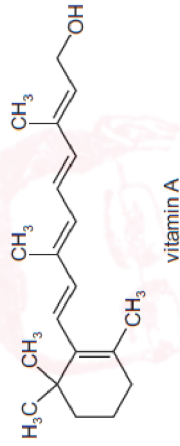
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Catalytic converters are used to modify exhaust emissions from motor vehicles.

Which reactions occur in catalytic converters?



Topic Chem 13 Q# 842/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org .o)
21 The diagram shows the structure of vitamin A.

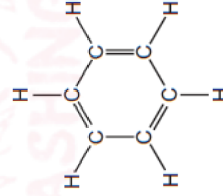


How many chiral centres are present in one vitamin A molecule?

- A 0 B 1 C 2 D 3

Topic Chem 13 Q# 843/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

20 In 1865 Kekulé suggested a ring structure for benzene, C_6H_6 , in which a hydrogen atom is attached to each carbon atom.

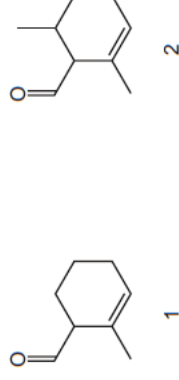


Kekulé structure

In this structure all of the bonds remain in the places shown. Assuming this is the structure of benzene, how many isomers of dichlorobenzene, $C_6H_4Cl_2$, would exist?

- A 3 B 4 C 5 D 6

Topic Chem 13 Q# 844/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)
20 The diagrams show two different compounds.



What is

- the total number of structural isomers, including compound 2, that could be formed by adding a second methyl group to the ring of compound 1,
- the number of π electrons in each compound?

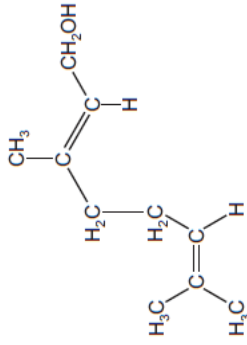
	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4

Topic Chem 13 Q# 845/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org .o)
19 Which reaction does not contribute to the problem of acid rain?

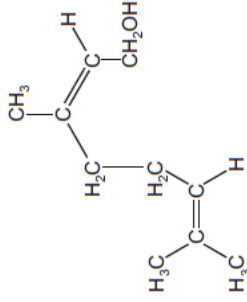
- A the combustion of fossil fuels
B the oxidation of sulfur dioxide to sulfur trioxide catalysed by nitrogen dioxide
C the reaction between nitrogen monoxide and carbon monoxide in a catalytic converter
D the reaction of sulfur trioxide with water



- 21 Geraniol and nerol are compounds found in some flower fragrances. They are isomers of each other.



geraniol



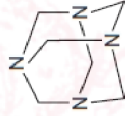
nerol

Which type of isomerism is shown here?

- A chain
 B geometrical (cis-trans)
 C optical
 D positional

- 9 Hexamine is a crystalline solid used as a fuel in portable stoves.

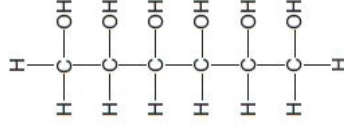
The diagram shows its skeletal structure.



What is the empirical formula of hexamine?

- A CH_2N B $\text{C}_3\text{H}_6\text{N}_2$ C $\text{C}_4\text{H}_8\text{N}_4$ D $\text{C}_6\text{H}_{12}\text{N}_4$

- 29 Sorbitol is a naturally-occurring compound with a sweet taste. It is often used as a substitute for sucrose by the food industry.



sorbitol

How many chiral centres are present in sorbitol?

- A 3 B 4 C 5 D 6

- 22 Crude oil is a mixture of many hydrocarbons ranging in size from 1 to 40 carbon atoms per molecule. The alkanes in crude oil can be separated because they have different boiling points.

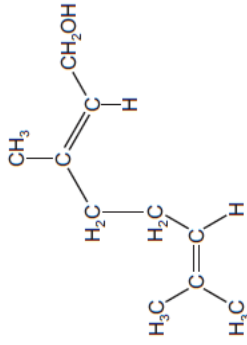
The table below shows the boiling points of some alkanes.

alkane	boiling point / $^{\circ}\text{C}$	M_r
butane	0	58
pentane	36	72
hexane	69	86
2-methylbutane	28	72
dimethylpropane	10	72
2,3-dimethylbutane	58	86

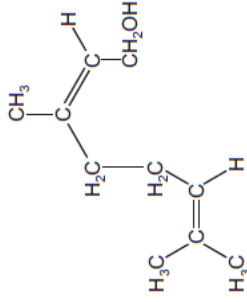
What is the correct explanation for the difference in the boiling points of the three isomers with $M_r = 72$?

- A Boiling point is dependent upon the length of the carbon chain only.
 B Increased branching on a carbon chain increases the boiling point.
 C Increased branching reduces the strength of the intermolecular hydrogen bonding.
 D Increased branching reduces the strength of the intermolecular van der Waals' forces.

- 21 Geraniol and nerol are compounds found in some flower fragrances. They are isomers of each other.



geraniol



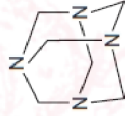
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Which type of isomerism is shown here?

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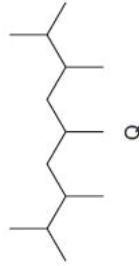


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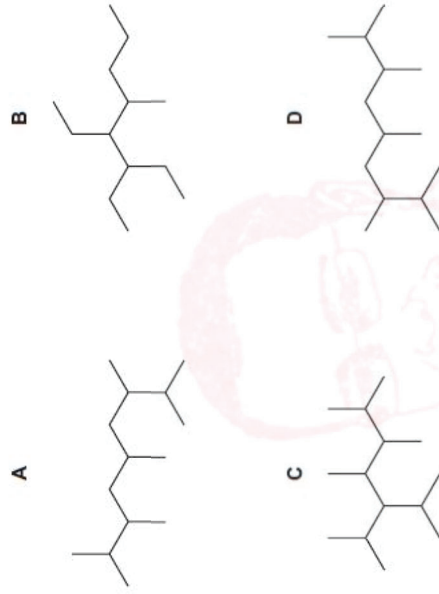
- A CH_2N B $\text{C}_3\text{H}_6\text{N}_2$ C $\text{C}_4\text{H}_8\text{N}_4$ D $\text{C}_6\text{H}_{12}\text{N}_4$



21 A new jet fuel has been produced that is a mixture of different structural isomers of compound Q.



Which skeletal formula represents a structural isomer of Q?

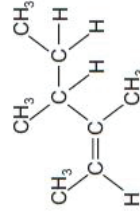


Topic Chem 13 Q# 851/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

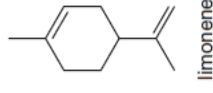
37 The diagram shows the structure of an alkene molecule.



Which statements about this molecule are correct?

- All the carbon atoms are in the same plane.
- It has geometrical isomers.
- It is optically active.

29 The citrus flavour of lemons is due to the compound limonene, present in both the peel and the juice.

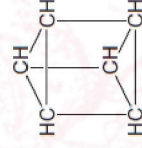


What is the mole ratio of carbon dioxide to water produced when limonene is completely burnt in oxygen?

	number of moles carbon dioxide	number of moles water
A	4	3
B	5	4
C	5	8
D	9	7

Topic Chem 13 Q# 853/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 In 1869 Ladenburg suggested a structure for benzene, C_6H_6 , in which one hydrogen atom is attached to each carbon atom.



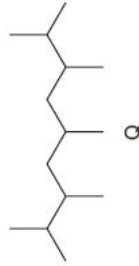
Ladenburg structure

A compound $C_9H_4C_{12}$ could be formed with the same carbon skeleton as the Ladenburg structure.

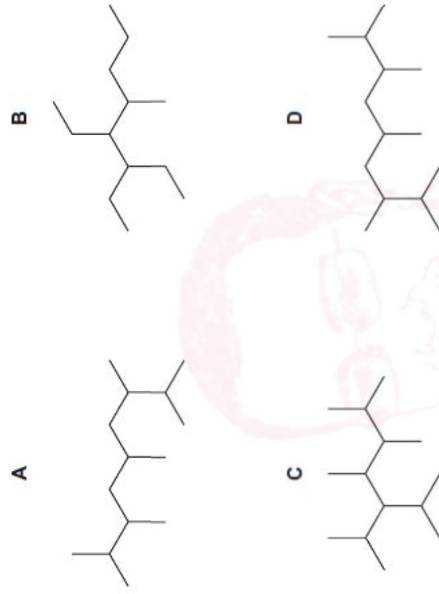
How many structural isomers would this compound have?

- A 3 B 4 C 5 D 6

21 A new jet fuel has been produced that is a mixture of different structural isomers of compound Q.



Which skeletal formula represents a structural isomer of Q?

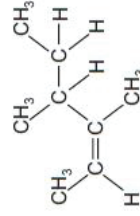


Topic Chem 13 Q# 851/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

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1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 The diagram shows the structure of an alkene molecule.



Which statements about this molecule are correct?

- All the carbon atoms are in the same plane.
- It has geometrical isomers.
- It is optically active.



Topic Chem 13 Q# 854/ AS Chemistry/2015/s/TZ.1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

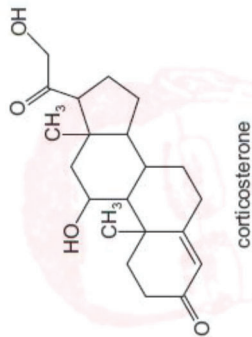
- 10 The double bond between the two carbon atoms in an ethene molecule consists of one σ bond and one π bond.

Which orbitals overlap to form each of these bonds?

	σ bond	π bond
A	sp^2-sp^2	p-p
B	sp^2-sp^2	sp^2-sp^2
C	sp^3-sp^3	p-p
D	sp^3-sp^3	sp^2-sp^2

Topic Chem 13 Q# 855/ AS Chemistry/2014/w/TZ.1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

- 26 Corticosterone is a hormone involved in the metabolism of carbohydrates and proteins.



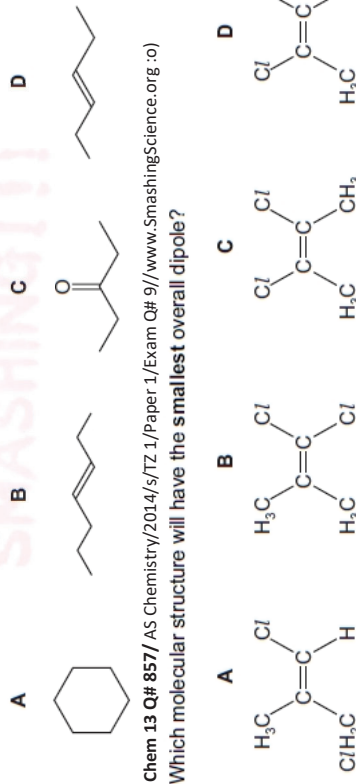
How many chiral centres are there in one molecule of corticosterone?

- A 5 B 6 C 7 D 8

Topic Chem 13 Q# 856/ AS Chemistry/2014/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

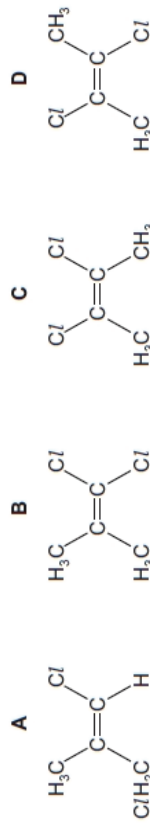
- 21 Use of the Data Booklet is relevant to this question.

Which compound has an M_r of 84 and will react with HBr to give a product with an M_r of 164.9?



Topic Chem 13 Q# 857/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

- 9 Which molecular structure will have the smallest overall dipole?



Topic Chem 13 Q# 858/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

- 24 There are three structural isomers with the formula C_5H_{12} .

Which formulae correctly represent these three structural isomers?

- A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$ $CH_3CH_2C(CH_3)_2CH_3$
 B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2(CH_2)CH_3$ $C(CH_3)_4$
 C $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3C(CH_3)_2CH_3$
 D $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$

Topic Chem 13 Q# 859/ AS Chemistry/2013/w/TZ.1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

- 23 Which compound exhibits stereoisomerism?

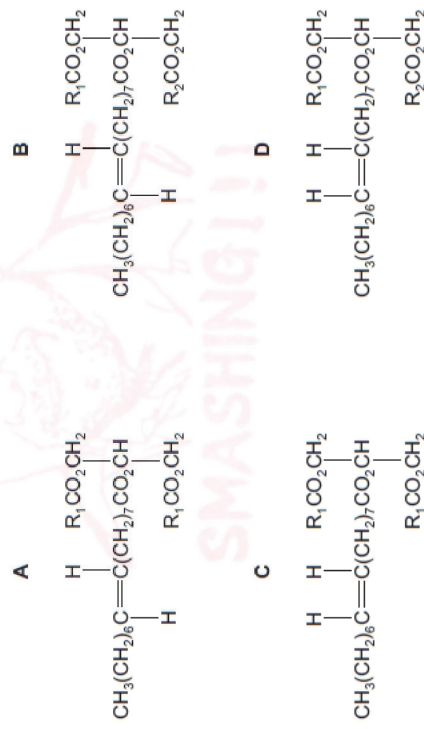
- A $CH_3CHClCH_3$
 B $CH_3CHClCH_2Cl$
 C $CH_3CCl_2CH_3$
 D $CH_2ClCH_2CH_2Cl$

Topic Chem 13 Q# 860/ AS Chemistry/2013/s/TZ.1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 Some vegetable oils contain 'trans fats' that are associated with undesirable increases in the amount of cholesterol in the blood.

In the diagrams below, R_1 and R_2 are different hydrocarbon chains.

Which diagram correctly illustrates an optically active 'trans fat'?



Topic Chem 13 Q# 854/ AS Chemistry/2015/s/TZ.1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)

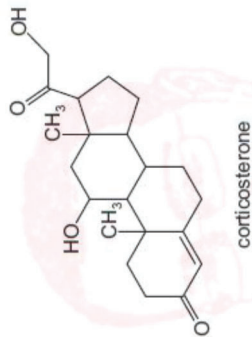
- 10 The double bond between the two carbon atoms in an ethene molecule consists of one σ bond and one π bond.

Which orbitals overlap to form each of these bonds?

	σ bond	π bond
A	sp^2-sp^2	p-p
B	sp^2-sp^2	sp^2-sp^2
C	sp^3-sp^3	p-p
D	sp^3-sp^3	sp^2-sp^2

Topic Chem 13 Q# 855/ AS Chemistry/2014/w/TZ.1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

- 26 Corticosterone is a hormone involved in the metabolism of carbohydrates and proteins.



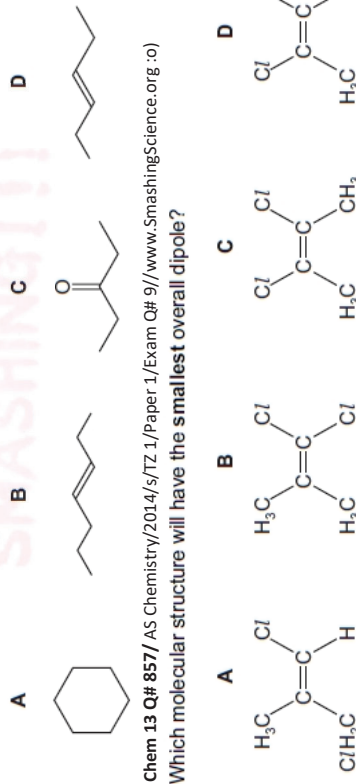
How many chiral centres are there in one molecule of corticosterone?

- A 5 B 6 C 7 D 8

Topic Chem 13 Q# 856/ AS Chemistry/2014/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

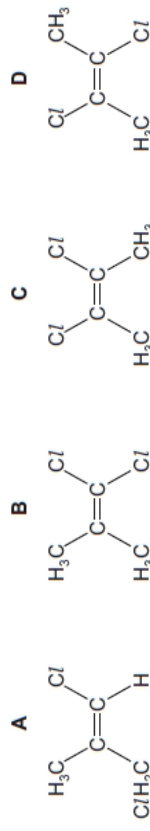
- 21 Use of the Data Booklet is relevant to this question.

Which compound has an M_r of 84 and will react with HBr to give a product with an M_r of 164.9?



Topic Chem 13 Q# 857/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 9//www.SmashingScience.org :o)

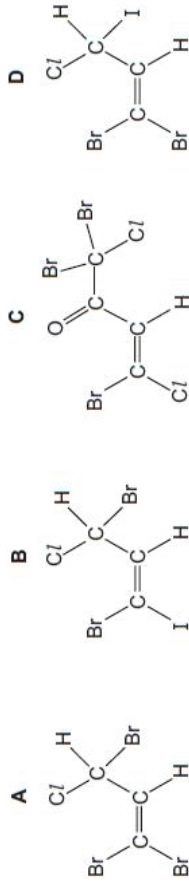
- 9 Which molecular structure will have the smallest overall dipole?



Topic Chem 13 Q# 861/ AS Chemistry/2013/s/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 The following compounds are found in the seaweed *Asparagopsis taxiformis*.

Which compound could show both *cis-trans* isomerism and optical isomerism?



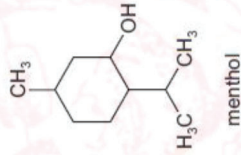
Topic Chem 13 Q# 862/ AS Chemistry/2013/s/TZ.1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

- A** aqueous bromine
B dilute hydrochloric acid
C limewater
D potassium dichromate(VI) in acidic solution

Topic Chem 13 Q# 863/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Menthol is an important compound extracted from the peppermint plant.



How many chiral centres are there in one molecule of menthol?

- A** 1 **B** 2 **C** 3 **D** 4

Topic Chem 13 Q# 864/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

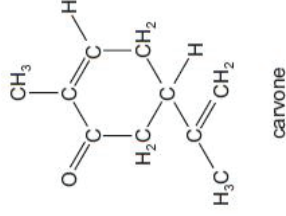
21 An alkene has the formula $\text{CH}_3\text{CH}=\text{CRCH}_2\text{CH}_3$ and does **not** possess *cis-trans* isomers.

What is R?

- A** H **B** Cl **C** CH_3 **D** C_2H_5

Topic Chem 13 Q# 865/ AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Carvone is found in spearmint.



How many σ and π bonds are present in this molecule?

	σ	π
A	13	3
B	22	3
C	22	6
D	25	3

Topic Chem 13 Q# 866/ AS Chemistry/2012/s/TZ.1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

	A	B	C	D
1 , 2 and 3 are correct		1 and 2 only are correct	2 and 3 only are correct	1 only is correct

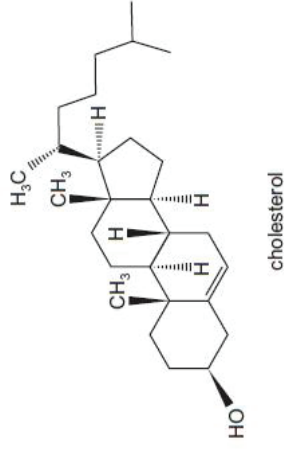
37 What is **always** involved in a carbon-carbon π bond?

- 1** a shared pair of electrons
2 a sideways overlap of p orbitals
3 delocalised electrons



Topic Chem 13 Q# 867/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 The diagram shows the structure of the naturally-occurring molecule cholesterol.



Student X claimed that the seventeen carbon atoms in the four rings all lie in the same plane.

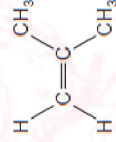
Student Y claimed that this molecule displays *cis-trans* isomerism at the C=C double bond.

Which of the students are correct?

- A both X and Y
- B neither X nor Y
- C X only
- D Y only

Topic Chem 13 Q# 868/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 The compound 2-methylpropene, C_4H_8 , is a monomer used in the production of synthetic rubber.



In addition to 2-methylpropene there are x other isomers of C_4H_8 , structural or otherwise, which contain a double bond.

What is the value of x ?

- A 1
- B 2
- C 3
- D 4

Topic Chem 13 Q# 869/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

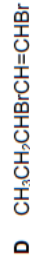
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which structural formulae represent 2,2-dimethylpentane?



Topic Chem 13 Q# 870/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Which compound exhibits both *cis-trans* and optical isomerism?



Topic Chem 13 Q# 871/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which commonly transported gas is non-flammable?

- A butane
- B hydrogen
- C oxygen
- D propene

Topic Chem 13 Q# 872/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

- A 7
- B 8
- C 9
- D 10



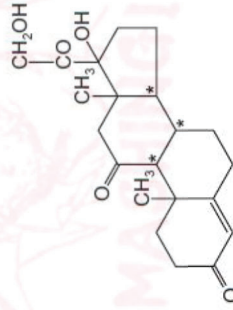
21 The presence of 11-*cis* retinal, C₂₀H₂₈O, in cells in the eye is important for vision.

The structure of retinal includes an aldehyde group, a cyclohexene ring and a long aliphatic side chain, in which a carbon-carbon double bond exists between carbons numbered 11 and 12.

Which pair of statements about 11-*cis* retinal could be correct?

	total number of >C=C< double bonds	arrangement around the adjacent carbons 11 and 12
A	5	
B	5	
C	6	
D	6	

20 The drug cortisone has the formula shown.



In addition to those chiral centres marked by an asterisk (*), how many other chiral centres are present in the cortisone molecule?

- A 0 B 1 C 2 D 3

20 The compound known as 'gamma-linolenic acid' is found in significant amounts in the seeds of the Evening Primrose plant. There is evidence that the compound may help patients with diabetes.

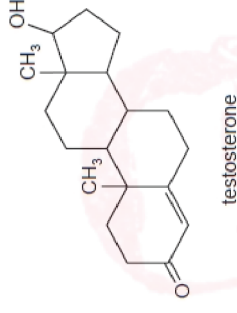


gamma-linolenic acid

How many *cis-trans* isomers does gamma-linolenic acid have?

- A 3 B 6 C 8 D 12

19 In recent years a number of athletes have been banned from sports because of their illegal use of synthetic testosterone, a naturally occurring hormone in the body.



How many chiral centres are present in a testosterone molecule?

- A 1 B 2 C 3 D 6

30 Oct-1-ene, CH₃(CH₂)₉CH=CH₂, can be thermally cracked.

Which of the compounds W, X, Y and Z can be obtained by thermally cracking oct-1-ene?

- | | | | |
|----------------------------------|------------------------------------|---|---------------------------------------|
| W | X | Y | Z |
| CH ₂ =CH ₂ | CH ₃ CH=CH ₂ | CH ₃ CH ₂ CH ₃ | CH ₂ =CHCH=CH ₂ |
| A W, X, Y and Z | | | |
| B W, X and Y only | | | |
| C W, X and Z only | | | |
| D W and X only | | | |

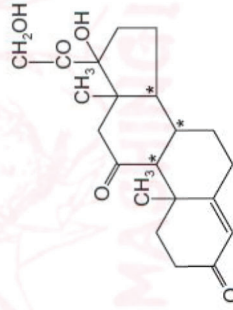
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In addition to those chiral centres marked by an asterisk (*), how many other chiral centres are present in the cortisone molecule?

- A 0 B 1 C 2 D 3



28 Alkenes react with aqueous hydrogen bromide. The reaction proceeds via an intermediate carbocation. The more stable the intermediate, the faster the reaction.

Which sequence correctly shows an **increase** in the speed of reaction of the alkenes with hydrogen bromide?

- A ethene, propene, 2-methylpropene
- B 2-methylpropene, ethene, propene
- C propene, ethene, 2-methylpropene
- D propene, 2-methylpropene, ethene

27 Which compound will decolourise $\text{Br}_2(\text{aq})$?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
- C $\text{CH}_3\text{CHCHCH}_2\text{CH}_2\text{CH}_2\text{OH}$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 One molecule of dodecane, $\text{C}_{12}\text{H}_{26}$, is cracked, producing three product molecules, X, Y and Z.

X is a straight chain alkane. Y and Z are straight chain alkenes with different M_r values.

Which statements about X, Y and Z are correct?

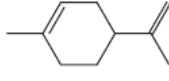
- 1 If Y and Z are but-1-ene and ethene respectively, X will be hexane.
- 2 If X is butane, then Y and Z could both show *cis-trans* isomerism.
- 3 X could be octane.

The responses **A** to **D** should be selected on the basis of

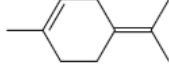
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 A diketone is a compound with two ketone groups and one carboxylic acid group.

limonene



terpinolene

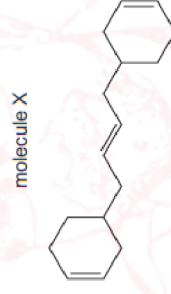


Which statements about the reactions of limonene and terpinolene are correct?

- 1 When reacted with an excess of hydrogen and a nickel catalyst, limonene and terpinolene produce the same compound.
- 2 An excess of hot concentrated acidified KMnO_4 reacts with limonene and with terpinolene to form different diketone acids.
- 3 The reactions of limonene and terpinolene with an excess of Br_2 produce positional isomers with the same number of chiral carbon atoms.

21 Structural isomerism **only** should be considered when answering this question.

Molecule X contains three C=C double bonds. One mole of X is reacted with three moles of HBr. The carbon skeleton is unchanged.



How many different products are formed?

- A 3
- B 4
- C 6
- D 8

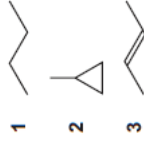
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



33 A gaseous hydrocarbon has a density of 2.42 g dm^{-3} under room conditions.

What could be the skeletal formula of this hydrocarbon?



Topic Chem 14 Q# 884/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 The table describes four reactions of propene.

Which row is correct?

	reagent used	name of main organic product
A	aqueous bromine	2-bromopropane
B	cold acidified aqueous potassium manganate(VII)	propane-1,3-diol
C	hydrogen chloride	2-chloropropane
D	steam	propan-1-ol

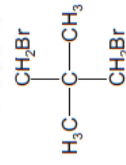
Topic Chem 14 Q# 885/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Which compound would produce two different carboxylic acids when treated with hot, concentrated, acidified manganate(VII) ions?



Topic Chem 14 Q# 886/ AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 The diagram shows the structure of a bromo compound that may be formed by the reaction of bromine with a hydrocarbon.



Which row is correct?

	type of reaction	mechanism
A	addition	electrophilic
B	addition	nucleophilic
C	substitution	nucleophilic
D	substitution	free-radical

Topic Chem 14 Q# 887/ AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Two students each make a statement about 2-methylbut-1-ene.

Student 1 states that 2-methylbut-1-ene has geometrical isomers.

Student 2 states that 2-methylbut-1-ene reacts with HBr in an addition reaction to give 1-bromo-2-methylbutane as the main product.

Which students are correct?

A both 1 and 2

B 1 only

C 2 only

D neither 1 nor 2

Topic Chem 14 Q# 888/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 The catalytic converters fitted to cars remove pollutants from the exhaust gases. Some of the reactions that occur involve oxygen, which comes from the air.

Which pollutants in the exhaust gases will react with oxygen on the surface of the catalytic converter?

1 NO₂

2 unburnt fuel

3 CO

Topic Chem 14 Q# 889/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 But-1-ene and but-2-ene are treated separately with cold, dilute acidified manganate(VII) ions.

Four students, W, X, Y and Z, make statements about these alkenes and the diols formed from them.

W One diol contains two primary alcohol groups.

X One diol contains a primary and a secondary alcohol group.

Y One diol contains two secondary alcohol groups.

Z Both alkenes exhibit *cis-trans* isomerism.

Which two students are correct?

A W and Y B W and Z C X and Y D X and Z

Topic Chem 14 Q# 890/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Which statements comparing ethene and ethane are correct?

- The bond angles in ethene are larger than the bond angles in ethane.
- Ethene reacts much more quickly with bromine in the dark than ethane does.
- Complete combustion of 0.01 mol of ethene or ethane produces the same volume of gas measured at room temperature and pressure.

Topic Chem 14 Q# 891/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Compound Q shows the following reactions.

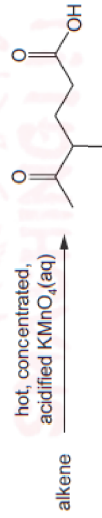
- It gives an orange precipitate with 2,4-dinitrophenylhydrazine.
- It gives a red-brown precipitate with Fehling's reagent.
- It gives a pale yellow precipitate with alkaline aqueous iodine.

What could be the identity of Q?

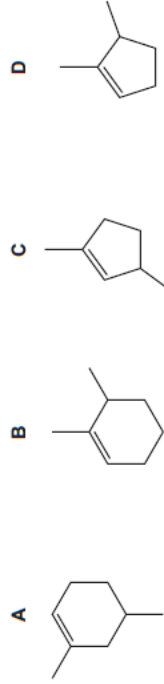
- ethanal
- propan-2-ol
- propanal
- propanone

Topic Chem 14 Q# 892/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 An alkene reacts with hot, concentrated, acidified potassium manganate(VII) to produce a single organic product as shown.



What is the structure of the alkene?



Topic Chem 14 Q# 893/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Alkanes are saturated hydrocarbons.

Which type of reaction are alkanes most likely to undergo?

- electrophilic addition
- electrophilic substitution
- free radical substitution
- nucleophilic addition

Topic Chem 14 Q# 894/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Which substance reacts with trichloroethene to give a chiral product?

- Br₂
- HCl
- NaCN
- NaOH

Topic Chem 14 Q# 895/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 What is the structural formula of the major product when hydrogen bromide reacts with 2-methylbut-2-ene?

- CH₂BrCH(CH₃)CH₂CH₃
- (CH₃)₂CBrCH₂CH₃
- (CH₃)₂CHCHBrCH₃
- (CH₃)₂CHCH₂CH₂Br

Topic Chem 14 Q# 896/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Many reactions take place in the engine and catalytic converter of a car.

Which pair of substances is produced **both** by the reactions in a car engine and in a catalytic converter?

- carbon dioxide and unburnt hydrocarbons
- carbon dioxide and water
- carbon monoxide and nitrogen
- carbon monoxide and unburnt hydrocarbons

Topic Chem 14 Q# 897/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

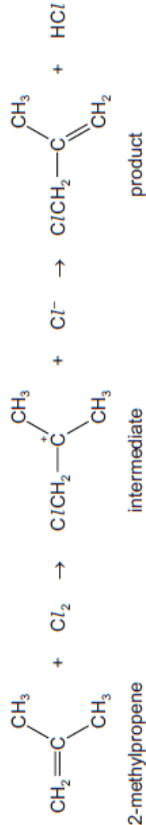
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



37 2-methylpropene can react in more than one way with chlorine.

One of the reactions follows the pathway shown.



2-methylpropene

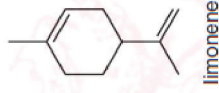
Which statements about this mechanism are correct?

- 1 The intermediate has all carbon atoms in the same plane.
- 2 There is an electrophilic attack on the double bond.
- 3 It is a free radical mechanism.

Topic Chem 14 Q# 898/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Limonene is found in lemons.



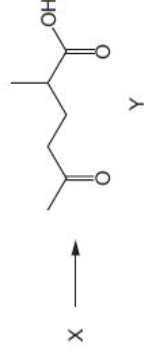
Limonene is heated with concentrated acidified potassium manganate(VII).

Which compounds are produced?

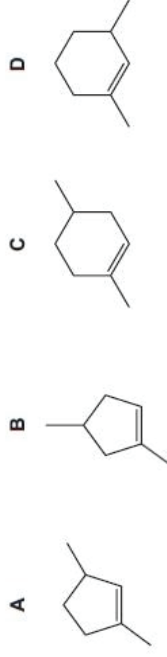
- 1 $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}(\text{CH}_2\text{CO}_2\text{H})_2$
- 2 CO_2
- 3 $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}(\text{COCH}_3)\text{CH}_2\text{CO}_2\text{H}$

Topic Chem 14 Q# 899/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Compound X can be converted into compound Y in a single step.



What could be the identity of X?



Topic Chem 14 Q# 900/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 22//

22 Many, but not all, organic reactions need to be heated before a reaction occurs.

Which reaction occurs quickly at room temperature, 20 °C?

- $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$
- $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
- $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

Topic Chem 14 Q# 901/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 An alkene is reacted with acidified manganate(VII) ions, MnO_4^- . The desired organic product has a relative molecular mass greater than that of the alkene by 34.

What conditions should be used?

- cold, concentrated MnO_4^-
- cold, dilute MnO_4^-
- hot, concentrated MnO_4^-
- hot, dilute MnO_4^-

Topic Chem 14 Q# 902/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



37 Which compounds can be obtained from but-2-ene in a single reaction?

- 1 $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$
- 2 $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
- 3 $\text{CH}_3\text{CO}_2\text{H}$

Topic Chem 14 Q# 903/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Propene undergoes a variety of reactions.

Which row is correct?

	reagent added to propene	products include
A	$\text{Br}_2(\text{aq})$	1-bromopropane
B	cold, dilute, acidified $\text{KMnO}_4(\text{aq})$	propanoic acid
C	$\text{HBr}(\text{g})$	2-bromopropane
D	hot, concentrated, acidified $\text{KMnO}_4(\text{aq})$	propanoic acid

Topic Chem 14 Q# 904/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Structural isomerism and stereoisomerism should be considered when answering this question.

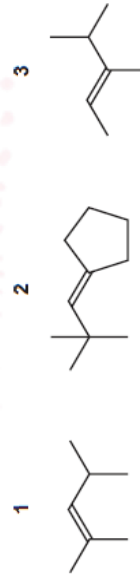
How many isomers with the formula C_4H_8 have structures that contain a π bond?

- A 1 B 2 C 3 D 4

Topic Chem 14 Q# 905/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which compounds would produce a carboxylic acid and a ketone when treated with hot, concentrated, acidified KMnO_4 ?



Topic Chem 14 Q# 906/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 The first propagation step in the reaction between methane and chlorine is shown.

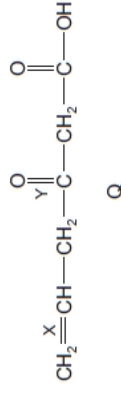


How many different first propagation steps are possible in the reaction between pentane and chlorine?

- A 2 B 3 C 4 D 5

Topic Chem 14 Q# 907/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Compound Q contains three double bonds per molecule.



Which bond, X or Y, will be ruptured by hot, concentrated acidified KMnO_4 and how many lone pairs of electrons are present in one molecule of Q?

	bond ruptured by hot, concentrated acidified KMnO_4	number of lone pairs
A	X	5
B	X	6
C	Y	5
D	Y	6

Topic Chem 14 Q# 908/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Which intermediate ion forms in the greatest amount during the addition of HBr to propene?

- A $\text{CH}_3\text{C}^+\text{HCH}_3$
 B $\text{CH}_3\text{CH}_2\text{CH}_2^+$
 C $\text{CH}_3\text{CH}^+\text{CH}_2\text{Br}$
 D $\text{CH}_3\text{CHBrCH}_2^-$

Topic Chem 14 Q# 909/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Cottonseed oil contains large amounts of polyunsaturated carboxylic acids. When this oil is used to make margarine, the C=C double bonds in the unsaturated carboxylic acids are hydrogenated.

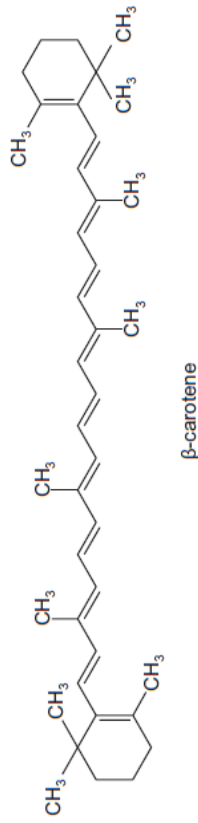
What reagents and conditions would be suitable to bring about this hydrogenation reaction?

- A H_2 gas, nickel catalyst, 400°C
 B LiAlH_4 in dry ether
 C NaBH_4 , aqueous solution
 D steam, concentrated H_2SO_4 , 300°C and 60 atm pressure



Topic Chem 14 Q# 910/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 β -carotene is responsible for the orange colour of carrots.



β -carotene is oxidised by hot, concentrated, acidified KMnO_4 .

When an individual molecule of β -carotene is oxidised in this way, many product molecules are formed.

How many of these product molecules contain a ketone functional group?

- A 4 B 6 C 9 D 11

Topic Chem 14 Q# 911/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Which equation correctly represents the balanced equation for the complete combustion of a hydrocarbon with the formula C_xH_y ?

- A $\text{C}_x\text{H}_y + (x + \frac{y}{2})\text{O}_2 \rightarrow x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O}$
 B $\text{C}_x\text{H}_y + (x + \frac{y}{4})\text{O}_2 \rightarrow x\text{CO}_2 + y\text{H}_2\text{O}$
 C $\text{C}_x\text{H}_y + (x + \frac{y}{4})\text{O}_2 \rightarrow x\text{CO}_2 + \frac{y}{4}\text{H}_2\text{O}$
 D $\text{C}_x\text{H}_y + (x + \frac{y}{2})\text{O}_2 \rightarrow x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O}$

Topic Chem 14 Q# 912/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Which row correctly describes the reaction between propene and bromine, $\text{Br}_2(\text{l})$?

	reaction mechanism	organic product
A	electrophilic addition	$\text{CH}_3\text{CHBrCH}_2\text{Br}$
B	electrophilic addition	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
C	nucleophilic substitution	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
D	nucleophilic substitution	$\text{CH}_3\text{CHBrCH}_2\text{Br}$

Topic Chem 14 Q# 913/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 The hydrocarbon $\text{C}_{17}\text{H}_{36}$ can be cracked.

Which compound is the least likely to be produced in this reaction?

- A C_3H_8 B C_4H_8 C C_8H_{16} D $\text{C}_{16}\text{H}_{34}$

Topic Chem 14 Q# 914/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 How many moles of oxygen molecules are needed for the complete combustion of one mole of 3-methylpent-2-ene?

- A 9 B $9\frac{1}{2}$ C 18 D 19

Topic Chem 14 Q# 915/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)

7 Which stage in the free radical substitution of methane by chlorine will have the lowest activation energy?

- A $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$
 B $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$
 C $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{CH}_3\cdot + \text{HCl}$
 D $\text{Cl}_2 \rightarrow \text{Cl}\cdot + \text{Cl}\cdot$

Topic Chem 14 Q# 916/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which molecules would be present in the mixture produced by the photochemical chlorination of methane?

- 1 hydrogen
 2 hydrogen chloride
 3 dichloromethane

Topic Chem 14 Q# 917/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Pentane, C_5H_{12} , is reacted with chlorine in the presence of ultraviolet light. A compound R is found in the products. R has molecular formula $\text{C}_5\text{H}_{10}\text{Cl}_2$. Each molecule of R contains one chiral carbon atom.

Which two atoms of the pentane chain could be bonded to chlorine atoms in this isomer?

- A 1 and 3 B 1 and 5 C 2 and 3 D 2 and 4

Topic Chem 14 Q# 918/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Bromine reacts with ethene to form 1,2-dibromoethane.

What is the correct description of the organic intermediate in this reaction?

- A It has a negative charge.
 B It is a free radical.
 C It is a nucleophile.
 D It is an electrophile.



Topic Chem 14 Q# 919/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which reagents and conditions will convert propane into 1-chloropropane?

- Cl₂ and sunlight
- conc. HCl, reflux
- PCl₅

Topic Chem 14 Q# 920/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

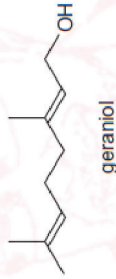
23 The cracking of a single hydrocarbon molecule, C₇H₁₆, produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms in one molecule. Each hydrocarbon product has non-cyclic structural isomers.

What is the value of n?

- A 4 B 6 C 8 D 9

Topic Chem 14 Q# 921/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Geraniol is a constituent of some perfumes.



Which statement about geraniol is not correct?

- Geraniol causes hot acidified potassium dichromate(VI) to change colour from orange to green.
- Geraniol decolourises bromine water.
- There are three methyl groups and three methylene (CH₂) groups in geraniol.
- There are two pairs of *cis-trans* isomers of geraniol.

Topic Chem 14 Q# 922/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 A reaction between chlorine and propane in ultraviolet light produces two isomeric monochloropropanes, C₃H₇Cl, as products.

Which information about this reaction is correct?

	type of bond fission in initiation step	expected ratio of 1-chloropropane to 2-chloropropane produced
A	heterolytic	1 : 1
B	heterolytic	3 : 1
C	homolytic	1 : 1
D	homolytic	3 : 1

Topic Chem 14 Q# 923/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 Energy is released in the human body by the oxidation of glucose in a complex sequence of reactions. Part of this sequence is the Krebs cycle. One reaction in the Krebs cycle is the conversion of fumaric acid into malic acid.



fumaric acid malic acid

Which reagents could achieve this transformation in the laboratory?

- acidified KMnO₄
- Br₂(aq) followed by hot NaOH(aq)
- H₂O with Pt catalyst
- steam with H₂SO₄

Topic Chem 14 Q# 924/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which alkenes, on reaction with steam at 600 K and 6 x 10⁵ Pa pressure in the presence of a phosphoric acid catalyst, could produce an alcohol containing a chiral carbon atom?

- (CH₃)₂C=CH₂
- CH₃CH=CHCH₃
- CH₃CH₂CH=CH₂

Topic Chem 14 Q# 919/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which reagents and conditions will convert propane into 1-chloropropane?

- Cl₂ and sunlight
- conc. HCl, reflux
- PCl₅

Topic Chem 14 Q# 920/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

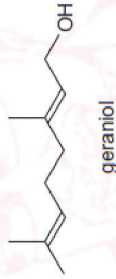
23 The cracking of a single hydrocarbon molecule, C₇H₁₆, produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms in one molecule. Each hydrocarbon product has non-cyclic structural isomers.

What is the value of n?

- A 4 B 6 C 8 D 9

Topic Chem 14 Q# 921/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Geraniol is a constituent of some perfumes.

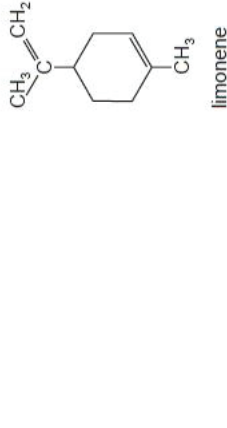


Which statement about geraniol is not correct?

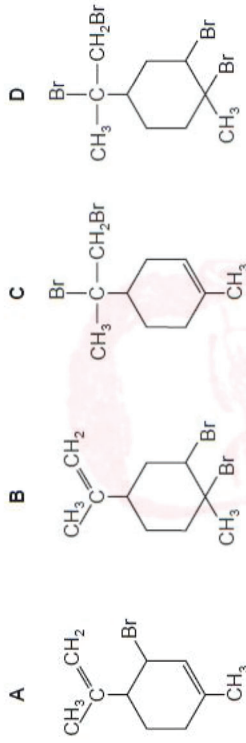
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- Geraniol decolourises bromine water.
- There are three methyl groups and three methylene (CH₂) groups in geraniol.
- There are two pairs of *cis-trans* isomers of geraniol.



25 Limonene is an oil formed in the peel of citrus fruits.

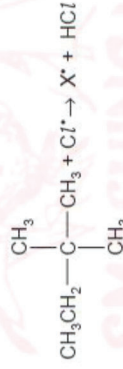


Which product is formed when an excess of bromine, Br₂(l), reacts with limonene at room temperature in the dark?



21 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical X[•] is formed.



How many different forms of X[•] are possible?

- A 1 B 2 C 3 D 4

26 Which equation represents a valid propagation step in the free radical reaction between ethane and chlorine?

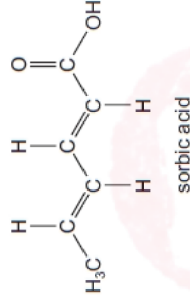
- A $\text{C}_2\text{H}_6 + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{H}^{\bullet}$
 B $\text{C}_2\text{H}_5\text{Cl} + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_4\text{Cl}^{\bullet} + \text{HCl}$
 C $\text{C}_2\text{H}_6 + \text{H}^{\bullet} \rightarrow \text{C}_2\text{H}_5^{\bullet} + \text{HCl}$
 D $\text{C}_2\text{H}_5^{\bullet} + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_5\text{Cl}$

25 Bromine reacts with ethene to form 1,2-dibromoethane.

What is the correct description of the organic intermediate in this reaction?

- A It has a negative charge.
 B It is a free radical.
 C It is a nucleophile.
 D It is an electrophile.

24 Sorbic acid is used as a food preservative because it kills fungi and moulds.



Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent.

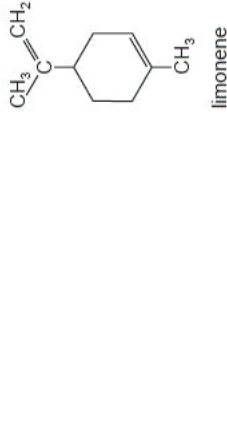
How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	2½
C	3	2
D	3	2½

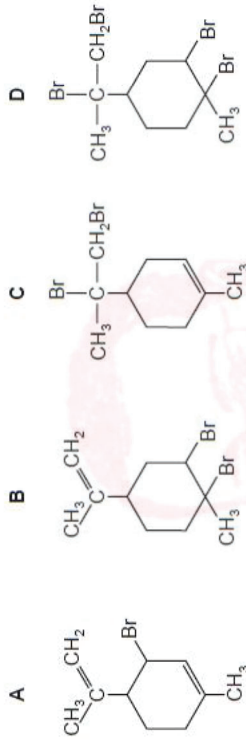
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

25 Limonene is an oil formed in the peel of citrus fruits.

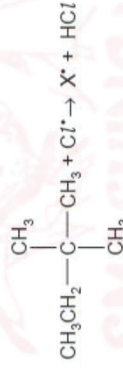


Which product is formed when an excess of bromine, Br₂(l), reacts with limonene at room temperature in the dark?



21 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical X[•] is formed.



How many different forms of X[•] are possible?

- A 1 B 2 C 3 D 4

26 Which equation represents a valid propagation step in the free radical reaction between ethane and chlorine?

- A $\text{C}_2\text{H}_6 + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{H}^{\bullet}$
 B $\text{C}_2\text{H}_5\text{Cl} + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_4\text{Cl}^{\bullet} + \text{HCl}$
 C $\text{C}_2\text{H}_6 + \text{H}^{\bullet} \rightarrow \text{C}_2\text{H}_5^{\bullet} + \text{HCl}$
 D $\text{C}_2\text{H}_5^{\bullet} + \text{Cl}^{\bullet} \rightarrow \text{C}_2\text{H}_5\text{Cl}$



- 37 A fraction of distilled crude oil contains molecules with between 15 and 19 carbon atoms. This fraction is cracked by strong heating.

Why is this done?

- To produce alkenes.
- To produce smaller molecules which are in higher demand.
- To insert oxygen atoms into the hydrocarbons.

Topic Chem 15 Q# 931/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org .o)
 37 2-bromopropane reacts with hot ethanolic sodium hydroxide.

Which substance is the major product of this reaction?

- propan-1-ol
- propan-2-ol
- 2-hydroxypropene
- propene

Topic Chem 15 Q# 932/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org .o)

- 32 The presence of a halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would be the quickest to produce a precipitate?



Topic Chem 15 Q# 933/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org .o)

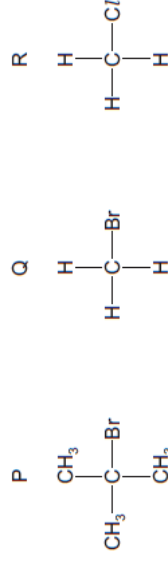
- 31 Structural isomerism and stereoisomerism should be taken into account when answering this question.

How many isomeric alkenes with formula C_5H_{10} are present in the mixture produced when 1,4-dibromopentane is reacted with NaOH in ethanol?

- 1
- 2
- 3
- 4

Topic Chem 15 Q# 934/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org .o)

- 30 The diagram shows the structures of three halogenoalkanes.



P, Q and R can all be hydrolysed.

Which row is correct?

	relative speed of hydrolysis		mechanism of hydrolysis	
	Q	R	P	Q
A	fast	slow	S_N1	S_N2
B	fast	slow	S_N2	S_N1
C	slow	fast	S_N1	S_N2
D	slow	fast	S_N2	S_N1

Topic Chem 15 Q# 935/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 29//www.SmashingScience.org .o)

- 29 A reaction occurs when a sample of 1-chloropropane is heated under reflux with sodium hydroxide dissolved in ethanol.

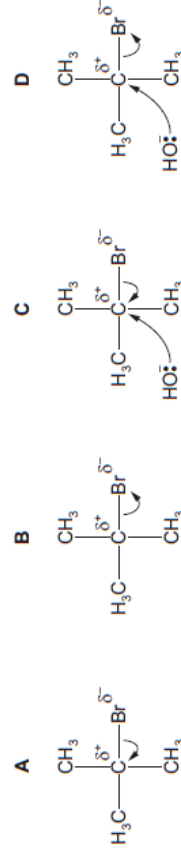
Which row is correct?

	type of reaction	name of product
A	elimination	propan-1-ol
B	elimination	propene
C	substitution	propan-1-ol
D	substitution	propene

Topic Chem 15 Q# 936/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org .o)

- 23 When 2-bromo-2-methylpropane reacts with aqueous sodium hydroxide, an alcohol is formed.

Which diagram describes the first step in the reaction mechanism?



Topic Chem 15 Q# 937/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org .o)

22 Structural isomerism **and** stereoisomerism should be considered when answering this question.

A colourless liquid, $C_6H_{11}Cl$, exists as a mixture of two optical isomers.

When heated with sodium hydroxide in ethanol, a mixture of **only two** alkenes is formed.

What could the colourless liquid be?

A $(CH_3CH_2)_2CHCl$

B $CH_3CH_2CH_2CHClCH_3$

C $CH_3CH_2CCl(CH_3)_2$

D $(CH_3)_2CHCHClCH_3$

Topic Chem 15 Q# 938/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which statements are correct?

1 1,1-difluoroethane is less reactive than 1,1-dichloroethane.

2 1,1-difluoroethane is polar.

3 The C–F bond is stronger than the C–Cl bond.

Topic Chem 15 Q# 939/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

20 Bromoethane reacts with cyanide ions, producing propanenitrile.

Which statement about the S_N2 mechanism of this reaction is correct?

A The lone pair of electrons on C of CN^- attacks the carbon atom of the C–Br bond.

B The lone pair of electrons on C of CN^- attacks the carbocation formed when the C–Br bond breaks.

C The lone pair of electrons on N of CN^- attacks the carbon atom of the C–Br bond.

D The lone pair of electrons on N of CN^- attacks the carbocation formed when the C–Br bond breaks.

Topic Chem 15 Q# 940/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 In which reactions is the major product formed by a nucleophilic substitution reaction?

1 bromoethane + potassium cyanide in ethanol

2 bromoethane + ammonia in ethanol under pressure

3 bromoethane + hot concentrated sodium hydroxide in ethanol

Topic Chem 15 Q# 941/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 25//www.SmashingScience.org .o)

25 Dibromopentanes can undergo 'double elimination' reactions to produce hydrocarbons.



Which isomer produces only one hydrocarbon product?

A 1,5-dibromopentane

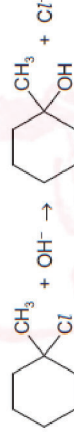
B 1,4-dibromopentane

C 2,3-dibromopentane

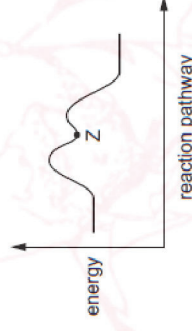
D 2,4-dibromopentane

Topic Chem 15 Q# 942/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org .o)

25 1-chloro-1-methylcyclohexane is hydrolysed by heating with $NaOH(aq)$.



The reaction pathway is shown.



One carbon atom in 1-chloro-1-methylcyclohexane is bonded to three other carbon atoms.

What is the charge on this carbon atom at point Z?

A 1–

B δ^-

C δ^+

D 1+

Topic Chem 15 Q# 943/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org .o)

23 Iodoethane, CH_3CH_2I , reacts with aqueous silver nitrate at $50^\circ C$. A precipitate forms during this reaction.

Which row of the table is correct about this reaction?

	type of organic reaction	colour of precipitate
A	electrophilic substitution	cream
B	electrophilic substitution	yellow
C	nucleophilic substitution	cream
D	nucleophilic substitution	yellow

Topic Chem 15 Q# 937/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org .o)

22 Structural isomerism **and** stereoisomerism should be considered when answering this question.

A colourless liquid, $C_6H_{11}Cl$, exists as a mixture of two optical isomers.

When heated with sodium hydroxide in ethanol, a mixture of **only two** alkenes is formed.

What could the colourless liquid be?

A $(CH_3CH_2)_2CHCl$

B $CH_3CH_2CH_2CHClCH_3$

C $CH_3CH_2CCl(CH_3)_2$

D $(CH_3)_2CHCHClCH_3$

Topic Chem 15 Q# 938/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which statements are correct?

1 1,1-difluoroethane is less reactive than 1,1-dichloroethane.

2 1,1-difluoroethane is polar.

3 The C–F bond is stronger than the C–Cl bond.

Topic Chem 15 Q# 939/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

20 Bromoethane reacts with cyanide ions, producing propanenitrile.

Which statement about the S_N2 mechanism of this reaction is correct?

A The lone pair of electrons on C of CN^- attacks the carbon atom of the C–Br bond.

B The lone pair of electrons on C of CN^- attacks the carbocation formed when the C–Br bond breaks.

C The lone pair of electrons on N of CN^- attacks the carbon atom of the C–Br bond.

D The lone pair of electrons on N of CN^- attacks the carbocation formed when the C–Br bond breaks.

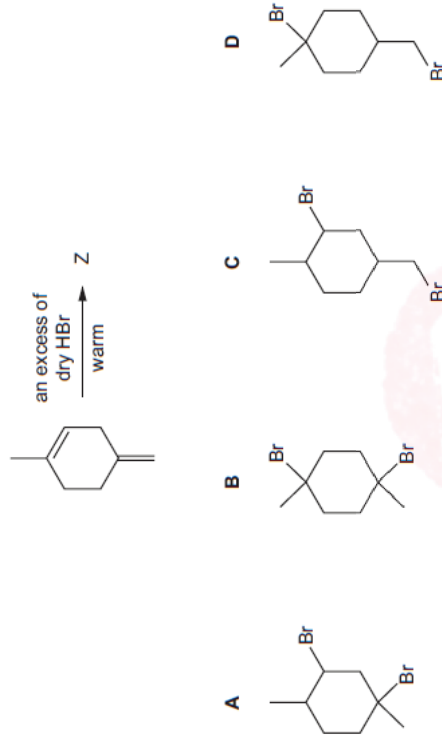
Topic Chem 15 Q# 940/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org .o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



27 What is the major product Z of the following reaction?



Topic Chem 15 Q# 945/ AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 2-bromo-2-methylpentane is a tertiary haloalkane.

Which organic products are formed when 2-bromo-2-methylpentane reacts with a hot concentrated ethanolic solution of sodium hydroxide?

- A** 2-methylpent-1-ene only
B 2-methylpent-1-ene and 2-methylpent-2-ene
C 2-methylpent-2-ene only
D 2-methylpent-2-ene and 4-methylpent-2-ene

Topic Chem 15 Q# 946/ AS Chemistry/2020/m/TZ.2/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Which row identifies a suitable starting material and reagent that can be used to produce butanenitrile?

	starting material	reagent
A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$	HCN
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$	NaCN
C	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$	HCN
D	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$	NaCN

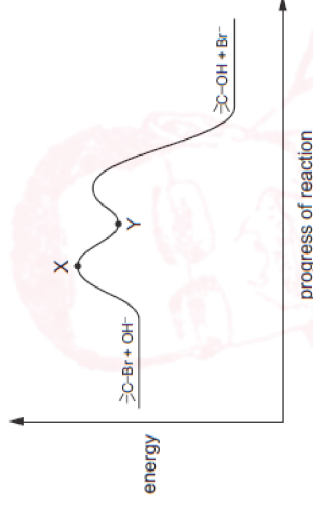
24 Bromoethane and chloroethane are added separately to water. Hydrolysis reactions occur.

Which compound hydrolyses more rapidly and what is the mechanism?

	compound that hydrolyses more rapidly	mechanism
A	bromoethane	electrophilic substitution
B	bromoethane	nucleophilic substitution
C	chloroethane	electrophilic substitution
D	chloroethane	nucleophilic substitution

Topic Chem 15 Q# 948/ AS Chemistry/2019/w/TZ.1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 A tertiary bromoalkane, indicated here by >C-Br , reacts with aqueous NaOH. The mechanism has the reaction pathway shown.



Which point in the diagram is correctly identified?

- A** X is >C^+
B X is $\left[\text{HO} \cdots \text{C} \cdots \text{Br} \right]^-$
C Y is >C^+
D Y is $\left[\text{HO} \cdots \text{C} \cdots \text{Br} \right]^-$

Topic Chem 15 Q# 949/ AS Chemistry/2019/s/TZ.1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Which reaction is most likely to involve the formation of a positively charged intermediate?

- A** 1-bromopentane and warm dilute NaOH(aq)
B 1-bromo-2,2-dimethylpropane and warm dilute NaOH(aq)
C 1-bromo-3-methylbutane and warm dilute NaOH(aq)
D 2-bromo-2-methylbutane and warm dilute NaOH(aq)



Topic Chem 15 Q# 950/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

24 Bromopropane reacts with water as shown.



Which statement is correct?

- A This is an elimination reaction.
- B This is a hydrolysis reaction.
- C This is a redox reaction.
- D This reaction tends to proceed via the $\text{S}_{\text{N}}1$ mechanism.

Topic Chem 15 Q# 951/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 23//www.SmashingScience.org .o)

23 Structural isomerism and stereoisomerism should be considered when answering this question.

2-bromopentane is heated with an excess of ethanolic sodium hydroxide.

How many different hydrocarbons are produced?

- A 1
- B 2
- C 3
- D 4

Topic Chem 15 Q# 952/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

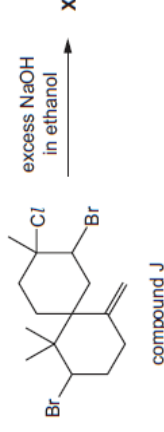
38 The halogenoalkanes listed below all react with $\text{NaOH}(\text{aq})$.

Which reactions proceed mainly by an $\text{S}_{\text{N}}1$ mechanism?

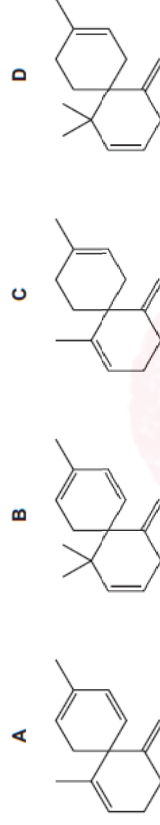
- 1 1-iodopropane
- 2 2-iodo-2-methylpropane
- 3 2-bromo-2-methylbutane

Topic Chem 15 Q# 953/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org .o)

25 Compound J, $\text{C}_{16}\text{H}_{22}\text{Br}_2\text{Cl}$ is reacted with an excess of a hot concentrated solution of sodium hydroxide in ethanol. One of the products is X.



What could be the skeletal formula of X?



Topic Chem 15 Q# 954/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org .o)

23 The conversion of propene to propan-2-ol can be carried out in two stages represented by the equations shown.



How can these two reactions be described?

	reaction 1	reaction 2
A	addition	elimination
B	addition	substitution
C	elimination	substitution
D	substitution	elimination

Topic Chem 15 Q# 955/ AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org .o)

20 What is true of every nucleophile?

- A It attacks a double bond.
- B It donates a lone pair of electrons.
- C It is a single atom.
- D It is negatively charged.



- 22 Sodium methoxide, $\text{Na}^+\text{CH}_3\text{O}^-$, reacts with 2-chloro-2-methylpropane in a nucleophilic substitution reaction. The nucleophile is the CH_3O^- ion.

Which row is correct?

	intermediate or transition state	product
A	$(\text{CH}_3)_3\text{C}^+$	$(\text{CH}_3)_3\text{COCH}_3$
B	$(\text{CH}_3)_3\text{C}^+$	$(\text{CH}_3)_3\text{CCH}_2\text{OH}$
C	$[\text{HOCH}_2-\text{C}(\text{CH}_3)_3-\text{C}]^-$	$\text{HOCH}_2\text{C}(\text{CH}_3)_3$
D	$[\text{H}_3\text{CO}-\text{C}(\text{CH}_3)_3-\text{C}]^-$	$\text{H}_3\text{COOC}(\text{CH}_3)_3$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 38 Organic compound X gives a precipitate when warmed with aqueous silver nitrate. This precipitate dissolves when concentrated aqueous ammonia is added.

What could X be?

- 1-bromopropane
- 2-chlorobutane
- 2-iodo-2-methylpropane

- 27 A reaction occurs when a sample of 1-chloropropane is heated under reflux with sodium hydroxide dissolved in ethanol.

Which row is correct?

	type of reaction	name of product
A	elimination	propan-1-ol
B	elimination	propene
C	substitution	propan-1-ol
D	substitution	propene

- 21 An organic ion containing a carbon atom with a negative charge is called a carbanion.

An organic ion containing a carbon atom with a positive charge is called a carbocation. The reaction between aqueous sodium hydroxide and 1-bromobutane proceeds by an $\text{S}_{\text{N}}2$ mechanism.

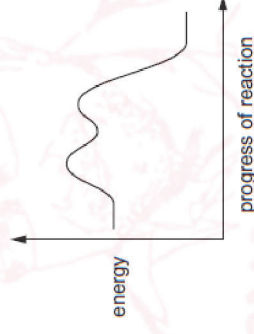
What is the first step in the mechanism?

- attack by a nucleophile on a carbon atom with a partial positive charge
- heterolytic bond fission followed by attack by an electrophile on a carbanion
- heterolytic bond fission followed by attack by a nucleophile on a carbocation
- homolytic bond fission followed by attack by a nucleophile on a carbocation

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 38 A reaction pathway diagram is shown.



Which reactions would have this reaction pathway diagram?

- $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \rightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{NaBr}$
- $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + 2\text{NH}_3 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Cl}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that includes the formation of a positive ion?

- 1 first ionisation energy
- 2 heterolytic fission of a covalent bond
- 3 enthalpy change of atomisation

Topic Chem 15 Q# 962/ AS Chemistry/2017/m/TZ 1/Paper 1/Exam Q# 24//

24 Which organic reaction is an example of nucleophilic substitution?



Topic Chem 15 Q# 963/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 The following statements are about the reaction of NaOH(aq) with the three chloroalkanes shown.



Which statements are correct?

- 1 $(\text{CH}_3)_2\text{CHCH}_2\text{Cl}$ reacts with NaOH(aq) by an $\text{S}_{\text{N}}2$ mechanism.
- 2 The tertiary chloroalkane reacts more quickly than the others because the carbon atom bonded to the Cl atom is more positive in this molecule.
- 3 The Cl atoms in the three chloroalkanes are attacked by OH^- .

Topic Chem 15 Q# 964/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which statements help to explain the mechanism of the reaction between 1-chloropropane and ammonia?

- 1 1-chloropropane has a δ^- chlorine atom that forms hydrogen bonds with a δ^+ hydrogen atom in ammonia.
- 2 1-chloropropane is a polar compound with a δ^+ carbon atom.
- 3 There is a lone pair of electrons on the nitrogen atom in ammonia.

Topic Chem 15 Q# 965/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Which radical is most likely to form by the homolytic fission of one covalent bond in bromochloromethane, CH_2BrCl ?



Topic Chem 15 Q# 966/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Bromoethane reacts with NaOH in different ways depending on the solvent used.

Which statements about these reactions are correct?

	solvent used	main organic product
1	water	ethane-1,2-diol
2	ethanol	ethene
3	water	ethanol

Topic Chem 15 Q# 967/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which types of reaction can occur with 1-bromobutane?

- 1 elimination
- 2 hydrolysis
- 3 free radical substitution

31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that includes the formation of a positive ion?

- 1 first ionisation energy
- 2 heterolytic fission of a covalent bond
- 3 enthalpy change of atomisation

Topic Chem 15 Q# 962/ AS Chemistry/2017/m/TZ 1/Paper 1/Exam Q# 24//

24 Which organic reaction is an example of nucleophilic substitution?



Topic Chem 15 Q# 963/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

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Which statements are correct?

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- 2 The tertiary chloroalkane reacts more quickly than the others because the carbon atom bonded to the Cl atom is more positive in this molecule.
- 3 The Cl atoms in the three chloroalkanes are attacked by OH^- .

Topic Chem 15 Q# 964/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which statements help to explain the mechanism of the reaction between 1-chloropropane and ammonia?

- 1 1-chloropropane has a δ^- chlorine atom that forms hydrogen bonds with a δ^+ hydrogen atom in ammonia.
- 2 1-chloropropane is a polar compound with a δ^+ carbon atom.
- 3 There is a lone pair of electrons on the nitrogen atom in ammonia.



25 A student prepares pentan-1-ol by the alkaline hydrolysis of 1-iodopentane. She gently warms the reaction mixture for 20 minutes.



When the student uses 1-chloropentane to prepare the same alcohol she has to change the condition of the reaction.

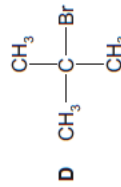
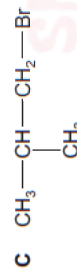
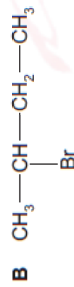
Which change in condition should she use and what is the correct reason for its use?

	change in condition	reason
A	heat under reflux	C-Cl bond is more polar than the C-I bond
B	heat under reflux	C-Cl bond is stronger than the C-I bond
C	room temperature	C-Cl bond is more polar than the C-I bond
D	room temperature	C-Cl bond is shorter than the C-I bond

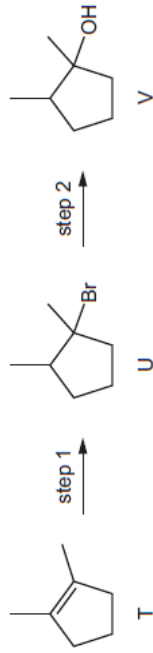
25 Structural isomerism and stereoisomerism should be considered in answering this question.

Compound J is reacted with KOH dissolved in ethanol. Three isomeric alkenes with molecular formula C_4H_8 are formed.

What is J?



24 Hydrogen bromide can be added to T to give compound U. Compound U can be hydrolysed to compound V.



Four students, W, X, Y and Z, made the following statements.

W All the atoms in a molecule of compound T lie in the same plane.

X Compound V contains only one chiral centre.

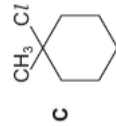
Y Step 1 is an electrophilic addition reaction.

Z Step 2 is a nucleophilic substitution reaction.

Which two students are correct?

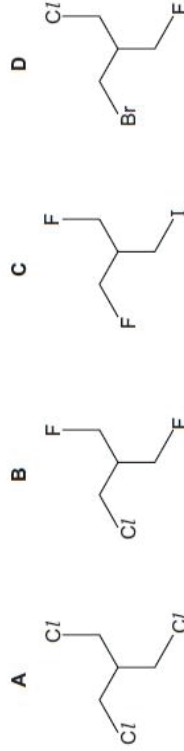
A W and Y B W and Z C X and Y D Y and Z

24 Which compound undergoes an $\text{S}_{\text{N}}1$ substitution reaction with $\text{NaOH}(\text{aq})$?



26 The presence of a halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would be the quickest to produce a precipitate?

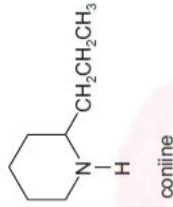


Topic Chem 15 Q# 973/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)
 25 2-bromopropane reacts with a hot concentrated solution of sodium hydroxide in ethanol.

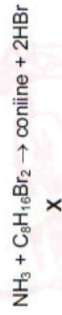
Which substance is the major product of this reaction?

- A propan-1-ol
- B propan-2-ol
- C 2-hydroxypropene
- D propene

Topic Chem 15 Q# 974/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)
 24 Coniine is the major constituent of the poison 'oil of hemlock'.



Coniine can be synthesised by reacting ammonia with a dibromo compound, X.



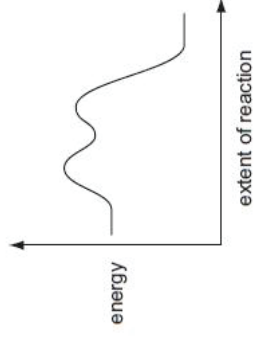
What is the name of compound X?

- A 1,1-dibromo-2-propylcyclopentane
- B 1,2-dibromo-2-propylcyclopentane
- C 1,4-dibromooctane
- D 1,5-dibromooctane

Topic Chem 15 Q# 975/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 A reaction pathway diagram is shown.



Which reactions would have this profile?

- 1 $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \rightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- 2 $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{NaBr}$
- 3 $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + 2\text{NH}_3 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Cl}$

Topic Chem 15 Q# 976/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 X is an organic compound that gives a precipitate with aqueous silver nitrate. This precipitate remains undissolved when concentrated aqueous ammonia is added.

What is a possible identity for X?

- 1 iodomethane
- 2 2-bromobutane
- 3 2-chlorobutane

Topic Chem 15 Q# 977/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)
 25 In the hydrolysis of bromoethane by aqueous sodium hydroxide, what is the nature of the attacking group and of the leaving group?

	attacking group	leaving group
A	electrophile	electrophile
B	electrophile	nucleophile
C	nucleophile	electrophile
D	nucleophile	nucleophile



Topic Chem 15 Q# 978/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 1, 1-dichloropropane reacts with aqueous sodium hydroxide in a series of steps to give propanal.



Which term describes the first step of this reaction?

- A addition
- B elimination
- C oxidation
- D substitution

Topic Chem 15 Q# 979/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 The hydrolysis of 1-chloropropane to produce propan-1-ol is much slower than the corresponding hydrolysis of 1-iodopropane.

Which statement explains this observation?

- A Chlorine is more electronegative than iodine.
- B The bond strength of the C–I bond is less than that of the C–Cl bond.
- C The carbon atom in the C–Cl bond is more δ^+ than that in the C–I bond.
- D The hydrolysis involves a nucleophilic addition reaction.

Topic Chem 15 Q# 980/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 The organic compound X gives a precipitate when warmed with aqueous silver nitrate. This precipitate dissolves when concentrated aqueous ammonia is added.

What is a possible identity for X?

- 1 1-bromopropane
- 2 2-chlorobutane
- 3 2-iodo,2-methylpropane

Topic Chem 15 Q# 981/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 A carbanion is an organic ion in which a carbon atom has a negative charge. A carbocation is an organic ion in which a carbon atom has a positive charge.

The reaction between aqueous sodium hydroxide and 1-bromobutane proceeds by an $\text{S}_{\text{N}}2$ mechanism.

How should the first step in the mechanism be described?

- A attack by a nucleophile on a carbon atom with a partial positive charge
- B heterolytic bond fission followed by an attack by an electrophile on a carbanion
- C heterolytic bond fission followed by an attack by a nucleophile on a carbocation
- D homolytic bond fission followed by an attack by a nucleophile on a carbocation

Topic Chem 15 Q# 982/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Aqueous sodium hydroxide reacts with 1-bromopropane to give propan-1-ol.

How should the first step in the mechanism be described?

- A by a curly arrow from a lone pair on the OH^- ion to the $\text{C}^{\delta+}$ atom of 1-bromopropane
- B by a curly arrow from the $\text{C}^{\delta+}$ atom of 1-bromopropane to the OH^- ion
- C by a curly arrow from the C–Br bond to the C atom
- D by the homolytic fission of the C–Br bond

Topic Chem 15 Q# 983/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Chloroethane can be used to make sodium propanoate.



The intermediate, Q, is hydrolysed with boiling aqueous sodium hydroxide, to give sodium propanoate.

Which reagent would produce the intermediate, Q, from chloroethane?

- A concentrated ammonia solution
- B dilute sulfuric acid
- C hydrogen cyanide
- D potassium cyanide

Topic Chem 15 Q# 984/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



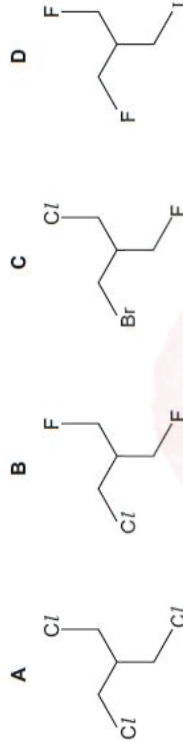
40 How can a good yield of ethylamine be made using bromoethane as starting material?

- 1 by heating bromoethane with an excess of ammonia gas in a sealed tube
- 2 by adding dilute aqueous ammonia to bromoethane at room temperature
- 3 by heating bromoethane under reflux with aqueous ammonium chloride

Topic Chem 15 Q# 985/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org .o)

27 The presence of halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would produce a precipitate quickest?



Topic Chem 15 Q# 986/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 X is an organic compound. X gives a precipitate with aqueous silver nitrate. Some or all of this precipitate remains undissolved when an excess of dilute aqueous ammonia is added.

What could be the identity of X?

- 1 2-chlorobutane
- 2 2-bromobutane
- 3 iodomethane

Topic Chem 15 Q# 987/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)

24 What is involved in the mechanism of the reaction between aqueous sodium hydroxide and 1-bromobutane?

- A attack by a nucleophile on a carbon atom with a partial positive charge
- B heterolytic bond fission and attack by a nucleophile on a carbocation
- C homolytic bond fission and attack by an electrophile on a carbanion
- D homolytic bond fission and attack by a nucleophile on a carbocation

Topic Chem 15 Q# 988/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Bromoethane undergoes all of the conversions shown.

Which conversions are examples of nucleophilic substitution?

- 1 $C_2H_5Br \rightarrow C_2H_5CN$
- 2 $C_2H_5Br \rightarrow C_2H_5OH$
- 3 $C_2H_5Br \rightarrow C_2H_5NH_2$

Topic Chem 15 Q# 989/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org .o)

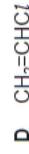
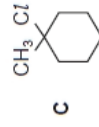
22 The formula CH_3 can represent an anion, a cation or a free radical. Species with the molecular formula CH_3 can act as an electrophile, a free radical or a nucleophile depending on the number of outer shell electrons on the central carbon atom.

How many outer shell electrons must be present for CH_3 to act in these different ways?

	CH_3 as an electrophile	CH_3 as a free radical	CH_3 as a nucleophile
A	6	7	8
B	6	8	7
C	7	6	8
D	8	7	6

Topic Chem 15 Q# 990/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org .o)

28 Which compound undergoes an S_N1 substitution reaction?



Topic Chem 15 Q# 991/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org .o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



39 Which reactions are examples of nucleophilic substitution?

- $\text{CH}_3\text{CH}_2\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{Br}^-$
- $\text{CH}_3 + \text{H}_2\text{O} \xrightarrow{\text{H}^+} \text{CH}_3\text{OH} + \text{H}^+$
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{HCl}$

Topic Chem 15 Q# 992/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 When an isomer Y of molecular formula $\text{C}_4\text{H}_9\text{Br}$ undergoes hydrolysis in aqueous alkali to form an alcohol $\text{C}_4\text{H}_9\text{OH}$, the rate of reaction is found to be unaffected by changes in the concentration of OH^- ions present.

Which is the most likely molecular structure of Y?

- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$
- $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{CH}_3$
- $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$
- $(\text{CH}_3)_3\text{CBr}$

Topic Chem 15 Q# 993/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which statements are true for an $\text{S}_{\text{N}}2$ reaction?

- One bond is broken as another bond is formed.
- The formation of a transition state involves the collision of two molecules or ions.
- A carbon atom in the transition state is bonded, either fully or partially, to five other atoms.

Topic Chem 15 Q# 994/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 In the hydrolysis of bromoethane by aqueous sodium hydroxide, what is the nature of the attacking group and of the leaving group?

	attacking group	leaving group
A	electrophile	electrophile
B	electrophile	nucleophile
C	nucleophile	electrophile
D	nucleophile	nucleophile

Topic Chem 15 Q# 995/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 What always applies to a nucleophile?

- It attacks a double bond.
- It has a lone pair of electrons.
- It is a single atom.
- It is negatively charged.

Topic Chem 16 Q# 996/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 Which pair of alcohols are isomers of each other?

- butan-1-ol and 2,2-dimethylpropan-1-ol
 - butan-2-ol and 2-methylpropan-2-ol
 - pentan-1-ol and 2-methylpropan-2-ol
 - propan-2-ol and 2-methylpropan-2-ol
- Topic Chem 16 Q# 997/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

34 Crotyl alcohol, $\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH}$, is a colourless liquid which is used as a solvent.

Crotyl alcohol will react separately with Br_2 , $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$, conc. KMnO_4/H^+ and PCl_5 under suitable conditions.

Which row is correct?

	reactant	conditions	main product
A	Br_2	room temperature	$\text{CH}_3\text{CH}=\text{CHCH}_2\text{Br}$
B	$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$	heat under reflux	$\text{CH}_3\text{CH}=\text{CHCHO}$
C	conc. KMnO_4/H^+	heat under reflux	$\text{CH}_3\text{CH}=\text{CHCO}_2\text{H}$
D	PCl_5	room temperature	$\text{CH}_3\text{CH}=\text{CHCH}_2\text{Cl}$

Topic Chem 16 Q# 998/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

31 A sample of 2.30 g of ethanol is mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture is boiled under reflux for one hour. The required organic product is then collected by distillation. The yield of product is 60.0%.

Which mass of product is collected?

- 1.32 g
- 1.38 g
- 1.80 g
- 3.00 g

Topic Chem 16 Q# 999/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

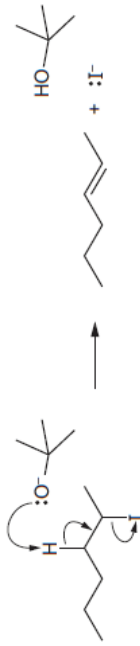
40 Which reactions of propan-1-ol have water as one of the products?

- passing propan-1-ol vapour over hot Al_2O_3
- mixing propan-1-ol with warm ethanoic acid and a few drops of concentrated sulfuric acid
- warming propan-1-ol with HBr



Topic Chem 16 Q# 1000/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Hex-2-ene can be made by the reaction shown.



Which statement about this reaction is correct?

- A $(\text{CH}_3)_3\text{CO}^-$ is behaving as a Brønsted-Lowry base.
 - B $(\text{CH}_3)_3\text{CO}^-$ is behaving as an oxidising agent.
 - C The C-I bond breaks via homolytic fission.
 - D This is a hydrolysis reaction.
- Topic Chem 16 Q# 1001/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 24//www.SmashingScience.org :o)
- 24 Which compound produces a ketone when refluxed with an acidified solution of potassium dichromate(VI)?

- A pentan-1-ol
- B 2-methylbutan-1-ol
- C 2-methylbutan-2-ol
- D 3-methylbutan-2-ol

Topic Chem 16 Q# 1002/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 How many tertiary alcohols have the molecular formula $\text{C}_9\text{H}_{14}\text{O}$?

- A 1
- B 2
- C 3
- D 4

Topic Chem 16 Q# 1003/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Three reactions of primary alcohols are listed.

Which reactions give water as one of the products?

- 1 reaction with ethanoic acid
- 2 reaction with concentrated HBr
- 3 passing the alcohol vapour over heated Al_2O_3

Topic Chem 16 Q# 1004/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 An alcohol with the molecular formula $\text{C}_5\text{H}_{12}\text{O}$ decolourises warm acidified potassium manganate(VII). The alcohol also gives a yellow precipitate with alkaline aqueous iodine.

What could be the identity of the alcohol?

- A 2-methylbutan-2-ol
- B 3-methylbutan-2-ol
- C pentan-1-ol
- D pentan-3-ol

Topic Chem 16 Q# 1005/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 An alcohol has the molecular formula $\text{C}_9\text{H}_{12}\text{O}$. It has several isomers.

Which isomer forms a yellow precipitate with alkaline aqueous iodine?

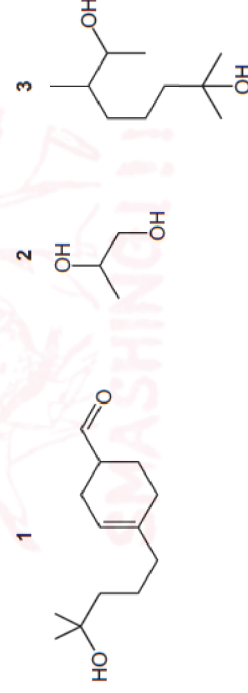
- A 2,2-dimethylpropan-1-ol
- B 2-methylbutan-2-ol
- C 3-methylbutan-2-ol
- D pentan-3-ol

Topic Chem 16 Q# 1006/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

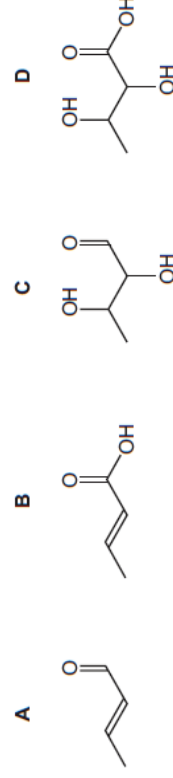
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which compounds will produce a yellow precipitate with alkaline aqueous iodine?



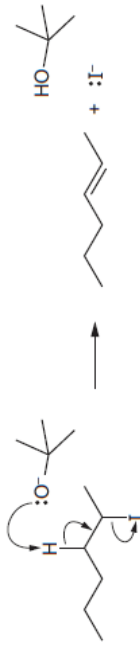
Topic Chem 16 Q# 1007/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 What is the skeletal formula of the compound formed when $\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH}$ is heated, under reflux, with $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$?



Topic Chem 16 Q# 1000/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Hex-2-ene can be made by the reaction shown.



Which statement about this reaction is correct?

- A $(\text{CH}_3)_3\text{CO}^-$ is behaving as a Brønsted-Lowry base.
 - B $(\text{CH}_3)_3\text{CO}^-$ is behaving as an oxidising agent.
 - C The C-I bond breaks via homolytic fission.
 - D This is a hydrolysis reaction.
- Topic Chem 16 Q# 1001/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 24//www.SmashingScience.org :o)
- 24 Which compound produces a ketone when refluxed with an acidified solution of potassium dichromate(VI)?

- A pentan-1-ol
- B 2-methylbutan-1-ol
- C 2-methylbutan-2-ol
- D 3-methylbutan-2-ol

Topic Chem 16 Q# 1002/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 How many tertiary alcohols have the molecular formula $\text{C}_9\text{H}_{14}\text{O}$?

- A 1
- B 2
- C 3
- D 4

Topic Chem 16 Q# 1003/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

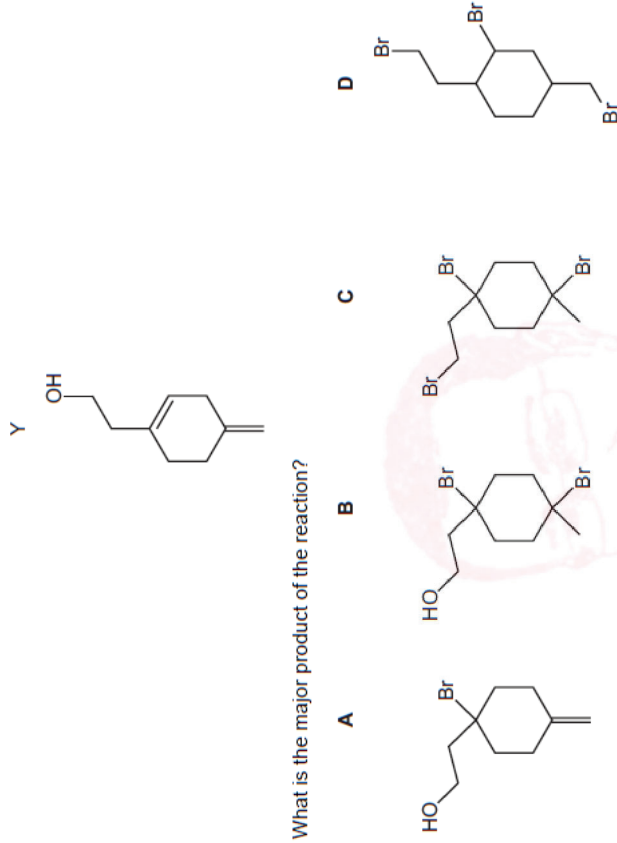
39 Three reactions of primary alcohols are listed.

Which reactions give water as one of the products?

- 1 reaction with ethanoic acid
- 2 reaction with concentrated HBr
- 3 passing the alcohol vapour over heated Al_2O_3



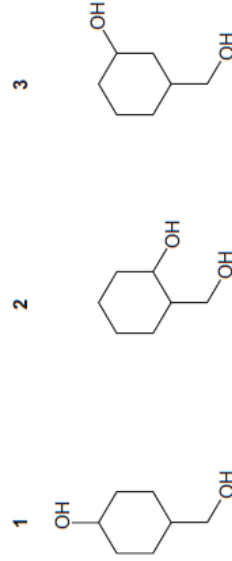
Topic Chem 16 Q# 1008/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 26//www.SmashingScience.org :o)
 26 An excess of dry HBr is warmed with compound Y.



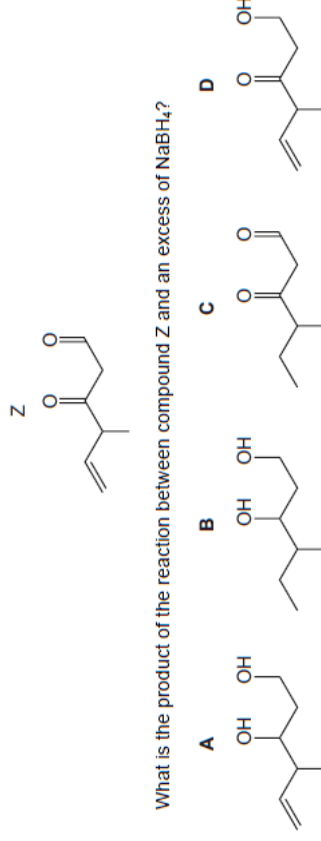
Topic Chem 16 Q# 1009/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which compounds, on heating with an excess of concentrated sulfuric acid, produce only one product with molecular formula C₇H₁₀?



Topic Chem 16 Q# 1010/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)
 26 The diagram shows the structure of compound Z.



Topic Chem 16 Q# 1011/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)
 25 Alcohol X is oxidised to form compound Y.

The composition of Y is 54.54% carbon, 36.36% oxygen and 9.10% hydrogen. The M_r of Y is 88.0.

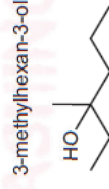
What could be the structure of alcohol X?

- A CH₃CH₂CH(OH)CH₃
 B CH₃CH₂CH₂CH₂CH₂OH
 C CH₃CH₂CH₂CH₂OH
 D CH₃CH₂CH(OH)CH₂CH₃

Topic Chem 16 Q# 1012/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 Structural isomerism and stereoisomerism should be considered when answering this question.

3-methylhexan-3-ol reacts with hot, concentrated sulfuric acid to form several isomeric compounds with the molecular formula C₇H₁₄.



How many isomeric compounds could be formed in this reaction?

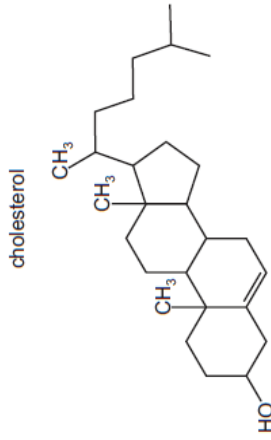
- A 3 B 4 C 5 D 6

Topic Chem 16 Q# 1013/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



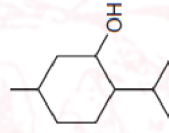
37 The diagram shows the structure of cholesterol.



Which statements about cholesterol are correct?

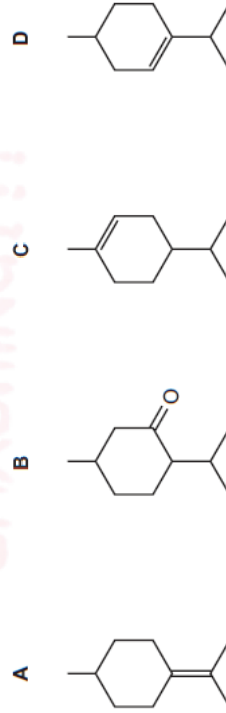
- The molecule contains a secondary alcohol group.
 - The molecule contains two π bonds.
 - All carbon atoms in the four rings lie in the same plane.
- Topic Chem 16 Q# 1014/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 26/ www.SmashingScience.org :o)
- 26 Menthol is a naturally occurring alcohol.

menthol



When menthol is heated with concentrated sulfuric acid it reacts. The products formed include compound T.

What could be the structure of compound T?



Topic Chem 16 Q# 1015/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 25/ www.SmashingScience.org :o)

25 Which product is formed when 3-methylpentane-1,3,4-triol is heated under reflux with an excess of acidified potassium dichromate(VI)?

- A $\text{HO}_2\text{CCH}_2\text{C}(\text{CH}_3)(\text{OH})\text{COCH}_3$
 B $\text{HO}_2\text{CCH}_2\text{COC}(\text{OH})(\text{CH}_3)_2$
 C $\text{OHCCH}_2\text{C}(\text{CH}_3)(\text{OH})\text{COCH}_3$
 D $\text{HO}_2\text{CCH}_2\text{CO}(\text{CH}_3)\text{COCH}_3$

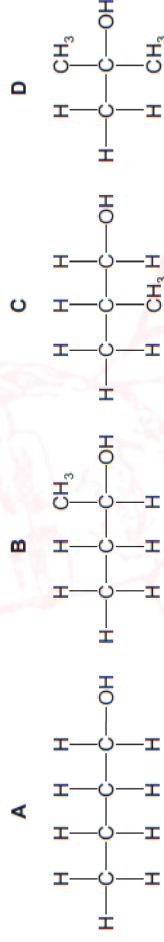
Topic Chem 16 Q# 1016/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 24/ www.SmashingScience.org :o)

24 Which reagent could detect the presence of alcohol in a mixture consisting mainly of alkanes and alkenes?

- A Na
 B Br_2 (in CCl_4)
 C KMnO_4 (aq)
 D 2,4-dinitrophenylhydrazine

Topic Chem 16 Q# 1017/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 23/ www.SmashingScience.org :o)

23 Which alcohol can be dehydrated to give two products which are structural isomers of each other?



Topic Chem 16 Q# 1018/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 25/ www.SmashingScience.org :o)

25 Which volume of hydrogen, measured under room conditions, is produced when 0.160 g of methanol reacts with an excess of sodium?

- A 60 cm^3 B 120 cm^3 C 240 cm^3 D 480 cm^3

Topic Chem 16 Q# 1019/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 24/ www.SmashingScience.org :o)

24 Structural isomerism and stereoisomerism should be considered when answering this question.

The molecular formula of compound X is $\text{C}_5\text{H}_{12}\text{O}$.

Compound X:

- reacts with alkaline aqueous iodine
- can be dehydrated to form two alkenes only.

What could be the identity of compound X?

- A $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
 B $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
 C $(\text{CH}_3)_2\text{CHCH}(\text{OH})\text{CH}_3$
 D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$



Topic Chem 16 Q# 1020/ AS Chemistry/2017/1s/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 A sample of 2.30 g of ethanol was mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The required organic product was then collected by distillation. The yield of product was 60.0%.

Which mass of product was collected?

- A 1.32 g B 1.38 g C 1.80 g D 3.00 g

Topic Chem 16 Q# 1021/ AS Chemistry/2017/1s/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

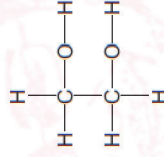
- 27 Q is a compound with the molecular formula $C_4H_{10}O$. Q can be oxidised with acidified potassium dichromate(VI). Q cannot be made by reducing a carboxylic acid with $LiAlH_4$.

What is the structure of Q?

- A $CH_3CH(OH)CH_2CH_3$
B $CH_3CH_2CH_2CH_2OH$
C $(CH_3)_3COH$
D $(CH_3)_2CHCH_2OH$

Topic Chem 16 Q# 1022/ AS Chemistry/2017/1m/TZ.2/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Ethane-1,2-diol has the following structure.



Without breaking the C–C bond, there are five possible oxidation products.

What is the total number of aldehyde groups and carboxylic acid groups in these five products?

	–CHO	–COOH
A	3	3
B	3	4
C	4	3
D	4	4

Topic Chem 16 Q# 1023/ AS Chemistry/2017/1m/TZ.2/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

- 26 Propan-2-ol undergoes many reactions.

Which row is correct?

	reagent added to propan-2-ol	product
A	acidified $KMnO_4$	CH_3CH_2CHO
B	Cl_2	$CH_3CHClCH_3$
C	conc. H_2SO_4	$CH_3CH=CH_2$
D	methanoic acid	$HCO_2CH_2CH_2CH_3$

Topic Chem 16 Q# 1024/ AS Chemistry/2016/1w/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

- 25 X, Y and Z are three isomeric alcohols.

- X $CH_3CH_2CH_2CH_2CH_2OH$
Y $CH_3CH_2CH(OH)CH_2CH_3$
Z $(CH_3)_2C(OH)CH_2CH_3$

Two or more of these alcohols react with mild oxidising agents.

One of these alcohols, when dehydrated, will give a pair of cis-trans isomers with molecular formula C_5H_{10} .

Which row is correct?

	reacts with mild oxidising reagents	gives cis-trans isomers
A	X, Y and Z	Y only
B	X, Y and Z	Z only
C	X and Y only	Y only
D	X and Y only	Z only

Topic Chem 16 Q# 1020/ AS Chemistry/2017/1s/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 A sample of 2.30 g of ethanol was mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The required organic product was then collected by distillation. The yield of product was 60.0%.

Which mass of product was collected?

- A 1.32 g B 1.38 g C 1.80 g D 3.00 g

Topic Chem 16 Q# 1021/ AS Chemistry/2017/1s/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

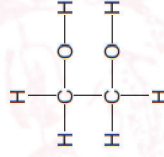
- 27 Q is a compound with the molecular formula $C_4H_{10}O$. Q can be oxidised with acidified potassium dichromate(VI). Q cannot be made by reducing a carboxylic acid with $LiAlH_4$.

What is the structure of Q?

- A $CH_3CH(OH)CH_2CH_3$
B $CH_3CH_2CH_2CH_2OH$
C $(CH_3)_3COH$
D $(CH_3)_2CHCH_2OH$

Topic Chem 16 Q# 1022/ AS Chemistry/2017/1m/TZ.2/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Ethane-1,2-diol has the following structure.



Without breaking the C–C bond, there are five possible oxidation products.

What is the total number of aldehyde groups and carboxylic acid groups in these five products?

	–CHO	–COOH
A	3	3
B	3	4
C	4	3
D	4	4



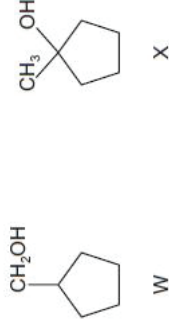
26 Which row correctly shows a primary, a secondary and a tertiary alcohol?

	primary	secondary	tertiary
A	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CHOH} \\ \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CHOH} \\ \\ \text{CH}_2\text{OH} \end{array}$
B	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_3-\text{C}-\text{H} \\ \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}-\text{OH} \\ \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}-\text{H} \\ \\ \text{CH}_2\text{OH} \end{array}$
C	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_3-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_3-\text{C}-\text{CH}_2\text{OH} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_3-\text{C}-\text{CH}_2\text{OH} \\ \\ \text{CH}_2\text{OH} \end{array}$
D	$\begin{array}{c} \text{H} \\ \\ \text{CH}_3-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}-\text{OH} \\ \\ \text{CH}_3 \end{array}$

26 Which compound cannot be oxidised by acidified potassium dichromate(VI) solution but does react with sodium metal?

- A** $(\text{CH}_3)_3\text{COH}$
B $\text{CH}_3\text{COCH}_2\text{CH}_3$
C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
D $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$

27 Which reagent will give a different observation with compounds W and X?



- A** hot SOCl_2
B hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$
C $\text{NaOH}(\text{aq})$
D warm Fehling's reagent

9 Methylpropan-1-ol and butan-1-ol are structural isomers. Methylpropan-1-ol has a lower boiling point.

Which statement explains why the boiling point of methylpropan-1-ol is lower than that of butan-1-ol?

- A** Methylpropan-1-ol cannot form hydrogen bonds.
B Methylpropan-1-ol has weaker covalent bonds than butan-1-ol.
C Methylpropan-1-ol has weaker van der Waals' forces than butan-1-ol.

D Methylpropan-1-ol molecules have more surface area than butan-1-ol molecules.

24 Lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$, causes pain when it builds up in muscles.

Which reagent reacts with both of the $-\text{OH}$ groups in lactic acid?

- A** acidified potassium dichromate(VI)
B ethanol
C sodium
D sodium hydroxide

23 Considering only structural isomers, what is the number of alcohols of each type with the formula $\text{C}_4\text{H}_{10}\text{O}$?

	primary	secondary	tertiary
A	3	3	2
B	4	2	2
C	4	3	1
D	5	2	1



Topic Chem 16 Q# 1031/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 39//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 The compound pentan-1,4-diol has two OH groups per molecule and can be oxidised.

Which statements about pentan-1,4-diol or its oxidation products are correct?

- When one mole of pentan-1,4-diol reacts with an excess of sodium metal, one mole of hydrogen molecules is produced.
- At least one of the possible oxidation products of pentan-1,4-diol will react with 2,4-dinitrophenylhydrazine reagent.
- Dehydration of pentan-1,4-diol could produce a compound with empirical formula C_5H_8 .

Topic Chem 16 Q# 1032/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 28//www.SmashingScience.org :o)

28 Compound X has the molecular formula $C_4H_{10}O_2$. X has an unbranched carbon chain and contains two OH groups.

On reaction with an excess of hot, acidified, aqueous manganate(VII) ions, X is converted into a compound of molecular formula $C_4H_6O_4$.

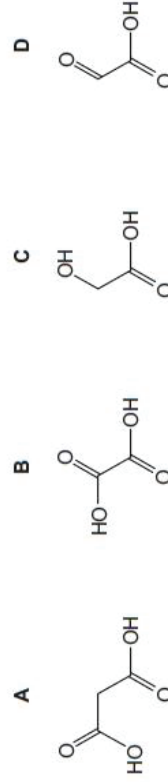
To which two carbon atoms in the chain of X are the two OH groups attached?

- 1st and 2nd
- 1st and 3rd
- 1st and 4th
- 2nd and 3rd

Topic Chem 16 Q# 1033/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 21//www.SmashingScience.org :o)

21 Hydroxyethanal, $HOCH_2CHO$, is heated under reflux with an excess of acidified potassium dichromate(VI) until no further oxidation takes place.

What is the skeletal formula of the organic product?



Topic Chem 16 Q# 1034/ AS Chemistry/2013/w/TZ.1/Paper.1/Exam Q# 27//www.SmashingScience.org :o)

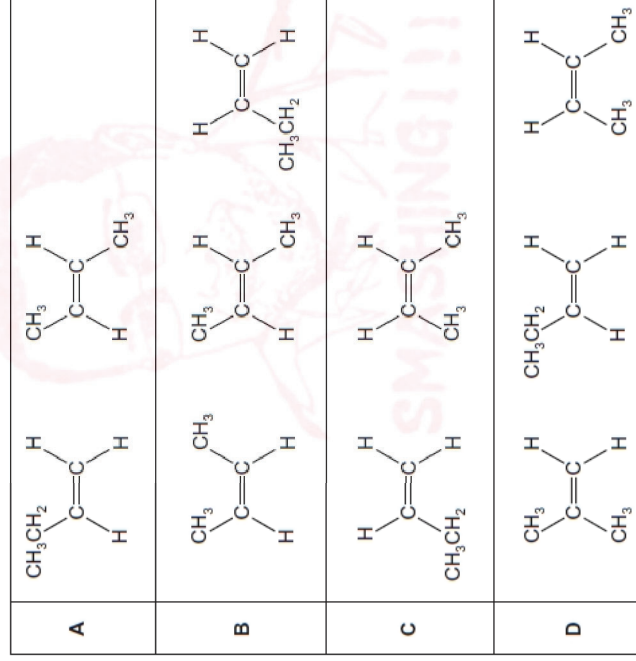
27 Primary alcohols can be oxidised to aldehydes using either acidified potassium dichromate(VI) or acidified potassium manganate(VII). Both these oxidising agents change colour as they are reduced.

What is the colour of each oxidising agent before and after it has reacted?

	acidified potassium dichromate(VI)		acidified potassium manganate(VII)	
	before	after	before	after
A	green	orange	purple	colourless
B	orange	green	colourless	purple
C	orange	green	purple	colourless
D	purple	colourless	orange	green

Topic Chem 16 Q# 1035/ AS Chemistry/2013/w/TZ.1/Paper.1/Exam Q# 25//www.SmashingScience.org :o)

25 What are the only structures formed when butan-2-ol is heated with concentrated H_2SO_4 ?



Topic Chem 16 Q# 1031/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 39//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 The compound pentan-1,4-diol has two OH groups per molecule and can be oxidised.

Which statements about pentan-1,4-diol or its oxidation products are correct?

- When one mole of pentan-1,4-diol reacts with an excess of sodium metal, one mole of hydrogen molecules is produced.
- At least one of the possible oxidation products of pentan-1,4-diol will react with 2,4-dinitrophenylhydrazine reagent.
- Dehydration of pentan-1,4-diol could produce a compound with empirical formula C_5H_8 .

Topic Chem 16 Q# 1032/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 28//www.SmashingScience.org :o)

28 Compound X has the molecular formula $C_4H_{10}O_2$. X has an unbranched carbon chain and contains two OH groups.

On reaction with an excess of hot, acidified, aqueous manganate(VII) ions, X is converted into a compound of molecular formula $C_4H_6O_4$.

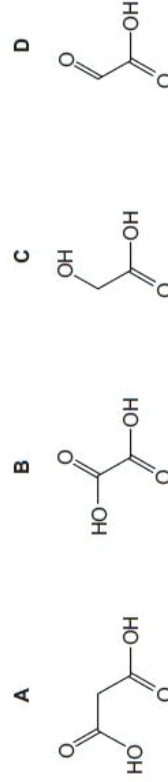
To which two carbon atoms in the chain of X are the two OH groups attached?

- 1st and 2nd
- 1st and 3rd
- 1st and 4th
- 2nd and 3rd

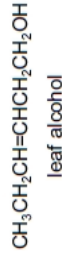
Topic Chem 16 Q# 1033/ AS Chemistry/2014/s/TZ.1/Paper.1/Exam Q# 21//www.SmashingScience.org :o)

21 Hydroxyethanal, $HOCH_2CHO$, is heated under reflux with an excess of acidified potassium dichromate(VI) until no further oxidation takes place.

What is the skeletal formula of the organic product?



- 22 The compound 'leaf alcohol' is partly responsible for the smell of new-mown grass.



What will be formed when 'leaf alcohol' is oxidised using an excess of hot, acidified $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$?

- A $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{H}$
 B $\text{CH}_3\text{CH}_2\text{COCOCCH}_2\text{CO}_2\text{H}$
 C $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CO}_2\text{H}$
 D $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ and $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$

26 Use of the Data Booklet is relevant to this question.

2.30 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The desired organic product was then collected by distillation. The yield of product was 60.0%.

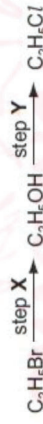
What mass of product was collected?

- A 1.32 g B 1.38 g C 1.80 g D 3.20 g

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 38 Chloroethane can be formed from bromoethane in two steps.



Which statements about these steps are correct?

- 1 Step X involves nucleophilic substitution.
 2 Hot aqueous sodium hydroxide is the reagent in step X.
 3 Hot aqueous sodium chloride is the reagent in step Y.



- 24 But-2-ene-1,4-diol is converted in two steps through an intermediate X into ketobutanedioic acid.



What could be the reagent for step 1 and the intermediate X?

	reagent for step 1	X
A	cold acidified KMnO_4	$\text{HOCH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$
B	hot acidified KMnO_4	$\text{OHCCH}(\text{OH})\text{CH}_2\text{CHO}$
C	steam and concentrated H_2SO_4	$\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{OH}$
D	warm acidified $\text{K}_2\text{Cr}_2\text{O}_7$	$\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

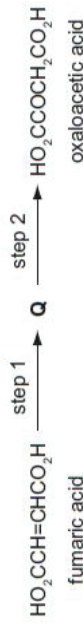
- 38 A number of alcohols with the formula $\text{C}_4\text{H}_{10}\text{O}$ are separately oxidised. Using 70 g of the alcohols a 62% yield of organic product is achieved.

What mass of product could be obtained?

- 1 42.2 g of butanone
 2 51.6 g of butanoic acid
 3 51.6 g of 2-methyl propanoic acid



20 Fumaric acid can be converted into oxaloacetic acid by a two-step process involving the intermediate Q.



Each of these steps can be achieved in the laboratory by a single reagent.

What could be the intermediate Q and the reagent for step 2?

	Q	reagent for step 2
A	$\text{HO}_2\text{CCHBrCH}_2\text{CO}_2\text{H}$	warm acidified KMnO_4
B	$\text{HO}_2\text{CCHBrCH}(\text{OH})\text{CO}_2\text{H}$	warm $\text{NaOH}(\text{aq})$
C	$\text{HO}_2\text{CCH}(\text{OH})\text{CH}_2\text{CO}_2\text{H}$	Fehling's solution
D	$\text{HO}_2\text{CCH}(\text{OH})\text{CH}_2\text{CO}_2\text{H}$	warm acidified $\text{K}_2\text{Cr}_2\text{O}_7$

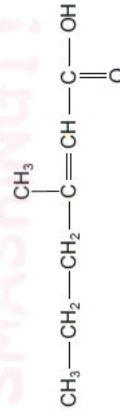
12 Aluminium chloride catalyses certain reactions by forming carbocations with chloroalkanes as shown.



Which property makes this reaction possible?

- A AlCl_3 exists as the dimer Al_2Cl_6 in the vapour.
- B AlCl_3 is a covalent molecule.
- C The aluminium atom in AlCl_3 has an incomplete octet of electrons.
- D The chlorine atom in RCI has a vacant p orbital.

28 An unpleasant smelling chemical produced in the human armpit is 3-methylhex-2-enoic acid.



If this compound is reacted with a cold, dilute, acidified solution of potassium manganate(VII), how many chiral centres will be produced?

- A 0
- B 1
- C 2
- D 3

25 Use of the Data Booklet is relevant to this question.

2.76 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The organic product was then collected by distillation.

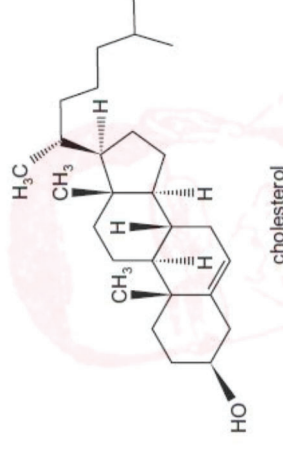
The yield of product was 75.0%.

What mass of product was collected?

- A 1.98 g
- B 2.07 g
- C 2.70 g
- D 4.80 g

20 This question should be answered by considering the reactions of KMnO_4 with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



Separate oxidation reactions are carried out using different conditions.

- cold, dilute acidified KMnO_4
- hot, concentrated acidified KMnO_4

Which statements about the products formed are correct?

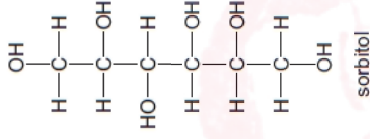
	cold, dilute acidified KMnO_4 : number of hydroxy groups present	hot, concentrated acidified KMnO_4 : number of 6-membered rings remaining
A	1	2
B	1	3
C	3	2
D	3	3



Topic Chem 16 Q# 1046/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Sorbitol is an artificial sweetener used to sweeten chocolate which is suitable for diabetics.



Which functional groups can be produced when this molecule is subjected to oxidation under suitable conditions?

- aldehyde
- carboxylic acid
- ketone

Topic Chem 16 Q# 1047/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

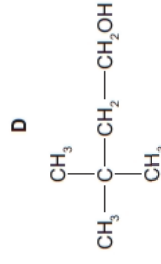
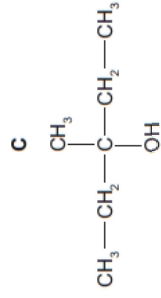
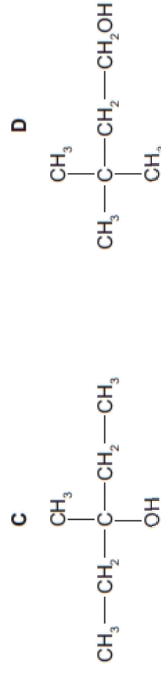
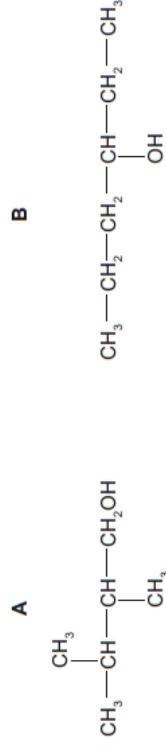
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Which statements are correct in terms of the Brønsted-Lowry theory of acids and bases?

- Water can act as either an acid or a base.
- Sulfuric acid, H_2SO_4 , does not behave as an acid when dissolved in ethanol, $\text{C}_2\text{H}_5\text{OH}$.
- The ammonium ion acts as a base when dissolved in liquid ammonia.

Topic Chem 16 Q# 1048/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Which isomer of $\text{C}_6\text{H}_{13}\text{OH}$ gives the greatest number of different alkenes when it is dehydrated?



Topic Chem 16 Q# 1049/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

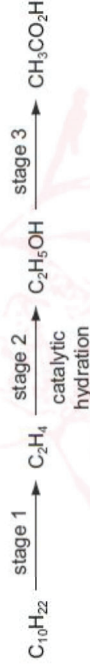
23 Pentanol, $\text{C}_5\text{H}_{11}\text{OH}$, has four structural isomers that are primary alcohols.

How many of these primary alcohols contain a chiral carbon atom?

- A** 0 **B** 1 **C** 2 **D** 3

Topic Chem 16 Q# 1050/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)

19 In the reaction pathway below, an alkane is converted into a carboxylic acid through several stages.



Which processes occur at stage 1 and at stage 3?

	stage 1	stage 3
A	condensation	combustion
B	cracking	dehydration
C	cracking	oxidation
D	dehydration	combustion

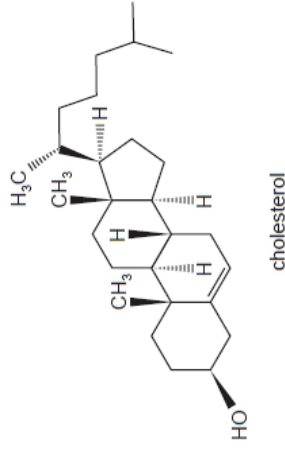
Topic Chem 16 Q# 1051/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



37 The diagram shows the structure of the naturally-occurring molecule cholesterol.



Which statements about cholesterol are correct?

- 1 The molecule contains a secondary alcohol group.
- 2 The molecule contains two π bonds.
- 3 All carbon atoms in the four rings lie in the same plane.

Topic Chem 16 Q# 1052/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Which alcohol gives only one possible oxidation product when warmed with dilute acidified potassium dichromate(VI)?

- A butan-1-ol
- B butan-2-ol
- C 2-methylpropan-1-ol
- D 2-methylpropan-2-ol

Topic Chem 16 Q# 1053/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

- A butan-1-ol
- B butan-2-ol
- C 2-methylpropan-1-ol
- D 2-methylpropan-2-ol

Topic Chem 16 Q# 1054/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 What will react differently with the two isomeric alcohols, $(CH_3)_2CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

- A acidified aqueous potassium manganate(VII)
- B concentrated sulfuric acid
- C phosphorus pentachloride
- D sodium

Topic Chem 16 Q# 1055/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 2-Methylbuta-1,3-diene, $CH_2=C(CH_3)-CH=CH_2$, is used as a monomer in the manufacture of synthetic rubbers.

Which compound would **not** produce this monomer on treatment with concentrated sulfuric acid at $170^\circ C$?

- A $(CH_3)_2C(OH)CH(OH)CH_3$
- B $HOCH_2CH(CH_3)CH_2CH_2OH$
- C $HOCH_2CH(CH_3)CH(OH)CH_3$
- D $HOCH_2C(CH_3)(OH)CH_2CH_3$

Topic Chem 17 Q# 1056/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

33 W reacts with alkaline $I_2(aq)$ to form a yellow precipitate and $CH_3CH_2CO_2^-$ ions.

Which row identifies W and the yellow precipitate?

	identity of W	identity of yellow precipitate
A	butanone	CHI_3
B	butanone	CH_3I
C	propanone	CHI_3
D	propanone	CH_3I

Topic Chem 17 Q# 1057/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)

36 A carbonyl compound, X, reacts with HCN in the presence of NaCN to make a compound with M_r 85. Compound X does **not** react with Fehling's reagent.

What is compound X?

- A butanal
- B butanone
- C propanal
- D propanone

Topic Chem 17 Q# 1058/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

35 The skeletal formulae of two organic compounds are shown.

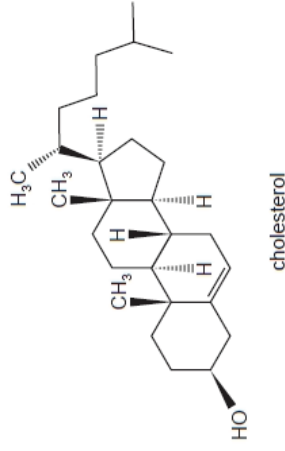


Which reagents can be used to distinguish these two compounds?

- 1 alkaline $I_2(aq)$
- 2 acidified $K_2Cr_2O_7$
- 3 2,4-dinitrophenylhydrazine (2,4-DNPH reagent)

A 1, 2 and 3 B 1 and 3 only C 2 and 3 only D 2 only

37 The diagram shows the structure of the naturally-occurring molecule cholesterol.



Which statements about cholesterol are correct?

- 1 The molecule contains a secondary alcohol group.
- 2 The molecule contains two π bonds.
- 3 All carbon atoms in the four rings lie in the same plane.

Topic Chem 16 Q# 1052/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Which alcohol gives only one possible oxidation product when warmed with dilute acidified potassium dichromate(VI)?

- A butan-1-ol
- B butan-2-ol
- C 2-methylpropan-1-ol
- D 2-methylpropan-2-ol

Topic Chem 16 Q# 1053/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

- A butan-1-ol
- B butan-2-ol
- C 2-methylpropan-1-ol
- D 2-methylpropan-2-ol

Topic Chem 16 Q# 1054/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 What will react differently with the two isomeric alcohols, $(CH_3)_2CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

- A acidified aqueous potassium manganate(VII)
- B concentrated sulfuric acid
- C phosphorus pentachloride
- D sodium



Topic Chem 17 Q# 1059/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 33//www.SmashingScience.org :o)

33 Which compound gives both:

- an orange precipitate with 2,4-DNPH reagent
- and a yellow precipitate with alkaline $I_2(aq)$

- A ethanol
 B methanal
 C propanal
 D propanone

Topic Chem 17 Q# 1060/ AS Chemistry/2021/m/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Reduction of compound R with $LiAlH_4$ gives the compound 4-methylpentane-2,3-diol.

What could be the identity of compound R?



Topic Chem 17 Q# 1061/ AS Chemistry/2021/m/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Alcohol Y gives a yellow precipitate with alkaline aqueous iodine. It can be oxidised to give a mixture of products including substance Z. Substance Z gives a red-brown precipitate with Fehling's solution.

Which alcohol could be Y?

- A $CH_3CH(OH)CH(CH_3)CH_2OH$
 B $CH_3C(OH)(CH_3)CH_2CH_2OH$
 C $CH_3CH(OH)CH_2CH(OH)CH_3$
 D $CH_2(OH)CH_2CH(OH)CH_2CH_3$

Topic Chem 17 Q# 1062/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which reactions have a coloured organic product?

- 1 ethanal + 2,4-dinitrophenylhydrazine reagent
 2 ethanol + acidified potassium dichromate(VI)
 3 ethene + cold dilute acidified potassium manganate(VII)

Topic Chem 17 Q# 1063/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Which pairs of compounds may be distinguished by testing with alkaline aqueous iodine?

- 1 butanal and butanone
 2 pentan-2-one and pentan-3-ol
 3 propanone and propan-2-ol

Topic Chem 17 Q# 1064/ AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Which statement is correct for the reaction of carbonyl compounds with HCN?

- A The reaction is catalysed by concentrated H_2SO_4 .
 B Pentan-2-one and HCN react to give a chiral product.
 C The reaction is a condensation reaction.
 D The reaction is nucleophilic substitution.

Topic Chem 17 Q# 1065/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Two carbonyl compounds have the molecular formula C_3H_6O .

Which reagents give different observations with these two compounds?

- 1 acidified aqueous potassium manganate(VII)
 2 Fehling's reagent
 3 alkaline aqueous iodine
 Topic Chem 17 Q# 1066/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

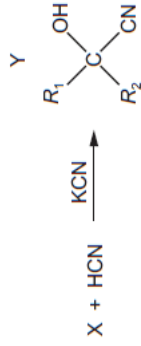
28 Ethanedioic acid has the formula HO_2CCO_2H .

What is the formula of aluminium ethanedioate?

- A AlC_2O_4 B $Al(C_2O_4)_3$ C $Al_2C_2O_4$ D $Al_2(C_2O_4)_3$



26 The diagram shows the formation of compound Y from compound X in a chemical reaction. R₁ and R₂ are alkyl groups.



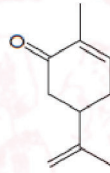
Which row about this reaction is correct?

	mechanism	compound X
A	electrophilic addition	aldehyde
B	electrophilic addition	ketone
C	nucleophilic addition	ketone
D	nucleophilic addition	aldehyde

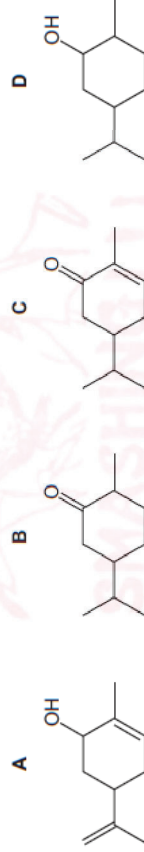
Topic Chem 17 Q# 1068/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Carvone is found in spearmint oil.

carvone



Which product is formed when carvone is reacted with NaBH₄?



Topic Chem 17 Q# 1069/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

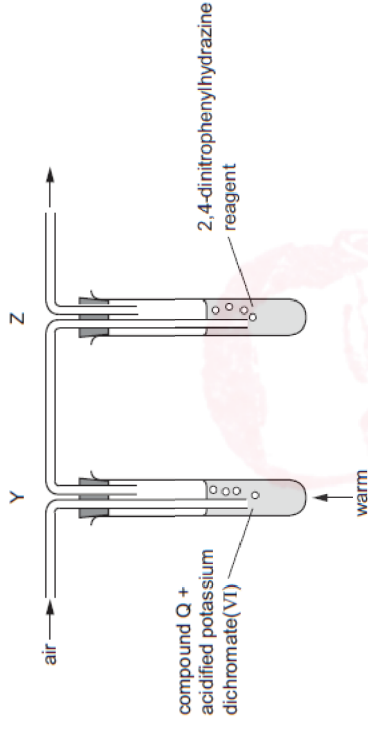
27 Which pair of test results would prove that a substance, X, is a ketone?

- A X has no reaction with Tollens' reagent. X reacts with alkaline aqueous iodine.
- B X is reduced by lithium aluminium hydride. X is oxidised by acidified dichromate(VI).
- C X reacts with 2,4-DNPH reagent. X has no reaction with Fehling's reagent.
- D X reacts with hydrogen cyanide. X is reduced by lithium aluminium hydride.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 When the apparatus is set up as shown, an orange precipitate forms in test-tube Z.



What could compound Q be?

- 1 CH₃CH₂CH₂OH
- 2 CH₃CH(OH)CH₃
- 3 (CH₃)₂COH

Topic Chem 17 Q# 1071/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 In which of the reactions is the organic compound oxidised by the given reagent?

- 1 CH₃CHO + HCN reagent
- 2 CH₃CH₂CH₂CHO + Tollens' reagent
- 3 CH₃CH₂CHO + Fehling's reagent

26 The diagram shows the formation of compound Y from compound X in a chemical reaction. R₁ and R₂ are alkyl groups.



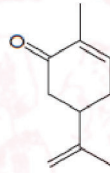
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B	electrophilic addition	ketone
C	nucleophilic addition	ketone
D	nucleophilic addition	aldehyde

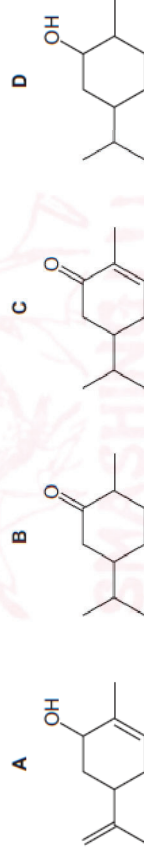
Topic Chem 17 Q# 1068/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

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carvone



Which product is formed when carvone is reacted with NaBH₄?



Topic Chem 17 Q# 1069/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

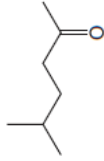
27 Which pair of test results would prove that a substance, X, is a ketone?

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- B X is reduced by lithium aluminium hydride. X is oxidised by acidified dichromate(VI).
- C X reacts with 2,4-DNPH reagent. X has no reaction with Fehling's reagent.
- D X reacts with hydrogen cyanide. X is reduced by lithium aluminium hydride.



Topic Chem 17 Q# 1072/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 The skeletal formula of compound X is shown.



Which row is correct?

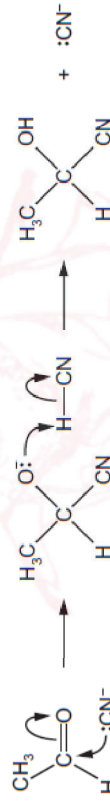
	molecular formula of X	observation on addition of X to Fehling's reagent
A	C ₇ H ₁₄ O	no change
B	C ₇ H ₁₄ O	red precipitate forms
C	C ₇ H ₁₆ O	no change
D	C ₇ H ₁₆ O	red precipitate forms

Topic Chem 17 Q# 1073/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Ethanal and hydrogen cyanide react together. The reaction mechanism involves cyanide ions.



Which statements about this mechanism are correct?

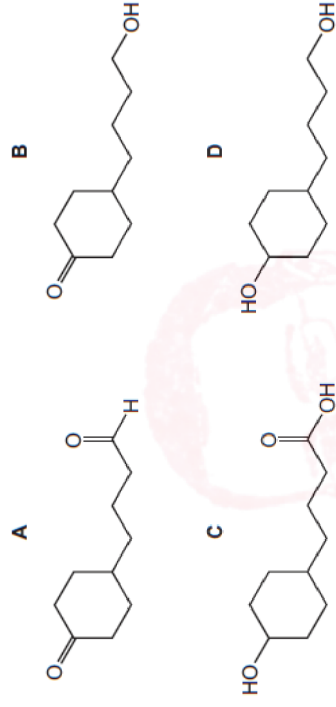
- 1 CN⁻ acts as a catalyst.
- 2 CN⁻ is a nucleophile.
- 3 It is an addition reaction.

Topic Chem 17 Q# 1074/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Compound X is treated with an excess of lithium aluminium hydride. The reaction is allowed to go to completion.



What is the structure of the organic product?



Topic Chem 17 Q# 1075/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Hydrogen cyanide reacts with propanone in the presence of potassium cyanide.

Which statements about this reaction are correct?

- 1 The cyanide ion is a catalyst for the reaction.
- 2 This is an addition reaction.
- 3 The intermediate behaves as a base.

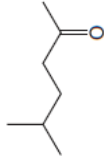
Topic Chem 17 Q# 1076/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

Topic Chem 17 Q# 1072/ AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 The skeletal formula of compound X is shown.



Which row is correct?

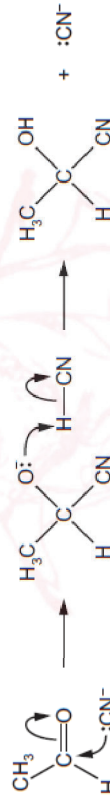
	molecular formula of X	observation on addition of X to Fehling's reagent
A	C ₇ H ₁₄ O	no change
B	C ₇ H ₁₄ O	red precipitate forms
C	C ₇ H ₁₆ O	no change
D	C ₇ H ₁₆ O	red precipitate forms

Topic Chem 17 Q# 1073/ AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Ethanal and hydrogen cyanide react together. The reaction mechanism involves cyanide ions.



Which statements about this mechanism are correct?

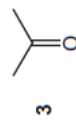
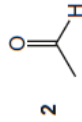
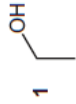
- 1 CN⁻ acts as a catalyst.
- 2 CN⁻ is a nucleophile.
- 3 It is an addition reaction.



38 Compound Y

- reacts with alkaline aqueous iodine to form a yellow precipitate
- changes the colour of warm, acidified potassium dichromate(VI) solution.

What could be compound Y?



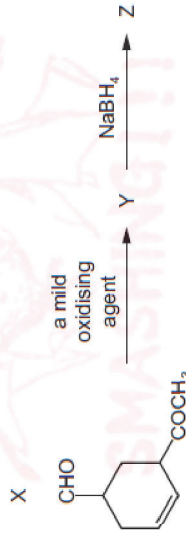
Topic Chem 17 Q# 1077/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Which reagent may be used to distinguish between propanone and ethanol?

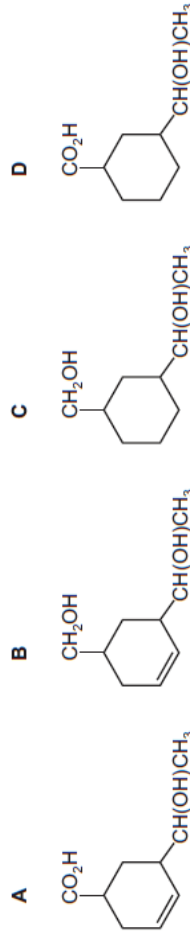
- A 2,4-dinitrophenylhydrazine
 B bromine water
 C Fehling's reagent
 D Tollens' reagent

Topic Chem 17 Q# 1078/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Compound X is treated with two reagents successively, forming compound Z.



What could be Z?



Topic Chem 17 Q# 1079/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 An organic compound T undergoes the following reactions.

- T is oxidised by hot, acidified potassium manganate(VII).
- T reacts with sodium to give hydrogen.

What could be compound T?

- A $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
 B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
 C $(\text{CH}_3)_3\text{COH}$
 D $\text{CH}_3\text{CH}_2\text{COCH}_3$

Topic Chem 17 Q# 1080/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 The compounds listed are reacted with hydrogen cyanide.

Which compounds produce a molecule containing a chiral centre?

- 1 butanal
 2 butanone
 3 pentan-2-one

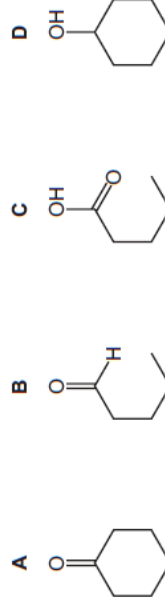
Topic Chem 17 Q# 1081/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 When compound X is heated with $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$, a colour change from orange to green is observed.

Two tests are carried out on the organic product of this reaction.

test	result
Tollens' reagent	no change
2,4-dinitrophenylhydrazine	orange precipitate

What could be compound X?



27 Structural isomerism only should be considered when answering this question.

All the isomeric alcohols with the molecular formula $C_4H_{10}O$ are added separately to warm alkaline aqueous iodine.

How many of the isomers give a yellow precipitate?

- A 0 B 1 C 2 D 3

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Ethanal reacts with HCN in the presence of KCN.

Which changes in bonding occur during this reaction?

- A carbon-carbon bond is formed.
- A carbon-hydrogen bond is broken.
- A carbon-nitrogen bond is broken.

27 Which compound shows optical isomerism and gives a positive test with alkaline aqueous iodine?

- $CH_3COCH(OH)CH_3$
- $CH_3COCH_2CH_2OH$
- $HOCH_2CH(CH_3)CHO$
- $(CH_3)_2C(OH)CHO$

The responses A to D should be selected on the basis of

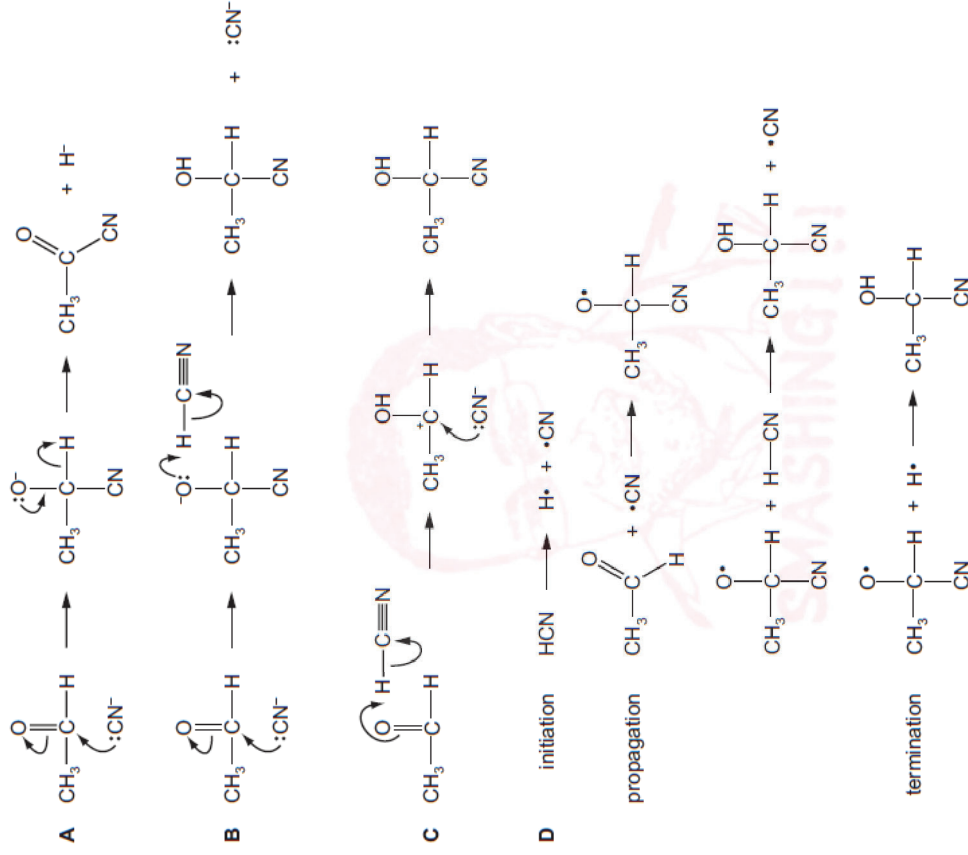
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 The M_r of compound X is 72. The composition by mass of X is 66.7% carbon, 11.1% hydrogen and 22.2% oxygen. X gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent. X does not react with Fehling's reagent.

What can be deduced from this information?

- X is a carbonyl compound.
- X is a ketone.
- X is butanone.

26 What is the mechanism for the reaction of ethanal, CH_3CHO , with hydrogen cyanide, HCN, in the presence of NaCN?



25 Compound Q

- contains a chiral centre,
- gives a positive result with Fehling's reagent,
- gives a positive result with alkaline aqueous iodine.

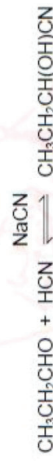
What could compound Q be?

- A 1-hydroxybutanone
 B 2-hydroxybutanal
 C 3-hydroxybutanal
 D 3-hydroxybutanone

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Propanal reacts with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.



Which statements about the reaction of propanal with hydrogen cyanide are correct?

- 1 HCN is a weaker nucleophile than the nucleophile provided by NaCN.
- 2 The reaction mechanism involves two steps.
- 3 The product of the reaction has a chiral carbon atom.

26 Compound X produces a carboxylic acid when heated under reflux with acidified potassium dichromate(VI). Compound X does not react with sodium metal.

What could be the identity of compound X?

- A propanal
 B propanone
 C propan-1-ol
 D propan-2-ol

23 Which compound reacts with 2,4-dinitrophenylhydrazine reagent but does not react with Tollens' reagent?

- A $\text{CH}_3\text{COCOC}_2\text{H}_5$
 B $\text{CH}_3\text{CH}(\text{OH})\text{CHO}$
 C CH_3COCHO
 D $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 The reaction of ethanal, CH_3CHO , with HCN to form 2-hydroxypropanenitrile is catalysed by NaCN.

What are features of the intermediate of this reaction?

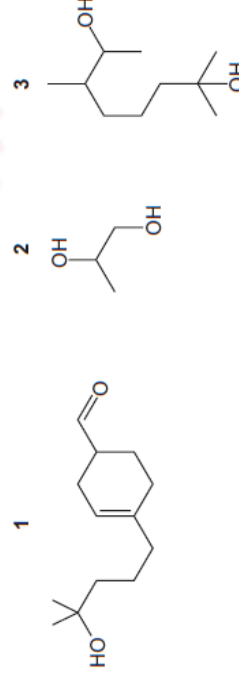
- 1 It is chiral.
- 2 It has a single negative charge on one of its atoms.
- 3 It is a nucleophile.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 The compounds below are used to make perfumes.

Which compounds will produce a yellow precipitate with alkaline aqueous iodine?



25 Compound Q

- contains a chiral centre,
- gives a positive result with Fehling's reagent,
- gives a positive result with alkaline aqueous iodine.

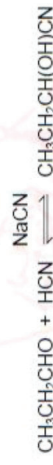
What could compound Q be?

- A 1-hydroxybutanone
 B 2-hydroxybutanal
 C 3-hydroxybutanal
 D 3-hydroxybutanone

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Propanal reacts with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.



Which statements about the reaction of propanal with hydrogen cyanide are correct?

- 1 HCN is a weaker nucleophile than the nucleophile provided by NaCN.
- 2 The reaction mechanism involves two steps.
- 3 The product of the reaction has a chiral carbon atom.

26 Compound X produces a carboxylic acid when heated under reflux with acidified potassium dichromate(VI). Compound X does not react with sodium metal.

What could be the identity of compound X?

- A propanal
 B propanone
 C propan-1-ol
 D propan-2-ol



27 3-methylbutanone is treated with alkaline aqueous iodine. The mixture of products is then acidified.

Which compound is present in the final mixture of products?

- A 3-methylbutanoic acid
- B butanoic acid
- C methylpropanoic acid
- D propanoic acid

26 Glucose can be used to prepare sorbitol, a compound used as a sugar substitute.



Which reagent may be used for this conversion?

- A acidified potassium dichromate(VI)
- B sodium borohydride
- C sodium hydroxide
- D Tollens' reagent

29 Which compound gives a positive test with alkaline aqueous iodine and does **not** show optical isomerism?

- A $\text{CH}_3\text{COCH}_2\text{CH}_2\text{OH}$
- B $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CHO}$
- C $\text{CH}_3\text{COCH}(\text{OH})\text{CH}_3$
- D $(\text{CH}_3)_2\text{C}(\text{OH})\text{CHO}$

25 Diols in which both hydroxy groups are bonded to the same carbon atom spontaneously eliminate a molecule of water to produce a carbonyl compound.

Which compound is hydrolysed to form a product that gives a positive reaction with 2,4-dinitrophenylhydrazine but **not** with Fehling's reagent?

- A 1,1-dibromopropane
- B 1,2-dibromopropane
- C 1,3-dibromopropane
- D 2,2-dibromopropane

20 Structural isomerism and stereoisomerism should be considered when answering this question.

Each of the following carbonyl compounds is reacted with NaBH_4 . The product of each reaction is heated with Al_2O_3 at 600°C , generating one product or a mixture of isomers.

Which carbonyl compound will produce the most isomers?

- A butanal
- B butanone
- C pentan-3-one
- D propanone

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which compounds react with alkaline aqueous iodine to give a pale yellow precipitate of tri-iodomethane?

- 1 butanone
- 2 ethanal
- 3 propan-2-ol

29 Compound X, $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{CHO})\text{CH}_3$, is heated under reflux with an excess of acidified $\text{K}_2\text{Cr}_2\text{O}_7$ to form compound Y.

Both X and Y are separately warmed with Fehling's solution and the observations noted.

What are the observations?

- A Both X and Y give a red precipitate.
- B Only X gives a red precipitate.
- C Only Y gives a red precipitate.
- D Neither X nor Y gives a red precipitate.



Topic Chem 17 Q# 1100/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

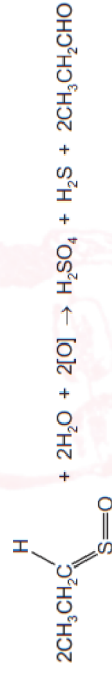
- A The cyanohydrin product has one chiral centre.
- B The cyanohydrin product is formed by electrophilic addition.
- C The cyanohydrin product is formed via an intermediate which contains a C–OH group.
- D The formation of the cyanohydrin product requires the use of cyanide ions as a catalyst.

Topic Chem 17 Q# 1101/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

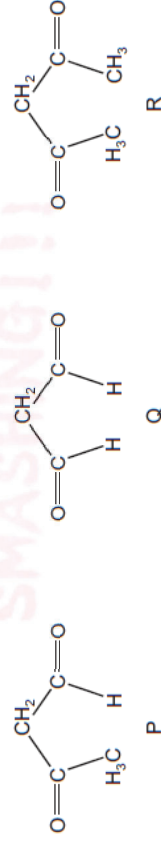
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 When onions are peeled in air, the reaction shown is thought to occur.



Which tests would give a positive reaction with the organic product?

- 1 warming with Tollens' reagent
 - 2 warming with acidified potassium manganate(VII)
 - 3 warming with alkaline aqueous iodine
- Topic Chem 17 Q# 1102/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)
- 27 P, Q and R are carbonyl compounds.



Fehling's solution can be used to help identify these compounds.

Which compounds form a red-brown precipitate on warming with Fehling's solution?

- A P, Q and R
- B P and Q only
- C P only
- D Q only

Topic Chem 17 Q# 1103/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Which reagent cannot be used to distinguish between ethanal and propanone?

- A acidified sodium dichromate(VI) solution
- B alkaline aqueous iodine
- C cold acidified potassium manganate(VII) solution
- D Fehling's reagent

Topic Chem 17 Q# 1104/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Alcohol Y gives product Z after mild oxidation. Z gives a positive result with Tollens' reagent and with 2,4-dinitrophenylhydrazine reagent.

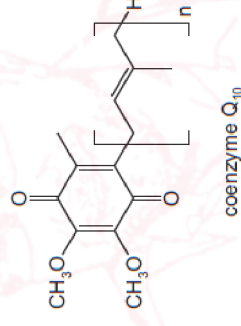
What could be the identity of alcohol Y?

- A butan-1-ol
- B butan-2-ol
- C butan-2,3-diol
- D 2-methylbutan-2-ol

Topic Chem 17 Q# 1105/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 People who take statin drugs to control their blood cholesterol may also take 'coenzyme Q₁₀'.

The diagram shows a simplified structure of one form of this coenzyme.



Which row describes this structure correctly?

	the coenzyme is	number of π bonds in one molecule
A	an aldehyde	$n + 2$
B	an aldehyde	$n + 4$
C	a ketone	$n + 2$
D	a ketone	$n + 4$

Topic Chem 17 Q# 1100/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

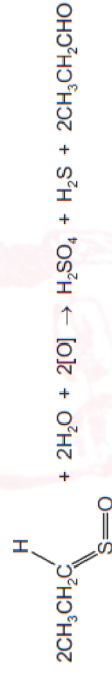
- A The cyanohydrin product has one chiral centre.
- B The cyanohydrin product is formed by electrophilic addition.
- C The cyanohydrin product is formed via an intermediate which contains a C–OH group.
- D The formation of the cyanohydrin product requires the use of cyanide ions as a catalyst.

Topic Chem 17 Q# 1101/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

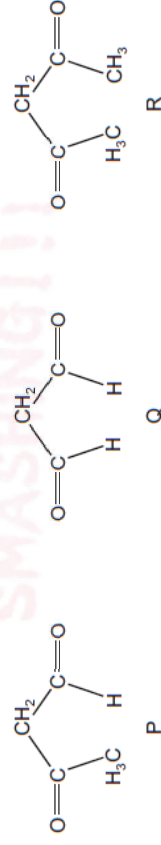
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 When onions are peeled in air, the reaction shown is thought to occur.



Which tests would give a positive reaction with the organic product?

- 1 warming with Tollens' reagent
 - 2 warming with acidified potassium manganate(VII)
 - 3 warming with alkaline aqueous iodine
- Topic Chem 17 Q# 1102/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)
- 27 P, Q and R are carbonyl compounds.



Fehling's solution can be used to help identify these compounds.

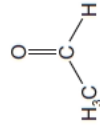
Which compounds form a red-brown precipitate on warming with Fehling's solution?

- A P, Q and R
- B P and Q only
- C P only
- D Q only

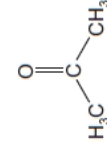


Topic Chem 17 Q# 1106/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

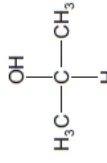
28 Tollens' reagent can be used to help identify compounds P, Q and R.



P



Q



R

Which compound(s) form a silver precipitate on warming with Tollens' reagent?

A P and Q B P only C Q only D R only

Topic Chem 17 Q# 1107/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Which reagent will give a different observation with compounds P and Q?



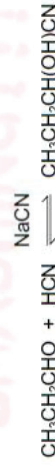
- A $\text{Br}_2(\text{aq})$
B hot acidified KMnO_4
C silver nitrate in ammonia solution
D warm acidified $\text{K}_2\text{Cr}_2\text{O}_7$

Topic Chem 17 Q# 1108/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Propanal will react with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.



Which statements about the reaction of propanal with hydrogen cyanide are correct?

- 1 The CN^- ion attacks the propanal molecule to form an intermediate ion.
2 The product of the reaction has a chiral carbon atom.
3 The CN^- ion is a stronger electrophile than the HCN molecule.

Topic Chem 17 Q# 1109/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which feature applies to the cyanohydrin product?

- A It has one chiral centre.
B It is formed by electrophilic addition.
C It is formed via an intermediate which contains the C–OH group.
D Its formation requires the use of cyanide ions as a catalyst.

Topic Chem 17 Q# 1110/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 In which reactions is the organic compound oxidised by the given reagent?

- 1 $\text{CH}_3\text{CH}_2\text{CHO} + \text{Fehling's reagent}$
2 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{Tollens' reagent}$
3 $\text{CH}_3\text{CHO} + 2,4\text{-dinitrophenylhydrazine reagent}$

Topic Chem 17 Q# 1111/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 In 1903 Arthur Lapworth became the first chemist to investigate a reaction mechanism. The reaction he investigated was that of hydrogen cyanide with propanone.

What do we now call the mechanism of this reaction?

- A electrophilic addition
B electrophilic substitution
C nucleophilic addition
D nucleophilic substitution

Topic Chem 17 Q# 1112/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 $\text{CH}_3\text{COCH}_2\text{CH}_2\text{OH}$ W $\text{CH}_3\text{COCH}_2\text{CHO}$ X $\text{CH}_3\text{CH(OH)CH}_2\text{CH}_3$ Y $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ Z

Which of these compounds can be oxidised by acidified dichromate(VI) solution and also gives a positive response to Tollens' reagent?

- A W and X only
B W and Y only
C X and Z only
D Y and Z only



Topic Chem 17 Q# 1113/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

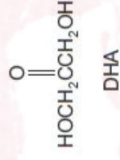
25 Which compound, on reaction with hydrogen cyanide, produces a compound with a chiral centre?

- A CH_3CHO
- B $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
- C $\text{CH}_3\text{CO}_2\text{CH}_3$
- D HCHO

Topic Chem 17 Q# 1114/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 DHA is a colourless liquid which reacts with protein in skin to cause it to darken. It has the structure shown.



Which observations would be made when testing this substance?

- 1 Hydrogen is produced when sodium is added.
- 2 A coloured precipitate is produced when 2,4-dinitrophenylhydrazine reagent is added.
- 3 A silver precipitate is produced when Tollens' reagent is added.

Topic Chem 17 Q# 1115/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Disaccharides, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, are important in the human diet. For example, sucrose is found in pastries and lactose occurs in milk products.

Both of these compounds can be hydrolysed.



Which statements about these hydrolysis products are correct?

- 1 Glucose and fructose have structural isomers.
- 2 Glucose and galactose are optical isomers.
- 3 Glucose and galactose are ketones.

Topic Chem 17 Q# 1116/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

33 The three statements that follow are all true.

Which of these can be explained, at least in part, by reference to hydrogen bonding?

- 1 At 0°C ice floats on water.
- 2 The boiling point of propan-2-ol is 82°C . The boiling point of propanone is 56°C .
- 3 At 20°C propanone and propanal mix completely.

Topic Chem 17 Q# 1117/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)
29 Aldehydes and ketones are carbonyl compounds.

Which of them react with NaBH_4 and react with Fehling's reagent?

- A both aldehydes and ketones
- B aldehydes only
- C ketones only
- D neither aldehydes nor ketones



Topic Chem 17 Q# 1118/ AS Chemistry/201.1/s/TZ.1/Paper.1/Exam Q# 28//www.SmashingScience.org :o)

28 A compound Y is treated with warm acidified potassium dichromate(VI). The resulting organic product gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent but does not give a silver mirror with Tollens' reagent.

What is Y?

- A butan-1-ol
- B butan-2-ol
- C butanal
- D 2-methylpropan-2-ol

Topic Chem 17 Q# 1119/ AS Chemistry/201.1/s/TZ.1/Paper.1/Exam Q# 26//www.SmashingScience.org :o)

26 Compound X changes the colour of warm acidified sodium dichromate(VI) from orange to green. 1 mol of X reacts with 2 mol of HCN in the presence of KCN.

What could X be?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
- B $\text{CH}_3\text{COCH}_2\text{COCH}_3$
- C $\text{H}_2\text{C}=\text{CHCH}_2\text{CHO}$
- D $\text{OHCCH}_2\text{CH}_2\text{CHO}$

Topic Chem 17 Q# 1120/ AS Chemistry/201.0/s/TZ.1/Paper.1/Exam Q# 24//www.SmashingScience.org :o)

24 What is formed when propanone is refluxed with a solution of NaBH_4 ?

- A propanal
- B propan-1-ol
- C propan-2-ol
- D propane

Topic Chem 17 Q# 1121/ AS Chemistry/201.0/s/TZ.1/Paper.1/Exam Q# 23//www.SmashingScience.org :o)

23 Which reagent will give similar results with both butanone and butanal?

- A acidified aqueous potassium dichromate(VI)
- B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)
- C an aqueous solution containing $[\text{Ag}(\text{NH}_3)_2]^+$ (Tollens' reagent)
- D 2,4-dinitrophenylhydrazine reagent

Topic Chem 17 Q# 1122/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 40//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 A compound has a relative molecular mass of 88 and its molecule contains only four carbon atoms.

What could this compound be?

- 1 a saturated non-cyclic diol
- 2 a secondary alcohol containing an aldehyde group
- 3 a primary alcohol containing a ketone group

Topic Chem 17 Q# 1123/ AS Chemistry/2009/s/TZ.1/Paper.1/Exam Q# 26//www.SmashingScience.org :o)

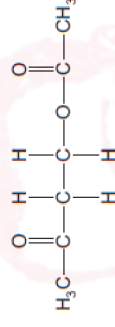
26 Glycol, used in anti-freeze, has the formula $\text{HOCH}_2\text{CH}_2\text{OH}$. It can be oxidised to give a number of products.

What is the molecular formula of an oxidation product of glycol that will **not** react with sodium?

- A $\text{C}_2\text{H}_2\text{O}_2$
- B $\text{C}_2\text{H}_2\text{O}_3$
- C $\text{C}_2\text{H}_2\text{O}_4$
- D $\text{C}_2\text{H}_4\text{O}_2$

Topic Chem 18 Q# 1124/ AS Chemistry/2022/w/TZ.1/Paper.1/Exam Q# 36//www.SmashingScience.org :o)

36 Compound X reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound shown.



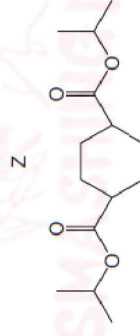
What is the molecular formula of compound X?

- A $\text{C}_2\text{H}_4\text{O}$
- B $\text{C}_2\text{H}_6\text{O}_2$
- C $\text{C}_4\text{H}_8\text{O}$
- D $\text{C}_4\text{H}_{10}\text{O}_2$

Topic Chem 18 Q# 1125/ AS Chemistry/2022/w/TZ.1/Paper.1/Exam Q# 32//www.SmashingScience.org :o)

32 An alcohol, X, reacts with a dicarboxylic acid, Y, to form a double ester, Z.

The diagram shows the structure of the ester.



Which row about the reactants forming ester Z is correct?

	the class of alcohol X	the shape of the ring in Y
A	secondary	non-planar
B	secondary	planar
C	tertiary	non-planar
D	tertiary	planar

Topic Chem 17 Q# 1118/ AS Chemistry/201.1/s/TZ.1/Paper.1/Exam Q# 28//www.SmashingScience.org :o)

28 A compound Y is treated with warm acidified potassium dichromate(VI). The resulting organic product gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent but does not give a silver mirror with Tollens' reagent.

What is Y?

- A butan-1-ol
- B butan-2-ol
- C butanal
- D 2-methylpropan-2-ol

Topic Chem 17 Q# 1119/ AS Chemistry/201.1/s/TZ.1/Paper.1/Exam Q# 26//www.SmashingScience.org :o)

26 Compound X changes the colour of warm acidified sodium dichromate(VI) from orange to green. 1 mol of X reacts with 2 mol of HCN in the presence of KCN.

What could X be?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
- B $\text{CH}_3\text{COCH}_2\text{COCH}_3$
- C $\text{H}_2\text{C}=\text{CHCH}_2\text{CHO}$
- D $\text{OHCCH}_2\text{CH}_2\text{CHO}$

Topic Chem 17 Q# 1120/ AS Chemistry/201.0/s/TZ.1/Paper.1/Exam Q# 24//www.SmashingScience.org :o)

24 What is formed when propanone is refluxed with a solution of NaBH_4 ?

- A propanal
- B propan-1-ol
- C propan-2-ol
- D propane

Topic Chem 17 Q# 1121/ AS Chemistry/201.0/s/TZ.1/Paper.1/Exam Q# 23//www.SmashingScience.org :o)

23 Which reagent will give similar results with both butanone and butanal?

- A acidified aqueous potassium dichromate(VI)
- B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)
- C an aqueous solution containing $[\text{Ag}(\text{NH}_3)_2]^+$ (Tollens' reagent)
- D 2,4-dinitrophenylhydrazine reagent

Topic Chem 17 Q# 1122/ AS Chemistry/2009/w/TZ.1/Paper.1/Exam Q# 40//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



Topic Chem 18 Q# 1126/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

- 38 Two 1 g samples of Y are reacted separately and completely with sodium and with sodium carbonate. The volumes of the gases produced are collected and measured.

	relative volumes of gases	
	with Na	with Na ₂ CO ₃
Y	2	1

What could Y be?

- A CH₃CH(OH)CH₂OH
B CH₃CH(OH)CO₂H
C CH₃COCH₂OH
D CH₃COCO₂H
- Topic Chem 18 Q# 1127/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
- 37 Which compound produces butan-2-ol and ethanoic acid on hydrolysis?

- A CH₃CO₂CH(CH₃)₂
B CH₃CO₂CH(CH₃)CH₂CH₃
C CH₃CH(CH₃)CO₂CH₂CH₃
D CH₃CH₂CO₂CH(CH₃)CH₂CH₃

Topic Chem 18 Q# 1128/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 How many esters have the molecular formula C₄H₈O₂?

- A 2 B 3 C 4 D 5

Topic Chem 18 Q# 1129/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Which compound will react with LiAlH₄ to form two optical isomers?

- A CH₃CH₂COCH₃
B CH₃CH₂CH₂CHO
C CH₃CH₂COCH₂CH₃
D CH₃CH(CH₃)CH₂CO₂H
- Topic Chem 18 Q# 1130/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

- 35 Compound X contains a single ester group.

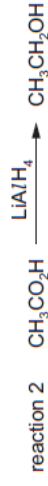
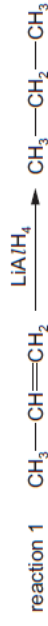
X contains 27.6% by mass of oxygen.

Which pair of products could be produced by the hydrolysis of X?

- A butan-1-ol and ethanoic acid
B ethanol and propanoic acid
C methanol and methanoic acid
D propan-2-ol and butanoic acid

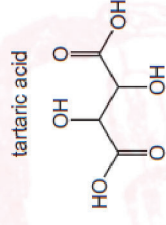
Topic Chem 18 Q# 1131/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

- 34 A student suggests two uses of LiAlH₄.



Which reactions would give the product shown?

- A both reactions
B reaction 1 only
C reaction 2 only
D neither reaction
- Topic Chem 18 Q# 1132/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
- 32 The structure of tartaric acid is shown.



Four moles of substance X react with one mole of tartaric acid.

What could be substance X?

- A sodium
B sodium carbonate
C sodium hydrogencarbonate
D sodium hydroxide
- Topic Chem 18 Q# 1133/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)
- 29 The structural formula of an ester is (CH₃)₂CHOCO(CH₂)₂CH₃.

This ester is boiled with aqueous hydrochloric acid.

Which two products are formed?

- A propan-1-ol and butanoic acid
B propan-2-ol and butanoic acid
C propan-1-ol and propanoic acid
D propan-2-ol and propanoic acid

Topic Chem 18 Q# 1126/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

- 38 Two 1 g samples of Y are reacted separately and completely with sodium and with sodium carbonate. The volumes of the gases produced are collected and measured.

	relative volumes of gases	
	with Na	with Na ₂ CO ₃
Y	2	1

What could Y be?

- A CH₃CH(OH)CH₂OH
B CH₃CH(OH)CO₂H
C CH₃COCH₂OH
D CH₃COCO₂H
- Topic Chem 18 Q# 1127/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
- 37 Which compound produces butan-2-ol and ethanoic acid on hydrolysis?

- A CH₃CO₂CH(CH₃)₂
B CH₃CO₂CH(CH₃)CH₂CH₃
C CH₃CH(CH₃)CO₂CH₂CH₃
D CH₃CH₂CO₂CH(CH₃)CH₂CH₃

Topic Chem 18 Q# 1128/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 How many esters have the molecular formula C₄H₈O₂?

- A 2 B 3 C 4 D 5

Topic Chem 18 Q# 1129/ AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Which compound will react with LiAlH₄ to form two optical isomers?

- A CH₃CH₂COCH₃
B CH₃CH₂CH₂CHO
C CH₃CH₂COCH₂CH₃
D CH₃CH(CH₃)CH₂CO₂H
- Topic Chem 18 Q# 1130/ AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 35//www.SmashingScience.org :o)

- 35 Compound X contains a single ester group.

X contains 27.6% by mass of oxygen.

Which pair of products could be produced by the hydrolysis of X?

- A butan-1-ol and ethanoic acid
B ethanol and propanoic acid
C methanol and methanoic acid
D propan-2-ol and butanoic acid



28 Citric acid is found in lemon juice.

citric acid



Which volume of 0.40 mol dm⁻³ sodium hydroxide solution is required to neutralise a solution containing 0.0050 mol of citric acid?

- A 12.5 cm³ B 25.0 cm³ C 37.5 cm³ D 50.0 cm³

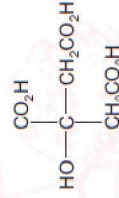
24 When an organic compound, Q, is treated with phosphorus pentachloride, fumes of hydrogen chloride are evolved. When Q is warmed with acidified aqueous potassium dichromate(VI), the solution turns green.

What is Q?

- A CH₃CH₂CHO
 B CH₃CH₂CO₂H
 C CH₃CH(OH)CH₃
 D (CH₃)₃COH

27 How many moles of hydrogen, H₂, are evolved when an excess of sodium metal is added to one mole of citric acid?

citric acid



- A 0.5 B 1.5 C 2 D 4

24 The compound cetyl palmitate, C₁₅H₃₁CO₂C₁₆H₃₃, is a waxy solid.

Cetyl palmitate is heated under reflux with an excess of aqueous sodium hydroxide.

Which products will be formed?

- A C₁₅H₃₁ONa and C₁₆H₃₃CO₂Na
 B C₁₅H₃₁CO₂Na and C₁₆H₃₃ONa
 C C₁₅H₃₁OH and C₁₆H₃₃CO₂Na
 D C₁₅H₃₁CO₂Na and C₁₆H₃₃OH

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 An organic compound, T, does **not** fizz when aqueous sodium carbonate is added to it.

Compound T contains 27.6% by mass of oxygen.

What could be the identity of T?

- 1 propanal
 2 ethyl butanoate
 3 3-methylpentanoic acid

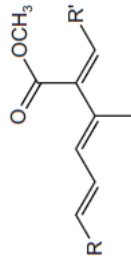
29 Which reaction gives butanoic acid as one of its products?

- A acid hydrolysis of butyl ethanoate
 B alkaline hydrolysis of butyl ethanoate
 C acid hydrolysis of ethyl butanoate
 D alkaline hydrolysis of ethyl butanoate



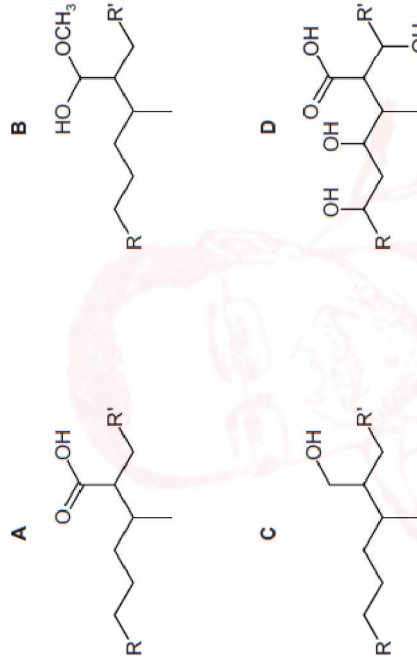
- 23 Part of the structure of strobilurin is shown. R and R' are inert groups.

strobilurin



Strobilurin is warmed with aqueous sulfuric acid producing compound X. Compound X is then treated with hydrogen in the presence of a nickel catalyst producing compound Y.

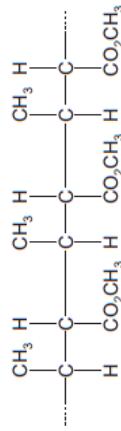
What could be the structure of compound Y?



The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 The diagram shows part of the structure of polymer X.

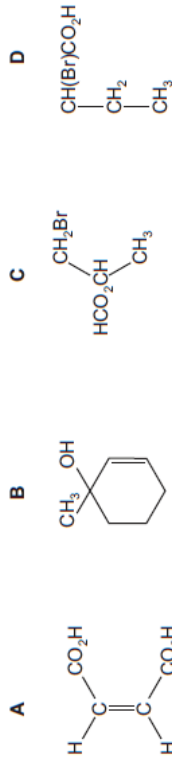


Which reagents react with polymer X?

- aqueous sulfuric acid
- aqueous sodium hydroxide
- sodium



- 29 Which compound is chiral and reacts with Na₂CO₃ to give CO₂?

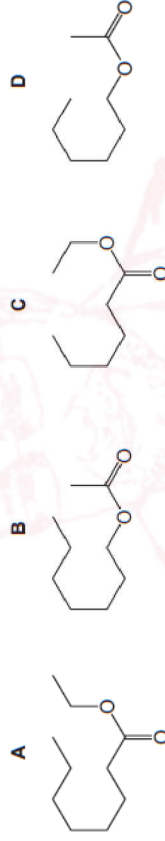


- 30 Which reaction produces an organic anion with a good yield?

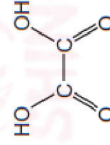
- heating ethanenitrile under reflux with dilute sodium hydroxide
- heating ethanenitrile under reflux with dilute sulfuric acid
- heating ethane with sodium metal
- heating ethanol under reflux with dilute sodium hydroxide

- 26 When compound X is heated under reflux with aqueous sodium hydroxide solution two products are formed: sodium ethanoate and hexan-1-ol.

What is compound X?



- 22 The diagram shows the structure of ethanedioic acid.



Ethanedioic acid reacts with ethanol in the presence of a few drops of concentrated sulfuric acid to form a diester. The molecular formula of the diester is C₈H₁₀O₄.

What is the structural formula of the diester?

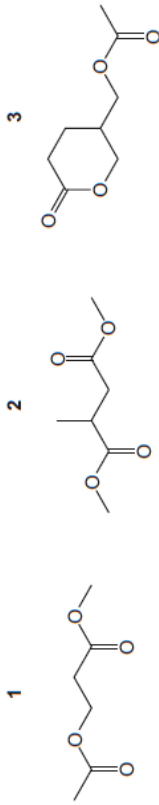
- CH₃CH₂CO₂CO₂CH₂CH₃
- CH₃CH₂OCOCO₂CH₂CH₃
- CH₃CH₂O₂CO₂CCH₂CH₃
- CH₃CO₂CH₂CH₂OCOCCH₃



Topic Chem 18 Q# 1146/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

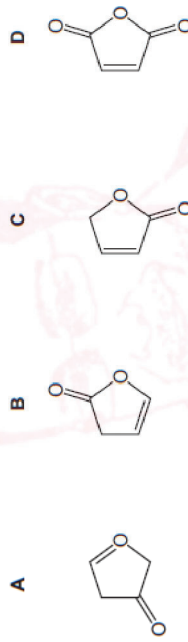
40 Which compounds produce three different organic products when hydrolysed?



Topic Chem 18 Q# 1147/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 When $\text{CH}_2(\text{OH})\text{CH}=\text{CHCO}_2\text{H}$ is warmed with a little concentrated sulfuric acid, a cyclic compound is formed.

What is the skeletal formula of the cyclic compound?



Topic Chem 18 Q# 1148/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Tartaric acid, $\text{HO}_2\text{CCH}(\text{OH})\text{CO}_2\text{H}$, is found in many plants.

A sample of tartaric acid reacts with an excess of LiAlH_4 to form the organic product J.

What happens when $\text{NaOH}(\text{aq})$ is added to separate samples of tartaric acid and J?

- A Both tartaric acid and J react.
B Only tartaric acid reacts.
C Only J reacts.
D Neither tartaric acid nor J react.

Topic Chem 18 Q# 1149/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Carboxylic acids react with alcohols to produce esters.

Carboxylic acid X forms one ester only with molecular formula $\text{C}_5\text{H}_{10}\text{O}_2$.

What could X be?

- 1 ethanoic acid
2 propanoic acid
3 butanoic acid

Topic Chem 18 Q# 1150/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Carboxylic acids can be made by several different reactions.

Which statements are correct?

- 1 The acid hydrolysis of $\text{CH}_3\text{CH}_2\text{CN}$ will make ethanoic acid.
2 The oxidation of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ will make butanoic acid.
3 The oxidation of $\text{CH}_3\text{CH}_2\text{CHO}$ will make propanoic acid.

Topic Chem 18 Q# 1151/ AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Carboxylic acids can be prepared from alcohols, nitriles or esters.

Which statements are correct?

- 1 Both primary and secondary alcohols can be oxidised to carboxylic acids.
2 Carboxylic acids can be made from nitriles by hydrolysis.
3 Ethyl propanoate gives propanoic acid when reacted with hydrochloric acid.



Topic Chem 18 Q# 1158/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Which reagent could be used to carry out the following reaction?

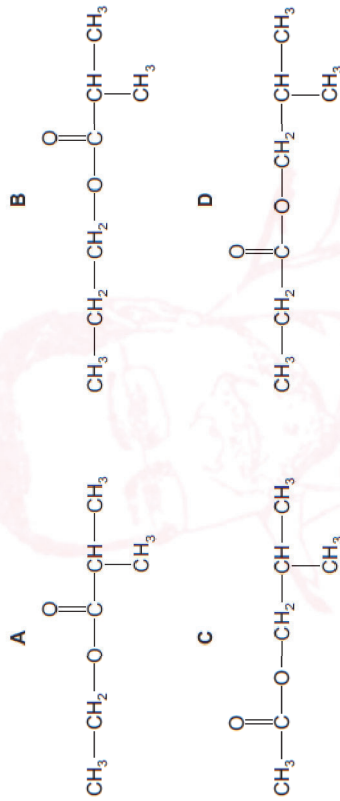


- A a solution containing acidified dichromate(VI) ions
- B a solution containing dilute, acidified manganate(VII) ions
- C a solution containing hot, concentrated, acidified manganate(VII) ions
- D concentrated sulfuric acid

Topic Chem 18 Q# 1159/ AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Ethyl propanoate is refluxed with aqueous sodium hydroxide. The alcohol produced is then reacted with methyl propanoic acid to make a second ester.

What is the structural formula of this second ester?

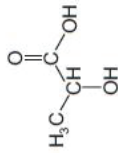


Topic Chem 18 Q# 1160/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

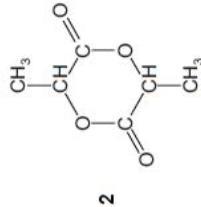
40 The structure of lactic acid is shown.



lactic acid

Which esters might form when lactic acid is heated?

1 $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H}$



3 $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{CH}(\text{OH})\text{CH}_3$

Topic Chem 18 Q# 1161/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Alcohols, aldehydes and nitriles can each be converted into carboxylic acids.

Which descriptions of their conversions into carboxylic acids are correct?

	alcohols	aldehydes	nitriles
A	hydrolysis	hydrolysis	hydrolysis
B	hydrolysis	hydrolysis	oxidation
C	oxidation	oxidation	hydrolysis
D	oxidation	oxidation	oxidation

Topic Chem 18 Q# 1162/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Ethanedioic acid has the formula $\text{HO}_2\text{CCO}_2\text{H}$.

What is the formula of aluminium ethanedioate?

A $\text{Al}(\text{C}_2\text{O}_4)_3$ B $\text{Al}(\text{C}_2\text{O}_4)_2$ C $\text{Al}_2(\text{C}_2\text{O}_4)_3$ D $\text{Al}_2(\text{C}_2\text{O}_4)_4$

Topic Chem 18 Q# 1163/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 30//

30 A sample of the ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$ is hydrolysed. The product mixture is then treated with hot, acidified KMnO_4 .

What are the final carbon-containing products?

- A $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ only
- B $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- D $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$



28 At room temperature, propanoic acid was reacted to produce sodium propanoate. No gas was produced during the reaction.

What could the propanoic acid have reacted with?

- A $\text{NaHCO}_3(\text{aq})$ B $\text{NaOH}(\text{aq})$ C $\text{Na}_2\text{CO}_3(\text{aq})$ D $\text{Na}_2\text{SO}_4(\text{aq})$

Topic Chem 18 Q# 1165/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

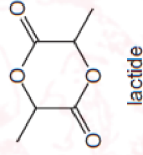
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Which statements about ethanol and ethanoic acid are correct?

- Both react with a suitable reagent to form an ester.
- Both react with sodium.
- Both are soluble in water.

Topic Chem 18 Q# 1166/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Lactide is an intermediate in the manufacture of a synthetic fibre.



Which compound, on heating with an acid catalyst, can produce lactide?

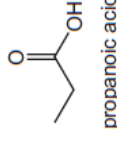
- hydroxyethanoic acid
- 2-hydroxybutanoic acid
- 2-hydroxypropanoic acid
- 3-hydroxypropanoic acid

Topic Chem 18 Q# 1167/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk and is partly responsible for the flavour of Swiss cheese.

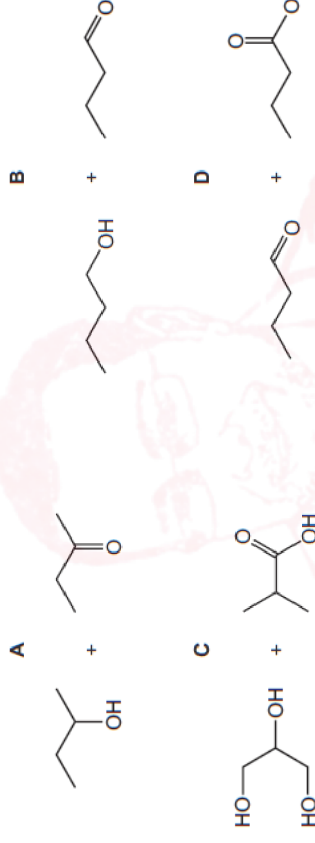


Which starting materials can be used to produce propanoic acid?

- $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- $\text{CH}_3\text{CH}_2\text{CHO}$
- $\text{CH}_3\text{CH}_2\text{CN}$

Topic Chem 18 Q# 1168/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Which two compounds can react together to produce an ester?

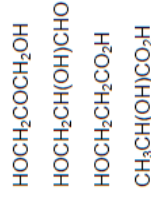


Topic Chem 18 Q# 1169/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Several structural isomers of $\text{C}_3\text{H}_6\text{O}_3$ are listed below.



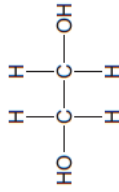
Which statements about these structural isomers are correct?

- One mole of each reacts with two moles of sodium.
- Only one of the isomers contains a tertiary alcohol group.
- They all contain a primary alcohol group.



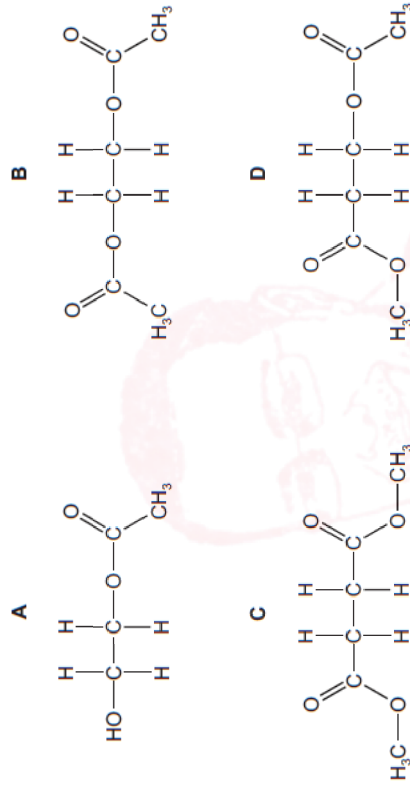
Topic Chem 18 Q# 1170/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 A solvent, X, used in printing inks has a molecular formula $C_2H_6O_2$. It may be made by reacting ethane-1,2-diol with ethanoic acid in the presence of an acid catalyst.



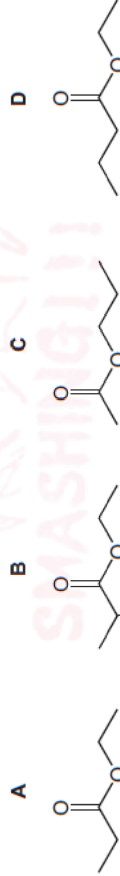
ethane-1,2-diol

What is the structure of solvent X?



Topic Chem 18 Q# 1171/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

- 29 Which formula represents an ester that will form propanoic acid on hydrolysis with dilute sulfuric acid?



Topic Chem 18 Q# 1172/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

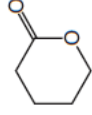
- 29 The ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$ was hydrolysed under acidic conditions.

What are the organic products of this hydrolysis?

- A butanoic acid and 2-methylpropan-1-ol
B butanoic acid and 2-methylpropan-2-ol
C butan-1-ol and 2-methylpropanoic acid
D propanoic acid and 2-methylpropan-1-ol

Topic Chem 18 Q# 1173/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Cyclic esters are also known as lactones. *Delta* lactone is used as a solvent and in the manufacture of polyesters.



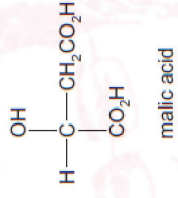
delta lactone

From which compound could *delta* lactone be made by a single reaction?

- A $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
B $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
C $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
D $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$

Topic Chem 18 Q# 1174/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

- 26 Malic acid is found in apples.

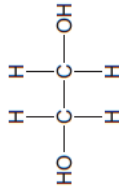


Which reagent will react with all three $-\text{OH}$ groups present in the malic acid molecule?

- A ethanol in the presence of concentrated sulfuric acid
B potassium hydroxide
C sodium
D sodium carbonate

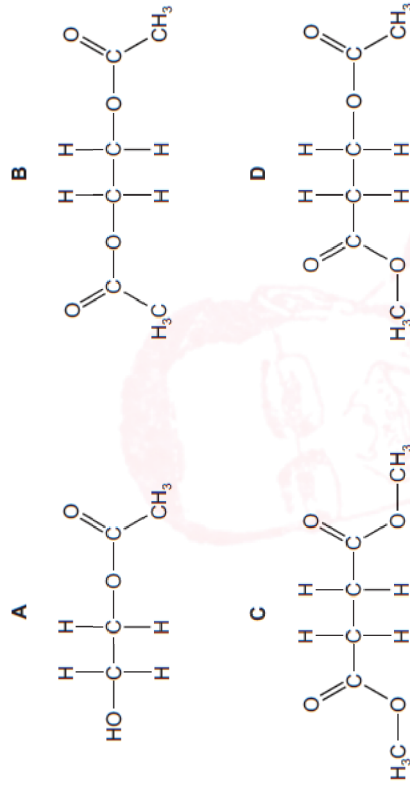
Topic Chem 18 Q# 1170/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 A solvent, X, used in printing inks has a molecular formula $C_2H_6O_2$. It may be made by reacting ethane-1,2-diol with ethanoic acid in the presence of an acid catalyst.



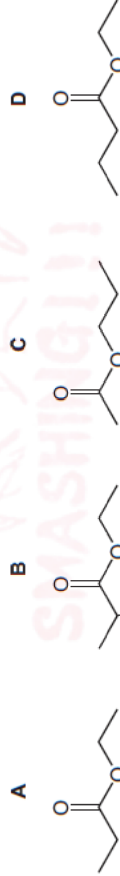
ethane-1,2-diol

What is the structure of solvent X?



Topic Chem 18 Q# 1171/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

- 29 Which formula represents an ester that will form propanoic acid on hydrolysis with dilute sulfuric acid?



Topic Chem 18 Q# 1172/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

- 29 The ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$ was hydrolysed under acidic conditions.

What are the organic products of this hydrolysis?

- A butanoic acid and 2-methylpropan-1-ol
B butanoic acid and 2-methylpropan-2-ol
C butan-1-ol and 2-methylpropanoic acid
D propanoic acid and 2-methylpropan-1-ol



21 The structural formula of compound X is shown below.



compound X

What is the name of compound X and how does its boiling point compare with that of butanoic acid?

	name of X	boiling point of X
A	methyl propanoate	higher than butanoic acid
B	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

Topic Chem 18 Q# 1176/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 An unknown organic compound Z reacts with sodium to give a combustible gas as one product. Z does not give a yellow precipitate with alkaline aqueous iodine.

What is a possible identity of Z?

- ethanoic acid
- pentan-3-ol
- propan-1-ol

Topic Chem 18 Q# 1177/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which reagents, when used in an excess, can be used to make sodium lactate, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{Na}$, from lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$?

- Na
- NaHCO_3
- NaOH

30 Which row of the table is correct?

	increasing number of carbon atoms \longrightarrow			
A	ethyl methanoate	methyl propanoate	pentyl pentanoate	propyl butanoate
B	ethyl methanoate	methyl propanoate	propyl butanoate	pentyl pentanoate
C	methyl propanoate	propyl butanoate	ethyl methanoate	pentyl pentanoate
D	propyl butanoate	ethyl methanoate	pentyl pentanoate	methyl propanoate

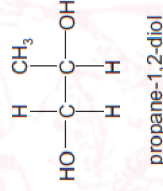
Topic Chem 18 Q# 1179/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Which mixture could be used to produce propyl methanoate?

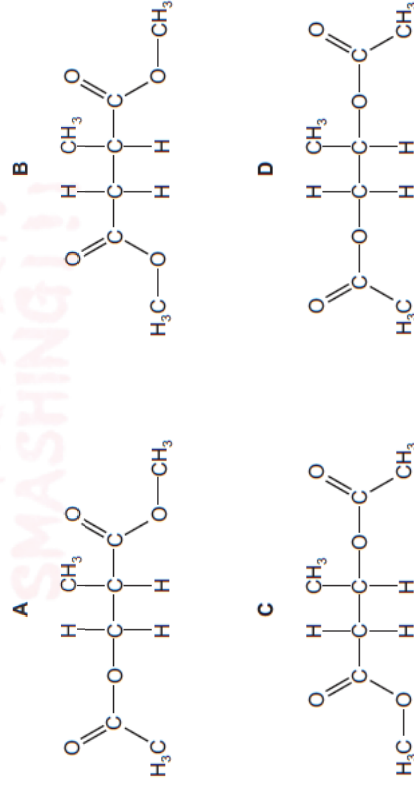
- $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ and CH_3OH
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ and HCO_2H
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and HCO_2H
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ and CH_3OH

Topic Chem 18 Q# 1180/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 The fragrance compounds of perfumes are often dissolved in solvent Y, which has a molecular formula $\text{C}_3\text{H}_{12}\text{O}_4$. It is made by reacting propane-1,2-diol with ethanoic acid in the presence of an acid catalyst.



What is the structure of solvent Y?



Topic Chem 18 Q# 1181/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which reactions result in the formation of propanoic acid?

- $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$ with dilute $\text{H}_2\text{SO}_4(\text{aq})$
- $\text{CH}_3\text{CH}=\text{CHCH}_3$ with hot, concentrated $\text{H}^+/\text{MnO}_4^- (\text{aq})$
- $\text{CH}_3\text{CH}_2\text{OH}$ with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}(\text{aq})$

Topic Chem 18 Q# 1182/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 An oxidising agent that can oxidise ethanal to ethanoic acid, or to ethanoate ions, will also oxidise methanoic acid, HCO_2H , to carbon dioxide and water.

Which reagents, on heating, will react differently with HCO_2H and $\text{CH}_3\text{CO}_2\text{H}$?

- $\text{Na}_2\text{CO}_3(\text{aq})$
- Fehling's reagent
- dilute acidified KMnO_4

Topic Chem 18 Q# 1183/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)
30 Which compound produces butan-2-ol and ethanoic acid on hydrolysis?

- $\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$
- $\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- $\text{CH}_3\text{CH}(\text{CH}_3)\text{CO}_2\text{CH}_2\text{CH}_3$
- $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$

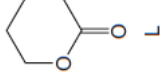
Topic Chem 18 Q# 1184/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)
20 How many isomeric esters have the molecular formula $\text{C}_4\text{H}_8\text{O}_2$?

- 2
- 3
- 4
- 5

Topic Chem 18 Q# 1185/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 5-hydroxypentanoic acid is readily converted into the cyclic compound L.



Which statements about this reaction are correct?

- Acidified sodium dichromate(VI) is used as a reagent.
- A water molecule is produced in the reaction.
- The reaction is catalysed by concentrated H_2SO_4 .

Topic Chem 18 Q# 1186/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 An organic compound, X, will react with calcium metal to produce a salt with the empirical formula $\text{CaC}_4\text{H}_4\text{O}_4$.

What could be the identity of X?

- ethanoic acid
 - butanedioic acid
 - 2-methylpropanedioic acid
- Topic Chem 18 Q# 1187/ AS Chemistry/2014/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)
28 The ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3$ is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

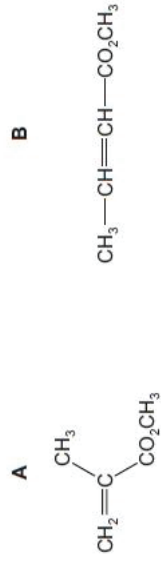
- CH_2O
- CH_4O
- $\text{C}_2\text{H}_4\text{O}$
- $\text{C}_3\text{H}_6\text{O}_2$



Topic Chem 18 Q# 1188/ AS Chemistry/2014/w/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Methyl methylpropenoate is the monomer used to make Perspex.

Which diagram correctly shows methyl methylpropenoate?



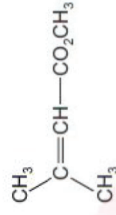
B



C



D



Topic Chem 18 Q# 1189/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Use of the Data Booklet is relevant to this question.

In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with this information?

- 74.00g of butan-2-ol \rightarrow 44.64g of butanone
- 74.00g of butan-1-ol \rightarrow 54.56g of butanoic acid
- 74.00g of 2-methylpropan-1-ol \rightarrow 54.56g of 2-methylpropanoic acid

Topic Chem 18 Q# 1190/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 The molecule responsible for the pineapple flavour used in sweets is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$.

Which statements about this molecule are correct?

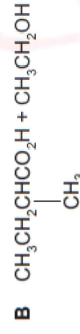
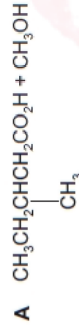
- The name of this compound is ethyl butanoate.
- This compound is a structural isomer of hexanoic acid.
- When this compound is heated with aqueous sodium hydroxide, the products are butan-1-ol and sodium ethanoate.

Topic Chem 18 Q# 1191/ AS Chemistry/2014/s/TZ.1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 An ester with an odour of banana has the following formula.

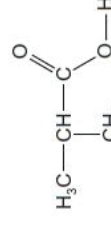
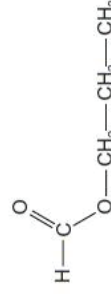
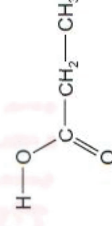
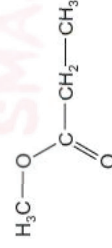


Which pair of reactants, under suitable conditions, will produce this ester?



Topic Chem 18 Q# 1192/ AS Chemistry/2013/w/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 How many of the compounds shown will react with aqueous sodium hydroxide to form the sodium salt of a carboxylic acid?

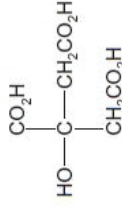


- A** 1 **B** 2 **C** 3 **D** 4



Topic Chem 18 Q# 1193/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 How many moles of hydrogen, H₂, are evolved when an excess of sodium metal is added to one mole of citric acid?



citric acid

- A 1 B 2 C 3 D 4

Topic Chem 18 Q# 1194/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

6 An experiment is set up to measure the rate of hydrolysis of ethyl ethanoate.



The hydrolysis is found to be slow in neutral aqueous solution but it proceeds at a measurable rate when the solution is acidified with hydrochloric acid.

What is the function of the hydrochloric acid?

- A to dissolve the ethyl ethanoate
 B to ensure that the reaction reaches equilibrium
 C to increase the reaction rate by catalytic action
 D to suppress ionisation of the ethanoic acid formed

Topic Chem 18 Q# 1195/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 Which reagents, when used in an excess, can be used to make sodium lactate, CH₃CH(OH)CO₂Na, from lactic acid, CH₃CH(OH)CO₂H?

- 1 Na
 2 NaHCO₃
 3 NaOH

Topic Chem 18 Q# 1196/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 A sun protection cream contains the following ester as its active ingredient.



Which substances are present in the products of its hydrolysis by aqueous sodium hydroxide?

1 CH₃CH₂CH₂CH₂CH(CH₂CH₃)CH₂OH

2 CH₃O-C₆H₄-CH=CHCO₂⁻Na⁺

3 CH₃O-C₆H₄-CO₂⁻Na⁺

Topic Chem 18 Q# 1197/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 The structural formula of a compound X is shown below.



What is the name of compound X and how does its boiling point compare with that of butanoic acid?

	name of X	boiling point of X
A	methyl propanoate	higher
B	methyl propanoate	lower
C	propyl methanoate	higher
D	propyl methanoate	lower

Topic Chem 18 Q# 1198/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Compound X, C₆H₁₂O, is oxidised by acidified sodium dichromate(VI) to compound Y.

Compound Y reacts with ethanol in the presence of a little concentrated sulfuric acid to give liquid Z.

What is the formula of Z?

- A CH₃(CH₂)₄COCH₂CH₃
 B CH₃(CH₂)₄CO₂CH₂CH₃
 C CH₃CH₂CO₂(CH₂)₄CH₃
 D CH₃CO₂(CH₂)₅CH₃



22 A compound Y has all of the properties below.

- It is a liquid at 25°C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could Y be?

- A ethanoic acid
 B ethanol
 C ethene
 D ethyl ethanoate

Topic Chem 18 Q# 1209/ AS Chemistry/2010/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Compound X reacts with ethanoic acid in the presence of an H⁺ catalyst to produce the compound below.



What is the molecular formula of compound X?

- A C₂H₆O₂ B C₂H₆O₃ C C₄H₈O D C₄H₈O₂

Topic Chem 18 Q# 1210/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

- 1 calcium carbonate
 2 calcium hydroxide
 3 potassium nitrate

Topic Chem 18 Q# 1211/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Which compound is a product of the hydrolysis of CH₃CO₂C₃H₇ by boiling aqueous sodium hydroxide?

- A CH₃OH B C₃H₇OH C C₃H₇CO₂H D C₃H₇CO₂⁻ Na⁺

30 The acarid mite releases *lardolure* to attract other mites to a host. This chemical can be destroyed by hydrolysis with acid.



A simplified formula for *lardolure* may be written as follows.

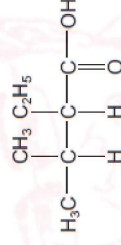


What are the products of its hydrolysis?

- A RCH(CH₃)CO₂H + CH₃OH
 B RCH(CH₃)CO₂H + HCO₂H
 C RCH(CH₃)OH + CO₂
 D RCH(CH₃)OH + HCO₂H

Topic Chem 18 Q# 1213/ AS Chemistry/2009/w/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 The characteristic odour of rum is attributed to the compound 2-ethyl-3-methylbutanoic acid.



2-ethyl-3-methylbutanoic acid

Which compound will produce 2-ethyl-3-methylbutanoic acid by heating under reflux with alcoholic sodium cyanide and subsequent acid hydrolysis of the reaction product?

- A $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CH}_2-\text{CHBr}-\text{CH}_3$
 B $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CHBr}-\text{CH}_2-\text{CH}_3$
 C $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CH}(\text{CH}_2\text{Br})-\text{CH}_2-\text{CH}_3$
 D $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CH}_2-\text{CH}(\text{CH}_2\text{Br})-\text{CH}_3$

22 A compound Y has all of the properties below.

- It is a liquid at 25°C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could Y be?

- A ethanoic acid
 B ethanol
 C ethene
 D ethyl ethanoate

Topic Chem 18 Q# 1209/ AS Chemistry/2010/w/TZ.1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

21 Compound X reacts with ethanoic acid in the presence of an H⁺ catalyst to produce the compound below.



What is the molecular formula of compound X?

- A C₂H₆O₂ B C₂H₆O₃ C C₄H₈O D C₄H₈O₂

Topic Chem 18 Q# 1210/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

- 1 calcium carbonate
 2 calcium hydroxide
 3 potassium nitrate

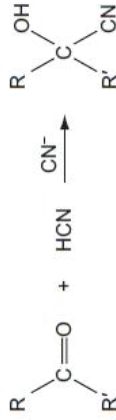
Topic Chem 18 Q# 1211/ AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Which compound is a product of the hydrolysis of CH₃CO₂C₃H₇ by boiling aqueous sodium hydroxide?

- A CH₃OH B C₃H₇OH C C₃H₇CO₂H D C₃H₇CO₂⁻ Na⁺



28 Cyanohydrins can be made from carbonyl compounds by generating CN^- ions from HCN in the presence of a weak base.



In a similar reaction, $^- \text{CH}_2\text{CO}_2\text{CH}_3$ ions are generated from $\text{CH}_3\text{CO}_2\text{CH}_3$ by strong bases.

Which compound can be made from an aldehyde and $\text{CH}_3\text{CO}_2\text{CH}_3$ in the presence of a strong base?

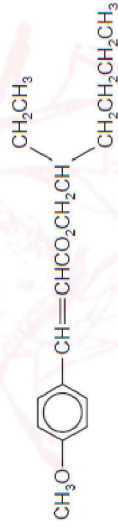
- A $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{CH}_3$
 B $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
 C $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{CH}_3$
 D $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CO}_2\text{CH}_3$

Topic Chem 18 Q# 1215/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 A sun protection cream contains the following ester as its active ingredient.



What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

- 1 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{OH}$
 2 $\text{CH}_3\text{O}-\text{C}_6\text{H}_4-\text{CH}=\text{CHCO}_2^- \text{Na}^+$
 3 $\text{CH}_3\text{O}-\text{C}_6\text{H}_4-\text{CO}_2^- \text{Na}^+$

30 A compound Y has the following properties.

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not decolourise acidified potassium manganate(VII).

What could Y be?

- A ethane
 B ethanoic acid
 C ethanol
 D ethyl ethanoate

Topic Chem 18 Q# 1217/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

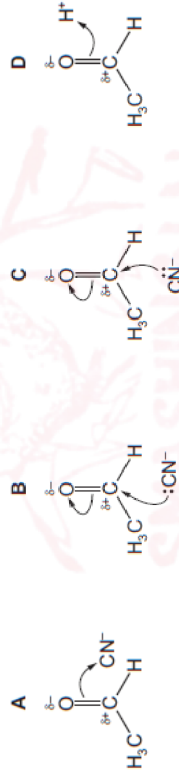
27 Which ester is formed when the alcohol $\text{CH}_3\text{CH}_2\text{OH}$ is reacted with $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$?

- A ethyl propanoate
 B ethyl butanoate
 C propyl ethanoate
 D butyl ethanoate

Topic Chem 19 Q# 1218/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)

34 Ethanal reacts with hydrogen cyanide in the presence of KCN to produce a hydroxynitrile.

What is the first step in the mechanism of this reaction?



Topic Chem 19 Q# 1219/ AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

- A The cyanohydrin product has one chiral centre.
 B The cyanohydrin product is formed by electrophilic addition.
 C The cyanohydrin product is formed via an intermediate which contains a C–OH group.
 D The formation of the cyanohydrin product requires the use of cyanide ions as a catalyst.



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 In which different forms does nitrogen exist in compounds?

- 1 bonded by a triple covalent bond
- 2 as part of a cation
- 3 in an oxidation state of +5

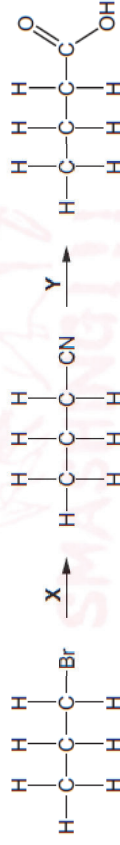
19 One molecule of ammonia reacts with one molecule of ethyl methanoate, $\text{HCO}_2\text{C}_2\text{H}_5$, to produce one molecule of methanamide, HCONH_2 , and only one other molecule, X.

One molecule of methanamide decomposes on heating strongly to produce one molecule of ammonia and only one other molecule, Y.

What could be the identities of X and Y?

	X	Y
A	ethanoic acid	carbon monoxide
B	ethanoic acid	hydrogen cyanide
C	ethanol	carbon monoxide
D	ethanol	hydrogen cyanide

26 X and Y are the reagents required to convert 1-bromopropane into butanoic acid.



What are the correct identities of X and Y?

	X	Y
A	NH_3	$\text{HCl}(\text{aq})$
B	KCN in $\text{C}_2\text{H}_5\text{OH}$	$\text{NaOH}(\text{aq})$
C	KCN in $\text{C}_2\text{H}_5\text{OH}$	$\text{HCl}(\text{aq})$
D	HCN	$\text{NaOH}(\text{aq})$

19 Methylamine, CH_3NH_2 , has very similar chemical properties to ammonia, NH_3 .

Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.



A sample of methylammonium chloride is heated with aqueous sodium hydroxide.

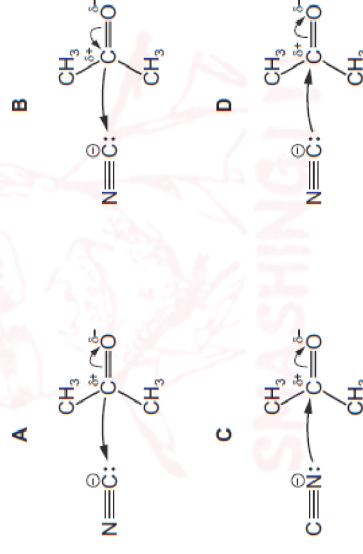
What are the products?

- ammonia, sodium chloride and water
- ammonia, sodium hydrogencarbonate and sodium chloride
- methylamine, hydrogen chloride and water
- methylamine, sodium chloride and water

26 Propanone reacts with an aqueous mixture of HCN and NaCN by a nucleophilic addition mechanism.

The first stage of the mechanism involves attack by cyanide ions.

Which diagram correctly represents this?



24 Chloroethane can be used to make sodium propanoate.

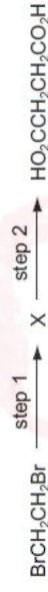


The intermediate, Q, is hydrolysed with boiling aqueous sodium hydroxide to give sodium propanoate.

Which reagent would produce the intermediate, Q, from chloroethane?

- A concentrated ammonia solution
- B dilute sulfuric acid
- C hydrogen cyanide in water
- D potassium cyanide in ethanol

21 Butanedioic acid occurs in amber, algae, lichens, sugar cane and beets. It may be synthesised in two steps from 1,2-dibromoethane.



Which reagents could be used for this synthesis?

	step 1	step 2
A	HCN(g)	HCl(aq)
B	HCO ₂ Na(aq)	HCl(aq)
C	KCN(aq/alcoholic)	H ₂ SO ₄ (aq)
D	NaOH(aq)	K ₂ Cr ₂ O ₇ /H ₂ SO ₄ (aq)

The responses A to D should be selected on the basis of

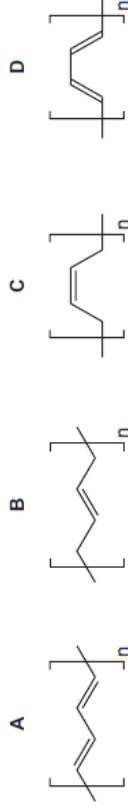
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 How can the rate of reaction between ethanal and aqueous hydrogen cyanide be increased?

- 1 by irradiation with ultraviolet light
- 2 by a rise in temperature
- 3 by the addition of a small quantity of aqueous sodium cyanide

39 The monomer buta-1,3-diene can undergo addition polymerisation in various ways. Two of the polymers that can be made are called *cis*-poly(buta-1,3-diene) and *trans*-poly(buta-1,3-diene). In these names *cis* and *trans* have their usual meanings.

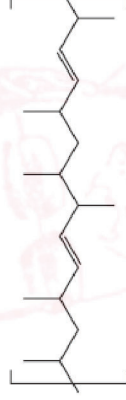
What is the structure of the repeat unit of *cis*-poly(buta-1,3-diene)?



5 In which structure are three atoms bonded together in a straight line?

- A poly(ethene), $-(\text{CH}_2\text{CH}_2)_n-$
- B propane, C₃H₈
- C silicon tetrachloride, SiCl₄
- D sulfur hexafluoride, SF₆

39 The diagram shows a section of an addition polymer formed from two different monomers.



One of the monomers is propene.

What is the other monomer?



24 Chloroethane can be used to make sodium propanoate.

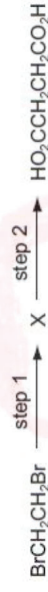


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Which reagents could be used for this synthesis?

	step 1	step 2
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B	HCO ₂ Na(aq)	HCl(aq)
C	KCN(aq/alcoholic)	H ₂ SO ₄ (aq)
D	NaOH(aq)	K ₂ Cr ₂ O ₇ /H ₂ SO ₄ (aq)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 How can the rate of reaction between ethanal and aqueous hydrogen cyanide be increased?

- 1 by irradiation with ultraviolet light
- 2 by a rise in temperature
- 3 by the addition of a small quantity of aqueous sodium cyanide



37 Polymer Z contains the length of polymer chain shown below.

This short length of chain is found many times within the chains of polymer Z, although it is **not** the repeat unit.



What could be the name of polymer Z?

- 1 poly(2-chloropropene)
- 2 poly(chloroethene)
- 3 PVC

Topic Chem 20 Q# 1238/ AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Poly(ethene) and PVC are examples of addition polymers.

Which statements are correct?

- 1 On combustion, PVC can produce carbon monoxide, carbon dioxide and hydrogen chloride.
- 2 When poly(ethene) is buried in a landfill site, it will not significantly biodegrade.
- 3 The empirical formula of an addition polymer is the same as that of the monomer.

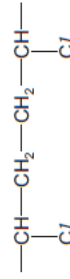
Topic Chem 20 Q# 1239/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 3//

3 In which structure are three atoms bonded together in a straight line?

- A poly(ethene), $-\text{CH}_2\text{CH}_2-$
- B propane, C_3H_8
- C silicon tetrachloride, SiCl_4
- D sulfur hexafluoride, SF_6

Topic Chem 20 Q# 1240/ AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 23//

23 A section of an addition polymer chain is shown.



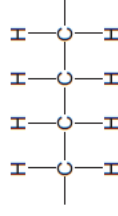
Which monomer could be used to make this polymer?

- A $\text{CH}_2\text{CHCH}_2\text{Cl}$
- B CH_2CHCl
- C CH_3CHCHCl
- D $\text{CHClCHCH}_2\text{CH}_2\text{Cl}$



Topic Chem 20 Q# 1241/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 The diagram shows a short length of an addition polymer chain.



The polymer has a relative molecular mass of approximately 10 000.

Approximately how many monomer units are joined together in each polymer molecule?

- A 180
- B 360
- C 625
- D 710

Topic Chem 20 Q# 1242/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 Polymerisation of ethene gives poly(ethene).

How does the bonding between carbon atoms in poly(ethene) compare with that in ethene?

- A longer and stronger in poly(ethene)
- B longer and weaker in poly(ethene)
- C shorter and stronger in poly(ethene)
- D shorter and weaker in poly(ethene)

Topic Chem 20 Q# 1243/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 PVC is difficult to dispose of. Two possible methods are burying it in landfill sites and disposal by combustion.

Which row of the table is correct?

	rate of biodegradation of PVC in landfill sites	gases produced when PVC combusts
A	fast	CO_2 , H_2O , HCl
B	fast	CO_2 , H_2O , Cl_2
C	slow	CO_2 , H_2O , Cl_2
D	slow	CO_2 , H_2O , HCl

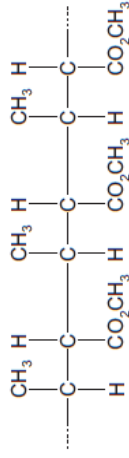
Topic Chem 20 Q# 1244/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



40 The diagram shows the structure of an addition polymer, X.



Which reagents react with polymer X?

- 1 aqueous sulfuric acid
- 2 aqueous sodium hydroxide
- 3 sodium

Topic Chem 20 Q# 1245/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

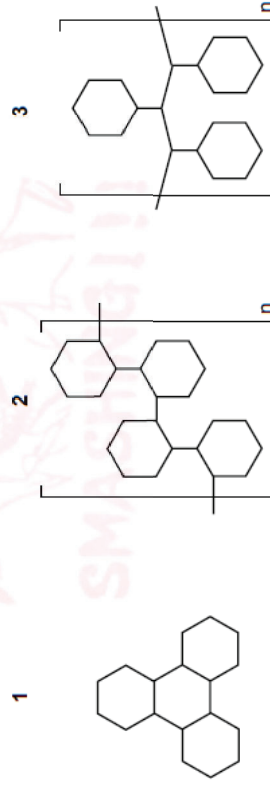
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 The diagram shows the structure of cyclohexene.



cyclohexene

Which structures could be formed by addition reactions with cyclohexene as the only reactant?



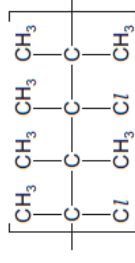
Topic Chem 20 Q# 1246/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Which statement about poly(chloroethene) is correct?

- A The polymer can be cracked to produce chlorinated alkenes.
- B The polymer has harmless combustion products.
- C The polymer is readily biodegradable when buried.
- D The repeat unit of the polymer has an M_r of 97.

Topic Chem 20 Q# 1247/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 A section showing two repeat units of an addition polymer is shown.



What is the identity of the monomer that produced this polymer?

- A 2-chloro-3-methylbutane
- B 2-chloro-3-methylbut-2-ene
- C 2-chloroprop-2-ene
- D 2,4-dichloro-3,3,4,5-tetramethylhexane

Topic Chem 20 Q# 1248/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Which types of bond breakage and bond formation occur in the addition polymerisation of alkenes?

	bond breakage	bond formation
A	π only	σ only
B	π only	σ and π
C	σ and π	σ only
D	σ and π	σ and π

Topic Chem 20 Q# 1249/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

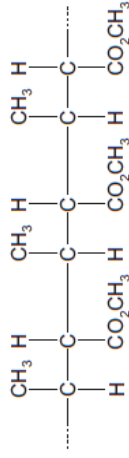
29 Synthetic resins, plasticisers and many other chemicals can be made by polymerisation of a variety of monomers including prop-2-en-1-ol, $\text{CH}_2=\text{CHCH}_2\text{OH}$.

Which structure represents the repeat unit in poly(prop-2-en-1-ol)?

- A $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{OH}-$
- B $-\text{CH}_2-\text{CH}(\text{CH}_2\text{OH})-$
- C $-\text{CH}(\text{OH})=\text{C}(\text{CH}_2\text{OH})-$
- D $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-$

Topic Chem 20 Q# 1245/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

40 The diagram shows the structure of an addition polymer, X.



Which reagents react with polymer X?

- 1 aqueous sulfuric acid
- 2 aqueous sodium hydroxide
- 3 sodium

Topic Chem 20 Q# 1245/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

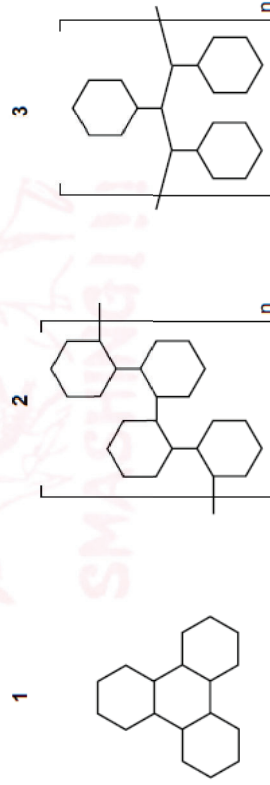
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 The diagram shows the structure of cyclohexene.



cyclohexene

Which structures could be formed by addition reactions with cyclohexene as the only reactant?



Topic Chem 20 Q# 1246/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

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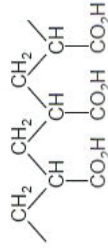
Topic Chem 20 Q# 1250/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Which statement does **not** correctly describe the polymer PVC?

- A Combustion of PVC waste produces a highly acidic gas.
- B PVC molecules are saturated.
- C The empirical formula of PVC is the same as the empirical formula of its monomer.
- D The repeat unit of PVC is $-(CH_2CHCl)-$.

Topic Chem 20 Q# 1251/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 One of the characteristics of addition polymerisation is that the empirical formulae of the polymer and of its monomer are the same. The absorbent material in babies' disposable nappies is made from the addition polymer shown.



From which monomer could this addition polymer be obtained?

- A $CH_3CH(OH)CO_2H$
- B $HOCH_2CH_2CO_2H$
- C $H_2C=CHCO_2H$
- D $HO_2CCH=CHCO_2H$

Topic Chem 20 Q# 1252/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

26 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

- A It destroys the ozone layer.
- B It does not burn easily.
- C It is easily biodegradable.
- D Its combustion products are harmful.

Topic Chem 20 Q# 1253/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 A monomer undergoes addition polymerisation. A 1 mol sample of the monomer is completely polymerised.

How many moles of polymer might, theoretically, be formed?

- 1 1
- 2 10^{-6}
- 3 $\frac{1}{6.02 \times 10^{23}}$

Topic Chem 20 Q# 1254/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

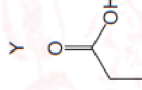
23 Polymerisation of chloroethene gives PVC.

How does the carbon-carbon bond in PVC compare with that in chloroethene?

- A longer and stronger
- B longer and weaker
- C shorter and stronger
- D shorter and weaker

Topic Chem 21 Q# 1255/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

38 Which compounds can be used to make Y in a single-step reaction?



- 1 propanenitrile
- 2 ethanenitrile
- 3 propyl ethanoate
- 4 ethyl propanoate

- A 1 and 3
- B 1 and 4
- C 2 and 3
- D 2 and 4

Topic Chem 21 Q# 1256/ AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

31 Three colourless liquids with the following formulae are contained in separate unlabelled bottles.



Which two tests, carried out on separate samples of each liquid, will successfully identify each liquid?

	test 1	test 2
A	$NaHCO_3$	2,4-DNPH reagent
B	$NaHCO_3$	Tollens' reagent
C	warm acidified dichromate	2,4-DNPH reagent
D	warm acidified dichromate	Tollens' reagent

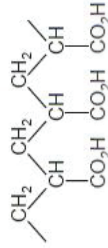
Topic Chem 20 Q# 1250/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

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- C $H_2C=CHCO_2H$
- D $HO_2CCH=CHCO_2H$

Topic Chem 20 Q# 1252/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)

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Topic Chem 20 Q# 1253/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

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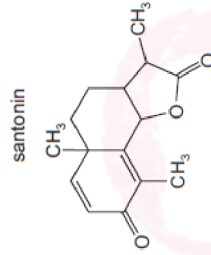


Topic Chem 21 Q# 1257/ AS Chemistry/2022/w/TZ.1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 Compound R can be formed from 1-bromopropane using a nucleophilic substitution reaction followed by an oxidation reaction.

What is the identity of R?

- A propanoic acid
 - B propanone
 - C propylamine
 - D propyl ethanoate
- Topic Chem 21 Q# 1258/ AS Chemistry/2022/w/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)
- 29 The structure of santonin is shown.



Santonin is first treated with warm dilute H_2SO_4 . The product of this reaction is treated with cold dilute acidified KMnO_4 . A final product, Q, is obtained.

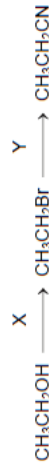
How many atoms of hydrogen in each molecule of product Q will react with sodium metal?

- A 2
- B 4
- C 5
- D 6

Topic Chem 21 Q# 1259/ AS Chemistry/2022/w/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 Which pair of reagents react together in a redox reaction?

- A $\text{CH}_3\text{CHCH}_2 + \text{Br}_2$
 - B $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{concentrated H}_3\text{PO}_4$
 - C $\text{CH}_3\text{COCH}_3 + \text{HCN}$
 - D $\text{HCO}_2\text{-C}_2\text{H}_5 + \text{dilute H}_2\text{SO}_4$
- Topic Chem 21 Q# 1260/ AS Chemistry/2022/s/TZ.1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)
- 26 Ethanol can be used to make propanenitrile in two steps.



What types of reaction are X and Y?

	X	Y
A	free-radical substitution	electrophilic substitution
B	free-radical substitution	nucleophilic substitution
C	nucleophilic substitution	nucleophilic substitution
D	nucleophilic substitution	electrophilic substitution

Topic Chem 21 Q# 1261/ AS Chemistry/2022/m/TZ.2/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

- 38 Compound Y is heated with a mild oxidising agent. One of the products of the reaction reacts with hydrogen cyanide forming 2-hydroxybutanenitrile.

What is compound Y?

- A butan-1-ol
- B butan-2-ol
- C propan-1-ol
- D propan-2-ol

Topic Chem 21 Q# 1262/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

- 30 Butanoic acid is prepared from 1-bromopropane.

This synthesis requires a sequence of two reactions.

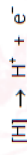
Which compound is prepared in the first stage of the synthesis?

- A 1-aminopropane
- B propan-1-ol
- C butanal
- D butanenitrile

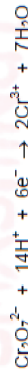
Topic Chem 21 Q# 1263/ AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

- 25 When an organic compound is oxidised, any oxygen atom gained by the organic molecule is considered to be from a water molecule also producing $2\text{H}^+ + 2\text{e}^-$. Any hydrogen atom lost may be considered to be lost as $\text{H}^+ + \text{e}^-$.

These changes can be represented by the following two equations.



Compound X is oxidised by heating under reflux with hot, acidified potassium dichromate(VI) for one hour. The half-equation for the reduction reaction is shown.



Under these conditions, one mole of potassium dichromate(VI) oxidises three moles of X.

What could X be?

- A propanal
- B propan-1-ol
- C propan-1,2-diol
- D propan-1,3-diol



27 In this question you can assume that ^1H and ^3H have the same chemical properties.

A sample of ethanal contains only one isotope of hydrogen, ^1H .

It is reduced to compound Z, $\text{C}_2\text{H}_6\text{O}$, in a nucleophilic addition reaction using NaBH_4 . All the hydrogen atoms in the NaBH_4 are the ^3H isotope.



Compound Z is then oxidised back to ethanal and water.



Which statement about the final mixture of products is correct?

- A Both ethanal and water contain ^3H atoms.
- B Ethanal is the only product containing ^3H atoms.
- C Neither ethanal nor water contain ^3H atoms.
- D Water is the only product containing ^3H atoms.

24 A student converts 1-iodopropane, $\text{C}_3\text{H}_7\text{I}$, into butanoic acid, $\text{C}_4\text{H}_7\text{CO}_2\text{H}$, by a two-stage chemical synthesis.

In the first of the two stages, which reagent is reacted with 1-iodopropane?

- A aqueous sodium hydroxide
- B ethanolic ammonia
- C ethanolic potassium cyanide
- D ethanolic sodium hydroxide

The responses A to D should be selected on the basis of

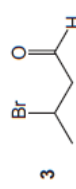
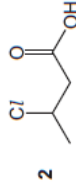
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



39 3-oxobutanoic acid can be synthesised in a two-step process.



What could be the structure of X?



29 Ethene is reacted with steam in the presence of concentrated H_3PO_4 . The product of this reaction is added to acidified potassium dichromate(VI) and heated under reflux for one hour. The final organic product is collected and labelled X.

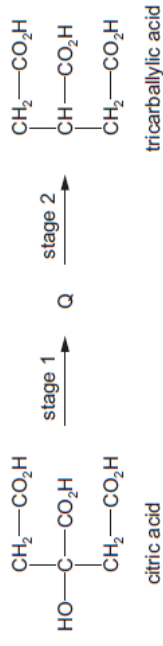
But-2-ene is treated with hot, concentrated, acidified potassium manganate(VII). The final organic product is collected and labelled Y.

Which statement is correct?

- A One molecule of X has more carbon atoms than one molecule of Y.
- B One molecule of Y has more carbon atoms than one molecule of X.
- C X and Y have different functional groups.
- D X is the same compound as Y.



25 Citric acid can be converted into tricarballylic acid in two stages. An intermediate, Q, is formed.



Which reagents are needed for each stage?

	stage 1	stage 2
A	concentrated H_2SO_4	$\text{H}_2(\text{g})$ and Ni
B	concentrated H_2SO_4	LiAlH_4
C	LiAlH_4	$\text{H}_2\text{SO}_4(\text{aq})$
D	$\text{NaOH}(\text{aq})$	$\text{H}_2(\text{g})$ and Ni

Topic Chem 21 Q# 1269/ AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

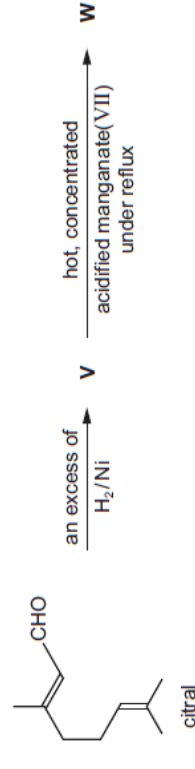
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

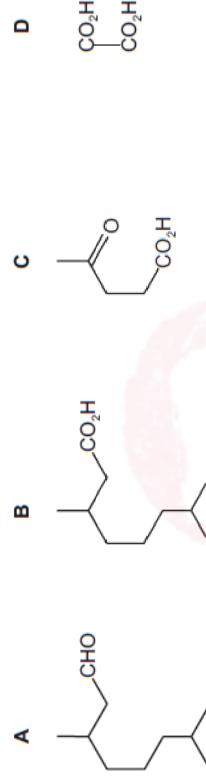
39 For which reactions are the colour changes described correctly?

	reagents	colour change
1	pentanal + hot, acidified potassium dichromate(VI)	orange to green
2	pentan-2-one + warm Fehling's reagent	no change
3	cyclohexane + cold, acidified potassium manganate(VII)	purple to colourless

30 Citral is found in lemongrass oil. It can react to give compound W.



What could compound W be?



Topic Chem 21 Q# 1271/ AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 Diols in which both hydroxy groups are bonded to the same carbon can spontaneously eliminate a molecule of water to produce a carbonyl compound.

Which compound, after complete hydrolysis, gives a positive reaction with Tollens' reagent?

- A 1,1-dibromobutane
- B 1,2-dibromobutane
- C 1,3-dibromobutane
- D 2,2-dibromobutane

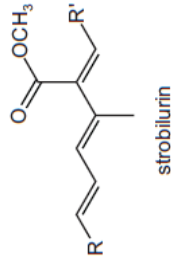
Topic Chem 21 Q# 1272/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Which reaction would not give ethanoic acid?

- A heating ethanenitrile under reflux with dilute sodium hydroxide
- B heating ethanenitrile under reflux with dilute sulfuric acid
- C heating ethanal under reflux with acidified sodium dichromate(VI)
- D heating ethanol under reflux with acidified sodium dichromate(VI)

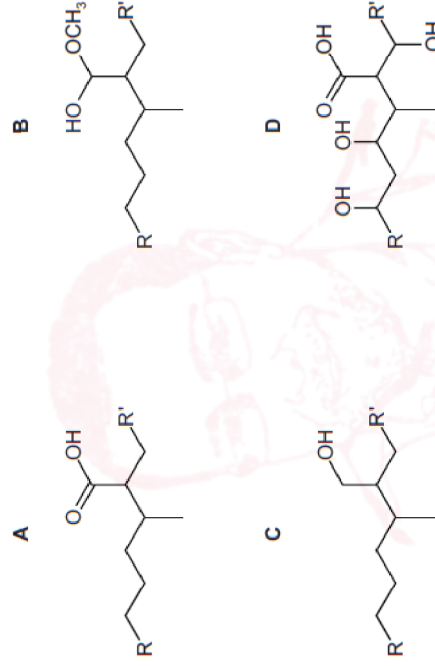


Topic Chem 21 Q# 1273/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)
 23 Part of the structure of a fungicide, strobilurin, is shown. R and R' are inert groups.



In this reaction, strobilurin is warmed with aqueous sulfuric acid producing compound X. Compound X is then treated with hydrogen in the presence of a nickel catalyst producing compound Y.

What could be the structure of compound Y?



Topic Chem 21 Q# 1274/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Several steps are involved in the synthesis of 2-hydroxypropanoic acid from ethanol.

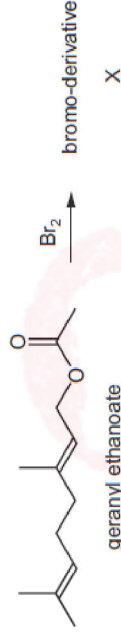


Which statements concerning this synthesis are correct?

- The chain length can be increased during a step involving reaction between HCN and an aldehyde.
- The carboxyl group can be made by hydrolysis of a nitrile by boiling with NaOH(aq) and then acidifying.
- The ethanol should be first oxidised by heating it under reflux with an excess of acidified potassium dichromate(VI).

Topic Chem 21 Q# 1275/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Geranyl ethanoate is present in ginger and cocoa, and is used in shampoos and soaps as a perfume. It reacts with an excess of bromine in an organic solvent to give X, a bromo-derivative.



Including geranyl ethanoate, how many cis-trans isomers are there of geranyl ethanoate, and how many chiral centres are there in X?

	cis-trans isomers	chiral centres in X
A	2	3
B	2	4
C	4	3
D	4	4

Topic Chem 21 Q# 1276/ AS Chemistry/2016/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)

22 Which pair of reagents will take part in a redox reaction?

- $CH_3CHCH_2 + Br_2$
- $CH_3CH_2CH_2OH + \text{concentrated } H_3PO_4$
- $CH_3COCH_3 + HCN$
- $HCO_2C_2H_5 + \text{dilute } H_2SO_4$

Topic Chem 21 Q# 1277/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
 The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



40 Compound X has the molecular formula $C_3H_6O_3$.

Heating X under reflux with acidified $K_2Cr_2O_7$ forms $HO_2CCOCOC_2H_5$.

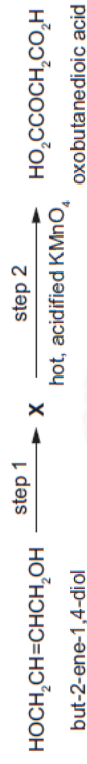
Reacting X with $NaBH_4$ forms $HOCH_2CH(OH)CH_2OH$.

What is a possible structural formula for X?

- $HOCH_2CH_2CO_2H$
- $HOCH_2CH(OH)CHO$
- $HOCH_2COCH_2OH$

Topic Chem 21 Q# 1278/ AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 But-2-ene-1,4-diol is converted in two steps through an intermediate X into oxobutanedioic acid.



What could be the reagent for step 1 and what is the intermediate X?

	reagent for step 1	X
A	cold, acidified $KMnO_4$	$HOCH_2CH_2CH(OH)CH_2OH$
B	hot, acidified $K_2Cr_2O_7$	$HO_2CCH=CHCO_2H$
C	steam and concentrated H_2SO_4	$HOCH_2CH(OH)CH_2CH_2OH$
D	warm, acidified $K_2Cr_2O_7$	$OHCCH(OH)CH_2CHO$

Topic Chem 21 Q# 1279/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

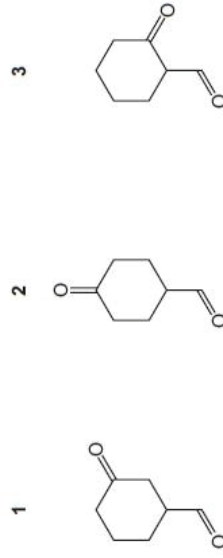
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Each of the compounds below is treated separately with excess $NaBH_4$. The product of each reaction is then heated with excess concentrated H_2SO_4 .

In each case, one or more products are formed with molecular formula C_7H_{10} .

Which compounds give only one final product with the molecular formula C_7H_{10} ?



Topic Chem 21 Q# 1280/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Butan-2-ol can be made by reducing X with H_2/Ni .

Butan-2-ol can be dehydrated to form Y and Z which are structural isomers of each other.

Which row is correct?

	X is	cis-trans isomerism is shown by
A	an aldehyde	both Y and Z
B	an aldehyde	only one of Y and Z
C	a ketone	both Y and Z
D	a ketone	only one of Y and Z

Topic Chem 21 Q# 1281/ AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)

25 If the starting material is iodoethane, which sequence of reactions will produce propanoic acid as the main final product in good yield?

A add $NaOH(aq)$, isolate the organic product, add acidified $K_2Cr_2O_7$ and boil under reflux

B add $NaOH(aq)$, isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

C heat with HCN in ethanol, isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

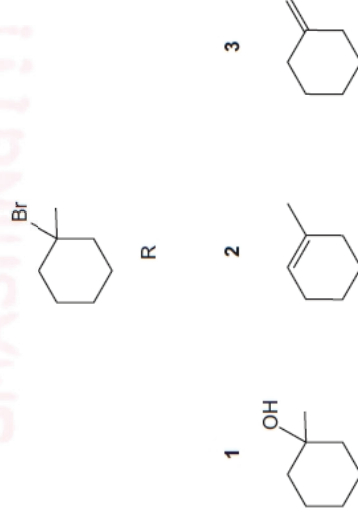
D heat with KCN in ethanol, isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

Topic Chem 21 Q# 1282/ AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which compounds will react with HBr to give the compound R?



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 For which mixtures of reagents are the colour changes described correctly?

	reagents	colour change
1	pentanal + hot, acidified potassium dichromate(VI)	orange to green
2	pentan-2-one + warm Fehling's reagent	no change
3	cyclohexane + cold, acidified potassium manganate(VII)	purple to colourless

Topic Chem 21 Q# 1284/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

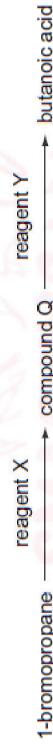
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Which pairs of reagents will take part in a redox reaction?

- $\text{CH}_3\text{COCH}_3 + \text{Tollens' reagent}$
- $\text{CH}_3\text{CH}_2\text{CHO} + \text{Fehling's reagent}$
- $\text{CH}_3\text{CH}=\text{CH}_2 + \text{Br}_2$

Topic Chem 21 Q# 1285/ AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 Butanoic acid can be produced from 1-bromopropane using reagents X and Y as shown below.



What could be reagents X and Y?

	X	Y
A	KCN in ethanol	HCl(aq)
B	KCN in ethanol	NaOH(aq)
C	NH_3 in ethanol	HCl(aq)
D	NaOH(aq)	$\text{H}^+/\text{Cr}_2\text{O}_7^{2-}(\text{aq})$

20 Many organic reactions need to be heated before reaction occurs, but some do not require heating.

Which reaction occurs quickly at room temperature?

- $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$
- $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
- $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

Topic Chem 21 Q# 1287/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 The compounds below are treated with hydrogen cyanide.

Which compounds react and produce a molecule containing a chiral centre?

- butanal
- pentan-3-one
- 2-chlorobutane

Topic Chem 21 Q# 1288/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which reactions can be used to make an alcohol in the laboratory?

- hydrolysis of a bromoalkane with NaOH(aq)
- reduction of a ketone with NaBH_4
- reduction of an aldehyde with NaBH_4

Topic Chem 21 Q# 1289/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 38 An organic compound Y, molecular formula $C_6H_{14}O$, may be oxidised to compound Z, molecular formula $C_6H_{12}O_2$.

What could be the structural formula of Y?

- $CH_3CH_2CH(CH_2OH)CH_2CH_3$
- $(CH_3)_3CCH_2CH_2OH$
- $CH_3CH_2CH(CH_3)CH_2CH_2OH$

Topic Chem 21 Q# 1290/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

- 28 In which reaction is the organic compound oxidised?

- $CH_3CH_2OH + \text{concentrated } H_3PO_4$
- $CH_3CH_2CH_2CHO + \text{Tollens' reagent}$
- $CH_3COCH_3 + 2,4\text{-dinitrophenylhydrazine reagent}$
- $CH_3CN + \text{dilute } H_2SO_4$

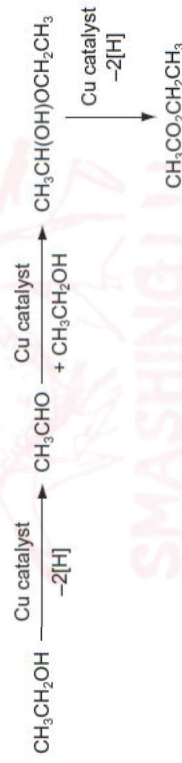
Topic Chem 21 Q# 1291/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

- 21 Which reaction will give the best yield of 1-chloropropane?

- chlorine gas with propene gas in the dark
- propan-1-ol with dilute $NaCl(aq)$
- propan-1-ol with PCl_5
- propene with dilute $HCl(aq)$

Topic Chem 21 Q# 1292/ AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

- 20 A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.

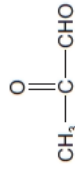


Which process is involved at some stage in this reaction sequence?

- electrophilic addition
- nucleophilic addition
- nucleophilic substitution
- reduction

Topic Chem 21 Q# 1293/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

- 27 Burnt sugar has a characteristic smell caused partly by the following compound.



This compound contains two functional groups.

Which reagent will react with only one of the functional groups?

- acidified potassium dichromate(VI)
- 2,4-dinitrophenylhydrazine
- hydrogen cyanide
- sodium hydroxide

Topic Chem 21 Q# 1294/ AS Chemistry/2013/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)

- 21 Lactic acid (2-hydroxypropanoic acid), $CH_3CH(OH)CO_2H$, is found in sour milk.

Which reaction could occur with lactic acid?

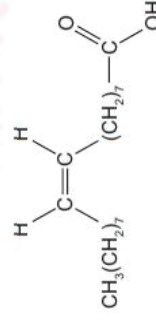
- $CH_3CH(OH)CO_2H + CH_3OH \rightarrow CH_3CH(OCH_3)CO_2H + H_2O$
- $CH_3CH(OH)CO_2H + HCO_2H \rightarrow CH_3CH(O_2CH)CO_2H + H_2O$
- $CH_3CH(OH)CO_2H + NaHCO_3 \rightarrow CH_3CH(ONa)CO_2H + H_2O + CO_2$
- $CH_3CH(OH)CO_2H + Cl_2 \rightarrow CH_3CH(Cl)CO_2H + HOC\bar{I}$

Topic Chem 21 Q# 1295/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 40 Oleic acid is found in olive oil. It has the following formula.



Which reagents will give a positive result with oleic acid?

- aqueous bromine
- acidified potassium dichromate(VI)
- Fehling's reagent



Topic Chem 21 Q# 1296/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 Which reagents react with butanone, $C_2H_5COCH_3$?

- Tollens' reagent
- sodium borohydride
- 2,4-dinitrophenylhydrazine reagent

Topic Chem 21 Q# 1297/ AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)

29 Many, but not all, organic reactions need to be heated before reaction occurs.

Which reaction occurs at a good rate at room temperature ($20^\circ C$)?

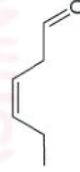
- $CH_3OH + PCl_5 \rightarrow CH_3Cl + POCl_3 + HCl$
- $CH_3CH_2Br + KCN \rightarrow CH_3CH_2CN + KBr$
- $CH_3CH_2OH \rightarrow C_2H_4 + H_2O$
- $CH_3CH_2CN + 2H_2O \rightarrow CH_3CH_2CO_2H + NH_3$

Topic Chem 21 Q# 1298/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 The compound *cis*-hex-3-enal is responsible for the characteristic smell of cut grass. The human nose is particularly sensitive to this compound, being able to detect 0.25 parts per billion in air.

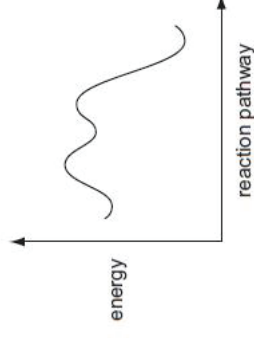


cis-hex-3-enal

Which reagents will react with *cis*-hex-3-enal?

- sodium
- sodium borohydride
- Fehling's reagent

Topic Chem 21 Q# 1299/ AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)
28 A reaction pathway diagram is shown.



Which reaction does **not** have such a profile?

- $CH_3CHO + HCN \xrightarrow{NaCN} CH_3CH(OH)CN$
- $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$
- $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$



Topic Chem 21 Q# 1300/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

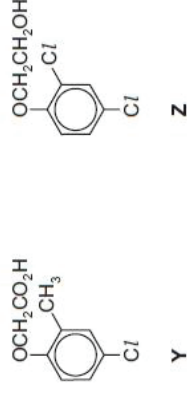
39 On acid hydrolysis, which compounds produce propanoic acid?

- $CH_3CH_2CO_2CH_3$
- $CH_3CH_2CH_2CN$
- $CH_3CH_2CH_2Cl$



Topic Chem 21 Q# 1301/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Y and Z are two widely-used selective weed killers.



Which reagent will distinguish Y from Z?

- A acidified $\text{AgNO}_3(\text{aq})$
 B Fehling's solution
 C Na
 D $\text{Na}_2\text{CO}_3(\text{aq})$

Topic Chem 21 Q# 1302/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

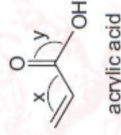
30 The functional group in a primary alcohol is $-\text{CH}_2\text{OH}$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

- A Al_2O_3 B $\text{CH}_3\text{CO}_2\text{H}$ C HBr D Na

Topic Chem 21 Q# 1303/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Acrylic acid is produced from propene, a gaseous product of oil refineries.



Which statement about acrylic acid is **not** correct?

- A Both bond angles x and y are approximately 120° .
 B It decolourises aqueous bromine.
 C It gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent.
 D It reacts with an alcohol to give an ester.

Topic Chem 21 Q# 1304/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

39 An organic compound decolourises aqueous bromine and reacts with sodium to produce hydrogen.

Which molecular formula could represent this compound?

- 1 $\text{C}_3\text{H}_6\text{O}$
 2 $\text{C}_3\text{H}_4\text{O}_2$
 3 $\text{C}_3\text{H}_8\text{O}$

Topic Chem 21 Q# 1305/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 Glyceraldehyde, $\text{HOCH}_2\text{CH}(\text{OH})\text{CHO}$, is formed during photosynthesis, and contains a chiral carbon atom.

Which reagents will react with glyceraldehyde to produce an organic product **without** a chiral carbon atom?

- 1 warmed acidified $\text{K}_2\text{Cr}_2\text{O}_7$
 2 NaBH_4
 3 Tollens' reagent

Topic Chem 21 Q# 1306/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)

27 Which compound would undergo nucleophilic addition?

- A bromoethane, $\text{C}_2\text{H}_5\text{Br}$
 B ethanal, CH_3CHO
 C ethane, C_2H_6
 D ethene, C_2H_4

Topic Chem 21 Q# 1307/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Tartaric acid is present in some wines. It may be synthesised in the laboratory in two steps.

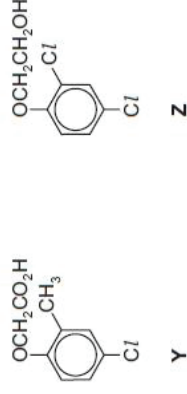


Which reagents could be used for this synthesis?

	step 1	step 2
A	$\text{HCl}(\text{aq})$	$\text{HCN}(\text{g})$
B	$\text{HCN}, \text{NaCN}(\text{aq}/\text{alcoholic})$	$\text{H}_2\text{SO}_4(\text{aq})$
C	$\text{H}_2\text{SO}_4(\text{aq})$	$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4(\text{aq})$
D	$\text{KCN}(\text{aq}/\text{alcoholic})$	$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4(\text{aq})$

Topic Chem 21 Q# 1301/ AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 Y and Z are two widely-used selective weed killers.



Which reagent will distinguish Y from Z?

- A acidified $\text{AgNO}_3(\text{aq})$
 B Fehling's solution
 C Na
 D $\text{Na}_2\text{CO}_3(\text{aq})$

Topic Chem 21 Q# 1302/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

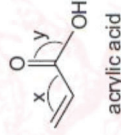
30 The functional group in a primary alcohol is $-\text{CH}_2\text{OH}$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

- A Al_2O_3 B $\text{CH}_3\text{CO}_2\text{H}$ C HBr D Na

Topic Chem 21 Q# 1303/ AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)

20 Acrylic acid is produced from propene, a gaseous product of oil refineries.



Which statement about acrylic acid is **not** correct?

- A Both bond angles x and y are approximately 120° .
 B It decolourises aqueous bromine.
 C It gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent.
 D It reacts with an alcohol to give an ester.

Topic Chem 21 Q# 1304/ AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

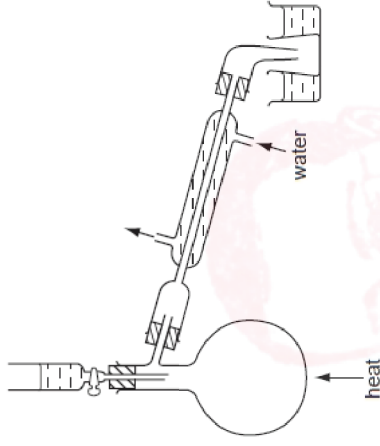
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



Topic Chem 21 Q# 1308/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

40 The diagram shows some laboratory apparatus.



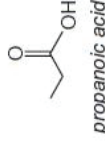
Which preparations could this apparatus be used for?

- 1 bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid
- 2 ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid
- 3 1,2-dibromoethane, from bromine and ethene

Topic Chem 21 Q# 1309/ AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

37 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



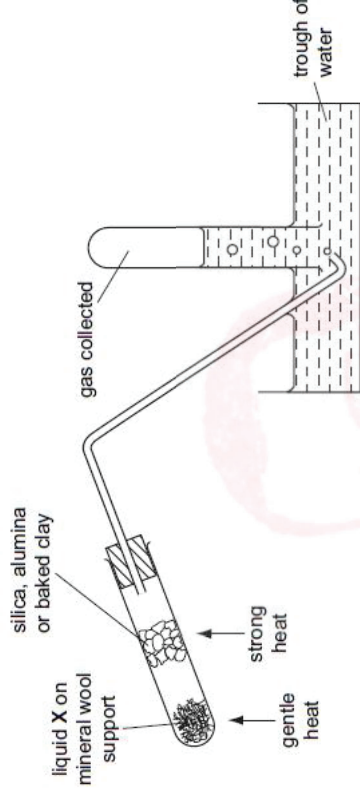
Which starting materials could be used to synthesise propanoic acid?

- 1 $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- 2 $\text{CH}_3\text{CH}_2\text{CN}$
- 3 $\text{CH}_3\text{CH}_2\text{CHO}$

Topic Chem 21 Q# 1310/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

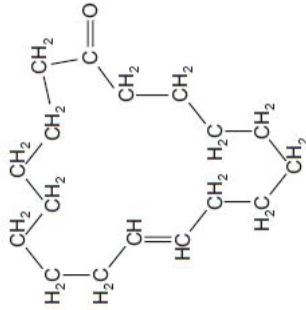
39 The diagram shows an experiment.



Which processes could be demonstrated by using the above apparatus?

- 1 the oxidation of ethanol (the liquid **X**)
- 2 the dehydration of ethanol (the liquid **X**)
- 3 the cracking of paraffin (the liquid **X**)

27 The naturally-occurring molecule civetone is found in a gland of the African civet cat and has been used in perfumery.

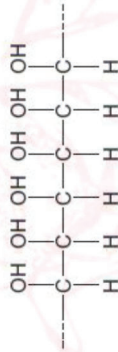


civetone

With which reagent will civetone **not** react?

- A 2,4-dinitrophenylhydrazine reagent
 - B Fehling's reagent
 - C hydrogen bromide
 - D sodium tetrahydridoborate(III) (sodium borohydride)
- Topic Chem 21 Q# 1312/ AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)

23 The following diagram represents the structure of a possible polymer.



By which method might this polymer be made?

- A polymerise ethene followed by hydration
 - B polymerise ethene followed by oxidation with cold acidified KMnO₄
 - C polymerise 1,2-dichloroethene followed by hydrolysis
 - D polymerise 1,2-dichloroethene followed by oxidation with cold acidified KMnO₄
- Topic Chem 21 Q# 1313/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)

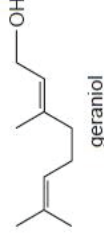
6 In which reaction does the carbon-containing product have a smaller bond angle than the organic reactant?

- A bromoethane refluxed with ethanolic sodium hydroxide
- B complete combustion of methane in air
- C methane and an excess of chlorine under ultraviolet light
- D polymerisation of ethene

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

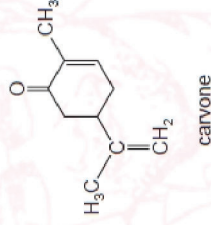
38 Geraniol is one of several compounds produced by the scent glands of honey bees to help them mark nectar-bearing flowers and locate the entrances to their hives.



Which reactions will geraniol undergo?

- 1 reaction with hot concentrated acidic KMnO₄ to give propanone
 - 2 addition of halogens
 - 3 reaction with aqueous NaHCO₃ to give CO₂
- Topic Chem 21 Q# 1315/ AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)

28 Carvone gives the characteristic flavour to caraway and spearmint.



Prolonged heating of carvone with hot concentrated acidified potassium manganate(VII) produces carbon dioxide and a compound X.

X contains nine carbon atoms and reacts with 2,4-dinitrophenylhydrazine reagent.

What is the maximum number of molecules of 2,4-dinitrophenylhydrazine that will react with one molecule of X?

- A 1
- B 2
- C 3
- D 4

25 Which reaction would **not** give propene as one product?

- A adding an excess of concentrated sulfuric acid to propan-1-ol
- B adding warm aqueous sodium hydroxide to 2-bromopropane
- C adding warm ethanolic sodium hydroxide to 1-bromopropane
- D passing propan-2-ol vapour over heated aluminium oxide



40 In the mass spectrum of a compound, Z, the relative abundances of the M and M+1 peaks are in the ratio 13 : 1.

What is compound Z?

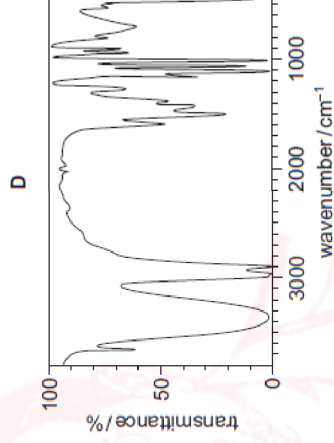
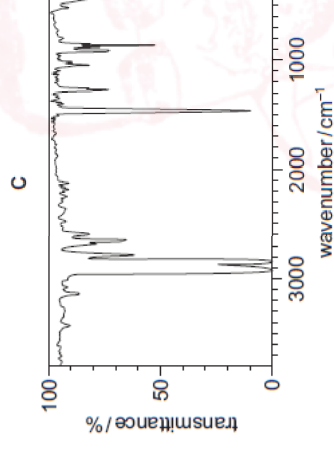
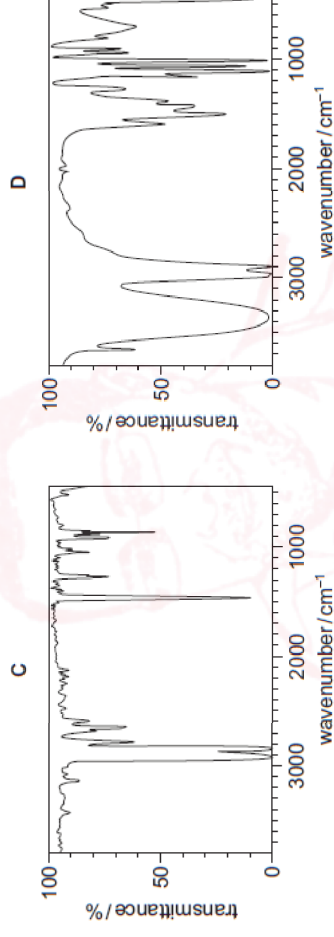
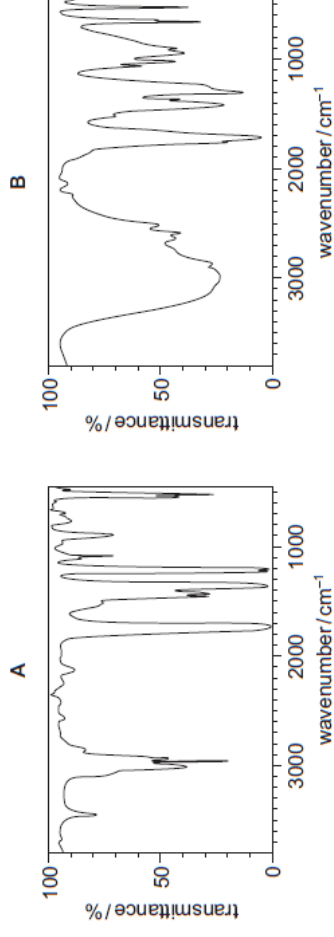
- A butyl butanoate
- B hexan-3-one
- C 2,2,3-trimethylhexane
- D 3,3-dimethylpentan-1-ol

40 A scientist chooses either infrared spectroscopy or mass spectrometry to find a particular piece of information.

In which row has the **best** choice been made?

	target information	analytic method used
A	identities of functional groups in an organic compound	infrared spectroscopy
B	identities of functional groups in an organic compound	mass spectrometry
C	values of successive ionisation energies of Na	infrared spectroscopy
D	values of successive ionisation energies of Na	mass spectrometry

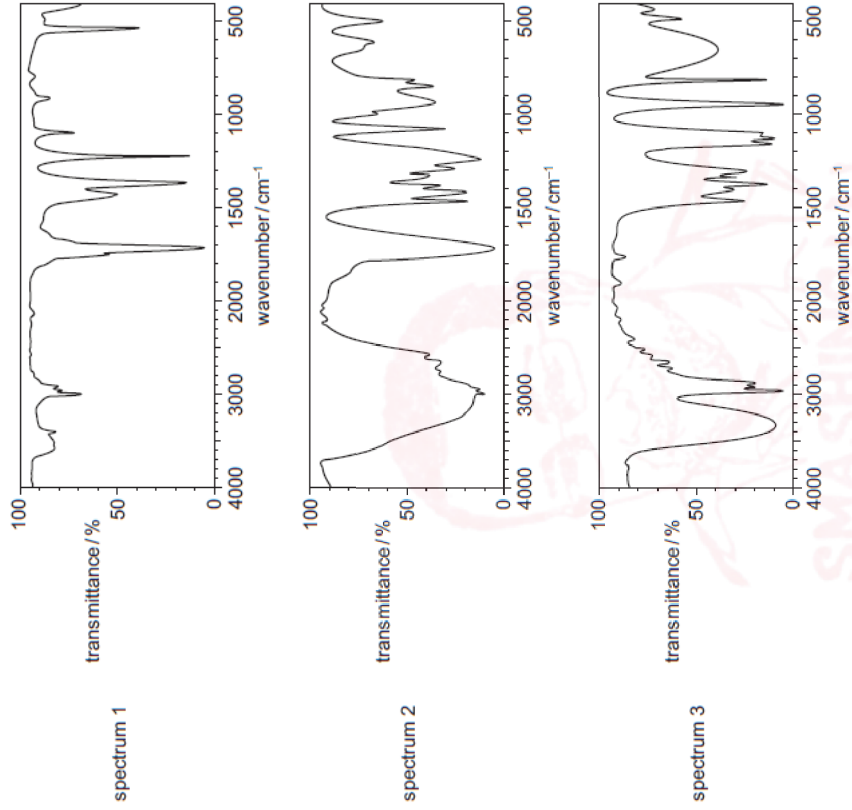
40 Which diagram shows the infrared spectrum of a compound that contains both a C=O and an O-H group?



bond	functional group containing the bond	characteristic infrared absorption range (in wavenumbers)/ cm ⁻¹
C-O	hydroxy, ester	1040-1300
C=C	aromatic compound, alkene	1500-1680
C=O	amide carbonyl, carboxyl ester	1640-1690 1670-1740 1710-1750
C≡N	nitrile	2200-2250
C-H	alkane	2850-3100
N-H	amine, amide	3300-3500
O-H	carboxyl hydroxy	2500-3000 3200-3650



30 The infra-red spectra of three organic compounds are shown.

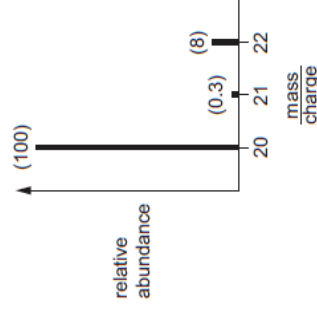


What could the three compounds be?

	spectrum 1	spectrum 2	spectrum 3
A	propanoic acid	propanone	propan-2-ol
B	propanone	propanoic acid	propan-2-ol
C	propanone	propan-2-ol	propanoic acid
D	propan-2-ol	propanoic acid	propanone



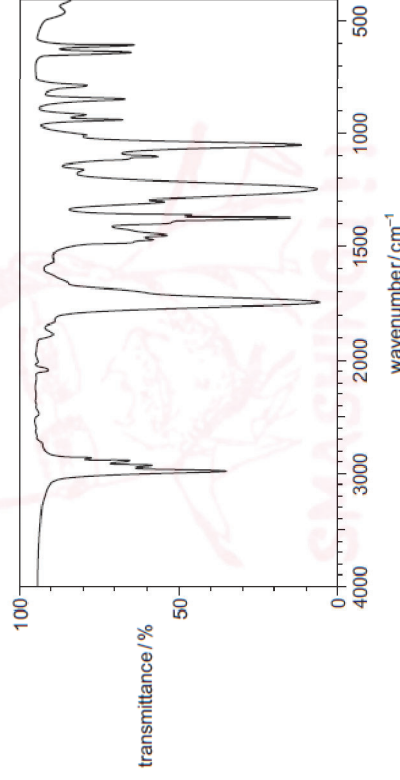
1 The mass spectrum of a sample of neon is shown. The relative abundance of each peak is written in brackets above it.



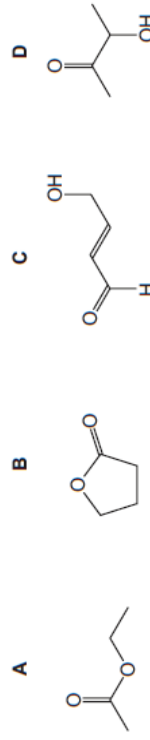
What is the relative atomic mass, A_r , of this sample of neon?

- A 20.15 B 20.20 C 21.00 D 21.82

26 Compound X has the empirical formula C_3H_4O . Its infra-red spectrum is shown.



What could be the skeletal formula of compound X?



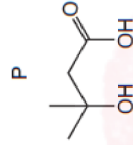
Topic Chem 22 Q# 1323/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 38//www.SmashingScience.org :o)
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

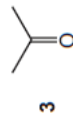
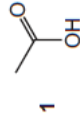
38 An excess of P reacts with Q, in the presence of concentrated sulfuric acid, to form R.

Effervescence is seen when a piece of sodium is added to pure R.

The structure of P is shown.

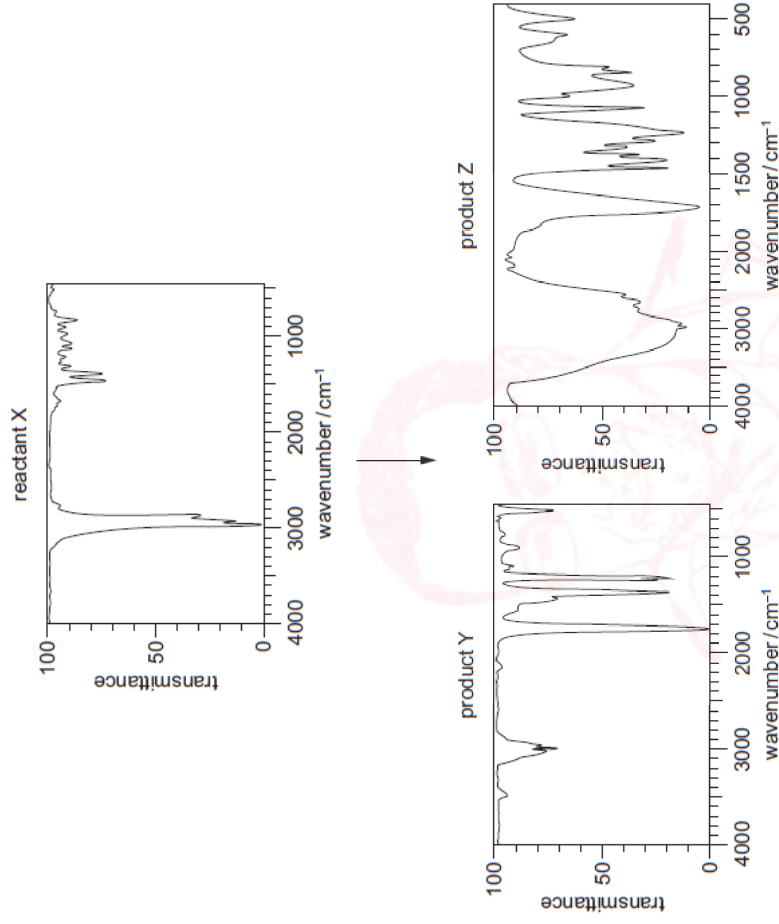


Which organic compounds could be compound Q?



Topic Chem 22 Q# 1324/ AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 When reactant X is treated with a suitable reagent, products Y and Z are formed. Infrared spectra of X, Y and Z are shown.



Which row could be correct?

	X	Y	Z
A	2,3-dimethylpent-2-ene	propanone	butanone
B	2-methylpent-2-ene	propanone	propanoic acid
C	pent-2-ene	ethanoic acid	propanoic acid
D	propyl propanoate	propan-1-ol	propanoic acid

Topic Chem 22 Q# 1325/ AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)

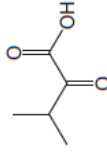
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



37 The structure of compound R is shown.

compound R

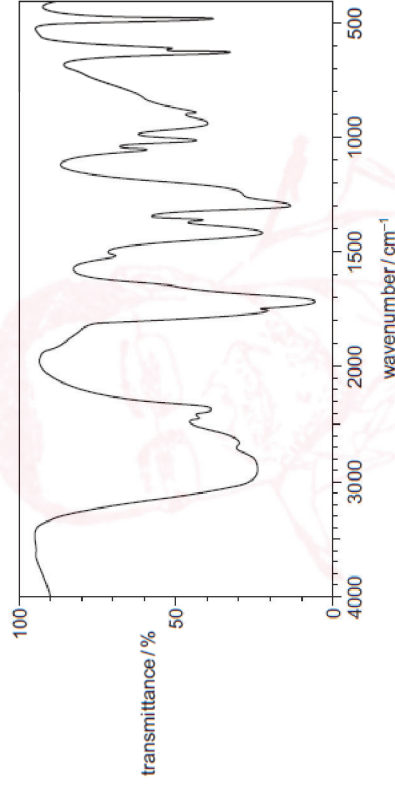


Which statements about compound R are correct?

- 1 It has an M_r of 116.
- 2 It contains two groups that show strong absorptions between 1640 and 1740 cm^{-1} in its infrared spectrum.
- 3 Its only infrared absorption between 2500 and 3000 cm^{-1} is sharp and strong.

Topic Chem 22 Q# 1326/ AS Chemistry/2020/s/TZ.1/Paper.1/Exam Q# 29//www.SmashingScience.org :o)

29 Compound X has the infra-red spectrum shown.



What could be the identity of compound X?

- A ethanoic acid
- B ethanol
- C ethylethanoate
- D propanone

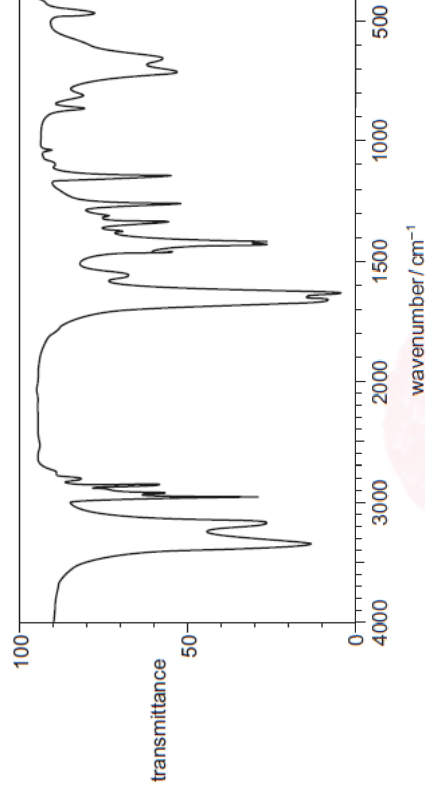
Topic Chem 22 Q# 1327/ AS Chemistry/2020(m/TZ.2/Paper.1/Exam Q# 27//www.SmashingScience.org :o)

27 Which reaction would produce propanoic acid as one of its products?

- A heating $(\text{CH}_3)_2\text{C}=\text{CHCH}_2\text{CH}_3$ with concentrated, acidified KMnO_4
- B heating $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3$ with $\text{NaOH}(\text{aq})$
- C heating $\text{CH}_3\text{CH}_2\text{OH}$ with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ under reflux
- D reacting CH_3CHO with HCN then heating the organic product with $\text{H}_2\text{SO}_4(\text{aq})$

Topic Chem 22 Q# 1328/ AS Chemistry/2020(m/TZ.2/Paper.1/Exam Q# 23//www.SmashingScience.org :o)

23 The infrared spectrum shown was obtained from a compound J.



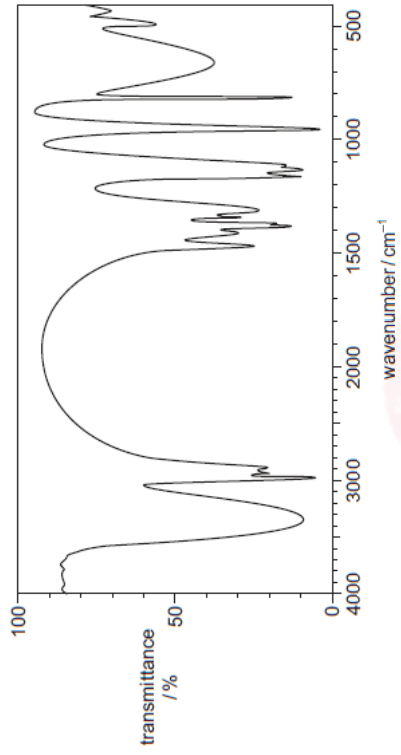
Which statement about J is correct?

- A Both $\text{C}=\text{O}$ and $\text{C}\equiv\text{N}$ are present.
- B Neither $\text{C}=\text{O}$ nor $\text{C}\equiv\text{N}$ are present.
- C $\text{C}=\text{O}$ is present but not $\text{C}\equiv\text{N}$.
- D $\text{C}\equiv\text{N}$ is present but not $\text{C}=\text{O}$.



Topic Chem 22 Q# 1329/ AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)

30 The infra-red spectrum of compound P is shown.

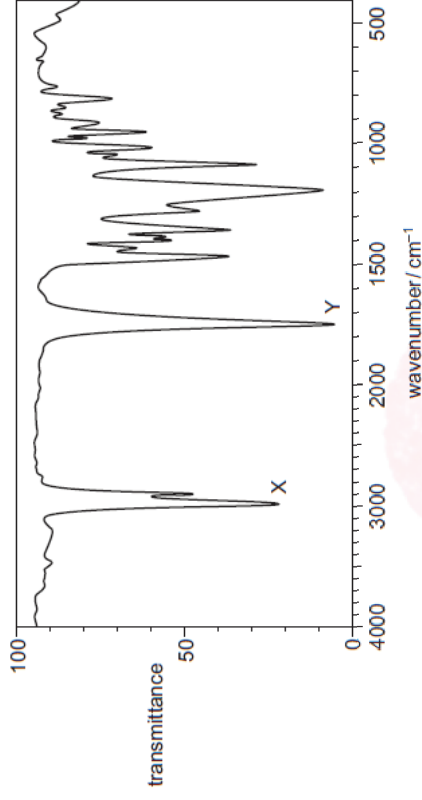


What could be compound P?

- A methyl ethanoate
- B propanal
- C propanoic acid
- D propan-2-ol

Topic Chem 22 Q# 1330/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)

24 The infra-red spectrum of a substance with empirical formula C_2H_4O is shown.

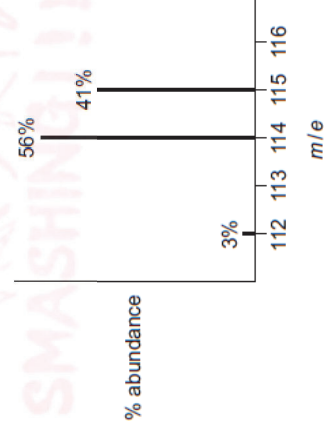


Which bonds are responsible for peak X and peak Y?

	peak X	peak Y
A	C-H	C=C
B	C-H	C=O
C	O-H	C=C
D	O-H	C=O

Topic Chem 22 Q# 1331/ AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)

2 A sample of element X is analysed using mass spectrometry. The mass spectrum obtained is shown.



What is the relative atomic mass of this sample of element X?

- A 113.7
- B 114.0
- C 114.2
- D 114.4



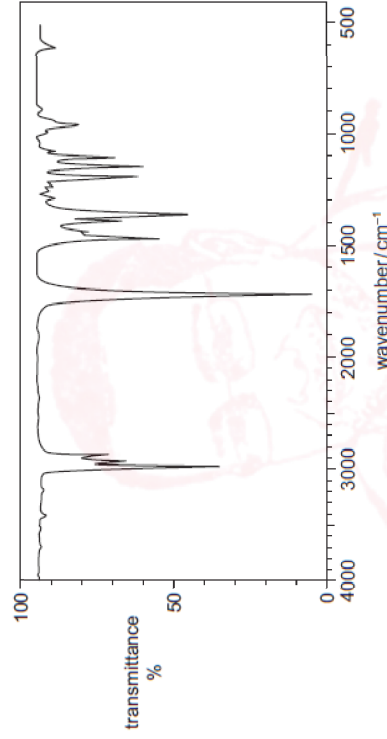
- 30 An infra-red spectrum shows a broad peak at 3000 cm^{-1} and a strong peak at 1710 cm^{-1} .

Which substance could have produced this spectrum?

- A methyl propanoate
- B propan-2-ol
- C propanoic acid
- D propanone

- 30 J is a branched-chain alcohol, $\text{C}_5\text{H}_{12}\text{O}$. J is heated under reflux with an excess of $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ until no further reaction occurs. An organic compound K is formed in good yield.

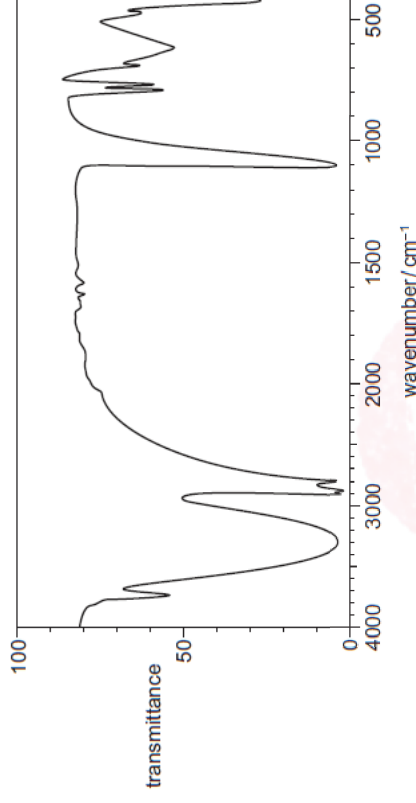
The infra-red spectrum of K is shown.



What are the structures of the branched-chain alcohol J and compound K?

	J	K
A	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{OH}$	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CHO}$
B	$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}_2\text{COCCH}_2\text{CH}_3$
C	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{OH})\text{CH}_3$	$\text{CH}_3\text{CH}(\text{CH}_3)\text{COCH}_3$
D	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{OH}$	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{COOH}$

- 30 Compound X contains three carbon atoms. Part of a simplified infra-red spectrum of compound X is shown.



Which compound could be X?

- A $\text{CH}_3\text{CH}_2\text{CHO}$
- B $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D $\text{CH}_3\text{CO}_2\text{CH}_3$

- 30 How many structural isomers with the molecular formula $\text{C}_4\text{H}_{10}\text{O}$ give infra-red absorptions both at approximately 1200 cm^{-1} and at approximately 3400 cm^{-1} ?

- A 2
- B 4
- C 6
- D 7

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 Beams of charged particles are deflected by an electric field. In identical conditions the angle of deflection of a particle is proportional to its charge / mass ratio.

In an experiment, protons are deflected by an angle of $+15^\circ$. In another experiment under identical conditions, particle Y is deflected by an angle of -5° .

What could be the composition of particle Y?

	protons	neutrons	electrons
1	1	2	2
2	3	3	5
3	4	5	1

Topic Chem 22 Q# 1337/ AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

31 A sample of boron contains aluminium as the only impurity. A mass spectrum of the mixture shows three lines corresponding to three ions, X^+ , Y^+ and Z^+ .

ion	X^+	Y^+	Z^+
m/e	10	11	27
percentage abundance	15.52	74.48	10.00

Which statements are correct?

- There are more electrons in Z^+ than in X^+ .
- The A_r of boron in the sample is 10.83 to four significant figures.
- There are more protons in Y^+ than in X^+ .

Mark Scheme

Q# 1/ Chem 1 AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)
4 | D

Q# 2/ Chem 1 AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
4 | D

Q# 3/ Chem 3 AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | B

Q# 4/ Chem 1 AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | B

Q# 5/ Chem 1 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | A

Q# 6/ Chem 1 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | A

Q# 7/ Chem 1 AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)
4 | B

Q# 8/ Chem 1 AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
3 | A

Q# 9/ Chem AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 7//www.SmashingScience.org :o)
7 | C

Q# 10/ Chem 1 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | C

Q# 11/ Chem 1 AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | D

Q# 12/ Chem 1 AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | A

Q# 13/ Chem 1 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
3 | C

Q# 14/ Chem 1 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | C

Q# 15/ Chem 1 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)
10 | A

Q# 16/ Chem 1 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | A

Q# 17/ Chem 1 AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
32 | D

Q# 18/ Chem 1 AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
31 | A

Q# 19/ Chem 1 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
31 | B

Q# 20/ Chem 1 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 32//www.SmashingScience.org :o)
32 | A

Q# 21/ Chem 1 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
3 | D

Q# 22/ Chem 1 AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)
31 | A

Q# 23/ Chem 1 AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | D

Q# 24/ Chem 1 AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 10//www.SmashingScience.org :o)
10 | D

Q# 25/ Chem 1 AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | A

Q# 26/ Chem 1 AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 4//www.SmashingScience.org :o)
4 | C

Q# 27/ Chem 1 AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 3//www.SmashingScience.org :o)
3 | C

Q# 28/ Chem 1 AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | A

Q# 29/ Chem 1 AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 2//www.SmashingScience.org :o)
2 | A

Q# 30/ Chem 1 AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 4//www.SmashingScience.org :o)
4 | C

Q# 31/ Chem 1 AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)
12 | A

Q# 32/ Chem 1 AS Chemistry/2017/m/TZ 2/Paper 1/Exam Q# 1//www.SmashingScience.org :o)
1 | C



Q# 101/ Chem 2 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 14//www.SmashingScience.org :o) **14** **B**

Q# 102/ Chem 2 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) **33** **D**

Q# 103/ Chem 2 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **A**

Q# 104/ Chem 2 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 12//www.SmashingScience.org :o) **12** **C**

Q# 105/ Chem 2 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o) **9** **C**

Q# 106/ Chem 2 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) **8** **D**

Q# 107/ Chem 2 AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) **2** **D**

Q# 108/ Chem 2 AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) **2** **D**

Q# 109/ Chem 2 AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o) **1** **D**

Q# 110/ Chem 3 AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **B**

Q# 111/ Chem 3 AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 112/ Chem 3 AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) **8** **A**

Q# 113/ Chem 3 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o) **7** **C**

Q# 114/ Chem 3 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **B**

Q# 115/ Chem 3 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **B**

Q# 116/ Chem 3 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **D**

Q# 117/ Chem 3 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 25//www.SmashingScience.org :o) **25** **D**

Q# 118/ Chem 3 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 119/ Chem 3 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 35//www.SmashingScience.org :o) **35** **D**

Q# 120/ Chem 3 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o) **34** **B**

Q# 121/ Chem 3 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 18//www.SmashingScience.org :o) **18** **A**

Q# 122/ Chem 3 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o) **34** **B**

Q# 123/ Chem 3 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o) **3** **B**

Q# 124/ Chem 3 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 125/ Chem 3 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 34//www.SmashingScience.org :o) **34** **A**

Q# 126/ Chem 3 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **B**

Q# 127/ Chem 3 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **A**

Q# 128/ Chem 3 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **A**

Q# 129/ Chem 3 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 19//www.SmashingScience.org :o) **19** **A**

Q# 130/ Chem 3 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 8//www.SmashingScience.org :o) **8** **C**

Q# 131/ Chem 3 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **A**

Q# 132/ Chem 3 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 3//www.SmashingScience.org :o) **3** **A**

Q# 133/ Chem 3 AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **B**

Q# 134/ Chem 3 AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o) **3** **D**

Q# 135/ Chem 3 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 136/ Chem 3 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **A**

Q# 137/ Chem 3 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **D**

Q# 138/ Chem 3 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **B**

Q# 139/ Chem 3 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **C**

Q# 140/ Chem 3 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 36//www.SmashingScience.org :o) **36** **A**

Q# 141/ Chem 3 AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **D**

Q# 142/ Chem 3 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **A**

Q# 143/ Chem 3 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **D**

Q# 144/ Chem 3 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) **2** **D**

Q# 145/ Chem 3 AS Chemistry/2018/m/TZ 2/Paper
1/Exam Q# 1//www.SmashingScience.org :o) **1** **D**

Q# 146/ Chem 3 AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **B**

Q# 147/ Chem 3 AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o) **1** **C**

Q# 148/ Chem 3 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 149/ Chem 3 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **C**

Q# 150/ Chem 3 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **A**

Q# 151/ Chem 3 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **A**

Q# 152/ Chem 3 AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) **7** **C**

Q# 153/ Chem 3 AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **C**

Q# 154/ Chem 3 AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) **2** **B**

Q# 155/ Chem 3 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **C**

Q# 156/ Chem 3 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 31//www.SmashingScience.org :o) **31** **B**

Q# 157/ Chem 3 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 15//www.SmashingScience.org :o) **15** **A**

Q# 158/ Chem 3 AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) **4** **A**

Q# 159/ Chem 3 AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **D**

Q# 160/ Chem 3 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) **5** **B**

Q# 161/ Chem 3 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) **6** **C**

Q# 162/ Chem 3 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **D**

Q# 163/ Chem 3 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o) **31** **C**

Q# 164/ Chem 3 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 14//www.SmashingScience.org :o) **14** **B**

Q# 165/ Chem 3 AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 35//www.SmashingScience.org :o) **35** **A**

Q# 166/ Chem 3 AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) **32** **C**

Q# 167/ Chem 3 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) **33** **B**



Q# 168/ Chem 3 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **B**

Q# 169/ Chem 3 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o) 31 | **B**

Q# 170/ Chem 3 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o) 3 | **D**

Q# 171/ Chem 3 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 12//www.SmashingScience.org :o) 12 | **B**

Q# 172/ Chem 3 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) 33 | **D**

Q# 173/ Chem 3 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o) 1 | **A**

Q# 174/ Chem 3 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) 4 | **C**

Q# 175/ Chem 3 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **D**

Q# 176/ Chem 3 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 13//www.SmashingScience.org :o) 13 | **A**

Q# 177/ Chem 3 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **B**

Q# 178/ Chem 3 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o) 11 | **C**

Q# 179/ Chem 3 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **C**

Q# 180/ Chem 3 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) 33 | **A**

Q# 181/ Chem 3 AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **B**

Q# 182/ Chem 3 AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) 4 | **C**

Q# 183/ Chem 3 AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **B**

Q# 184/ Chem 3 AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **C**

Q# 185/ Chem 4 AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **A**

Q# 186/ Chem 4 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **A**

Q# 187/ Chem 4 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **D**

Q# 188/ Chem 4 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) 33 | **A**

Q# 189/ Chem 4 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) 8 | **A**

Q# 190/ Chem 4 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **D**

Q# 191/ Chem 4 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 33//www.SmashingScience.org :o) 33 | **C**

Q# 192/ Chem 4 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **D**

Q# 193/ Chem 4 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) 4 | **D**

Q# 194/ Chem 4 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o) 33 | **D**

Q# 195/ Chem 4 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **B**

Q# 196/ Chem 4 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **B**

Q# 197/ Chem 4 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **A**

Q# 198/ Chem 4 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **B**

Q# 199/ Chem 4 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **B**

Q# 200/ Chem 4 AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **C**

Q# 201/ Chem 4 AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) 2 | **A**

Q# 202/ Chem 4 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **B**

Q# 203/ Chem 4 AS Chemistry/2018/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **C**

Q# 204/ Chem 4 AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **B**

Q# 205/ Chem 4 AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) 8 | **C**

Q# 206/ Chem 4 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **B**

Q# 207/ Chem 4 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **D**

Q# 208/ Chem 4 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **D**

Q# 209/ Chem 4 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) 2 | **D**

Q# 210/ Chem 4 AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **A**

Q# 211/ Chem 4 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **C**

Q# 212/ Chem 4 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 8//www.SmashingScience.org :o) 8 | **A**

Q# 213/ Chem 4 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **C**

Q# 214/ Chem 4 AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **C**

Q# 215/ Chem 4 AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **C**

Q# 216/ Chem 4 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) 4 | **A**

Q# 217/ Chem 4 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o) 34 | **C**

Q# 218/ Chem 4 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o) 4 | **D**

Q# 219/ Chem 4 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 2//www.SmashingScience.org :o) 2 | **B**

Q# 220/ Chem 4 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **A**

Q# 221/ Chem 4 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o) 10 | **C**

Q# 222/ Chem 4 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) 8 | **C**

Q# 223/ Chem 4 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **D**

Q# 224/ Chem 4 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o) 8 | **B**

Q# 225/ Chem 4 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o) 6 | **B**

Q# 226/ Chem 4 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o) 31 | **B**

Q# 227/ Chem 4 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o) 5 | **B**

Q# 228/ Chem 4 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o) 10 | **C**

Q# 229/ Chem 4 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o) 31 | **B**

Q# 230/ Chem 4 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o) 3 | **C**

Q# 231/ Chem 4 AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o) 7 | **C**

Q# 232/ Chem 4 AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o) 32 | **A**

Q# 233/ Chem 5 AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **C**

Q# 234/ Chem 5 AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o) 10 | **B**

Q# 235/ Chem 5 AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o) 9 | **D**



Q# 236/ Chem 5 AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
10 | C

Q# 237/ Chem 5 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | A

Q# 238/ Chem 5 AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 239/ Chem 5 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | C

Q# 240/ Chem 5 AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 241/ Chem 5 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
4 | D

Q# 242/ Chem 5 AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
32 | A

Q# 243/ Chem 5 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | A

Q# 244/ Chem 5 AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
32 | B

Q# 245/ Chem 5 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 246/ Chem 5 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
6 | C

Q# 247/ Chem 5 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
32 | D

Q# 248/ Chem 5 AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o)
31 | A

Q# 249/ Chem 5 AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o)
5 | C

Q# 250/ Chem 5 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
4 | C

Q# 251/ Chem 5 AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | D

Q# 252/ Chem 5 AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 253/ Chem 5 AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | A

Q# 254/ Chem 5 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 255/ Chem 5 AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | A

Q# 256/ Chem 5 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | D

Q# 257/ Chem 5 AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | C

Q# 258/ Chem 5 AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
6 | C

Q# 259/ Chem 5 AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | B

Q# 260/ Chem 5 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 261/ Chem 5 AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | D

Q# 262/ Chem 5 AS Chemistry/2018/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | B

Q# 263/ Chem 5 AS Chemistry/2018/m/TZ 2/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | B

Q# 264/ Chem 5 AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 265/ Chem 5 AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
11 | C

Q# 266/ Chem 5 AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | D

Q# 267/ Chem 5 AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | D

Q# 268/ Chem 5 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | C

Q# 269/ Chem 5 AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 270/ Chem 5 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | C

Q# 271/ Chem 5 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
33 | B

Q# 272/ Chem 5 AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 15//www.SmashingScience.org :o)
15 | C

Q# 273/ Chem 5 AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 274/ Chem 5 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 5//www.SmashingScience.org :o)
5 | D

Q# 275/ Chem 5 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
32 | D

Q# 276/ Chem 5 AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
10 | A

Q# 277/ Chem 5 AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 278/ Chem 5 AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
6 | D

Q# 279/ Chem 5 AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 280/ Chem 5 AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
11 | B

Q# 281/ Chem 5 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | A

Q# 282/ Chem 5 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | B

Q# 283/ Chem 5 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
32 | C

Q# 284/ Chem 5 AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o)
3 | B

Q# 285/ Chem 5 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o)
5 | B

Q# 286/ Chem 5 AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o)
3 | D

Q# 287/ Chem 5 AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
11 | B

Q# 288/ Chem 5 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | A

Q# 289/ Chem 5 AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 12//www.SmashingScience.org :o)
12 | D

Q# 290/ Chem 5 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
4 | A

Q# 291/ Chem 5 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
11 | A

Q# 292/ Chem 5 AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
10 | C

Q# 293/ Chem 5 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
7 | C

Q# 294/ Chem 5 AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 3//www.SmashingScience.org :o)
3 | D

Q# 295/ Chem 5 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
6 | C

Q# 296/ Chem 5 AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 19//www.SmashingScience.org :o)
19 | A

Q# 297/ Chem 5 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | C

Q# 298/ Chem 5 AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | D

Q# 299/ Chem 5 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
9 | B

Q# 300/ Chem 5 AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
8 | B

Q# 301/ Chem 5 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o)
5 | B

Q# 302/ Chem 5 AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
4 | C

Q# 303/ Chem 5 AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
6 | C



- Q# 304/ Chem 5** AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 8/ /www.SmashingScience.org :o) **8** | **C**
- Q# 305/ Chem 5** AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **D**
- Q# 306/ Chem 6** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 12/ /www.SmashingScience.org :o) **12** | **B**
- Q# 307/ Chem 6** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 11/ /www.SmashingScience.org :o) **11** | **C**
- Q# 308/ Chem 6** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 17/ /www.SmashingScience.org :o) **17** | **A**
- Q# 309/ Chem 6** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 12/ /www.SmashingScience.org :o) **12** | **C**
- Q# 310/ Chem 6** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 11/ /www.SmashingScience.org :o) **11** | **B**
- Q# 311/ Chem 6** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **A**
- Q# 312/ Chem 6** AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **C**
- Q# 313/ Chem 6** AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **D**
- Q# 314/ Chem 6** AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 8/ /www.SmashingScience.org :o) **8** | **C**
- Q# 315/ Chem 6** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **B**
- Q# 316/ Chem 6** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 8/ /www.SmashingScience.org :o) **8** | **A**
- Q# 317/ Chem 6** AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 8/ /www.SmashingScience.org :o) **8** | **B**
- Q# 318/ Chem 6** AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 2/ /www.SmashingScience.org :o) **2** | **C**
- Q# 319/ Chem 6** AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 5/ /www.SmashingScience.org :o) **5** | **D**
- Q# 320/ Chem 6** AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **D**
- Q# 321/ Chem 6** AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **D**
- Q# 322/ Chem 6** AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 6/ /www.SmashingScience.org :o) **6** | **A**
- Q# 323/ Chem 6** AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **B**
- Q# 324/ Chem 6** AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **D**
- Q# 325/ Chem 6** AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **B**
- Q# 326/ Chem 6** AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 8/ /www.SmashingScience.org :o) **8** | **C**
- Q# 327/ Chem 6** AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 7/ /www.SmashingScience.org :o) **7** | **B**
- Q# 328/ Chem 6** AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 14/ /www.SmashingScience.org :o) **14** | **D**
- Q# 329/ Chem 6** AS Chemistry/2018/m/TZ 2/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **D**
- Q# 330/ Chem 6** AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 6/ /www.SmashingScience.org :o) **6** | **A**
- Q# 331/ Chem 6** AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **A**
- Q# 332/ Chem 6** AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **B**
- Q# 333/ Chem 6** AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 17/ /www.SmashingScience.org :o) **17** | **A**
- Q# 334/ Chem 6** AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 36/ /www.SmashingScience.org :o) **36** | **A**
- Q# 335/ Chem 6** AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **B**
- Q# 336/ Chem 6** AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **A**
- Q# 337/ Chem 6** AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 3/ /www.SmashingScience.org :o) **3** | **D**
- Q# 338/ Chem 6** AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **C**
- Q# 339/ Chem 6** AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 1/ /www.SmashingScience.org :o) **1** | **A**
- Q# 340/ Chem 6** AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **B**
- Q# 341/ Chem 6** AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 4/ /www.SmashingScience.org :o) **4** | **B**
- Q# 342/ Chem 6** AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 2/ /www.SmashingScience.org :o) **2** | **D**
- Q# 343/ Chem 6** AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 3/ /www.SmashingScience.org :o) **3** | **B**
- Q# 344/ Chem 6** AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 2/ /www.SmashingScience.org :o) **2** | **A**
- Q# 345/ Chem 6** AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 16/ /www.SmashingScience.org :o) **16** | **C**
- Q# 346/ Chem 6** AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 11/ /www.SmashingScience.org :o) **11** | **B**
- Q# 347/ Chem 6** AS Chemistry/2012/w/TZ 1/Paper
1/Exam Q# 1/ /www.SmashingScience.org :o) **1** | **B**
- Q# 348/ Chem 6** AS Chemistry/2012/s/TZ 1/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **D**
- Q# 349/ Chem 6** AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 2/ /www.SmashingScience.org :o) **2** | **C**
- Q# 350/ Chem 6** AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 2/ /www.SmashingScience.org :o) **2** | **A**
- Q# 351/ Chem 6** AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 4/ /www.SmashingScience.org :o) **4** | **D**
- Q# 352/ Chem 6** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 6/ /www.SmashingScience.org :o) **6** | **D**
- Q# 353/ Chem 6** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **B**
- Q# 354/ Chem 6** AS Chemistry/2010/m/TZ 2/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **D**
- Q# 355/ Chem 6** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 7/ /www.SmashingScience.org :o) **7** | **D**
- Q# 356/ Chem 7** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 14/ /www.SmashingScience.org :o) **14** | **A**
- Q# 357/ Chem 7** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 13/ /www.SmashingScience.org :o) **13** | **B**
- Q# 358/ Chem 7** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 14/ /www.SmashingScience.org :o) **14** | **B**
- Q# 359/ Chem 7** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 13/ /www.SmashingScience.org :o) **13** | **D**
- Q# 360/ Chem 7** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 13/ /www.SmashingScience.org :o) **13** | **D**
- Q# 361/ Chem 7** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 12/ /www.SmashingScience.org :o) **12** | **A**
- Q# 362/ Chem 7** AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 32/ /www.SmashingScience.org :o) **32** | **D**
- Q# 363/ Chem 7** AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **B**
- Q# 364/ Chem 7** AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 31/ /www.SmashingScience.org :o) **31** | **A**
- Q# 365/ Chem 7** AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 9/ /www.SmashingScience.org :o) **9** | **B**
- Q# 366/ Chem 7** AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 31/ /www.SmashingScience.org :o) **31** | **B**
- Q# 367/ Chem 7** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 34/ /www.SmashingScience.org :o) **34** | **D**
- Q# 368/ Chem 7** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 33/ /www.SmashingScience.org :o) **33** | **A**
- Q# 369/ Chem 7** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 10/ /www.SmashingScience.org :o) **10** | **C**



- Q# 438/ Chem 7** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 15//www.SmashingScience.org :o)
- 15** | **A**
- Q# 439/ Chem 7** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **A**
- Q# 440/ Chem 7** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **D**
- Q# 441/ Chem 7** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 9//www.SmashingScience.org :o)
- 9** | **A**
- Q# 442/ Chem 7** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
- 8** | **D**
- Q# 443/ Chem 7** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
- 33** | **C**
- Q# 444/ Chem 7** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 17//www.SmashingScience.org :o)
- 17** | **A**
- Q# 445/ Chem 8** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 16//www.SmashingScience.org :o)
- 16** | **A**
- Q# 446/ Chem 8** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 15//www.SmashingScience.org :o)
- 15** | **A**
- Q# 447/ Chem 8** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 15//www.SmashingScience.org :o)
- 15** | **B**
- Q# 448/ Chem 8** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 16//www.SmashingScience.org :o)
- 16** | **B**
- Q# 449/ Chem 8** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 15//www.SmashingScience.org :o)
- 15** | **A**
- Q# 450/ Chem 8** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 451/ Chem 8** AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 31//www.SmashingScience.org :o)
- 31** | **A**
- Q# 452/ Chem 8** AS Chemistry/2021/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **D**
- Q# 453/ Chem 8** AS Chemistry/2021/s/TZ 1/Paper
1/Exam Q# 5//www.SmashingScience.org :o)
- 5** | **B**
- Q# 454/ Chem 8** AS Chemistry/2024/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 455/ Chem 8** AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **D**
- Q# 456/ Chem 8** AS Chemistry/2021/m/TZ 2/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **C**
- Q# 457/ Chem 8** AS Chemistry/2020/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 458/ Chem 8** AS Chemistry/2020/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
- 6** | **C**
- Q# 459/ Chem 8** AS Chemistry/2020/m/TZ 2/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **B**
- Q# 460/ Chem 8** AS Chemistry/2019/w/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **C**
- Q# 461/ Chem 8** AS Chemistry/2019/s/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **B**
- Q# 462/ Chem 8** AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **B**
- Q# 463/ Chem 8** AS Chemistry/2019/m/TZ 2/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **B**
- Q# 464/ Chem 8** AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **C**
- Q# 465/ Chem 8** AS Chemistry/2018/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 466/ Chem 8** AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
- 4** | **C**
- Q# 467/ Chem 8** AS Chemistry/2018/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **B**
- Q# 468/ Chem 8** AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 7//www.SmashingScience.org :o)
- 7** | **D**
- Q# 469/ Chem 8** AS Chemistry/2017/w/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **C**
- Q# 470/ Chem 8** AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **A**
- Q# 471/ Chem 8** AS Chemistry/2017/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **B**
- Q# 472/ Chem 8** AS Chemistry/2017/m/TZ 2/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **B**
- Q# 473/ Chem 8** AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 474/ Chem 8** AS Chemistry/2016/w/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **C**
- Q# 475/ Chem 8** AS Chemistry/2016/s/TZ 1/Paper
1/Exam Q# 37//www.SmashingScience.org :o)
- 37** | **B**
- Q# 476/ Chem 8** AS Chemistry/2016/m/TZ 2/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **C**
- Q# 477/ Chem 8** AS Chemistry/2015/w/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **D**
- Q# 478/ Chem 8** AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **D**
- Q# 479/ Chem 8** AS Chemistry/2015/s/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **D**
- Q# 480/ Chem 8** AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 33//www.SmashingScience.org :o)
- 33** | **B**
- Q# 481/ Chem 8** AS Chemistry/2014/w/TZ 1/Paper
1/Exam Q# 1//www.SmashingScience.org :o)
- 1** | **A**
- Q# 482/ Chem 8** AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
- 8** | **A**
- Q# 483/ Chem 8** AS Chemistry/2014/s/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **C**
- Q# 484/ Chem 8** AS Chemistry/2013/w/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
- 6** | **D**
- Q# 485/ Chem 8** AS Chemistry/2013/s/TZ 1/Paper
1/Exam Q# 8//www.SmashingScience.org :o)
- 8** | **D**
- Q# 486/ Chem 8** AS Chemistry/2011/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **A**
- Q# 487/ Chem 8** AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
- 6** | **A**
- Q# 488/ Chem 8** AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 4//www.SmashingScience.org :o)
- 4** | **C**
- Q# 489/ Chem 8** AS Chemistry/2011/s/TZ 1/Paper
1/Exam Q# 12//www.SmashingScience.org :o)
- 12** | **B**
- Q# 490/ Chem 8** AS Chemistry/2010/w/TZ 1/Paper
1/Exam Q# 32//www.SmashingScience.org :o)
- 32** | **C**
- Q# 491/ Chem 8** AS Chemistry/2010/s/TZ 1/Paper
1/Exam Q# 12//www.SmashingScience.org :o)
- 12** | **D**
- Q# 492/ Chem 8** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 34//www.SmashingScience.org :o)
- 34** | **B**
- Q# 493/ Chem 8** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 11//www.SmashingScience.org :o)
- 11** | **A**
- Q# 494/ Chem 8** AS Chemistry/2009/w/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **C**
- Q# 495/ Chem 8** AS Chemistry/2009/s/TZ 1/Paper
1/Exam Q# 10//www.SmashingScience.org :o)
- 10** | **C**
- Q# 496/ Chem 9** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 25//www.SmashingScience.org :o)
- 25** | **D**
- Q# 497/ Chem 9** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 19//www.SmashingScience.org :o)
- 19** | **A**
- Q# 498/ Chem 9** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 18//www.SmashingScience.org :o)
- 18** | **B**
- Q# 499/ Chem 9** AS Chemistry/2022/w/TZ 1/Paper
1/Exam Q# 17//www.SmashingScience.org :o)
- 17** | **C**
- Q# 500/ Chem 9** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 6//www.SmashingScience.org :o)
- 6** | **C**
- Q# 501/ Chem 9** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 23//www.SmashingScience.org :o)
- 23** | **D**
- Q# 502/ Chem 9** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 19//www.SmashingScience.org :o)
- 19** | **A**
- Q# 503/ Chem 9** AS Chemistry/2022/s/TZ 1/Paper
1/Exam Q# 18//www.SmashingScience.org :o)
- 18** | **C**
- Q# 504/ Chem 9** AS Chemistry/2022/m/TZ 2/Paper
1/Exam Q# 19//www.SmashingScience.org :o)
- 19** | **D**



Q# 771/ Chem 12 AS Chemistry/2016/m/TZ 2/Paper 1/Exam Q# 17//www.SmashingScience.org :o)	17	A
Q# 772/ Chem 12 AS Chemistry/2015/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)	19	A
Q# 773/ Chem 12 AS Chemistry/2015/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)	18	A
Q# 774/ Chem 12 AS Chemistry/2014/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)	35	A
Q# 775/ Chem 12 AS Chemistry/2013/w/TZ 1/Paper 1/Exam Q# 17//www.SmashingScience.org :o)	17	D
Q# 776/ Chem 12 AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25	D
Q# 777/ Chem 12 AS Chemistry/2012/w/TZ 1/Paper 1/Exam Q# 16//www.SmashingScience.org :o)	16	A
Q# 778/ Chem 12 AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)	5	C
Q# 779/ Chem 12 AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)	34	B
Q# 780/ Chem 12 AS Chemistry/2012/s/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)	19	C
Q# 781/ Chem 12 AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)	36	A
Q# 782/ Chem 12 AS Chemistry/2011/w/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)	34	A
Q# 783/ Chem 12 AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37	B
Q# 784/ Chem 12 AS Chemistry/2011/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)	18	C
Q# 785/ Chem 12 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 36//www.SmashingScience.org :o)	36	A
Q# 786/ Chem 12 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)	30	D
Q# 787/ Chem 12 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 15//www.SmashingScience.org :o)	15	D
Q# 788/ Chem 12 AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)	35	C
Q# 789/ Chem 12 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 35//www.SmashingScience.org :o)	35	C
Q# 790/ Chem 12 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)	19	A
Q# 791/ Chem 12 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)	18	A
Q# 792/ Chem 12 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 34//www.SmashingScience.org :o)	34	D
Q# 793/ Chem 12 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 18//www.SmashingScience.org :o)	18	C
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Q# 796/ Chem 13 AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27	B
Q# 797/ Chem 13 AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)	24	D
Q# 798/ Chem 13 AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 33//www.SmashingScience.org :o)	33	A
Q# 799/ Chem 13 AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)	24	D
Q# 800/ Chem 13 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39	C
Q# 801/ Chem 13 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 36//www.SmashingScience.org :o)	36	A
Q# 802/ Chem 13 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 26//www.SmashingScience.org :o)	26	C
Q# 803/ Chem 13 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)	6	B
Q# 804/ Chem 13 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)	23	C



Q# 805/ Chem 13 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)	23	C
Q# 806/ Chem 13 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 1//www.SmashingScience.org :o)	1	C
Q# 807/ Chem 13 AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	D
Q# 808/ Chem 13 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38	C
Q# 809/ Chem 13 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)	30	A
Q# 810/ Chem 13 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	D
Q# 811/ Chem 13 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)	31	B
Q# 812/ Chem 13 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 3//www.SmashingScience.org :o)	3	B
Q# 813/ Chem 13 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28	D
Q# 814/ Chem 13 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	C
Q# 815/ Chem 13 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org :o)	30	D
Q# 816/ Chem 13 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25	D
Q# 817/ Chem 13 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	B
Q# 818/ Chem 13 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 2//www.SmashingScience.org :o)	2	D
Q# 819/ Chem 13 AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 5//www.SmashingScience.org :o)	5	C
Q# 820/ Chem 13 AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37	B
Q# 821/ Chem 13 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org :o)	29	A
Q# 822/ Chem 13 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25	D
Q# 823/ Chem 13 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	A
Q# 824/ Chem 13 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	D
Q# 825/ Chem 13 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 31//www.SmashingScience.org :o)	31	C
Q# 826/ Chem 13 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	A
Q# 827/ Chem 13 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	C
Q# 828/ Chem 13 AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)	22	C
Q# 829/ Chem 13 AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	A
Q# 830/ Chem 13 AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	B
Q# 831/ Chem 13 AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	B
Q# 832/ Chem 13 AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	D
Q# 833/ Chem 13 AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37	B
Q# 834/ Chem 13 AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org :o)	21	A
Q# 835/ Chem 13 AS Chemistry/2017/w/TZ 1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20	C
Q# 836/ Chem 13 AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org :o)	6	A
Q# 837/ Chem 13 AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37	B



Q# 1038/ Chem 16 AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38 B	Q# 1072/ Chem 17 AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20 A	Q# 1088/ Chem 17 AS Chemistry/2018/m/TZ.2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 A
Q# 1039/ Chem 16 AS Chemistry/2012/w/TZ.1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)	24 C	Q# 1073/ Chem 17 AS Chemistry/2020/m/TZ.2/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37 A	Q# 1089/ Chem 17 AS Chemistry/2018/m/TZ.2/Paper 1/Exam Q# 26//www.SmashingScience.org :o)	26 A
Q# 1040/ Chem 16 AS Chemistry/2012/s/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38 A	Q# 1074/ Chem 17 AS Chemistry/2020/m/TZ.2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 D	Q# 1090/ Chem 17 AS Chemistry/2018/m/TZ.2/Paper 1/Exam Q# 23//www.SmashingScience.org :o)	23 A
Q# 1041/ Chem 16 AS Chemistry/2012/s/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20 D	Q# 1075/ Chem 17 AS Chemistry/2019/w/TZ.1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 A	Q# 1091/ Chem 17 AS Chemistry/2017/w/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)	40 A
Q# 1042/ Chem 16 AS Chemistry/2012/s/TZ.1/Paper 1/Exam Q# 12//www.SmashingScience.org :o)	12 C	Q# 1076/ Chem 17 AS Chemistry/2019/s/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38 B	Q# 1092/ Chem 17 AS Chemistry/2017/w/TZ.1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 C
Q# 1043/ Chem 16 AS Chemistry/2011/w/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 C	Q# 1077/ Chem 17 AS Chemistry/2019/s/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)	29 A	Q# 1093/ Chem 17 AS Chemistry/2017/w/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 C
Q# 1044/ Chem 16 AS Chemistry/2011/w/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25 C	Q# 1078/ Chem 17 AS Chemistry/2019/s/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 A	Q# 1094/ Chem 17 AS Chemistry/2017/w/TZ.1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)	26 B
Q# 1045/ Chem 16 AS Chemistry/2011/w/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20 C	Q# 1079/ Chem 17 AS Chemistry/2019/s/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 A	Q# 1095/ Chem 17 AS Chemistry/2017/s/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)	29 A
Q# 1046/ Chem 16 AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)	40 A	Q# 1080/ Chem 17 AS Chemistry/2019/m/TZ.2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 A	Q# 1096/ Chem 17 AS Chemistry/2017/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25 D
Q# 1047/ Chem 16 AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 31//www.SmashingScience.org :o)	31 D	Q# 1081/ Chem 17 AS Chemistry/2019/m/TZ.2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 D	Q# 1097/ Chem 17 AS Chemistry/2017/s/TZ.1/Paper 1/Exam Q# 20//www.SmashingScience.org :o)	20 B
Q# 1048/ Chem 16 AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25 B	Q# 1082/ Chem 17 AS Chemistry/2019/m/TZ.2/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 C	Q# 1098/ Chem 17 AS Chemistry/2017/m/TZ.2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 A
Q# 1049/ Chem 16 AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 23//www.SmashingScience.org :o)	23 B	Q# 1083/ Chem 17 AS Chemistry/2018/w/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)	40 B	Q# 1099/ Chem 17 AS Chemistry/2017/m/TZ.2/Paper 1/Exam Q# 29//www.SmashingScience.org :o)	29 B
Q# 1050/ Chem 16 AS Chemistry/2011/s/TZ.1/Paper 1/Exam Q# 19//www.SmashingScience.org :o)	19 C	Q# 1084/ Chem 17 AS Chemistry/2018/w/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 A	Q# 1100/ Chem 17 AS Chemistry/2017/m/TZ.2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 D
Q# 1051/ Chem 16 AS Chemistry/2010/w/TZ.1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37 D	Q# 1085/ Chem 17 AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)	40 A	Q# 1101/ Chem 17 AS Chemistry/2016/w/TZ.1/Paper 1/Exam Q# 40//www.SmashingScience.org :o)	40 B
Q# 1052/ Chem 16 AS Chemistry/2010/w/TZ.1/Paper 1/Exam Q# 24//www.SmashingScience.org :o)	24 B	Q# 1086/ Chem 17 AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 26//www.SmashingScience.org :o)	26 B	Q# 1102/ Chem 17 AS Chemistry/2016/w/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 B
Q# 1053/ Chem 16 AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)	29 B	Q# 1087/ Chem 17 AS Chemistry/2018/s/TZ.1/Paper 1/Exam Q# 25//www.SmashingScience.org :o)	25 C	Q# 1103/ Chem 17 AS Chemistry/2016/s/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 B
Q# 1054/ Chem 16 AS Chemistry/2010/s/TZ.1/Paper 1/Exam Q# 22//www.SmashingScience.org :o)	22 B	Q# 1062/ Chem 17 AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	39 D		
Q# 1055/ Chem 16 AS Chemistry/2009/s/TZ.1/Paper 1/Exam Q# 29//www.SmashingScience.org :o)	29 D	Q# 1063/ Chem 17 AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38 B		
		Q# 1064/ Chem 17 AS Chemistry/2021/s/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 B		
		Q# 1065/ Chem 17 AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 39//www.SmashingScience.org :o)	40 B		
		Q# 1066/ Chem 17 AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 D		
		Q# 1067/ Chem 17 AS Chemistry/2021/m/TZ.2/Paper 1/Exam Q# 26//www.SmashingScience.org :o)	26 C		
		Q# 1068/ Chem 17 AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 28//www.SmashingScience.org :o)	28 A		
		Q# 1069/ Chem 17 AS Chemistry/2020/w/TZ.1/Paper 1/Exam Q# 27//www.SmashingScience.org :o)	27 C		
		Q# 1070/ Chem 17 AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 38//www.SmashingScience.org :o)	38 B		
		Q# 1071/ Chem 17 AS Chemistry/2020/s/TZ.1/Paper 1/Exam Q# 37//www.SmashingScience.org :o)	37 C		



Q# 1305/ Chem 21 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org .o)	38	B
Q# 1306/ Chem 21 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org .o)	27	B
Q# 1307/ Chem 21 AS Chemistry/2010/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org .o)	23	B
Q# 1308/ Chem 21 AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org .o)	40	B
Q# 1309/ Chem 21 AS Chemistry/2010/s/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org .o)	37	A
Q# 1310/ Chem 21 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 39//www.SmashingScience.org .o)	39	C
Q# 1311/ Chem 21 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 27//www.SmashingScience.org .o)	27	B
Q# 1312/ Chem 21 AS Chemistry/2009/w/TZ 1/Paper 1/Exam Q# 23//www.SmashingScience.org .o)	23	C
Q# 1313/ Chem 21 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 6//www.SmashingScience.org .o)	6	D
Q# 1314/ Chem 21 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 38//www.SmashingScience.org .o)	38	B
Q# 1315/ Chem 21 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 28//www.SmashingScience.org .o)	28	C
Q# 1316/ Chem 21 AS Chemistry/2009/s/TZ 1/Paper 1/Exam Q# 25//www.SmashingScience.org .o)	25	B
Q# 1317/ Chem 22 AS Chemistry/2022/w/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org .o)	40	D
Q# 1318/ Chem 22 AS Chemistry/2022/s/TZ 1/Paper 1/Exam Q# 40//www.SmashingScience.org .o)	40	A
Q# 1319/ Chem 22 AS Chemistry/2022/m/TZ 2/Paper 1/Exam Q# 40//www.SmashingScience.org .o)	40	B
Q# 1320/ Chem 22 AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	B
Q# 1321/ Chem 22 AS Chemistry/2021/w/TZ 1/Paper 1/Exam Q# 11//www.SmashingScience.org .o)	1	A

Q# 1322/ Chem 22 AS Chemistry/2021/s/TZ 1/Paper 1/Exam Q# 26//www.SmashingScience.org .o)	26	A
Q# 1323/ Chem 22 AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 38//www.SmashingScience.org .o)	38	B
Q# 1324/ Chem 22 AS Chemistry/2021/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	B
Q# 1325/ Chem 22 AS Chemistry/2020/w/TZ 1/Paper 1/Exam Q# 37//www.SmashingScience.org .o)	37	B
Q# 1326/ Chem 22 AS Chemistry/2020/s/TZ 1/Paper 1/Exam Q# 29//www.SmashingScience.org .o)	29	A
Q# 1327/ Chem 22 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 27//www.SmashingScience.org .o)	27	A
Q# 1328/ Chem 22 AS Chemistry/2020/m/TZ 2/Paper 1/Exam Q# 23//www.SmashingScience.org .o)	23	C
Q# 1329/ Chem 22 AS Chemistry/2019/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	D
Q# 1330/ Chem 22 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 24//www.SmashingScience.org .o)	24	B
Q# 1331/ Chem 22 AS Chemistry/2019/s/TZ 1/Paper 1/Exam Q# 21//www.SmashingScience.org .o)	2	D
Q# 1332/ Chem 22 AS Chemistry/2019/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	C
Q# 1333/ Chem 22 AS Chemistry/2018/w/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	C
Q# 1334/ Chem 22 AS Chemistry/2018/s/TZ 1/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	C
Q# 1335/ Chem 22 AS Chemistry/2018/m/TZ 2/Paper 1/Exam Q# 30//www.SmashingScience.org .o)	30	B
Q# 1336/ Chem 22 AS Chemistry/2017/s/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org .o)	31	B
Q# 1337/ Chem 22 AS Chemistry/2016/w/TZ 1/Paper 1/Exam Q# 31//www.SmashingScience.org .o)	31	B

2016 Data Booklet and Periodic Table

The Data Booklet was used for all Paper 1, 2 and 4 exams until and including winter 2021.

Two Data Booklets cover the time period of this Work Book, one for exams after 2009 and the other for exam after 2016. Only the data booklet for 2016 is given here, but for exam questions for years 2009 to 2015 care should be taken checking the mark schemes, sometimes constants change from one edition of a Data Booklet to another, so **answers to calculations using data from an unintended Data Booklet might be a little out as a result.** If unsure, check out the earlier data booklet for questions 2015 and before (Google: "2009 data booklet 9701").

Contents: Tables of Chemical Data

1	Important values, constants and standards	3
2	Ionisation energies (1st, 2nd, 3rd and 4th) of selected elements in kJ mol⁻¹	4
3	Bond energies	5
4	Standard electrode potential and redox potentials, E^o at 298K (25 °C)	7
5	Atomic and ionic radii	10
6	Typical proton (¹H) chemical shift values (δ) relative to TMS = 0	12
7	Typical carbon (¹³C) chemical shift values (δ) relative to TMS = 0	13
8	Characteristic infra-red absorption frequencies for some selected bonds	14
9	The orientating effect of groups in aromatic substitution reactions	15
10	Names, structures and abbreviations of some amino acids	16
11	The Periodic Table of Elements	17

1 Important values, constants and standards

molar gas constant	$R = 8.31 \text{ JK}^{-1} \text{ mol}^{-1}$
the Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
the Avogadro constant	$L = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
rest mass of proton, ${}^1_1\text{H}$	$m_p = 1.67 \times 10^{-27} \text{ kg}$
rest mass of neutron, ${}^1_0\text{n}$	$m_n = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron, ${}^0_{-1}\text{e}$	$m_e = 9.11 \times 10^{-31} \text{ kg}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ under room conditions (where s.t.p. is expressed as 101 kPa, approximately, and 273K [0 °C])
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K [25 °C])
specific heat capacity of water	$= 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ ($= 4.18 \text{ J g}^{-1} \text{ K}^{-1}$)



2016 Data Booklet and Periodic Table

The Data Booklet was used for all Paper 1, 2 and 4 exams until and including winter 2021.

Two Data Booklets cover the time period of this Work Book, one for exams after 2009 and the other for exam safter 2016. Only the data booklet for 2016 is given here, but for exam questions for years 2009 to 2015 care should be taken checking the mark schemes, sometimes constants change from one edition of a Data Booklet to another, so **answers to calculations using data from an unintended Data Booklet might be a little out** as a result. If unsure, check out the earlier data booklet for questions 2015 and before (Google: "2009 data booklet 9701").

Contents: Tables of Chemical Data

	Page no.
1	3
2	4
3	5
4	7
5	10
6	12
7	13
8	14
9	15
10	16
11	17

1 Important values, constants and standards

molar gas constant	$R = 8.31 \text{ JK}^{-1} \text{ mol}^{-1}$
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rest mass of neutron, ${}^1_0\text{n}$	$m_n = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron, ${}^0_{-1}\text{e}$	$m_e = 9.11 \times 10^{-31} \text{ kg}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ under room conditions (where s.t.p. is expressed as 101 kPa, approximately, and 273 K [0 °C])
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K [25 °C])
specific heat capacity of water	$= 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ ($= 4.18 \text{ J g}^{-1} \text{ K}^{-1}$)



2 Ionisation energies (1st, 2nd, 3rd and 4th) of selected elements, in kJ mol^{-1}

	Proton number	First	Second	Third	Fourth
H	1	1310	–	–	–
He	2	2370	5250	–	–
Li	3	519	7300	11800	–
Be	4	900	1760	14800	21000
B	5	799	2420	3660	25000
C	6	1090	2350	4610	6220
N	7	1400	2860	4590	7480
O	8	1310	3390	5320	7450
F	9	1680	3370	6040	8410
Ne	10	2080	3950	6150	9290
Na	11	494	4560	6940	9540
Mg	12	736	1450	7740	10500
Al	13	577	1820	2740	11600
Si	14	786	1580	3230	4360
P	15	1060	1900	2920	4960
S	16	1000	2260	3390	4540
Cl	17	1260	2300	3850	5150
Ar	18	1520	2660	3950	5770
K	19	418	3070	4600	5860
Ca	20	590	1150	4940	6480
Sc	21	632	1240	2390	7110
Ti	22	661	1310	2720	4170
V	23	648	1370	2870	4600
Cr	24	653	1590	2990	4770
Mn	25	716	1510	3250	5190
Fe	26	762	1560	2960	5400
Co	27	757	1640	3230	5100
Ni	28	736	1750	3390	5400
Cu	29	745	1960	3350	5690
Zn	30	908	1730	3828	5980
Ga	31	577	1980	2960	6190
Br	35	1140	2080	3460	4850
Rb	37	403	2632	3900	5080
Sr	38	548	1060	4120	5440
Ag	47	731	2074	3361	5000
I	53	1010	1840	3000	4030
Cs	55	376	2420	3300	4400
Ba	56	502	966	3390	4700



3 Bond Energies

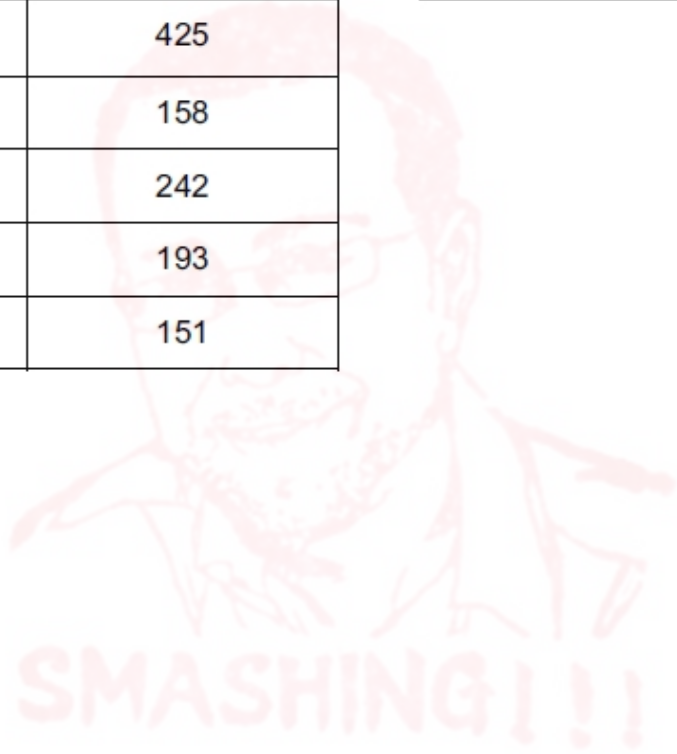
3(a) Bond energies in diatomic molecules (these are exact values)

Homonuclear

Bond	Energy / kJ mol^{-1}
H—H	436
D—D	442
N≡N	944
O=O	496
P≡P	485
S=S	425
F—F	158
Cl—Cl	242
Br—Br	193
I—I	151

Heteronuclear

Bond	Energy / kJ mol^{-1}
H—F	562
H—Cl	431
H—Br	366
H—I	299
C≡O	1077



3(b) Bond energies in polyatomic molecules (these are average values)

Homonuclear

Bond	Energy / kJ mol^{-1}
C—C	350
C=C	610
C≡C	840
C \cdots C (benzene)	520
N—N	160
N=N	410
O—O	150
Si—Si	225
P—P	200
S—S	265

Heteronuclear

Bond	Energy / kJ mol^{-1}
C—H	410
C—Cl	340
C—Br	280
C—I	240
C—N	305
C=N	610
C≡N	890
C—O	360
C=O	740
C=O in CO_2	805
N—H	390
N—Cl	310
O—H	460
Si—Cl	360
Si—H	320
Si—O (in $\text{SiO}_2(\text{s})$)	460
Si=O (in $\text{SiO}_2(\text{g})$)	640
P—H	320
P—Cl	330
P—O	340
P=O	540
S—H	340
S—Cl	250
S—O	360
S=O	500



4 Standard electrode potential and redox potentials, E^\ominus at 298 K (25°C)

For ease of reference, two tables are given:

- (a) an extended list in alphabetical order;
 (b) a shorter list in decreasing order of magnitude, i.e. a redox series.

(a) E^\ominus in alphabetical order

Electrode reaction	E^\ominus / V
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0.80
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1.66
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2.90
$\text{Br}_2 + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1.07
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2.87
$\text{Cl}_2 + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1.36
$2\text{HOCl} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Cl}_2 + 2\text{H}_2\text{O}$	+1.64
$\text{ClO}^- + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{Cl}^- + 2\text{OH}^-$	+0.89
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0.28
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+1.82
$[\text{Co}(\text{NH}_3)_6]^{2+} + 2\text{e}^- \rightleftharpoons \text{Co} + 6\text{NH}_3$	-0.43
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0.91
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0.74
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0.41
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0.52
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0.34
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0.15
$[\text{Cu}(\text{NH}_3)_4]^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu} + 4\text{NH}_3$	-0.05
$\text{F}_2 + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2.87
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0.44
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0.04
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0.77
$[\text{Fe}(\text{CN})_6]^{3-} + \text{e}^- \rightleftharpoons [\text{Fe}(\text{CN})_6]^{4-}$	+0.36
$\text{Fe}(\text{OH})_3 + \text{e}^- \rightleftharpoons \text{Fe}(\text{OH})_2 + \text{OH}^-$	-0.56
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2$	0.00
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2 + 2\text{OH}^-$	-0.83
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0.54
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2.92
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3.04
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2.38
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1.18
$\text{Mn}^{3+} + \text{e}^- \rightleftharpoons \text{Mn}^{2+}$	+1.49
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1.23
$\text{MnO}_4^- + \text{e}^- \rightleftharpoons \text{MnO}_4^{2-}$	+0.56
$\text{MnO}_4^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{MnO}_2 + 2\text{H}_2\text{O}$	+1.67
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.52
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2 + \text{H}_2\text{O}$	+0.81
$\text{NO}_3^- + 3\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{HNO}_2 + \text{H}_2\text{O}$	+0.94
$\text{NO}_3^- + 10\text{H}^+ + 8\text{e}^- \rightleftharpoons \text{NH}_4^+ + 3\text{H}_2\text{O}$	+0.87



Electrode reaction	E^\ominus/V
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2.71
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0.25
$[\text{Ni}(\text{NH}_3)_6]^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni} + 6\text{NH}_3$	-0.51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.77
$\text{HO}_2^- + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons 3\text{OH}^-$	+0.88
$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.23
$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0.40
$\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0.68
$\text{O}_2 + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{HO}_2^- + \text{OH}^-$	-0.08
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0.13
$\text{Pb}^{4+} + 2\text{e}^- \rightleftharpoons \text{Pb}^{2+}$	+1.69
$\text{PbO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Pb}^{2+} + 2\text{H}_2\text{O}$	+1.47
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2 + 2\text{H}_2\text{O}$	+0.17
$\text{S}_2\text{O}_8^{2-} + 2\text{e}^- \rightleftharpoons 2\text{SO}_4^{2-}$	+2.01
$\text{S}_4\text{O}_6^{2-} + 2\text{e}^- \rightleftharpoons 2\text{S}_2\text{O}_3^{2-}$	+0.09
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0.14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0.15
$\text{V}^{2+} + 2\text{e}^- \rightleftharpoons \text{V}$	-1.20
$\text{V}^{3+} + \text{e}^- \rightleftharpoons \text{V}^{2+}$	-0.26
$\text{VO}^{2+} + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	+0.34
$\text{VO}_2^+ + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O}$	+1.00
$\text{VO}_3^- + 4\text{H}^+ + \text{e}^- \rightleftharpoons \text{VO}^{2+} + 2\text{H}_2\text{O}$	+1.00
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0.76

All ionic states refer to aqueous ions but other state symbols have been omitted.



(b) E^\ominus in decreasing order of oxidising power

(a selection only – see also the extended alphabetical list on the previous pages)

Electrode reaction	E^\ominus / V
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$	+2.01
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1.77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.52
$PbO_2 + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$	+1.47
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07
$ClO^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89
$NO_3^- + 10H^+ + 8e^- \rightleftharpoons NH_4^+ + 3H_2O$	+0.87
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0.81
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54
$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	+0.40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.15
$S_4O_6^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$	+0.09
$2H^+ + 2e^- \rightleftharpoons H_2$	0.00
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	-0.13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	-0.14
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	-0.44
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0.76
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$	-0.83
$V^{2+} + 2e^- \rightleftharpoons V$	-1.20
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2.38
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	-2.87
$K^+ + e^- \rightleftharpoons K$	-2.92




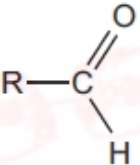
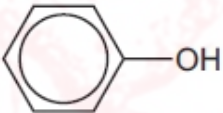
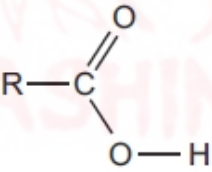
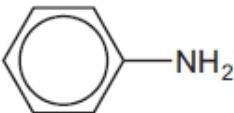
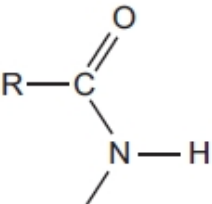
5 Atomic and ionic radii

(a) Period 1	atomic / nm		ionic / nm			
single covalent	H	0.037	H ⁻	0.208		
van der Waals	He	0.140				
(b) Period 2	atomic / nm		ionic / nm			
metallic	Li	0.152	Li ⁺	0.060		
	Be	0.112	Be ²⁺	0.031		
single covalent	B	0.080	B ³⁺	0.020		
	C	0.077	C ⁴⁺	0.015	C ⁴⁻	0.260
	N	0.074			N ³⁻	0.171
	O	0.073			O ²⁻	0.140
	F	0.072			F ⁻	0.136
van der Waals	Ne	0.160				
(c) Period 3	atomic / nm		ionic / nm			
metallic	Na	0.186	Na ⁺	0.095		
	Mg	0.160	Mg ²⁺	0.065		
	Al	0.143	Al ³⁺	0.050		
single covalent	Si	0.117	Si ⁴⁺	0.041	Si ⁴⁻	0.271
	P	0.110			P ³⁻	0.212
	S	0.104			S ²⁻	0.184
	Cl	0.099			Cl ⁻	0.181
van der Waals	Ar	0.190				
(d) Group 2	atomic / nm		ionic / nm			
metallic	Be	0.112	Be ²⁺	0.031		
	Mg	0.160	Mg ²⁺	0.065		
	Ca	0.197	Ca ²⁺	0.099		
	Sr	0.215	Sr ²⁺	0.113		
	Ba	0.217	Ba ²⁺	0.135		
	Ra	0.220	Ra ²⁺	0.140		




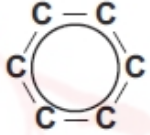
(e) Group 14	atomic / nm	ionic / nm	
single covalent	C 0.077		
	Si 0.117	Si ⁴⁺	0.041
	Ge 0.122	Ge ²⁺	0.093
metallic	Sn 0.162	Sn ²⁺	0.112
	Pb 0.175	Pb ²⁺	0.120
(f) Group 17	atomic / nm	ionic / nm	
single covalent	F 0.072	F ⁻	0.136
	Cl 0.099	Cl ⁻	0.181
	Br 0.114	Br ⁻	0.195
	I 0.133	I ⁻	0.216
	At 0.140		
(g) First row transition elements	atomic / nm	ionic / nm	
metallic	Sc 0.164		Sc ³⁺ 0.081
	Ti 0.146	Ti ²⁺ 0.090	Ti ³⁺ 0.067
	V 0.135	V ²⁺ 0.079	V ³⁺ 0.064
	Cr 0.129	Cr ²⁺ 0.073	Cr ³⁺ 0.062
	Mn 0.132	Mn ²⁺ 0.067	Mn ³⁺ 0.062
	Fe 0.126	Fe ²⁺ 0.061	Fe ³⁺ 0.055
	Co 0.125	Co ²⁺ 0.078	Co ³⁺ 0.053
	Ni 0.124	Ni ²⁺ 0.070	Ni ³⁺ 0.056
	Cu 0.128	Cu ²⁺ 0.073	
	Zn 0.135	Zn ²⁺ 0.075	

6 Typical proton (^1H) chemical shift values (δ) relative to TMS = 0

type of proton	environment of proton	example structures	chemical shift range (δ)
C-H	alkane	$-\text{CH}_3, -\text{CH}_2-, >\text{CH}-$	0.9–1.7
	alkyl next to C=O	$\text{CH}_3-\text{C}=\text{O}, -\text{CH}_2-\text{C}=\text{O}, >\text{CH}-\text{C}=\text{O}$	2.2–3.0
	alkyl next to aromatic ring	$\text{CH}_3-\text{Ar}, -\text{CH}_2-\text{Ar}, >\text{CH}-\text{Ar}$	2.3–3.0
	alkyl next to electronegative atom	$\text{CH}_3-\text{O}, -\text{CH}_2-\text{O}, -\text{CH}_2-\text{Cl}, >\text{CH}-\text{Br}$	3.2–4.0
	attached to alkyne	$\equiv\text{C}-\text{H}$	1.8–3.1
	attached to alkene	$=\text{CH}_2, =\text{CH}-$	4.5–6.0
	attached to aromatic ring		6.0–9.0
	aldehyde		9.3–10.5
O-H (see note below)	alcohol	$\text{RO}-\text{H}$	0.5–6.0
	phenol		4.5–7.0
	carboxylic acid		9.0–13.0
N-H (see note below)	alkyl amine	$\text{R}-\text{NH}-$	1.0–5.0
	aryl amine		3.0–6.0
	amide		5.0–12.0

Note: δ values for $-\text{O}-\text{H}$ and $-\text{N}-\text{H}$ protons can vary depending on solvent and concentration

7 Typical carbon (^{13}C) chemical shift values (δ) relative to TMS = 0

hybridisation of the carbon atom	environment of carbon atom	example structures	chemical shift range (δ)
sp^3	alkyl	CH_3- , $-\text{CH}_2-$, $-\text{CH}<$, $>\text{C}<$	0–50
sp^3	next to alkene/arene	$-\text{C}-\text{C}=\text{C}$, $-\text{C}$ - 	10–40
sp^3	next to carbonyl/carboxyl	$-\text{C}-\text{COR}$, $-\text{C}-\text{CO}_2\text{R}$	25–50
sp^3	next to nitrogen	$-\text{C}-\text{NH}_2$, $-\text{C}-\text{NR}_2$, $-\text{C}-\text{NHCO}$	30–65
sp^3	next to chlorine ($-\text{CH}_2\text{-Br}$ and $-\text{CH}_2\text{-I}$ are in the same range as alkyl)	$-\text{C}-\text{Cl}$	30–60
sp^3	next to oxygen	$-\text{C}-\text{OH}$, $-\text{C}-\text{O}-\text{CO}-$	50–70
sp^2	alkene or arene	$>\text{C}=\text{C}<$, 	110–160
sp^2	carboxyl	$\text{R}-\text{CO}_2\text{H}$, $\text{R}-\text{CO}_2\text{R}$	160–185
sp^2	carbonyl	$\text{R}-\text{CHO}$, $\text{R}-\text{CO}-\text{R}$	190–220
sp	alkyne	$\text{R}-\text{C}\equiv\text{C}-$	65–85
sp	nitrile	$\text{R}-\text{C}\equiv\text{N}$	100–125

8 Characteristic infra-red absorption frequencies for some selected bonds

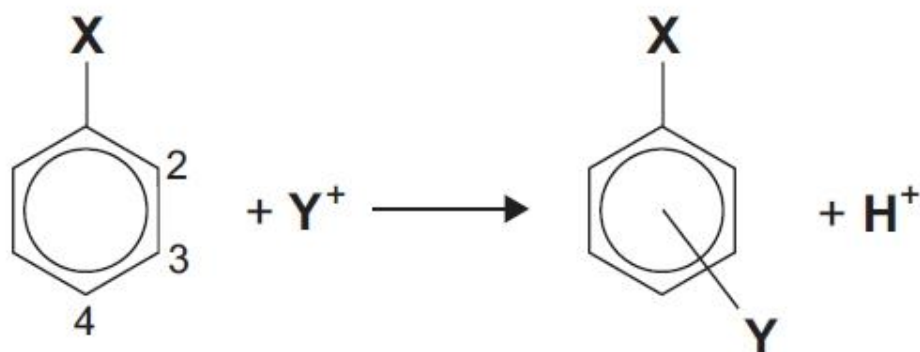
bond	functional groups containing the bond	absorption range (in wavenumbers) /cm ⁻¹	appearance of peak (s = strong, w = weak)
C–O	alcohols, ethers, esters	1040–1300	s
C=C	aromatic compounds, alkenes	1500–1680	w unless conjugated
C=O	amides, ketones and aldehydes, carboxylic acids, esters	1640–1690	s
		1670–1740	s
		1680–1730	s
		1710–1750	s
C≡C	alkynes	2150–2250	w unless conjugated
C≡N	nitriles	2200–2250	w
C–H	alkanes, CH ₂ –H alkenes/arenes, =C–H	2850–2950	s
		3000–3100	w
N–H	amines, amides	3300–3500	w
O–H	carboxylic acids, RCO ₂ –H H-bonded alcohol, RO–H free alcohol, RO–H	2500–3000	s and very broad
		3200–3600	s
		3580–3650	s and sharp

SMASHING!!!



9 The orientating effect of groups in aromatic substitution reactions.

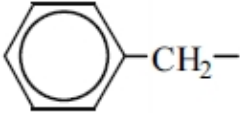
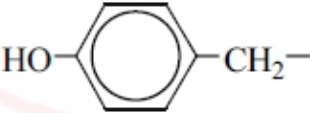
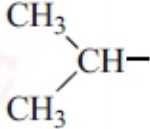
The position of the incoming group, Y, is determined by the nature of the group, X, already bonded to the ring, and not by the nature of the incoming group Y.



X- groups that direct the incoming Y group to the 2- or 4- positions	X- groups that direct the incoming Y group to the 3- position
-NH ₂ , -NHR or -NR ₂	-NO ₂
-OH or -OR	-NH ₃ ⁺
-NHCOR	-CN
-CH ₃ , -alkyl	-CHO, -COR
-Cl	-CO ₂ H, -CO ₂ R

SMASHING!!!

10 Names, structures and abbreviations of some amino acids

name	3-letter abbreviation	1-letter symbol	structure of side chain R- in
			$\begin{array}{c} \text{NH}_2 \\ \\ \text{R}-\text{CH} \\ \\ \text{CO}_2\text{H} \end{array}$
alanine	Ala	A	CH ₃ -
aspartic acid	Asp	D	HO ₂ CCH ₂ -
cysteine	Cys	C	HSCH ₂ -
glutamic acid	Glu	E	HO ₂ CCH ₂ CH ₂ -
glycine	Gly	G	H-
lysine	Lys	K	H ₂ NCH ₂ CH ₂ CH ₂ CH ₂ -
phenylalanine	Phe	F	
serine	Ser	S	HOCH ₂ -
tyrosine	Tyr	Y	
valine	Val	V	

Important values, constants and standards (2022 and after)

Important values, constants and standards

molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
Avogadro constant	$L = 6.022 \times 10^{23} \text{ mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K (25°C))
specific heat capacity of water	$c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (4.18 J g ⁻¹ K ⁻¹)



Periodic table

The Periodic Table of Elements

Group																																					
1	2											13	14	15	16	17	18																				
3	4	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> Key atomic number atomic symbol name relative atomic mass </div> <div style="border: 1px solid black; padding: 5px;"> 1 H hydrogen 1.0 </div> </div>																2	18																		
11	12																	17	18																		
Li lithium 6.9	Be beryllium 9.0																	F fluorine 19.0	Ne neon 20.2																		
Na sodium 23.0	Mg magnesium 24.3																	Cl chlorine 35.5	Ar argon 39.9																		
19	20																	35	36																		
K potassium 39.1	Ca calcium 40.1																	Br bromine 79.9	Kr krypton 83.8																		
37	38																	53	54																		
Rb rubidium 85.5	Sr strontium 87.6																	I iodine 126.9	Xe xenon 131.3																		
55	56																	85	86																		
Cs caesium 132.9	Ba barium 137.3																	At astatine —	Rn radon —																		
87	88																	—	—																		
Fr francium —	Ra radium —																	—	—																		
57	58																	67	68	69	70	71															
La lanthanum 138.9	Ce cerium 140.1																	Ho holmium 164.9	Er erbium 167.3	Tm thulium 168.9	Yb ytterbium 173.1	Lu lutetium 175.0															
89	90																	99	100	101	102	103															
Ac actinium —	Th thorium 232.0																	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —															
63	64																	72	73	74	75	76	77	78	79	80											
Eu europium 152.0	Gd gadolinium 157.3																	Yb ytterbium 173.1	Lu lutetium 175.0	—	—	—	—	—	—	—	—	—	—	—							
93	94																	103	104	105	106	107	108	109	110	111	112										
Np neptunium —	Pu plutonium —																	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

