

ALyl Chem 20 EQ P1 22w to 09s Paper 1 Polymerisation 27marks

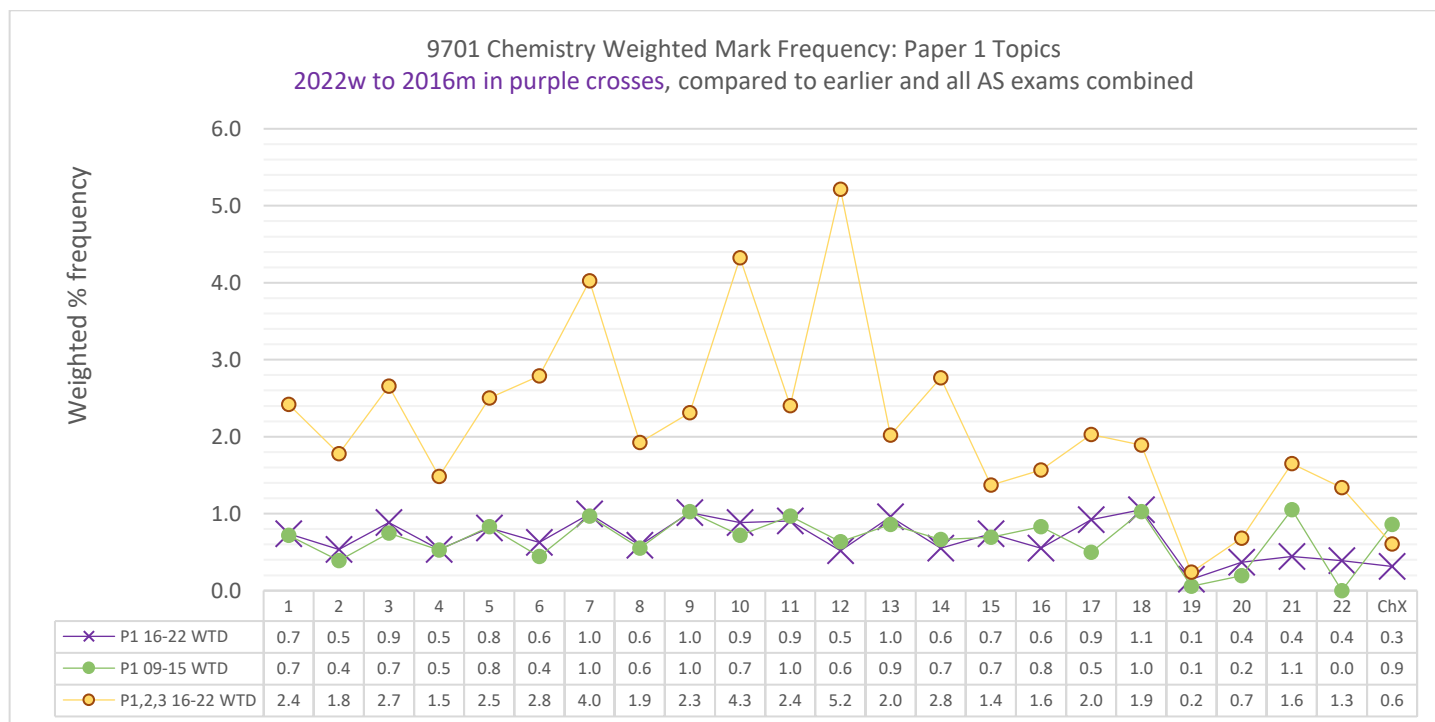
As you start and work through this worksheet you can tick off your progress to show yourself how much you have done, and what you need to do next. The first task is just to read the first question and should take you less than one minutes to complete.

Paper 1 Topic 20

Checklist Tick each task off as you go along

RANK:

		P1 Noob	P1 Novice	P1 Bronze	P1 Silver	P1 Gold	P1 ¹ Winner	P1 Hero	P1 Legend
		1 Q started	1 Q done	10% of marks	25% of marks	40% of marks	50% of marks	75% of marks	100% of marks
Topic (marks)	27		1	3	7	11	14	20	27
Time @75s/mark (minutes)	34		1	3	8	14	17	25	34



What the most thoughtful students will get out of their extensive studying will be a capacity to do meaningful brain-based work even under stressful conditions, which is a part of the self-mastery skillset that will continue to deliver value for the whole of their lives. Outstanding grades will also happen, but the most important goal from skillful action in study is being better at any important task, even if circumstances do not feel ideal.

As you are moving through your studies you can learn more about yourself by trying out new ways to manage yourself, and analysing how effective those new techniques were. In this reflective process not only will you get better at working positively and productively to deliver ambitious and successful outcomes, but you will be working towards one aspect of life's highest pursuit, summarised and inscribed on the Temple of Apollo at Delphi: "know thyself".

- To complete these questions, as important as your answer, is checking your answer against the mark scheme.
- For each page or group of 10 questions, convert your mark score into a percentage. This will allow you to see (and feel) your progress as you get more experience and understanding with each topic.
- Multiple choice questions, done carefully where you explain and show yourself your thinking using written notes as you move through each question, can be more useful than just Paper 2 for students aiming for a C or B grade. Paper 2 should be the larger focus for students aiming for A and A* grades, however.
- If you find you get a higher percentage answering short answer questions than multiple choice questions that often means you are NOT using the marking scheme correctly; your correct answer might not be fully complete for all the marks you are awarding. The marks easiest to miss rely on providing the largest amount of detail.

¹ **DO NOT** work on these higher levels of completion in your A2 year unless you have also achieved at least a "Silver" (25%) in the same topic in **Paper 2**, which is **MOST** of your **AS grade**, and Paper 3 which is a smaller part of your year but still important.

20 Polymerisation

20.1 Addition polymerisation

Learning outcomes

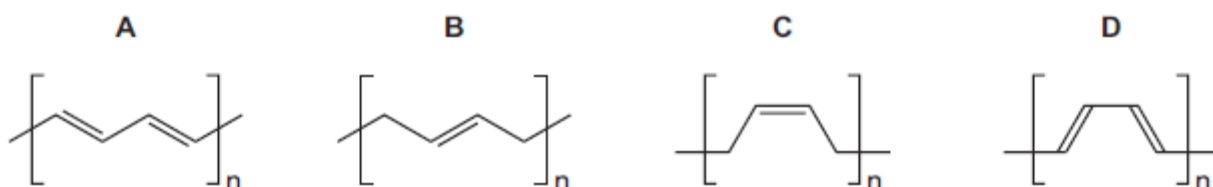
Candidates should be able to:

- 1 describe addition polymerisation as exemplified by poly(ethene) and poly(chloroethene), PVC
- 2 deduce the repeat unit of an addition polymer obtained from a given monomer
- 3 identify the monomer(s) present in a given section of an addition polymer molecule
- 4 recognise the difficulty of the disposal of poly(alkene)s, i.e. non-biodegradability and harmful combustion products

Q# 1232/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 39//www.SmashingScience.org :o)

- 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)?



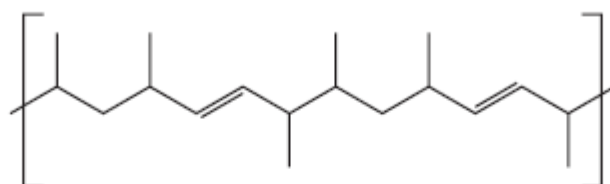
Q# 1233/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 5//www.SmashingScience.org :o)

- 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, C_3H_8
- C silicon tetrachloride, SiCl_4
- D sulfur hexafluoride, SF_6

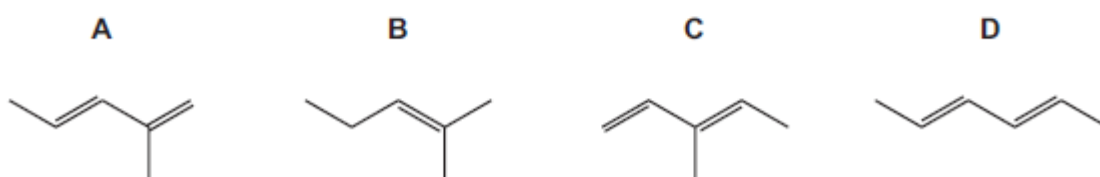
Q# 1234/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 39//www.SmashingScience.org :o)

- 39 The diagram shows a section of an addition polymer formed from two different monomers.

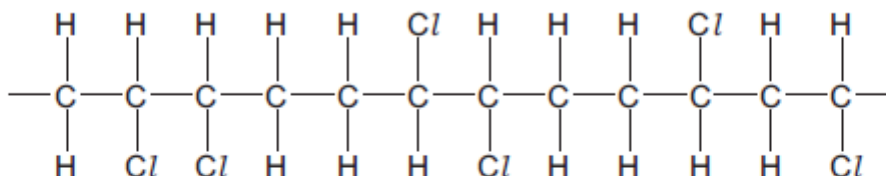


One of the monomers is propene.

What is the other monomer?



37 A molecule of a polymer contains the sequence shown.



Which monomer could produce this polymer by addition polymerisation?

- A $\text{CHCl}=\text{CHCl}$
- B $\text{CH}_2=\text{CHCl}$
- C $\text{CH}_3\text{CCl}=\text{CHCl}$
- D $\text{CH}_3\text{CCl}=\text{CH}_2$

22 Which statement is correct when referring to the complete combustion of PVC?

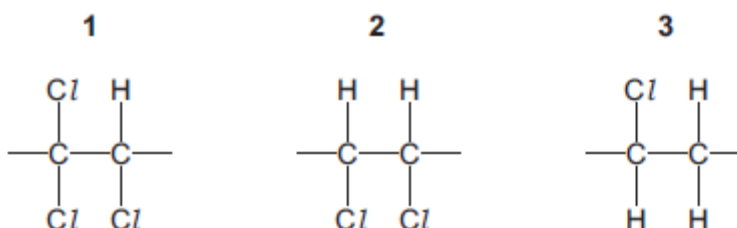
- A A gas is made which contributes to global warming.
- B Carbon dioxide and water are the only products.
- C If water is used to clean the exhaust gases, the water becomes alkaline.
- D There is no need to treat the exhaust gases as the products are non-hazardous.

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

A	B	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 mixture of the three isomers of $\text{C}_2\text{H}_2\text{Cl}_2$ is polymerised.

Which sequences will be seen within the polymer chains?



Q# 1238/ AS Chemistry/2020/s/TZ 1/Paper 1/Q# 24//www.SmashingScience.org :o)

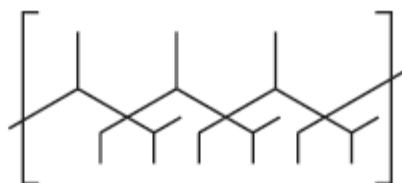
24 Poly(propene) is an addition polymer.

What are the C–C–C bond angles along its polymer chain?

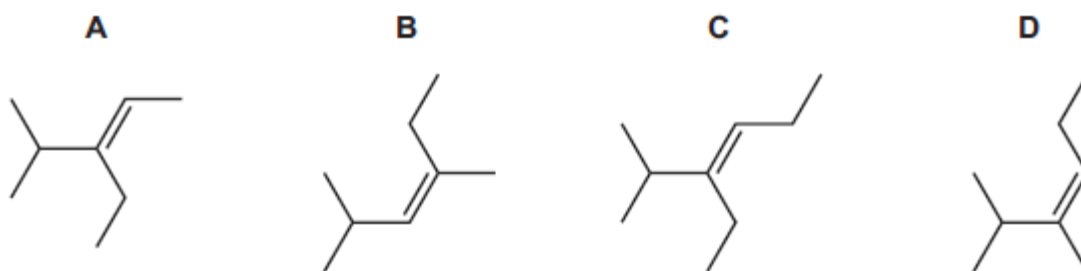
- A They are all 109°.
- B Half of them are 109° and half are 120°.
- C Half of them are 90° and half are 180°.
- D They are all 120°.

Q# 1239/ AS Chemistry/2020/m/TZ 2/Paper 1/Q# 24//www.SmashingScience.org :o)

24 A section of a polymer chain is shown.



What is the correct monomer?



Q# 1240/ AS Chemistry/2019/s/TZ 1/Paper 1/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 about poly(alkene)s are correct?

- 1 Poly(alkene)s do not react with Br₂(aq) in the dark.
- 2 Disposal of poly(alkene)s by combustion can produce harmful products.
- 3 Poly(alkene)s do not readily biodegrade.

Q# 1241/ AS Chemistry/2018/s/TZ 1/Paper 1/Q# 37//www.SmashingScience.org :o)

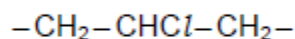
The responses **A** to **D** should be selected on the basis of

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 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

Q# 1242/ AS Chemistry/2018/m/TZ 2/Paper 1/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.

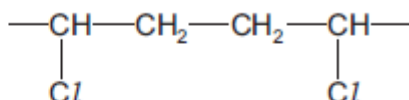
Q# 1243/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 3//

3 In which structure are three atoms bonded together in a straight line?

- A poly(ethene), $-(\text{CH}_2\text{CH}_2)_n-$
- B propane, C_3H_8
- C silicon tetrachloride, SiCl_4
- D sulfur hexafluoride, SF_6

Q# 1244/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 23//

23 A section of an addition polymer chain is shown.

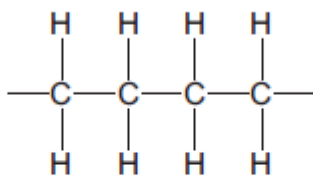


Which monomer could be used to make this polymer?

- A $\text{CH}_2\text{CHCH}_2\text{Cl}$
- B CH_2CHCl
- C CH_3CHCHCl
- D $\text{CHClCHCH}_2\text{CH}_2\text{Cl}$



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

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)

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?

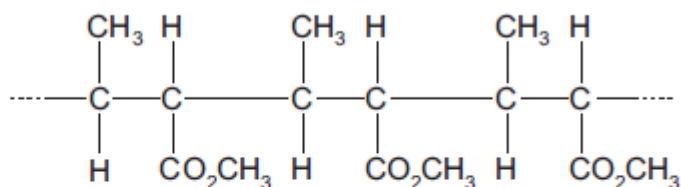
	rate of biodegradation of PVC in landfill sites	gases produced when PVC combusts
A	fast	CO ₂ , H ₂ O, HCl
B	fast	CO ₂ , H ₂ O, Cl ₂
C	slow	CO ₂ , H ₂ O, Cl ₂
D	slow	CO ₂ , H ₂ O, HCl

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

A	B	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?

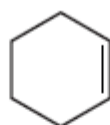
- 1 aqueous sulfuric acid
- 2 aqueous sodium hydroxide
- 3 sodium

Q# 1249/ AS Chemistry/2016/s/TZ 1/Paper 1/Q# 38//www.SmashingScience.org :o)

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

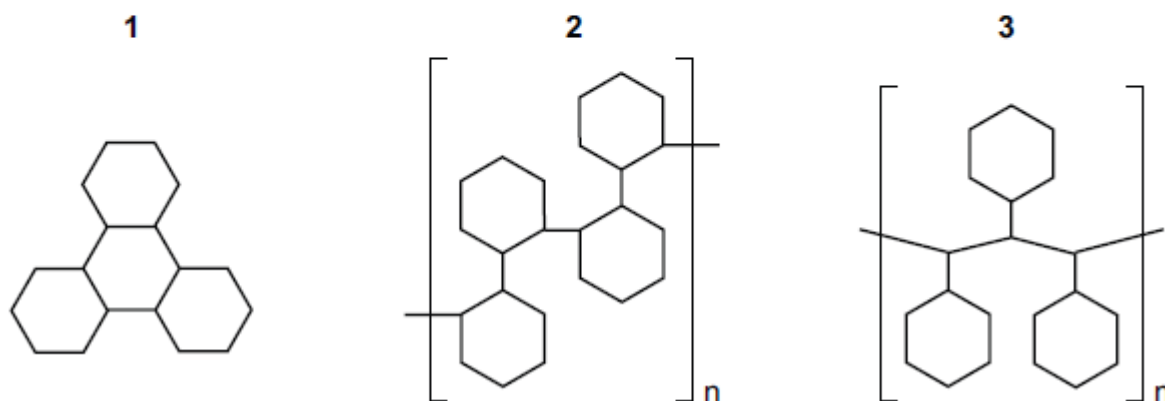
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

38 The diagram shows the structure of cyclohexene.



cyclohexene

Which structures could be formed by addition reactions with cyclohexene as the only reactant?



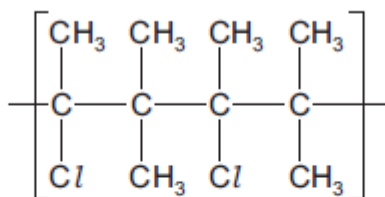
Q# 1250/ AS Chemistry/2016/m/TZ 2/Paper 1/Q# 29//www.SmashingScience.org :o)

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.

Q# 1251/ AS Chemistry/2016/m/TZ 2/Paper 1/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-chloropent-2-ene
- D 2,4-dichloro-3,3,4,5-tetramethylhexane

Q# 1252/ AS Chemistry/2013/w/TZ 1/Paper 1/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

Q# 1253/ AS Chemistry/2013/s/TZ 1/Paper 1/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 $-\text{CH}_2-\text{CH}-\text{CH}_2-\text{OH}-$
- B $-\text{CH}_2-\underset{\text{CH}_2\text{OH}}{\text{CH}}-$
- C $-\text{CH}=\underset{\text{CH}_2\text{OH}}{\text{C}}-$
- D $-\text{CH}_2-\text{CH}-\underset{\text{OH}}{\text{CH}_2}-$

Q# 1254/ AS Chemistry/2012/s/TZ 1/Paper 1/Q# 30//www.SmashingScience.org :o)

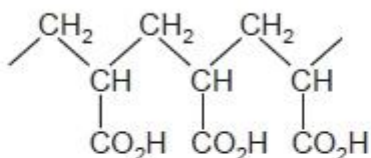
30 Which statement does **not** correctly describe the polymer PVC?

- 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 $-(\text{CHClCHCl})-$.



Q# 1255/ AS Chemistry/2010/w/TZ 1/Paper 1/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 $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$
 - B $\text{HOCH}_2\text{CH}_2\text{CO}_2\text{H}$
 - C $\text{H}_2\text{C}=\text{CHCO}_2\text{H}$
 - D $\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$
- Q# 1256/ AS Chemistry/2010/s/TZ 1/Paper 1/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.
- Q# 1257/ AS Chemistry/2009/w/TZ 1/Paper 1/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 $\frac{1}{6.02 \times 10^{23}}$



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

Mark Scheme **ALvl Chem 20 EQ P1 22w to 09s Paper 1 Polymerisation 27mark**

Q# 1232/ AS Chemistry/2022/w/TZ 1/Paper 1/Q#

39//www.SmashingScience.org :o)

39 | C

Q# 1233/ AS Chemistry/2022/s/TZ 1/Paper 1/Q#

5//www.SmashingScience.org :o)

5 | D

Q# 1234/ AS Chemistry/2022/s/TZ 1/Paper 1/Q#

39//www.SmashingScience.org :o)

39 | D

Q# 1235/ AS Chemistry/2022/m/TZ 2/Paper 1/Q#

37//www.SmashingScience.org :o)

37 | B

Q# 1236/ AS Chemistry/2020/w/TZ 1/Paper 1/Q#

22//www.SmashingScience.org :o)

22 | A

Q# 1237/ AS Chemistry/2020/s/TZ 1/Paper 1/Q#

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40 | A

Q# 1238/ AS Chemistry/2020/s/TZ 1/Paper 1/Q#

24//www.SmashingScience.org :o)

24 | A

Q# 1239/ AS Chemistry/2020/m/TZ 2/Paper 1/Q#

24//www.SmashingScience.org :o)

24 | A

Q# 1240/ AS Chemistry/2019/s/TZ 1/Paper 1/Q#

37//www.SmashingScience.org :o)

37 | A

Q# 1241/ AS Chemistry/2018/s/TZ 1/Paper 1/Q#

37//www.SmashingScience.org :o)

37 | C

Q# 1242/ AS Chemistry/2018/m/TZ 2/Paper 1/Q#

37//www.SmashingScience.org :o)

37 | A

Q# 1243/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 3//

3 | D

Q# 1244/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 23//

23 | B

Q# 1245/ AS Chemistry/2017/s/TZ 1/Paper 1/Q#

23//www.SmashingScience.org :o)

23 | B

Q# 1246/ AS Chemistry/2017/m/TZ 2/Paper 1/Q#

24//www.SmashingScience.org :o)

24 | B

Q# 1247/ AS Chemistry/2016/w/TZ 1/Paper 1/Q#

22//www.SmashingScience.org :o)

22 | D

Q# 1248/ AS Chemistry/2016/s/TZ 1/Paper 1/Q#

40//www.SmashingScience.org :o)

40 | B

Q# 1249/ AS Chemistry/2016/s/TZ 1/Paper 1/Q#

38//www.SmashingScience.org :o)

38 | B

Q# 1250/ AS Chemistry/2016/m/TZ 2/Paper 1/Q#

29//www.SmashingScience.org :o)

29 | A

Q# 1251/ AS Chemistry/2016/m/TZ 2/Paper 1/Q#

22//www.SmashingScience.org :o)

22 | B

Q# 1252/ AS Chemistry/2013/w/TZ 1/Paper 1/Q#

30//www.SmashingScience.org :o)

30 | A

Q# 1253/ AS Chemistry/2013/s/TZ 1/Paper 1/Q# 29//:o)

29 | B

Q# 1254/ AS Chemistry/2012/s/TZ 1/Paper 1/Q# 30//:o)

30 | D

Q# 1255/ AS Chemistry/2010/w/TZ 1/Paper 1/Q# 20//:o)

20 | C

Q# 1256/ AS Chemistry/2010/s/TZ 1/Paper 1/Q# 26//:o)

26 | D

Q# 1257/ AS Chemistry/2009/w/TZ 1/Paper 1/Q# 31//:o)

31 | C

Q# 1258/ AS Chemistry/2009/s/TZ 1/Paper 1/Q# 23//:o)

23 | B

