Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3013059835

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
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Answer **all** questions.
Electronic calculators may be used.
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The number of marks is given in brackets [ ] at the end of each question or part question.

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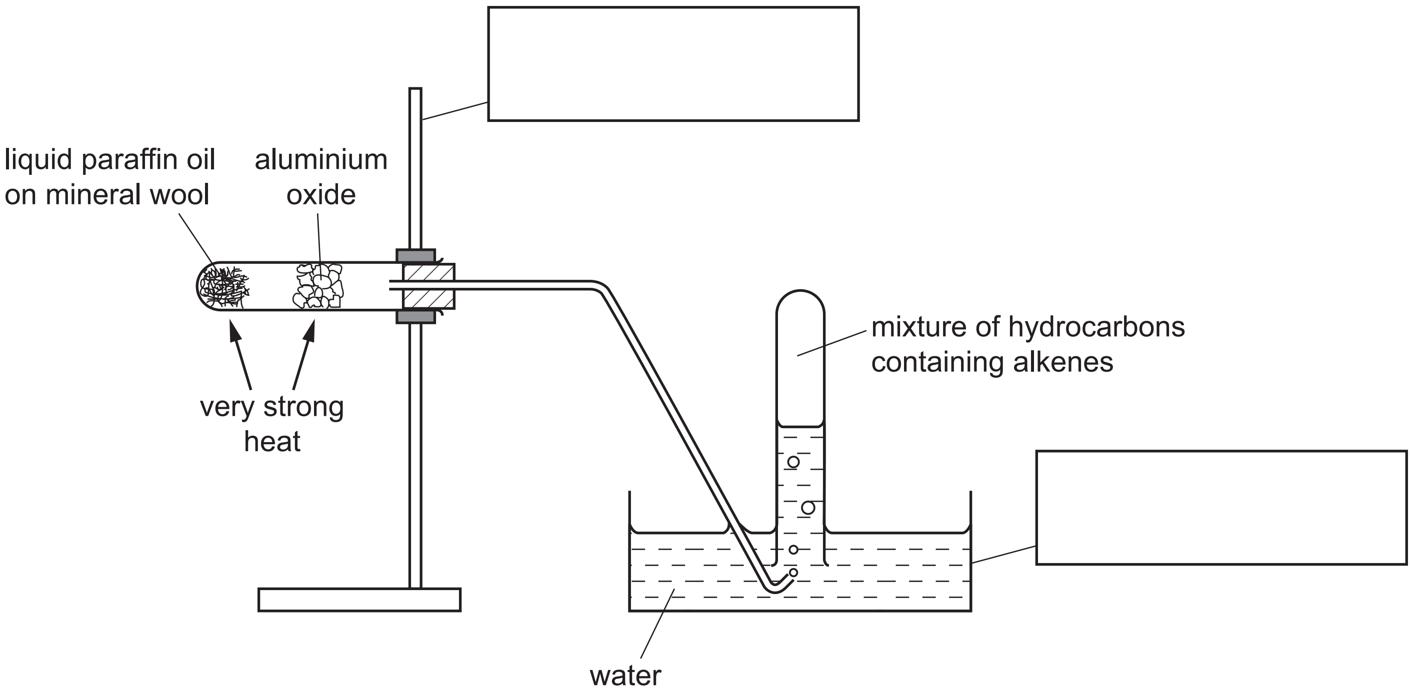
This document consists of **8** printed pages and **4** blank pages.

IB16 11_0620_63/3RP

CAMBRIDGE International Examinations

[Turn over

1 The diagram shows the apparatus used to crack paraffin oil. Paraffin oil vapour is passed over heated aluminium oxide to produce a mixture of hydrocarbons containing alkenes.



(a) Complete the boxes to name the apparatus. [2]

(b) What is the purpose of the mineral wool?

....

.... [1]

(c) Give a test to show the presence of alkenes.

test ....

result ....
[2]

(d) Why must the delivery tube be removed from the water when the heating is stopped?

.... [1]

[Total: 6]

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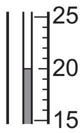
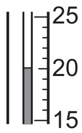
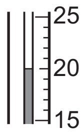
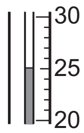
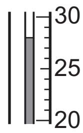
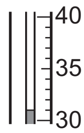
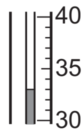
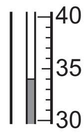
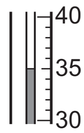
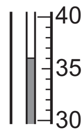
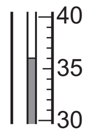
2 A student investigated what happened when two different metals, iron and magnesium, reacted with aqueous copper(II) sulfate.
Two experiments were carried out.

(a) *Experiment 1*

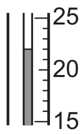
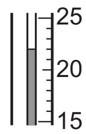
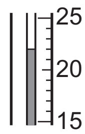
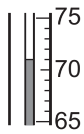
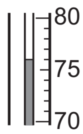
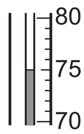
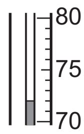
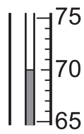
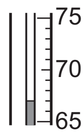
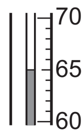
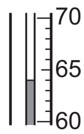
A measuring cylinder was used to pour 25 cm^3 of aqueous copper(II) sulfate into a polystyrene cup. The initial temperature of the solution was measured, then again at 30 seconds and at 60 seconds.
At 60 seconds, the iron was added to the aqueous copper(II) sulfate and the mixture stirred continuously with a thermometer.
The temperature of the mixture was measured every 30 seconds for 300 seconds (5 minutes).
Use the thermometer diagrams to record the results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
thermometer diagram											
temperature / °C											

[2]

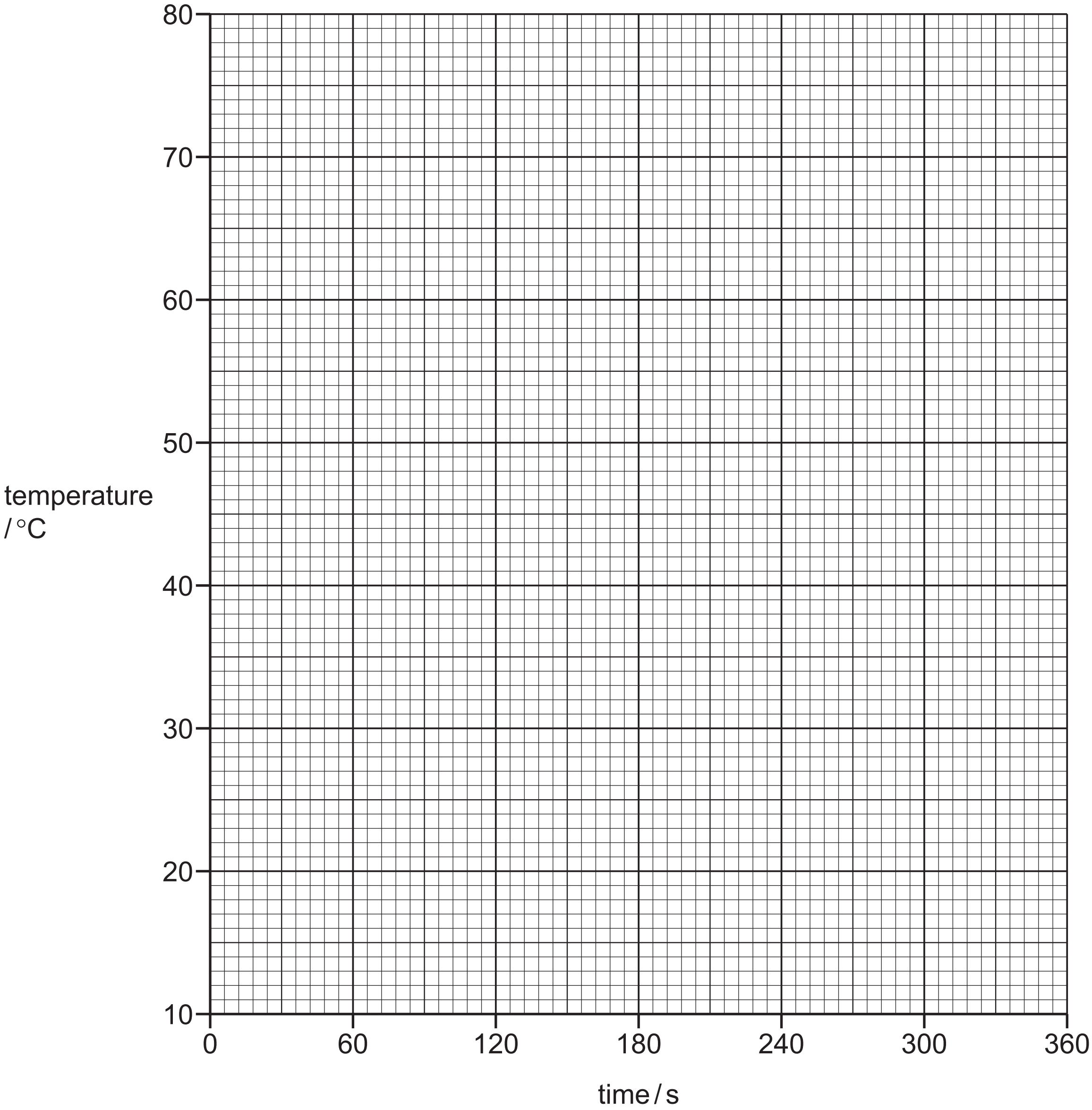
(b) *Experiment 2*

Experiment 1 was repeated using magnesium instead of iron.
Use the thermometer diagrams to record the results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
thermometer diagram											
temperature / °C											

[2]

(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label the graphs.



[4]

(d) (i) **From your graph**, deduce the temperature of the mixture in Experiment 1 after 135 seconds.
Show clearly **on the grid** how you worked out your answer.

.... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the mixture in Experiment 2 to change by 30 °C **after the magnesium was added**.
Show clearly **on the grid** how you worked out your answer.

.... s [2]

(e) Predict the temperature of the mixture in Experiment 2 after one hour. Explain your answer.

....

.... [2]

(f) Suggest an advantage of taking the temperature readings every 15 seconds.

....

.... [2]

(g) Explain why a polystyrene cup is used in the experiments and **not** a copper can.

....

.... [2]

[Total: 18]

3 Two solutions, solution **Q** and solution **R**, were analysed. Solution **Q** was aqueous sulfuric acid.

tests on solution Q

(a) Solution **Q** was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for **tests 1–4**.

(i) **test 1**

The pH of the first portion of solution **Q** was measured.

pH .... [1]

(ii) **test 2**

Magnesium ribbon was added to the second portion of solution **Q**. The gas given off was tested.

observations ....

.... [3]

(iii) **test 3**

Sodium carbonate was added to the third portion of solution **Q**. The gas given off was tested.

observations ....

.... [3]

(iv) **test 4**

Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of solution **Q**.

observations .... [1]

tests on solution R

Solution **R** was divided into three equal portions in three test-tubes.
The following tests were carried out.

tests	observations
test 5 The pH of the first portion of solution **R** was measured.	pH = 10
test 6 Drops of aqueous sodium hydroxide were added to the second portion of solution **R** and the test-tube shaken. Excess aqueous sodium hydroxide was then added to the test-tube.	white precipitate no visible change
test 7 Aqueous iron(II) sulfate was added to the third portion of solution **R** and the mixture shaken.	green precipitate formed

(b) Identify solution **R**.

....

.... [2]

[Total: 10]

4 A liquid cleaner is a mixture of three substances. These substances are shown in the table.

name of substance	properties of substance
water	liquid, boiling point 100 °C
sodium carbonate	solid, soluble in water
silica	solid, insoluble in water

Plan an experiment to obtain separate pure samples of each substance from the mixture in the liquid cleaner. You are provided with common laboratory apparatus.

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 6]

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Cambridge IGCSE

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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

0804599590

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2016**

1 hour

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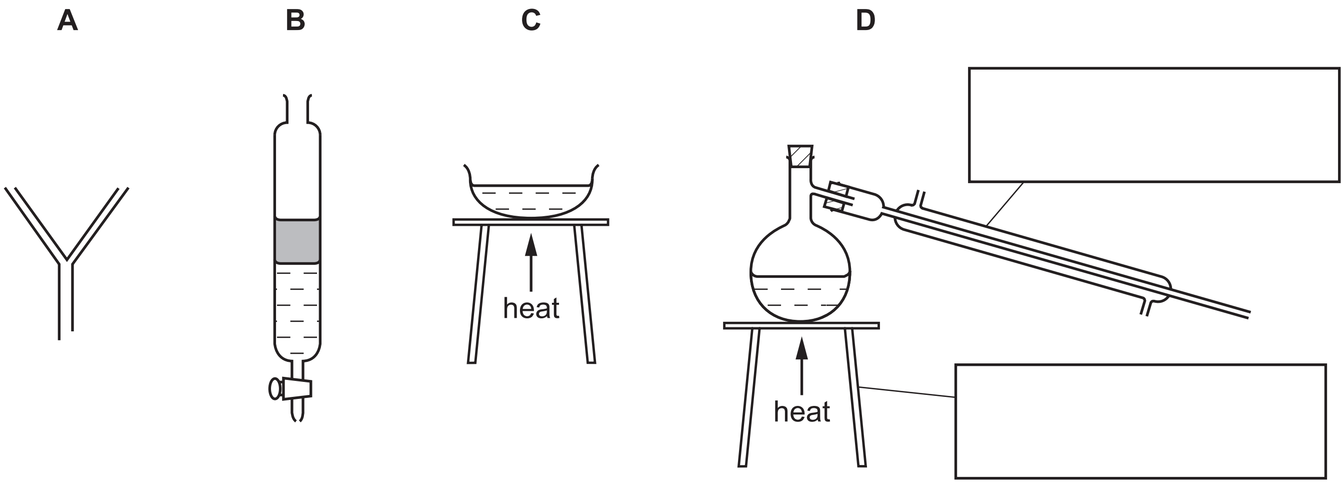
[Turn over

1 This question is about the separation of mixtures.
The diagram shows four sets of apparatus that can be used to separate mixtures.



(a) Complete the boxes to name the apparatus. [2]

(b) The table shows four different mixtures.

Complete the table to show which set of apparatus should be used to obtain the substance listed. The first one has been completed for you. Each set of apparatus can be used once, more than once or not at all.

mixture	to obtain	use apparatus
petroleum and water	petroleum	**B**
sodium chloride dissolved in water	sodium chloride crystals	....
sodium chloride dissolved in water	water	....
insoluble silver chloride and water	silver chloride	....

[3]

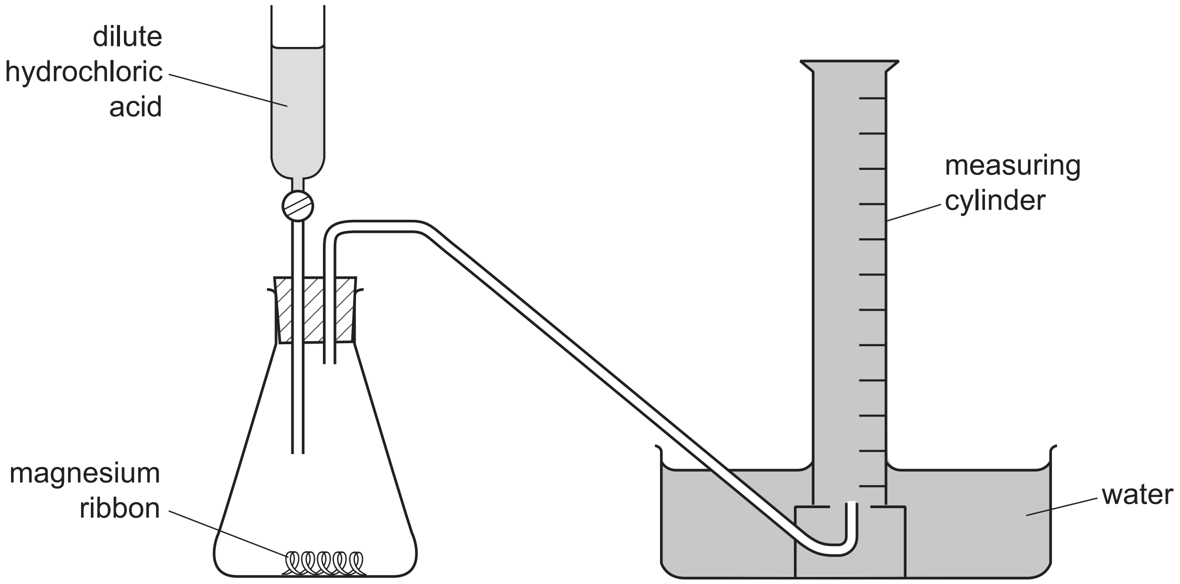
(c) Put a ring around the separation method that should be used to separate a mixture of coloured dyes.

centrifugation chromatography condensation evaporation

[1]

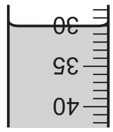
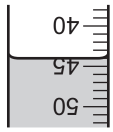
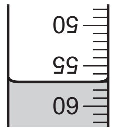
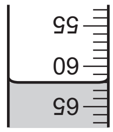
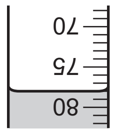
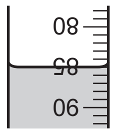
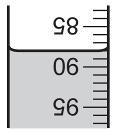
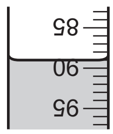
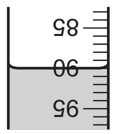
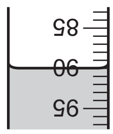
[Total: 6]

2 A student investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature.
The apparatus was set up as shown in the diagram.



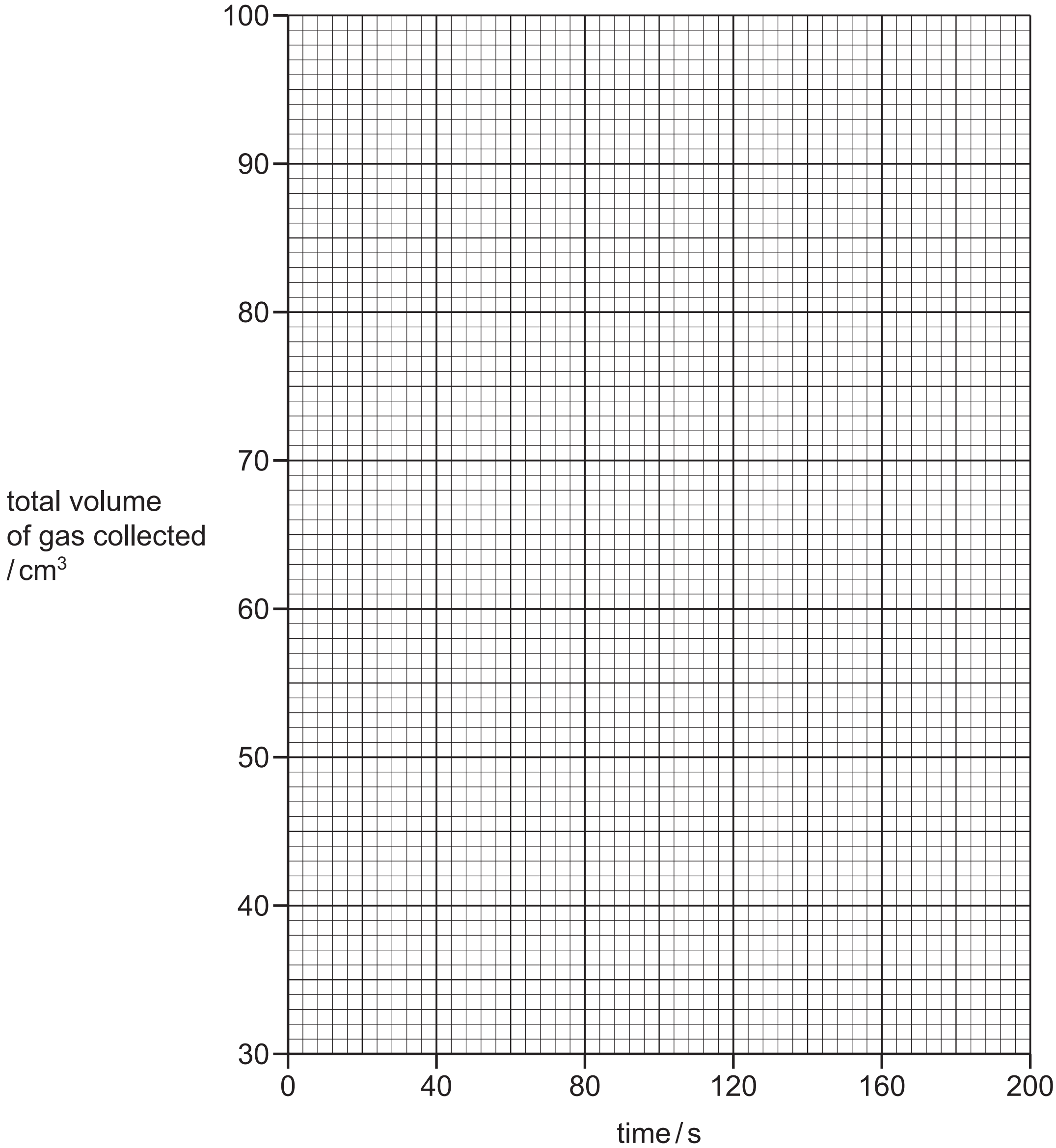
30 cm^3 of dilute hydrochloric acid were added to the conical flask containing magnesium ribbon. The timer was then started and the volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

(a) Use the measuring cylinder diagrams to record the total volume of gas collected in the table.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		30
20		
40		
60		
80		
100		
120		
140		
160		
180		

[2]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) **(i)** Which result is anomalous?

.... [1]

(ii) Suggest a possible reason for this anomalous result.

.... [1]

(iii) **Use your graph** to deduce the total volume of gas that you would have expected to collect instead of this anomalous volume.
Show clearly **on the grid** how you worked out your answer.

.... cm^3 [2]

(d) Explain why the total volume of gas collected does **not** increase after 160 seconds.

....

.... [2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time / s}}$$

(i) Calculate the volume of gas collected between 20 seconds and 40 seconds.

.... [1]

(ii) Calculate the average rate of reaction between 20 seconds and 40 seconds.
Include the unit.

average rate of reaction = ... [2]

(f) Room temperature was 20 °C.

Sketch **on the grid** the graph you would expect if the experiment were repeated at 30 °C. [2]

(g) Suggest why the reading on the measuring cylinder was 30 cm^3 after the acid had been added and before the timer had been started.

....

.... [1]

(h) Suggest and explain **one** improvement to this experiment.

....

....

.... [2]

[Total: 19]

3 Two solutions, solution **S** and solution **T**, were analysed. Solution **S** was dilute hydrochloric acid. The tests on solution **S** and solution **T**, and some of the observations, are shown.

tests on solution S

(a) Solution **S** was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for **tests 1–4**.

(i) **test 1**

The pH of the first portion of solution **S** was tested.

pH .... [1]

(ii) **test 2**

Copper(II) oxide was added to the second portion of the solution. The mixture was heated.

observations ....

....

.... [2]

(iii) **test 3**

Solid sodium carbonate was added to the third portion of the solution. The gas given off was tested.

observations ....

.... [3]

(iv) **test 4**

Dilute nitric acid and aqueous silver nitrate were added to the fourth portion of the solution.

observations .... [1]

tests on solution T

(b) Tests were carried out on solution **T** and the following observations made.

tests	observations
Solution **T** was divided into three equal portions in three test-tubes. Appearance of the solution.	yellow solution
Drops of aqueous sodium hydroxide were added to the second portion of the solution and the test-tube shaken. Excess aqueous sodium hydroxide was then added to the test-tube.	red-brown precipitate no visible change
Aqueous sodium hydroxide and aluminium foil were added to the third portion of the solution and the mixture heated. The gas given off was tested with pH indicator paper.	pungent gas formed, pH 10

Identify solution **T**.

....

.... [2]

[Total: 9]

4 Metal rings can be coated with a layer of copper using electricity.
Plan an experiment to electroplate a small metal ring with copper.
You are provided with common laboratory apparatus, a copper rod, copper(II) sulfate crystals, water and a small metal ring.
Include a labelled diagram in your answer.

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 6]

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

0345891151

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2016**

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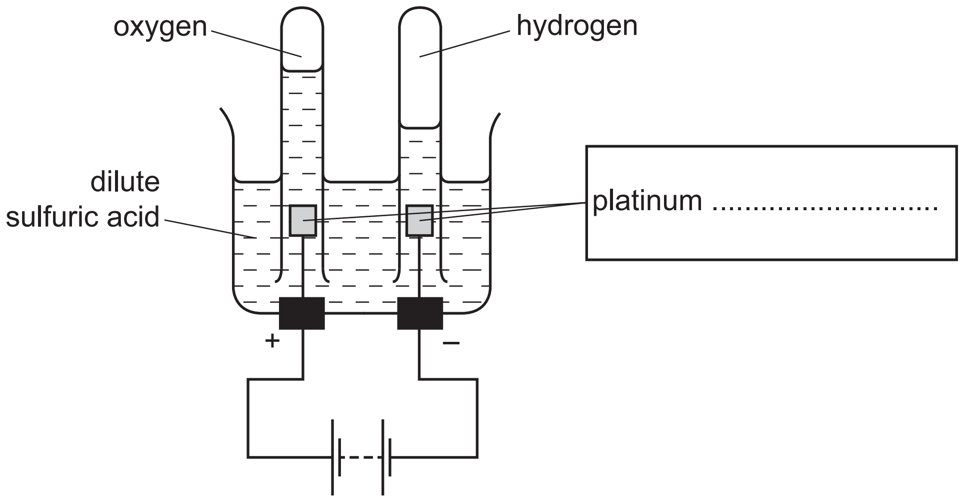
1 The diagram shows the apparatus used to electrolyse dilute sulfuric acid.



(a) Complete the box to show the role of the platinum. [1]

(b) Give **one** observation made during this electrolysis.

.... [1]

(c) **(i)** Compare the volumes of oxygen and hydrogen produced.

....

.... [2]

(ii) Which substance breaks down to form these gases?

.... [1]

(d) Give **one** test to distinguish between oxygen and hydrogen.

test ....

result with oxygen ....

result with hydrogen ....

[2]

[Total: 7]

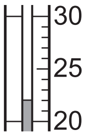
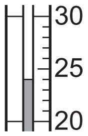
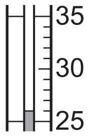
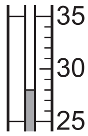
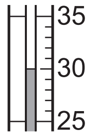
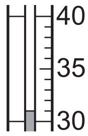
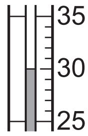
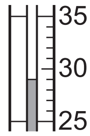
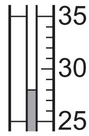
2 A student investigated what happened when dilute nitric acid reacted with aqueous solutions of two different alkalis, solution **N** and solution **O**.

Two experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 50 cm^3 of solution **N** into a polystyrene cup. The initial temperature of the solution was measured.
A burette was filled with nitric acid to the 0.0 cm^3 mark.
5.0 cm^3 of nitric acid were added to solution **N** in the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
A further 5.0 cm^3 of nitric acid were added to the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
The student continued to add 5.0 cm^3 portions of nitric acid to the polystyrene cup, until a total volume of 40 cm^3 of nitric acid had been added. After each addition, the solution was stirred and the maximum temperature measured.

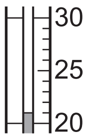
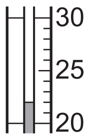
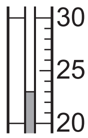
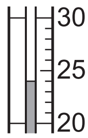
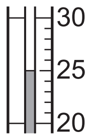
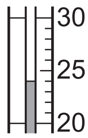
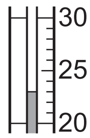
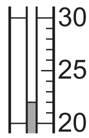
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram	 30 25 20	 30 25 20	 35 30 25	 35 30 25	 35 30 25	 40 35 30	 35 30 25	 35 30 25	 35 30 25
maximum temperature of the solution in the polystyrene cup / °C									

[2]

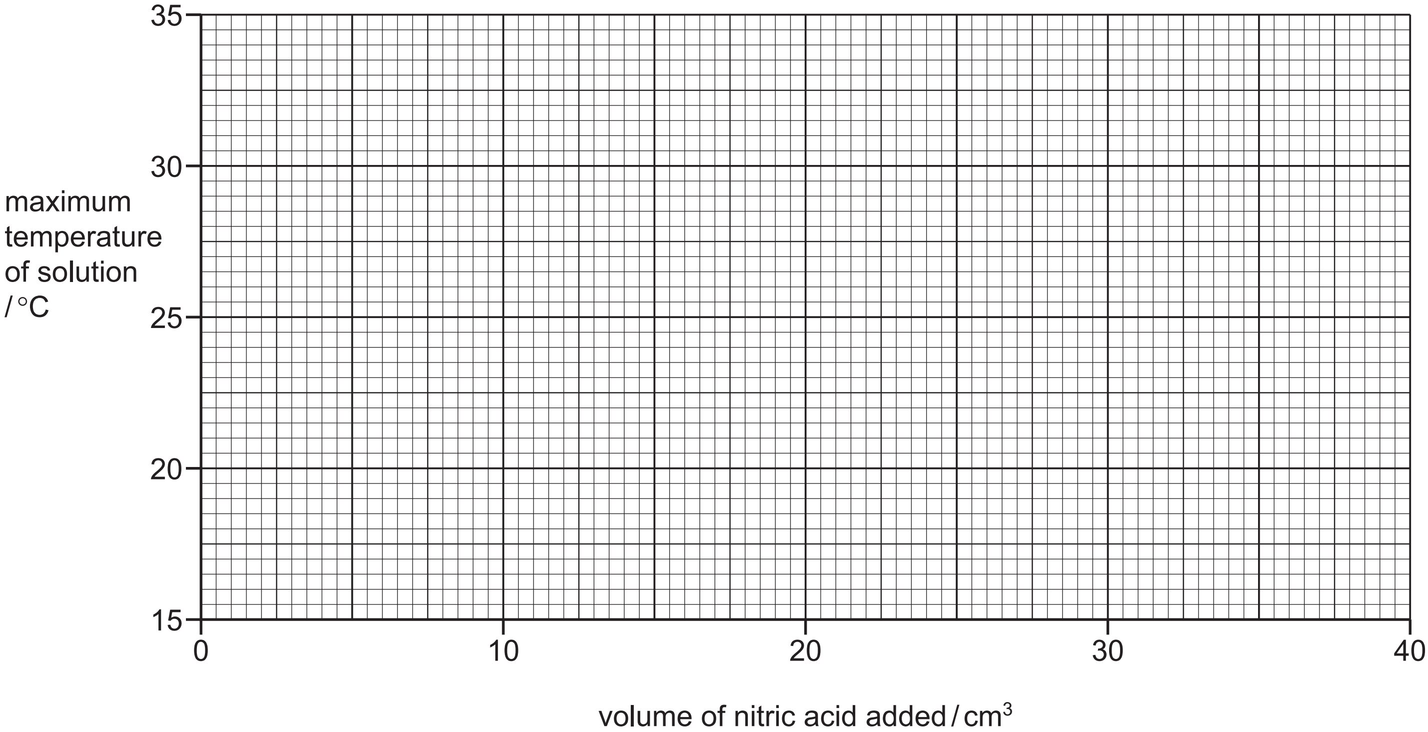
(b) *Experiment 2*

Experiment 1 was repeated using solution **O** instead of solution **N**.
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram	 30 25 20	 30 25 20	 30 25 20	 30 25 20	 30 25 20	 30 25 20	 30 25 20	 30 25 20	 30 25 20
maximum temperature of the solution in the polystyrene cup / °C									

[2]

(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs.
Clearly label your graphs.



[4]

(d) **Use your graph** to estimate the maximum temperature of the solution when 13 cm^3 of nitric acid were added to 50 cm^3 of solution **N** in Experiment 1.
Show clearly **on the grid** how you worked out your answer.

.... °C [2]

(e) Name a suitable indicator that could be used in Experiment 1.

.... [1]

(f) Solution **N** and solution **O** were the same concentration.

In which experiment is the temperature change greater? Suggest why the temperature change is greater in this experiment.

....

.... [2]

(g) How would the results differ in Experiment 1 if 100 cm^3 of solution **N** were used?

....

.... [1]

(h) Suggest why a polystyrene cup was used in these experiments and **not** a copper can.

.... [1]

(i) State **one** source of error in the experiments. Suggest an improvement to reduce this source of error.

source of error ....

improvement ....
[2]

[Total: 17]

3 Solid **P**, which is an aluminium salt, was analysed.
The tests on solid **P**, and some of the observations, are shown.

tests on solid P

(a) test 1

Solid **P** was divided into three portions. The first portion of solid **P** was heated.

observations *condensation formed on the sides of the test-tube* ....

Any gases given off were tested with cobalt(II) chloride paper.

observations *cobalt(II) chloride paper turned from blue to pink* ....

What does **test 1** tell you about solid **P**?

.... [1]

(b) test 2

A flame test was carried out on the second portion of solid **P**.

observations .... [1]

tests on a solution of P

Distilled water was added to the rest of solid **P** in a test-tube and shaken to dissolve.

(c) The solution was divided into four equal portions in four test-tubes. The following tests were carried out.

(i) test 3

Several drops of aqueous sodium hydroxide were added to the first portion of the solution.

Excess aqueous sodium hydroxide was then added to the mixture.

observations ....

....

.... [3]

(ii) test 4

Several drops of aqueous ammonia were added to the second portion of the solution.

Excess aqueous ammonia was then added to the mixture.

observations ....

.... [2]

Two further tests were carried out and the following observations made.

tests on a solution of **P**	observations
test 5 Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.	no visible reaction
test 6 Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of the solution.	white precipitate formed

(d) What does **test 5** tell you about solid **P**?

.... [1]

(e) Identify solid **P**.

.... [1]

(f) Describe the appearance of solid **P**.

.... [1]

[Total: 10]

4 Agri Limes are mixtures of calcium carbonate and calcium oxide. Farmers use Agri Limes on fields to neutralise acidity.

Plan an investigation to find out which of **two** different Agri Limes, **Q** or **R**, will neutralise more acid. You are provided with common laboratory apparatus and chemicals, including dilute nitric acid.

....

....

....

....

....

....

....

.... [6]

[Total: 6]

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Cambridge IGCSE

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 0 9 0 6 6 3 2 9 1 1 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 12.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **12** printed pages.

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1 **(a)** Complete the table.

particle	charge	relative mass
proton	+1	
neutron		1
electron		

[2]

(b) The following are isotopes of carbon.

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

(i) In terms of numbers of protons, neutrons and electrons, how are these **three** isotopes the same and how are they different?

They are the same because ....

....

They are different because ....

....
[3]

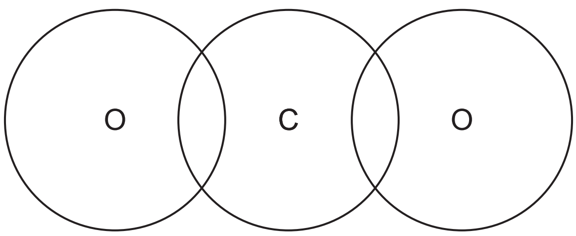
(ii) Why do all isotopes of carbon have the same chemical properties?

.... [1]

(c) Name **two** forms of the element carbon which have giant covalent structures.

.... and .... [1]

(d) Complete the diagram to show the electron arrangement in a carbon dioxide molecule.
Show the outer shell electrons only.



[2]

[Total: 9]

2 Beryllium is a metallic element in Group II.

(a) Give the electronic structure of a beryllium atom.

.... [1]

(b) Give the formula of beryllium oxide.

.... [1]

(c) **(i)** Describe the bonding in a metallic element such as beryllium.
Include a labelled diagram and any appropriate charges in your answer.

....

....

.... [3]

(ii) Explain why metallic elements, such as beryllium, are good conductors of electricity.

....

.... [1]

(d) Beryllium hydroxide is amphoteric.
Beryllium hydroxide reacts with acids. The salts formed contain positive beryllium ions.

(i) Give the formula of the positive beryllium ion.

.... [1]

(ii) Write a chemical equation for the reaction between beryllium hydroxide and hydrochloric acid.

.... [2]

(iii) Beryllium hydroxide also reacts with alkalis. The salts formed contain beryllate ions, BeO_2^{2-}.

Suggest a chemical equation for the reaction between beryllium hydroxide and sodium hydroxide solution.

.... [2]

[Total: 11]

3 When lead(II) nitrate is heated, two gases are given off and solid lead(II) oxide remains. The equation for the reaction is shown.

$$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$$

(a) Calculate the M_r of lead(II) nitrate.

.... [1]

(b) 6.62 g of lead(II) nitrate are heated until there is no further change in mass.

(i) Calculate the mass of lead(II) oxide produced.

.... g [2]

(ii) Calculate the volume of oxygen, O_2, produced at room temperature and pressure (r.t.p.).

.... dm^3 [2]

(c) Describe a test for oxygen.

test ....

result ....

[2]

(d) Lead(II) oxide is insoluble. A student adds solid lead(II) oxide to dilute nitric acid until the lead(II) oxide is in excess. Aqueous lead(II) nitrate and water are produced.

(i) What is meant by the term *excess*?

.... [1]

(ii) How would the student know when the lead(II) oxide is in excess?

.... [1]

(iii) Write a chemical equation for the reaction.

.... [1]

[Total: 10]

4 Silicon(IV) oxide and sodium chloride have different types of bonding and structure.

(a) Name the type of bonding present in

silicon(IV) oxide, ...

sodium chloride. ....
[2]

(b) Name the type of structure present in silicon(IV) oxide.

.... [1]

(c) **(i)** Silicon(IV) oxide has a high melting point. Explain why.

....

.... [2]

(ii) Silicon(IV) oxide is a poor conductor of electricity. Explain why.

.... [1]

(d) Solid sodium chloride does not conduct electricity. However, it conducts electricity when molten.

Explain why solid sodium chloride does **not** conduct electricity, whereas molten sodium chloride does conduct electricity.

....

....

....

.... [3]

(e) A **concentrated** aqueous solution of sodium chloride is electrolysed using carbon electrodes.

(i) Name the products formed at the electrodes.

product at the positive electrode (anode) ....

product at the negative electrode (cathode) ....
[2]

(ii) Write an ionic half-equation for the reaction occurring at the negative electrode.

.... [1]

(f) A **dilute** aqueous solution of sodium chloride is electrolysed using carbon electrodes.

Name the main product formed at the positive electrode.

.... [1]

(g) Molten sodium chloride is electrolysed using carbon electrodes.

(i) Name the product formed at the negative electrode.

.... [1]

(ii) Write an ionic half-equation for the reaction occurring at the negative electrode.

.... [1]

(iii) Chlorine is produced at the positive electrode.

Give the test for chlorine.

test ....

result ....
[2]

[Total: 17]

5 Sulfuric acid can be manufactured from the raw materials sulfur, air and water. The process can be divided into four stages.

stage 1 converting sulfur into sulfur dioxide

stage 2 converting sulfur dioxide into sulfur trioxide

stage 3 converting sulfur trioxide into oleum, $H_2S_2O_7$

stage 4 converting oleum into sulfuric acid

stage 1

(a) **(i)** Describe how sulfur is converted into sulfur dioxide.

.... [1]

(ii) Write a chemical equation for the conversion of sulfur into sulfur dioxide.

.... [1]

stage 2

(b) Sulfur dioxide is converted into sulfur trioxide according to the following equation.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The reaction is carried out at a temperature of 450 °C and a pressure of 1–2 atmospheres using a catalyst. The energy change, ΔH, for the reaction is –196 kJ / mol.

(i) What is the meaning of the symbol $\rightleftharpoons$?

.... [1]

(ii) Name the catalyst used in this reaction.

.... [1]

(iii) Why is a catalyst used?

.... [1]

(iv) If a temperature higher than 450 °C were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

....

.... [2]

(v) Suggest a reason why a temperature lower than 450 °C is **not** used.

....

.... [1]

(vi) If a pressure higher than 1–2 atmospheres were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

....

.... [2]

stage 3

(c) (i) What is added to sulfur trioxide to convert it into oleum?

.... [1]

(ii) Write a chemical equation for the conversion of sulfur trioxide into oleum.

.... [1]

stage 4

(d) (i) What is added to oleum to convert it into sulfuric acid?

.... [1]

(ii) Write a chemical equation for the conversion of oleum into sulfuric acid.

.... [1]

(e) Give **one** use of sulfuric acid.

.... [1]

(f) Sulfuric acid reacts with a hydrocarbon called benzene to produce benzenesulfonic acid, $C_6H_5SO_3H$. Benzenesulfonic acid is a strong acid which ionises to produce hydrogen ions, H^+, and benzenesulfonate ions, $C_6H_5SO_3^-$.

(i) What is meant by the term *strong acid*?

.... [1]

(ii) Describe how to show that a 1 mol / dm^3 solution of benzenesulfonic acid is a strong acid.

....

.... [2]

(iii) Write a chemical equation for the reaction between benzenesulfonic acid and sodium carbonate, Na_2CO_3.

.... [2]

[Total: 20]

6 Synthetic polyamides are made by condensation polymerisation.

(a) **(i)** What is meant by the term *condensation polymerisation*?

....

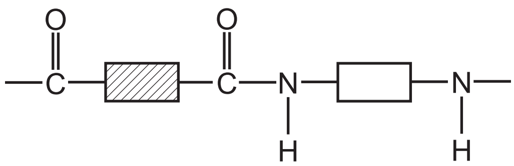
....

.... [3]

(ii) Name another type of polymerisation.

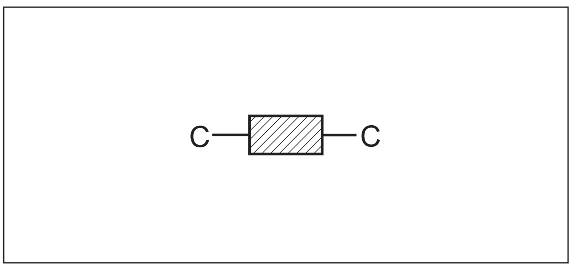
.... [1]

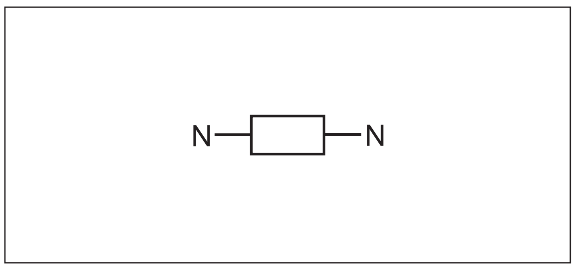
(b) One repeat unit of a synthetic polyamide is represented by the following structure.



(i) Draw a ring around the amide link. [1]

(ii) Complete the diagrams to show the structures of the monomers used to produce the synthetic polyamide. Show all the missing atoms and bonds.





[2]

(iii) Name an example of a synthetic polyamide.

.... [1]

(c) Proteins and synthetic polyamides have similarities and differences.

(i) Name the type of compounds that are the monomers used to make up proteins.

.... [1]

(ii) Starting with a sample of protein, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include
- the name of the process used to break down the protein into its monomers,
- the name of the process used to separate the monomers,
- the method used to detect the monomers after they have been separated,
- the method used to identify the monomers after they have been separated.

....

....

....

....

.... [4]

[Total: 13]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 T*l* thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 F*l* flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5182765417

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
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The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

1 Particles behave differently when in different physical states.

(a) Solids have a fixed volume and a definite shape.
Gases have no fixed volume and take the shape of the container.

Describe the volume and shape of liquids.

....

.... [1]

(b) Complete the table to show the separation, arrangement and movement of particles in each physical state.

state	separation of particles	arrangement of particles	movement of particles
solid			
liquid	touching one another	randomly arranged	move over one another
gas			

[6]

(c) Name the following changes of state.

(i) Ice turning into water.

.... [1]

(ii) Solid carbon dioxide turning directly into gaseous carbon dioxide at room temperature.

.... [1]

[Total: 9]

2 This question is about atoms, ions and isotopes.

(a) Define the term *nucleon number*.

....

.... [2]

(b) Give the electronic structure of the following atom and ion.

Na ....

P^{3-} ....

[2]

(c) State **one** medical use of radioactive isotopes.

.... [1]

(d) What is meant by the term *relative atomic mass*?

....

....

.... [2]

(e) Suggest why the relative atomic mass of chlorine is **not** a whole number.

....

....

.... [2]

(f) Aluminium is a metal in Group III.

Describe the bonding in aluminium.
Include a labelled diagram and any appropriate charges in your answer.

[3]

[Total: 12]

3 Clean, dry air contains a small amount of carbon dioxide.

(a) The percentages of the **other** gases present in clean, dry air are shown in the table.

Complete the table by inserting the names of these gases.

name of gas	percentage present
	78
	21
	1

[2]

(b) Oxides of nitrogen are atmospheric pollutants which can cause acid rain.

Describe the formation of oxides of nitrogen and suggest how they can cause acid rain.

....

....

....

.... [3]

(c) Methane contributes to the greenhouse effect.

State **two** sources of methane.

1 ....

2 ....

[2]

(d) Combustion and respiration add carbon dioxide to the atmosphere.

Name **one** natural process which removes carbon dioxide from the atmosphere.

.... [1]

[Total: 8]

4 Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

(a) Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

....

....

copper(II) oxide

....

....
[4]

(b) When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

(i) Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.

......$Cu(s) + 8HNO_3(aq) \rightarrow$ ....$(aq) + 4H_2O(l) + 2NO(g)$
[2]

(ii) How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

....

.... [1]

[Total: 7]

5 Chlorine, bromine and iodine are halogens.

(a) Chlorine can be made in the laboratory by heating manganese(IV) oxide with concentrated hydrochloric acid.

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

Calculate the volume of 8.00 mol / dm^3 HCl(aq) needed to react with 3.48 g of MnO_2.

- moles of MnO_2 used

.... mol

- moles of HCl needed

.... mol

- volume of HCl needed

.... cm^3
[4]

(b) A student bubbled chlorine gas into a test-tube containing aqueous potassium bromide.

(i) Describe the colour change seen in the test-tube.

from .... to ....
[2]

(ii) Complete the **ionic** equation for this reaction.

Include state symbols.

$$Cl_2(g) + ...Br^-(aq) \rightarrow .... + ...$$

[3]

(c) When one mole of bromine, Br_2, reacts with one mole of propene, one organic product is formed.

(i) Which part of the propene molecule reacts with bromine?

.... [1]

(ii) What is the name of the type of reaction which takes place between bromine and propene?

.... [1]

(d) When one mole of chlorine, Cl_2, reacts with one mole of propane, a mixture of two structural isomers is formed.

(i) What is the name of the type of reaction which takes place between chlorine and propane?

.... [1]

(ii) Explain what is meant by the term *structural isomers*.

....

.... [2]

(iii) Draw the structure of **two** structural isomers formed when **one** mole of chlorine reacts with **one** mole of propane.

[2]

(e) Iodine forms an oxide which has the composition by mass: I, 76.0%; O, 24.0%.

(i) Use this information to determine the empirical formula of this oxide of iodine.

empirical formula .... [3]

(ii) The oxide of iodine in **(e)(i)** dissolves in water.

Predict and explain the effect of adding Universal Indicator to an aqueous solution of this oxide of iodine.

effect on Universal Indicator ....

explanation ....
[2]

[Total: 21]

6 Aluminium is a very important metal.

Aluminium is extracted from its ore, bauxite, by electrolysis. Bauxite is an impure form of aluminium oxide, Al_2O_3.

(a) Describe how aluminium is extracted from **bauxite**. Include an ionic half-equation for the reaction at each electrode.

description ....

....

....

....

....

....

....

....

ionic half-equation for the anode reaction ....

ionic half-equation for the cathode reaction..
[5]

(b) Explain why the anodes have to be replaced regularly.

....

.... [2]

(c) Give **two** uses of aluminium and give a reason why aluminium is suitable for each use.

use 1 ....

reason ....

use 2 ....

reason ....
[4]

[Total: 11]

Question 7 starts on the next page.

7 Proteins are a major constituent of food.

Proteins are polymers.

(a) What is a polymer?

....

....

.... [2]

(b) Proteins can be converted into amino acids.

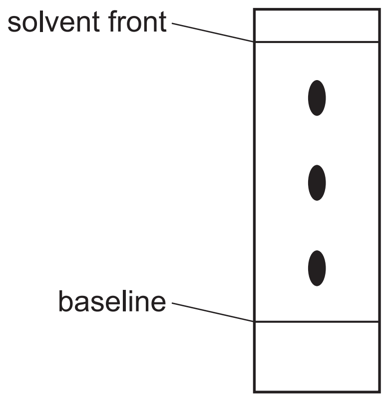
(i) Name the type of chemical reaction which occurs when proteins are converted into amino acids.

.... [1]

(ii) Suggest a condition needed to convert proteins into amino acids.

.... [1]

(c) A colourless mixture of amino acids was separated by chromatography.
Amino acid **X** has an R_f value of 0.8.
The chromatogram of the mixture after treatment with a locating agent is shown.



(i) How is an R_f value calculated?

R_f =

[1]

(ii) On the diagram put a ring around the spot caused by amino acid **X**. [1]

(iii) Describe how you would perform a chromatography experiment to produce the chromatogram shown in **(c)**. Assume you have been given the mixture of amino acids and a suitable locating agent. You are provided with common laboratory apparatus.

....

....

....

....

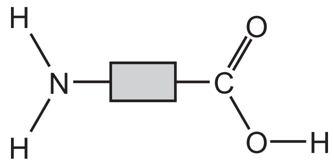
....

.... [3]

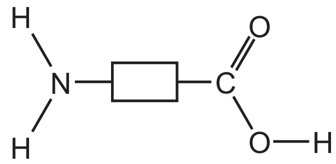
(d) When one molecule of an amino acid **A** combines with one molecule of another amino acid **B**, two different dipeptide molecules could be formed.

Draw the structures of the **two** different dipeptide molecules.
Show all of the atoms and all of the bonds in the linkages.

amino acid **A**



amino acid **B**



[3]

[Total: 12]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		**Key** atomic number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6396621448

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **16** printed pages.

IB16 11_0620_41/3RP

CAMBRIDGE International Examinations

1 The table gives some information about five substances.

substance	melting point / °C	boiling point / °C	solubility in water	electrical conductivity when molten	electrical conductivity when solid
F	–97	65	very soluble	does not conduct	does not conduct
G	1600	2230	insoluble	does not conduct	does not conduct
H	801	1413	soluble	conducts	does not conduct
I	–57	126	insoluble	does not conduct	does not conduct
J	1085	2562	insoluble	conducts	conducts

(a) Which substance in the table has ionic bonding?

.... [1]

(b) Which substance in the table has a giant covalent structure?

.... [1]

(c) Name a method you could use to separate a mixture of substance **J** and water.

.... [1]

(d) Name a method you could use to obtain substance **F** from a mixture of substance **F** and water.

.... [2]

(e) Describe how you could obtain a solid sample of substance **H** from a mixture of substance **H** and substance **G**.

....

....

....

....

....

.... [3]

(f) Substance **J** is a metal.

Describe how substance **J** is able to conduct electricity when it is a solid.

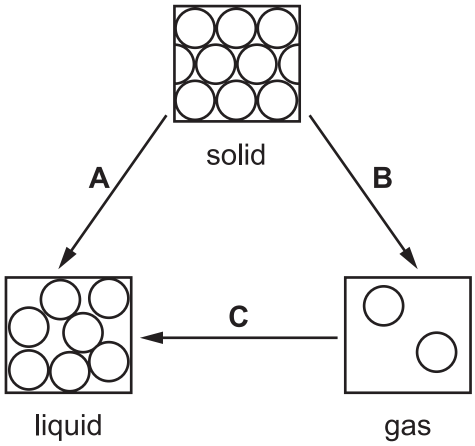
....

....

.... [2]

[Total: 10]

2 Matter can exist as solid, liquid or gas. The arrows show some changes of state.



(a) Name the changes of state represented on the diagram.

(i) **A** .... [1]

(ii) **B** .... [1]

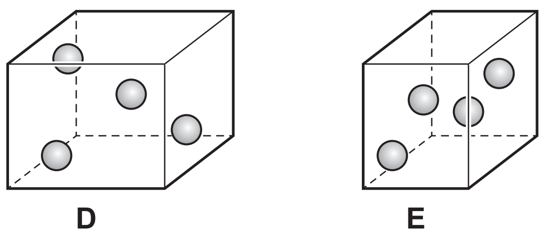
(iii) **C** .... [1]

(b) Explain why energy has to be supplied to turn a liquid into a gas.

....

.... [1]

(c) The diagrams represent the same number of particles of a gas in two containers, **D** and **E**, which have different volumes. The two containers are at the same temperature.



In which container will the pressure be higher? Explain your answer.

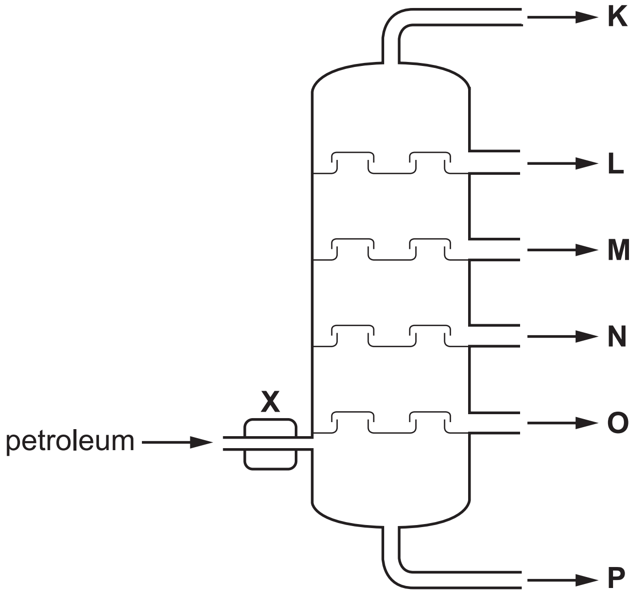
....

....

.... [1]

[Total: 5]

3 **(a)** Petroleum is a mixture of hydrocarbons. It is separated into useful fractions by fractional distillation. This can be done using the fractionating column shown.



(i) What happens to the petroleum at point **X**, before it enters the fractionating column?

....

.... [1]

(ii) State **two** ways in which fraction **O** differs from fraction **L**.

....

....

.... [2]

(b) Most of the hydrocarbons obtained from petroleum are alkanes. The alkanes are an homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}.

Give **two** characteristics, other than having the same general formula, of members of an homologous series.

....

....

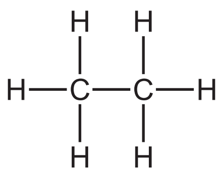
.... [2]

(c) The alkane with the molecular formula C_5H_{12} can exist as a number of structural isomers.

Draw the structures of **two** isomers with the formula C_5H_{12}.

[2]

(d) The alkane ethane has the structure shown.



When a mixture of ethane and chlorine is exposed to ultraviolet light a substitution reaction takes place.

Draw the structure of **one** organic product from this substitution reaction.

[1]

(e) Isoprene is a naturally occurring hydrocarbon.

(i) Explain how the name of isoprene suggests that it contains a C=C double bond.

.... [1]

(ii) A sample of isoprene had the following composition by mass: C, 88.24%; H, 11.76%.

Calculate the empirical formula of isoprene. Show all your working.

empirical formula = ... [3]

(iii) What additional information would be required to calculate the molecular formula of isoprene?

.... [1]

[Total: 13]

4 **(a)** Ammonia, NH_3, is made by reacting nitrogen with hydrogen in the Haber process.

(i) Write a chemical equation for the formation of ammonia in the Haber process.

.... [2]

(ii) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen ....

hydrogen ....
[2]

(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature ....

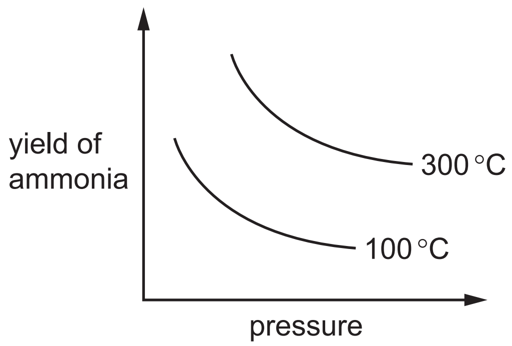
pressure ....
[2]

(b) Ammonia is also made when ammonium carbonate decomposes.

$$(NH_4)_2CO_3(s) \rightleftharpoons 2NH_3(g) + H_2O(g) + CO_2(g)$$

The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



(i) What is meant by the term *equilibrium* for a reversible reaction?

....

....

.... [2]

(ii) Using information from the graph, explain whether the reaction is endothermic or exothermic.

....

.... [1]

(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

....

....

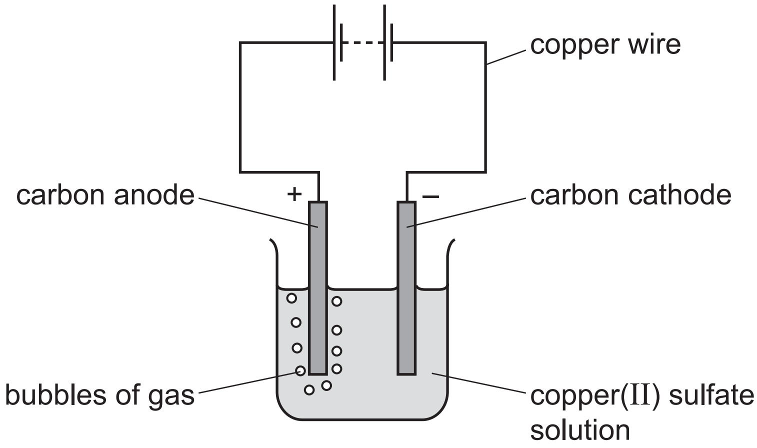
....

....

.... [3]

[Total: 12]

5 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(a) A gas was formed at the anode.

Identify this gas and give the test for this gas.

gas ....

test ....

result of test ....
[3]

(b) During electrolysis, electricity passes through the copper(II) sulfate solution.

Solid copper(II) sulfate does not conduct electricity.

Explain **both** of these statements.

....

....

....

....

.... [3]

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.

anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(i) Which species is reduced during the electrolysis? Explain your answer.

....

....

.... [2]

(ii) The masses of the copper electrodes changed during the electrolysis.

State how **and** explain why the masses of the **two** copper electrodes changed.
Use the ionic half-equations to help you.

....

....

....

....

....

....

.... [3]

(iii) Explain why, during the electrolysis, the colour of the copper(II) sulfate solution does **not** change.

....

....

.... [1]

[Total: 12]

6 Nylon, *Terylene* and proteins are all polymers.

(a) What is a polymer?

....

....

.... [2]

(b) Proteins are natural polymers. Proteins are biodegradable.

(i) Name the type of linkage in proteins.

.... [1]

(ii) What is meant by the term *biodegradable*?

....

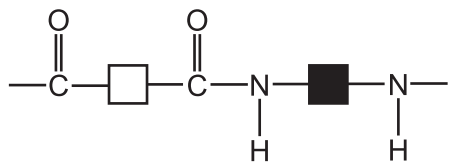
....

.... [2]

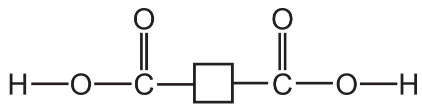
(iii) Name another natural polymer.

.... [1]

(c) Nylon and *Terylene* are synthetic polymers.
The repeat unit of nylon can be shown as



Terylene can be made from the monomers shown.



Draw a diagram to show the repeat unit of *Terylene*.

[3]

[Total: 9]

7 Calcium chloride can be made by reacting calcium carbonate with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of calcium carbonate was added to $50.0\,cm^3$ of $0.500\,mol/dm^3$ hydrochloric acid. The solution was filtered to remove the excess calcium carbonate.

(a) How many moles of HCl were used in this reaction?

.... mol [2]

(b) Deduce the number of moles of carbon dioxide gas made in this reaction.

.... mol [1]

(c) Calculate the mass of carbon dioxide made in this reaction.

.... g [2]

(d) Calculate the volume, in dm^3, of carbon dioxide made in this reaction at room temperature and pressure (r.t.p.).

.... dm^3 [1]

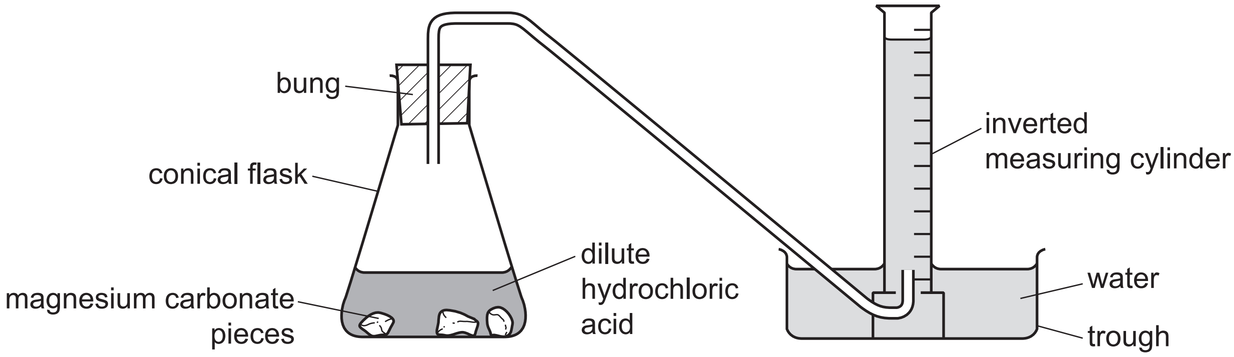
[Total: 6]

Question 8 starts on the next page.

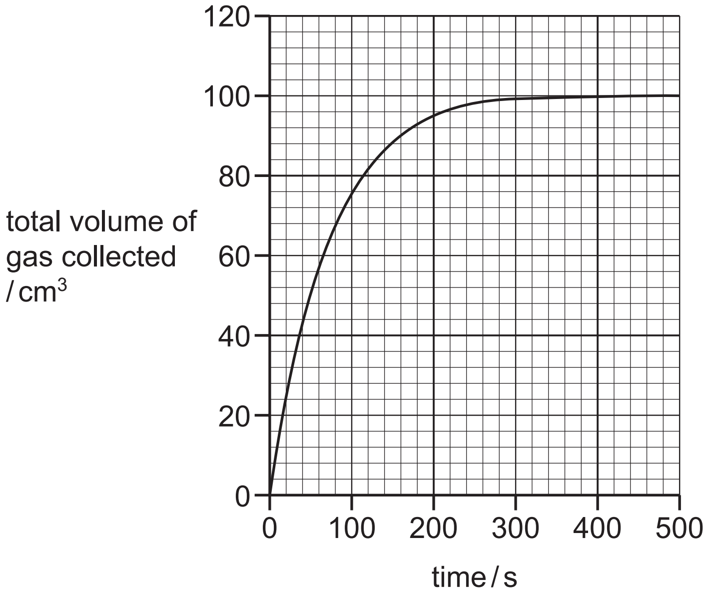
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

....

....

....

....

.... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction ....

....

....

total volume of gas ....

....

....
[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

....

....

....

....

....

....

.... [5]

[Total: 13]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.).

Cambridge IGCSE

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Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2016**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

0838065749

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

This document consists of **16** printed pages.

IB16 11_0620_23/6RP

CAMBRIDGE
International Examinations

1 ‘Particles moving **very slowly** from an area of higher concentration to an area of lower concentration.’

Which process is being described?

A a liquid being frozen

B a solid melting

C a substance diffusing through a liquid

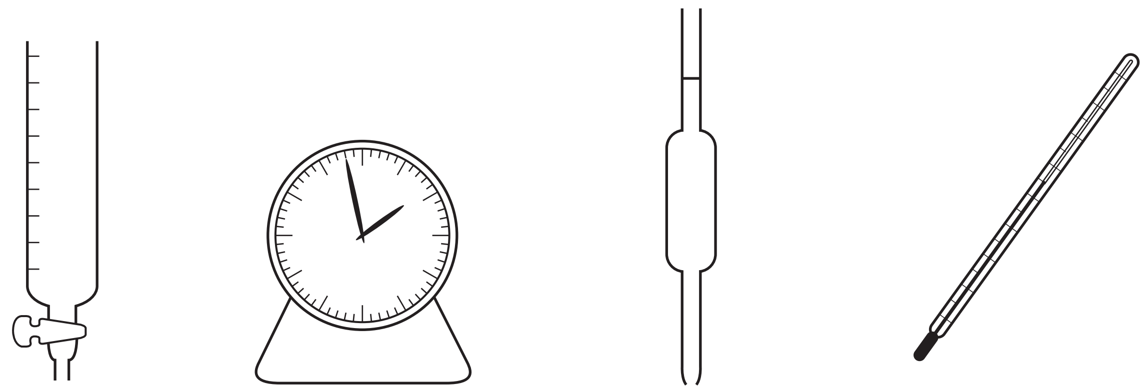
D a substance diffusing through the air

2 A student mixes 25 cm^3 samples of dilute hydrochloric acid with different volumes of aqueous sodium hydroxide.

In each case, the student measures the change in temperature to test if the reaction is exothermic.

Which piece of apparatus is **not** needed?

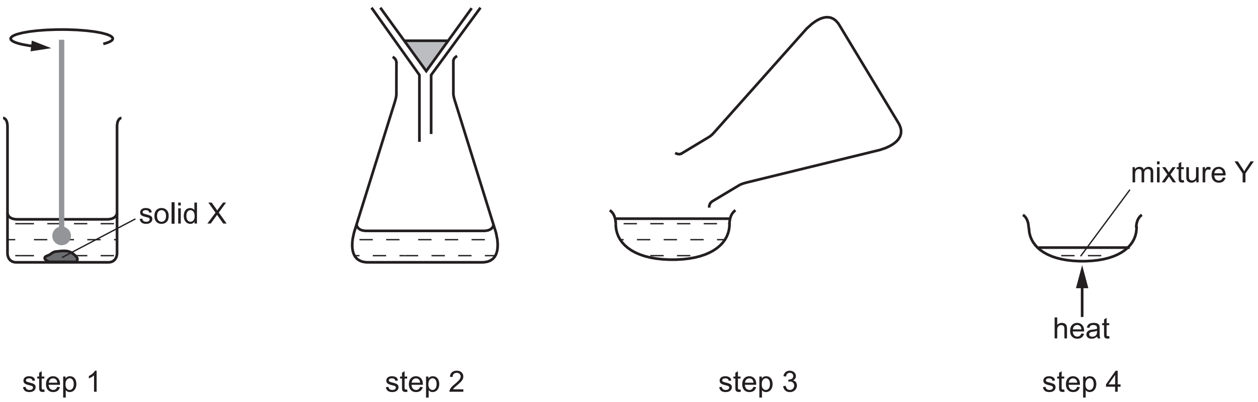
A	**B**	**C**	**D**



burette	clock	pipette	thermometer

3 A solid X is purified in five steps.

The first four steps of the purification are shown in the diagram.



In **step 5**, how is a pure sample of solid X obtained from mixture Y?

A dissolving

B distillation

C evaporating

D filtering

4 An atom has three electron shells. There are three electrons in the outer shell.

How many protons and how many neutrons are in this atom?

	protons	neutrons
A	13	14
B	13	27
C	14	13
D	21	24

5 Ethanol is a liquid at room temperature and boils at 78 °C.

Sodium chloride is a solid at room temperature.

Which statement about the bonding in ethanol and sodium chloride is **not** correct?

A Each ethanol molecule is held together by weak covalent bonds.

B The ethanol molecules are held together by weak attractive forces.

C The sodium ions and chloride ions are held together by strong attractive forces.

D The sodium ions and chloride ions are held together in a giant lattice.

6 The molecules N_2, C_2H_4, CO_2 and CH_3OH all have covalent bonds.

These bonds consist of shared pairs of electrons.

Which row gives the total number of shared pairs of electrons in the molecules shown?

	molecule	total number of shared pairs of electrons
A	N_2	2
B	C_2H_4	6
C	CO_2	2
D	CH_3OH	4

7 Metals are malleable.

Which statement explains why metals are malleable?

A Metallic bonding is very strong.

B Metals are good conductors of electricity.

C Positive metal ions are arranged in a regular lattice structure.

D The layers of positive metal ions can slide over each other.

8 The equation shows the complete combustion of propane.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

Which statement is correct?

A $10\,cm^3$ of propane cannot burn if less than $50\,cm^3$ of oxygen is present.

B $10\,cm^3$ of propane would produce $40\,cm^3$ of liquid water.

C $100\,cm^3$ of oxygen would be sufficient to react completely with $20\,cm^3$ of propane.

D This reaction would result in an increase in the volume of gas.

9 Sodium hydroxide reacts with sulfuric acid.

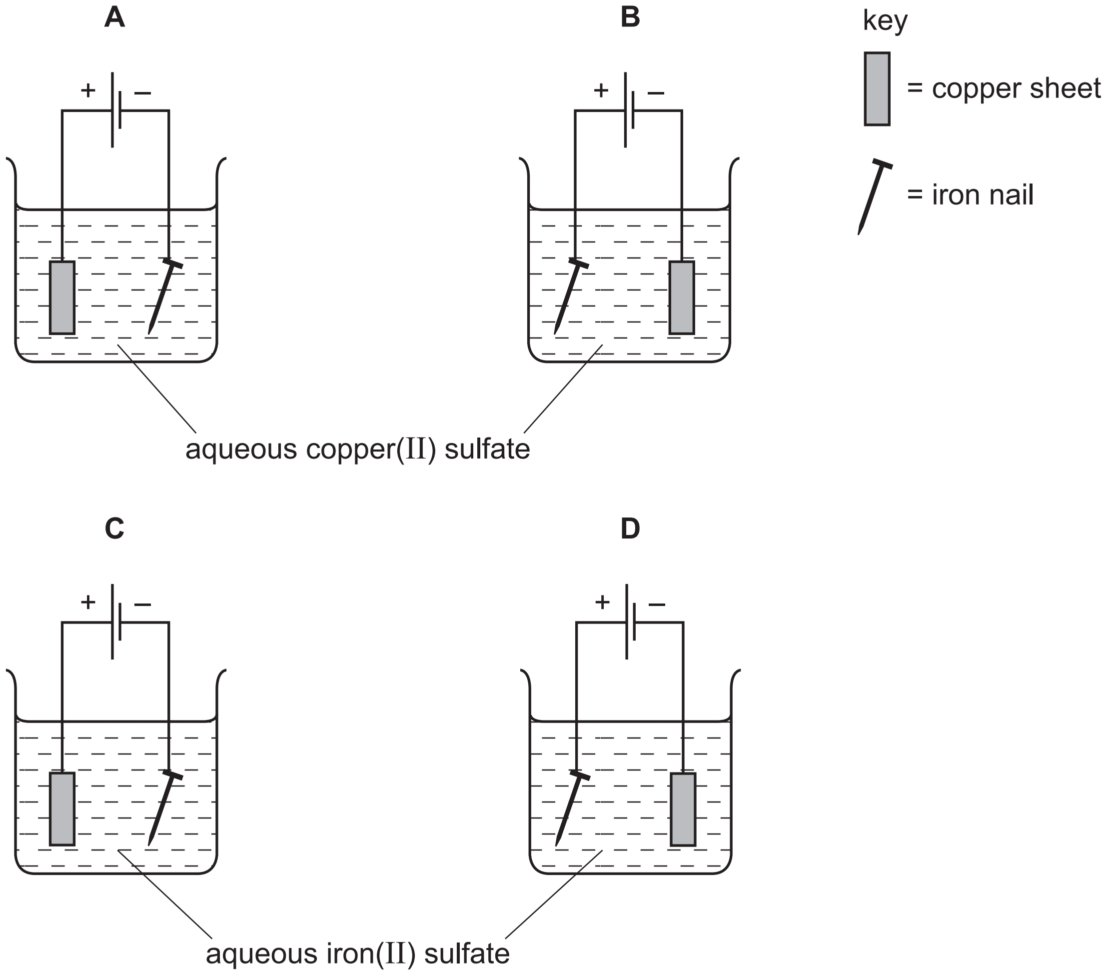
The equation for the reaction is shown.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

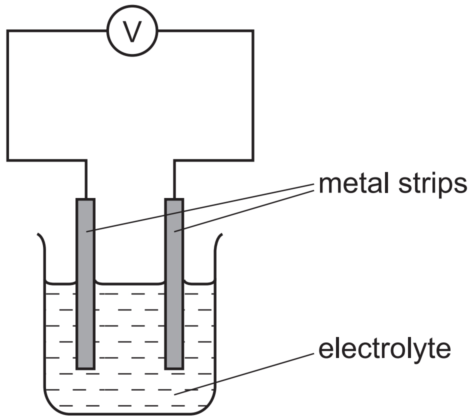
Which volume of $0.4\,mol/dm^3$ sodium hydroxide reacts with $50.0\,cm^3$ of $0.1\,mol/dm^3$ sulfuric acid?

A $12.5\,cm^3$ **B** $25.0\,cm^3$ **C** $50.0\,cm^3$ **D** $100.0\,cm^3$

10 Which apparatus could be used to electroplate an iron nail with copper?



11 The diagram shows two different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

A copper and iron

B copper and magnesium

C copper and zinc

D magnesium and iron

12 10 g of ammonium nitrate are added to water at 25 °C and the mixture stirred. The ammonium nitrate dissolves and, after one minute, the temperature of the solution is 10 °C.

Which word describes this change?

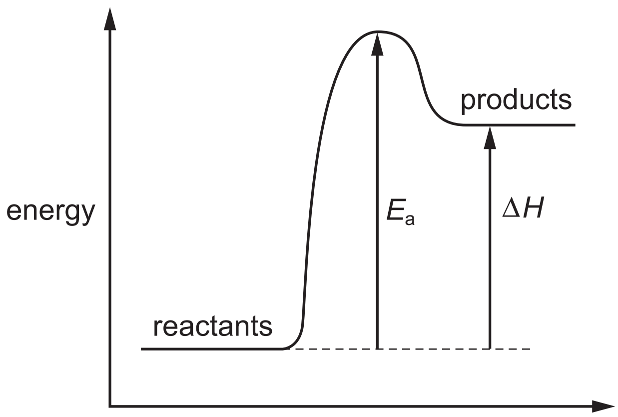
A endothermic

B exothermic

C neutralisation

D reduction

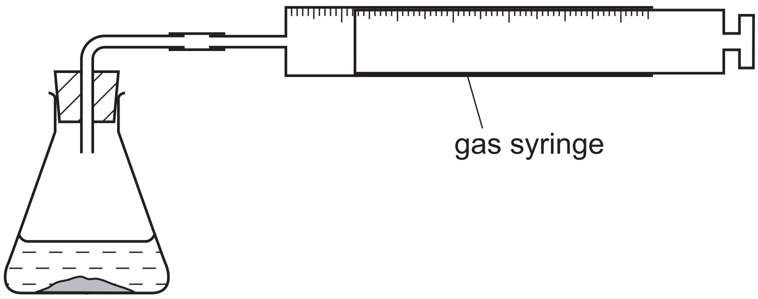
13 The energy level diagram for a reaction is shown.



Which row is correct?

	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	+	exothermic	+

14 An experiment X is carried out between a solid and a solution using the apparatus shown.

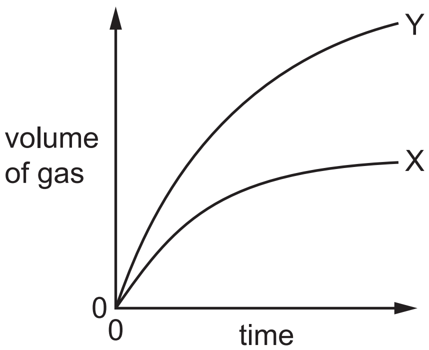


The volume of gas given off is measured at different times and the results plotted on a graph.

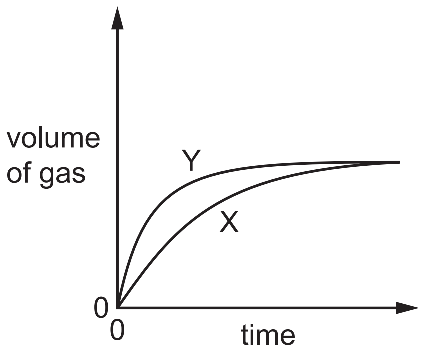
In a second experiment Y, the surface area of the solid is increased but all other factors remain the same.

Which graph shows the results of experiments X and Y?

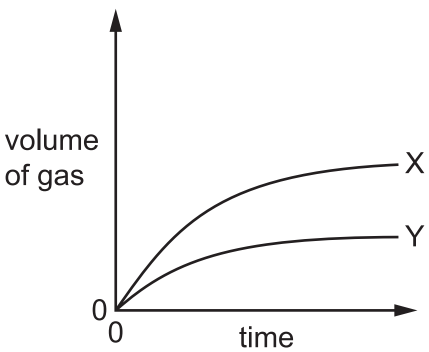
A



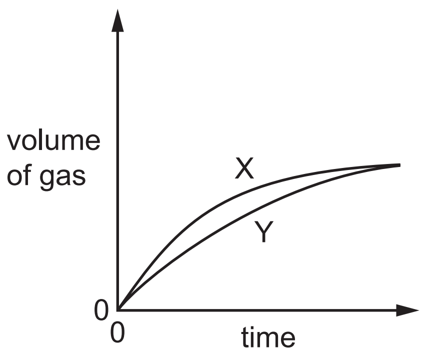
B



C



D



15 Which change in conditions increases the energy of the particles in a reaction?

A addition of a catalyst

B increase in concentration

C increase in surface area

D increase in temperature

16 Chlorine can be manufactured by the following reaction. The reaction is exothermic.

$$4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$$

Which change increases the yield of chlorine at equilibrium?

A adding more $HCl(g)$

B adding more $H_2O(g)$

C decreasing the pressure

D increasing the temperature

17 Which change represents an oxidation reaction?

A chlorine changes to chlorate(I) ions

B chlorine changes to chloride ions

C copper(II) ions change to copper

D potassium manganate(VII) ions change to potassium manganate(VI) ions

18 Germanium oxide is a white powder.

Germanium oxide reacts with concentrated hydrochloric acid.

Germanium oxide reacts with concentrated aqueous sodium hydroxide.

Germanium oxide does not dissolve when added to water.

Which type of oxide is germanium oxide?

A acidic

B amphoteric

C basic

D neutral

19 Hydrogen chloride gas reacts with water to produce an acidic solution. The equation for the reaction is shown.

$$HCl + H_2O \rightarrow Cl^- + H_3O^+$$

Which statement describes what happens during the reaction?

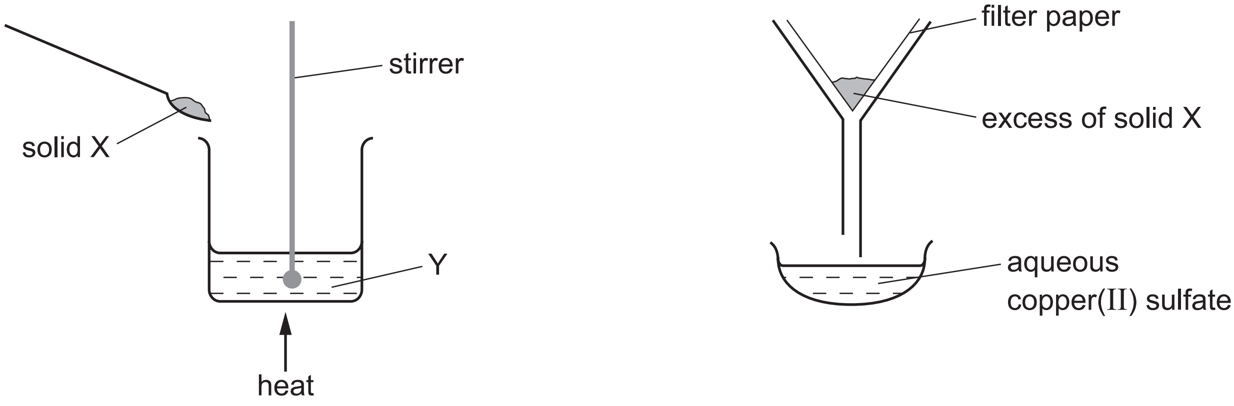
A The chloride ion is formed by accepting an electron from the water.

B The hydrogen chloride loses an electron to form the chloride ion.

C The water accepts a proton from the hydrogen chloride.

D The water donates a proton to the hydrogen chloride.

20 The apparatus shown is used to prepare aqueous copper(II) sulfate.



What are X and Y?

	X	Y
A	copper	aqueous iron(II) sulfate
B	copper(II) chloride	sulfuric acid
C	copper(II) oxide	sulfuric acid
D	sulfur	aqueous copper(II) chloride

21 Information about some silver compounds is shown in the table.

compound	formula	solubility in water
silver carbonate	Ag_2CO_3	insoluble
silver chloride	$AgCl$	insoluble
silver nitrate	$AgNO_3$	soluble
silver oxide	Ag_2O	insoluble

Which equation shows a reaction which **cannot** be used to make a silver salt?

A $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $Ag_2O(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l)$

C $Ag_2CO_3(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$

D $2Ag(s) + 2HCl(aq) \rightarrow 2AgCl(s) + H_2(g)$

22 What is **not** a property of Group I metals?

A They are soft and can be cut with a knife.

B They react when exposed to oxygen in the air.

C They produce an acidic solution when they react with water.

D They react rapidly with water producing hydrogen gas.

23 Compound T is added to dilute hydrochloric acid and warmed gently.

The mixture gives off a gas which turns acidified aqueous potassium manganate(VII) from purple to colourless.

A flame test on compound T gives a lilac flame.

What is compound T?

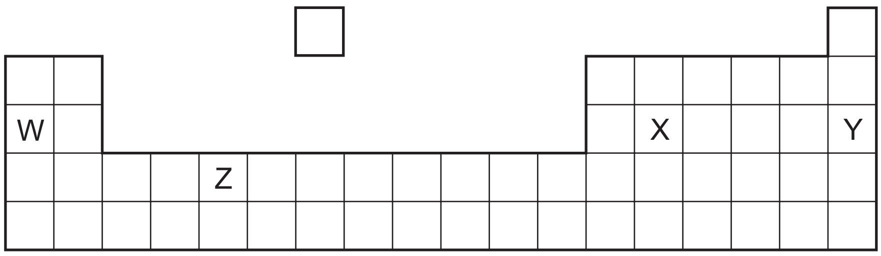
A sodium sulfate

B sodium sulfite

C potassium sulfate

D potassium sulfite

24 Part of the Periodic Table is shown.



Which row correctly describes the properties of elements W, X, Y and Z?

	has variable oxidation states	reacts with cold water	very unreactive	has four outer shell electrons
A	W	Y	Z	X
B	X	W	Y	Z
C	Z	W	Y	X
D	Z	Y	X	W

25 Basic oxides and oxygen are used to convert iron into steel.

Which statement is **not** correct?

A Carbon is converted into carbon dioxide.

B Silicon is converted into silicon(IV) oxide.

C The basic oxides react with acidic impurities to form slag.

D The oxygen reacts with the iron to produce hematite.

26 The results of two experiments are given.

1 Cobalt displaces manganese from an aqueous solution of a manganese salt.

2 Manganese displaces silver from an aqueous solution of a silver salt.

Three more experiments are carried out.

3 Cobalt is added to an aqueous solution of a silver salt.

4 Manganese is added to an aqueous solution of a cobalt salt.

5 Silver is added to an aqueous solution of a cobalt salt.

In which experiments does a reaction take place?

A 3 only **B** 3 and 4 **C** 4 and 5 **D** 5 only

27 Cryolite, Na_3AlF_6, is added to aluminium oxide in the electrolytic extraction of aluminium.

What is the reason for this?

A to decrease the melting point of the electrolyte

B to protect the anodes

C to produce more aluminium

D to stop the aluminium reacting with air

28 Different forms of steel contain different proportions of carbon.

Steel P contains a high proportion of carbon.

Steel Q contains a low proportion of carbon.

Which statement is correct?

A P is stronger and more brittle than Q.

B P is stronger and less brittle than Q.

C P is less strong and more brittle than Q.

D P is less strong and less brittle than Q.

29 Air is a mixture of gases.

Which gas is present in the largest amount?

A argon

B carbon dioxide

C nitrogen

D oxygen

30 Which information about carbon dioxide and methane is correct?

		carbon dioxide	methane
A	formed when vegetation decomposes	✓	✗
B	greenhouse gas	✓	✓
C	present in unpolluted air	✗	✗
D	produced during respiration	✗	✓

key
✓ = true
✗ = false

31 A metal, X, is used to make oil pipelines.

X corrodes in air and water.

X can be protected from corrosion by attaching blocks of element Y.

Which statement is correct?

A This process is known as galvanising.

B Y forms positive ions more readily than X.

C Y is an unreactive metal.

D Y is an unreactive non-metal.

32 The Haber process for the manufacture of ammonia occurs at 450 °C and 250 atmospheres. The nitrogen and hydrogen are supplied in a 1:3 ratio by volume. The reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,\text{kJ/mol}$$

Which change causes an increase in the yield of ammonia?

A decreasing the concentration of nitrogen

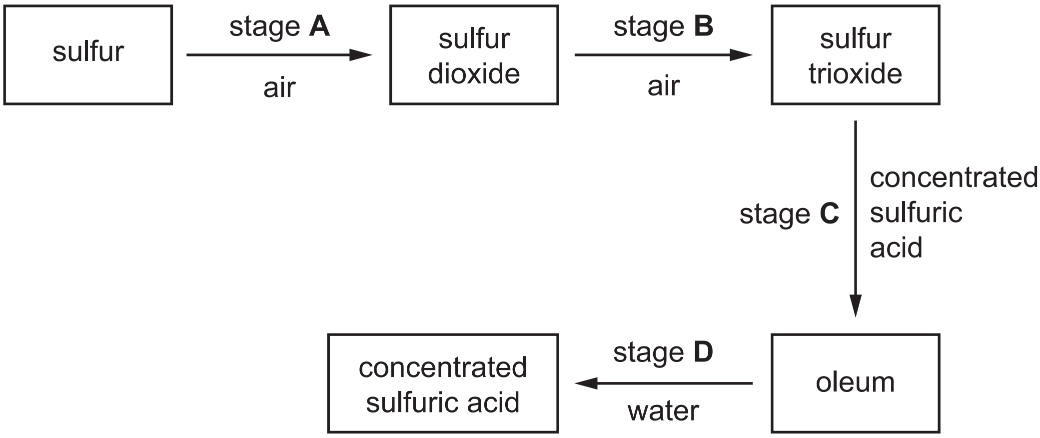
B decreasing the pressure

C decreasing the temperature

D using equal amounts of the two reactants

33 The following scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



34 Slaked lime is used to neutralise an acidic soil.

How does the pH of the soil change?

	from	to
A	6	7
B	7	8
C	8	7
D	8	6

35 Which list shows the fractions obtained from distilling petroleum, in order of increasing boiling point?

A bitumen $\rightarrow$ diesel oil $\rightarrow$ fuel oil $\rightarrow$ lubricating oil

B diesel oil $\rightarrow$ gasoline $\rightarrow$ naphtha $\rightarrow$ kerosene

C gasoline $\rightarrow$ naphtha $\rightarrow$ kerosene $\rightarrow$ diesel oil

D kerosene $\rightarrow$ lubricating oil $\rightarrow$ naphtha $\rightarrow$ refinery gas

36 Butane reacts as shown.

$$\text{butane} \xrightarrow[\text{and heat}]{\text{catalyst}} \text{butene} + \text{hydrogen}$$

What is this type of reaction?

A combustion

B cracking

C polymerisation

D reduction

37 Substance Z has the following characteristics.

1 It burns in an excess of oxygen to form carbon dioxide and water.

2 It is oxidised by air to form a liquid smelling of vinegar.

3 It reacts with carboxylic acids to form esters.

What is substance Z?

A ethane

B ethanoic acid

C ethanol

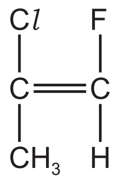
D ethyl ethanoate

38 Ethanol is manufactured by the catalytic addition of steam to ethene and by fermentation.

Which row shows an advantage and a disadvantage of using the catalytic addition of steam to ethene compared to fermentation?

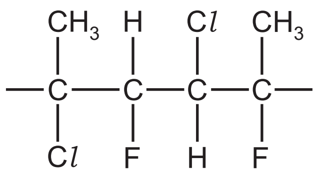
	advantage	disadvantage
A	fast	the product is impure
B	fast	uses non-renewable materials
C	the product is pure	slow
D	uses renewable materials	slow

39 The organic compound shown can be polymerised.

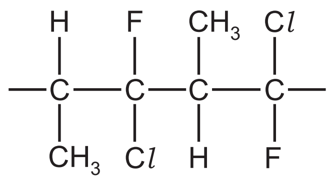


Which diagram represents a section of the polymer?

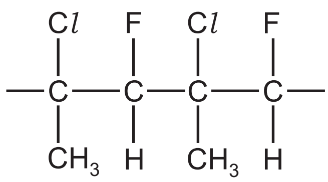
A



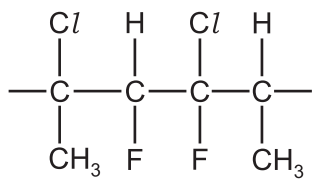
B



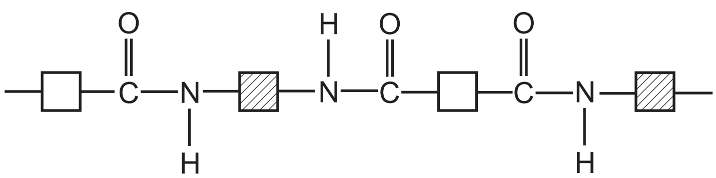
C



D



40 The partial structure of a polymer is shown.



Which type of polymer is represented?

A a carbohydrate

B a polyamide

C a polyester

D an addition polymer

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2016**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

3303892045

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 20.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.

1 ‘Particles moving **very slowly** from an area of higher concentration to an area of lower concentration.’

Which process is being described?

A a liquid being frozen

B a solid melting

C a substance diffusing through a liquid

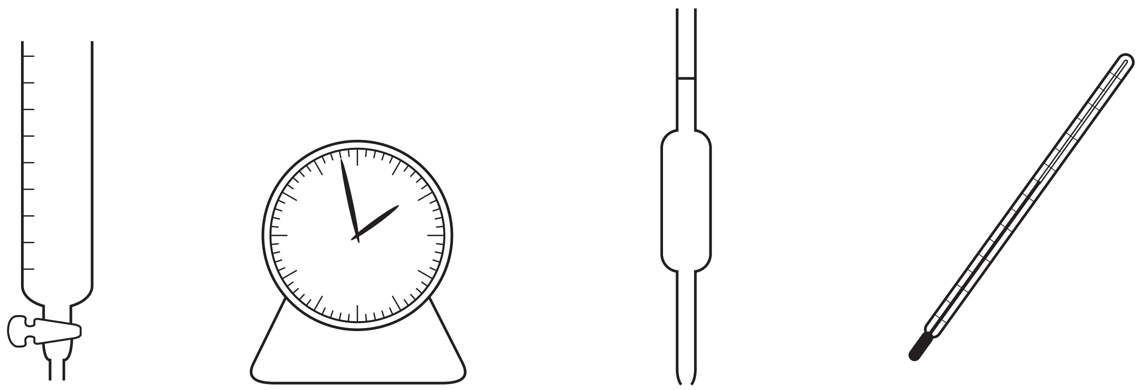
D a substance diffusing through the air

2 A student mixes $25\,cm^3$ samples of dilute hydrochloric acid with different volumes of aqueous sodium hydroxide.

In each case, the student measures the change in temperature to test if the reaction is exothermic.

Which piece of apparatus is **not** needed?

A	B	C	D



burette	clock	pipette	thermometer

3 A sample contains a mixture of powdered limestone (calcium carbonate), sugar and wax.

What is the correct way to obtain a pure sample of sugar?

A Dissolve the mixture in dilute hydrochloric acid, filter and wash the residue.

B Dissolve the mixture in hexane, filter and evaporate the filtrate.

C Dissolve the mixture in water, filter and evaporate the filtrate.

D Dissolve the mixture in water, filter and wash the residue.

4 The table shows information about four different particles.

particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Na	11	23	11	W	11
Na^+	11	23	11	12	X
O	8	16	8	Y	8
O^{2-}	8	16	8	8	Z

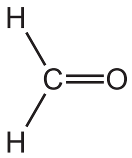
What are the values of W, X, Y and Z?

	W	X	Y	Z
A	11	10	10	8
B	11	11	8	10
C	12	10	8	10
D	12	11	10	8

5 In which ionic compound do the metal ion and the non-metal ion have the same electronic structure?

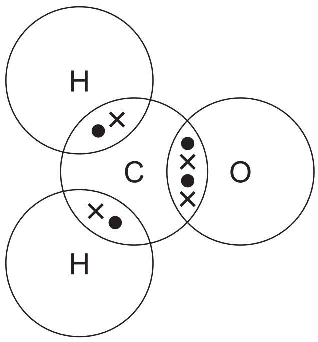
A CaO **B** KBr **C** MgO **D** NaC*l*

6 The structure of methanal is shown.

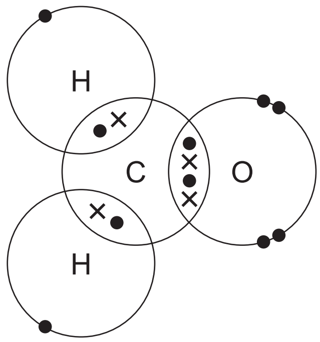


Which diagram shows the arrangement of outer shell electrons in a molecule of methanal?

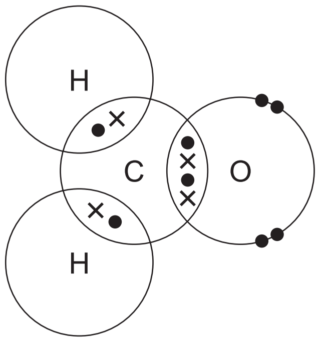
A



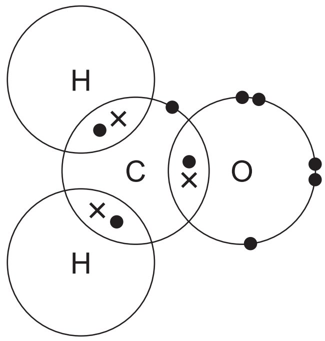
B



C



D



7 Iron is a metal. Its structure consists of a giant lattice of positive ions in a ‘sea of electrons’.

Which statements about solid iron are correct?

1 Iron conducts electricity because the electrons are free to move.

2 Iron conducts heat because the positive ions are free to move.

3 Iron has a high melting point due to the strong covalent bonds.

4 Iron is malleable because the layers of ions can slide over one another.

A 1 and 3 **B** 1 and 4 **C** 1 only **D** 2, 3 and 4

8 Which sample contains the greatest number of molecules?

A 4 g of hydrogen

B 18 g of water

C 24 dm^3 of oxygen

D 66 g of carbon dioxide

9 Sodium carbonate solution reacts with dilute hydrochloric acid. The equation for the reaction is shown.

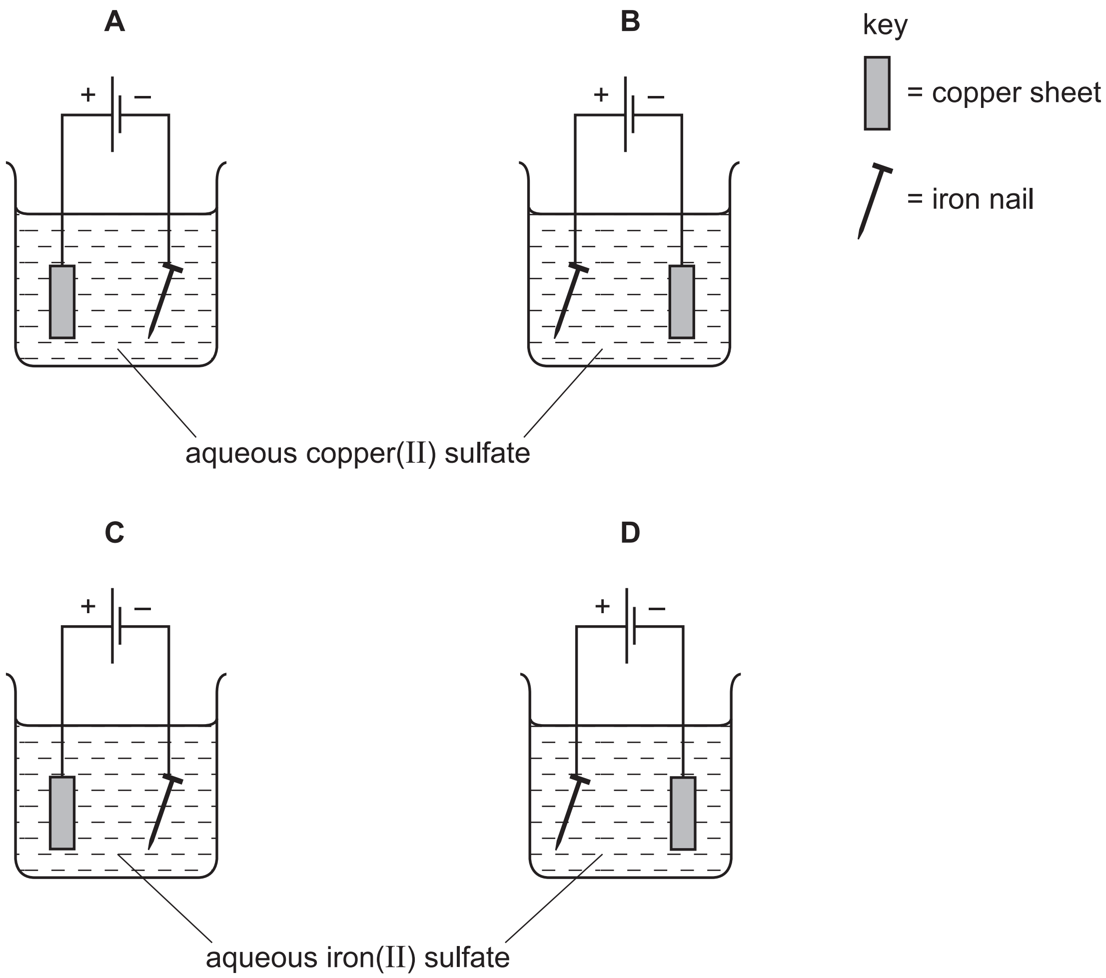
$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Excess sodium carbonate is added to 10.0 cm^3 of 0.10 mol / dm^3 hydrochloric acid.

Which volume of carbon dioxide gas is made?

A 12 cm^3 **B** 24 cm^3 **C** 12 000 cm^3 **D** 24 000 cm^3

10 Which apparatus could be used to electroplate an iron nail with copper?



11 A student sets up a number of simple cells by putting strips of two different metals into dilute sulfuric acid.

Which cell produces the highest voltage?

A copper and magnesium

B copper and zinc

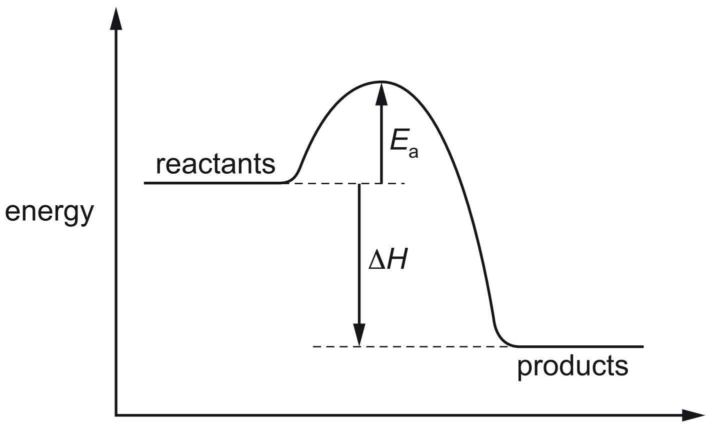
C iron and copper

D magnesium and zinc

12 Which experiment is the most exothermic?

	initial temperature / °C	final temperature / °C
A	20	5
B	20	32
C	25	12
D	25	34

13 The energy level diagram for a reaction is shown.



Which row is correct?

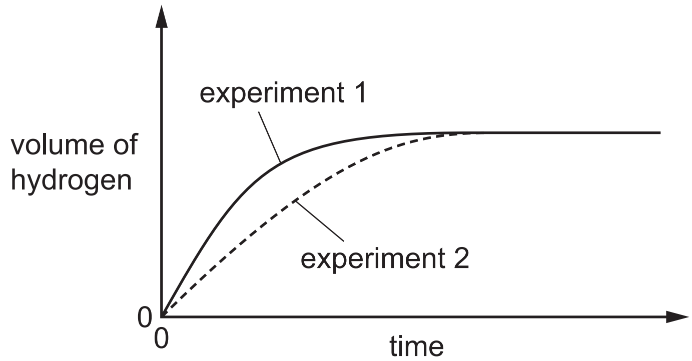
	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	–	exothermic	+

14 Zinc granules are reacted with excess dilute hydrochloric acid.

The volume of hydrogen given off is measured at different times.

The results are shown on the graph, labelled experiment 1.

The results for a second experiment are also shown on the graph, labelled experiment 2.



Which change to the conditions was made in experiment 2?

A The concentration of the hydrochloric acid was decreased.

B The size of the zinc granules was decreased.

C The surface area of the zinc granules was increased.

D The temperature was increased.

15 In an experiment nitric acid is added to excess marble chips and the volume of carbon dioxide formed is measured.

The experiment is repeated using smaller marble chips. All other conditions remain the same.

Which statement about the second experiment is correct?

A The collisions are more frequent and higher energy.

B The collisions are more frequent and the same energy.

C The collisions are the same frequency and the same energy.

D The collisions are the same frequency and higher energy.

16 At 400 °C the reaction between hydrogen and iodine reaches an equilibrium. The reaction is exothermic.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = -13\,kJ/mol$$

Which change in conditions would increase the percentage of hydrogen iodide in the equilibrium mixture?

A a decrease in pressure

B a decrease in temperature

C an increase in pressure

D an increase in temperature

17 Chromium forms the compound chromium(III) sulfate.

What does the (III) represent?

A the charge on a sulfate ion

B the number of chromium ions combined with one sulfate ion

C the number of sulfate ions combined with one chromium ion

D the oxidation state of chromium

18 Germanium oxide is a white powder.

Germanium oxide reacts with concentrated hydrochloric acid.

Germanium oxide reacts with concentrated aqueous sodium hydroxide.

Germanium oxide does not dissolve when added to water.

Which type of oxide is germanium oxide?

A acidic

B amphoteric

C basic

D neutral

19 Hydrogen chloride gas reacts with water to produce an acidic solution. The equation for the reaction is shown.

$$HCl + H_2O \rightarrow Cl^- + H_3O^+$$

Which statement describes what happens during the reaction?

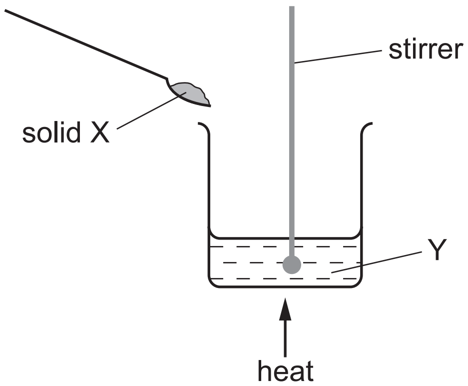
A The chloride ion is formed by accepting an electron from the water.

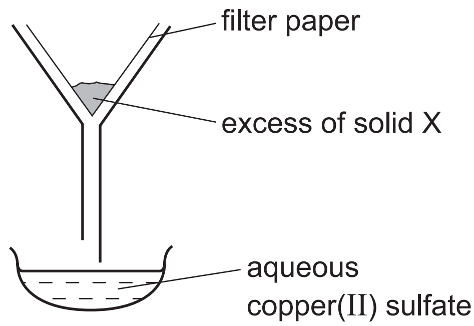
B The hydrogen chloride loses an electron to form the chloride ion.

C The water accepts a proton from the hydrogen chloride.

D The water donates a proton to the hydrogen chloride.

20 The apparatus shown is used to prepare aqueous copper(II) sulfate.





What are X and Y?

	X	Y
A	copper	aqueous iron(II) sulfate
B	copper(II) chloride	sulfuric acid
C	copper(II) oxide	sulfuric acid
D	sulfur	aqueous copper(II) chloride

21 Information about some silver compounds is shown in the table.

compound	formula	solubility in water
silver carbonate	Ag_2CO_3	insoluble
silver chloride	$AgCl$	insoluble
silver nitrate	$AgNO_3$	soluble
silver oxide	Ag_2O	insoluble

Which equation shows a reaction which **cannot** be used to make a silver salt?

A $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $Ag_2O(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l)$

C $Ag_2CO_3(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$

D $2Ag(s) + 2HCl(aq) \rightarrow 2AgCl(s) + H_2(g)$

22 What is **not** a property of Group I metals?

A They are soft and can be cut with a knife.

B They react when exposed to oxygen in the air.

C They produce an acidic solution when they react with water.

D They react rapidly with water producing hydrogen gas.

23 Aqueous sodium hydroxide was added slowly, until in excess, to separate solutions of W, X, Y and Z.

The results are shown.

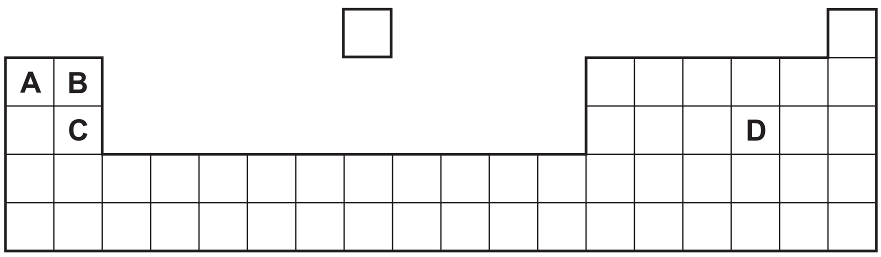
solution	initial observation with aqueous sodium hydroxide	final observation with excess aqueous sodium hydroxide
W	white precipitate formed	precipitate dissolves
X	white precipitate formed	no change
Y	pale blue precipitate formed	no change
Z	green precipitate formed	no change

Which row identifies the metal ions in the solutions?

	metal ion in solution W	metal ion in solution X	metal ion in solution Y	metal ion in solution Z
A	aluminium	calcium	copper(II)	iron(II)
B	aluminium	calcium	iron(II)	copper(II)
C	aluminium	iron(II)	calcium	copper(II)
D	calcium	aluminium	copper(II)	iron(II)

24 Part of the Periodic Table is shown.

Which element has two electrons in its outer shell and three electron shells?



25 Impurities in iron obtained from the blast furnace include carbon, phosphorus and silicon.

Which impurities are removed from the molten iron as gases when it is made into steel?

A carbon and phosphorus

B carbon and silicon

C carbon only

D phosphorus and silicon

26 Y displaces X from its aqueous sulfate.

X does not displace W from its aqueous sulfate.

X displaces Z from its aqueous sulfate.

What is the order of reactivity of elements W, X, Y and Z?

	most reactive	→		least reactive
A	W	X	Y	Z
B	W	Y	X	Z
C	Z	X	Y	W
D	Z	W	Y	X

27 Which statement about the industrial extraction of aluminium from aluminium oxide is correct?

A Aluminium is extracted by heating its oxide with carbon.

B Aluminium is extracted using electrolysis and is collected at the anode.

C Aluminium is extracted using platinum electrodes and direct current.

D Molten cryolite is used as a solvent for aluminium oxide.

28 The alloy brass is a mixture of copper and another metal.

Brass is used to make the pins of electrical plugs.

Copper is used to make electrical wiring.

Which row about brass is correct?

	hardness	electrical conductivity	other metal
A	harder than copper	better than copper	tin
B	harder than copper	worse than copper	zinc
C	softer than copper	better than copper	tin
D	softer than copper	worse than copper	zinc

29 Air is a mixture of gases.

Which gas is present in the largest amount?

A argon

B carbon dioxide

C nitrogen

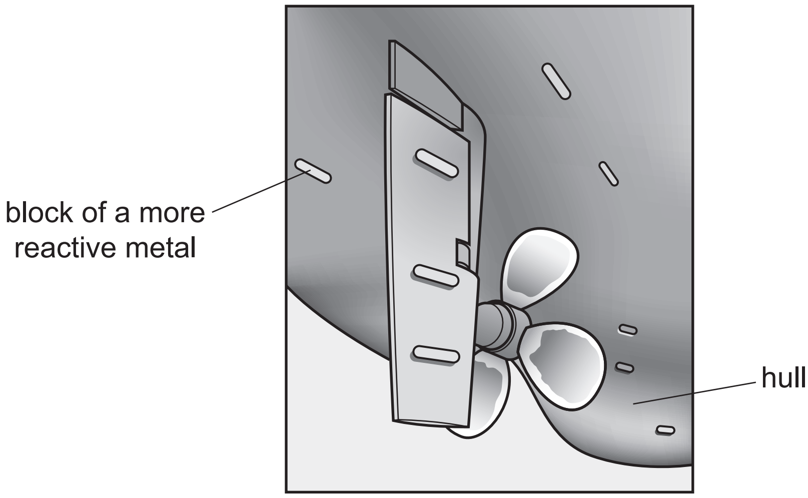
D oxygen

30 Which information about carbon dioxide and methane is correct?

		carbon dioxide	methane
A	formed when vegetation decomposes	✓	✗
B	greenhouse gas	✓	✓
C	present in unpolluted air	✗	✗
D	produced during respiration	✗	✓

key
✓ = true
✗ = false

31 Boats made from steel can be protected from rusting by attaching blocks of a more reactive metal to the hull of the boat.



Which statement is correct?

A Copper is used for the blocks because it does not react with water.

B Magnesium is not used for the blocks because it reacts with steel.

C The metal used for the blocks loses electrons more easily than steel.

D This form of protection from rusting is called galvanising.

32 Ammonia is manufactured by the Haber process, using an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

It is not possible to obtain 100% yield.

What is the reason for this?

A A high pressure is used.

B Ammonia decomposes at high temperature.

C Some of the ammonia is recycled.

D The ammonia reacts with the catalyst.

33 Sulfuric acid is manufactured by a series of chemical reactions, one of which is catalysed by vanadium(V) oxide.

What is the equation for the reaction catalysed by vanadium(V) oxide?

A $S + O_2 \rightarrow SO_2$

B $2S + 3O_2 \rightarrow 2SO_3$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $SO_3 + H_2O \rightarrow H_2SO_4$

34 Which substance gives off carbon dioxide on heating?

A lime

B limestone

C limewater

D slaked lime

35 Petroleum is separated into fractions.

Which statement is **not** correct?

A Each fraction contains a mixture of hydrocarbon molecules.

B Fuel oil burns easily and is used as fuel in cars.

C Refinery gas is the fraction containing the smallest molecules.

D The fractions are separated depending on their boiling point range.

36 Butane reacts as shown.

$$\text{butane} \xrightarrow[\text{and heat}]{\text{catalyst}} \text{butene} + \text{hydrogen}$$

What is this type of reaction?

A combustion

B cracking

C polymerisation

D reduction

37 Substance Z has the following characteristics.

1 It burns in an excess of oxygen to form carbon dioxide and water.

2 It is oxidised by air to form a liquid smelling of vinegar.

3 It reacts with carboxylic acids to form esters.

What is substance Z?

A ethane

B ethanoic acid

C ethanol

D ethyl ethanoate

38 Ethanol is manufactured by the catalytic addition of steam to ethene and by fermentation.

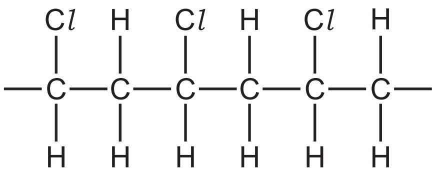
Which row shows an advantage and a disadvantage of using the catalytic addition of steam to ethene compared to fermentation?

	advantage	disadvantage
A	fast	the product is impure
B	fast	uses non-renewable materials
C	the product is pure	slow
D	uses renewable materials	slow

39 Chloroethene, $CH_2{=}CHCl$, can be polymerised.

Which diagram represents a section of the polymer?

A



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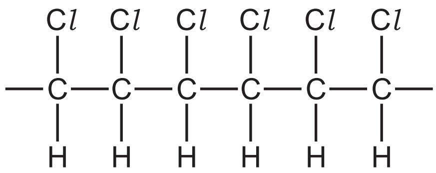

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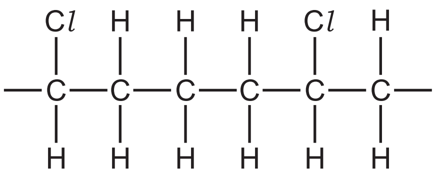

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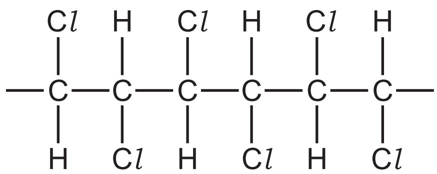

40 *Terylene* is a synthetic polymer.

Which statement about *Terylene* is **not** correct?

A It contains amide linkages.

B It contains carbon and oxygen atoms.

C It is made from small units called monomers.

D It is formed by condensation polymerisation.

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The Periodic Table of Elements

Key

atomic number **atomic symbol** name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2016**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

6942475041

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 20.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **20** printed pages.

1 'Particles moving **very slowly** from an area of higher concentration to an area of lower concentration.'

Which process is being described?

A a liquid being frozen

B a solid melting

C a substance diffusing through a liquid

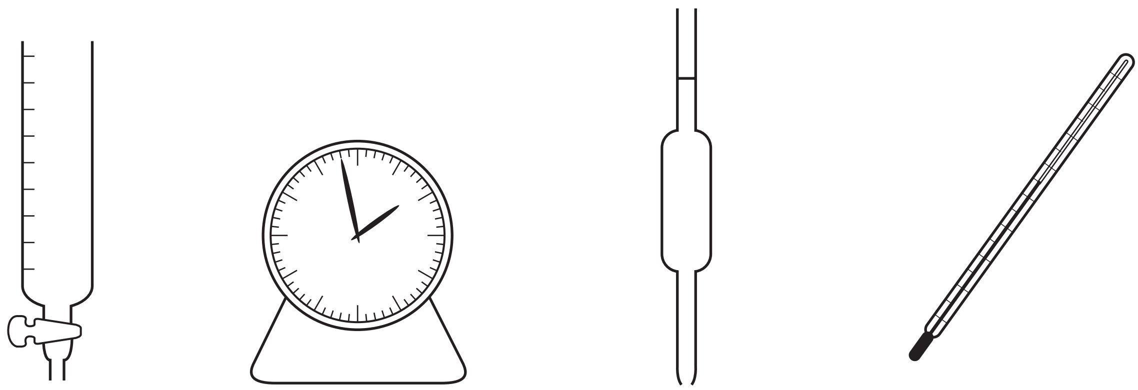
D a substance diffusing through the air

2 A student mixes $25\,cm^3$ samples of dilute hydrochloric acid with different volumes of aqueous sodium hydroxide.

In each case, the student measures the change in temperature to test if the reaction is exothermic.

Which piece of apparatus is **not** needed?

A **B** **C** **D**



burette clock pipette thermometer

3 Information about the solubility of four solids, P, Q, R and S, is given in the table.

	P	Q	R	S
solubility in water	dissolves	insoluble	insoluble	dissolves

A student attempted to separate mixtures of these solids using the following method.

1 Add the mixture to a beaker of water and stir.

2 Filter the mixture.

3 Crystallise one of the solids from the filtrate.

Which of the following mixtures could **not** be separated by this method?

A a mixture of P and R

B a mixture of Q and P

C a mixture of Q and R

D a mixture of R and S

4 The table shows information about atoms of three different elements.

element	proton number	nucleon number	number of protons	number of neutrons	number of electrons
chlorine	17	35	17	W	17
chlorine	17	X	17	19	17
argon	Y	40	18	22	18
potassium	19	39	19	20	Z

What are the values of W, X, Y and Z?

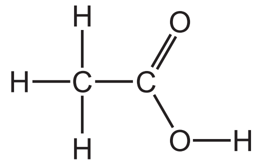
	W	X	Y	Z
A	18	35	18	19
B	18	36	18	19
C	19	35	19	18
D	19	36	19	18

5 Metal P reacts with non-metal Q to form a compound.

Which process takes place and which type of compound is formed?

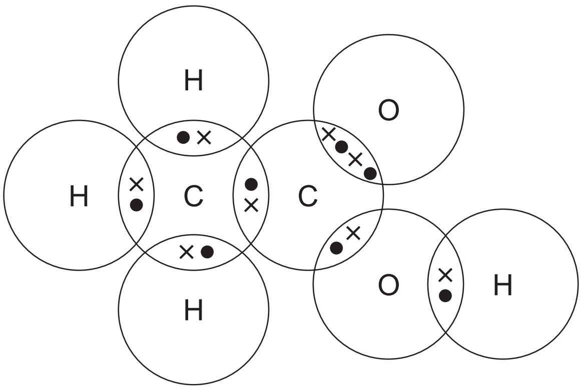
	process	type of compound
A	electrons are transferred from P to Q	covalent
B	electrons are transferred from P to Q	ionic
C	electrons are transferred from Q to P	covalent
D	electrons are transferred from Q to P	ionic

6 The structure of ethanoic acid is shown.



Which diagram shows the arrangement of outer shell electrons in a molecule of ethanoic acid?

A



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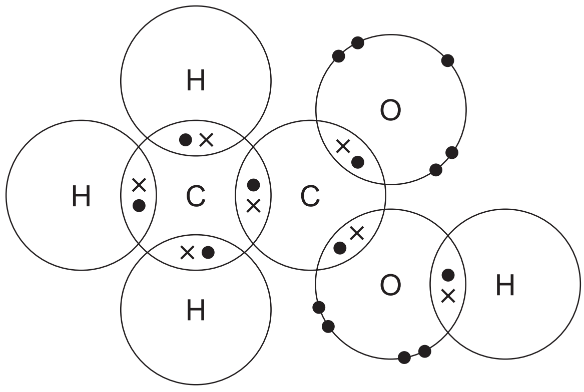

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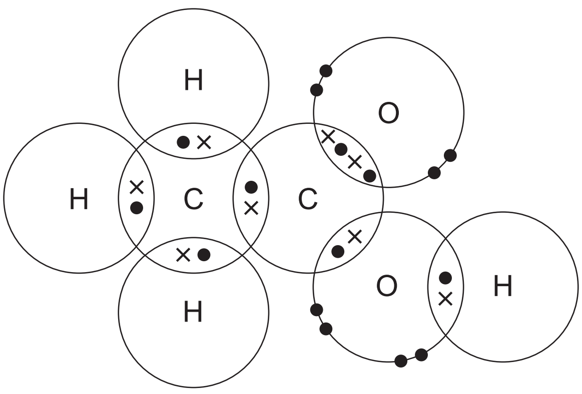

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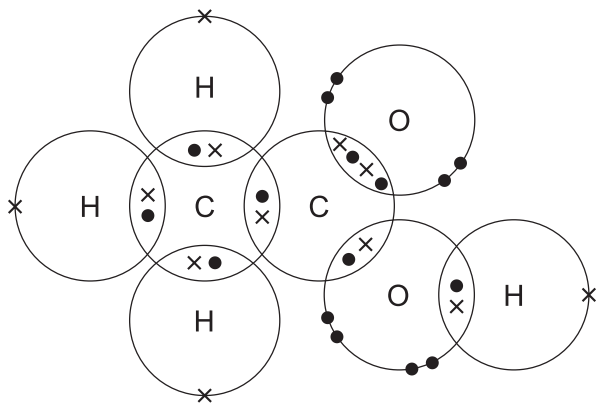


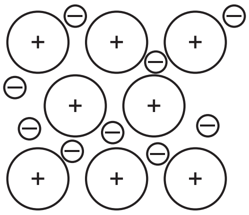
7 X is a solid at room temperature.

X has a high melting point.

Solid X conducts electricity.

Which diagram shows how the particles are arranged in solid X?

A



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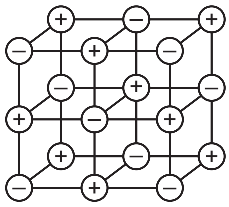

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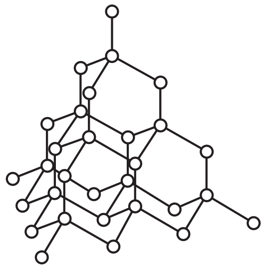

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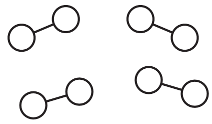


8 Benzene is a liquid with molecular formula C_6H_6.

Ethene is a gas with molecular formula C_2H_4.

Which statement is correct?

A 1 mole of benzene and 1 mole of ethene contain the same number of atoms.

B 1 mole of benzene and 1 mole of ethene both have a volume of $24\,dm^3$ at room temperature and pressure.

C Both benzene and ethene have the same empirical formula.

D The number of carbon atoms in 0.5 moles of ethene is equal to the Avogadro constant.

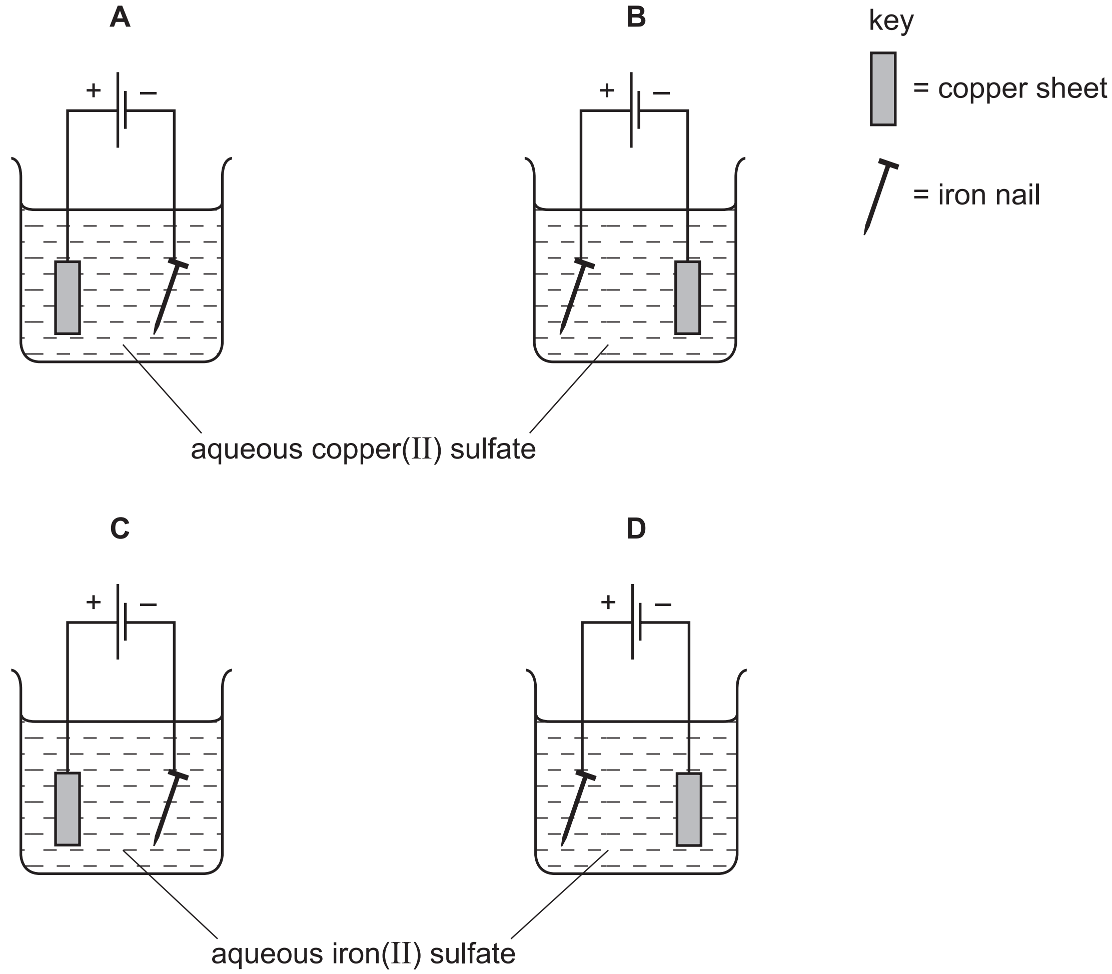
9 Sodium hydrogencarbonate undergoes thermal decomposition as shown.

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

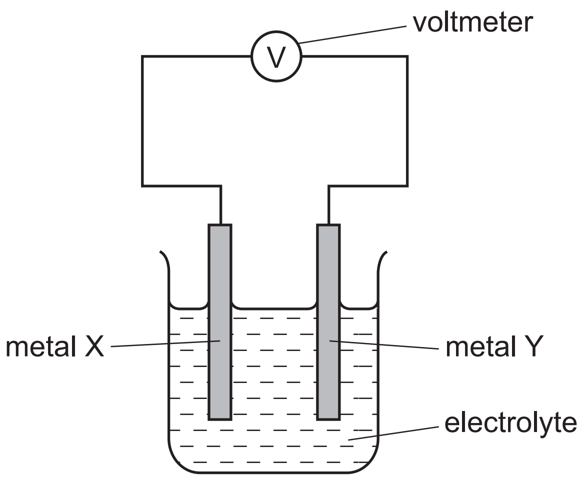
What is the maximum mass of sodium carbonate that can be made from 0.100 moles of sodium hydrogencarbonate?

A 4.15 g **B** 5.30 g **C** 10.6 g **D** 21.2 g

10 Which apparatus could be used to electroplate an iron nail with copper?



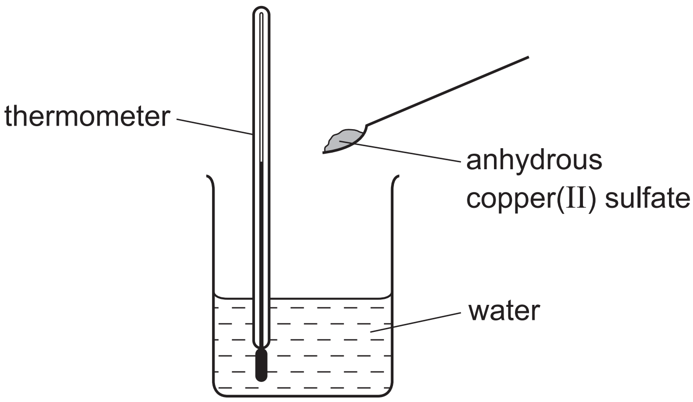
11 The diagram shows a simple cell.



Which two metals produce the highest reading on the voltmeter?

	X	Y
A	magnesium	copper
B	magnesium	iron
C	zinc	copper
D	zinc	iron

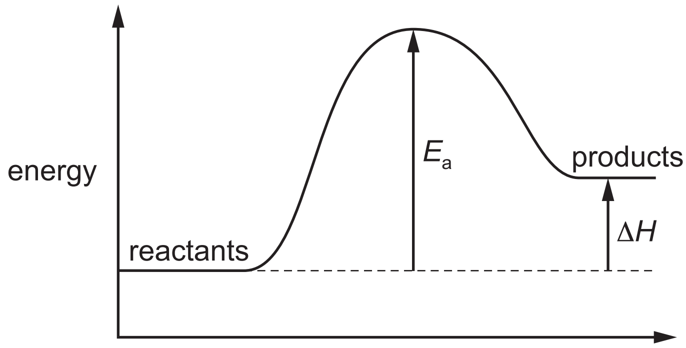
12 When anhydrous copper(II) sulfate is added to water a solution is formed and heat is given out.



Which row shows the temperature change and the type of reaction taking place?

	temperature change	type of reaction
A	decrease	endothermic
B	decrease	exothermic
C	increase	endothermic
D	increase	exothermic

13 The energy level diagram for a reaction is shown.



Which statement is **not** correct for this energy level diagram?

A It could be the energy level diagram for the reaction when petrol is burnt.

B Less energy is released in bond forming than is needed for bond breaking.

C The activation energy, E_a, has a positive value.

D The energy change, ΔH, for the reaction is positive.

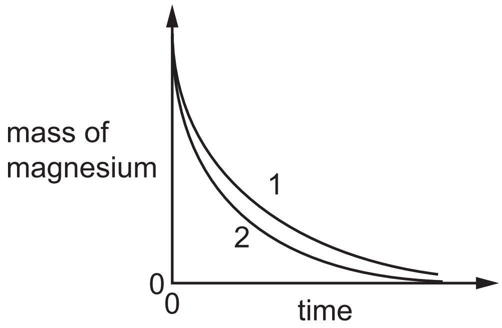
14 The rate of reaction between magnesium and excess dilute hydrochloric acid was followed by measuring the mass of magnesium present at regular time intervals.

Two experiments were performed.

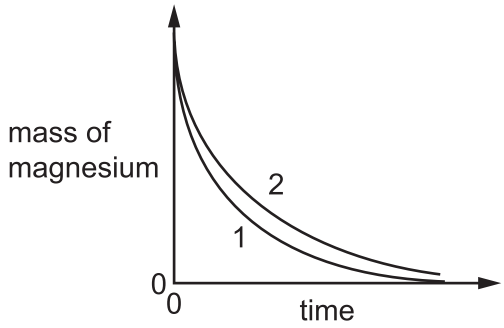
Both experiments used 0.1 g of magnesium ribbon. The acid in experiment 1 was less concentrated than in experiment 2.

Which graph shows the results of the experiments?

A



B



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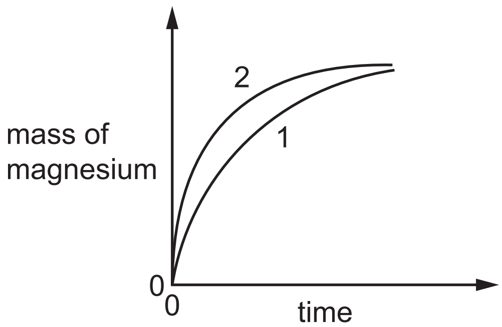
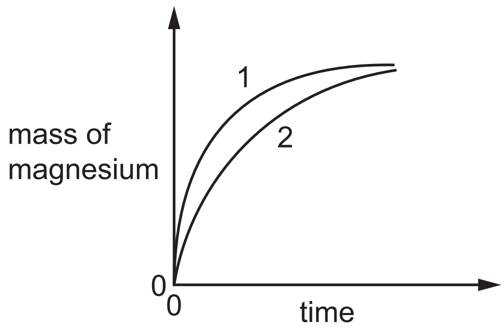


D



15 Which statement explains why coal dust forms an explosive mixture with air?

A Coal dust catalyses the explosion.

B Coal dust has a large surface area.

C Crushing coal increases the concentration of the coal.

D Crushing coal increases the temperature of the coal.

16 The following reversible reaction takes place in a closed vessel at constant temperature.

$$P(g) + Q(g) + R(g) \rightleftharpoons S(g) + T(g)$$

When the system has reached equilibrium, more T is added.

After the addition of T, which substances increase in concentration?

A P, Q, R and S

B P and Q only

C P, Q and R only

D S only

17 Four ionic half-equations are shown.

1 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

2 $2I^-(aq) \rightarrow I_2(aq) + 2e^-$

3 $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$

4 $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$

Which statement is correct?

A In equation 1, copper(II) ions are oxidised to copper.

B In equation 2, iodide ions are reduced to iodine.

C In equation 3, iron(II) ions are oxidised to iron(III) ions.

D In equation 4, chlorine is oxidised to chloride ions.

18 Germanium oxide is a white powder.

Germanium oxide reacts with concentrated hydrochloric acid.

Germanium oxide reacts with concentrated aqueous sodium hydroxide.

Germanium oxide does not dissolve when added to water.

Which type of oxide is germanium oxide?

A acidic

B amphoteric

C basic

D neutral

19 Hydrogen chloride gas reacts with water to produce an acidic solution. The equation for the reaction is shown.

$$HCl + H_2O \rightarrow Cl^- + H_3O^+$$

Which statement describes what happens during the reaction?

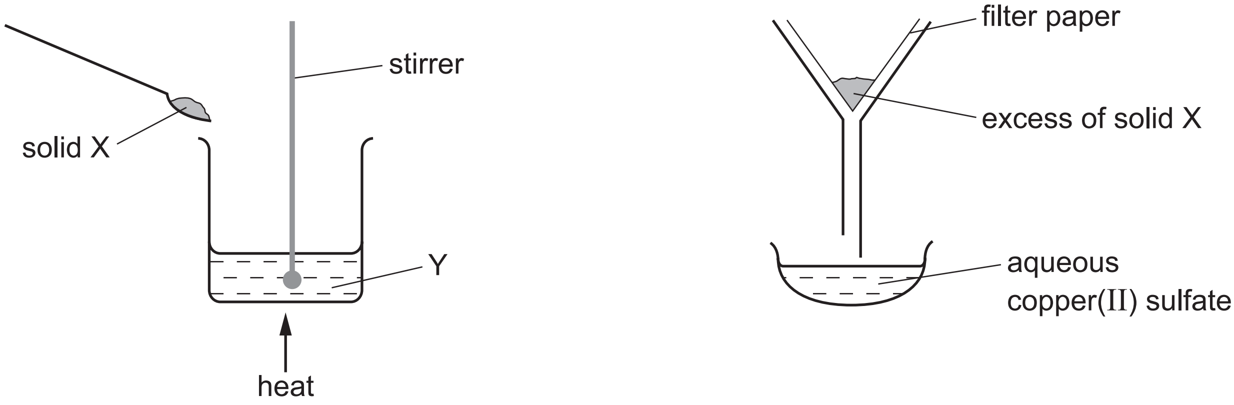
A The chloride ion is formed by accepting an electron from the water.

B The hydrogen chloride loses an electron to form the chloride ion.

C The water accepts a proton from the hydrogen chloride.

D The water donates a proton to the hydrogen chloride.

20 The apparatus shown is used to prepare aqueous copper(II) sulfate.



What are X and Y?

	X	Y
A	copper	aqueous iron(II) sulfate
B	copper(II) chloride	sulfuric acid
C	copper(II) oxide	sulfuric acid
D	sulfur	aqueous copper(II) chloride

21 Information about some silver compounds is shown in the table.

compound	formula	solubility in water
silver carbonate	Ag_2CO_3	insoluble
silver chloride	$AgCl$	insoluble
silver nitrate	$AgNO_3$	soluble
silver oxide	Ag_2O	insoluble

Which equation shows a reaction which **cannot** be used to make a silver salt?

A $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $Ag_2O(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l)$

C $Ag_2CO_3(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$

D $2Ag(s) + 2HCl(aq) \rightarrow 2AgCl(s) + H_2(g)$

22 What is **not** a property of Group I metals?

A They are soft and can be cut with a knife.

B They react when exposed to oxygen in the air.

C They produce an acidic solution when they react with water.

D They react rapidly with water producing hydrogen gas.

23 Four substances, P, Q, R and S, are tested as shown.

test	substance			
	P	Q	R	S
dilute hydrochloric acid added	gas given off which 'pops' with a lighted splint	gas given off which turns limewater milky	no reaction	no reaction
dilute aqueous sodium hydroxide added and warmed gently	no reaction	no reaction	gas given off which turns damp, red litmus paper blue	no reaction

What are P, Q, R and S?

	P	Q	R	S
A	Mg	Na_2CO_3	NH_4Cl	$NaCl$
B	Mg	NH_4Cl	Na_2CO_3	$NaCl$
C	Mg	Na_2CO_3	$NaCl$	NH_4Cl
D	Na_2CO_3	Mg	$NaCl$	NH_4Cl

24 Which statement about transition elements and their compounds is correct?

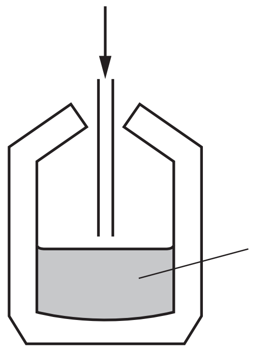
A All the transition elements have an oxidation state of +2 only.

B Aqueous solutions of the salts of transition elements are generally coloured.

C Transition elements change from metal to non-metal across the period.

D Transition elements can act as catalysts but their compounds cannot.

25 Impure iron from the blast furnace is converted to steel as shown.



Which statement about the process is correct?

A Acidic oxides are added to remove alkaline impurities.

B Coke is added as a reducing agent.

C Oxygen is blown in to oxidise the impure iron.

D The steel produced contains less carbon than the impure iron.

26 The ionic equations represent the reactions between four metals, P, Q, R and S, and solutions of the salts of the same metals.

$$P + Q^{2+} \rightarrow \text{no reaction}$$

$$R + P^{2+} \rightarrow R^{2+} + P$$

$$Q + S^{2+} \rightarrow Q^{2+} + S$$

$$S + P^{2+} \rightarrow S^{2+} + P$$

$$S + R^{2+} \rightarrow S^{2+} + R$$

$$S + Q^{2+} \rightarrow \text{no reaction}$$

What is the correct order of reactivity of the metals?

	most	→		least
A	P	R	S	Q
B	Q	R	S	P
C	Q	S	R	P
D	S	Q	P	R

27 Aluminium is extracted by electrolysis.

From which ore is aluminium extracted and at which electrode is aluminium deposited during electrolysis?

	ore	electrode
A	bauxite	negative
B	bauxite	positive
C	cryolite	negative
D	cryolite	positive

28 Zinc oxide can be reacted with carbon to produce zinc metal.

Which equation for this reaction is correct?

A $2ZnO + C \rightarrow 2Zn + CO$

B $2ZnO + 2C \rightarrow 2Zn + 2CO_2$

C $ZnO + C \rightarrow Zn + CO$

D $ZnO + 2C \rightarrow Zn + 2CO_2$

29 Air is a mixture of gases.

Which gas is present in the largest amount?

A argon

B carbon dioxide

C nitrogen

D oxygen

30 Which information about carbon dioxide and methane is correct?

		carbon dioxide	methane
A	formed when vegetation decomposes	✓	✗
B	greenhouse gas	✓	✓
C	present in unpolluted air	✗	✗
D	produced during respiration	✗	✓

key
✓ = true
✗ = false

31 Underwater steel pipes can be protected from corrosion by attaching magnesium blocks to them.

Which equation represents the reaction that prevents corrosion?

A $Fe \rightarrow Fe^{2+} + 2e^-$

B $Fe^{2+} \rightarrow Fe^{3+} + e^-$

C $Mg \rightarrow Mg^{2+} + 2e^-$

D $Mg^{2+} + 2e^- \rightarrow Mg$

32 Ammonia is manufactured by the Haber process. The reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ/mol$$

Which statement about the Haber process is correct?

A The reaction is irreversible and produces only one product.

B The reaction is reversible and produces less ammonia at high pressure.

C The reaction is reversible and produces less ammonia at high temperature.

D The reaction is slow because a catalyst is not used in the Haber process.

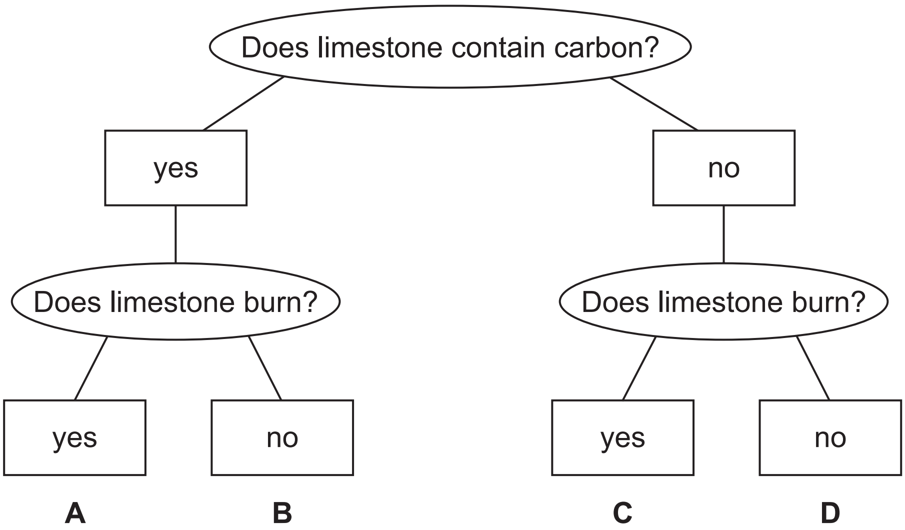
33 Sulfuric acid is manufactured by the Contact process.

The most important reaction takes place in the presence of a catalyst.

What are the reactants and the catalyst for this reaction?

	reactants	catalyst
A	sulfur and oxygen	vanadium(V) oxide
B	sulfur dioxide and oxygen	vanadium(V) oxide
C	sulfur dioxide and steam	iron
D	sulfur trioxide and water	platinum

34 Which box corresponds to limestone?



35 Petroleum is an important fossil fuel.

Which row correctly describes petroleum?

	type of substance	composition
A	compound	mainly hydrocarbons
B	compound	only hydrogen and carbon
C	mixture	mainly hydrocarbons
D	mixture	only hydrogen and carbon

36 Butane reacts as shown.

$$\text{butane} \xrightarrow[\text{and heat}]{\text{catalyst}} \text{butene} + \text{hydrogen}$$

What is this type of reaction?

A combustion

B cracking

C polymerisation

D reduction

37 Substance Z has the following characteristics.

1 It burns in an excess of oxygen to form carbon dioxide and water.

2 It is oxidised by air to form a liquid smelling of vinegar.

3 It reacts with carboxylic acids to form esters.

What is substance Z?

A ethane

B ethanoic acid

C ethanol

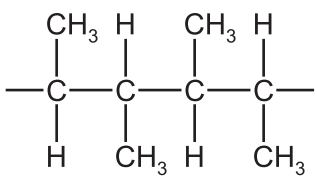
D ethyl ethanoate

38 Ethanol is manufactured by the catalytic addition of steam to ethene and by fermentation.

Which row shows an advantage and a disadvantage of using the catalytic addition of steam to ethene compared to fermentation?

	advantage	disadvantage
A	fast	the product is impure
B	fast	uses non-renewable materials
C	the product is pure	slow
D	uses renewable materials	slow

39 The partial structure of addition polymer X is shown.



Which monomer is used to form polymer X?

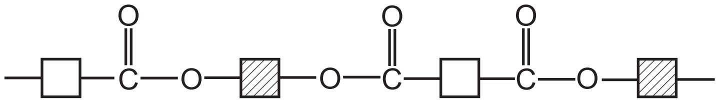
A $CH_2=CH_2$

B $CH_3CH=CH_2$

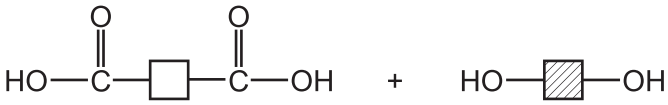
C $CH_3CH=CHCH_3$

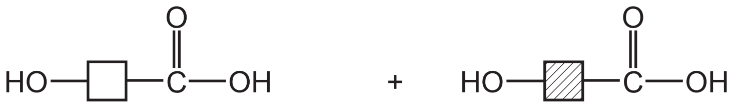
D $CH_3CH_2CH=CH_2$

40 The diagram shows the partial structure of *Terylene*.



From which pair of compounds is it made?

A 

B 

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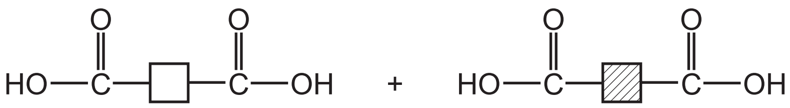
D 

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2016**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Mark
1(a)	(clamp / retort) stand trough	**1** **1**
1(b)	to absorb / hold / keep / soak up / contain the paraffin oil	**1**
1(c)	**M1** bromine (aqueous / in cyclohexane) **M2** turns colourless / decolourised	**1** **1**
1(d)	to prevent suck back (of water)	**1**

Question	Answer	Mark
2(a)	table of results for Experiment 1 temperature boxes completed correctly 20, 20, 20, 25, 28, 31, 33, 34, 35, 36, 36	**2**
2(b)	table of results for Experiment 2 temperature boxes completed correctly 22, 22, 22, 71, 76, 75, 72, 70, 67, 65, 64	**2**
2(c)	all points correctly plotted ± half a small square smooth line graphs labelled	**2** **1** **1**
2(d)(i)	working shown clearly as construction lines or cross value from graph (29–30 °C ± 0.5 °C)	**1** **1**
2(d)(ii)	value from graph (72 s) –60 s	**1** **1**
2(e)	room temperature or initial temperature from table (20–22 °C) reaction has finished / stopped	**1** **1**
2(f)	more readings / points / data smoother curve / better or more accurate graph	**1** **1**
2(g)	polystyrene is an insulator / copper is a (good) conductor reduced heat losses	**1** **1**

Question	Answer	Mark
3(a)(i)	pH 1–3	**1**
3(a)(ii)	effervescence / fizzing / bubbling / solid disappears / dissolves lighted splint 'pops'	**1** **1** **1**
3(a)(iii)	effervescence / fizzing / bubbling / solid disappears / dissolves limewater milky	**1** **1** **1**
3(a)(iv)	white precipitate	**1**
3(b)	calcium / Ca^{2+} hydroxide / OH^-	**1** **1**

Question	Answer	Mark
4	**silica** filter (the cleaner) wash the residue dry the residue **water** heat (the filtrate / cleaner) condense the vapour **sodium carbonate** heat to dryness / no liquid left (then solid) sodium carbonate is left **OR** heat until saturated then cool to crystallise / leave to crystallise	**6**

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Question	Answer	Mark
1(a)	(liebig) condenser tripod	**1** **1**
1(b)	sodium chloride crystals: **C** water: **D** silver chloride: **A**	**1** **1** **1**
1(c)	chromatography	**1**

Question	Answer	Mark
2(a)	table of results volume boxes completed correctly (30), 44, 57, 62, 78, 85, 88, 89, 90, 90	**2**
2(b)	all points correctly plotted smooth line graph	**2** **1**
2(c)(i)	point at 60 s / 62 cm^3 / fourth point / measurement 4	**1**
2(c)(ii)	misread measuring cylinder / read too early	**1**
2(c)(iii)	value from graph (68–70) shown clearly	**1** **1**
2(d)	the Reaction has finished all the <u>acid</u> has reacted / HCl is the limiting factor	**1** **1**
2(e)(i)	value from graph or table (57–44 = 13 cm^3)	**1**
2(e)(ii)	13 / 20 = 0.65 cm^3 / s	**1** **1**

Question	Answer	Mark
2(f)	steeper curve to same level	1 1
2(g)	air is displaced (when the acid is added)	1
2(h)	improvement explanation use a burette / graduated pipette / gas syringe improves accuracy **OR** use cotton thread to hold a test-tube (containing the acid) in the flask no air is collected **OR** repeat the experiment take average / more frequent readings	1 1

Question	Answer	Mark
3(a)(i)	pH 1–3	**1**
3(a)(ii)	solid disappears / dissolves blue / green colour	**1** **1**
3(a)(iii)	solid dissolves limewater turns milky	**1** **1** **1**
3(a)(iv)	white precipitate	**1**
3(b)	iron(III) nitrate	**1** **1**

Question	Answer	Mark
4	clean / sandpaper the metal ring dissolve copper(II) sulfate in water / copper(II) sulfate solution set up circuit / switch on electricity / complete circuit copper rod anode(+ ve electrode) metal ring cathode(– ve electrode) rotate the metal ring / agitate remove the metal ring, wash and dry	**6**

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Question	Answer	Mark
1(a)	electrodes	**1**
1(b)	bubbles / fizz / effervescence	**1**
1(c)(i)	more hydrogen twice as much hydrogen / half as much oxygen	**1** **1**
1(c)(ii)	water	**1**
1(d)	*lighted splint* no effect / brighter light for oxygen 'pops' for hydrogen **OR** *glowing splint* relights for oxygen no effect for hydrogen	 **1** **1** **1** **1**

Question	Answer	Mark
2(a)	table of results for Experiment 1 all temperature boxes completed correctly 22, 24, 26, 28, 30, 31, 30, 29, 28	**2**
2(b)	table of results for Experiment 2 initial and other temperature boxes completed correctly 20, 21, 22, 23, 24, 25, 24, 23, 22	**2**
2(c)	all points correctly plotted best-fit smooth line graphs labels	**2** **1** **1**
2(d)	value from graph (27 °C) shown clearly	**1** **1**
2(e)	phenolphthalein / litmus / suitable named indicator	**1**
2(f)	Experiment 1 / solution **N** solution **N** is a stronger acid / has a higher pH	**1** **1**
2(g)	measured results / temperature changes / results would be smaller **OR** larger / double volume needed to reach same temperature changes	**1**
2(h)	polystyrene is an insulator / copper is a (good) conductor	**1**
2(i)	source of error: heat losses / using a measuring cylinder improvement: lag or insulate / use burette	**1** **1**

Question	Answer	Mark
3(a)	water present / hydrated	**1**
3(b)	no change / colour	**1**
3(c)(i)	white precipitate dissolves	**1** **1** **1**
3(c)(ii)	white precipitate no change	**1** **1**
3(d)	not a halide	**1**
3(e)	(aluminium) sulfate	**1**
3(f)	white (crystals)	**1**

Question	Answer	Mark
4	**method adding Agri Lime to acid** add weighed amount / known mass of Agri Lime **Q** to a known volume of acid with a named indicator added to the acid until the indicator changes colour note the mass of Agri Lime **Q** added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the smaller amount of Agri Lime is better' **OR** **method adding acid to Agri Lime** use weighed amount / known mass of Agri Lime **Q** add acid to it gradually / from a burette with a named indicator added to the acid until the indicator changes colour note volume of acid added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the larger volume of acid is better'	**6**

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CHEMISTRY	**0620/43**
Paper 4 Extended Theory	**October/November 2016**
MARK SCHEME	
Maximum Mark: 80	

Published

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Question	Answer	Marks
1(a)	proton: +1, 1 neutron: 0, 1 electron: –1, $^1/_{1840}$	**2**
1(b)(i)	(same) number of protons and electrons / 6 protons and six electrons (different) neutron (number) / 6,7 and 8 neutrons	**2** **1**
1(b)(ii)	same <u>number</u> of electrons / electron configuration	**1**
1(c)	diamond *and* graphite	**1**
1(d)	two double bonds with no extra electrons on the carbon atoms both oxygen atoms with four non-bonding electrons	**1** **1**

Question	Answer	Marks
2(a)	2,2 / 2.2	**1**
2(b)	BeO	**1**
2(c)(i)	positive ions / cations labelled or named in text electrons labelled or named in text attraction between positive ions and negative electrons	**1** **1** **1**
2(c)(ii)	(conduction due to) moving electrons / mobile electrons	**1**
2(d)(i)	Be^{2+}	**1**
2(d)(ii)	$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$ formula of $BeCl_2$ all formulae correct and balancing correct	**2**
2(d)(iii)	$2NaOH + Be(OH)_2 \rightarrow Na_2BeO_2 + 2H_2O$ formula of Na_2BeO_2 all formulae correct and balancing correct	**2**

Question	Answer	Marks
3(a)	331	1
3(b)(i)	**M1** mol = 6.62 / 331 **OR** 0.02 **M2** 0.02 × 223 = 4.46 (g)	1 1
3(b)(ii)	**M1** mol O_2 = 0.02 ÷ 2 **OR** 0.01 **M2** vol = 0.01 × 24 = 0.24 (dm^3)	1 1
3(c)	*test:* glowing splint *result:* relights / rekindles	1 1
3(d)(i)	more than enough to react (with all the acid) **OR** some lead oxide remains after the reaction **OR** (nitric) acid is limiting	1
3(d)(ii)	solid stops dissolving	1
3(d)(iii)	$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$ **OR** $PbO + 2H^+ \rightarrow Pb^{2+} + H_2O$	1

Question	Answer	Marks
4(a)	*silicon(IV) oxide*: covalent *sodium chloride*: ionic / electrovalent	1 1
4(b)	giant molecular / macromolecular / giant covalent / giant atomic	1
4(c)(i)	**M1** (covalent) bonds are strong **M2** a lot of heat or energy is needed to break / weaken / overcome bonds **OR** there are no <u>weak bonds</u> **OR** there are <u>no intermolecular forces</u> **OR** covalent bonds are the <u>only bonds</u> **OR** strong bonds are the <u>only bonds</u>	2
4(c)(ii)	(it has) no moving ions / no moving electrons / all electrons are used in bonding / no moving charged particles	1
4(d)	(sodium chloride contains) ions / is ionic in the solid ions are not moving / they are in fixed positions ions can move when molten	1 1 1
4(e)(i)	*product at the positive electrode:* chlorine *product at the negative electrode:* hydrogen	1 1
4(e)(ii)	$2H^+ + 2e^{(-)} \rightarrow H_2$ **OR** $2H_3O^+ + 2e^{(-)} \rightarrow H_2 + 2H_2O$	1
4(f)	oxygen	1
4(g)(i)	sodium	1
4(g)(ii)	$Na^+ + e^{(-)} \rightarrow Na$	1

Question	Answer	Marks
4(g)(iii)	*test:* (damp blue) litmus *result:* bleached / removes colour / (turns) white	1 1

Question	Answer	Marks
5(a)(i)	burned / heated in air	1
5(a)(ii)	$S + O_2 \rightarrow SO_2$	1
5(b)(i)	equilibrium / reversible	1
5(b)(ii)	vanadium(V) oxide / vanadium pentoxide	1
5(b)(iii)	increase rate (of reaction) / allow lower temperature to be used / allow lower pressure to be used	1
5(b)(iv)	less SO_3 forward reaction is exothermic / it is exothermic / reverse reaction is endothermic	1 1
5(b)(v)	rate too low / reaction too slow / slower	1
5(b)(vi)	more SO_3 fewer moles or molecules (of gas) on right-hand side / more moles or molecules(of gas) on left-hand side	1 1
5(c)(i)	concentrated sulfuric acid / concentrated H_2SO_4	1
5(c)(ii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	1

Question	Answer	Marks
5(d)(i)	water	**1**
5(d)(ii)	$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	**1**
5(e)	detergents / car batteries / dyes / paints / synthetic resins / printing inks / metal extraction / cleaning metals /	**1**
5(f)(i)	exists completely as ions (in solution) / completely dissociates (in solution) / completely ionises (in solution)	**1**
5(f)(ii)	Universal Indicator / pH paper / pH indicator / pH meter Universal Indicator or pH paper or pH indicator turns red / pH 0–1	**1** **1**
5(f)(iii)	$Na_2CO_3 + 2C_6H_5SO_3H \rightarrow 2C_6H_5SO_3Na + CO_2 + H_2O$ formula of $C_6H_5SO_3Na$ all formulae correct and balancing correct	**2**

Question	Answer	Marks
6(a)(i)	*condensation:* **M1** (two) molecules / monomers joining **M2** with the removal of a (small) molecule *polymerisation:* **M3** (to form) a large molecule / a long chain	**3**
6(a)(ii)	addition	**1**
6(b)(i)	circled amide link	**1**
6(b)(ii)	all missing atoms and bonds shown on the diacid all missing atoms and bonds shown on the diamine	**1** **1**

Question	Answer	Marks
6(b)(iii)	nylon / Kevlar / Nomex	**1**
6(c)(i)	amino acids	**1**
6(c)(ii)	hydrolysis chromatography (spray with) locating agent / UV determine R_f values / compare with standards	**1** **1** **1** **1**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/42**

Paper 4 Extended Theory **October/November 2016**

MARK SCHEME

Maximum Mark: 80

Published

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Cambridge is publishing the mark schemes for the October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

Question	Answer	Mark
1(a)	fixed volume **AND** take the shape of the container	1
1(b)	<table><tr><td>solid</td><td>touching</td><td>regular</td><td>vibrate</td></tr><tr><td>liquid</td><td></td><td></td><td></td></tr><tr><td>gas</td><td>not touching</td><td>random</td><td>random</td></tr></table>	6
1(c)(i)	melting	1
1(c)(ii)	sublimation	1

Question	Answer	Mark
2(a)	(total) number of protons and neutrons in a nucleus (of an atom)	2
2(b)	Na 2 : 8 : 1 P^{3-} 2 : 8 : 8	2
2(c)	radiotherapy **OR** treatment of cancer	1
2(d)	<u>average</u> mass of (naturally occurring) <u>atom(s)</u> (of an element) (compared to an atom of) ^{12}C	2

Question	Answer	Mark
2(e)	chlorine must have more than one isotope the masses of these isotopes / (any given) mass numbers are averaged	**2**
2(f)	lattice of labelled Al^{3+} ions electrons seen on the diagram between the ions attraction between (positive) ions and (sea of / delocalised) electrons	**3**

Question	Answer	Mark
3(a)	nitrogen (78%) **AND** oxygen (21%) noble gases **OR** argon (1%)	**2**
3(b)	nitrogen **AND** oxygen (from the air) react (in the) high temperatures of a car engine NO_x / oxides of nitrogen react with or dissolve in water (to form an acid)	**3**
3(c)	any 2 from: (named) ruminant animal / cattle / (anaerobic) digestion / flatulence (in animals) / animal waste / (animal) dung decomposing vegetation / animals / organisms / decaying (organic) matter / (fractional distillation / cracking of) petroleum / crude oil / hydrocarbons / natural gas / coal /	**2**
3(d)	photosynthesis	**1**

Question	Answer	Mark
4(a)	*copper(II) carbonate* fizzes / bubbles / effervescence dissolves / disappears *copper(II) oxide* dissolves / disappears blue (solution formed)	2 2
4(b)(i)	$Cu(NO_3)_2$ $\underline{3}Cu$ **AND** $\underline{3}Cu(NO_3)_2$	2
4(b)(ii)	hydrogen (gas) is not produced (when copper reacts with nitric acid)	1

Question	Answer	Mark
5(a)	$20\,cm^3$ **M1** M_r of MnO_2: 87 **M2** moles of MnO_2 used: 3.48 / 87 = 0.04 **M3** moles of HCl needed: $0.04 \times 4 = 0.16$ **M4** volume of HCl needed: $(0.16/8.0) \times 1000$ **AND** $20\,cm^3$	4
5(b)(i)	from colourless to yellow / orange / brown	2
5(b)(ii)	$Cl_2(g) + 2Br^-(aq) \rightarrow Br_2(aq) + 2Cl^-(aq)$ **M1** (aq) as state symbols for the two products given **M2** correct products **M3** balancing	3

Question	Answer	Mark
5(c)(i)	the (C=C) double bond	**1**
5(c)(ii)	addition **OR** bromination	**1**
5(d)(i)	substitution	**1**
5(d)(ii)	(compounds with the) same molecular formula different structural formulae or structures	**2**
5(d)(iii)	structure of 1–chloropropane structure of 2–chloropropane	**2**
5(e)(i)	I_2O_5 **M1** 76.0 / 127 **AND** 24.0 / 16.0 **M2** 0.59 **AND** 1.5 **OR** 1 **AND** 2.5 **M3** I_2O_5	**3**
5(e)(ii)	(turns) red / pink / orange / yellow iodine is a non-metal	**2**

Question	Answer	Mark
6(a)	bauxite/Alumina is dissolved in <u>molten</u> cryolite cryolite lowers the melting temperature molten aluminium forms *anode reaction*: $2O^{2-} \rightarrow O_2 + 4e^-$ *cathode reaction:* $Al^{3+} + 3e^- \rightarrow Al$	**5**

Question	Answer	Mark
6(b)	carbon or graphite electrode reacts with oxygen / burns (in oxygen) / combusts	**2**
6(c)	*use 1*: manufacture of aircraft *reason 1*: low density *use 2*: food containers **OR** cooking foil *reason 2*: Al resistant to corrosion	**4**

Question	Answer	Mark
7(a)	large / big molecule made from (many) monomers (joined together)	**2**
7(b)(i)	hydrolysis	**1**
7(b)(ii)	acid (conditions) / enzyme	**1**
7(c)(i)	$\frac{\text{distance moved by substance}}{\text{distance moved by solvent (front)}}$	**1**
7(c)(ii)	circle around top spot	**1**
7(c)(iii)	mixture of amino acids is placed as a spot onto a (pencil) baseline placed into a (suitable) solvent / water a locating agent is added to the (finished) chromatogram (to reveal spots)	

Question	Answer	Mark
7(d)	fully displayed amide link between any two ‘blocks’ dipeptide 1: amino acid **A** on left-hand side and amino acid **B** on right-hand side **AND** dipeptide 2: amino acid B on left-hand side and amino acid A on right-hand side correct terminal amine and carboxylic acid group on both correct dipeptides	**3**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/41**

Paper 4 Extended Theory **October/November 2016**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Question	Answer	Marks
1(a)	**H**	1
1(b)	**G**	1
1(c)	filtration	1
1(d)	fractional distillation	1 1
1(e)	add / mix / stir / dissolve / shake / heat with water filter / decant heat (filtrate) or (leave filtrate to) evaporate	1 1 1
1(f)	electrons (electrons) move / flow (throughout structure)	1 1

Question	Answer	Marks
2(a)(i)	melt(ing)	1
2(a)(ii)	sublimation / sublime	1
2(a)(iii)	condensing / condensation	1
2(b)	overcome / break the attractive forces	1
2(c)	**E AND** particles hit the walls (of the container) more often	1

Question	Answer	Marks
3(a)(i)	heated / evaporated / boiled	**1**
3(a)(ii)	any 2 from: (**O** is) more viscous / thicker (**O** is) darker (**O** has) longer / bigger molecules / more carbon atoms (**O** has a) higher boiling point **OR** melting point (**O** is) less flammable	**2**
3(b)	any 2 from: similar / same chemical properties same functional group trend / pattern in physical properties (neighbouring members) differ by CH_2 common methods of preparation	**2**
3(c)	any 2 structures from: pentane methylbutane dimethylpropane	**2**
3(d)	correct structure with any number from 1 to 6 of the hydrogen atoms replaced by chlorine atoms	**1**
3(e)(i)	(ends in) ene	**1**
3(e)(ii)	**M1** 88.24 / 12 **AND** 11.76 / 1 **M2** 7.353 / 7.353 (= 1) **AND** 11.76 / 7.353 = (1.6) **M3** C_5H_8	**1** **1** **1**
3(e)(iii)	relative molecular mass	**1**

Question	Answer	Marks
4(a)(i)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ **M1** formulae **M2** balancing	2
4(a)(ii)	(nitrogen) air / atmosphere (hydrogen) steam / water / hydrocarbons / natural gas	1 1
4(a)(iii)	(temperature) answer in range 370–470 °C (pressure) answer in range 150–300 atm	1 1
4(b)(i)	**M1** forward and reverse reactions (occur) **M2** amounts / moles / concentrations (of reagents and products) constant **OR** **M2** rate of forward and reverse reactions equal	1 1
4(b)(ii)	<u>endothermic</u> **AND** yield increases as temperature increases	1
4(b)(iii)	**M1** yield decreases (as pressure increases) **M2** because more moles / molecules (of gas) on the right **M3** so position of equilibrium moves left	1 1 1

Question	Answer	Marks
5(a)	(gas) oxygen (test) glowing splint (result of test) relights	1 1 1
5(b)	reference to ions / ionic ions cannot move in solid **OR** are in fixed positions in solid ions can move when in solution	1 1 1
5(c)(i)	copper ions / Cu^{2+} gain of electrons / oxidation number decreases	1 1
5(c)(ii)	any 3 from: anode decreases (in mass) copper removed (from anode) / solid (copper from anode) becomes aqueous cathode increases (in mass) copper deposited / added / Cu^{2+} deposited as Cu (on cathode)	3
5(c)(iii)	copper is both added and removed (at same rate) **OR** the concentration (of copper ions) does not change	1

Question	Answer	Marks
6(a)	large / big molecule made from (many) monomers (joined together)	1 1
6(b)(i)	amide / peptide	1
6(b)(ii)	(can be) broken down by microbes / bacteria	1 1
6(b)(iii)	starch / cellulose / DNA / RNA / polysaccharides /	1

Question	Answer	Marks
6(c)(i)	**M1** at least one correct ester linkage between boxes **M2** at least two boxes shown and sufficient correct C and O atoms to make **two correct** ester linkages **M3** continuation bond(s) **AND** if more than one repeat unit is shown, the repeat unit must be correctly identified	1 1 1

Question	Answer	Marks
7(a)	0.025 **M1** 50 / 1000 (=0.05) **M2** (0.05 × 0.5) = 0.025	 1 1
7(b)	0.0125	1
7(c)	0.55 **M1** 44 **M2** 0.55	 1 1
7(d)	0.3	1

Question	Answer	Marks
8(a)(i)	any 4 from: slowed down acid became less concentrated **OR** fewer particles per unit volume fewer collisions per second **OR** lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	**4**
8(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second **OR** higher collision rate same volume of gas amount / moles hydrochloric acid is not changed	**4**
8(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second **OR** higher collision rate more particles have sufficient energy to react / activation energy more of the collisions are successful	**5**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice **October/November 2016**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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This document consists of **2** printed pages.

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**D**
2	**B**	22	**C**
3	**D**	23	**D**
4	**A**	24	**C**
5	**A**	25	**D**
6	**B**	26	**A**
7	**D**	27	**A**
8	**C**	28	**A**
9	**B**	29	**C**
10	**A**	30	**B**
11	**B**	31	**B**
12	**A**	32	**C**
13	**B**	33	**B**
14	**B**	34	**A**
15	**D**	35	**C**
16	**A**	36	**B**
17	**A**	37	**C**
18	**B**	38	**B**
19	**C**	39	**C**
20	**C**	40	**B**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice **October/November 2016**

MARK SCHEME

Maximum Mark: 40

Published

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Cambridge is publishing the mark schemes for the October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**D**
2	**B**	22	**C**
3	**C**	23	**A**
4	**C**	24	**C**
5	**C**	25	**C**
6	**C**	26	**B**
7	**B**	27	**D**
8	**A**	28	**B**
9	**A**	29	**C**
10	**A**	30	**B**
11	**A**	31	**C**
12	**B**	32	**B**
13	**D**	33	**C**
14	**A**	34	**B**
15	**B**	35	**B**
16	**B**	36	**B**
17	**D**	37	**C**
18	**B**	38	**B**
19	**C**	39	**A**
20	**C**	40	**A**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/21**

Paper 2 Multiple Choice **October/November 2016**

MARK SCHEME

Maximum Mark: 40

Published

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Cambridge is publishing the mark schemes for the October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**D**
2	**B**	22	**C**
3	**C**	23	**A**
4	**B**	24	**B**
5	**B**	25	**D**
6	**C**	26	**C**
7	**A**	27	**A**
8	**D**	28	**C**
9	**B**	29	**C**
10	**A**	30	**B**
11	**A**	31	**C**
12	**D**	32	**C**
13	**A**	33	**B**
14	**A**	34	**B**
15	**B**	35	**C**
16	**C**	36	**B**
17	**C**	37	**C**
18	**B**	38	**B**
19	**C**	39	**C**
20	**C**	40	**A**

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

* 9 4 4 8 3 5 3 4 4 1 *

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

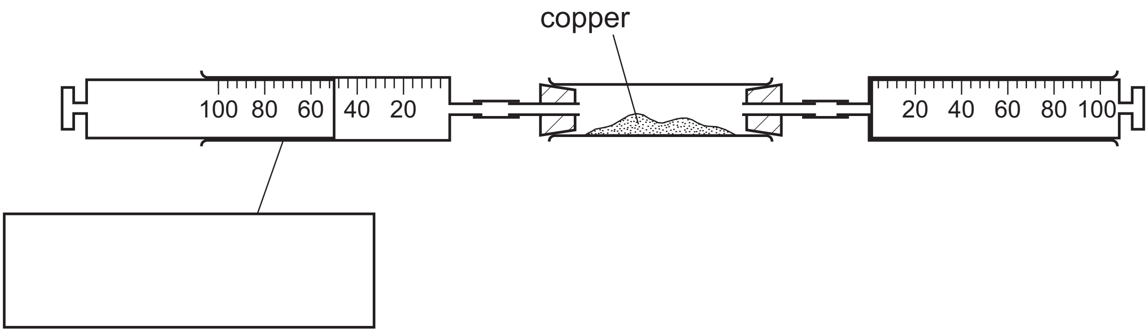
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **9** printed pages and **3** blank pages.

IB16 06_0620_63/4RP

CAMBRIDGE
International Examinations

1 Air is a mixture of gases. The diagram shows the apparatus used to find the percentage of oxygen in air.
50 cm^3 of air were passed backwards and forwards over excess heated copper until there was no further change. The apparatus was left to cool and the volume of gas remaining was 40 cm^3.



(a) Complete the box to name the apparatus. [1]

(b) Use an arrow to indicate where heat is applied. [1]

(c) The colour of the copper changed from .... to .... [2]

(d) From the results, work out the percentage of oxygen in the air.

.... % [2]

[Total: 6]

2 A student investigated what happens when dilute hydrochloric acid and copper(II) sulfate solution react with different metals.

Five experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 10 cm^3 of dilute hydrochloric acid into a boiling tube.
The temperature of the hydrochloric acid was measured.
1 g of zinc was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

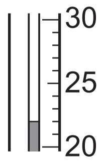
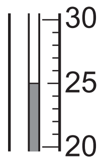
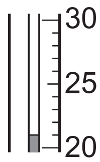
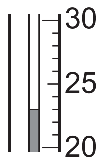
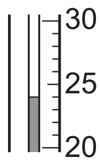
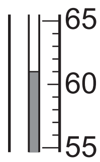
Experiment 2

Experiment 1 was repeated using 1 g of iron instead of zinc.

Experiment 3

Experiment 1 was repeated using 1 g of magnesium instead of zinc.

Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
1					
2					
3					

[3]

(b) The gas produced in experiment 3 was tested with a lighted splint and the result recorded below.

test ...lighted splint...

result ...popped...

Name the gas given off in experiment 3.

.... [1]

(c) *Experiment 4*

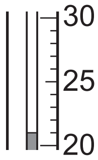
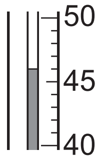
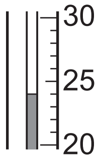
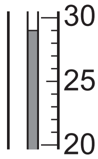
A measuring cylinder was used to pour 10 cm^3 of copper(II) sulfate solution into a boiling tube.
The temperature of the solution was measured.
1 g of magnesium was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

Experiment 5

Experiment 4 was repeated using 1 g of iron instead of magnesium.
The observation was recorded below.

......The solution turned colourless and a brown deposit formed......

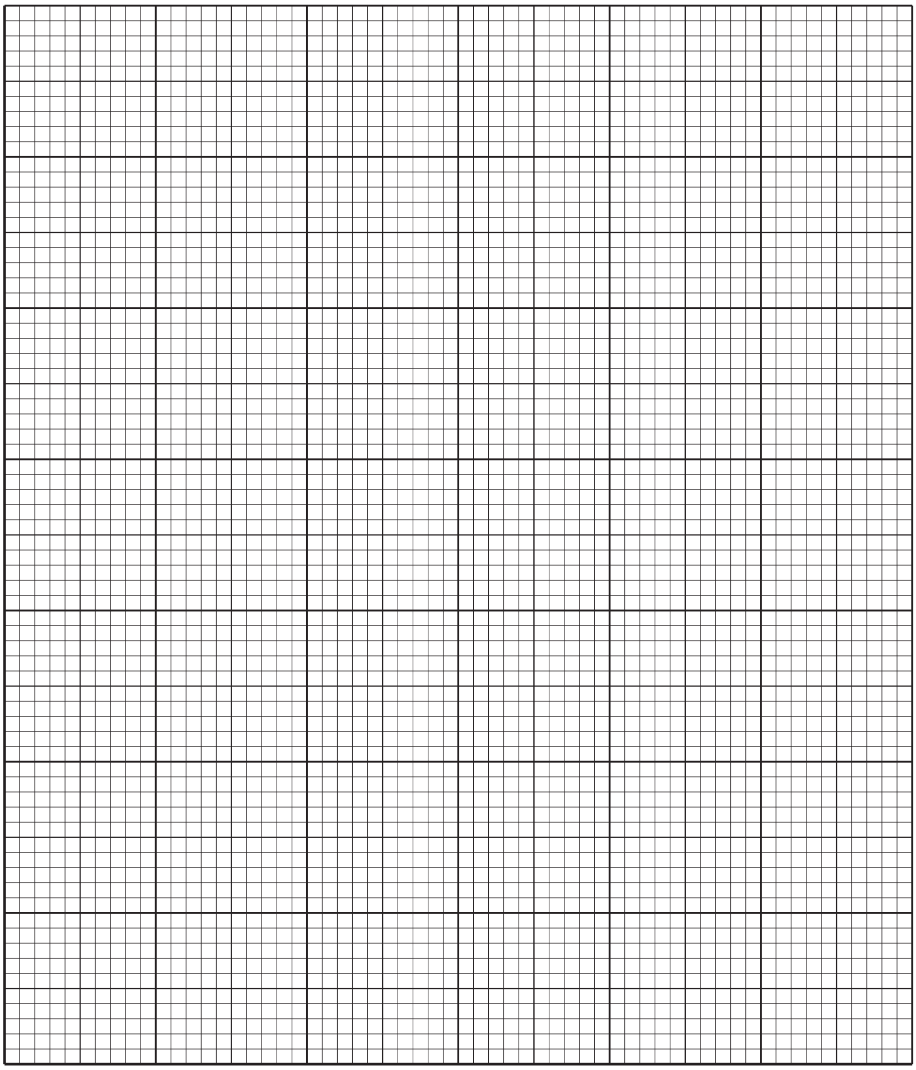
Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
4					
5					

[2]

(d) Draw a labelled bar chart for the results of experiments 1, 2, 3, 4 and 5 on the grid below.

temperature rise / °C



[3]

(e) Use the results for experiments 1, 2 and 3 to answer the following questions.

(i) Which experiment, 1, 2 or 3, produced the largest temperature rise?

.... [1]

(ii) Suggest why this experiment produced the largest temperature rise.

....

.... [1]

(f) Explain the observations in experiment 5.

....

....

.... [2]

(g) Suggest why potassium was **not** used as one of the metals in these experiments.

.... [1]

(h) Give **one** advantage of using a measuring cylinder to add the hydrochloric acid to the boiling tube.

.... [1]

(i) Suggest and explain **one** improvement to increase the accuracy of these experiments.

....

....

.... [2]

[Total: 17]

3 A mixture of two solids, **G** and **H**, was analysed. Solid **G** was zinc nitrate, which is water soluble, and solid **H** is insoluble in water.
The tests on the mixture, and some of the observations, are shown.

Distilled water was added to the mixture in a boiling tube and shaken. The contents of the boiling tube were filtered keeping the filtrate and the residue.

tests on filtrate

(a) The filtrate was divided into four test-tubes and the following tests carried out.

(i) Drops of aqueous sodium hydroxide were added to the first portion of the solution.
Excess aqueous sodium hydroxide was then added to the test-tube.

observations ....

....

.... [3]

(ii) Using the second portion of the solution, the test in **(a)(i)** was repeated using aqueous ammonia instead of aqueous sodium hydroxide.

observations ....

.... [2]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observations .... [1]

(iv) Aqueous sodium hydroxide and aluminium foil were added to the fourth portion of the solution.
The mixture was warmed and the gas given off was tested.

observations ....

....

.... [3]

tests on residue

Two tests are carried out and the following observations made.

tests	observations
A spatula was used to transfer some of the residue into a test-tube. Dilute hydrochloric acid was added to the residue. The gas given off was tested.	rapid effervescence, limewater turned milky
A flame test was carried out on the residue.	red flame colour

(b) Identify solid **H**.

....

.... [2]

[Total: 11]

4 Nickel sulfate-6-water, $NiSO_4.6H_2O$, is a blue crystalline salt.

Plan an experiment to obtain a sample of pure water from this salt. Your answer should include a diagram of the apparatus, any expected observations and a test to show the presence of pure water.
You are provided with common laboratory apparatus.

....

....

....

....

....

....

.... [6]

[Total: 6]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2553361951

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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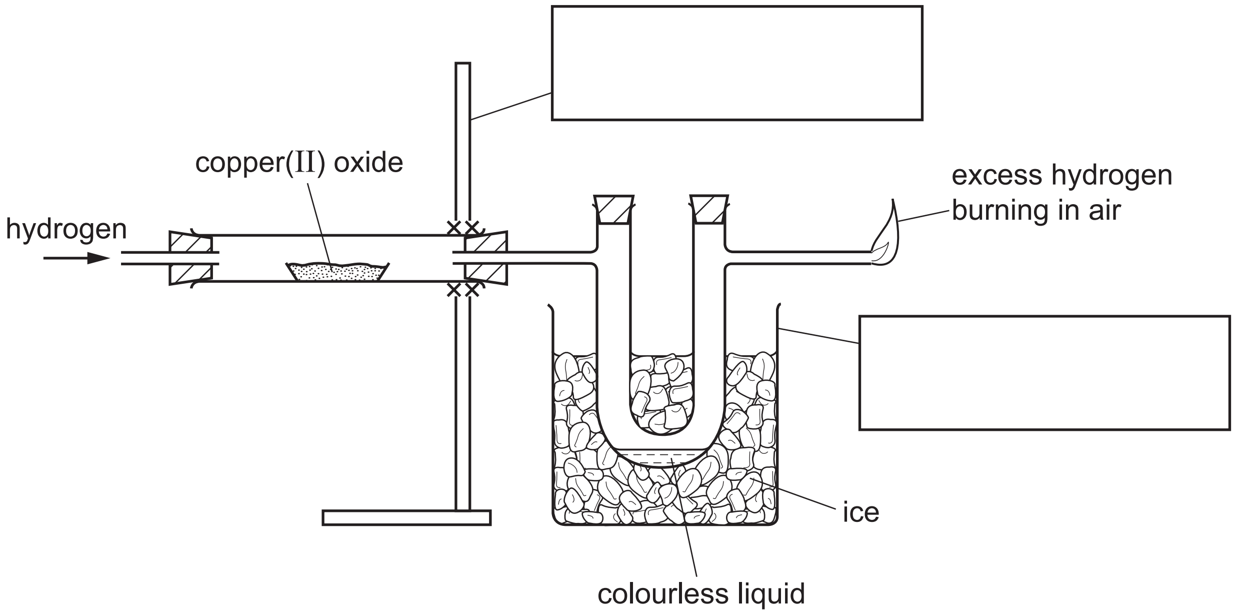
IB16 06_0620_62/4RP

1 The diagram shows the apparatus used to reduce copper(II) oxide with hydrogen.



(a) Complete the boxes to name the apparatus. [2]

(b) Use an arrow to indicate where heat is applied. [1]

(c) The colour of the copper(II) oxide changes from .... to .... [2]

(d) Suggest a reason why the U-tube is surrounded by ice.

.... [1]

(e) **(i)** Identify the colourless liquid formed.

.... [1]

(ii) Give a chemical test for this liquid.

test ....

result ....

[2]

(iii) How could you show that this liquid is pure?

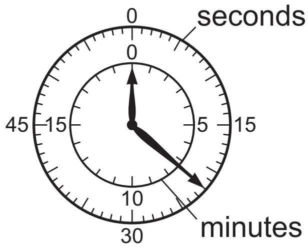
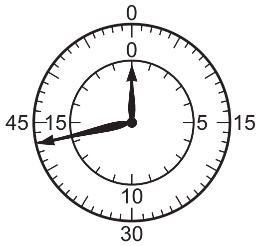
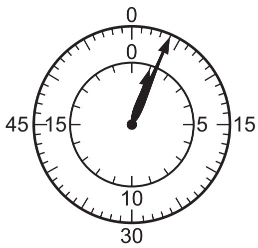
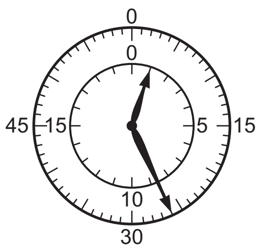
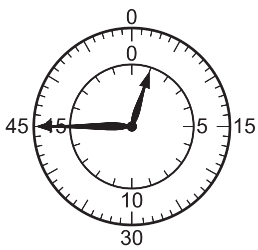
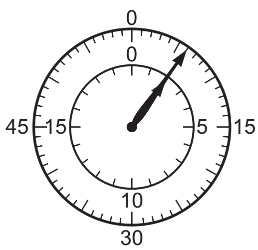
.... [1]

[Total: 10]

2 A student investigated the rate of reaction between hydrogen peroxide and aqueous potassium iodide. When these chemicals react they form iodine. Sodium thiosulfate solution reacts with iodine and can be used to show how fast the reaction proceeds.

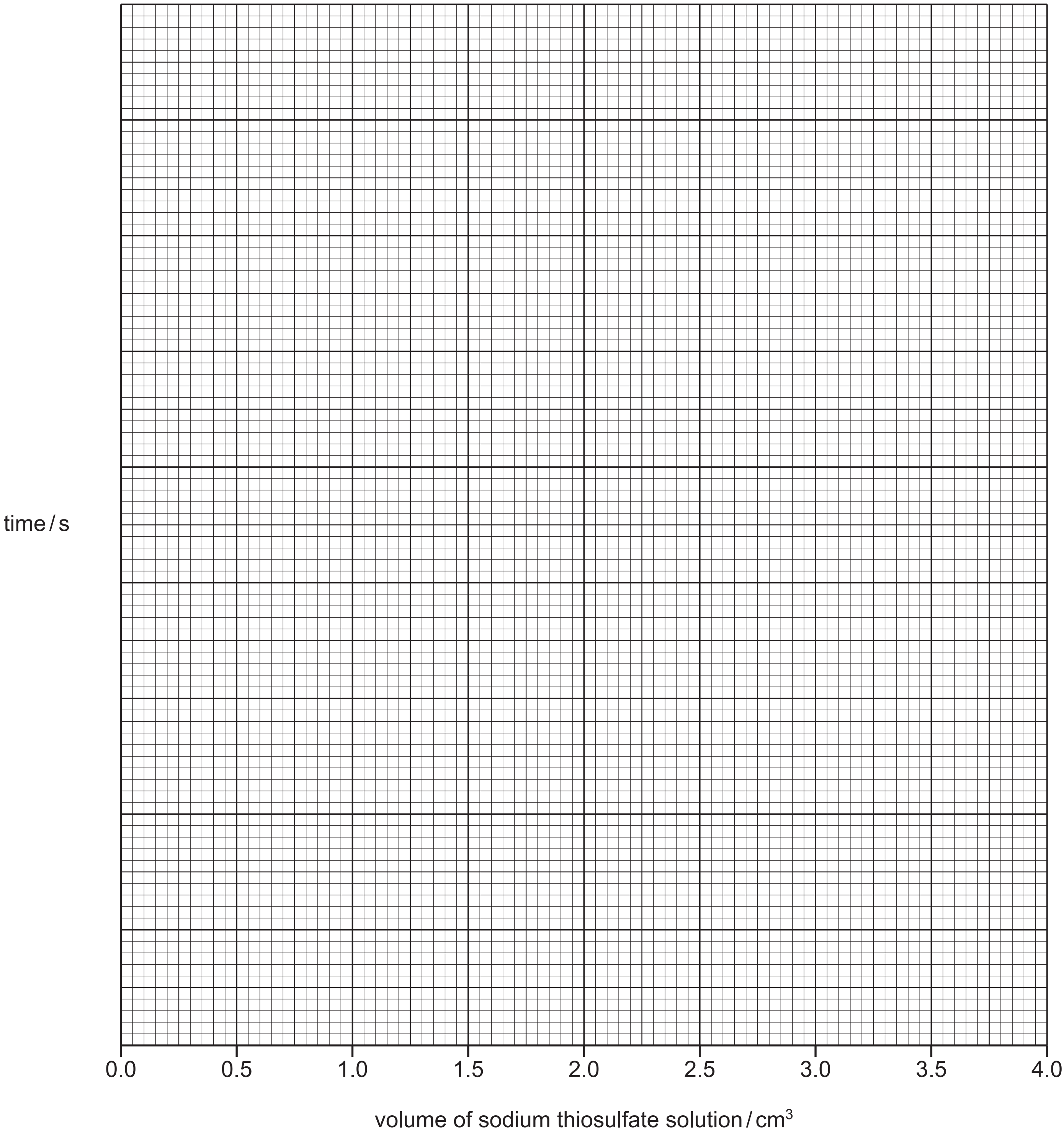
(a) A burette was filled up to the 0.0 cm^3 mark with sodium thiosulfate solution.
Using a large measuring cylinder, 100 cm^3 of distilled water were poured into a conical flask.
Using a small measuring cylinder, 6 cm^3 of sulfuric acid, 1 cm^3 of starch solution and 4 cm^3 of aqueous potassium iodide were added to the flask.
0.5 cm^3 of sodium thiosulfate solution was added from the burette to the mixture in the flask and swirled to mix.
The reaction was then started by adding 3 cm^3 of hydrogen peroxide solution to the mixture, and the timer started.
The time taken for a blue colour to appear was noted.
A further 0.5 cm^3 of sodium thiosulfate solution was added to the mixture in the conical flask, swirled and the blue colour disappeared. The time when the blue colour reappeared was noted.
The experiment continued by adding further 0.5 cm^3 portions of sodium thiosulfate solution until a total of 3.0 cm^3 of sodium thiosulfate solution had been added, noting the times at which the blue colour reappeared.

Use the timer diagrams on page 4 to record the times in seconds in the table.

total volume of sodium thiosulfate solution added / cm^3	timer diagram	time at which blue colour appeared / s
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

[3]

(b) Plot the results you have obtained on the grid and draw a best-fit straight-line graph.



[5]

(c) (i) **From your graph** deduce the time at which the blue colour would appear if a total of 4.0 cm^3 of sodium thiosulfate solution were added to the mixture in the conical flask.
Show clearly **on the grid** how you worked out your answer.

.... [3]

(ii) Sketch **on the grid** the graph you would expect if the experiment was repeated at a higher temperature. [1]

(d) Suggest the purpose of the starch solution.

.... [1]

(e) **(i)** Suggest **one** advantage of using a pipette to measure the volume of the hydrogen peroxide.

.... [1]

(ii) Suggest and explain **one** disadvantage of using a pipette to measure the volume of the hydrogen peroxide.

....

.... [2]

(f) Explain **one** disadvantage of using a beaker instead of a conical flask.

....

.... [1]

[Total: 17]

3 Two solids, **E** and **F**, were analysed. Solid **E** was sodium sulfite. Both solids were found to be water soluble.
The tests on the solids, and some of the observations, are shown below.

tests on solid E

(a) Describe the appearance of the solid.

.... [1]

(b) Distilled water was added to solid **E** in a test-tube and shaken to dissolve.

The solution was divided into two portions in two test-tubes and the following tests carried out.

(i) Aqueous sodium hydroxide was added to the first portion of the solution.

observations .... [1]

(ii) Dilute hydrochloric acid was added to the second portion of the solution. The mixture was warmed. The gas given off was tested with a piece of filter paper soaked in aqueous acidified potassium manganate(VII) solution.

observations ....

.... [2]

(c) A flame test was carried out on solid **E**.

observations .... [1]

tests on solid F

tests	observations
The solid was heated. The gas given off was tested with damp, red litmus paper.	pungent gas evolved red litmus paper turned blue
Aqueous sodium hydroxide was added to solid **F** and the mixture heated. The gas given off was tested.	pungent gas evolved Universal Indicator paper showed pH 10

(d) Identify the gas given off in the tests on solid **F**.

.... [1]

(e) Identify **one** of the ions in solid **F**.

.... [1]

[Total: 7]

4 Potassium sulfate is the salt produced when sulfuric acid is neutralised by potassium hydroxide solution.
The correct amount of potassium hydroxide solution must be added to neutralise all of the sulfuric acid.
Plan an experiment to obtain pure crystals of potassium sulfate from sulfuric acid and potassium hydroxide solution.
You are provided with common laboratory apparatus.

....

....

....

....

....

....

....

....

.... [6]

[Total: 6]

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

3845366912

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

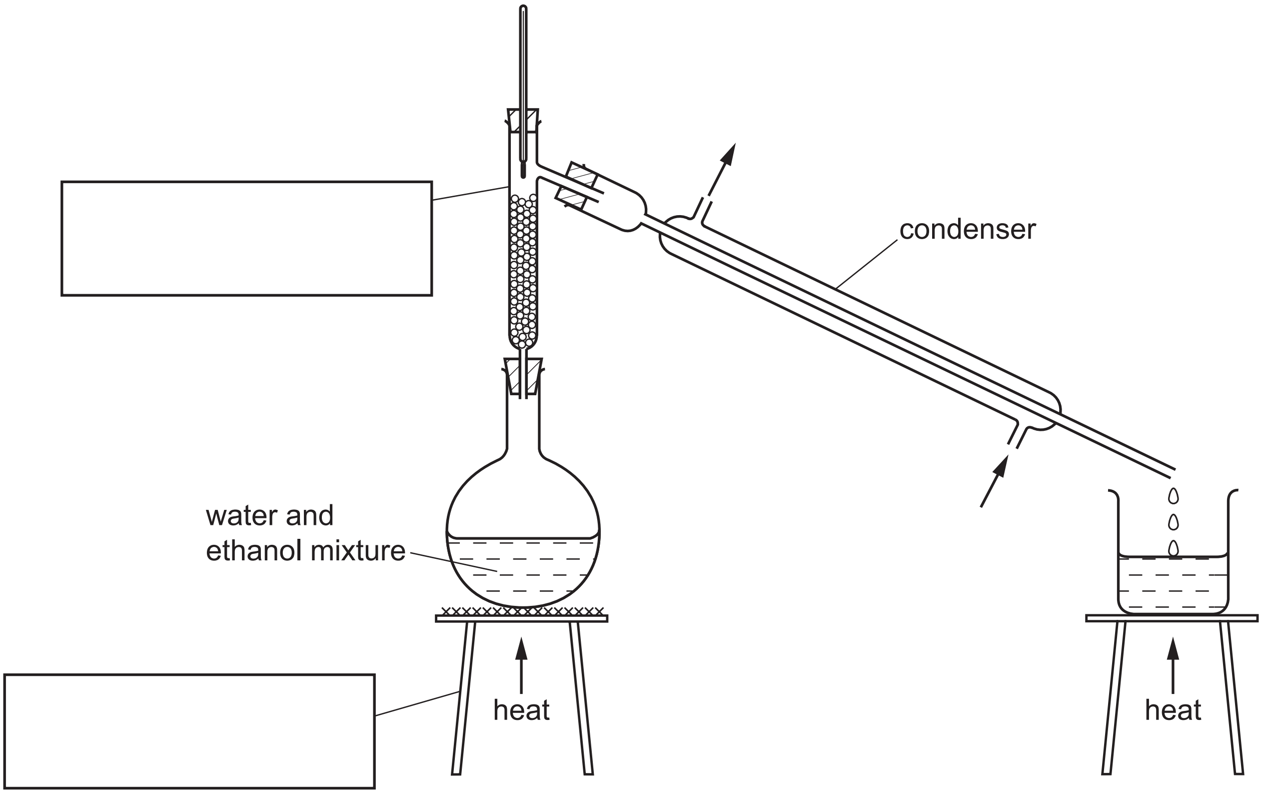
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **8** printed pages.

IB16 06_0620_61/3RP

CAMBRIDGE
International Examinations

1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100 °C, and ethanol, boiling point 78 °C.



(a) Complete the boxes to name the apparatus. [2]

(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus.

.... [1]

(d) Which liquid would collect first? Explain your answer.

....

.... [2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?

.... [1]

[Total: 7]

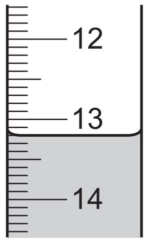
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

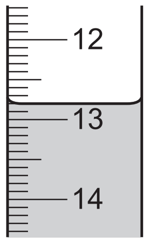
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



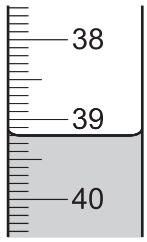
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3		
initial burette reading / cm^3		
difference / cm^3		

[4]

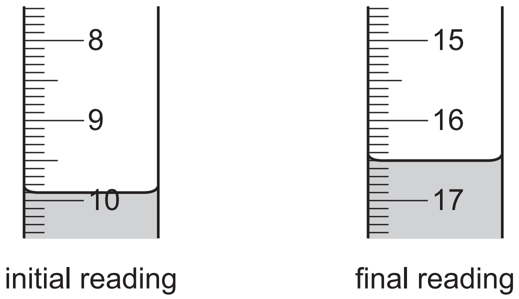
(b) What colour change was observed in the flask in experiment 2?

from .... to .... [1]

(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



	experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

.... [1]

(e) Complete the sentence below.

Experiment .... needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

.... [1]

(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results ....

reason ....
[2]

(h) **(i)** Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3.

.... [1]

(ii) Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**.

.... [1]

(i) Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated.

....

....

....

....

.... [3]

[Total: 17]

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
tests on solid **C** Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	 colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

.... [2]

(b) Describe the appearance of solution **D**.

.... [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) **test 1**

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations ....

.... [3]

(ii) **test 2**

Excess aqueous ammonia was added to solution **D**.

observations .... [2]

(iii) **test 3**

Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate.

observations .... [1]

(d) Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous.

Suggest **one** safety precaution when using chromium(VI).

.... [1]

[Total: 10]

4 Calcium burns in air to form calcium oxide. The reaction is vigorous and some of the calcium oxide can be lost as smoke.
Plan an investigation to determine the maximum mass of oxygen that combines to form calcium oxide when 2 g of calcium granules are burnt in air.
You are provided with common laboratory apparatus and calcium granules.

....

....

....

....

....

....

....

.... [6]

[Total: 6]

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 2 3 9 9 4 3 4 4 8 2 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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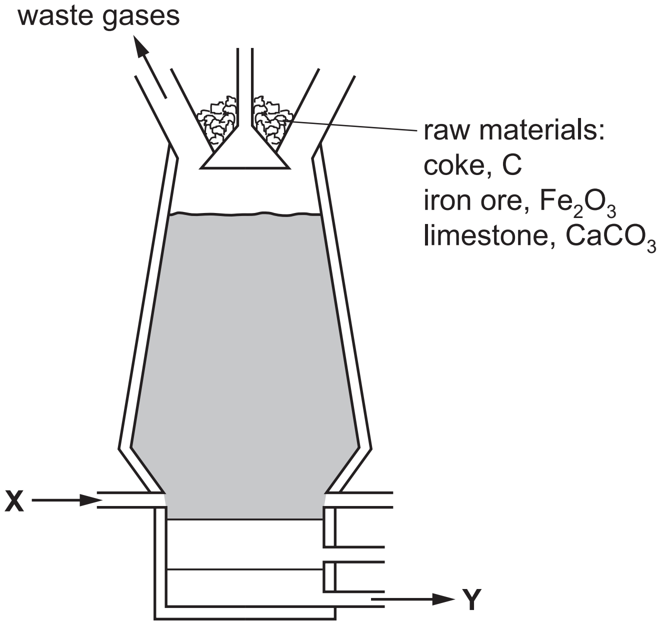
This document consists of **14** printed pages and **2** blank pages.

IB16 06_0620_43/3RP

CAMBRIDGE International Examinations

1 The diagram shows a blast furnace.



(a) The following equations represent reactions which take place in the blast furnace.

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $CO_2 + C \rightarrow 2CO$

E $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(i) Which reaction is used to increase the temperature inside the blast furnace? .... [1]

(ii) Which reaction is an example of thermal decomposition? .... [1]

(iii) In which reaction is carbon both oxidised and reduced? .... [1]

(iv) Which equation shows the removal of an impurity from the iron? .... [1]

(v) Which equation shows the reaction of an acidic substance with a basic substance?

.... [1]

(b) Use the diagram of the blast furnace to help you answer these questions.

(i) What enters the blast furnace at **X**?

.... [1]

(ii) What leaves the blast furnace at **Y**?

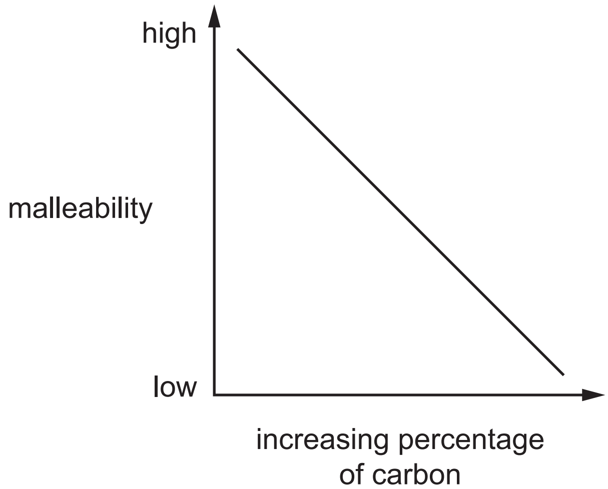
.... [1]

(iii) Name **two** waste gases that leave the blast furnace.

1. ....

2. .... [2]

(c) The graph shows how the malleability of iron changes as the percentage of carbon in the iron changes.



(i) Describe how the malleability of iron changes as the percentage of carbon changes.

....

.... [1]

(ii) Iron obtained from the blast furnace contains high levels of carbon.

Explain how the amount of carbon in the iron can be decreased.

....

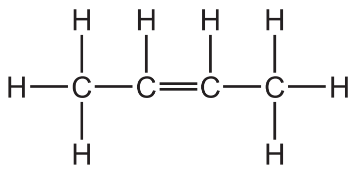
....

.... [2]

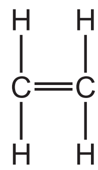
[Total: 12]

2 The structures of six organic compounds are shown.

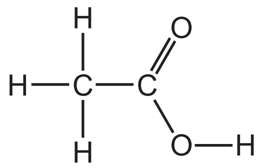
A



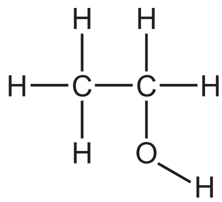
B



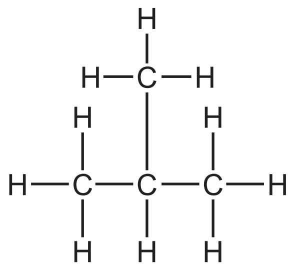
C



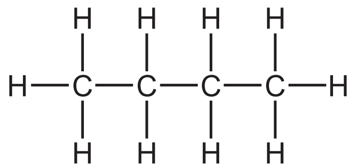
D



E



F



(a) Give the name of **F**.

.... [1]

(b) Identify **two** of the compounds that are members of the same homologous series.
Give the general formula of this homologous series.

compounds ....

general formula ....
[2]

(c) Which **two** compounds are isomers of each other?
Explain why they are isomers.

compounds ....

explanation ....

....
[3]

(d) Explain why **B** is an unsaturated hydrocarbon.

....

....

.... [2]

(e) Describe how **D** is manufactured from **B**. Give a chemical equation for the reaction.

....

....

.... [3]

(f) Compound **A** forms an addition polymer.

Draw **two** repeat units of the addition polymer formed from **A**.

[2]

[Total: 13]

3 Clean dry air contains mainly nitrogen and oxygen.

(a) Name **two** other gases that are in clean dry air.

....

.... [2]

(b) Air often contains pollutants.

Identify **three** common gaseous pollutants in air and state how each of these pollutants are produced.

pollutant gas 1 ....

how it is produced ....

....

pollutant gas 2 ....

how it is produced ....

....

pollutant gas 3 ....

how it is produced ....

....
[6]

[Total: 8]

4 **(a)** Potassium iodide is an ionic compound.

(i) Describe what happens, in terms of electron loss and gain, when a potassium atom reacts with an iodine atom.

....

....

....

.... [2]

(ii) Describe the structure of solid potassium iodide. You may draw a diagram.

....

....

.... [2]

(iii) Explain why potassium iodide has a high melting point.

....

....

.... [2]

(b) Potassium iodide and lead nitrate are both soluble. Lead iodide is insoluble.

(i) Describe how a pure dry sample of lead iodide could be made from solid potassium iodide and solid lead nitrate.

....

....

....

....

....

.... [4]

(ii) Write an ionic equation for the formation of lead iodide, PbI_2, when potassium iodide and lead nitrate react with each other.
State symbols are **not** required.

.... [2]

(c) When chlorine gas is bubbled through an aqueous solution of potassium iodide, a redox reaction takes place.

$$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$$

(i) State the colour change expected in this reaction.

start colour ....

end colour ....
[2]

(ii) Identify the reducing agent in this reaction. Explain your answer.

....

....

.... [2]

[Total: 16]

5 Dilute hydrochloric acid reacts with sodium carbonate solution.

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

(a) Explain why effervescence is seen during the reaction.

....

.... [1]

(b) Dilute hydrochloric acid was titrated with sodium carbonate solution.

- 10.0 cm^3 of 0.100 mol / dm^3 hydrochloric acid were placed in a conical flask.
- A few drops of methyl orange indicator were added to the dilute hydrochloric acid.
- The mixture was titrated with sodium carbonate solution.
- 16.2 cm^3 of sodium carbonate solution were required to react completely with the acid.

(i) What colour would the methyl orange indicator be in the hydrochloric acid?

.... [1]

(ii) Calculate how many moles of hydrochloric acid were used.

.... mol [1]

(iii) Use your answer to **(b)(ii)** and the equation for the reaction to calculate the number of moles of sodium carbonate that reacted.

.... mol [1]

(iv) Use your answer to **(b)(iii)** to calculate the concentration of the sodium carbonate solution in mol / dm^3.

.... mol / dm^3 [2]

(c) In another experiment, 0.020 mol of sodium carbonate were reacted with excess hydrochloric acid.

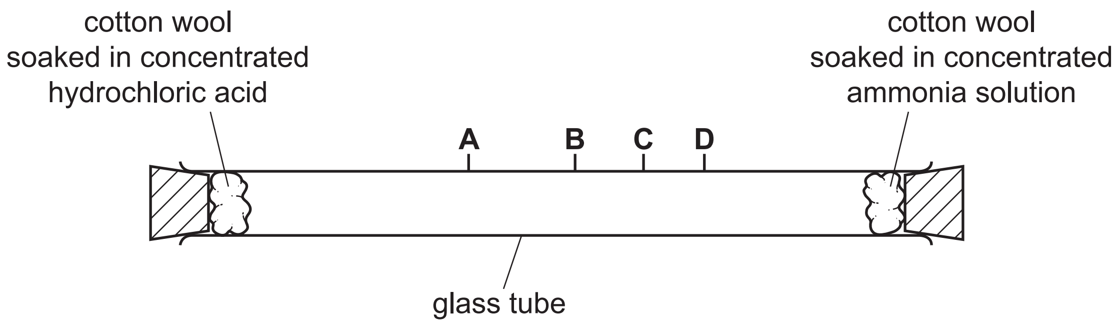
Calculate the maximum volume (at r.t.p.) of carbon dioxide gas that could be made in this reaction.

.... dm^3 [3]

[Total: 9]

6 Concentrated ammonia solution gives off ammonia gas. Concentrated hydrochloric acid gives off hydrogen chloride gas. Ammonia, NH_3, and hydrogen chloride, HCl, are both colourless gases. Ammonia reacts with hydrogen chloride to make the white solid ammonium chloride.

Apparatus is set up as shown.



After ten minutes a white solid forms in the tube where the gases meet.

(a) **(i)** Write the chemical equation for the reaction of ammonia with hydrogen chloride.

.... [1]

(ii) Name the process by which the ammonia and hydrogen chloride gases move in the tube.

.... [1]

(iii) At which point, **A**, **B**, **C** or **D**, does the white solid form? Explain why the white solid forms at that point.

the solid forms at ....

explanation ....

....
[3]

(iv) The experiment was repeated at a higher temperature.

Predict how the results of the experiment would be different. Explain your answer.

....

....

.... [3]

(b) Some of the white solid is removed from the tube and dissolved in water.

Describe how the white solid could be tested to show it contains,

(i) ammonium ions,

test ....

....

result ....

....
[3]

(ii) chloride ions.

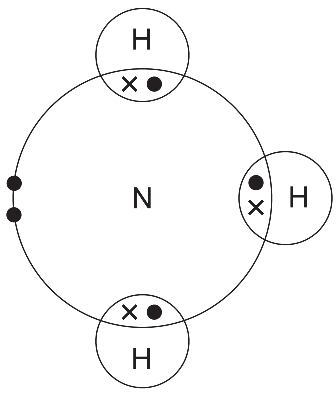
test ....

....

result ....

....
[3]

(c) The diagram shows the electron arrangement in a molecule of ammonia, showing only outer shell electrons.

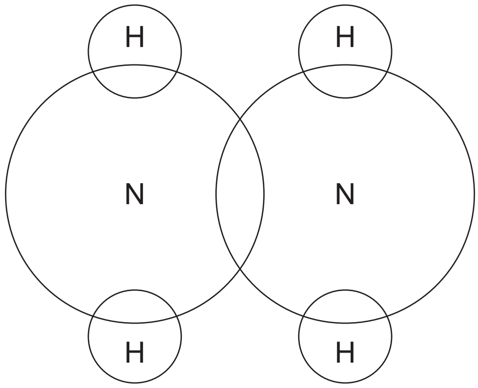


(i) State the type of bonding in ammonia.

.... [1]

(ii) Hydrazine, N_2H_4, is another compound of nitrogen and hydrogen.

Complete the diagram to show the electron arrangement in a molecule of hydrazine, showing only outer shell electrons.



[3]

(d) Nylon and proteins are both polymers containing nitrogen.

(i) Name the linkages found in the polymers of nylon and protein.

.... [1]

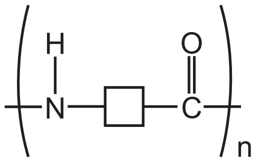
(ii) Describe **one** difference in the structures of nylon and protein.

.... [1]

(iii) What is the general name given to the products of hydrolysis of proteins?

.... [1]

(e) Suggest the structure of the monomer used to make the polymer shown.



[1]

[Total: 22]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3291778503

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 12.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **12** printed pages.

IB16 06_0620_42/3RP

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International Examinations

[Turn over

1 **(a)** For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.
Elements may be used once, more than once or not at all.

(i) an element which is gaseous at room temperature and pressure

.... [1]

(ii) an element which forms an oxide that is a reactant in photosynthesis

.... [1]

(iii) an element that is a product of photosynthesis

.... [1]

(iv) an element that makes up approximately 78% by volume of the air

.... [1]

(v) an element which has atoms with a full outer shell of electrons

.... [1]

(vi) an element which exists as both diamond and graphite

.... [1]

(vii) an element that reacts vigorously with cold water

.... [1]

(viii) a soft metallic element which is stored in oil

.... [1]

(b) Give the formula of a compound that contains

(i) only boron and oxygen, ... [1]

(ii) only lithium and nitrogen. .... [1]

[Total: 10]

2 **(a)** **(i)** Define the term *atomic number*.

.... [1]

(ii) Define the term *nucleon number*.

....

.... [2]

(b) The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	6	6	6	${}^{12}_{6}C$
B	12	12	12	
C	8			${}^{16}_{8}O^{2-}$
D	11	10	13	

[6]

[Total: 9]

3 Gallium is a metallic element in Group III. It has similar properties to aluminium.

(a) **(i)** Describe the structure and bonding in a metallic element.
You should include a labelled diagram in your answer.

....

.... [3]

(ii) Explain why metallic elements such as gallium are good conductors of electricity.

.... [1]

(b) Give the formula of

gallium(III) chloride, ...

gallium(III) sulfate. ....
[2]

(c) Gallium(III) oxide, Ga_2O_3, is amphoteric.

(i) Write the chemical equation for the reaction between gallium(III) oxide and dilute nitric acid to form a salt and water only.

.... [2]

(ii) The reaction between gallium(III) oxide and sodium hydroxide solution forms only water and a salt containing the negative ion $Ga_2O_4^{2-}$.

Write the chemical equation for this reaction.

.... [2]

(d) Alloys of gallium and other elements are often more useful than the metallic element itself.

Suggest **two** reasons why alloys of gallium are more useful than the metallic element.

....

.... [2]

[Total: 12]

4 Hydrogen can be manufactured from methane by steam reforming.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The reaction is carried out using a nickel catalyst at temperatures between 700 °C and 1100 °C and using a pressure of one atmosphere.

The forward reaction is endothermic.

(a) What is meant by the term *catalyst*?

....

.... [2]

(b) Suggest **two** reasons why a temperature lower than 700 °C is not used.

....

.... [2]

(c) Suggest **one** advantage of using a pressure greater than one atmosphere.

.... [1]

(d) Suggest **one** disadvantage of using a pressure greater than one atmosphere.

.... [1]

(e) Hydrogen can also be manufactured by electrolysis. The electrolyte is concentrated aqueous sodium chloride. The electrodes are inert.

The products of electrolysis are hydrogen, chlorine and sodium hydroxide.

(i) Define the term *electrolysis*.

....

.... [2]

(ii) Name a substance that can be used as the inert electrodes.

.... [1]

(iii) Write an ionic half-equation for the reaction in which hydrogen is produced.

.... [1]

(iv) Where is hydrogen produced in the electrolytic cell?

.... [1]

(v) Describe a test for chlorine.

test ....

result ....
[2]

(f) The electrolysis of concentrated aqueous sodium chloride can be represented by the following word equation.

sodium chloride + water $\rightarrow$ sodium hydroxide + hydrogen + chlorine

Construct a chemical equation to represent this reaction. Do not include state symbols.

.... [2]

(g) State one use of

chlorine, ...

sodium hydroxide, ...

hydrogen. ....
[3]

[Total: 18]

5 **(a)** Hydrocarbons are compounds which contain hydrogen and carbon only.

- $10\,cm^3$ of a gaseous hydrocarbon, C_xH_y, are burned in $100\,cm^3$ of oxygen, which is an excess of oxygen.
- After cooling to room temperature and pressure, there is $25\,cm^3$ of unreacted oxygen, $50\,cm^3$ of carbon dioxide and some liquid water.

All volumes are measured under the same conditions of temperature and pressure.

(i) What is meant by an *excess* of oxygen?

.... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

.... [1]

(iii) Complete the table below to express the smallest whole number ratio of

volume of hydrocarbon reacted : volume of oxygen reacted : volume of carbon dioxide produced

	volume of hydrocarbon reacted	volume of oxygen reacted	volume of carbon dioxide produced
smallest whole number ratio of volumes			

[1]

(iv) Use your answer to **(a)(iii)** to find the mole ratio in the equation below. Complete the equation and deduce the formula of the hydrocarbon.

$$.........C_xH_y(g) \; + \; ....O_2(g) \; \rightarrow \; ....CO_2(g) \; + \; ....H_2O(l)$$

formula of hydrocarbon = ...
[2]

(b) Cracking is used to convert long chain alkanes into shorter chain alkanes and alkenes. Alkenes are unsaturated compounds.

Decane, $C_{10}H_{22}$, can be cracked to give propene and one other product.

(i) Complete the chemical equation.

$$C_{10}H_{22} \rightarrow C_3H_6 + \text{..............}$$

[1]

(ii) What is meant by the term *unsaturated*?

.... [1]

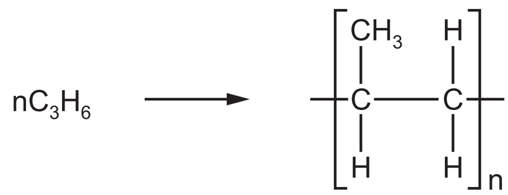
(iii) Describe a test to show that propene is an unsaturated compound.

test ....

result ....

[2]

(c) Propene can be polymerised. The only product is polypropene. The equation for the polymerisation is:



(i) Name the type of polymerisation that occurs.

.... [1]

(ii) Deduce the maximum mass of polypropene that could be produced from 1 kg of propene.

.... kg [1]

(iii) Give the empirical formula of

propene, ...

polypropene. ....

[2]

[Total: 13]

6 Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS.

(a) **(i)** The zinc sulfide in the ore is first converted into zinc oxide.

Describe how zinc oxide is made from zinc sulfide.

....

.... [1]

(ii) Write a chemical equation for the reaction in **(a)(i)**.

.... [2]

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

....

....

....

....

.... [3]

(ii) Explain why the zinc produced inside the furnace is a gas.

.... [1]

(iii) State the name of the physical change for conversion of gaseous zinc into molten zinc.

.... [1]

(c) Rusting of steel can be prevented by coating the steel with a layer of zinc.

Explain, in terms of electron transfer, why steel does **not** rust even if the layer of zinc is scratched so that the steel is exposed to air and water.

....

....

....

....

.... [4]

(d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, $FeCl_2$, is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, $FeCl_3$, is formed.

(i) Aqueous sodium hydroxide is added to the solutions of iron(II) chloride and iron(III) chloride.

Complete the table below, showing the observations you would expect to make.

	iron(II) chloride solution	iron(III) chloride solution
aqueous sodium hydroxide		

[2]

Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change	solution turns from colourless to brown
acidified potassium manganate(VII) solution	solution turns from purple to colourless	no change

(ii) What **types** of substance cause potassium iodide solution to turn from colourless to brown?

.... [1]

(iii) What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

.... [1]

(iv) Which **ion** in iron(III) chloride solution causes potassium iodide solution to turn from colourless to brown?

.... [1]

(v) Which **ion** in iron(II) chloride solution causes acidified potassium manganate(VII) solution to turn from purple to colourless?

.... [1]

[Total: 18]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
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lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4054381962

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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This document consists of **16** printed pages.

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1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton		
neutron		
electron	$\frac{1}{1840}$	

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

....

.... [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

....

.... [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
${}^{7}_{3}Li$			
${}^{34}_{16}S^{2-}$			
	19	22	18

[5]

[Total: 12]

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

.... mol

- number of moles of O_2 formed,

.... mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

.... dm^3
[3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

.... [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

.... [2]

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

....

....

....

.... [3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

.... [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

....

.... [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

....

.... [2]

(ii) Deduce the formula of calcium phosphate.

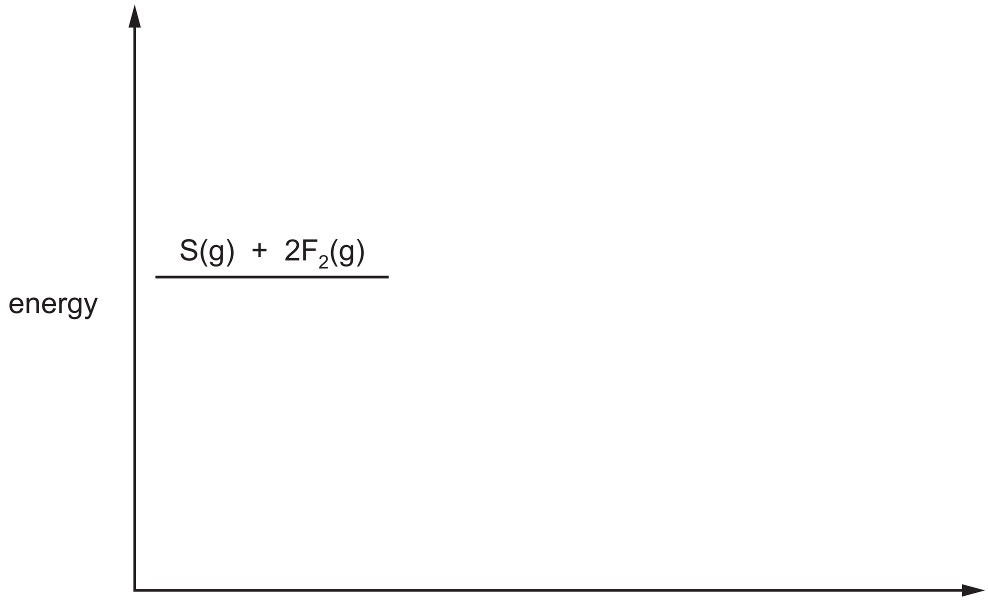
.... [1]

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

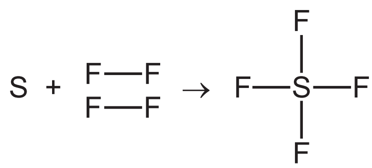


[3]

(ii) During the reaction the amount of energy given out is 780 kJ / mol.

The F–F bond energy is 160 kJ / mol.

Use this information to determine the bond energy, in kJ / mol, of one S–F bond in SF_4.



.... kJ / mol [3]

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

.... [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound ....

colour change from .... to ....
[3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

.... [1]

(ii) Give **one** use of argon.

.... [1]

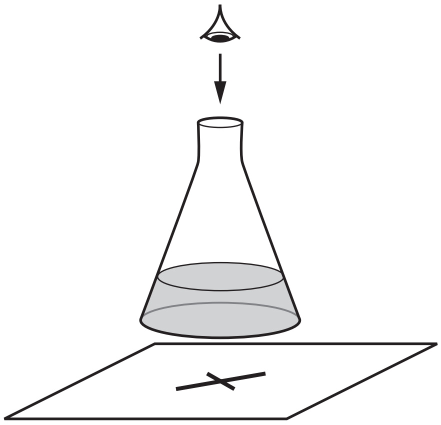
[Total: 27]

Question 3 starts on the next page.

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate / cm^3	volume of hydrochloric acid / cm^3	volume of distilled water / cm^3	time taken for cross to disappear from view / s
1	10	10	40	56
2	20	10	30	28
3				

(a) State the order in which the aqueous sodium thiosulfate, hydrochloric acid and distilled water should be added to the flask.

....

.... [1]

(b) In experiment 3 the student wanted the sodium thiosulfate to be double the concentration used in experiment 2.

(i) Complete the table to show the **volumes** which should be used and the **expected** time taken for the cross to disappear from view in experiment 3. [2]

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

....

....

....

.... [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

....

....

....

.... [3]

[Total: 8]

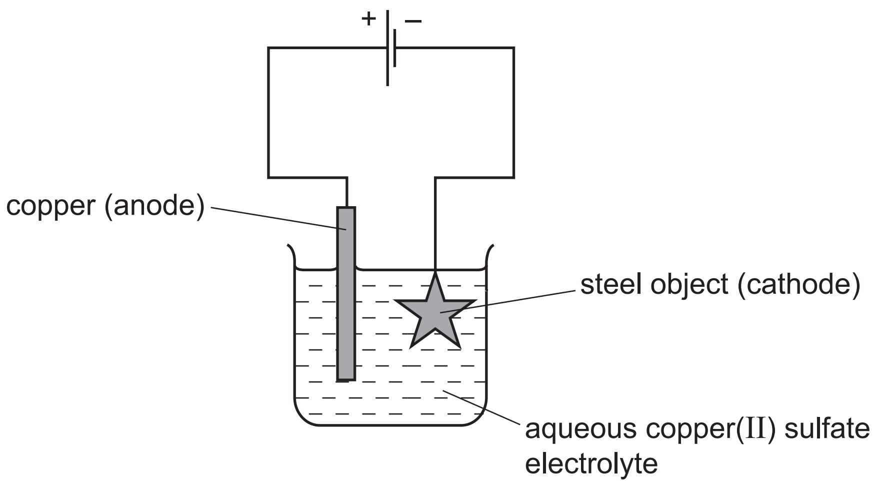
4 Electroplating steel objects with silver involves a three-step process.

step 1 A coating of copper is applied to the object.

step 2 A coating of nickel is applied to the object.

step 3 The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is

$$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$$

Explain whether this process is oxidation or reduction.

....

.... [1]

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

....

....

.... [2]

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

....

....

....

.... [2]

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

....

....

.... [3]

[Total: 8]

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material $\xrightarrow{\textbf{step 1}}$ sulfur dioxide $\xrightarrow{\textbf{step 2}}$ sulfur trioxide $\xrightarrow{\textbf{step 3}}$ oleum $\xrightarrow{\textbf{step 4}}$ sulfuric acid

(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

.... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

....

....

....

....

....

....

.... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$$H_2SO_4 + SO_3 \rightarrow \text{...............................}$$

[1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

....

....

.... [2]

(ii) Give the **names** of all products formed.

....

.... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

.... [1]

(ii) What type of reaction has occurred?

.... [1]

[Total: 12]

6 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

....

.... [2]

(b) Ethene, CH_2=CH_2, and propene, CH_2=$CHCH_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

.... [1]

(ii) What is the empirical formula of the polymer formed from ethene?

.... [1]

(iii) Propene has the structural formula CH_2=$CHCH_3$.

Draw **two** repeat units of the polymer made from propene.

[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.

[2]

(d) Esters are organic chemicals noted for their characteristic smells. Ethanoic acid and methanol will react to form an ester.

(i) Name the catalyst needed to form an ester from ethanoic acid and methanol.

.... [1]

(ii) Name the ester formed when ethanoic acid reacts with methanol.

.... [1]

(iii) Draw the structure of the ester formed when ethanoic acid reacts with methanol. Show all bonds.

[2]

(iv) Give the name of a polyester.

.... [1]

[Total: 13]

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 T*l* thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 F*l* flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2016**

45 Minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

0872645576

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

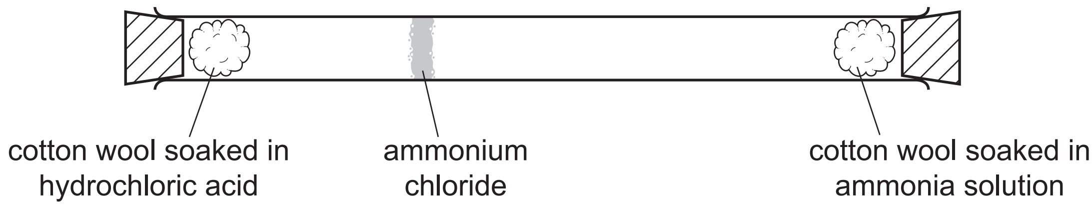
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 20.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.

1 The diagram shows an experiment to demonstrate diffusion.



Which statement explains why the ring of ammonium chloride appears as shown?

A Ammonia solution only produces a gas which moves until it meets the hydrochloric acid.

B Both solutions produce a gas, but ammonia moves quicker than hydrogen chloride because it is lighter.

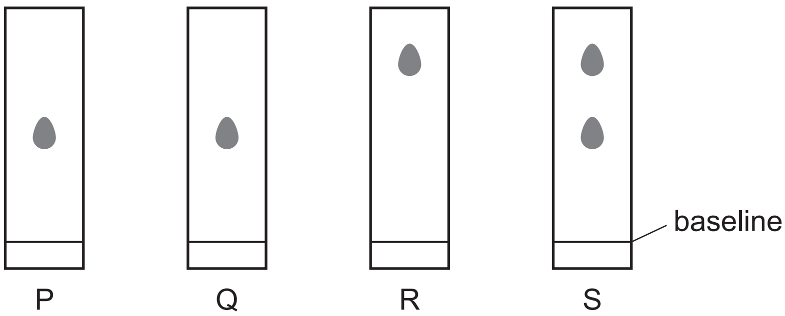
C Hydrochloric acid produces hydrogen chloride which stays at one end of the tube until the ammonia reaches it.

D The two solutions run along the tube until they meet.

2 Chromatography experiments are carried out on four substances, P, Q, R and S.

The same solvent is used in each experiment.

The resulting chromatograms are shown below.



Which statement is **not** correct?

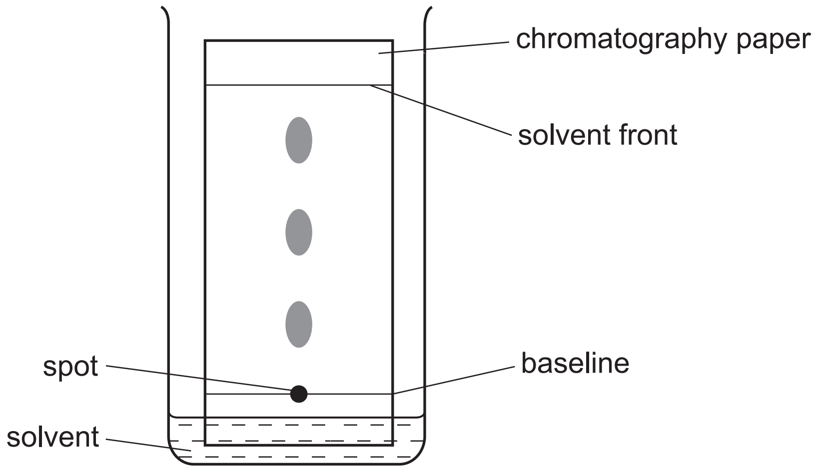
A P and Q are pure substances.

B P and R are different substances.

C R and S are pure substances.

D S is a mixture of substances.

3 The diagram shows the apparatus used to separate the different components of a mixture by chromatography.



Which statement about this experiment is correct?

A A locating agent is used to find the position of the solvent front.

B The components to be separated must be soluble in the solvent.

C The baseline on which the spot of the mixture is placed is drawn in ink.

D The R_f value is calculated by $\dfrac{\text{the distance travelled by the solvent front}}{\text{the distance travelled by the component}}$

4 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

5 The table shows the electronic structure of four atoms.

atom	electronic structure
W	2,8,1
X	2,8,4
Y	2,8,7
Z	2,8,8

Which two atoms combine to form a covalent compound?

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

6 Which statement describes the attractive forces between molecules (intermolecular forces)?

A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

7 Which substance exists as a lattice of positive ions in a ‘sea of electrons’?

A liquid potassium chloride

B solid graphite

C solid magnesium

D solid silicon(IV) oxide

8 Analysis of a compound formed between magnesium and nitrogen showed it contained 14.4 g of magnesium and 5.6 g of nitrogen.

What is the empirical formula of the compound?

A Mg_2N_3 **B** Mg_3N_2 **C** Mg_4N_6 **D** Mg_6N_4

9 An excess of zinc is added to 100 cm^3 of 1.0 mol / dm^3 hydrochloric acid.

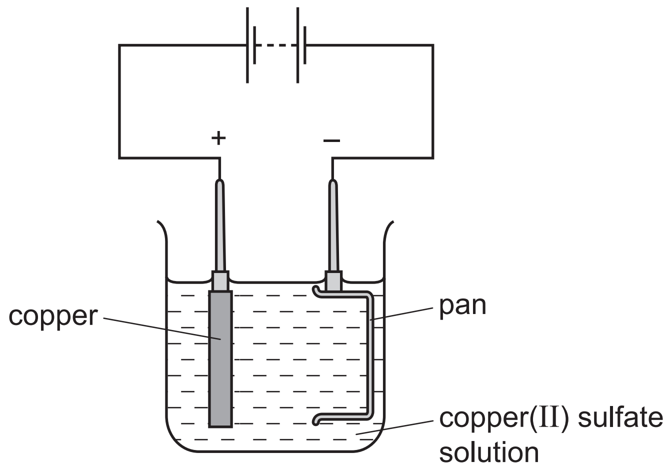
The equation for the reaction is:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

What is the maximum volume of hydrogen evolved at room temperature and pressure?

A 1.2 dm^3 **B** 2.0 dm^3 **C** 2.4 dm^3 **D** 24 dm^3

10 The diagram shows a method used to copper-plate a pan



Which equation represents the reaction at the cathode?

A $Cu^{2+} + 2e^- \rightarrow Cu$

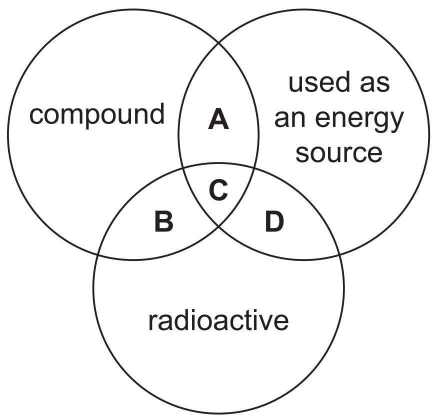
B $2H^+ + 2e^- \rightarrow H_2$

C $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

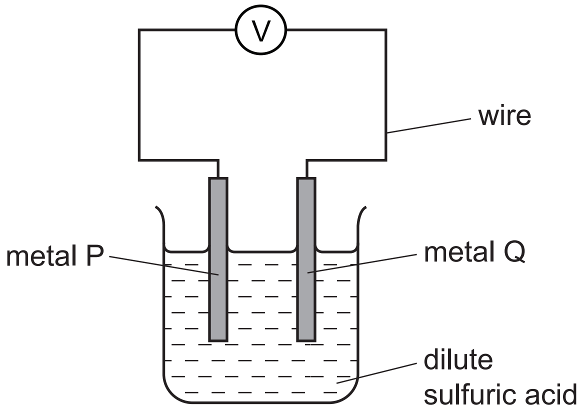
D $2O^{2-} \rightarrow O_2 + 4e^-$

11 The diagram shows some properties that substances may have.

To which labelled part of the diagram does ^{235}U belong?



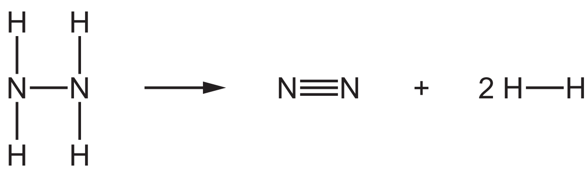
12 The diagram shows a simple cell.



Which pair of metals produces the largest voltage?

	metal P	metal Q
A	iron	copper
B	magnesium	copper
C	magnesium	zinc
D	zinc	copper

13 Hydrazine, N_2H_4, decomposes as shown.



The energy change for this reaction is –95 kJ / mol.

The table shows some bond energies involved.

bond	bond energy in kJ / mol
N≡N	945
N–H	391
H–H	436

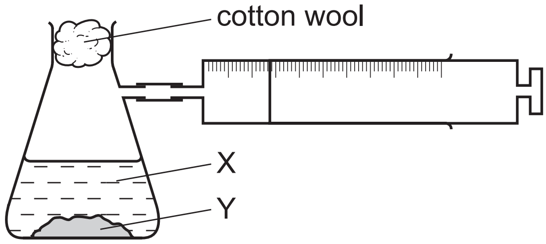
What is the bond energy of the N–N bond?

A 158 kJ / mol **B** 315 kJ / mol **C** 348 kJ / mol **D** 895 kJ / mol

14 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?

1



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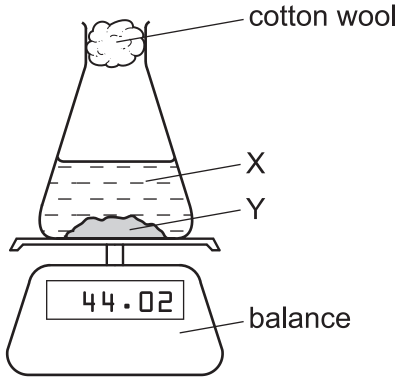

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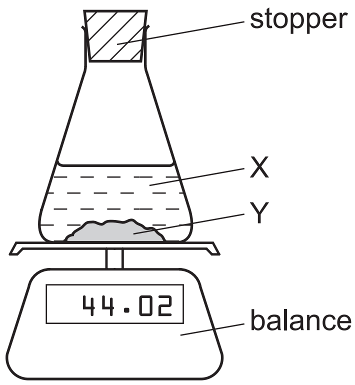

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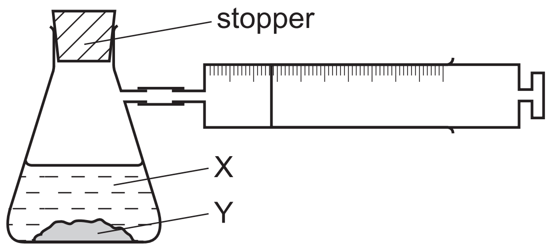


A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

15 Which row explains why increasing temperature increases the rate of reaction?

	particles collide more often	particles collide with more energy
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

16 Methanol is manufactured by reacting carbon monoxide and hydrogen together in the presence of an aluminium oxide catalyst.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The reaction is a reversible reaction.

The forward reaction is exothermic.

Which change in conditions increases the yield of methanol?

A decreasing the concentration of the carbon monoxide

B increasing the pressure

C increasing the rate of the reaction

D increasing the temperature

17 Which equation represents a reduction reaction?

A $Fe^{2+} + e^- \rightarrow Fe^{3+}$

B $Fe^{2+} \rightarrow Fe^{3+} + e^-$

C $Fe^{3+} + e^- \rightarrow Fe^{2+}$

D $Fe^{3+} \rightarrow Fe^{2+} + e^-$

18 Which statements are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

19 Which row describes whether an amphoteric oxide reacts with acids and bases?

	reacts with acids	reacts with bases
A	no	no
B	no	yes
C	yes	no
D	yes	yes

20 Barium sulfate is an insoluble salt.

It can be made by reacting copper(II) sulfate solution with barium nitrate solution.

$$CuSO_4(aq) + Ba(NO_3)_2(aq) \rightarrow Cu(NO_3)_2(aq) + BaSO_4(s)$$

What is the correct order of steps to obtain a pure, dry sample of barium sulfate from the reaction mixture?

	step 1	step 2	step 3
A	filter	evaporate the filtrate to dryness	leave the solid formed to cool
B	filter	evaporate the filtrate to the point of crystallisation	leave the filtrate to cool
C	filter	leave the residue in a warm place to dry	wash the residue with water
D	filter	wash the residue with water	leave the residue in a warm place to dry

21 Where in the Periodic Table is the metallic character of the elements greatest?

	left or right side of a period	at the top or bottom of a group
A	left	bottom
B	left	top
C	right	bottom
D	right	top

22 Which statement about the elements in Group I is correct?

A Hydrogen is evolved when they react with water.

B Ions of Group I elements have a –1 charge.

C Sodium is more reactive than potassium.

D Solid sodium is a poor electrical conductor.

23 Osmium is a transition element.

Which row gives the expected properties of osmium?

	melting point	density	compounds formed
A	high	high	coloured
B	high	high	white
C	high	low	white
D	low	high	coloured

24 Two statements about noble gases are given.

1 Noble gases are reactive, monatomic gases.

2 Noble gases all have full outer shells of electrons.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

25 Some properties of substance X are listed.

- It conducts electricity when molten.
- It has a high melting point.
- It burns in oxygen and the product dissolves in water to give a solution with pH 11.

What is X?

A a covalent compound

B a macromolecule

C a metal

D an ionic compound

26 Four metals P, Q, R and S are added to separate aqueous solutions of their ions.

The results are shown.

metal	P^{2+}	Q^{2+}	R^{2+}	S^{2+}
P	✗	✗	✓	✓
Q	✓	✗	✓	✓
R	✗	✗	✗	✗
S	✗	✗	✓	✗

key
✓ = reaction occurs
✗ = reaction does not occur

What is the order of reactivity of the metals, most reactive first?

A Q → P → S → R

B Q → S → P → R

C R → P → S → Q

D R → S → P → Q

27 Copper is a transition element used to make saucepans.

Which property is **not** correct for copper?

A good conductor of heat

B insoluble in water

C low melting point

D malleable (can be hammered into shape)

28 Aluminium is extracted by electrolysis of a mixture of aluminium oxide and cryolite.

Which statement is **not** correct?

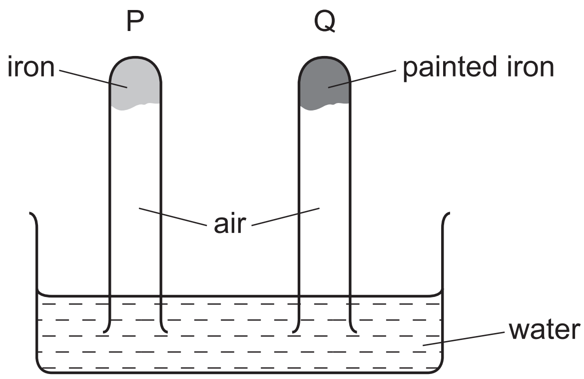
A The electrodes are made from graphite.

B The formula for aluminium oxide is Al_2O_3.

C The purpose of the cryolite is to lower the melting point of the mixture.

D The reaction taking place at the anode is $Al^{3+} + 3e^- \rightarrow Al$.

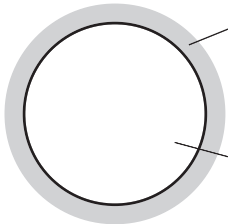
29 The diagram shows an experiment to investigate how paint affects the rusting of iron.



What happens to the water level in tubes P and Q?

	tube P	tube Q
A	falls	rises
B	no change	rises
C	rises	falls
D	rises	no change

30 A new planet has been discovered and its atmosphere has been analysed.



The table shows the composition of its atmosphere.

gas	percentage by volume
carbon dioxide	4
nitrogen	72
oxygen	24

Which gases are present in the atmosphere of the planet in a higher percentage than they are in the Earth's atmosphere?

A carbon dioxide and oxygen

B carbon dioxide only

C nitrogen and oxygen

D nitrogen only

31 Catalytic converters are used to remove some gaseous pollutants from car exhaust fumes.

Which gas is removed from the fumes by oxidation?

A carbon dioxide

B carbon monoxide

C nitrogen

D nitrogen oxide

32 Ammonia is produced by the Haber process.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g).$$

Which statement about the Haber process is **not** correct?

A An iron catalyst is used to increase the rate of reaction.

B The reaction is carried out at high temperature to increase the rate of reaction.

C The reaction is carried out at low pressure to increase the yield of ammonia.

D The reaction is reversible.

33 One step in the manufacture of sulfuric acid is the oxidation of sulfur dioxide to sulfur trioxide.

Which conditions are used for this step?

	temperature / °C	pressure / atmospheres	catalyst
A	450	1.5	iron
B	450	1.5	vanadium(V) oxide
C	450	200	iron
D	450	200	vanadium(V) oxide

34 Which process is used to make lime (calcium oxide) from limestone (calcium carbonate)?

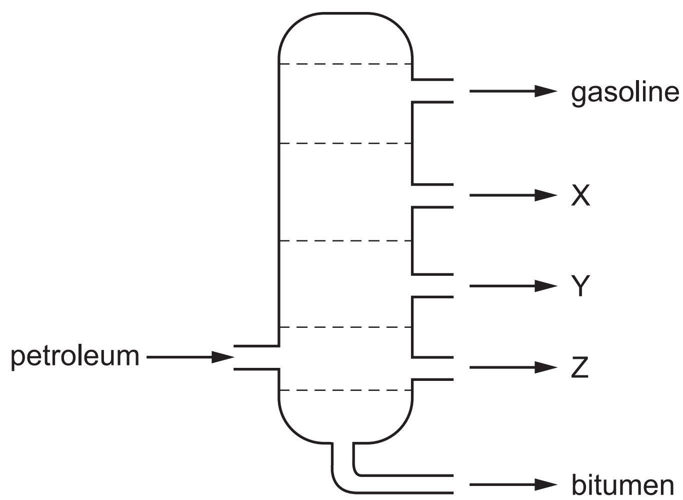
A chromatography

B electrolysis

C fractional distillation

D thermal decomposition

35 The diagram shows the separation of petroleum into fractions.



What could X, Y and Z represent?

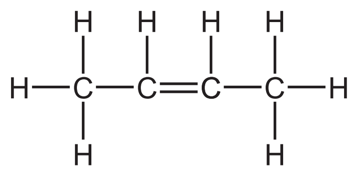
	X	Y	Z
A	diesel oil	lubricating fraction	paraffin
B	lubricating fraction	diesel oil	paraffin
C	paraffin	lubricating fraction	diesel oil
D	paraffin	diesel oil	lubricating fraction

36 Which compound does **not** belong to the same homologous series as the other three compounds?

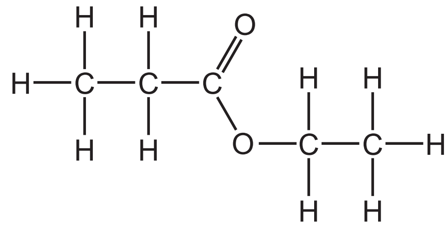
A CH_3OH **B** C_2H_5COOH **C** C_2H_5OH **D** $C_7H_{15}OH$

37 The structure of an alkene and the structure of an ester are shown.

P



Q



What are the names of P and Q?

	P	Q
A	but-1-ene	ethyl propanoate
B	but-1-ene	propyl ethanoate
C	but-2-ene	ethyl propanoate
D	but-2-ene	propyl ethanoate

38 What is an advantage of producing ethanol by fermentation of sugar compared to the catalytic addition of steam to ethene?

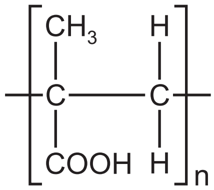
A The alcohol produced is purer.

B The process is faster.

C The process uses high temperature.

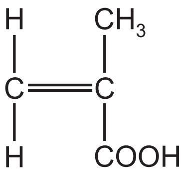
D The process uses renewable raw materials.

39 A polymer has the formula shown.

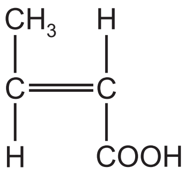


From which monomers can it be formed?

R



S



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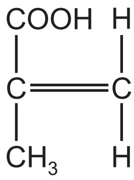
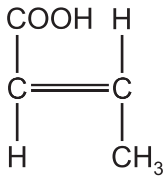


U



A R and S **B** R and T **C** S and U **D** T and U

40 Which row shows a natural polymer with the same linkages as a synthetic polymer?

	natural polymer	synthetic polymer
A	complex carbohydrate	nylon
B	complex carbohydrate	*Terylene*
C	protein	nylon
D	protein	*Terylene*

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
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actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2016**

45 Minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

1301766353

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Electronic calculators may be used.

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This document consists of **16** printed pages.

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International Examinations

[Turn over

1 The particles of a substance gain energy and change from a regular ordered structure to a disordered structure with large distances between the particles.

Which change of state is described?

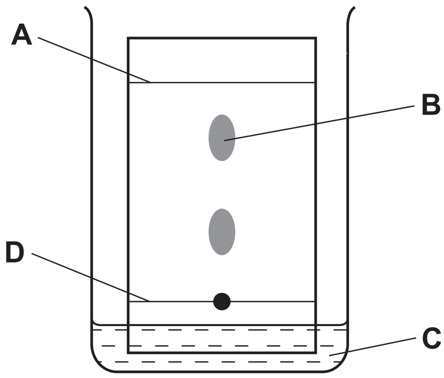
A boiling

B evaporation

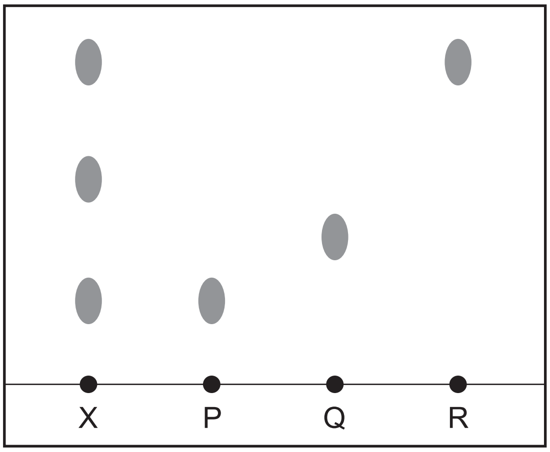
C melting

D sublimation

2 In the chromatography experiment shown, which label represents the solvent front?



3 X is a mixture of colourless compounds. The diagram shows a chromatogram of X and of three pure compounds, P, Q and R.



Which statement is **not** correct?

A A locating agent was used to develop the chromatogram of X.

B P and R could be present in X.

C P and R have different solubilities in the solvent.

D Q has a greater R_f value than R.

4 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

5 The table shows the electronic structure of four atoms.

atom	electronic structure
W	2,8,1
X	2,8,4
Y	2,8,7
Z	2,8,8

Which two atoms combine to form a covalent compound?

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

6 Which statement describes the attractive forces between molecules (intermolecular forces)?

A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

7 Metals consist of a lattice of positive ions in a ‘sea of electrons’.

Why is aluminium malleable?

A Its ions are attracted to the ‘sea of electrons’.

B Its ions are tightly packed together.

C Its ions repel each other.

D Its layers of ions can slide over each other.

8 A sample of 16.0 g of a metal oxide, MO, is reduced to 12.8 g of the metal, M.

What is the relative atomic mass, A_r, of M?

A 32 **B** 64 **C** 80 **D** 128

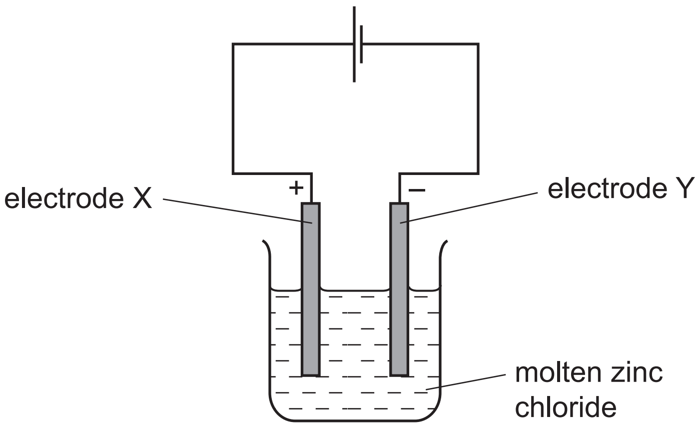
9 The equation for the reaction between calcium carbonate and hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

How many moles of calcium carbonate will give 24 cm^3 of carbon dioxide when reacted with an excess of the acid?

A 1 mol **B** 0.1 mol **C** 0.01 mol **D** 0.001 mol

10 The diagram shows the electrolysis of molten zinc chloride, $ZnCl_2$.



Which statement is correct?

A Oxidation occurs at electrode X and the equation is: $2Cl^- \rightarrow Cl_2 + 2e^-$.

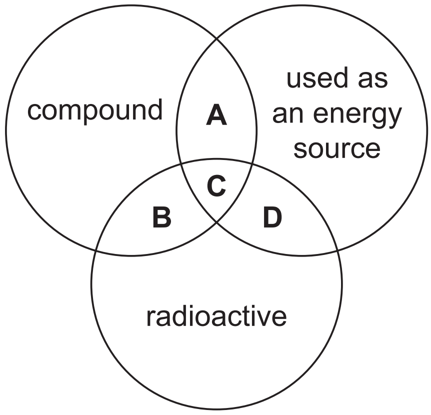
B Oxidation occurs at electrode Y and the equation is: $Zn^{2+} + 2e^- \rightarrow Zn$.

C Reduction occurs at electrode X and the equation is: $Zn^{2+} + 2e^- \rightarrow Zn$.

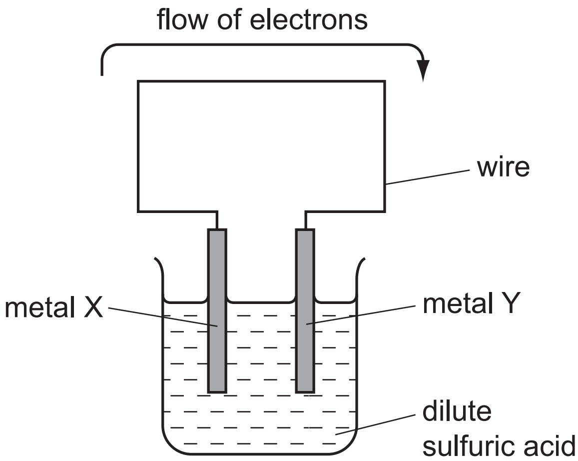
D Reduction occurs at electrode Y and the equation is: $2Cl^- \rightarrow Cl_2 + 2e^-$.

11 The diagram shows some properties that substances may have.

To which labelled part of the diagram does ^{235}U belong?



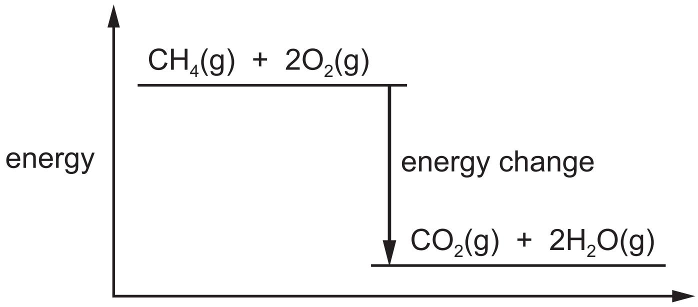
12 The diagram shows a simple cell.



For which pair of metals would electrons flow from metal X to metal Y?

	X	Y
A	copper	iron
B	copper	zinc
C	iron	zinc
D	zinc	iron

13 The energy level diagram for the combustion of methane is shown.



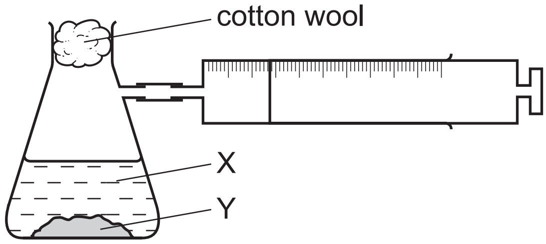
Which row gives the equation and energy change for this reaction?

	equation	energy change in kJ / mol
A	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	+891
B	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	–891
C	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	+891
D	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	–891

14 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?

1



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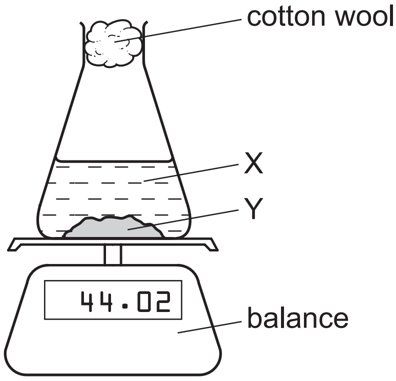

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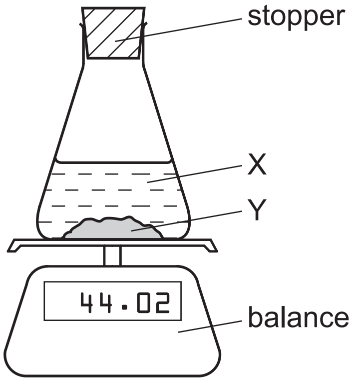

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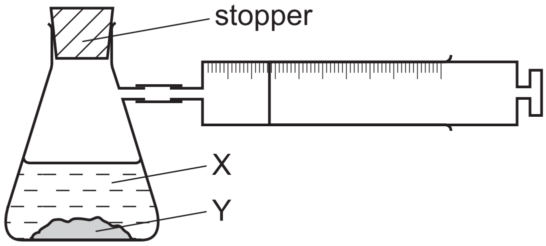


A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

15 Which row describes how the energy of collision between particles changes when concentration and temperature are increased?

	concentration	temperature
A	increases	increases
B	increases	no change
C	no change	increases
D	no change	no change

16 Methanol is made by reacting carbon monoxide with hydrogen.

The reaction is exothermic and is a chemical equilibrium.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Which changes in temperature and pressure increase the yield of methanol?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

17 Which equation represents a reduction reaction?

A $Fe^{2+} + e^- \rightarrow Fe^{3+}$

B $Fe^{2+} \rightarrow Fe^{3+} + e^-$

C $Fe^{3+} + e^- \rightarrow Fe^{2+}$

D $Fe^{3+} \rightarrow Fe^{2+} + e^-$

18 Which statements are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

19 Which row describes whether an amphoteric oxide reacts with acids and bases?

	reacts with acids	reacts with bases
A	no	no
B	no	yes
C	yes	no
D	yes	yes

20 Silver chloride is insoluble in water and is prepared by precipitation.

Which two substances can be used to make silver chloride?

A barium chloride and silver nitrate

B hydrochloric acid and silver

C hydrochloric acid and silver bromide

D sodium chloride and silver iodide

21 Where in the Periodic Table is the metallic character of the elements greatest?

	left or right side of a period	at the top or bottom of a group
A	left	bottom
B	left	top
C	right	bottom
D	right	top

22 Rubidium is a Group I metal.

Which statement about rubidium is **not** correct?

A It has a higher melting point than lithium.

B It has one electron in its outer shell.

C It reacts vigorously with water.

D It reacts with chlorine to form rubidium chloride, $RbCl$.

23 The table gives information about four elements, P, Q, R and S.

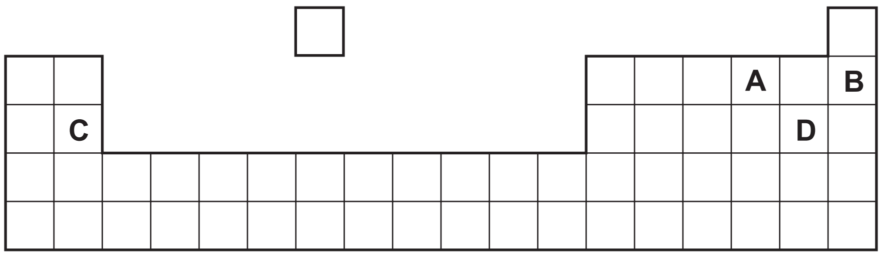
	melting point in °C	electrical conductivity of element when solid	density in g/cm^3	colour of iodide of element
P	98	good	0.97	white
Q	–39	good	13.53	red
R	1410	poor	2.33	colourless
S	1535	good	7.87	green

Which elements could be transition elements?

A P, Q and S **B** Q and S only **C** R and S only **D** S only

24 Part of the Periodic Table is shown.

Which element is a gas that does **not** form a compound with potassium?



25 Some magnesium compounds undergo thermal decomposition.

What are the products of thermal decomposition of magnesium nitrate, $Mg(NO_3)_2$, and magnesium hydroxide, $Mg(OH)_2$?

	$Mg(NO_3)_2$	$Mg(OH)_2$
A	MgO, NO_2 and O_2	MgO and H_2O
B	MgO, NO_2 and O_2	MgO and H_2
C	$Mg(NO_2)_2$ and O_2	MgO and H_2O
D	$Mg(NO_2)_2$ and O_2	MgO and H_2

26 Which property is **not** considered a typical metallic property?

A good conductor of heat

B low melting point

C malleable (can be hammered into shape)

D strong

27 Iron from a blast furnace is treated with oxygen and with calcium oxide to make steel.

Which substances in the iron are removed?

	oxygen removes	calcium oxide removes
A	carbon	acidic oxides
B	carbon	basic oxides
C	iron	acidic oxides
D	iron	basic oxides

28 Why is cryolite used during the extraction of aluminium by electrolysis?

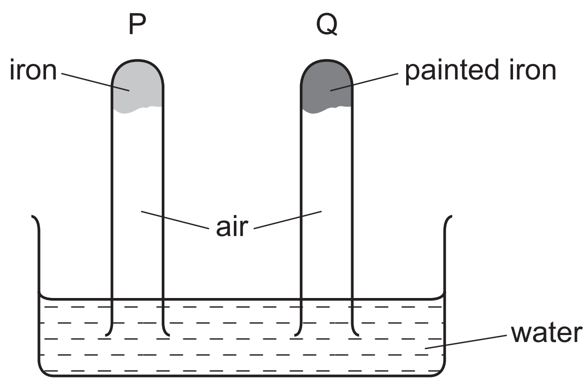
A It is a catalyst for the reaction.

B It lowers the melting point of the electrolyte.

C It protects the anodes.

D It separates the aluminium from the electrolyte.

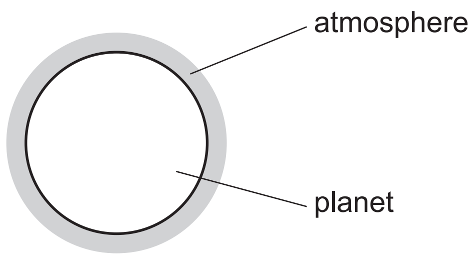
29 The diagram shows an experiment to investigate how paint affects the rusting of iron.



What happens to the water level in tubes P and Q?

	tube P	tube Q
A	falls	rises
B	no change	rises
C	rises	falls
D	rises	no change

30 A new planet has been discovered and its atmosphere has been analysed.



The table shows the composition of its atmosphere.

gas	percentage by volume
carbon dioxide	4
nitrogen	72
oxygen	24

Which gases are present in the atmosphere of the planet in a higher percentage than they are in the Earth's atmosphere?

A carbon dioxide and oxygen

B carbon dioxide only

C nitrogen and oxygen

D nitrogen only

31 The gases coming from a car's engine contain oxides of nitrogen.

How are these oxides formed?

A Nitrogen reacts with carbon dioxide.

B Nitrogen reacts with carbon monoxide.

C Nitrogen reacts with oxygen.

D Nitrogen reacts with petrol.

32 Ammonia is manufactured by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

What is the effect of increasing the pressure on the percentage yield and rate of formation of ammonia?

	percentage yield	rate of formation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

33 The Contact process is used for the manufacture of sulfuric acid.

Which statement about this process is **not** correct?

A A catalyst of iron is used.

B Oxygen from the air is used to react with sulfur dioxide.

C Sulfur trioxide dissolves in sulfuric acid to form oleum.

D The temperature used is around 450 °C.

34 Lime (calcium oxide) is used to treat waste water from a factory.

Which substance is removed by the lime?

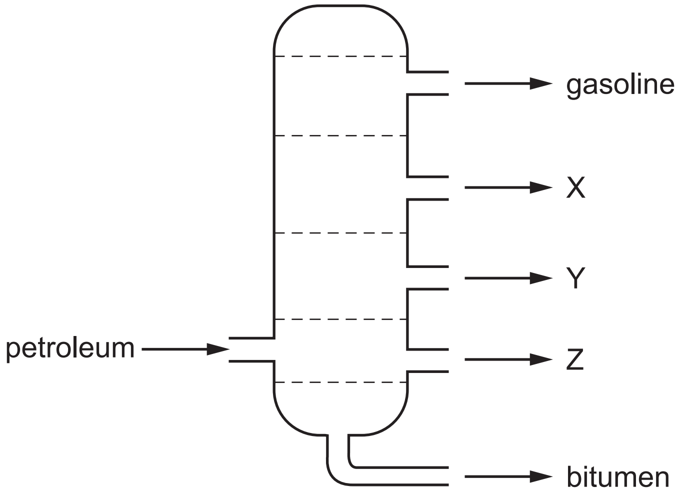
A ammonia

B sodium chloride

C sodium hydroxide

D sulfuric acid

35 The diagram shows the separation of petroleum into fractions.



What could X, Y and Z represent?

	X	Y	Z
A	diesel oil	lubricating fraction	paraffin
B	lubricating fraction	diesel oil	paraffin
C	paraffin	lubricating fraction	diesel oil
D	paraffin	diesel oil	lubricating fraction

36 Which compound is **not** an alkane, C_nH_{2n+2}?

A $CH_3CH_2CH_2CH_3$

B $(CH_3)_2CHCH_3$

C $CH_3CHCHCH_3$

D $(CH_3)_3CH$

37 An ester is formed when a carboxylic acid reacts with an alcohol.

Which ester is formed when propanoic acid and ethanol react?

A $CH_3CO_2CH_2CH_3$

B $CH_3CO_2CH_2CH_2CH_3$

C $CH_3CH_2CO_2CH_3$

D $CH_3CH_2CO_2CH_2CH_3$

38 What is an advantage of producing ethanol by fermentation of sugar compared to the catalytic addition of steam to ethene?

A The alcohol produced is purer.

B The process is faster.

C The process uses high temperature.

D The process uses renewable raw materials.

39 In which row are the monomer and polymer chain correctly matched?

	monomer	part of the polymer chain
A	$CH_3CH{=}CHCH_3$	$–CH(CH_3)–CH(CH_3)–CH(CH_3)–CH(CH_3)–$
B	$CH_2{=}CHCl$	$–CHCl–CHCl–CHCl–CHCl–$
C	$CH_3CH{=}CH_2$	$–CH_3–CH–CH_2–CH_3–CH–CH_2–$
D	$CH_2{=}CHCH_2CH_3$	$–CH_2–CH_2–CH_2–CH(CH_2CH_3)–$

40 Which two polymers have the same linkages bonding the monomers together?

A nylon and complex carbohydrate

B nylon and protein

C *Terylene* and complex carbohydrate

D *Terylene* and protein

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2016**

45 Minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

6622954837

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

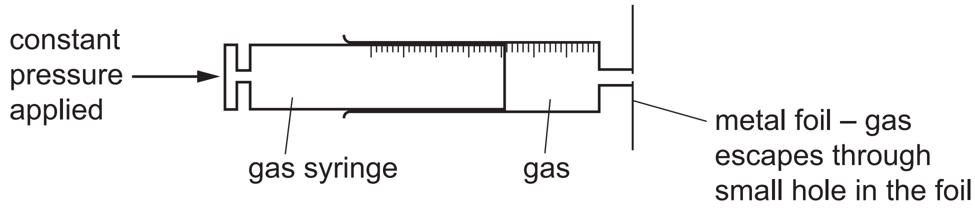
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 20.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.

IB16 06_0620_21/4RP

1 The rate of diffusion of two gases, methane, CH_4, and ethene, C_2H_4, is measured using the apparatus shown.



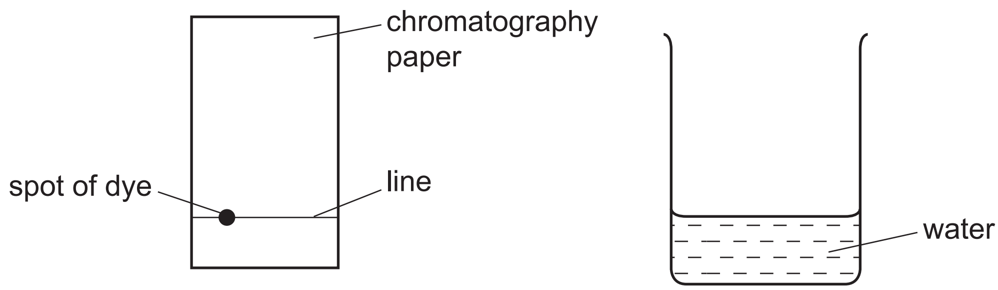
Which gas diffuses faster and why?

	gas that diffuses faster	reason
A	ethene	Ethene molecules are heavier and so move faster.
B	ethene	Ethene molecules have a double bond which makes them more reactive.
C	methane	Methane molecules are lighter and so move faster.
D	methane	Methane molecules are smaller so they can get out of the small hole more easily.

2 A sample of a dye is investigated by chromatography.

A line is drawn across a piece of chromatography paper and a spot of the dye is placed on it.

The paper is placed in water.

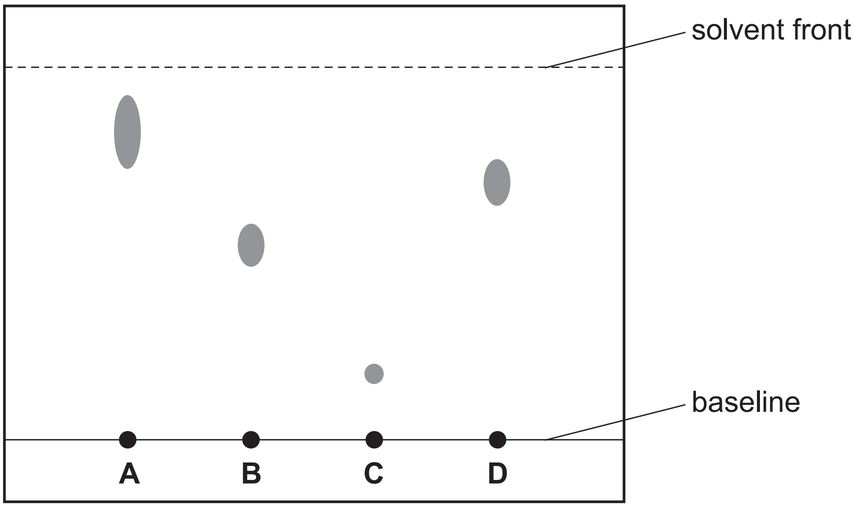


Which row is correct?

	what is used to draw the line	position of spot
A	ink	above the level of the water
B	ink	below the level of the water
C	pencil	above the level of the water
D	pencil	below the level of the water

3 The paper chromatogram below was obtained from four different dyes.

Which dye has an R_f value of 0.7?



4 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

5 The table shows the electronic structure of four atoms.

atom	electronic structure
W	2,8,1
X	2,8,4
Y	2,8,7
Z	2,8,8

Which two atoms combine to form a covalent compound?

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

6 Which statement describes the attractive forces between molecules (intermolecular forces)?

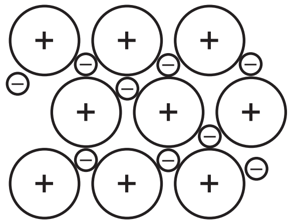
A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

7 The diagram represents the general structure of a solid Z.



What is Z?

A aluminium

B iodine

C silicon dioxide

D sulfur

8 A compound, X, contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass.

The relative molecular mass, M_r, of X is 60.

What is the molecular formula of X?

A CH_2O **B** CH_4O **C** C_2H_4O **D** $C_2H_4O_2$

9 $25\,cm^3$ of $0.1\,mol/dm^3$ hydrochloric acid exactly neutralise $20\,cm^3$ of aqueous sodium hydroxide.

The equation for this reaction is:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

What is the concentration of the sodium hydroxide solution?

A $0.080\,mol/dm^3$

B $0.800\,mol/dm^3$

C $0.125\,mol/dm^3$

D $1.25\,mol/dm^3$

10 Which reactions could take place at the anode during electrolysis?

1 $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$

2 $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

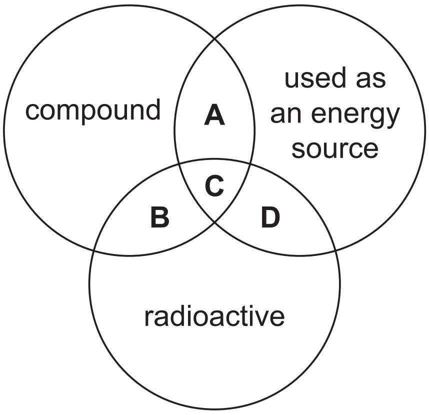
3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

4 $2H^+(aq) + 2e^- \rightarrow H_2(g)$

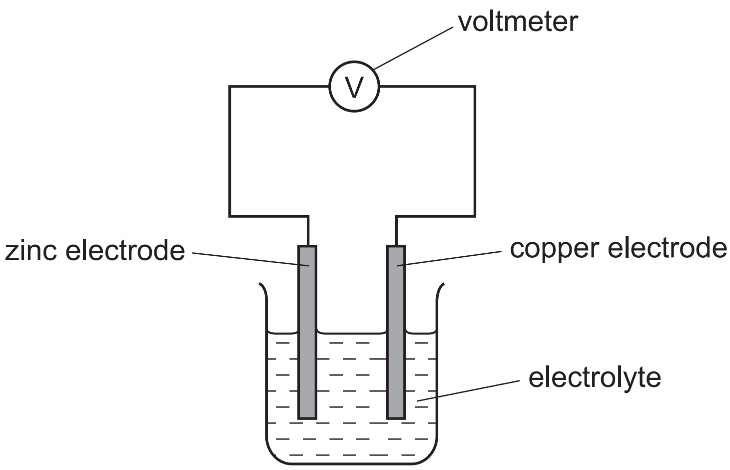
A 1 and 2 **B** 1 and 4 **C** 2 and 4 **D** 3 and 4

11 The diagram shows some properties that substances may have.

To which labelled part of the diagram does ^{235}U belong?



12 The diagram shows a simple cell.



Which statement about the process occurring when the cell is in operation is correct?

A Cu^{2+} ions are formed in solution.

B Electrons travel through the solution.

C The reaction $Zn \rightarrow Zn^{2+} + 2e^-$ occurs.

D The zinc electrode increases in mass.

13 Hydrogen burns exothermically in oxygen.

The equation for the reaction is:

$$2H_2 + O_2 \rightarrow 2H_2O$$

The table shows the bond energies involved.

bond	bond energy in kJ / mol
H–H	436
O=O	498
O–H	464

What is the energy given out during the reaction?

A –3226 kJ / mol

B –884 kJ / mol

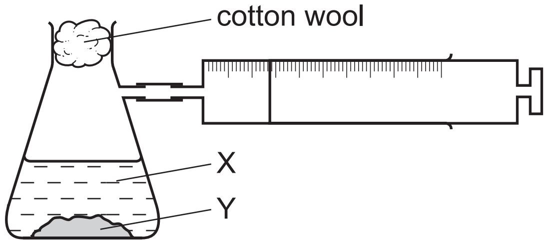
C –486 kJ / mol

D –442 kJ / mol

14 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?

1



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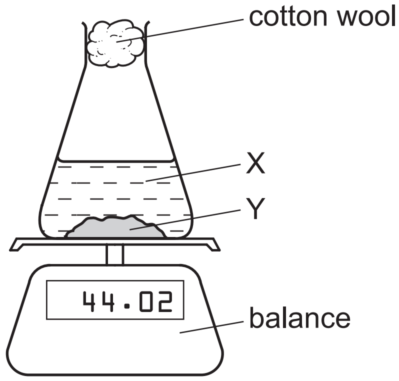

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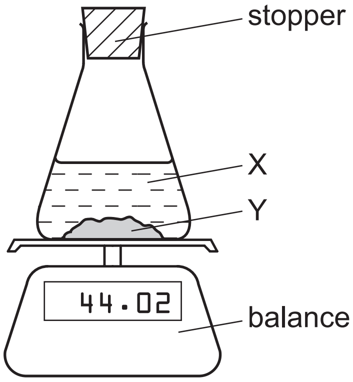

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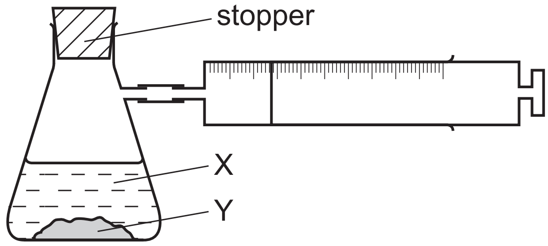


A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

15 Which statements explain why increasing temperature increases the rate of a chemical reaction?

1 Heat makes the molecules move faster and collide more often.

2 Heat makes the molecules collide with more energy so they are more likely to react.

3 Increasing temperature lowers the activation energy for the reaction.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 only

16 Steam reacts with carbon in an endothermic reaction.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

Which conditions of temperature and pressure would give the largest yield of hydrogen?

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

17 Which equation represents a reduction reaction?

A $Fe^{2+} + e^- \rightarrow Fe^{3+}$

B $Fe^{2+} \rightarrow Fe^{3+} + e^-$

C $Fe^{3+} + e^- \rightarrow Fe^{2+}$

D $Fe^{3+} \rightarrow Fe^{2+} + e^-$

18 Which statements are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

19 Which row describes whether an amphoteric oxide reacts with acids and bases?

	reacts with acids	reacts with bases
A	no	no
B	no	yes
C	yes	no
D	yes	yes

20 Which substance reacts with dilute sulfuric acid to form a salt that can be removed from the resulting mixture by filtration?

A aqueous barium chloride

B aqueous sodium hydroxide

C copper

D copper(II) carbonate

21 Where in the Periodic Table is the metallic character of the elements greatest?

	left or right side of a period	at the top or bottom of a group
A	left	bottom
B	left	top
C	right	bottom
D	right	top

22 Some properties of four elements, P, Q, R and S, are shown in the table.

Two of these elements are in Group I of the Periodic Table and two are in Group VII.

element	reaction with water	physical state at room temperature
P	reacts vigorously	solid
Q	does not react with water	solid
R	reacts explosively	solid
S	dissolves giving a coloured solution	liquid

Which statement is correct?

A P is below R in Group I.

B Q is above R in Group I.

C Q is below S in Group VII.

D R is below S in Group VII.

23 Which of the following could be a transition element?

	melting point in °C	density in g/cm^3	colour	electrical conductor
A	114	4.9	purple	no
B	659	2.7	grey	yes
C	1677	4.5	grey	yes
D	3727	2.3	black	yes

24 Two statements about argon are given.

1 Argon has a full outer shell of electrons.

2 Argon is very reactive and is used in lamps.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

25 A student investigated the reactions of four metals, R, S, T and U, with solutions of their salts.

The results are given in the table.

metal	metal salt	result
R	S nitrate	reacts
R	T nitrate	reacts
S	U nitrate	no reaction
T	U nitrate	reacts
U	R nitrate	no reaction

What is the order of reactivity of the metals, most reactive first?

A $R \rightarrow S \rightarrow U \rightarrow T$

B $R \rightarrow T \rightarrow U \rightarrow S$

C $S \rightarrow U \rightarrow T \rightarrow R$

D $U \rightarrow R \rightarrow T \rightarrow S$

26 Three students, X, Y and Z, were told that solid P reacts with dilute acids and also conducts electricity.

The table shows the students' suggestions about the identity of P.

X	Y	Z
copper	iron	graphite

Which of the students are correct?

A X, Y and Z **B** X only **C** Y only **D** Z only

27 Which statement about the uses of metals is correct?

A Aluminium is used in the manufacture of aircraft because of its strength and high density.

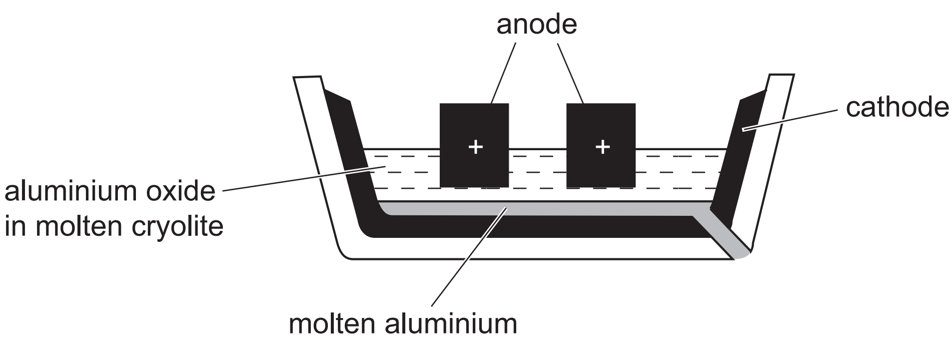
B Copper is used in electrical wiring because of its strength and high density.

C Mild steel is used in the manufacture of car bodies because of its strength and resistance to corrosion.

D Stainless steel is used in the construction of chemical plant because of its strength and resistance to corrosion.

28 Aluminium is manufactured by electrolysis of aluminium oxide.

The diagram shows the electrolysis cell.



Which statement about the process is **not** correct?

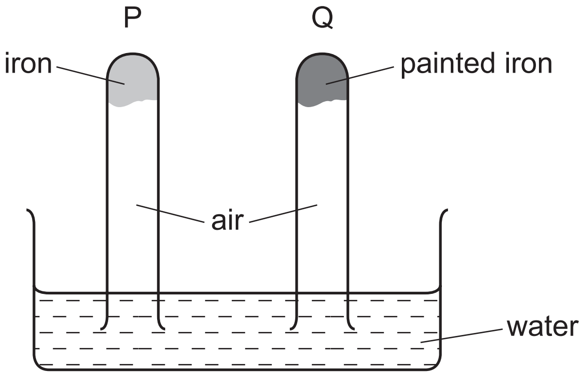
A Aluminium ions gain electrons during the electrolysis and are reduced.

B Cryolite is added to reduce the melting point of the aluminium oxide.

C The anode and cathode are made of graphite.

D The cathode has to be replaced regularly because it is burnt away.

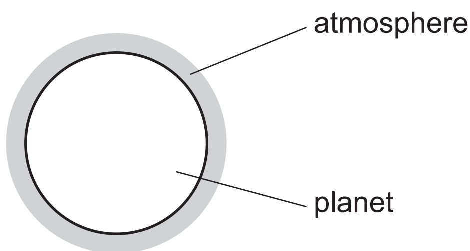
29 The diagram shows an experiment to investigate how paint affects the rusting of iron.



What happens to the water level in tubes P and Q?

	tube P	tube Q
A	falls	rises
B	no change	rises
C	rises	falls
D	rises	no change

30 A new planet has been discovered and its atmosphere has been analysed.



The table shows the composition of its atmosphere.

gas	percentage by volume
carbon dioxide	4
nitrogen	72
oxygen	24

Which gases are present in the atmosphere of the planet in a higher percentage than they are in the Earth's atmosphere?

A carbon dioxide and oxygen

B carbon dioxide only

C nitrogen and oxygen

D nitrogen only

31 Many car exhaust systems contain a catalytic converter.

Which change does **not** occur in a catalytic converter?

A carbon dioxide → carbon

B carbon monoxide → carbon dioxide

C nitrogen oxides → nitrogen

D unburnt hydrocarbons → carbon dioxide and water

32 Ammonia is formed by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which changes in conditions would increase the yield of ammonia?

	increase in pressure	increase in temperature
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

33 The equation for an exothermic reaction in the Contact process is shown.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

Which effects do increasing the temperature and using a catalyst have on the rate of formation of sulfur trioxide, SO_3?

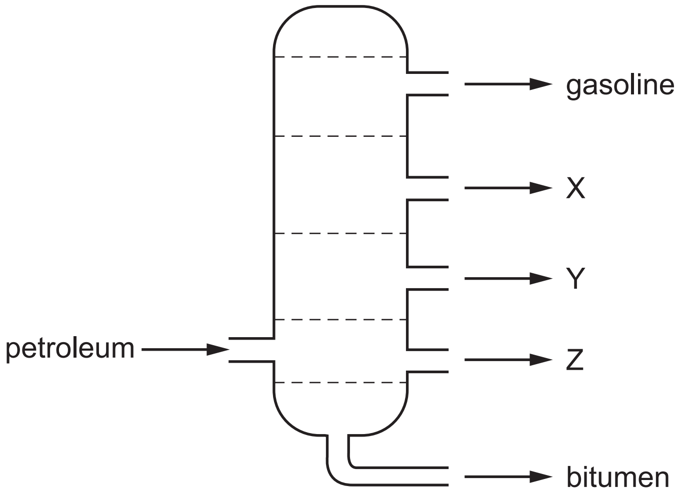
	increasing the temperature	using a catalyst
A	rate decreases	rate decreases
B	rate decreases	rate increases
C	rate increases	rate decreases
D	rate increases	rate increases

34 A farmer's soil is very low in both nitrogen (N) and phosphorus (P).

Which fertiliser would improve the quality of this soil most effectively?

	percentage		
	nitrogen (N)	phosphorus (P)	potassium (K)
A	11	11	27
B	12	37	10
C	28	10	10
D	31	29	9

35 The diagram shows the separation of petroleum into fractions.



What could X, Y and Z represent?

	X	Y	Z
A	diesel oil	lubricating fraction	paraffin
B	lubricating fraction	diesel oil	paraffin
C	paraffin	lubricating fraction	diesel oil
D	paraffin	diesel oil	lubricating fraction

36 Which of the compounds shown are in the same homologous series?

1 CH_3OH

2 CH_3CH_2OH

3 CH_3COOH

4 $CH_3CH_2CH_2OH$

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

37 Which compounds contain the same number of carbon, hydrogen and oxygen atoms?

W	X	Y	Z
ethyl methanoate	methyl ethanoate	methyl methanoate	ethyl ethanoate

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

38 What is an advantage of producing ethanol by fermentation of sugar compared to the catalytic addition of steam to ethene?

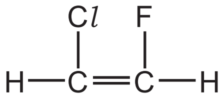
A The alcohol produced is purer.

B The process is faster.

C The process uses high temperature.

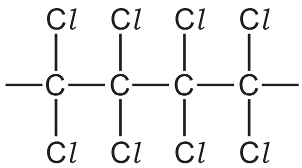
D The process uses renewable raw materials.

39 The structure of a monomer is shown.



Which polymer can be made from this monomer?

A



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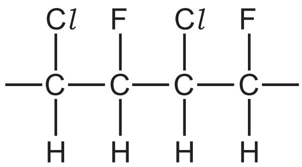

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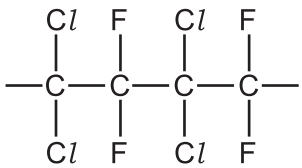

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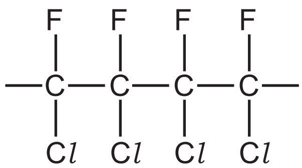
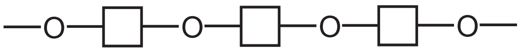


40 Which formula represents a polyester?

A



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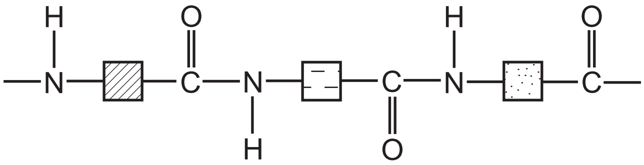

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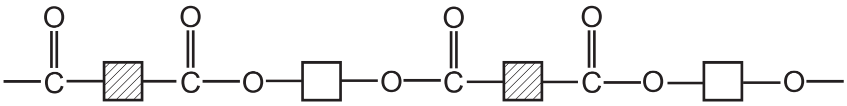

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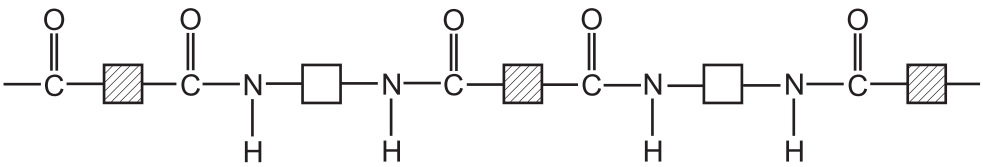

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		**Key** atomic number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2016**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	(gas) syringe;	**1**
1(b)	arrow under copper;	**1**
1(c)	 orange / red / brown / pink; to black;	**2** 1 1
1(d)	 volume of oxygen = 10 cm^3; % oxygen = 10/50 × 100 = 20%;	**2** 1 1

Question	Answer	Marks
2(a)	initial temperature boxes completed correctly: 22, 21, 24; maximum temperature boxes completed correctly: 25, 23, 61; temperature differences completed correctly: 3, 2, 37;	**3** 1 1 1
2(b)	hydrogen;	**1**
2(c)	all temperature boxes completed correctly: 21, 46 and 24, 29; differences completed correctly: 25, 5;	**2** 1 1
2(d)	*y*-axis scale linear and highest temperature change over half way up *y*-axis; all 5 bars at the correct height; <u>bars</u> clearly labelled;	**3** 1 1 1
2(e)(i)	experiment <u>3</u>;	**1**
2(e)(ii)	magnesium is the most reactive metal;	**1**
2(f)	copper formed; iron is more reactive / displacement reaction;	**2** 1 1
2(g)	potassium is too reactive / dangerous;	**1**
2(h)	quick / easy to use;	**1**
2(i)	insulate / lag tube / use a lid; to reduce heat losses; **OR** use a pipette / burette; instead of measuring cylinder / more accurate;	**2** 1 1 1 1

Question	Answer	Marks
3(a)(i)	white; precipitate; dissolves;	**3** 1 1 1
3(a)(ii)	white precipitate; dissolves;	**2** 1 1
3(a)(iii)	no reaction / change / precipitate;	**1**
3(a)(iv)	any 3 from: effervescence / fizz / bubbles; red litmus / pH paper; blue / pH > 7; pungent smell;	**3**
3(b)	lithium; carbonate;	**2** 1 1

Question	Answer	Marks
4	**method** heat the salt; condenser shown on diagram; drops of water / condensation; colour change / blue solid becomes paler; **test pure water** boiling point; 100 °C;	**6**

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Question	Answer	Marks
1(a)	 stand; beaker;	**2** 1 1
1(b)	arrow(s) underneath copper oxide;	**1**
1(c)	 black; to orange / red / brown / pink;	**2** 1 1
1(d)	to condense (the water vapour);	**1**
1(e)(i)	water;	**1**

1(e)(ii)	
	test: anhydrous copper(II) sulfate;
	result: turns blue;
	OR
	test: cobalt(II) chloride (paper);
	result: turns pink;
		2
		1
		1
		
		1
		1

1(e)(iii)	boiling / melting point determination;	**1**

Question	Answer	Marks
2(a)	all 6 times completed correctly (2 marks) (22, 43, 64, 86, 105, 126) 5 times completed correctly (1 mark); in seconds;	**3** 2 1
2(b)	appropriate scale for *y*-axis / increasing at 20 s per large square; *y*-axis is a linear scale; all 6 points plotted correctly ± half a small square (2 marks); 5 points plotted correctly ± half a small square (1 marks); best-fit straight-line graph;	**5** 1 1 2 1
2(c)(i)	value from graph ± half a small square (typically 167–170); units / s; extrapolation;	**3** 1 1 1
2(c)(ii)	sketch line below original line and diverging;	**1**
2(d)	as an indicator;	**1**
2(e)(i)	(more) accurate;	**1**
2(e)(ii)	solution slow to run out of pipette; difficult to know when to start timer / reaction does not start at once / inaccurate time measurement owtte;	**2** 1 1
2(f)	difficulty in swirling / mixing / shaking;	**1**

Question	Answer	Marks
3(a)	white (solid / crystals / powder);	**1**
3(b)(i)	no change;	**1**
3(b)(ii)	turns from purple / pink; to colourless / white;	**2** 1 1
3(c)	yellow / orange (flame);	**1**
3(d)	ammonia / NH_3;	**1**
3(e)	ammonium / NH_4^+;	**1**

Question	Answer	Marks
4	**making the salt** any 4 from: • known volume sulfuric acid; • add named indicator; • add potassium hydroxide solution to the acid until the indicator changes colour / is neutralised; • note / measure the volume of potassium hydroxide solution added; • repeat without indicator **OR** add (decolourising) charcoal; **obtaining crystals** any 2 from: • heat / evaporate solution to crystallising point until half evaporated **OR** until crystals (start to) form **OR** until saturated; • leave to cool; • filter to get crystals; • dry crystals (on filter paper) / leave to dry;	**6**

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CHEMISTRY **0620/61**

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Question	Answer	Marks
1(a)	 fractionating column; tripod;	**2** 1 1
1(b)	water labelled twice;	**1**
1(c)	heat under (the collecting) beaker;	**1**
1(d)	 **M1** ethanol; **M2** lowest / lower boiling point;	**2** 1 1
1(e)	ethanol is flammable;	**1**

Question	Answer	Marks
2(a)	final readings completed correctly: 13.2, 39.2; initial readings completed correctly: 0.0, 12.8; differences completed correctly: 13.2, 26.4; all readings and differences to 1 decimal place;	**4** 1 1 1 1
2(b)	<u>yellow</u> to orange / red / pink;	**1**
2(c)	initial and final readings completed correctly: 9.9, 16.5; difference completed correctly: 6.6;	**2** 1 1
2(d)	bubbles / fizzing / effervescence;	**1**
2(e)	Experiment <u>2</u>;	**1**
2(f)	use a pipette / burette;	**1**
2(g)	effect on results: none owtte; reason: no change in concentration owtte;	**2** 1 1
2(h)(i)	2:1;	**1**
2(h)(ii)	acid **B** is double the concentration of acid **A** ora / acid **B** is more concentrated ora;	**1**
2(i)	any suitable correct and different method **M1** method; **M2** reagents; **M3** result;	**3** 1 1 1

Question	Answer	Marks
3(a)	sodium; bromide;	**2** 1 1
3(b)	green;	**1**
3(c)(i)	green; precipitate; with excess, green solution / clear / dissolves;	**3** 1 1 1
3(c)(ii)	grey-green; precipitate;	**2** 1 1
3(c)(iii)	white precipitate;	**1**
3(d)	fume cupboard / protective clothing, e.g. gloves or goggles;	**1**

Question	Answer	Marks
4	any 6 from: weigh calcium; with lid / cover; heat / burn; allow air to enter / lift lid; cool; reweigh CaO; reheat to constant mass; calculate / find the difference;	**6**

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2016**

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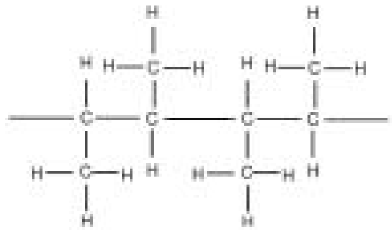
- max indicates the maximum number of marks that can be awarded
- ecf credit a correct statement that follows a previous wrong response
- ( ) the word / phrase in brackets is not required, but sets the context
- ora or reverse argument

Question	Answer	Marks
1(a)(i)	A;	**1**
1(a)(ii)	B;	**1**
1(a)(iii)	D;	**1**
1(a)(iv)	C;	**1**
1(a)(v)	C;	**1**
1(b)(i)	(hot) air;	**1**
1(b)(ii)	(molten) iron;	**1**
1(b)(iii)	any 2 from: carbon dioxide; carbon monoxide; nitrogen;	**2**
1(c)(i)	as the percentage of carbon increases, so the malleability decreases;	**1**
1(c)(ii)	 **M1** oxygen (gas) blown in; **M2** carbon dioxide formed / $C + O_2 \rightarrow CO_2$;	**2** 1 1

Question	Answer	Marks
2(a)	butane;	**1**
2(b)	compounds: E **and** F; general formula: C_nH_{2n+2}; **OR** compounds: A **and** B; general formula: C_nH_{2n};	**2** 1 1 1 1
2(c)	compounds: E **and** F; explanation: same molecular formula / contain the same number of atoms each element; different structures / different structural formulae / different arrangement of atoms;	**3** 1 2
2(d)	contains a double bond / not all bonds are single bonds; C and H only;	**2** 1 1
2(e)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$; any 2 from: high temperature / 220 °C–350 °C; high pressure / 60 atm–70 atm; phosphoric acid catalyst;	**3** 1 2

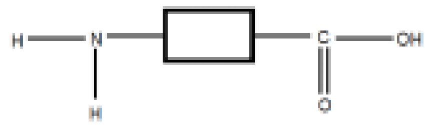
Question	Answer	Marks
2(f)	 **M1** correct carbon structure with only single bonds; **M2** continuation bonds;	**2**

Question	Answer	Marks
3(a)	any 2 from: carbon dioxide; nitrogen; any named noble gas;	**2**
3(b)	any 6 from: carbon monoxide; from incomplete combustion (of carbon-containing fuel); sulfur dioxide; from burning fossil fuels / roasting ores which contain sulphur / volcanoes; oxides of nitrogen; nitrogen reacting with oxygen in car engines / lightning; methane; from anaerobic decomposition / anaerobic decay;	**6**

Question	Answer	Marks
4(a)(i)	**M1** movement of electron(s) from potassium to iodine; **M2** one electron transferred;	**2** 1 1
4(a)(ii)	**M1** regular arrangement / (giant) lattice of alternating; **M2** positive potassium ions / K^+ **and** negative iodide ions / I^-;	**2** 1 1
4(a)(iii)	**M1** strong (forces of) attraction (between oppositely charged ions) / ionic bonds are strong; **M2** which require lots of energy to overcome / break;	**2** 1 1
4(b)(i)	**M1** dissolve solids (in water) and mix / combine / add; **M2** filter; **M3** wash the residue (with water); **M4** leave to dry / place in oven / dry between filter papers;	**4** 1 1 1 1
4(b)(ii)	$Pb^{2+} + 2I^- \rightarrow PbI_2$ formulae of ions correct; rest correct;	**2**
4(c)(i)	start colour: colourless; end colour: brown;	**2** 1 1
4(c)(ii)	**M1** iodide / I^-; **M2** it is oxidised **OR** it loses electrons / it increases oxidation number / it reduces the chlorine;	**2** 1 1

Question	Answer	Marks
5(a)	carbon dioxide / a gas is made;	**1**
5(b)(i)	red;	**1**
5(b)(ii)	0.001;	**1**
5(b)(iii)	0.0005;	**1**
5(b)(iv)	0.031 (2 marks) **M1 (iii)** / 0.0162;	**2**
5(c)	0.48 (dm^3) **M1** moles carbon dioxide = 0.02; **M2** volume carbon dioxide = 0.02 $\times$ 24; **M3** = 0.48 (dm^3);	**3** 1 1 1

Question	Answer	Marks
6(a)(i)	$NH_3 + HCl \rightarrow NH_4Cl$;	**1**
6(a)(ii)	diffusion;	**1**
6(a)(iii)		**3**
	solid forms at: A;	1
	explanation: ammonia molecules / particles have a smaller mass; (and so) move / diffuse faster;	2
6(a)(iv)		**3**
	M1 solid forms in less time / faster / quicker;	1
	M2 particles / molecules have more energy;	1
	M3 (and so) move faster / diffuse faster;	1
6(b)(i)		**3**
	test: add sodium hydroxide (solution and warm);	1
	result: test gas / ammonia with (red) litmus / Universal Indicator / pH paper; indicator turns blue / ammonia produced;	2
6(b)(ii)		**3**
	test: add silver nitrate (solution);	1
	result: add (dilute) nitric acid; white precipitate;	2

Question	Answer	Marks
6(c)(i)	covalent;	**1**
6(c)(ii)	 **M1** one shared pair of electrons between each N and H; **M2** one shared pair of electrons between the N atoms; **M3** one lone pair on each N and no additional electrons anywhere;	**3** 1 1 1
6(d)(i)	amide;	**1**
6(d)(ii)	proteins are made from more than two monomers; **OR** nylon is made from 1 or 2 monomers (only);	**1**
6(d)(iii)	amino acids;	**1**
6(e)	 ;	**1**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2016**

MARK SCHEME

Maximum Mark: 80

Published

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This document consists of **9** printed pages.

Abbreviations used in the Mark Scheme

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- / separates alternatives within a marking point
- **OR** gives alternative marking point
- **R** reject
- **I** ignore mark as if this material was not present
- **A** accept (a less than ideal answer which should be marked correct)
- **COND** indicates mark is conditional on previous marking point
- owtte or words to that effect (accept other ways of expressing the same idea)
- max indicates the maximum number of marks that can be awarded
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Question	Answer	Marks
1(a)(i)	nitrogen / oxygen / fluorine / neon;	**1**
1(a)(ii)	carbon;	**1**
1(a)(iii)	oxygen;	**1**
1(a)(iv)	nitrogen;	**1**
1(a)(v)	neon;	**1**
1(a)(vi)	carbon;	**1**
1(a)(vii)	lithium / fluorine;	**1**
1(a)(viii)	lithium;	**1**
1(b)(i)	B_2O_3;	**1**
1(b)(ii)	Li_3N;	**1**

Question	Answer	Marks
2(a)(i)	<u>number of protons</u> in one atom of an element;	**1**
2(a)(ii)	**M1** <u>number of protons and neutrons</u> in one atom of an element; **M2** in one atom of an element;	**2** 1 1
2(b)	A | 6 | 6 | 6 | $^{12}_{6}C$ B | 12 | 12 | 12 | $^{24}_{12}Mg$; C | 8 | 10; | 8; | $^{16}_{8}O^{2-}$ D | 11 | 10 | 13 | $^{24}_{11}Na^{+}$ 11, 24; Na;+;	**6**

A	6	6	6	$^{12}_{6}C$
B	12	12	12	$^{24}_{12}Mg$;
C	8	10;	8;	$^{16}_{8}O^{2-}$
D	11	10	13	$^{24}_{11}Na^{+}$ 11, 24; Na;+;

Question	Answer	Marks
3(a)(i)	**M1** positive ions / cations (labelled or named in text); **M2** electrons (labelled or named in text); **M3** attraction between positive and negative;	**3** 1 1 1
3(a)(ii)	(conduction due to) movement of electrons / mobile electrons;	**1**
3(b)	$GaCl_3$; $Ga_2(SO_4)_3$;	**2** 1 1
3(c)(i)	$Ga_2O_3 + 6HNO_3 \rightarrow 2Ga(NO_3)_3 + 3H_2O$ formula of $Ga(NO_3)_3$; all formulae and balancing correct;	**2**
3(c)(ii)	$Ga_2O_3 + 2NaOH \rightarrow Na_2Ga_2O_4 + H_2O$; formula of $Na_2Ga_2O_4$; all formulae and balancing correct;	**2**

Question	Answer	Marks
3(d)	any 2 from: • (do not) corrode; • strong; • hard; • (improved) appearance;	**2**

Question	Answer	Marks
4(a)	 **M1** substance that speeds up a reaction / increases rate; **M2** unchanged (chemically) at the end / not used up / lowers activation energy / provides alternative pathway;	**2** 1 1
4(b)	 **M1** too slow / slower; **M2** lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured;	**2** 1 1
4(c)	faster / increase rate;	**1**
4(d)	lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured; **OR** higher cost / expensive; **OR** safety risks;	**1**
4(e)(i)	 **M1** breakdown of an ionic compound when molten or in aqueous solution; **M2** (using) electricity / electric current / electrical energy;	**2** 1 1
4(e)(ii)	carbon / graphite / platinum;	**1**

Question	Answer		Marks
4(e)(iii)	$2H^+ + 2e^{(-)} \rightarrow H_2$; **OR** $2H_3O^+ + 2e^{(-)} \rightarrow H_2 + 2H_2O$;		1
4(e)(iv)	cathode / negative electrode;		1
4(e)(v)	 **M1** damp blue litmus paper; **M2** bleaches / loses colour / turns white / turns colourless;	 1 1	2
4(f)	$2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$ all formulae correct; balancing;		2
4(g)	 **M1** *chlorine*: treating (drinking) water / treating water in swimming pools / kill bacteria in water / chlorination of water / (manufacture of) paper products / plastics / PVC / dyes / textiles / medicines / antiseptics / insecticides / herbicides / fungicides / solvents / paints / disinfectant / bleach / hydrochloric acid; **M2** *sodium hydroxide*: drain cleaner / oven cleaner / extraction of aluminium / purification of bauxite / (manufacture of) biodiesel / paper / soap / detergents / washing powder / textiles / dyes; **M3** *hydrogen*: fuel / rocket fuel / fuel cells / in welding / (manufacture of) ammonia / NH_3 / margarine / methanol / hydrochloric acid / refrigerants;	 1 1 1	3

Question	Answer	Marks
5(a)(i)	more than enough to react (with all the hydrocarbon); **OR** (some) oxygen remaining;	**1**
5(a)(ii)	75 cm^3;	**1**
5(a)(iii)	2 : 15 : 10;	**1**
5(a)(iv)	 2 : 15 : 10 : 10; C_5H_{10};	**2** 1 1
5(b)(i)	C_7H_{16};	**1**
5(b)(ii)	contains a double bond / triple bond / multiple bond; **OR** not all bonds are single bonds;	**1**
5(b)(iii)	 test: aqueous bromine / bromine (water) / Br_2; result: (orange / yellow / brown) to colourless / decolourised / colour disappears;	**2** 1 1
5(c)(i)	addition;	**1**
5(c)(ii)	1 (kg);	**1**
5(c)(iii)	 propene: CH_2; polypropene: CH_2;	**2** 1 1

Question	Answer	Marks
6(a)(i)	roast / heat **and** in air / oxygen;	**1**
6(a)(ii)	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$; SO_2 on right of equation; all formulae and balancing correct;	**2**
6(b)(i)	**M1** heat produced by carbon / coke (burning in) oxygen / air; **OR** $C + O_2 \rightarrow CO_2$ produces heat / exothermic; **OR** $2C + O_2 \rightarrow 2CO$ produces heat / exothermic (scores **M1** and **M2**); **M2** $C + CO_2 \rightarrow 2CO$; **OR** $2C + O_2 \rightarrow 2CO$; **M3** $ZnO + CO \rightarrow Zn + CO_2$; **OR** $ZnO + C \rightarrow Zn + CO$; **OR** $2ZnO + C \rightarrow 2Zn + CO_2$;	**3** 1 1 1
6(b)(ii)	temperature (inside the furnace) is above 907 °C / temperature (inside the furnace) is above the boiling point (of zinc) / 1000 °C is above the boiling point (of zinc);	**1**
6(b)(iii)	condensation / condensing / condense;	**1**
6(c)	**M1** zinc is more reactive than iron / zinc is higher in the reactivity series than iron ora; **M2** zinc loses electrons; **M3** iron / steel / oxygen / air / water gains electrons **OR** electrons move to iron / steel / oxygen / air / water; **M4** (therefore) iron does not lose electrons / get oxidised / form iron(II) / form iron(III);	**4** 1 1 1 1

Question	Answer	Marks
6(d)(i)	green precipitate; 1 red-brown / brown / orange precipitate; 1	**2**
6(d)(ii)	oxidising agent / oxidant;	**1**
6(d)(iii)	reducing agent / reductant;	**1**
6(d)(iv)	iron(III) / Fe^{3+};	**1**
6(d)(v)	iron(II) / Fe^{2+};	**1**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2016**

MARK SCHEME

Maximum Mark: 80

Published

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Question	Answer	Marks
1(a)		**3**
1(b)(i)	**M1** <u>atom(s)</u> of the same element; **M2** with different number of neutrons;	**2** 1 1
1(b)(ii)	**M1** (both have) the same number of electrons; **M2** in the outer shell;	**2** 1 1
1(c)		**5**

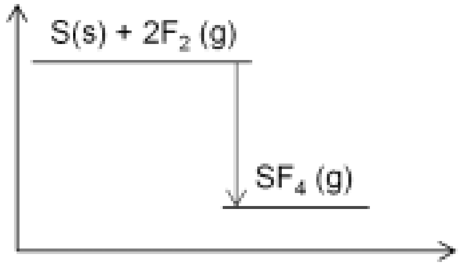
1(a):

particle	relative mass	relative charge
proton	1	+1
neutron	1	nil
electron	1 / 1840	–1

1(c):

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$	3	4	3
$^{34}_{16}S^{2-}$	16	18	18
$^{41}_{19}K^{+}$	19	22	18

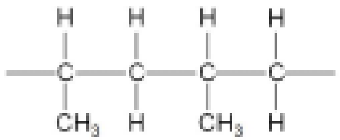
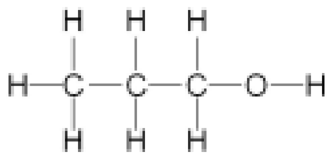
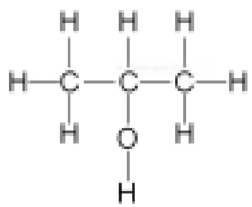
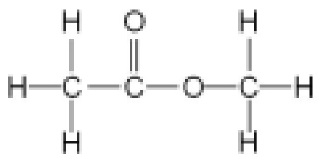
Question	Answer	Marks
2(a)	number of moles of $NaNO_3$ used: 3.40 / 85 = 0.04(00) (mol) **OR** $4.(00) \times 10^{-2}$ (mol); number of moles of O_2 formed: 0.04 / 2 = 0.02(00) (mol) **OR** $2.(00) \times 10^{-2}$ (mol); volume of O_2 formed: 0.02×24 = 0.48 (dm^3);	**3**
2(b)(i)	(a substance which is) a proton / H^+ / hydrogen ion acceptor;	**1**
2(b)(ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	**2**
2(c)	**M1** add a *named* acid, e.g. HCl **and** a named alkali, e.g. NaOH; **M2** Al_2O_3 will react with / neutralises both reagents; **M3** and so it will dissolve into the reagent / form a solution;	**3** 1 1 1
2(d)(i)	covalent;	**1**
2(d)(ii)	any 2 from: high melting point / high boiling point; poor conductor (of electricity); hard; insoluble;	**2**
2(e)(i)	**M1** (electrostatic) <u>attraction</u>; **M2** between <u>oppositely charged ions</u>;	**2** 1 1
2(e)(ii)	$Ca_3(PO_4)_2$;	**1**

Question	Answer	Marks
2(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat of reaction arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head;	**3** 1 1 1
2(f)(ii)	**M1** *bond energy of* $2F_2$: 2 × F–F = 2 × 160 = 320 (kJ/mol); **M2** *bond energy of all bonds in* SF_4: 780 + 320 = 1100 (kJ/mol); **M3** *calculated bond energy of* SF_4 *divided by 4*: 1100/4 = 275 (kJ/mol);	**3** 1 1 1
2(g)(i)	kills bacteria;	**1**
2(g)(ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;	**3** 1 1 1
2(h)(i)	it has a complete outer shell/a full outer shell/8 electrons in the outer shell;	**1**
2(h)(ii)	(in) lamps;	**1**

Question	Answer	Marks
3(a)	1 $Na_2S_2O_3$ 2 H_2O 3 HCl **OR** 1 HCl 2 H_2O 3 $Na_2S_2O_3$ **OR** 1 H_2O 2 $Na_2S_2O_3$ 3 HCl **OR** 1 H_2O 2 HCl 3 $Na_2S_2O_3$;	**1**
3(b)(i)	 **M1** volumes 40 : 10 : 10; **M2** time = 14;	**2** 1 1
3(b)(ii)	 **M1** more particles per unit volume / particles are closer together; **M2** increases the rate of collisions / there are more collisions per unit time;	**2** 1 1
3(c)	 **M1** particles gain more energy **and** move fast**er**; **M2** increasing rate of collisions / more collisions per unit time; **M3** higher proportion of particles have sufficient energy to react / collisions have sufficient energy to react / are above the activation energy;	**3** 1 1 1

Question	Answer	Marks
4(a)(i)	reduction **and** (the Cu^{2+} ion / copper ions) is gaining electrons / is decreasing in oxidation number;	**1**
4(a)(ii)		**2**
	formation of Cu^{2+} / copper ions at the anode happens at the same rate as;	1
	removal of Cu^{2+} / copper ions at the cathode ora;	1
4(b)		**2**
	replace (anode of) copper with nickel;	1
	replace electrolyte with nickel(II) sulfate / $NiSO_4$;	1
4(c)		**3**
	(good) catalysts;	1
	variable oxidation numbers;	1
	form coloured compounds / coloured ions;	1

Question	Answer	Marks
5(a)	(sulfur-containing) fossil fuels;	**1**
5(b)	**M1** vanadium pentoxide / vanadium(V) oxide / V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450 °C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium / reversible reaction;	**5** 1 1 1 1 1
5(c)	$H_2S_2O_7$;	**1**
5(d)(i)	3 correct (2 marks) 2 correct (1 mark) bubbles / effervescence / fizzing; dissolves / disappears / *forms* a solution; blue (solution);	**2**
5(d)(ii)	carbon dioxide and water and copper(II) sulfate;	**1**
5(e)(i)	carbon;	**1**
5(e)(ii)	dehydration;	**1**

Question	Answer	Marks
6(a)	fractional distillation; cracking;	**2** 1 1
6(b)(i)	addition;	**1**
6(b)(ii)	CH_2;	**1**
6(b)(iii)	 **M1** chain of 4 carbon atoms with single bonds and continuation bonds; **M2** correctly positioned CH_3 side chains;	**2**
6(c)	 ;  ;	**2**
6(d)(i)	(concentrated) sulfuric acid;	**1**
6(d)(ii)	methyl ethanoate;	**1**
6(d)(iii)	 **M1** ester link; **M2** rest of molecule;	**2**
6(d)(iv)	terylene;	**1**

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2016**

MARK SCHEME

Maximum Mark: 40

Published

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Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**C**	22	**A**
3	**B**	23	**A**
4	**B**	24	**D**
5	**C**	25	**C**
6	**C**	26	**A**
7	**C**	27	**C**
8	**B**	28	**D**
9	**A**	29	**D**
10	**A**	30	**A**
11	**D**	31	**B**
12	**B**	32	**C**
13	**A**	33	**B**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**C**
18	**D**	38	**D**
19	**D**	39	**B**
20	**D**	40	**C**

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2016**

MARK SCHEME

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This syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**D**	23	**D**
4	**B**	24	**B**
5	**C**	25	**A**
6	**C**	26	**B**
7	**D**	27	**A**
8	**B**	28	**B**
9	**D**	29	**D**
10	**A**	30	**A**
11	**D**	31	**C**
12	**D**	32	**D**
13	**B**	33	**A**
14	**D**	34	**D**
15	**C**	35	**D**
16	**B**	36	**C**
17	**C**	37	**D**
18	**D**	38	**D**
19	**D**	39	**A**
20	**A**	40	**B**

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2016**

MARK SCHEME

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Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**A**
2	**C**	22	**C**
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4	**B**	24	**C**
5	**C**	25	**B**
6	**C**	26	**C**
7	**A**	27	**D**
8	**D**	28	**D**
9	**C**	29	**D**
10	**A**	30	**A**
11	**D**	31	**A**
12	**C**	32	**B**
13	**C**	33	**D**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**A**
18	**D**	38	**D**
19	**D**	39	**B**
20	**A**	40	**C**

CHEMISTRY

Paper 0620/11
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**C**	22	**C**
3	**C**	23	**C**
4	**B**	24	**C**
5	**C**	25	**C**
6	**B**	26	**D**
7	**A**	27	**C**
8	**C**	28	**D**
9	**B**	29	**D**
10	**C**	30	**A**
11	**A**	31	**B**
12	**D**	32	**B**
13	**D**	33	**D**
14	**C**	34	**C**
15	**A**	35	**D**
16	**D**	36	**B**
17	**D**	37	**D**
18	**C**	38	**C**
19	**B**	39	**B**
20	**D**	40	**A**

General comments

Question **9** proved to be the most straightforward for candidates.

Candidates found Questions **5**, **8**, **10**, **11**, **17**, **22**, **25**, **26**, **28** and **30** to be the most challenging.

Comments on specific questions

Question 3

Response **A**. Candidates linked to 50 cm^3 with a burette, but did not take due account of the word "quickly".

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 7

Response **D**. Candidtaes knew that bonds sometimes involve sharing electrons, but this question involved ionic bonding.

Question 8

Response **B**. This was more popular than the correct answer.

Question 11

Response **C**. Candidates were unfamiliar with energy level diagrams and did not fully understand the term "exothermic".

Question 13

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 14

Response **B**. Candidates may have answered with respect to curve "S" itself.

Question 19

Response **A**. Candidates chosing response **A** may have done so based on the reason for step 3 without thinking sufficiently about step 4.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 22

Response **A**. Candidates perhaps did not appreciate that "explosively" is more reactive than "vigorously".

Question 25

Candidates did not appear to know that copper does not react with acids.

Question 32

Response **C**. Candidates did not know the effects of oxides of nitrogen.

CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**C**	23	**D**
4	**A**	24	**B**
5	**C**	25	**B**
6	**B**	26	**C**
7	**A**	27	**A**
8	**C**	28	**A**
9	**B**	29	**D**
10	**B**	30	**A**
11	**C**	31	**B**
12	**D**	32	**B**
13	**D**	33	**C**
14	**B**	34	**D**
15	**B**	35	**D**
16	**B**	36	**C**
17	**D**	37	**D**
18	**D**	38	**C**
19	**D**	39	**B**
20	**C**	40	**D**

General comments

Question **6** proved to be the most straightforward for candidates.

Candidates found questions **6**, **20** and **26** to be the most challenging.

<u>Comments on specific questions</u>

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 8

Response **B**. This response was more popular than the correct answer.

Question 10

Response **D**. This was a common incorrect response.

Question 13

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 26

Response **A**. This response was more popular than the correct answer.

Question 27

Response **B**. Candidates may have recognised that calcium oxide is a basic oxide, but the question refers to it removing "acidic oxides".

Question 28

Response **C**. Copper is a good conductor of electricity but this has no bearing on its use in cooking utensils.

Question 32

Response **A**. Candidates did not know the effects of oxides of nitrogen.

CHEMISTRY

Paper 0620/13
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**C**	22	**A**
3	**C**	23	**A**
4	**D**	24	**D**
5	**C**	25	**C**
6	**A**	26	**C**
7	**A**	27	**B**
8	**C**	28	**C**
9	**B**	29	**D**
10	**C**	30	**A**
11	**B**	31	**C**
12	**D**	32	**B**
13	**D**	33	**C**
14	**C**	34	**D**
15	**A**	35	**D**
16	**D**	36	**B**
17	**D**	37	**B**
18	**B**	38	**D**
19	**C**	39	**B**
20	**D**	40	**B**

General comments

Questions **14, 28** and **36** proved to be particularly straightforward for candidates.

Candidates found questions **5**, **7**, **17** and **38** to be the most challenging.

Comments on specific questions

Question 3

Response **A**. Candidates linked to 50 cm^3 with a burette, but did not take due account of the word "quickly".

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 6

Response **D**. This response was a common incorrect response.

Question 7

Respnses **B** and **C**. Both of these responses were more popular than the correct answer.

Question 8

Response **B**. This response was more popular than the correct answer.

Question 11

Response **C**. Candidates were unfamiliar with energy level diagrams and did not fully understand the term "exothermic".

Question 13

Response **B**. This response was a popular incorrect response.

Question 16

Response **A**. Candidates may have assumed that the reactions were not reversible.

Question 17

Response **B**. Candidates knew the litmus test but not the reaction between alkalis and ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 25

Response **D**. Candidates placed too much emphasis on the high melting point and did not consider the other information given.

Question 30

Response **D**. Candidates did not know the percentages of gases in the air.

Question 31

Response **B**. Candidates chosing this response knew that carbon monoxide was produced but did not take the rest of the question into account.

Question 35

Response **A**. Candidates recognised the three unnamed fractions but did not read further to find the alternative that put them in the correct order.

Question 38

Response **B**. Candidates knew that fermentation was correct but may not have read the rest of the responses carefully.

CHEMISTRY

Paper 0620/21
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**A**
2	**C**	22	**C**
3	**D**	23	**C**
4	**B**	24	**C**
5	**C**	25	**B**
6	**C**	26	**C**
7	**A**	27	**D**
8	**D**	28	**D**
9	**C**	29	**D**
10	**A**	30	**A**
11	**D**	31	**A**
12	**C**	32	**B**
13	**C**	33	**D**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**A**
18	**D**	38	**D**
19	**D**	39	**B**
20	**A**	40	**C**

General comments

Candidates performed well on this paper.

Candidates found Questions **1**, **11**, **19**, **24**, **25**, **36** and **39** to be particularly straightforward.

Comments on specific questions

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 12

Some candidates were unfamiliar with the content of this question.

Question 13

Responses **B** and **D**. Some candidates appeared to guess the answer rather than working it out.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 15

Candidates did not appear to know that heat has two different effects on a reaction rate.

Question 16

Responses **A** and **C**. Some candidates appeared to guess, rather than working out the answer.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 22

Response **A**. Candidates perhaps did not appreciate that “explosively” is more reactive than “vigorously”.

Question 27

Response **C**. Candidates did not seem to pay attention to the reasons but only to the uses.

Question 31

Response **D**. Some candidates may have selected response **D** because it was a reaction which they were less familiar with.

Question 33

Response **B**. Candidates may have misread the question and thought it related to yield as well as rate.

Question 38

Response **A**. Candidates may have thought “purer” referred to it being a natural product, rather than to the percentage of alcohol present.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**D**	23	**D**
4	**B**	24	**B**
5	**C**	25	**A**
6	**C**	26	**B**
7	**D**	27	**A**
8	**B**	28	**B**
9	**D**	29	**D**
10	**A**	30	**A**
11	**D**	31	**C**
12	**D**	32	**D**
13	**B**	33	**A**
14	**D**	34	**D**
15	**C**	35	**D**
16	**B**	36	**C**
17	**C**	37	**D**
18	**D**	38	**D**
19	**D**	39	**A**
20	**A**	40	**B**

General comments

Candidates performed well on this paper.

Candidates found Questions **7**, **11**, **19**, **24**, **26** and **36** to be particularly straightforward.

Comments on specific questions

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 9

Response **A**. Some candidates did not read the questions carefully and assumed the unit was dm^3.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 15

Response **A**. Many candidates did not read the question carefully and assumed that it was about the rate of reaction and not the energy of collision.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 23

Responses **A** and **B**. Some candidates assumed Q was a transition element because of its coloured compounds but did not take account of its melting point.

Question 25

Response **C**. Candidates wrongly assumed that magnesium nitrate decomposed in the same way as alkali metal nitrates.

Question 37

Response **B**. A common mistake was identifying propyl ethanoate.

Question 39

Response **C**. Some candidates did not realise that the "CH_3" group should be a branch from the chain.

CHEMISTRY

Paper 0620/23
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**C**	22	**A**
3	**B**	23	**A**
4	**B**	24	**D**
5	**C**	25	**C**
6	**C**	26	**A**
7	**C**	27	**C**
8	**B**	28	**D**
9	**A**	29	**D**
10	**A**	30	**A**
11	**D**	31	**B**
12	**B**	32	**C**
13	**A**	33	**B**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**C**
18	**D**	38	**D**
19	**D**	39	**B**
20	**D**	40	**C**

General comments

Candidates performed well on this paper.

Candidates found Questions **1, 2, 10, 11, 15, 24, 27** and **36** to be particularly straightforward.

Questions **9, 13** and **18** proved to be particularly challenging for candidates.

Comments on specific questions

Question 3

Response **D**.

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 7

Response **B**. Candidates knew about the conductivity of graphite but not about lack of metallic bonding.

Question 12

Response **C**. Some candidates assumed that because copper is unreactive, it could not produce the highest voltage.

Question 13

Response **B**. Candidates divided the energy of the triple bond by three instead of carrying out the intended calculation.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 16

Some candidates mistakenly thought that the question was asking about rate rather than yield of product.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 25

Response **D**. Candidates ignore the “burns in oxygen” statement.

Question 32

Some candidates assumed that the absence of the 'reversible arrow' symbol meant that the reaction was not reversible.

Question 38

Response **A**. Candidates may have thought “purer” referred to it being a natural product, rather than to the percentage of alcohol present.

CHEMISTRY

Paper 0620/31
Theory (Core)

Key messages

- Many candidates need more practice in questions involving qualitative analysis.
- It is important that candidates read the questions carefully in order to understand what exactly is being asked.
- Interpretation of data from tables was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of chemistry. Some candidates need more practice in reading and interpreting questions, for example the instructions were misinterpreted by many candidates in **Question 5(a)**.

Many candidates need more practice in answering extended questions such as **Questions 2(c)** and **Question 5(a)**. Other candidates need practice in answering questions relating to practical procedures involving rates of reaction and in drawing and labelling chemical apparatus. Knowledge of chemical tests involving colour changes, e.g. the aqueous bromine test for unsaturation and the test for water, was often poor.

Many candidates were able to undertake simple calculations, extract information from tables and graphs and balance symbol equations; others need to revise these areas more thoroughly.

Comments on specific questions

Question 1

(a) (i) The commonest error was to suggest that potassium chloride has diatomic molecules.

(ii) Many candidates correctly identified potassium chloride as having an ionic structure. The commonest errors were to suggest structure **A** or structure **E**.

(iii) Some candidates gave a suitable definition of an element. Other candidates used vague terms or confused atoms with molecules. A considerable minority of candidates disadvantaged themselves by referring to mixtures of atoms. A few candidates thought that potassium chloride is an element.

(iv) Common errors included $C_3H_3F_2Cl_2$ or writing a part structural formula e.g. $CH_2CHF_3Cl_2$.

(b) (i) Some candidates correctly referred to the numbers of neutrons. A large proportion of candidates suggested that there were different numbers of protons or electrons or referred to atomic masses.

(ii) Many candidates calculated the number of neutrons correctly. The commonest errors involved adding or multiplying the atomic numbers and atomic masses.

(iii) Most candidates realised that there are seven electrons in the outer shell of a chlorine atom. Many candidates drew the structure of a chlorine molecule instead of a chlorine atom. Some candidates made errors in the number of inner shell electrons; the commonest was to miss out the 8 electrons in the second shell.

Question 2

(a) Many candidates chose stainless steel for the bicycle frame and many gave three suitable reasons for its use. The commonest errors were related to imprecise terminology or quoting values from the table without adding comments such as “high strength” or “cheap”.

(b) (i) A minority of candidates gave the correct answer. The commonest incorrect answers were hematite, aluminium oxide (which is not an ore) or aluminium ore.

(ii) Few candidates gave a suitable explanation. Common errors included “aluminium reacts with carbon”, “aluminium conducts electricity” or an unqualified statement about the reactivity of aluminium.

(iii) Many candidates gave the correct electrode products. Some candidates gave the two correct products at the wrong electrodes. Other candidates gave only one product, usually at the cathode, or gave incorrect products such as hydrogen or nitrogen or chlorine, which are not present in aluminium oxide.

(c) Many candidates tackled this free response question well. The main errors were: lack of clarity about what states were being referred to when writing about changes of state; comments about atoms being some distance apart in the liquid state; or comments about atoms moving from place to place in the solid state. Better-performing candidates clearly stated the motion and distance apart of the particles in the gases, liquids and solids.

Question 3

(a) (i) Many candidates linked the trend in boiling points with the direction up or down the group. Other candidates just gave the unqualified answer “goes down”, which was not sufficiently detailed. A considerable number of candidates linked the boiling point to the density or melting point and not to the position in the group.

(ii) The majority of the candidates predicted the density of caesium correctly.

(iii) Many candidates realised that caesium is a solid at 20 °C but few gave a suitable reason. Many candidates just referred to the value of the melting point without reference to 20 °C being below the melting point while others gave reasons which referred to the boiling point instead of the melting point. A considerable number of candidates thought that caesium is a liquid at 20 °C.

(b) A minority of candidates gave the correct products of the reaction. The commonest error was to suggest that rubidium oxide was formed. Water or carbon dioxide were often seen as an incorrect products instead of hydrogen. A considerable minority of candidates gave the names of compounds which did not include rubidium, hydrogen or oxygen.

(c) Many candidates calculated the relative molecular mass of indigotin correctly. Other candidates filled in just one of the lines correctly. Some candidates made errors in the addition.

(d) (i) Many candidates correctly suggested why the base line in chromatography is drawn in pencil. The commonest error was to suggest that the ink reacts.

(ii) A majority of the candidates identified mixture **K** as not moving. The commonest error was to suggest mixture **J**.

(iii) A majority of the candidates identified mixture **J** as containing both dyes **X** and **Y**. The commonest error was to suggest mixture **K**.

(iv) Nearly all candidates recognised that mixture **J** did not contain dye **Z**. The commonest error was to suggest mixture **K**.

Question 4

(a) (i) Many candidates identified the alcohols; others gave reasons about the alcohol structure which were far too vague, e.g. "they contain hydrogen and oxygen".

(ii) Some candidates gave the correct answer **Q** and **T**; others either wrote only one of these letters or repeated **S** and **U** from **part (i)**.

(b) The commonest errors were to put the word "elements" in the first blank space and / or to put the word "compounds" in the last blank space.

(c) (i) Few candidates drew the structure of ethene correctly. Common errors were: to draw the structure of ethane; to draw carbon atoms with five bonds; or to include –OH groups. A number of candidates drew the correct structure of pentene instead of ethene.

(ii) Few candidates knew the aqueous bromine test. Common errors were: ethene turns colourless; no reaction; stating why the change occurred rather than giving a description of the colour change; or suggesting that the colour change was to "clear" or "to a different colour". A significant number of candidates did not respond to this question.

(iii) Many candidates realised that heat is needed for cracking. Fewer mentioned the need for a catalyst.

(iv) Many candidates were able to balance the equation correctly. The commonest errors involved simple errors of subtraction, e.g. $C_{13}H_{26}$ or $C_{12}H_{28}$. Other candidates incorrectly added $C_{16}H_{34}$ to C_3H_6.

Question 5

(a) The stem of the question was ignored by many candidates who did not appear to take notice of the essential words "trends" and "physical properties". Common errors included: lack of identification of trends; stating properties of individual halogens; and misunderstanding displacement reactions. Few candidates were able to write a relevant word equation for the displacement of a less reactive halogen from a halide salt by a more reactive one. Very often, incorrect products such as chlorine iodide were seen. Many candidates wrote products identical to the reactants.

(b) (i) Some candidates identified nitrogen dioxide as the problem; others just stated that a gas was given off. The effect of nitrogen dioxide on health was not well known. Many candidates just wrote "harmful" or "poisonous", rather than suggesting an effect on respiration, the throat or the eyes.

(ii) This part was well answered by the majority of candidates**.** The commonest error was to suggest pH 13.

(iii) Some candidates gave zinc nitrate and water as the correct answer. Other candidates suggested zinc or zinc oxide in place of zinc nitrate, or hydrogen or oxygen instead of water. A minority of candidates suggested substances containing elements that were not present in the reactants, e.g. lead.

Question 6

(a) Most candidates were able to describe the role of a catalyst.

(b) A majority of candidates were able to write the sign for a reversible reaction. Common errors were to write just a backward arrow or a forward arrow.

(c) The reaction was incorrectly labelled to be endothermic by the majority of the candidates, even though they went on to state that the energy level of the products was less than that of the reactants.

(d) (i) Many candidates correctly described the change in the percentage yield. The commonest errors were either to state that increasing temperature increases rate, or to omit reference to temperature altogether.

(ii) Most candidates gave the correct percentage. The commonest error was misreading from the graph to give 41%.

(e) The test for ammonia was not well known. A minority of candidates mentioned red litmus paper. Many candidates suggested other test reagents including copper(II) sulfate, aqueous bromine or silver nitrate. Some candidates suggested smelling the gas, which is not a good idea for safety reasons.

(f) Some candidates described the dipping the indicator paper or referenced a correct colour change. Few candidates mentioned comparison with a colour chart or pH chart.

(g) The equation was well balanced by some candidates. The stoichiometry of the ammonia was often correct but the stoichiometry of HCl was often incorrect. Common errors were $2HCl$ or $3HCl$.

Question 7

(a) Common errors in drawing the diagram included unidentifiable apparatus; a tube immersed in the reactants; and inappropriate apparatus. Many candidates did not label their apparatus. It was often difficult to distinguish a gas syringe from a measuring cylinder. When drawing pieces of glassware for measuring, the graduation marks should also be drawn. A significant number of candidates did not respond to this part.

(b) (i) This question was fairly well answered. Common errors were medium or large pieces or that less carbon dioxide was produced by small pieces. A considerable number of candidates wrote about particle theory, rather than referring to the graph.

(ii) Some candidates drew neat lines which met the line already present some time before 200 seconds. Other candidates finished their line too far above the 45 cm^3 level or made their line plateau after or at 200 seconds.

(iii) Many candidates did not look closely enough at the curve to see where it first hit the 45 cm^3 line. Consequently, many suggested the incorrect answer of 200 seconds.

(c) (i) Few candidates gave a correct use for calcium oxide. The commonest incorrect answers involved foods or drinks, making limestone or the vague “for construction”. Making iron was not accepted because it is calcium carbonate rather than calcium oxide that is put into the blast furnace. Steelmaking was, however, acceptable. A significant number of candidates did not respond to this question.

(ii) Some candidates realised that calcium oxide is a basic oxide. Others either wrote that it is “a metal oxide” (which is only sufficient for the second marking point) or did not respond to the second part of the question. Many candidates suggested that calcium oxide is an acidic oxide. A significant number of candidates did not respond to this question.

Question 8

(a) Many candidates wrote vague answers about reduction and often did not relate their answers to the equation given. A common error was to suggest that copper is reduced instead of copper(II) oxide. Very often, the copper being referred to was that on the right-hand side of the equation. Reduction of hydrogen was also commonly seen.

(b) (i) Many candidates gave the correct answer. The commonest error was to suggest either that the mass increases or to give an answer that did not refer to mass at all.

(ii) Very few candidates referred to the flammability of the hydrogen. Most candidates referred to the Bunsen burner or the gas coming from this.

(iii) The test for water was not well known. The commonest errors were blue copper(II) sulfate goes pink; blue copper(II) sulfate goes white; using the wrong test reagent; or not mentioning that the copper(II) sulfate or cobalt(II) chloride used in the test was anhydrous. A significant number of candidates did not respond to this part.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Questions requiring simple answers about atomic theory and organic structures were usually answered well, as were questions involving balancing equations and reaction rates.
- Questions requiring more detailed answers about kinetic particle theory needed to contain more focused explanations and attention to detail.
- Some candidates need more practice in answering questions requiring extended answers. Questions involving extended writing need to contain the same number of relevant points as the number of marks available. This principle also applies to any question that has more than one mark available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked. Practice of reading off graphical scales is also a skill which candidates need to be confident with.
- Questions relating to practical techniques such as chromatography need to be concentrated on and practised. In comparison questions, candidates need to mention both sources in the comparison.

General comments

Many candidates tackled this paper well, showing a good knowledge of chemistry. It was evident that some candidates are now using past paper practice as part of their revision programme; although more revision is needed on some aspects of the syllabus. Candidates had clearly practised balancing and completing equations as part of their revision. Some candidates wrote their answers as short phrases or bullet points; candidates were less likely to write vague statements or to contradict themselves if this was done.

Candidates tended to perform less well on the one-mark recall questions. The answers to questions on uses of different substances in **Questions 3(e)** and **7(c)** and knowledge of chemical tests in **Questions 2(c) and 3(d)** indicated a lack of revision by some candidates. Candidates found **Questions 6(b)**, **7(d)** and **8(d)** to be the most challenging on the paper. Many did not read the questions properly and the vast majority of candidates did not know how to do a flame test.

<u>Comments on specific questions</u>

Question 1

(a) (i) This question was attempted reasonably well; some candidates were not looking out for the charges and combination of metal and non-metal elements.

(ii) Some candidates could recognise the element but explanations were generally very poor. Many candidates used the word “element” in their explanation, for example, “contains one type of element”, instead of “contains one type of atom”.

(iii) Candidates did not take note of the word “simplest” in the question. Ionic charges were sometimes incorrectly included in candidates’ responses.

(b) (i) Some candidates incorrectly answered 15.

(ii) This question was mostly well answered; some candidates need more practice with electronic configurations.

(iii) Candidates struggled with this part and many different answers were seen.

(c) Many candidates did realise that it was an acidic oxide; some did not realise this when talking about type of oxide and merely stated “covalent”. Better-performing candidates made it clear which element they were referring to in their answer. For example, “phosphorus is a non-metal” was correct, whereas “it is a non-metal” was not specific enough.

Question 2

(a) Many candidates did not read the question carefully, and did not put the *metals* into the order of reactivity but ordered the metal oxides instead. Some candidates inverted the order. Candidates should be encouraged to read the question carefully before answering.

(b) This electrolysis question was done reasonably well and it was obvious that many candidates had been practising this style of question. Some candidates wrote the ions and not the final products and some candidates got the products the wrong way round.

(c) The chemical tests were not well known. The most common error was not writing down the word “precipitate” and just writing “green”.

(d) (i) This part was answered very well by most candidates.

(ii) Most candidates could describe one method of rust prevention but were not able to explain how it works.

Question 3

(a) Most candidates answered this question correctly.

(b) Candidates found this question to be quite challenging and “endothermic” was seen frequently as an answer, showing a misunderstanding of the energy level diagram. Candidates that managed to get the correct “exothermic” response usually then managed to give the correct reason as well.

(c) (i) This part was answered reasonably well and the correct answer was seen in many cases. Some candidates just wrote “decreases” which was insufficient.

(ii) The majority of candidates answered this question well.

(d) This question was very poorly answered and was omitted by many candidates.

(e) Candidates were not confident with this question. “Fertiliser” was a common wrong answer.

(f) Candidates who correctly named sulfur dioxide invariably got the correct explanation for this question. Many candidates answered that the sulfur was reduced instead of the sulfur dioxide.

(g) This part was very well done.

Question 4

(a) The definition for homologous series was poorly answered. Many candidates were confused with the definition of isomers.

(b) (i) Candidates struggled with the concept of saturated hydrocarbons. Some candidates answered "has single bonds" instead of "*only* has single bonds".

(ii) This question was well answered.

(iii) This question was very well answered.

(iv) This was question very well answered.

(c) (i) A very high percentage of candidates answered this question correctly.

(ii) Candidates found this question very challenging with many not answering it at all. Many candidates did not realise that the data needed to be used to answer the question. Candidates need to practice using data provided in the question in their answers for this type of question.

(iii) This was a well-answered question.

(d) (i) This question was well answered by candidates.

(ii) Some candidates were confused and answered in terms of other hazardous chemicals and not carbon monoxide.

Question 5

(a) Candidates struggled with this question. Some candidates could identify that the state was "liquid" but many could not explain why. Some candidates referred to bout room temperature instead of +6 °C.

(b) (i) Candidates answered this question well.

(ii) More practice is needed on the difference between the halogens and their halides.

(c) This question was done well by most candidates. The main error was using atomic numbers instead of mass numbers.

(d) (i) Generally, this question was answered well. The main error in this question was putting the cross in the solvent or on the edge of the paper.

(ii) This part was answered well; some candidates misread the question and answered "dye".

(iii) Candidates struggled with this part.

Question 6

(a) Some candidates could say that sodium had metallic properties like solid, shiny and heat conductor. Many candidates then struggled to add chemical properties to this. Candidates mainly described the reaction with water and this was generally answered well.

Word equations were sometimes missing. Often chemical equations were used and these were not always written correctly. Some candidates thought that sodium oxide is a product when sodium reacts with water.

(b) Many candidates could not describe how a flame test is carried out and most thought that the flame test should be done on sodium itself and not on a sodium compound. The colour of the flame was generally correctly identified.

(c) (i) Candidates did very well on this question.

(ii) This question was well answered. Candidates had a good knowledge of the colour changes involved.

(d) Candidates could identify why this reaction is carried out in a fume cupboard. Many candidates did not know what adverse effect on health could be caused.

Question 7

(a) Candidates did very well labelling the apparatus shown.

(b) (i) Most candidates could identify the correct concentration but did not correctly explain themselves. Some candidates did very well here and referred to the volumes of gases given off in the first 60 seconds to compare both concentrations.

(ii) This part was answered very well and most candidates were able to draw the curve on the graph well. Most candidates realised that the same volume of gas would be produced at the end of the experiment, which showed even more understanding.

(c) This question was answered poorly. The most popular answer was "as a fuel". The most popular wrong answer was "to make water".

(d) Many candidates did not answer this question.

Question 8

(a) Some candidates did not mention that an alloy is a mixture.

(b) Some candidates just wrote down the name of a metal, for example aluminium.

(c) Candidates struggled with this longer question about the kinetic particle model. Candidates were not detailed enough in their answers. They preferred to talk about the particles "moving fast" and "moving far apart", rather than the "particles sliding over each other" or that the "particles are close together" in a liquid. Candidates also spent too much time describing the function of the iron plate.

(d) Only a few candidates answered this question correctly. Many candidates did not answer this question at all, and those that did talked mainly about the particles in a gas and not in terms of a general property.

CHEMISTRY

Paper 0620/33
Theory (Core)

Key messages

- Many candidates need more practice in answering free response questions.
- Some candidates need further practice in drawing diagrams of apparatus.
- Interpretation of data from tables and graphs was generally well done.

General comments

Some candidates tackled this paper well, showing a good knowledge of chemistry. Some candidates need more practice in reading and interpreting questions, for example the instructions were misinterpreted by a minority of candidates in a few questions, such as **Question 5(b)**. The command word "deduce" did not appear to be known by many candidates (see Section 8.3 of the syllabus).

Many candidates need more practice in answering extended questions, such as **Question 4(b)** and **Question 5(a).** More practice is needed in reading the key points in the question, as well as in selecting relevant information and organising ideas in a logical fashion. Other candidates need practice in answering questions relating to practical procedures, such as chromatography and electrolysis, especially where the drawing of apparatus is required.

Many candidates were able to extract information from tables and graphs and balance symbol equations. Other candidates need more practice in writing word equations for the reactions of halogen with halides. Many candidates were able to undertake simple calculations of relative formula mass; others need to revise this area.

Comments on specific questions

Question 1

(a) (i) Most candidates identified diamond and graphite. The commonest error was to suggest the ionic giant structure, **A**.

(ii) Some candidates correctly identified structure **B** (ethene). The commonest error was to suggest structure **D**, through thinking about a displacement reaction rather than an addition reaction.

(iii) A minority of the candidates suggested that ethene is a gas at room temperature. A wide variety of incorrect answers were seen, including the structures **A**, **C** and **E**.

(iv) Many candidates identified structure **B** as a hydrocarbon. The commonest error was to suggest structure **D**. A considerable number of candidates suggested diamond or graphite.

(v) Many candidates wrote the formula for **D** correctly. The commonest errors were to miscount the chlorine or hydrogen atoms, leading to incorrect formulae such as C_5H_5Cl or $C_5H_{10}Cl_5$.

(b) (i) Some candidates gave good answers detailing the differences in the structure of the isotopes in terms of different numbers of neutrons or different mass numbers. Others confused neutrons with protons, or suggested that the atomic number was different. Some candidates stated that the relative atomic mass was different. Whilst this is true, it does not reflect the difference in atomic structure in terms of subatomic particles.

(ii) Many candidates deduced the correct number of neutrons. The commonest errors were to give the atomic number or to add together the atomic number and mass number.

Question 2

(a) Most candidates were able to extract relevant information from the table. The commonest errors were to mention density or electrical conductivity.

(b) Some candidates recognised that a solid can be separated from a liquid by filtration. A wide variety of incorrect answers were seen, the commonest being distillation, evaporation, or a membrane method such as osmosis.

(c) (i) Few candidates gave a suitable definition of electrolysis. The commonest error was to suggest the separation of substances by electricity. Many candidates gave very vague statements about electricity or purifying substances. The idea of decomposition or breaking down was rarely encountered. Many candidates did not consider that ions were involved and wrote about molecules.

(ii) Some candidates drew good diagrams showing the external circuit connected to the electrodes. Other candidates did not show the electrodes dipping into a liquid and / or did not label their diagrams. Other common errors were to place + and – signs too far from the electrodes; to show only the electrodes; to omit the power source; and to draw unworkable circuits, including short circuits.

(d) Many candidates did not understand the term recycling. Most candidates referred to reuse rather than recycling. Very few candidates referred to saving resources or reducing the need for mining. The commonest error was to write about reducing cost without qualification.

Question 3

(a) (i) Some candidates suggested a correct colour for astatine. Other candidates gave incorrect colours such as orange, brown or blue.

(ii) Some candidates described the trend in boiling points. Other candidates either did not relate the increase in boiling point to the position of the halogen in the group or tried to link it to the colour or the melting point.

(iii) A minority of the candidates realised that chlorine is a liquid at –50 °C. Most suggested that it is a gas. Many of the candidates who identified the correct state did not go on to reference both melting and boiling point in their explanations. Statements such as "–50 °C is above the melting point" were not sufficient, neither was just quoting melting and boiling points.

(b) (i) Some candidates identified the correct products. Other candidates just repeated the reactants on the right-hand side or gave interhalogen compounds, such as bromine astatide, or the answer potassium.

(ii) Very few candidates realised that the comparison was between the more reactive halogen (chlorine) and the less reactive halogen (bromine). Common errors included reference to: potassium being more reactive; bromine being more reactive; solubility differences; and the halides becoming more reactive down the group.

(c) Many candidates were able to calculate the relative molecular mass of methyl orange correctly. Common errors included: using atomic numbers instead of atomic masses; multiplying the oxygen and chlorine terms together; and omitting one or more of the figures in the last column of the table when doing the final addition.

(d) Few candidates recognised the colour change of methyl orange when placed in acid or in alkali. Many of the colours referred to were those of acids and alkalis in litmus or Universal Indicator. A considerable minority of candidates did not realise that methyl orange is an indicator and gave answers referring to boiling, evaporation or filtration. A significant proportion of candidates did not respond to this question.

(e) Some candidates drew good diagrams of the apparatus used for chromatography but many did not label their diagrams. Common errors were: the chromatography paper not dipping into either the solvent or the beaker; lack of beaker or other receptacle for carrying out the chromatography; incorrectly labelling the solvent as dye; or immersing the chromatography paper entirely in the solvent.

Question 4

(a) Some candidates gave a good definition of a hydrocarbon. Other candidates made simple errors such as omitting the essential word "only" or stated that the hydrocarbons were elements. A few candidates just referred to bonding between carbon atoms. A small number of candidates thought that oxygen was present in hydrocarbons.

(b) Few candidates answered this question completely correctly. Many candidates did not write essential details relating to boiling points, molecular size or masses and condensation of the fractions. Common errors included: the idea that the temperature in the column is higher at the top; missing out ideas about change of state; and trying to name fractions (often incorrectly).

(c) (i) Most candidates were able to state how the number of carbon atoms affects the boiling range either by reference to the average temperature of the boiling range or the differences in the values within each range. The commonest error was to omit the reference to the number of carbon atoms.

(ii) Most candidates were successful in determining the percentage by mass of fraction **F**.

(iii) A majority of the candidates realised that fraction **A** was mainly gaseous. The commonest error was to suggest either fraction **F** or fraction **B**.

(iv) Common incorrect answers often involved health or "facial scrub". A considerable number of candidates suggested that it is a fuel. Although a fuel can be made from bitumen, it is not correct to suggest that bitumen itself is a fuel. A significant proportion of candidates did not respond to this question.

(d) (i) The commonest correct answers related to high temperature or heating. A large number of candidates disadvantaged themselves by simply writing temperature, without reference to "high". Few candidates mentioned the use of a catalyst. A considerable minority of candidates suggested that water or oxygen should be added.

(ii) Many candidates were able to balance the equation for cracking successfully. The commonest errors were due to: mistakes in subtraction; addition of $C_{12}H_{26}$ to C_7H_{16}; or writing the formula for a simpler hydrocarbon, e.g. C_2H_4 or an element such as H or C.

Question 5

(a) Many candidates gave some general metallic properties of iron; electrical conductivity and high melting point being the commonest correct answers. Few candidates mentioned ductility or malleability or any chemical properties. Many candidates gave vague or irrelevant answers, e.g. "its relative atomic mass is 56" or "iron has a boiling point". Common errors included "iron is brightly coloured" and "iron is grey in colour". Many candidates did not write down five creditworthy points and many omitted to write about the chemical reactions of iron.

(b) (i) Few candidates focused on the information in the stem of the question that iron carbonyl is a covalent liquid. Many continued with the theme of iron, thinking that iron carbonyl must be like iron because it contains iron. Consequently, most candidates wrote incorrect answers such as "hard" or "high melting point".

(ii) Many candidates realised than carbon monoxide is poisonous. Incorrect answers often related to carbon monoxide being "hazardous" or "corrosive". A considerable minority of candidates focused on the iron compound instead of the carbon monoxide.

Question 6

(a) Most candidates recognised the symbol for a reversible reaction. Common errors included “a reaction which goes backwards” and ideas about amounts of products being formed without reference to reactants.

(b) Few candidates were able to state two conditions required for the hydration of ethene. Common errors included “low temperature” and “addition of hydrogen”. Few candidates mentioned a catalyst.

(c) The majority of candidates suggested that the reaction is endothermic but then gave a reason which suggested that energy is released. Better-performing candidates gave answers that referenced the energy levels in the diagram.

(d) (i) Most candidates correctly described how the percentage yield of ethanol changed with temperature. The commonest error was not to mention the temperature at all.

(ii) This part was well answered with most candidates deducing the correct percentage yield.

(e) (i) The structure of ethanol was not well known. Common errors included drawing the structure of methanol; drawing the structure of a hydrocarbon; drawing a hydrogen atom with two bonds e.g. C–H–O or C=H; or including a C=O bond.

(ii) Some candidates gave a suitable use of ethanol. Other candidates referred vaguely to “used in chemistry labs” or “used for making chemicals”. Few candidates mentioned its use as a solvent. Some candidates suggested that ethanol is used as a fuel, which was acceptable, but others suggested that it was the same as a particular fuel, e.g. “it’s gasoline”, which was not accepted.

(iii) Many candidates were able to balance the equation correctly. The commonest error was to try to balance with $2H_2O$ instead of $3H_2O$.

Question 7

(a) Most candidates gave a satisfactory description of how the reaction could be started. The commonest errors were either to suggest that the gas syringe had to be pushed in or that the zinc had to be heated.

(b) (i) A minority of candidates could explain why the volume of gas stays constant. Most incorrect answers referred either to the experimenter stopping the reaction or to some other external force, e.g. “the temperature had gone down”.

(ii) Most candidates correctly deduced the time taken to produce $20\,cm^3$ of gas.

(iii) Some candidates realised that only the temperature changed. The commonest error was to draw the finishing line well above the line already present. A considerable minority of candidates either drew a line with a shallower gradient or drew a line with a steeper gradient but with an unacceptably large hump in it, which then came down to join the horizontal line.

(c) Some candidates realised that powdered zinc would produce a faster rate of reaction than pieces of zinc. Other candidates thought, incorrectly, that the pieces of zinc had a larger surface area than the zinc powder.

(d) (i) The definition of the word compound was not well known. Many candidates mentioned mixtures while others mentioned elements. Few candidates wrote about different atoms bonding or joining.

(ii) Few candidates gave a suitable source of elemental sulfur. The commonest incorrect source was “sulfuric acid”. Many candidates thought that sulfur was extracted from foods or from bacteria. A significant proportion of candidates did not respond to this question.

(iii) Few candidates gave a suitable use of sulfur dioxide. A wide range of incorrect uses was seen ranging from “in the blast furnace” to the vague “in chemical reactions”. Many candidates suggested that sulfur dioxide is used to make sulfuric acid. This was not accepted since the raw material is sulfur rather than sulfur dioxide. A significant proportion of candidates did not respond to this question.

Question 8

(a) Some candidates were able to interpret the graph in terms of changes in pressure and volume. Other candidates wrote inexact answers such as “the volume goes down with pressure” (instead of the volume goes down as pressure increases). Some candidates tried to introduce kinetic particle theory into their answers unnecessarily.

(b) Some candidates wrote a simple answer, referring to the increase in distance. Other candidates tried to over-complicate their answers by introducing volumes and kinetic particle theory.

(c) (i) The simple answer that oxygen is removed from the carbon dioxide was rarely seen. Many candidates wrote vaguely about carbon being on the right-hand side and magnesium getting the oxygen, without reference to the carbon.

(ii) Candidates who realised that a metal oxide does not contain carbon gave the correct answer.

(iii) Few candidates wrote about problems, such as ice-caps melting, desertification or an increase in extreme weather patterns. The most common correct suggestion was (an increase in) global warming.

CHEMISTRY

Paper 0620/41
Theory (Extended)

Key messages

Candidates need to be reminded to use the correct terms. For example, there was frequent incorrect use of the word “element” instead of “atom”.

Candidates should try to cover the entire syllabus as part of their revision. It was noticeable that many of the organic parts of **Question 6** were omitted.

Candidates need to be reminded that if **one** use of a substance is asked for, then no more than **one** use should appear in the answer, as any incorrect uses given could contradict correct uses.

Candidates need to be reminded that a word equation, unless specifically asked for, is not acceptable if a chemical equation is asked for.

Some good examination technique was seen, for example the underlining of command words in the questions, but some responses were a rewriting of the question. Candidates should look to make answers concise and keep to the space available. Simple use of bullet points, rather than long rambling paragraphs, may help candidates hit the key points of an answer.

General comments

Candidates seemed well prepared. There was no evidence that there was insufficient time to complete the paper and there was little evidence of problems encountered in understanding wording of the questions.

Comments on specific questions

Question 1

(a) Most candidates were able to show that they had a good understanding of the structure of the atom. Many candidates did not realise that it was the relative charge that was asked for; “+1”, rather than “+”, for the relative charge of a proton was expected.

(b) (i) Most candidates realised that the number of neutrons is different from the number of protons but many candidates did not connect this difference specifically to atoms. Frequently, responses such as “elements with same number of protons but different numbers of neutrons” were seen.

(ii) Most candidates were aware that isotopes have the same numbers of electrons but only the better-performing candidates knew that the similarity of chemical properties was due to isotopes having the same number of outer electrons.

(c) Better-performing candidates realised that the particle in line three was an ion of an isotope of potassium and were able to use the correct mass number and atomic number.

Question 2

(a) This structured calculation was successfully completed by many candidates. It was clear that some candidates had not met the concept of the mole and struggled to complete the first answer. The third part showed that the conversion of a molar quantity to a gaseous was an unfamiliar concept to many candidates.

(b) (i) The syllabus definition of a base being a proton acceptor was well known. Superfluous comments about solubility and pH were often seen.

(ii) The formula of magnesium hydroxide proved challenging for many candidates, but those who were able to determine this generally were able to complete the rest of the equation successfully.

(c) In many cases, candidates did not address the question and did not describe the experiments needed, along with the key observation that insoluble aluminium oxide would dissolve in their chosen acid and base. Some candidates stated that aluminium oxide should be reacted with both an acid and a base.

(d) (i)(ii) Most candidates knew that the bonding within the giant structure was covalent; some candidates were unable to recall the typical properties of giant covalent structures.

(e) (i) The simple statement that ionic bonding is an attraction between oppositely charged ions was missed by many candidates who chose instead to describe how the ions were formed.

(ii) Having been given the formula of the phosphate ion, better-performing candidates were able to deduce the correct formula of calcium phosphate. Candidates who performed less well struggled to produce reasoned formulae. A common error was to give the formula of calcium phosphide, despite the phosphate ion being given as PO_4^{3-} in the question.

(f) (i) Many candidates were not aware of the conventions of energy level diagrams. It is expected that the products should be identified by a clear horizontal line with the formula above the line. The enthalpy change should be represented by a single headed vertical arrow (in this case pointing downwards) starting exactly from the energy of reactants and ending exactly at the energy of the reactants.

(ii) Better-performing candidates were able to rationalise that the total energy of bond breaking minus the total energy of bond making was equal to 780 kJ being lost. Thus, the energy taken in for bond breaking was 2×160 kJ (320 kJ) and this meant that the energy lost in bond making must have been 1100 kJ. The final step was to realise that 4 S–F bonds were made, so that the individual S–F bond energy was 1100/4 = 275 kJ.

(g) (i) The reason for chlorinating water was well known by nearly all candidates.

(ii) Many candidates answered this question successfully. Some candidates were unsure and responses suggesting copper(II) chloride was the compound followed by a colour change of white to blue were seen, suggesting confusion with the anhydrous copper(II) sulfate test.

(h) (i) The idea of a complete outer shell of electrons being responsible for argon's lack of reactivity was well known.

(ii) One use of argon was known by most candidates. Incorrect responses included "in neon lights" or "as lamp filaments" rather than "in filament lamps".

Question 3

(a) Most candidates were able to suggest that one of the reactants should be added last if the reaction were not to start before the timing began.

(b) (i) It was not universally appreciated that in order for the concentration to double, the volume of thiosulfate needed to be doubled yet the total volume be kept constant by reducing the volume of water added. Likewise, if the reaction rate were to double (due to a doubling of concentration) then the time taken for the experiment must be halved.

(ii) Most explanations for the reason for the increase in rate of reaction due to increased concentration did not give the two key points required. Incorrect and imprecise responses included phrases such as "there are more collisions" (there are not, as the number of collisions is the same; it is simply that they are able to occur in a shorter time); "There are more collisions per second" would have been acceptable. Another imprecise term was "the particles collide more", rather than "the particles collide more frequently".

(c) Most explanations for the reason of the increase in rate of reaction due to increased temperature did not give the key points required. Comments about a higher proportion of collisions have energy above the activation energy at higher temperature were almost universally omitted. Imprecision in many responses was seen, with phrases such as "particles collide faster" or "collisions have more energy".

Question 4

(a) (i) Most candidates knew the change was reduction but erroneously attributed the electron gain to the Cu (atoms) rather than Cu^{2+} (ions).

(ii) Many candidates were able to describe the release of Cu^{2+} ions from the anode and many went close to the second mark by describing the removal of Cu^{2+} ions onto the cathode. Many candidates did not state that the rates of these processes were equal.

(b) Almost all candidates were able to suggest that the copper anode should be replaced by one of nickel. Although many candidates went on to suggest using a nickel salt such as nickel(II) nitrate or sulfate, a significant proportion of candidates were unable to appreciate this change was also needed.

(c) Candidates are advised to read questions carefully. The question asked for three *different* properties of transition metals which set them apart from other metals. Thus, repeating the properties already given in the question received no credit and the frequently seen "good electrical conductivity" was an incorrect response.

Question 5

(a) Most candidates did not realise that the much of the sulfur used in the Contact process is the unwanted sulfur extracted from fossil fuels before they are combusted.

(b) The details of the Contact process were not universally known. Some very strong responses were seen but these were in a minority. Most candidates were able to state the temperature used. As vanadium has many oxides, it was the specific vanadium(V) oxide which was required as the catalyst. Equations, when seen, were generally well done but the reversible nature of the reaction was frequently omitted.

(c) Most candidates either knew, or were able to deduce, the formula of oleum.

(d) (i) Most candidates mentioned effervescence but did not go on to describe two other observations. Several candidates contradicted themselves by describing the carbonate dissolving and forming a precipitate.

(ii) Most candidates knew the three products of this reaction.

(e) (i) This new part of the 2016–2018 syllabus was known by relatively few candidates.

(ii) Consequently, hardly any candidates provided the expected response of “dehydration” and a variety of different reaction types were seen.

Question 6

(a) Most candidates knew the names of the two processes needed to obtain alkenes from crude oil. Candidates who performed less well described the processes rather than naming them.

(b) (i) The occasional incorrect answer “additional” was seen.

(ii) Very few candidates realised that the empirical formula of an addition polymer is the same as that of the monomer.

(iii) Only a minority of candidates were able to draw two repeat units of the polymer correctly. Frequent errors were to leave double bonds in the carbon chain or to join up six carbons in one single row, rather than four carbons with two $–CH_3$ side chains.

(c) The structure of the two alcohol isomers of C_3H_8O were drawn successfully by most candidates.

(d) (i) The identity of the catalyst needed to convert an alcohol and a carboxylic acid into an ester was rarely known.

(ii) Many of the candidates were successful in the naming of methyl ethanoate.

(iii) The drawing of the structure was done well.

(iv) The incorrect response of “nylon” was seen almost as frequently as the correct one of “*Terylene*”.

CHEMISTRY

Paper 0620/42

Theory (Extended)

Key messages

Candidates should recognise importance of learning definitions precisely.

Candidates should ensure that they know the differences between giant ionic structures held together by ionic bonds and giant metallic structures held together by metallic bonds.

Candidates should learn the formulae (including charges) of common ions referred to in the syllabus, as well as the relationship between the ionic charge and group number in the Periodic Table.

Candidates should be aware that rust is impure hydrated iron(III)oxide. It follows from this that **iron** is the only metallic element that can (form) rust.

If an equation is required as part of an extended answer, as in **Question 6(b)(i)** and **Question 6(c)**, the equation should be written on one line. All chemical equations should be balanced.

Candidates should know how to carry out tests to identify oxidising agents and reducing agents, as well as the results of these tests.

Comments on specific questions

Question 1

(a) All parts to this were answered extremely well by the vast majority of candidates. The exception was part **(viii)** where beryllium was seen regularly and boron occasionally. Some candidates may have been of the opinion that each element had to be used once and once only, but this was not the case.

(b) (i) This was answered well by a large number of candidates. The symbol for boron was sometimes written as Ba, Be or Br.

(ii) This was usually answered well, although a wide variety of incorrect answers was seen.

Question 2

(a) (i) The word *number* was an essential part of the answer to this question. Although the position of an element in the Periodic Table is based on its atomic number, the definition of atomic number is the number of protons *in one atom* of an element. The phrase "in one atom" was often missing.

(ii) The word *number* was an essential part of the answer to this question. It was also essential to state that nucleon number is the number of protons and neutrons *in one atom* of an element. Electrons were sometimes referred to inappropriately, and a small number of candidates confused nucleons with neutrons.

(b) Large numbers of candidates scored full credit in this question. The nucleon number of sodium was sometimes given as the more common 23, rather than the correct value of 24 for this isotope. Candidates should be aware that the proton number defines the element, as opposed to the nucleon number.

Question 3

(a) (i) There were many misconceptions and omissions evident here. Negative ions / anions were mentioned as well as positive ions. Protons or atoms were mentioned instead of positive ions. Those candidates who drew particles with a positive charge did not always refer to these particles as positive ions. Some candidates drew individual atoms or ions. The *attraction* between positive ions and electrons was usually omitted.

(ii) Reference to *movement* of electrons or *mobile* electrons was essential in the answer to this question. "Free electrons", "sea of electrons" or "delocalised electrons" was insufficient for the mark to be awarded. Some candidates referred to moving ions instead of moving electrons.

(b) This was usually answered well. The most common error was due to lack of knowledge of the formula and charge of the sulfate ion.

(c) (i) The formula and charge of the nitrate ion was known to only a minority of candidates.

(ii) Many candidates were able to deduce the formula of the sodium salt successfully from the information given and also to balance the equation successfully.

(d) This was answered very well by the majority of candidates.

Question 4

(a) Most candidates knew that catalysts were used to increase the rate of reactions. Some candidates chose to say only that catalysts *alter* the rate of a reaction. It is wrong to say catalysts do not take part in reactions, as many candidates did. The preferred terminology is that the catalyst is chemically unchanged at the end of a reaction.

(b) Candidates needed to address the problems caused by lower temperatures, as opposed to the advantages of using higher temperatures.

(c) The majority of candidates knew that increased pressure would lead to increased rate of reaction, although a small number of candidates mentioned increased yield.

(d) Candidates gave one of a wide number of correct answers to this question.

(e) (i) Many candidates correctly stated that electricity was required for electrolysis to take place, although it was also common to see references to anodes, cathodes and electrons. It was less common to see a correct statement regarding an electrolyte being chemically changed during the process. Those candidates who referred to a method of separation risked confusion between physical changes and chemical changes.

(ii) This was answered correctly by the majority of candidates. Inappropriate metals were occasionally seen.

(iii) Candidates continue to find ionic equations and ionic half-equations difficult. Formulae were often incorrect and electrons often appeared on the wrong side of the equation.

(iv) This was usually answered correctly, although a small but significant number of candidates read the question as "why" instead of "where" and so went on to answer incorrectly.

(v) This was usually answered correctly. Silver nitrate was occasionally seen as an incorrect reagent.

(f) This was often correct. Common errors included incorrect formulae, such as hydrogen as "H" and chlorine as "Cl".

(g) It was unusual for candidates to score all of the credit available. Sodium hydroxide was the substance most likely to be incorrect. Chemical reactions of sodium hydroxide were usually given as opposed to uses. The three substances are manufactured industrially, and as such are *not* used to produce naturally occurring products. The most common error concerning this misunderstanding is that hydrogen was thought to be used to produce water.

Candidates should make clear whether a substance is used to produce other substances for a specific purpose, or whether it is itself used for a specific purpose. For example, sodium hydroxide is used in the manufacture of soaps and detergents but would be totally unsuitable if used as a soap or detergent itself.

Question 5

(a) (i) Excess of a reactant means *more than enough* to react with the other reactant or reactants. In this case "an excess of oxygen" means that there is more than enough oxygen than is required to react with all the hydrocarbon.

(ii) This was almost always answered correctly.

(iii) Candidates found this more challenging. Answers were not always expressed as the *smallest* ratio (e.g. 10:75:50 was fairly commonly seen), nor were they always expressed as *whole numbers* (e.g. 1:7.5:5 was also a common response).

(iv) Candidates also found this question challenging. The answers $C_{10}H_{20}$, C_5H_{20} and C_5H_{20} were seen as incorrect formulae.

(b) (i) This was almost always answered correctly.

(ii) The preferred answer to this question was that an unsaturated molecule is a molecule that does not contain only single bonds between the atoms. A small number of candidates stated that unsaturated means containing single bonds only.

(iii) This was answered very well by the majority of candidates.

(c) (i) This was usually answered correctly. "Additional" and "condensation" were seen occasionally as answers.

(ii) In addition polymerisation there is only one product, so the maximum mass of the polymer must be equal to the mass of the monomer. Many candidates attempted mole calculations in which 42 (or multiples of 42) were commonly seen as the answer. *Deduce*, as opposed to calculate, was intended to be a clue to suggest that no calculation was required.

(iii) One of the characteristics of addition polymerisation is that the monomer and polymer have the same empirical formula. Formulae never begin with numbers, nor can they ever include *n* as an indeterminate integer. The responses "$–CH_2–$" and "$–(CH_2)_n–$" were both occasionally seen.

Question 6

(a) (i) Roasting or heating strongly were often omitted.

(ii) A variety of reactants and products were seen. Those candidates who gave correct reactants and products often left their attempted equation unbalanced.

(b) (i) The production of heat by the exothermic combustion of coke in air scored least regularly. Many candidates thought that "hot air" provided the heat. An equation for the production of carbon monoxide was only seen occasionally. Most candidates successfully wrote an equation for the reduction of zinc oxide.

(ii) This was usually answered correctly. Sublimation was seen occasionally.

(iii) This was usually answered quite well, although there were several candidates who referred to the temperature inside the furnace and the boiling point of zinc, but made no comment about the relative magnitude of both. The high temperature inside the furnace, without qualification, was insufficient to gain credit.

(c) This question produced a wide variety of answers. Most candidates referred to zinc being more reactive than iron / steel. Several candidates referred to loss of electrons by zinc, but the destination of the electrons was referred to less often. The question referred to *in terms of electron transfer* but several candidates gave little or no reference to electrons.

(d) (i) Some candidates had the colours the wrong way round. Various spellings of the word precipitate were seen.

(ii) The word *types* was often ignored. Specific compounds were often given.

(iii) The word *types* was often ignored. Specific compounds were often given.

(iv) Many candidates misinterpreted this question.

(v) Many candidates misinterpreted this question.

CHEMISTRY

Paper 0620/43
Theory (Extended)

Key messages

Candidates should read all parts of every question carefully in order avoid missing a question part out and to help ensure they answer what has been asked.

Candidates need to ensure they are familiar with quantitative work, including mole based calculations for solids, gases and solutions.

Clear working should be shown for calculations.

Chemical equations should be balanced symbol equations, unless the question specifically asks for a word equation. In this case, a symbol equation should **not** be given as the answer.

General comments

There was no evidence that candidates ran out of time. Some excellent answers were seen to all questions on the paper.

Candidates found the organic chemistry question and the moles-based calculation to be more challenging; they need to be familiar with these areas of the syllabus.

Comments on specific questions

Question 1

(a) This question tested understanding of the reactions that occur in the blast furnace; candidates found this challenging. Many candidates seemed reluctant to give the same answer in both parts **(iv)** and **(v)**.

(b) Many fully correct answers to part **(i)** were seen; incorrect responses such as “iron” and “oxygen” were also given.

The most common error in part **(ii)** was to suggest that the calcium silicate (slag) was removed from the very bottom of the blast furnace. Candidates should be aware that calcium silicate is less dense than iron and so is removed from above the iron.

Many correct answers were seen in part **(iii)** although some candidates suggested substances that are not gases and so could not be correct.

(c) Some candidates made careless errors in part **(i)** or gave incomplete answers that did not describe the changes in both variables. A common response was “as the percentage of carbon changes, the malleability of iron gets less”. Since how the percentage of carbon is changing (increasing or decreasing) is not specified, this response was not sufficient.

In part **(ii)**, many candidates had the correct general idea of the oxidation of carbon using oxygen, but they implied that just introducing oxygen into the impure iron to would be sufficient. In fact, the oxygen must be forced or blown into the impure iron.

Question 2

(a) Many candidates could name **F** as being butane but many candidates did not read the question carefully and wrote the formula rather than gave the name.

(b) The majority of candidates could identify two members of the same homologous series but it was common for other candidates either to name the compounds or to give their formulae, rather than give the general formula of the homologous series, as requested.

(c) Many fully correct answers were seen although some candidates found this question challenging. It was not uncommon for two compounds which were not isomers to be selected. Many candidates who selected two isomeric compounds could not complete the explanation successfully and commonly referred to "the same chemical formula", rather than referring to having the same *molecular* formula.

(d) Some candidates did not read the question with sufficient care. While many candidates attempted to explain why **B** is unsaturated or why **B** is a hydrocarbon, relatively few tried to explain why it is *both* unsaturated and a hydrocarbon. It should be noted that an unsaturated compound will have a multiple bond between two (carbon) atoms; unsaturation is **not** defined in terms of having as much hydrogen joined to the carbon atoms as possible.

(e) The conversion of ethene to ethanol was not well known. Despite the question stating that **D** is made from **B**, many candidates could not write the correct formulae for the reactants and products.

(f) The most common error was to draw a structure that showed four repeat units of poly(ethene), rather than two repeat units of poly(but-2-ene). When addition polymerisation occurs, the only part of the alkene molecule that reacts is the double bond between the carbon atoms. Therefore, a repeat unit can only have two carbon atoms in the chain between the two continuation bonds.

Question 3

(a) While many candidates could name two other constituents of clean dry air, some just repeated the names of the gases listed in the question or claimed that dry air contained water. A few candidates suggested that there were solids in the air and a significant number thought that air contains hydrogen gas.

(b) It was not uncommon for candidates to suggest pollutant gases that they had either already stated were components of clean dry air or that were not gases. Those candidates who did correctly identify pollutant gases, often did not state how each was produced. Some candidates gave vague answers such as "by industry" or "by cars" but more detail was required. For example, sulfur dioxide is produced by the burning of fossil fuels which contain sulfur; and nitrogen oxides are formed when atmospheric nitrogen and oxygen react with each other at the high temperatures in a car engine.

Question 4

(a) In part **(i)**, many good answers were seen that clearly described a potassium atom losing an electron and the electron then being gained by an iodine atom. Some candidates incorrectly tried to describe the sharing of electrons.

There were many very poor answers to part **(ii)**. Rather than describing the structure of solid potassium iodide, many candidates tried to describe the bonding again. Those who did try to describe the structure often wrote about the wrong sorts of particles and confusion between ionic and metallic structures was common.

Part **(iii)** was also poorly answered. Common errors included relating the melting point of the compound to the reactivity of the compound or its constituent elements, or to the melting point of the elements. Those candidates who knew that melting point depends on the forces of attraction sometimes incorrectly described the particles as molecules. Some candidates decided to use comparative terms and used phrases such as "the attraction between the particles is stronger". Many questions do require comparative answers but this one did not, since nothing was being compared. Saying something is strong*er* does not mean it is strong.

(b) In part **(i)**, some candidates were able to give complete and clear descriptions of what should have been a familiar laboratory technique (making a salt by precipitation). Some candidates did not add water to form solutions at the start of the process, and many candidates omitted the important step of washing the precipitate after filtration. Some candidates gave answers which suggested that they have never carried out a precipitation reaction, for example involving heating. There was evidence that some candidates did not read the question carefully as they used reagents other than the two specified in the question.

The ionic equation in part **(ii)** was only correctly given by the better-performing candidates; many candidates tried to write full chemical equations or wrote word equations.

(c) Many colours were suggested for the colour changes in part **(i)**. Candidates were required to recall that potassium chloride and potassium iodide are colourless, or that chlorine gas is green and that aqueous iodine is brown.

Some excellent responses were seen in part **(ii)** although some candidates thought the reducing agent was the species that got reduced rather than the species which reduced something else.

Question 5

(a) A number of candidates stated that there was effervescence because there was a reaction, or because the reaction was exothermic or a neutralisation reaction. It was evident that some candidates were not familiar with the word effervescence.

(b) In part **(i)**, the colour of the methyl orange indicator was fairly well known with the most common error being to state it was orange. The mole calculation which followed was very poorly answered and many candidates did not attempt many of the steps. There was a lack of working from many candidates. It is important that candidates show full and clear working, as credit can be awarded for correct working even if the final answer is incorrect.

Part **(ii)** required the use of the equation moles = concentration × volume (in dm^3). When an equation was stated by candidates, it was often incorrect.

In part **(iii)**, many candidates gave answers that were totally unconnected to their previous answer.

Part **(iv)** required use of the equation concentration = moles/volume (in dm^3) and this was often stated incorrectly. Many candidates were not familiar with calculations of this type.

(c) This calculation was poorly answered. Many candidates gave no working or confused working and an incorrect final answer.

Question 6

(a) Although many fully correct equations were seen in part **(i)**, there were a number of errors in the formulae of hydrogen chloride and ammonia, both of which were given on the Question Paper, and the identity of the single product.

Almost all candidates were able to correctly name diffusion in part **(ii)**.

In part **(iii)**, most candidates could correctly identify where the solid formed, and stated that ammonia molecules moved faster than hydrogen chloride molecules. Fewer candidates were able to link the speed of movement to the mass of the particles concerned. It is not sufficient just to say “ammonia is less dense” as this does not refer to the masses of the individual particles.

In part **(iv)**, many candidates realised the ring would form more quickly; most candidates then incorrectly linked this to the rate of reaction, rather than the speed of movement of the particles.

(b) Better-performing candidates were familiar with the ion tests in part **(b)**. For other candidates, there was common confusion between ammonium and ammonia and between chloride and chlorine. Consequently, tests for the wrong species were often stated.

(c) The majority of candidates could identify covalent bonding in ammonia in part **(i)**.

Part **(ii)** was frequently incorrect or left blank. One of the most common errors was to include a double bond between the nitrogen atoms.

Many candidates did not answer this question or gave incorrect responses. Better-performing candidates were able to name the amide link in part **(i)**.

Fewer candidates were able to describe the difference between nylon and proteins in part **(ii)**. A common error was to state that nylon is man-made but proteins are natural; this is a true statement but does not answer the question asked. Better-performing candidates stated that proteins are made from 20 amino acids while only one or two monomers are involved in nylon.

Only a minority of candidates knew the hydrolysis products of proteins in part **(iii)**.

In part **(iv)**, more candidates tried to draw the structure of the polymer than the structure of the monomer, as asked.

CHEMISTRY

Paper 0620/51
Practical Test

Key messages

Candidates should be familiar with the technique of carrying out a flame test and with the different colours of the silver halide precipitates.

In qualitative analysis exercises, candidates must follow the instructions given and record all observations.

Candidates should be aware that the mark allocation reflects the number of valid points to be made for the individual parts of questions.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

The majority of candidates successfully attempted and completed **Questions 1** and **2** and there was no evidence that candidates were short of time.

Most Supervisors submitted results for **Questions 1** and **2**; a few did not carry out **Question 2**. The Supervisor's results are used in the marking of both questions.

A number of Centres recorded unexpected volumes of acid in Experiments 1, 2 and 3 in **Question 1**. Centres should ensure that the Confidential Instructions, which clearly specify the concentrations of the solutions for **Question 1**, are followed. A minority of Centres supplied phenolphthalein to candidates instead of thymolphthalein. This should have been indicated on the Supervisor's Report.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a)(b) The tables of results were completed by all of the candidates. A minority of candidates recorded initial burette readings greater than the final burette readings. Some candidates recorded volumes to the nearest whole number only. Burette readings should be recorded to one decimal place. There was sometimes a wide variation in the results produced by different candidates from the same Centre. A significant number of candidates had burette readings over 30 cm^3 in Experiment 2.

(c) Incorrect colour changes, such as blue to clear or white, were frequently seen. Some candidates confused the initial and final colours.

(d) The observation that bubbles / effervescence / fizzing occurred was correctly given by some candidates. "Gas / carbon dioxide given off" is not an observation. Some vague answers referred to temperature changes.

(e) This was well answered. Most candidates recognised that Experiment 2 needed the largest volume of acid.

(f) Having used a measuring cylinder in the experiments, many candidates were able to suggest the use of a pipette or burette to measure the volume of the aqueous sodium carbonate.

(g) Better-performing candidates understood that warming the reactant would have no effect on the results as there was no change in concentration. A large number of candidates stated that the reaction would be quicker, not realising that the rate of reaction was not being measured. Reasons in terms of energy and movement of particles were not relevant for this question.

(h) (i) A ratio or some quantitative indication was required in the comparison. The majority of candidates recorded a correct ratio from their results; merely stating that more or less acid was used was insufficient.

(ii) Better-performing candidates realised that solution **B** was more concentrated than solution **A** because a smaller volume of **B** was used to neutralise the alkali. Incorrect answers referred to **A** being more concentrated as a larger volume of **A** was used, which showed a lack of knowledge and understanding. Some confused answers discussed the difference in the rate at which the two acids reacted.

(i) The question asked for a *different* method from titration that could be used to compare the concentration of the two acids. Despite this introduction, many candidates used the same method with a different alkali.

Vague answers such as “use a metal” or “use a reactant” and the use of unsafe reactants such as sodium were also seen. A large number of candidates suggested adding a different indicator, e.g. Universal Indicator, phenolphthalein or litmus, to the acids. Indicators are not reactants and would also not distinguish the two acids. Some answers suggested an electrical method with a bulb in a circuit which also would not work.

(j) This was well answered by the majority of candidates. Some answers were too vague.

Question 2

Solid **C** was sodium bromide. Solution **D** was aqueous chromium(III) chloride. The full range of marks was awarded for this question. Some observations bore no resemblance to those expected.

(a) Most candidates were able to test an aqueous solution of solid **D** and record a pH value close to the Supervisor’s value. The addition of aqueous silver nitrate in part **(ii)** should have resulted in a cream precipitate. A significant number of white precipitates were recorded. References to milky and cloudy were also seen.

(b) This was generally correct. There was evidence that some candidates had never performed a flame test from answers such as “lighted splint pops”.

(c) Some correct responses were seen.

(d) (i) Generally, the appearance of the solution was correctly described as green / blue. The inclusion of the term solid or precipitate was incorrect.

(ii) The incorrect use of terms was prevalent. The terms soluble, insoluble, dissolves and solution were often confused.

(iii) Reference to the formation of white precipitate showed a lack of care in observing the reactions.

(iv) Generally, this question was well answered with the recognition of the formation of a white precipitate. Some candidates used terms such as milky, cloudy or solid.

(e) Only the better-performing candidates answer this correctly. Many candidates incorrectly concluded that solution **D** was iron(II) sulfate. The presence of halide ions was well described and many answers indicated that solid **D** was a chloride.

Question 3

Most candidates weighed and burnt the calcium. Many methods described showed a lack of knowledge and understanding. The use of gas syringes to collect and measure the calcium oxide formed was common. References to heating calcium / calcium oxide and testing for oxygen with a glowing splint were common. There was confusion in the use of the terms volumes and moles of calcium and calcium oxide. Adding water to the calcium was a method that would not work.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

Centres should ensure that the solutions provided to candidates are of the required concentration. Where there is any doubt over the concentration of a reagent, then it should be standardised using normal volumetric techniques.

Candidates should be familiar with the technique of carrying out a flame test.

In qualitative analysis exercises, candidates must follow the instructions given.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

Most candidates had few difficulties with the qualitative analysis practical in **Question 2**.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a) Almost all candidates were able to complete the total volume column in the table; some candidates did not record their results to the expected one decimal place. Data read from the same piece of apparatus should always be recorded to a consistent number of decimal places. A small minority of candidates completed the times in minutes and seconds, despite the unit required being given in the column heading. A few candidates recorded decreasing times.

(b) Some excellent graphs were seen. Some candidates used inappropriate graph scales. The requirement for graph scales is that they are linear and that the plotted points take up over half the available space (see Section 8.5 of the syllabus). Some curves were also seen.

(c) In part **(i)** many candidates were able to extrapolate the line and read a value from it. Some candidates omitted the units or gave cm^3 as the units of time. Better-performing candidates had no difficulty adding the higher temperature line to the graph in part **(ii)**. Some candidates incorrectly thought the higher temperature would slow the reaction down and so make the times longer or that the lines would cross.

(d) The vast majority of candidates were able to state that the starch acted as an indicator or were able to describe the colour change it caused.

(e) A number of candidates stated that pipettes were quick to use as an advantage in part **(i)** but that they were inaccurate. The main advantage of using a pipette to measure volume is its accuracy; with the main disadvantage in this experiment being that it would take too long and therefore it would be difficult to know when to start timing.

(f) Most candidates realised that it would be difficult to swirl the beaker. A significant minority of candidates thought that the flask and the beaker were being used for measuring and so incorrectly wrote about scale divisions and accuracy.

Question 2

Solid **E** was sodium sulfite and solid **F** was urea.

(a) In part **(i)** some candidates seemed to be uneasy having no visible change in the first observational task, and so recorded some impossible observations.

Most candidates reported the appearance of a white precipitate in part **(ii)** although adding of nitric acid produced a range of answers, from no change through to completely dissolving.

Part **(iii)** was straightforward for those candidates who followed the instructions and the change from purple to colourless was reported by the majority of candidates. Some candidates commented on the colour change of litmus paper (from blue to pink) showing that they had not followed the instructions.

(b) This part required a flame test to be carried out. Some candidates reported blue, green or lilac flames for sodium ions and did not appear to be familiar with how to conduct these tests, as there were some reports of lighted splints popping or solids bubbling and giving off strong smelling gases.

(c) Most candidates who had correct test observations were able to draw correct conclusions about solid **E**. Candidates should try to make good use of the "Notes for use in Qualitative Analysis" provided towards the back of the Question Paper. These notes give the names and formulae of the ions that occur in compounds analysed in this practical examination. Using the notes should preclude the possibility of giving incorrect formulae for ions or of suggesting ions that are not covered by the syllabus.

(d) Most candidates correctly described **F** as being white. Some candidates did not state the colour.

(e) In part **(i)**, most candidates stated that the red litmus became blue; some incorrectly reported that it was bleached. The majority of candidates noticed that the solid became a liquid, but many missed the pungent smell. In part **(ii)**, the actual shade of colour produced depends on the degree of heating in part **(i)**, but if **F** is heated strongly, as instructed, a pink solution is obtained. Some candidates reported a blue precipitate, which suggests that they ignored the residue and just added sodium hydroxide to copper(II) sulfate solution.

(f) A range of incorrect test results was seen, including bleaching of damp litmus paper and turning limewater milky.

(g) Many candidates worked out that solid **F** contained ammonium ions, either from their results in **(h)** or **(e)(i).**

Question 3

The inclusion of a planning task was new for this year and some candidates found this challenging. There were two clear aspects required in the plans: how to make the salt (potassium sulfate) and then how to obtain pure crystals of it from the reaction mixture. Many candidates gave details of only one or other aspect, rather than both. Some excellent descriptions of how to make a solution of potassium sulfate were seen; common errors were to use Universal Indicator (which is not suitable since it gives a gradual colour change); not to use any indicator (and so there was no way of knowing when there were stoichiometric quantities of the acid and alkali); or to use an indicator but to leave it in the reaction mixture during the subsequent crystallisation stage. It was common for candidates to evaporate their solutions to dryness rather than just until they were saturated. There were some excellent descriptions of obtaining saturated solutions from some candidates.

CHEMISTRY

Paper 0620/53
Practical Test

Key messages

Conclusions are not required when a question requires observations to be given.

Candidates should be aware that the mark allocation reflects the number of valid points to be made for the individual parts of questions.

Candidates should be familiar with the technique of carrying out a flame test.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

There was no evidence of candidates running short of time and most candidates successfully reported results and observations for the practical tasks in both questions.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a) Almost all candidates were able to complete the initial and final temperatures correctly with the final temperature being higher than the initial. There were very few errors in calculating the temperature rises. A small number of candidates reported a larger temperature rise with iron that with zinc.

(b) The majority of candidates reported a correct test and result for hydrogen. Some candidates gave only the result and did not state the test; the test is not "the squeaky pop test", it is to expose the gas to a lighted splint, the result of which is the squeaky pop. Some candidates reported impossible test results which suggested the gas to be oxygen, carbon dioxide or chlorine.

(c) Almost all candidates recorded suitable results that showed good agreement to the Supervisor's results. Candidates found the observation more challenging. Reports of no reaction were not uncommon, despite the fact that the temperature had been reported to rise. Many candidates did not notice the formation of a brown solid.

(d) The requirement to draw a bar chart caused candidates few problems; a small minority drew bars to the wrong height or tried to draw a line graph. The most common error was selecting an inappropriate *y*-axis scale that resulted in the highest point coming to less than half way up the axis.

(e) Almost all candidates answered part **(i)** correctly. Part **(ii)** required the idea of a comparison, not just that magnesium was reactive but that it was *more* reactive than the other metals.

(f) This was well answered by candidates who had reported the correct test and result.

(g) Most candidates realised that because potassium was so reactive the reaction would become unsafe; some candidates suggested that potassium was unreactive and would do nothing.

(h) Many candidates did not answer this part correctly.

(i) Many candidates suggested repeating the experiment, however, the question asked for a *change*; repeating is not a change, it is doing the same thing again.

Question 2

The mixture contained two solids. Solid **G** was hydrated zinc nitrate and solid **H** was lithium carbonate.

(a) In parts **(i)** and **(ii)**, some candidates added too much sodium hydroxide or ammonia at once and so missed the initial formation of the white precipitate. The fact that in part **(i)** three marks were available should have suggested to candidates that there was more to it than "no change". It was not uncommon for candidates to report a white precipitate in part **(iii)** which is not a possible result. In part **(iv)**, the use of aqueous sodium hydroxide and aluminium foil should have alerted candidates to the fact that this was the test for nitrate ions and so they should be testing for the formation of ammonia. Many correct gas test results were seen although a number of candidates reported impossible results.

(b) Those candidates who did not observe a precipitate in parts **(a)(i)** and **(a)(ii)** struggled to identify the cation. This should have caused them to reconsider their observations and repeat parts **(a)(i)** and **(a)(ii)**. The formation of ammonia in part **(a)(iv)** lead some candidates to conclude incorrectly that solid **G** contained ammonium ions.

(c) This was often answered correctly although some candidates gave conclusions, rather than observations. If a candidate has conducted a test to show the gas produced is carbon dioxide, then the observation they record should be the correct test and positive result for carbon dioxide.

(d) Many correct flame colours were seen; some unlikely colours were also recorded. It was clear from some of the answers that some of the candidates did not know what a flame test was and so performed tests with lighted and glowing spills.

(e) Fully correct answers were common.

Question 3

The inclusion of a planning task was new for this year and some candidates found this challenging. There were three clear aspects required in the plan: a diagram showing how to obtain water from the hydrated crystals; the expected observations; and how to test to show the product is pure water. Most candidates heated the salt; some incorrectly started by adding water to the hydrated salt. Many candidates gave a correct observation of a colourless liquid being collected but very few commented on the colour change of the hydrated solid they would expect. This is despite the fact that in the testing stage many, incorrectly, tested using anhydrous copper(II) sulfate and knew there would be a colour change between the anhydrous and hydrated forms. These candidates were unable to make the link between this and an expected colour change in going from hydrated to anhydrous nickel(II) sulfate.

CHEMISTRY

Paper 0620/61
Practical Test

Key messages

Observations are those which you can see. For example, “fizzing” is an observation, “a gas was given off” is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used, substances involved, and practical procedures clearly specified with some idea of a conclusion. Preliminary notes are advisable before writing the plan.

General comments

The vast majority of candidates successfully attempted all of the questions. Candidates found the last question, **Question 4**, more demanding than the others. **Question 4** was a planning task involving a quantitative method.

The majority of candidates were able to complete tables of results from readings on diagrams, as in **Question 2**.

Comments on specific questions

Question 1

(a) Candidates had difficulty identifying the fractionating column. The column was often referred to as a test-tube or reference was made to the overall process of fractional distillation. Many candidates correctly named the tripod. Some candidates mistakenly identified it as a Bunsen burner or a stand and, in a small number of cases, a “dipod”. These candidates were not familiar with two dimensional diagrams.

(b) Incorrect answers used air instead of water. Steam or other named gases were also seen.

(c) A lot of candidates realised that the distillate / ethanol should not be heated. Some candidates wanted to lower the position of the thermometer. Others suggested that the water flow in the condenser was incorrect; the round-bottomed flask was unstable; or that it should be heated with an electrical heater.

(d) This was well answered. Some candidates did not compare the boiling point of ethanol with that of water.

(e) A large number of responses referred to controlling the heating or heating evenly. These answers were not credited.

Question 2

(a) This was often well answered. The most common error was to omit the decimal place with the initial reading of zero and to give “0” instead of “0.0”. Some candidates reversed the initial and final readings while others misread the burette diagrams, e.g. giving “13.2” instead of “12.8”. A few candidates gave the initial reading for Experiment 1 as “25.0” or “50.0”.

(b) This was poorly attempted despite the information that was given in the stem of the question of Experiment 2 and showed a lack of knowledge and understanding. Orange to pink / red was a common incorrect answer. Many other colours were cited including blue, colourless and green.

(c) This table of results was often completed correctly. A few candidates reversed the initial and final readings, while others misread the burette diagrams.

(d) This was also well answered, with the majority suggesting bubbles, fizzing or effervescence. There were a minority who stated that a gas or carbon dioxide would be produced but did not describe the observation. A significant number of candidates referred to a colour change or a temperature change.

(e) Most candidates could correctly identify Experiment 2 as needing the largest volume of acid to change the colour of the indicator.

(f) Most candidates understood that using a pipette or burette would be a more accurate method. Some candidates thought that a beaker or a measuring cylinder with more graduations would be appropriate.

(g) This question was only answered correctly by better-performing candidates. Most candidates thought that the rate was increased and gave the reason in terms of particles colliding. The minority that realised that there would be no effect on the results explained that there was no change in the concentration of the reactants in this acid-alkali titration.

(h)(i) This was well answered but the ratio was sometimes given as 1:2 rather than 2:1.

(ii) This was not always interpreted correctly from the ratio in part **(h)(i).** Many candidates suggested that a ratio of 2:1 for **A**:**B** volumes meant that the concentration of **A** was greater than the concentration of **B**.

(i) The question asked for a *different* method from titration that could be used to compare the concentration of the two acids. Despite this introduction, many candidates used the same method with a different alkali.

Vague answers such as “use a metal” or “use a reactant” and the use of unsafe reactants such as sodium were also seen. A large number of candidates suggested adding a different indicator, e.g. Universal Indicator, phenolphthalein or litmus, to the acids. Indicators are not reactants and would also not distinguish the two acids. Some answers suggested an electrical method with a bulb in a circuit which also would not work.

Question 3

(a) Many answers identified sodium bromide. Chloride and iodide were offered instead of bromide and a selection of metals, including other Group 1 metals, instead of sodium. This showed a lack of knowledge.

(b) A minority correctly of candidates described the appearance of the solution as green / blue.

(c) (i) The use of the terms soluble, insoluble, dissolves and solution was often confused.

(ii) Some candidates gave the expected observation of a grey-green precipitate which was insoluble in excess sodium hydroxide. Reference to the formation of white precipitate was common.

(iii) This was generally well answered with the recognition of the formation of a white precipitate. Some candidates thought that there would be no reaction and others suggested that the precipitate would dissolve.

(d) This was well answered and candidates are well aware of safety precautions that are necessary.

Question 4

Most candidates weighed and burnt the calcium. Many methods described showed a lack of knowledge and understanding. The use of gas syringes to collect and measure the calcium oxide formed was common. References to heating calcium / calcium oxide and testing for oxygen with a glowing splint were common. There was confusion in the use of the terms volumes and moles of calcium and calcium oxide. Adding water to the calcium was a method that would not work.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

Candidates should use a sharp pencil for plotting points and for drawing lines of best fit on their graphs. This allows them to correct any errors. Points are best plotted with a cross (×) to ensure that they are not obscured by either the grid lines or the line of best fit. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

Observations are those which you can see. For example, “fizzing” is an observation, “a gas was given off” is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

When a question asks for the name of a chemical, a correct formula is always acceptable; an incorrect formula is not.

General comments

The vast majority of candidates successfully attempted all of the questions. No question proved to be more demanding than the others.

Question 4 was a planning task testing the preparation of a soluble salt. There were several acceptable routes, most of which seemed familiar to candidates. The quality of answers was generally good.

The vast majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid, as in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates answered correctly.

(b) Most candidates put their arrow in the correct place, below the copper(II) oxide. A number of candidates did not attempt this question.

(c) The colour change was not generally well known, with many blues and whites seen.

(d) Most candidates knew that condensation took place in the U-tube surrounded by ice. A description of the process of condensation was acceptable.

(e) Water was identified by the majority of candidates. The “chemical test” was often correct, but a large minority gave a test for purity. When using copper(II) sulfate, it is important to specify anhydrous. Use of the formula $CuSO_4$ is ambiguous.

Question 2

(a) Nearly all candidates could read the clocks correctly. A few recorded times in minutes and seconds, or simply ignored the minutes.

(b) Most candidates chose an appropriate scale which enabled extrapolation in part **(c)**. The graph was plotted correctly by nearly all candidates and a ruler was generally used for the straight line.

(c) Nearly everyone correctly extrapolated the straight line to a reading at 4 cm^3. The most common error in taking this reading was to omit the units. The sketch of the line expected at a higher temperature was more challenging, with many assuming incorrectly that a higher temperature must be a higher line.

(d) Many candidates knew that the starch was used as an indicator or to make the colour change more obvious. The most common incorrect answer was that it acted as a catalyst.

(e) The use of a pipette to measure the volume of the hydrogen peroxide caused difficulties for many candidates. Most knew that it would be more accurate, but few could give valid disadvantages. A large number of candidates misunderstood the term pipette as meaning a teat pipette.

(f) Candidates found this question challenging.

Question 3

(a) Most answers correctly stated that sodium sulfite was white; “colourless” was seen fairly frequently.

(b) Most candidates realised that there would be no reaction with sodium hydroxide solution, but white precipitate was still a fairly common answer. Nearly all candidates realised that potassium manganate(VI) goes from purple to colourless in the presence of sulfur dioxide.

(c) The correct answer, a yellow flame test, was often seen; a significant number of candidates answered “red” and “lilac”.

(d) Most candidates correctly identified ammonia.

(e) The ammonium ion was the most common answer but many nitrates were seen.

Question 4

Nearly everyone attempted this question but only the better-performing candidates answered this fully correctly. Many candidates correctly suggested a titration method but other acceptable methods were seen. It was expected that a suitable indicator would be named. Universal Indicator is not suitable for titration as it does not have a sharp single colour change at the end-point.

Some candidates were able to provide a description of obtaining pure crystals from the solution by crystallisation. Ideally, this would have been evaporation until the point of crystallisation, followed by cooling, filtration, rinsing and drying. Sometimes candidates’ answers gave sequences which showed confusion. Evaporation to dryness would not give pure crystals.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key messages

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used, the method involved and with quantitative information clearly specified.

Observations are those which you can see. For example, "fizzing" is an observation, "a gas was given off" is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

General comments

The majority of candidates attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 3** and **4** most challenging.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid, as in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates labelled the apparatus as a syringe. Some candidates appeared to be unfamiliar with common laboratory apparatus.

(b) Most responses placed an arrow under the copper. A common incorrect answer was to place the arrow over the top of the tube containing the copper.

(c) Few candidates identified both colours. A large number of candidates referred to blue, white and green.

(d) Better-performing candidates worked out that 10 cm^3 of oxygen was used and correctly calculated that 20% of the air was oxygen. A large number of candidates did not read the question and worked out that 80% of the air was nitrogen.

Question 2

(a) The vast majority of candidates correctly completed the temperatures in the table from the thermometer diagrams.

(b) This question was well answered with hydrogen being recognised by many candidates.

(c) The vast majority of candidates correctly completed the temperatures from the thermometer diagrams.

(d) Most candidates drew the bars on the grid correctly. A large number chose an appropriate scale for the *y*-axis. Some labels were not clear, being positioned on the edge of two bars. A minority of candidates drew smooth line graphs, while others joined the points with straight lines drawn with a ruler.

(e) (i) This was well answered, with experiment 3 being correctly identified as producing the largest temperature rise.

(ii) Most candidates realised that magnesium produced the largest temperature rise and linked this to the greater reactivity of the magnesium compared to the other metals.

(f) Better-performing candidates discussed the displacement of copper by iron, which was the more reactive metal. Many responses showed a lack of knowledge and understanding, concluding that the brown deposit formed was rust or iron oxide. Other candidates discussed the relative magnitude of the temperature changes without referring to the observations given.

(g) Many candidates realised that using potassium would be dangerous as it is very or too reactive. Some vague and incorrect answers referring to the lack of reactivity of potassium were seen.

(h) Some candidates realised that an advantage of using a measuring cylinder was that it is quick and easy to use. Mistaken references to the accuracy or precision of a measuring cylinder were prevalent.

(i) The commonest correct improvement given was to use a pipette or burette instead of a measuring cylinder. There were very few references to preventing heat losses by insulating the boiling tube or by using a polystyrene cup. Many responses mentioned repeating the experiments and taking an average which did not answer the question.

Question 3

It was evident that some candidates had no knowledge of the tests required to complete the observations in the table.

(a) (i) A white precipitate soluble in excess aqueous sodium hydroxide was seldom known. Some candidates thought that the precipitate would be coloured. Additional incorrect observations, such as effervescence, were seen.

(ii) A white precipitate soluble in excess aqueous sodium hydroxide was seldom known. Some candidates thought that the precipitate would be insoluble in excess. Additional incorrect observations, such as effervescence, were seen.

(iii) Candidates generally did not realise that this test for a halide would be negative, having been told that the anion present was nitrate. Correct responses of “no change”, “no precipitate” and “no reaction” were seen. A large number of answers gave the formation of coloured precipitates.

(iv) The test for ammonia was described by many candidates using red litmus paper which turned blue. Very few references to bubbles or fizzing were recorded. A significant number of candidates did not know the test for nitrate ions and incorrectly discussed the evolution of hydrogen and lighted splints popping.

(b) The presence of lithium carbonate was identified by the better-performing candidates. Potassium, transition metals and carbon dioxide were common incorrect responses.

Question 4

Some candidates were clearly not prepared for this type of question.

Many candidates referred to heating and then collecting a sample of water. A lack of knowledge and understanding was often then evident, with answers mentioning adding water to the nickel(II) sulfate crystals. These candidates did not understand that water of crystallisation was part of the structure of the hydrated crystals. Common incorrect responses involved filtration of the crystals.

Many candidates did not read the question, which asked for a test for pure water and instead gave tests to show the presence of water.

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

8977051001

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

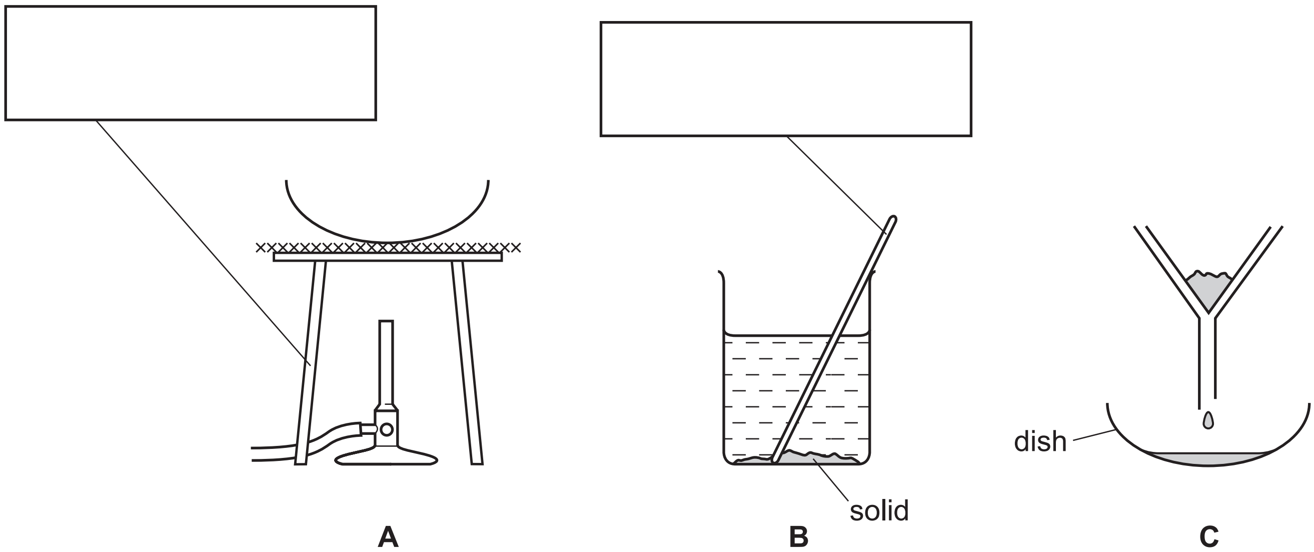
This document consists of **9** printed pages and **3** blank pages.

IB16 03_0620_62/5RP

CAMBRIDGE
International Examinations

[Turn over

1 The diagrams show the apparatus used to obtain crystals of calcium chloride from a mixture of solid calcium chloride and solid calcium carbonate.
Calcium chloride is soluble in water and calcium carbonate is insoluble in water.



(a) Complete the boxes to name the apparatus. [2]

(b) (i) Write down the order in which the apparatus should be used in this experiment.

.... [1]

(ii) Name the separation process in **C**.

.... [1]

(c) (i) What has been added to the mixture in **B**?

.... [1]

(ii) What is the general name given to the liquid in the dish in **C**?

.... [1]

(d) How would you know when to stop heating the dish in **A**?

....

.... [1]

[Total: 7]

2 A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm^3 of distilled water and 40 cm^3 of sulfuric acid into a 250 cm^3 conical flask.
A small measuring cylinder was used to add 2 cm^3 of methyl orange and 5 cm^3 of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.
The reaction was started by adding 5 cm^3 of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.
5 cm^3 of solution **K** was added to the conical flask. The timer was started and the mixture swirled.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.

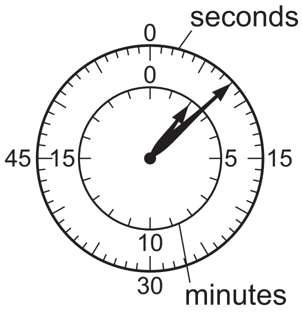
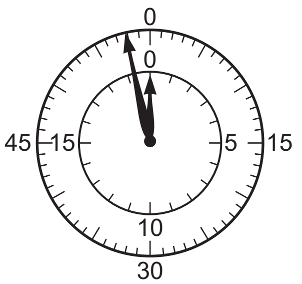
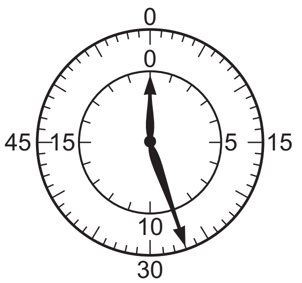
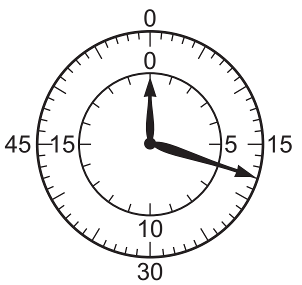
Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50 °C before adding the solution **K** to the flask. The same measurements were taken.

Stop-clock diagrams for these experiments are on page 4.

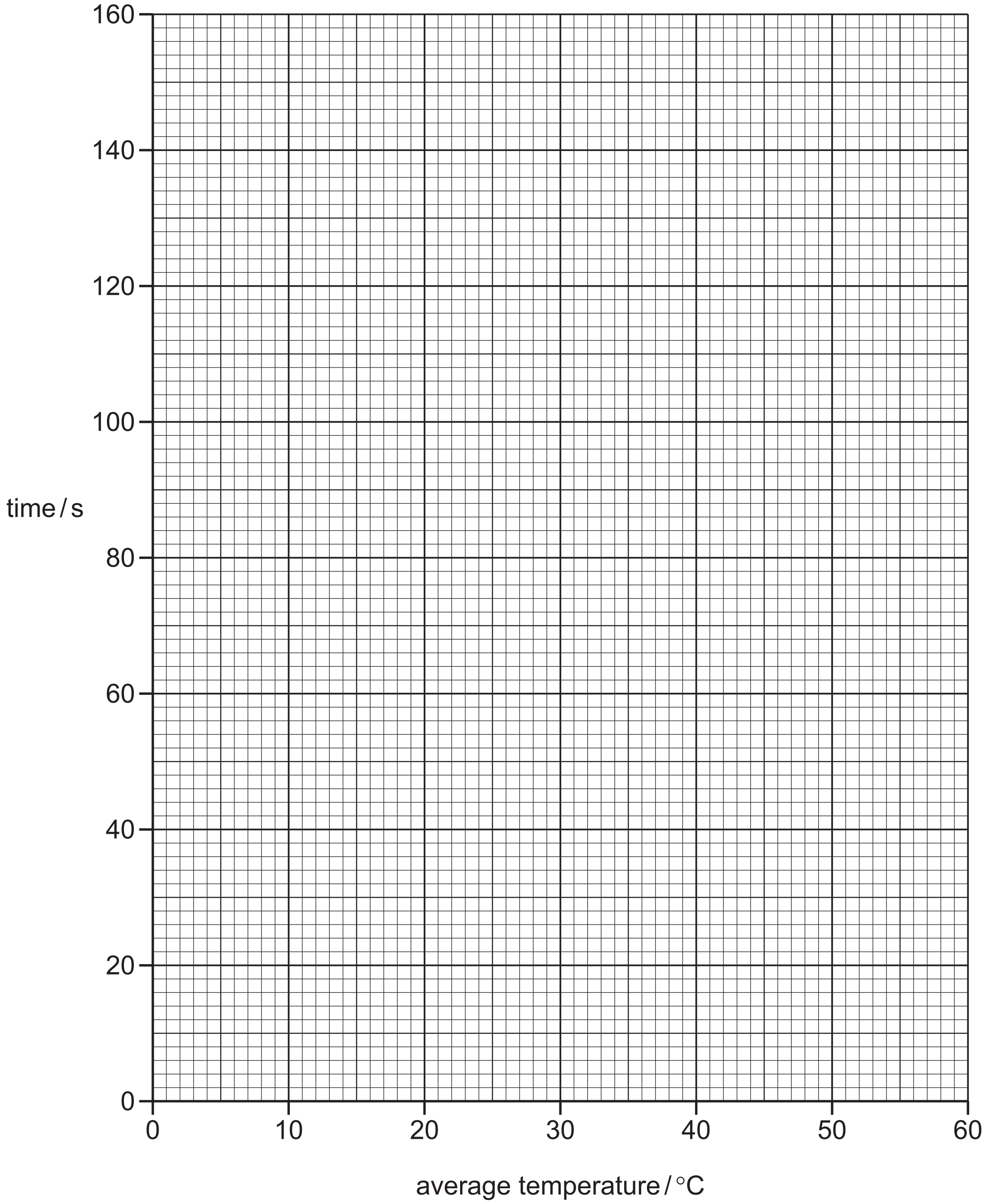
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow / s	initial temperature / °C	final temperature / °C	average temperature / °C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

.... [2]

(d) (i) In which experiment was the rate of reaction greatest?

.... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

....

....

.... [2]

(e) (i) Suggest and explain the effect **on the results** of using a burette to measure the volume of solution **J**.

....

.... [2]

(ii) Suggest and explain one **other** improvement to these experiments.

....

.... [2]

[Total: 17]

3 Two solids, **L** and **M**, were analysed. Solid **L** was copper(II) chloride and solid **M** was a different salt.
The tests on the solids, and some of the observations, are shown.

tests on solid L

(a) Describe the appearance of solid **L**.

observation .... [1]

(b) Distilled water was added to solid **L** and shaken to dissolve.

The solution was divided into four equal portions in four test-tubes and the following tests carried out.

(i) Drops of aqueous ammonia were added to the first portion of the solution.

Excess ammonia solution was then added to the mixture and shaken.

observation ....

....

....

.... [4]

(ii) Excess aqueous sodium hydroxide was added to the second portion of the solution.

observation ....

.... [1]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observation .... [1]

(iv) Dilute nitric acid was added to the fourth portion of the solution followed by aqueous barium nitrate.

observation .... [1]

tests on solid M

Tests are carried out and the following observations made.

tests on solid **M**	observations
Appearance of the solid.	white crystals
The solid was heated and the gas given off was tested with damp red litmus paper.	a sublimate formed on the sides of the test-tube litmus paper turned blue
Solid **M** was dissolved in water to form a solution. Aqueous sodium hydroxide was added to the solution and the mixture heated. The gas given off was tested.	pungent gas evolved pH paper showed pH 10
Dilute nitric acid was added to the solution followed by aqueous silver nitrate.	yellow precipitate

(c) Identify solid **M**.

....

.... [2]

[Total: 10]

4 The label on a bottle of orange drink stated 'contains no artificial colours'. A scientist thought that the orange colour in the drink was a mixture of two artificial colours:

- Sunset Yellow E110
- Allura Red E129

Plan an investigation to show that the orange colour in the drink did **not** contain these two artificial colours.
You are provided with samples of E110, E129 and the orange colouring from the drink. You are also provided with common laboratory apparatus.
You may draw a diagram to help answer the question.

....

....

....

....

....

....

....

.... [6]

[Total: 6]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9003309678

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **14** printed pages and **2** blank pages.

IB15 03_0620_42/7RP

CAMBRIDGE International Examinations

[Turn over

1 **(a)** The table below gives information about particles.

Complete the table. The first line has been done for you.

particle	number of protons	number of electrons	electronic configuration	charge on particle
A	12	10	2,8	2+
B		18	2,8,8	1–
C	18		2,8,8	0
D	8	10		

[4]

(b) Gallium is a Group III element.

Define the term *element*.

....

....

.... [1]

(c) The following are gallium atoms.

$^{69}_{31}Ga$ $^{71}_{31}Ga$

Complete the following table.

atom	number of protons	number of neutrons	number of electrons
$^{69}_{31}Ga$			
$^{71}_{31}Ga$			

[3]

[Total: 8]

2 Rubidium, Rb, is a Group I element. It has similar physical and chemical properties to the other elements in Group I.

(a) Predict how many electrons there are in the outer shell of a rubidium atom.

.... [1]

(b) Predict **one** physical property of rubidium which is the same as that of a transition element such as iron.

.... [1]

(c) Predict **two** physical properties of rubidium which are different to those of a transition element such as iron.

....

.... [2]

(d) When rubidium is added to cold water a reaction occurs.

(i) Suggest **two** observations that would be made when rubidium is added to cold water.

....

.... [2]

(ii) What would be the colour of the solution if methyl orange was added to it after the reaction?

.... [1]

(iii) Write a chemical equation for the reaction between rubidium and water.

.... [2]

(iv) Put the Group I elements, caesium, lithium, potassium, rubidium and sodium in their order of reactivity with water. Put the most reactive element first.

most reactive ⟶ least reactive

[1]

(v) Suggest **one** safety measure that should be used when rubidium is added to cold water.

.... [1]

(e) The phosphate ion has the formula PO_4^{3-}.

Deduce the formula of rubidium phosphate.

.... [1]

[Total: 12]

3 Carbon dioxide and silicon(IV) oxide are oxides of Group IV elements.

(a) Complete the following table.

	carbon dioxide	silicon(IV) oxide
formula		SiO_2
melting point / °C	–56	1610
physical state at 25 °C	gas	
conduction of electricity	non-conductor	
structure		macromolecular

[4]

(b) **(i)** Name the type of bonds that exist between the atoms in silicon(IV) oxide.

.... [1]

(ii) Explain why silicon(IV) oxide has a very high melting point.

....

.... [1]

(iii) Explain, in terms of attractive forces between particles, why carbon dioxide has a very low melting point.

....

.... [1]

(iv) Explain, in terms of particles, why carbon dioxide is a non-conductor of electricity.

....

.... [1]

(c) Suggest a chemical equation for the reaction between sodium hydroxide solution and carbon dioxide.

.... [2]

(d) **(i)** Name the type of chemical reaction in which carbon dioxide is produced from fossil fuels.

.... [1]

(ii) Name the chemical process in which green plants convert carbon dioxide into carbohydrates.

.... [1]

(iii) Name the chemical process in which living things produce carbon dioxide.

.... [1]

[Total: 13]

4 Hydrogen peroxide, H_2O_2, decomposes into water and oxygen in the presence of a catalyst, manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

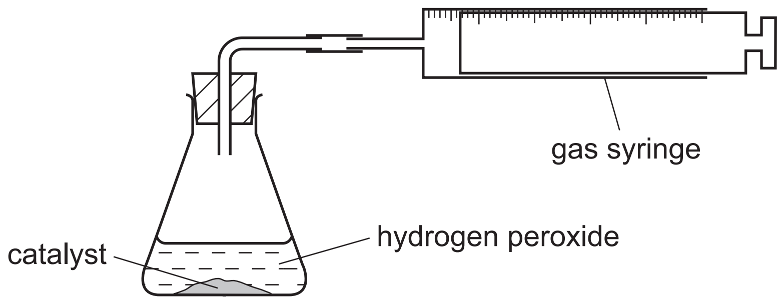
(a) What is meant by the term *catalyst*?

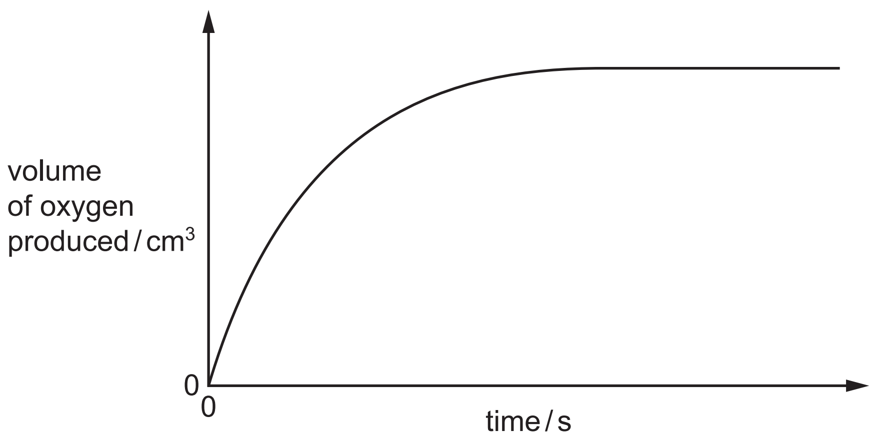
....

.... [2]

(b) A student studies the rate of decomposition of hydrogen peroxide using the apparatus shown. The student uses 20 cm^3 of 0.1 mol/dm^3 hydrogen peroxide and 1.0 g of manganese(IV) oxide.

The student measures the volume of oxygen given off at regular time intervals until the reaction stops. A graph of the results is shown.





(i) When is the rate of reaction highest?

.... [1]

(ii) Suggest **one** method of increasing the rate of reaction using the same amounts of hydrogen peroxide and manganese(IV) oxide.

.... [1]

(c) **(i)** Calculate the number of moles of hydrogen peroxide used in this experiment.

.... mol [1]

(ii) Use your answer to **(c)(i)** and the equation to calculate the number of moles of oxygen produced in the reaction.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

.... mol [1]

(iii) Calculate the volume (at r.t.p.) of oxygen produced.

.... dm^3 [1]

(iv) What would be the effect on the volume of oxygen produced if the mass of catalyst was increased?

.... [1]

(v) Deduce the volume of oxygen that would be produced if 20 cm^3 of 0.2 mol / dm^3 hydrogen peroxide was used instead of 20 cm^3 of 0.1 mol / dm^3 hydrogen peroxide.

.... dm^3 [1]

(d) The student carries out a second experiment to investigate whether another substance, copper(II) oxide, is a better catalyst than manganese(IV) oxide.

Describe how the second experiment is carried out. You should state clearly how you would make sure that the catalyst is the only variable.

....

....

....

....

....

.... [3]

[Total: 12]

5 This question is about compounds of nitrogen.

(a) (i) Describe the Haber Process giving reaction conditions and a chemical equation. Reference to rate and yield is not required.

....

....

....

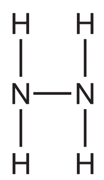
....

.... [5]

(ii) Give **one** use of ammonia.

.... [1]

(b) The diagram shows the structure of a hydrazine molecule.



Draw the electron arrangement of a hydrazine molecule. Show the outer shell electrons only.

[2]

(c) Hydrazine is a base.

(i) Define the term *base*.

.... [1]

(ii) Complete the chemical equation to show that hydrazine acts as a base when added to water.

$N_2H_4 + H_2O \rightarrow$ .... + ... [1]

(d) Nitrogen dioxide is an atmospheric pollutant.

(i) State **one** environmental problem caused by nitrogen dioxide.

.... [1]

(ii) Explain how oxides of nitrogen, such as nitrogen dioxide, are formed in car engines.

....

.... [2]

[Total: 13]

6 Iron pyrite, FeS_2, is known as Fool's Gold because it is a shiny yellow solid which is similar in appearance to gold. Iron pyrite is an ionic compound. Gold is a metallic element.

(a) Iron pyrite, FeS_2, contains positive and negative ions. The positive ion is Fe^{2+}.

Deduce the formula of the negative ion.

.... [1]

(b) A student is provided with a sample of iron pyrite and a sample of gold.

Suggest how the student could distinguish between the two substances.

....

.... [2]

(c) Sulfur dioxide is produced on a large scale by heating iron pyrite strongly in air. The iron pyrite reacts with oxygen in the air producing iron(III) oxide, Fe_2O_3, and sulfur dioxide.

(i) Construct a chemical equation for the reaction between iron pyrite and oxygen.

.... [2]

(ii) Give **one** use of sulfur dioxide.

.... [1]

[Total: 6]

7 **(a)** Alkanes and alkenes are examples of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

....

.... [1]

(ii) Give the general formula of straight-chain

alkanes, ...

alkenes. ....
[2]

(b) A compound X contains carbon, hydrogen and oxygen only.

X contains 54.54% of carbon by mass, 9.09% of hydrogen by mass and 36.37% of oxygen by mass.

(i) Calculate the empirical formula of compound X.

[2]

(ii) Compound X has a relative molecular mass of 88.

Deduce the molecular formula of compound X.

[2]

(c) An ester has the molecular formula $C_3H_6O_2$.

Name and give the structural formulae of **two** esters with the molecular formula $C_3H_6O_2$.

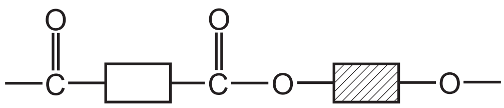
name of ester		
structural formula		

[4]

(d) Name the ester produced from the reaction of propanoic acid and methanol.

.... [1]

(e) A polyester is represented by the structure shown.



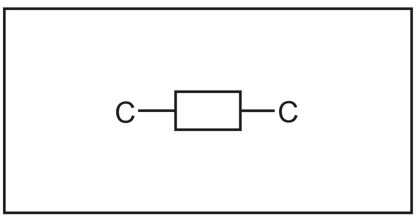
(i) What type of polymerisation is used for the production of polyesters?

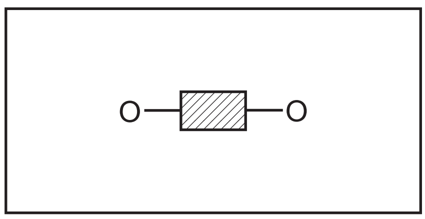
.... [1]

(ii) Which simple molecule is removed when the polyester is formed?

.... [1]

(iii) Complete the diagrams below to show the structures of the monomers used to produce the polyester. Show all atoms and bonds.





[2]

[Total: 16]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number atomic symbol name relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2016**

45 Minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

6492011221

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

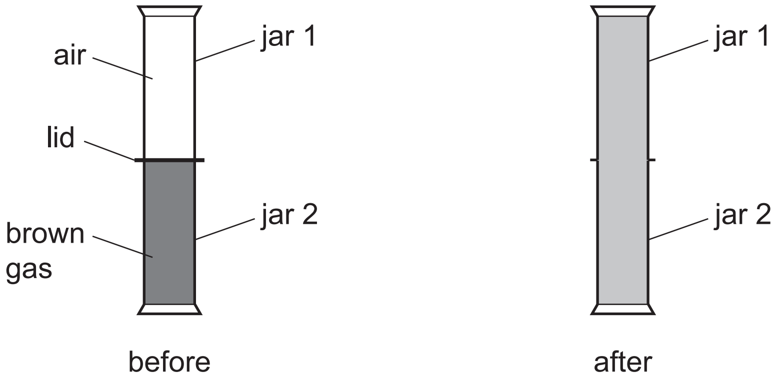
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

IB16 03_0620_22/3RP

CAMBRIDGE International Examinations

1 Two gas jars are set up as shown.



The lid is removed and the gas jars are left to stand. After some time the contents of both gas jars are brown.

Which process causes this to happen?

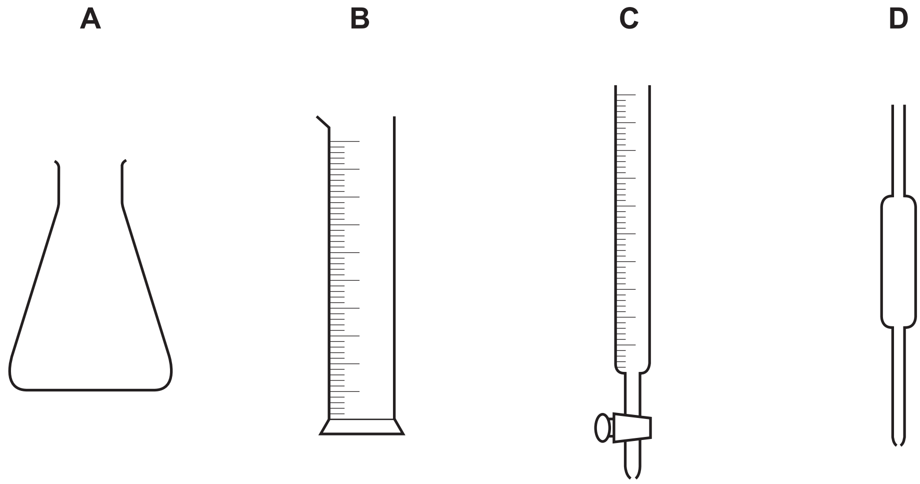
A condensation

B diffusion

C evaporation

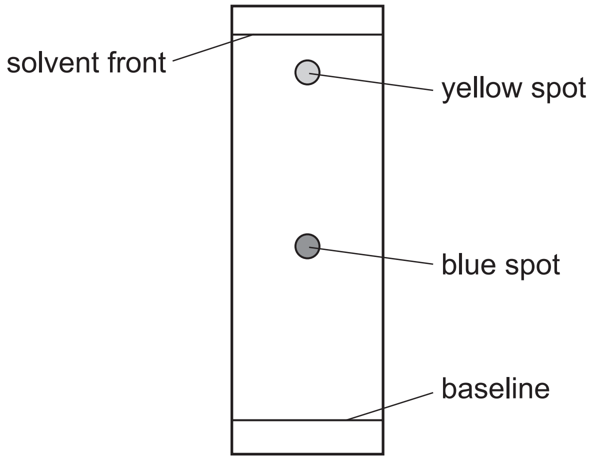
D filtration

2 Which piece of apparatus is used to measure variable quantities of liquid in a titration?



3 A sample of a green food colouring was separated into its component colours using paper chromatography.

The results obtained are shown.



What is the R_f value of the blue spot?

A 0.45 **B** 0.90 **C** 1.10 **D** 2.20

4 In which row are the substances correctly classified?

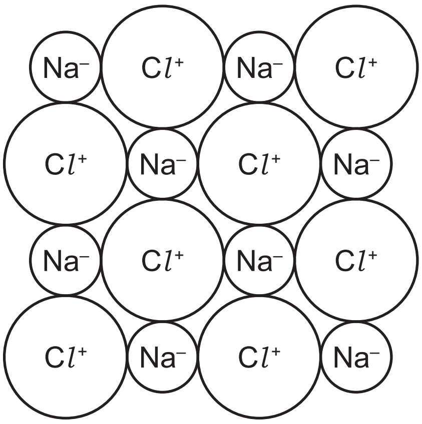
	element	compound	mixture
A	brass	sulfur	water
B	sulfur	brass	water
C	sulfur	water	brass
D	water	sulfur	brass

5 Which molecule contains only single covalent bonds?

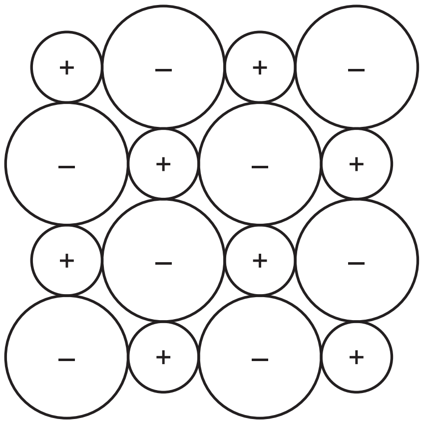
A Cl_2 **B** CO_2 **C** N_2 **D** O_2

6 Which structure represents the sodium chloride lattice?

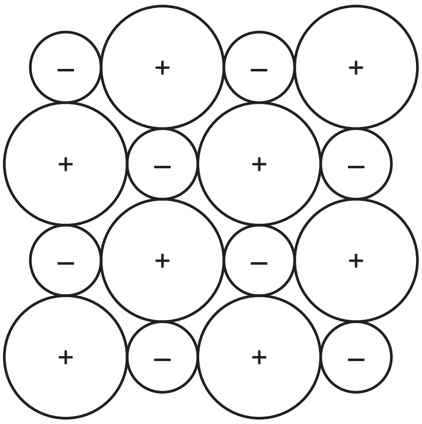
A



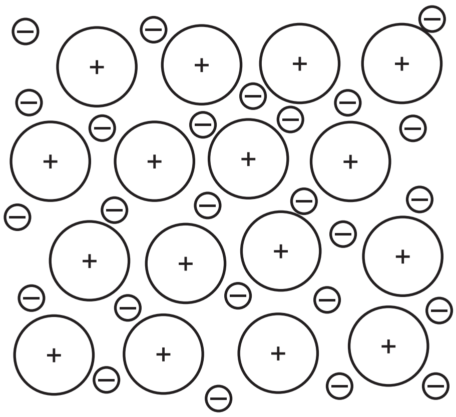
B



C



D



7 X and Y are isotopes of the same element.

Which statement is correct?

A X and Y have atoms with different numbers of electron shells.

B X and Y have atoms with the same nucleon number.

C X and Y have atoms with the same number of outer shell electrons.

D X and Y have different chemical properties.

8 Which quantities of chemicals will react exactly with no reactants left over?

A 12 g of carbon and 12 g of oxygen

B 12 g of carbon and 48 g of oxygen

C 12 g of magnesium and 16 g of oxygen

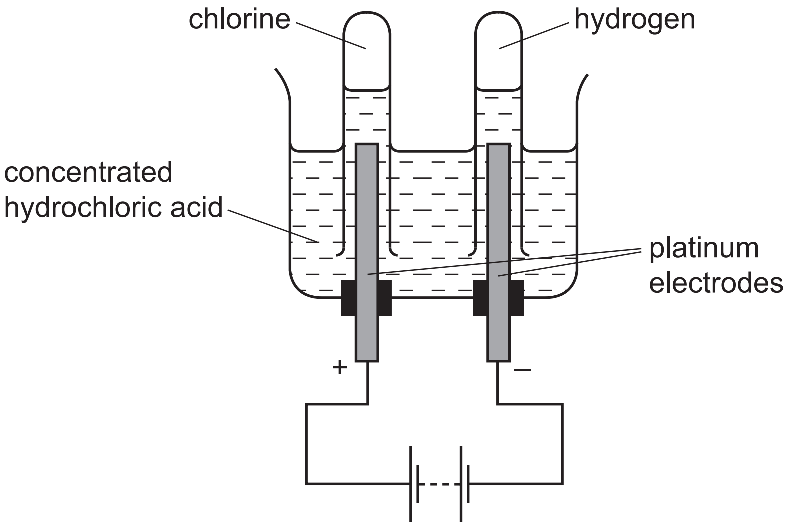
D 24 g of magnesium and 16 g of oxygen

9 Magnesium nitride is formed when magnesium burns in air. Magnesium nitride is an ionic compound.

What is the formula of magnesium nitride?

A MgN_2 **B** Mg_2N_2 **C** Mg_2N_3 **D** Mg_3N_2

10 The electrolysis of concentrated hydrochloric acid is shown.



Which statement describes what happens to the electrons during the electrolysis?

A They are added to chloride ions.

B They are added to hydrogen ions.

C They move through the circuit from positive to negative.

D They move through the solution from negative to positive.

11 Which reaction does **not** occur in the extraction of aluminium?

A $Al^{3+} + 3e^- \rightarrow Al$

B $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

C $2O^{2-} \rightarrow O_2 + 4e^-$

D $C + O_2 \rightarrow CO_2$

12 Which substance could **not** be used as a fuel to heat water in a boiler?

A ethanol

B hydrogen

C methane

D oxygen

13 Which row describes an endothermic reaction?

	energy needed to break bonds / kJ	energy released by forming bonds / kJ	temperature
A	400	200	decreases
B	400	800	decreases
C	600	200	increases
D	600	800	increases

14 A reversible reaction is shown.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -58\,kJ/mol$$

Which statement about an equilibrium mixture of NO_2 and N_2O_4 is correct?

A If the pressure is decreased the amount of N_2O_4 increases.

B If the temperature is increased the amount of N_2O_4 increases.

C The rates of formation and decomposition of N_2O_4 are not the same.

D The decomposition of N_2O_4 is an endothermic reaction.

15 Which statement about catalysts in chemical reactions is **not** correct?

A Catalysts are not used up in the reaction.

B Catalysts increase the energy of the reacting particles.

C Catalysts increase the rate of the reaction.

D Catalysts lower the activation energy.

16 Zinc is extracted from zinc blende by roasting it in air to form zinc oxide.

The zinc oxide is then heated with carbon to form zinc.

The equations for the reactions are shown.

1 $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

2 $ZnO + C \rightarrow Zn + CO$

Which statement about reactions 1 and 2 is **not** correct?

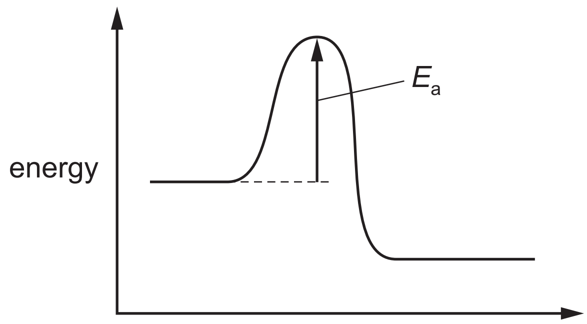
A In reaction 1 the oxidation state of sulfur increases and it is oxidised.

B In reaction 1 the oxidation state of zinc increases and it is oxidised.

C In reaction 2 the carbon acts as a reducing agent and it is oxidised.

D In reaction 2 the oxidation state of zinc decreases and it is reduced.

17 The diagram shows an energy level diagram for a reaction.



The diagram shows that the reaction is ......1...... .

Increasing the temperature increases the rate of reaction. A reason for this is that the ......2....... .

Which words correctly complete gaps 1 and 2?

	1	2
A	endothermic	activation energy decreases
B	endothermic	collision rate increases
C	exothermic	activation energy decreases
D	exothermic	collision rate increases

18 Concentrated hydrochloric acid is a *strong acid*.

What is meant by the terms 'strong' and 'acid'?

	strong	acid
A	contains a low proportion of water	accepts protons
B	contains a low proportion of water	donates protons
C	fully ionised	accepts protons
D	fully ionised	donates protons

19 Which oxide is amphoteric?

A aluminium oxide

B calcium oxide

C carbon monoxide

D sodium oxide

20 A salt is made by adding an excess of an insoluble metal oxide to an acid.

How is the excess metal oxide removed from the mixture?

A chromatography

B crystallisation

C distillation

D filtration

21 A substance is heated with aluminium foil in aqueous sodium hydroxide. A gas is produced which turns damp, red litmus paper blue.

Which anion is present in the substance?

A carbonate

B iodide

C nitrate

D sulfate

22 An element does not conduct electricity and exists as diatomic molecules.

Where in the Periodic Table is the element found?

23 In the Periodic Table, how does the metallic character of the elements vary from left to right across a period?

A It decreases.

B It increases.

C It increases then decreases.

D It stays the same.

24 The elements in a group of the Periodic Table show the following trends.

1 The element with the lowest proton number has the lowest reactivity.

2 All the elements in the group form basic oxides.

3 The density of the elements increases down the group.

4 The melting point of the elements decreases down the group.

In which group are the elements found?

A I **B** IV **C** VI **D** VII

25 Brass is an alloy of two metals.

Which row gives a correct use for the two metals from which brass is made?

	metal 1	metal 2
A	used for electrical wiring	used for galvanising steel
B	used for galvanising steel	used for making aircraft
C	used for making aircraft	used for making cutlery
D	used for making cooking pans	used for electrical wiring

26 Iron is extracted from hematite in the blast furnace.

The hematite contains silicon(IV) oxide (sand) as an impurity.

What reacts with this impurity to remove it?

A calcium oxide

B carbon

C carbon dioxide

D slag

27 The reaction below is called the ‘thermite reaction’.

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

Which pair of substances reacts in a similar way?

A Fe and MgO

B Fe and ZnO

C Mg and CuO

D Zn and Al_2O_3

28 One method of preventing the rusting of iron is to keep oxygen away from the surface of the metal.

Which way of rust prevention does **not** use this method?

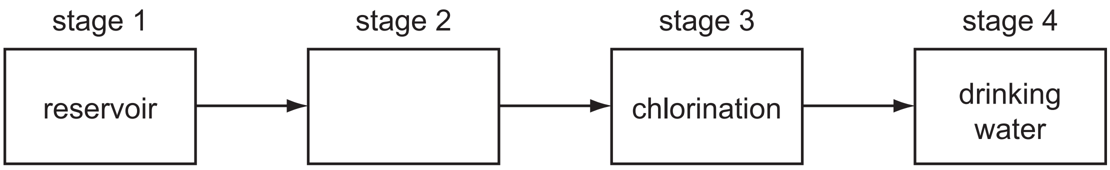
A coating the iron with grease

B connecting the iron to a more reactive metal

C covering the iron with plastic

D painting the iron

29 The diagram shows how water is treated to make it suitable for drinking.



What happens in stage 2?

A condensation

B distillation

C evaporation

D filtration

30 Nitrogen monoxide is produced in a car engine when petrol is burnt.

The gases from the car engine are passed through a catalytic converter.

In the catalytic converter the nitrogen monoxide reacts with carbon monoxide to form nitrogen and carbon dioxide.

Which statement is **not** correct?

A Carbon monoxide is oxidised in the catalytic converter.

B Carbon monoxide is produced by the complete combustion of petrol.

C Nitrogen monoxide is formed by the reaction of nitrogen and oxygen.

D Nitrogen monoxide is reduced in the catalytic converter.

31 Which pollutant gas can be produced as a result of incomplete combustion of octane, C_8H_{18}?

A carbon

B carbon dioxide

C carbon monoxide

D methane

32 Fertilisers are used to provide three elements needed to increase the yield of crops.

Which two compounds would provide all three of these elements?

A ammonium nitrate and calcium phosphate

B ammonium nitrate and potassium sulfate

C potassium nitrate and calcium phosphate

D potassium nitrate and potassium sulfate

33 What is a property of concentrated sulfuric acid but **not** of dilute sulfuric acid?

A It is a dehydrating agent.

B It neutralises alkalis.

C It produces a white precipitate with barium nitrate.

D It reacts with metals to give a salt and hydrogen.

34 Why does a farmer put lime (calcium oxide) on the soil?

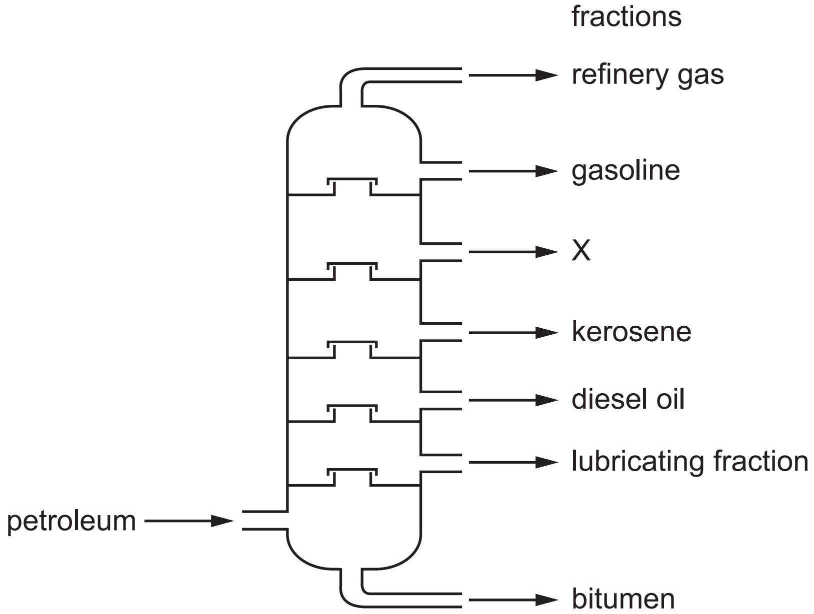
A to act as a fertiliser

B to kill pests

C to make the soil less acidic

D to make the soil less alkaline

35 What is the name of fraction X?



A alcohol

B fuel oil

C naphtha

D paraffin

36 Which compounds are alkanes?

compound	W	X	Y	Z
formula	C_4H_{10}	C_5H_{10}	C_6H_{12}	C_6H_{14}

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

37 The statements below are about the alcohol homologous series.

The alcohols have the same ......1...... formula.

The alcohols have ......2...... chemical properties because they have the same ......3...... .

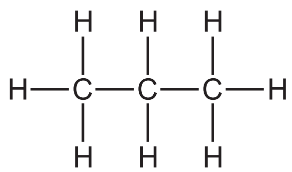
The melting points of the alcohols ......4...... as the number of carbon atoms increases.

Which words correctly complete gaps 1–4?

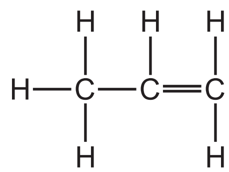
	1	2	3	4
A	general	different	functional group	decrease
B	general	similar	electronic structure	increase
C	general	similar	functional group	increase
D	molecular	similar	functional group	increase

38 Which structure represents a compound that dissolves in water to form an acidic solution?

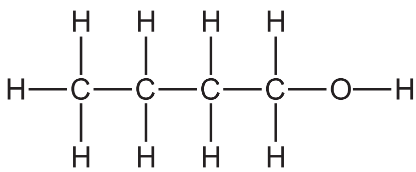
A



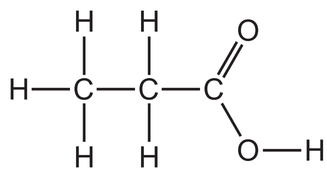
B



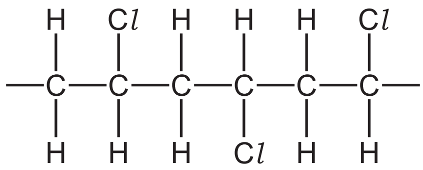
C



D

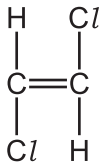


39 The partial structure of an addition polymer is shown.

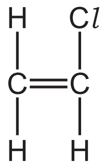


What is the structure of the monomer used to make this polymer?

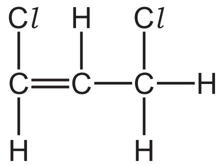
A



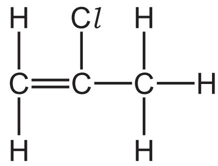
B



C



D



40 Which statement about polymers is correct?

A Addition polymers are all biodegradable.

B Condensation polymers can all be hydrolysed to give amino acids.

C Condensation polymers only exist in nature.

D Forming addition polymers produces only one product.

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			**Key** atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
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87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the March 2016 series

0620 CHEMISTRY

0620/62 Paper 6 (Alternative to Practical), maximum raw mark 40

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Abbreviations used in the Mark Scheme

- ; separates marking points
- / separates alternatives within a marking point
- () the word or phrase in brackets is not required but sets the context
- **A** accept (a less than ideal answer which should be marked correct)
- **I** ignore (mark as if this material were not present)
- **R** reject
- ecf credit a correct statement that follows a previous wrong response
- ora or reverse argument
- owtte or words to that effect (accept other ways of expressing the same idea)

Question	Answer	Marks
1(a)	tripod; stirring rod / stirrer;	**2**
1(b)(i)	B C A;	**1**
1(b)(ii)	filtration;	**1**
1(c)(i)	water;	**1**
1(c)(ii)	filtrate;	**1**
1(d)	solid / crystals appearing on edge / glass rod test;	**1**

Question	Answer	Marks
2(a)	In each column: 4 correct = [2] 3 correct = [1] average temperature boxes completed correctly: 16, 27, 41, 50; times completed in seconds correctly: 128, 58, 27, 18;	**4**
2(b)	all points plotted correctly = [3] smooth line graph;	**4**
2(c)	value from graph: 12–13 s; extrapolation;	**2**
2(d)(i)	Experiment 4;	**1**
2(d)(ii)	any **2** from: highest temperature; more energy; more (chance of) collisions;	**2**
2(e)(i)	more accurate; than a measuring cylinder;	**2**

Question	Answer	Marks
2(e)(ii)	insulation / use a lid; to reduce heat losses; OR repeats; average results; OR measure water or sulphuric acid or methyl orange using a burette / use a 2 d.p. stopwatch / digital thermometer; reference to accuracy;	**2**

Question	Answer	Marks
3(a)	blue / green (solid / crystals);	**1**
3(b)(i)	(pale) blue; precipitate; royal / deep blue; dissolves / solution;	**4**
3(b)(ii)	(pale) blue precipitate;	**1**
3(b)(iii)	white precipitate;	**1**
3(b)(iv)	no reaction / change / precipitate;	**1**
3(c)	ammonium; iodide;	**2**

Question	Answer	Marks
4	any **6** from: chromatography; (pencil) baseline / origin; apply orange colour to paper; and samples of both E110 and E129; solvent / named solvent; check heights of spots of E colours against orange drink; conclusion / allow comparison to known R_f values;	**6**

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the February/March 2016 series

0620 CHEMISTRY

0620/42 Paper 4 (Extended Theory), maximum raw mark 80

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Abbreviations used in the Mark Scheme

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- **R** reject
- ecf credit a correct statement that follows a previous wrong response
- ora or reverse argument
- owtte or words to that effect (accept other ways of expressing the same idea)

Question	Answer	Marks
1(a)	B = 17; C = 18; D = 2,8; 2^- / $^-2$;	**4**
1(b)	Substance that cannot be broken down into anything simpler / substance that cannot be broken down (by chemical means) / substance containing **atoms** with the same atomic number or proton number;	**1**
1(c)	<table><tr><td>number of protons</td><td>number of neutrons</td><td>number of electrons</td></tr><tr><td>31</td><td>38</td><td>31</td></tr><tr><td>31</td><td>40</td><td>31</td></tr></table>**M1** column one; **M2** column two; **M3** column three;	**3**

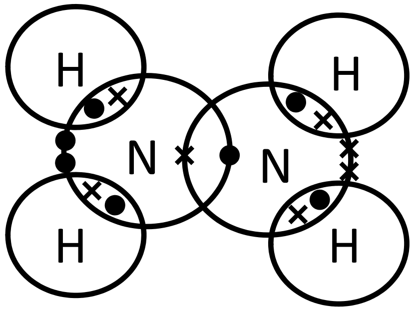
Question	Answer	Marks
2(a)	1;	**1**
2(b)	conducts electricity or heat / malleable / ductile / sonorous / shiny;	**1**
2(c)	any two from: • (low) melting point / (low) boiling point; • hardness / softness / rubidium can be cut easily; • strength; • (low) density;	**2**

Question	Answer	Marks
2(d)(i)	any two from: • bubbles / effervescence / fizzing; • flame / sparks / ignites; • movement; • dissolves / forms a solution / disappears / gets smaller; • floats; • rubidium melts / rubidium forms a ball; • explosion;	**2**
2(d)(ii)	yellow;	**1**
2(d)(iii)	$2Rb + 2H_2O \rightarrow 2RbOH + H_2$ formula of RbOH; whole equation completely correct;	**2**
2(d)(iv)	caesium → rubidium → potassium → sodium → lithium / Cs → Rb → K → Na → Li;	**1**
2(d)(v)	goggles / glasses / gloves / safety screen / stand at safe distance / tongs / open space;	**1**
2(e)	Rb_3PO_4;	**1**

Question	Answer	Marks
3(a)	<table><tr><td>CO_2;</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td>solid;</td></tr><tr><td></td><td>poor conductor / non-conductor;</td></tr><tr><td>simple molecular / simple (covalent);</td><td></td></tr></table>	**4**
3(b)(i)	covalent;	**1**

Question	Answer	Marks
3(b)(ii)	all bonds are (very) strong or bonds; **or** bonds need a lot of energy or heat to break; **or** (there are) no weak bonds / no (weak) intermolecular forces;	**1**
3(b)(iii)	weak forces between molecules; **or** weak intermolecular forces or weak van der Waals' forces; **or** low amount of energy needed to break intermolecular / van der Waals' forces;	**1**
3(b)(iv)	no (moving) ions / no mobile or moving electrons / all electrons used in bonding / made of uncharged molecules;	**1**
3(c)	$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$ **or** $NaOH + CO_2 \rightarrow NaHCO_3$ formula of Na_2CO_3 / $NaHCO_3$; whole equation correct;	**2**
3(d)(i)	(complete) combustion / burning;	**1**
3(d)(ii)	photosynthesis;	**1**
3(d)(iii)	respiration;	**1**

Question	Answer	Marks
4(a)	**M1** (substance that) speeds up a reaction / increases the rate of a reaction; **M2** any one from: unchanged (chemically at the end) / not used up; lowers activation energy;	**2**
4(b)(i)	at the start/initially / t = 0;	**1**
4(b)(ii)	catalyst should be powdered / increase surface area (of catalyst) / decrease particle size (of catalyst); **or** increase temperature / heat / warm;	**1**
4(c)(i)	0.002 (mol);	**1**
4(c)(ii)	0.001 (mol);	**1**
4(c)(iii)	0.024 (dm^3);	**1**
4(c)(iv)	no change / no effect;	**1**
4(c)(v)	0.048 (dm^3);	**1**
4(d)	same mass / amount of / moles / 1.0 g of catalyst; same temperature; same volume **and** concentration of hydrogen peroxide / 20 cm^3 of 0.1 mol / dm^3 of hydrogen peroxide or reactant;	**3**

Question	Answer	Marks
5(a)(i)	pressure in range 150–300 atmospheres / atm; temperature in range 370–470 °C; iron (catalyst); balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$; equilibrium / reversible;	**5**
5(a)(ii)	manufacture of fertilisers / nylon / nitric acid / cleaning agent(allow oven cleaner) / hair dye / urea / refrigeration / explosives;	**1**
5(b)	 **M1** all shared electrons correct (5 bonds); **M2** exactly two non-bonding electrons on each N and no additional non-bonding electrons;	**2**
5(c)(i)	proton / H^+ acceptor;	**1**
5(c)(ii)	$(N_2H_4 + H_2O) \rightarrow N_2H_5^+ + OH^-$; **or** $(N_2H_4) + 2H_2O \rightarrow N_2H_6^{2+} + 2OH^-$;	**1**
5(d)(i)	acid rain / effect of acid rain / (photochemical) smog / (producing) low level ozone;	**1**
5(d)(ii)	**M1** nitrogen and oxygen (from the air) react / combine or word equation; **M2** at high temperature / spark / very hot;	**2**

Question	Answer	Marks
6(a)	S_2^{2-}; **or** S^-;	**1**
6(b)	test conductivity; gold conducts / ora; **or** malleability / hit with a hammer; gold malleable / only gold produces ringing sound / ora; **or** density; gold denser / ora; **or** add acid / any named / formula of acid; gold does not react (ignore products with pyrites) / ora; **or** heat (both strongly) in air / oxygen; iron pyrite reacts (ignore products); **or** melting point; gold lower / ora; **or** heat with a more reactive metal than iron; gold does not react / ora;	**2**
6(c)(i)	$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$ all formulae; balancing;	**2**

Question	Answer	Marks
6(c)(ii)	bleaching (in the manufacture of) wood pulp (for paper or straw or wool or cotton) / (food) preservative or killing bacteria in food or wine / fumigant / refrigerant / tanning(leather);	**1**

Question	Answer	Marks
7(a)(i)	compound containing carbon and hydrogen only;	**1**
7(a)(ii)	C_nH_{2n+2}; C_nH_{2n};	**2**
7(b)(i)	mol C = 54.54 / 12 or 4.5(45) **and** mol H = 9.09 / 1 or 9.09 **and** mol O = 36.37 / 16 or 2.27; C_2H_4O;	**2**
7(b)(ii)	M_r of C_2H_4O = 44; 88 / 44 = 2 therefore $C_4H_8O_2$;	**2**
7(c)	methyl ethanoate; / ethyl methanoate; CH_3COOCH_3; / $HCOOC_2H_5$;	**4**
7(d)	methyl propanoate;	**1**
7(e)(i)	condensation;	**1**
7(e)(ii)	water / H_2O;	**1**
7(e)(iii)	dicarboxylic acid or diacyl chloride; diol;	**2**

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the March 2016 series

0620 CHEMISTRY

0620/22 Paper 2 (Multiple Choice – Extended), maximum raw mark 40

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the March 2016 series for most Cambridge IGCSE® and Cambridge International A and AS Level components.

CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**C**	22	**C**
3	**A**	23	**A**
4	**C**	24	**A**
5	**A**	25	**A**
6	**B**	26	**A**
7	**C**	27	**C**
8	**D**	28	**B**
9	**D**	29	**D**
10	**B**	30	**B**
11	**B**	31	**C**
12	**D**	32	**C**
13	**A**	33	**A**
14	**D**	34	**C**
15	**B**	35	**C**
16	**B**	36	**B**
17	**D**	37	**C**
18	**D**	38	**D**
19	**A**	39	**B**
20	**D**	40	**D**

CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**C**	22	**A**
3	**A**	23	**D**
4	**C**	24	**D**
5	**D**	25	**D**
6	**D**	26	**A**
7	**A**	27	**D**
8	**C**	28	**D**
9	**B**	29	**C**
10	**C**	30	**C**
11	**D**	31	**C**
12	**C**	32	**D**
13	**C**	33	**C**
14	**B**	34	**C**
15	**A**	35	**B**
16	**B**	36	**B**
17	**D**	37	**B**
18	**D**	38	**C**
19	**C**	39	**C**
20	**C**	40	**D**

General comments

Candidates performed well on this paper.

Questions 1, **2**, **14** and **28** were answered correctly by most candidates.

Questions 11 and **25** and **39** proved to be the most challenging with only the strongest candidates answering correctly.

Comments on specific questions

Question 4

A number of candidates wrongly selected **B**, thinking that brass (an alloy) is a compound.

Question 9

Candidates did not appear confident in this area, with a significant number giving **C** as the answer.

Question 10

Weaker candidates selected **A**, with these candidates recognising the correct products but the wrong electrodes.

Question 13

Weaker candidates mistook increasing particle size for increasing surface area and so selected **A**.

Question 16

A significant number of candidates selected **C**, showing that while they realised that red shows an acid they did not know that orange also shows acidity.

Question 20

A number of candidates did not realise the significance of 'diatomic molecules' which leads to Group 7 rather than Group 8 and so selected **B** as their answer.

Question 23

Less confident candidates gave **B** as the answer because it showed a coloured oxide.

Question 24

Candidates did not appear to be familiar with the properties of uranium, with a number giving **A** as the answer.

Question 31

A number of candidates selected **B**, possibly misreading 'potassium' for 'phosphorus'.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**C**	22	**C**
3	**A**	23	**A**
4	**C**	24	**A**
5	**A**	25	**A**
6	**B**	26	**A**
7	**C**	27	**C**
8	**D**	28	**B**
9	**D**	29	**D**
10	**B**	30	**B**
11	**B**	31	**C**
12	**D**	32	**C**
13	**A**	33	**A**
14	**D**	34	**C**
15	**B**	35	**C**
16	**B**	36	**B**
17	**D**	37	**C**
18	**D**	38	**D**
19	**A**	39	**B**
20	**D**	40	**D**

General comments

Overall, candidates performed well on this paper and showed strong subject knowledge.

Comments on specific questions

Question 3

Weaker candidates measured the distances correctly but inverted the formula for calculation and so gave **D** as the answer.

Question 10

D was a common incorrect answer. Candidates understood that electrons move from negative to positive but some did not realise that this only happens in the external circuit, not through the solution.

Question 15

D was a common incorrect answer.

Question 17

Most candidates realised that increasing temperature increases collision rate but some candidates appear to have misread the energy level diagram taking the initial rise to indicate an endothermic reaction, giving **B** as their answer.

Question 23

A number of weaker candidates selected **C** as the answer and may have confused the change in metallic character with a different property such as melting point.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- The standard of English shown in answers was good.
- Candidates should be reminded to read questions carefully in order to understand exactly what is being asked and to check that they have included this in their answers.
- Interpretation of data from tables and completion of chemical equations was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. Weaker candidates sometimes left questions unanswered but on the whole candidates attempted all questions. Questions involving general chemistry including, electrolysis and atomic structure were tackled well by many candidates.

Some candidates need more practice in reading and interpreting questions. Occasionally questions were misinterpreted by a small number of candidates. For example, in question **4(b)(iv)** many candidates gave the name of an element and not a compound, whilst in **5(d)(ii)** many did not refer to the equation and gave only vague answers about hydrated or anhydrous salts, often using copper(II) sulfate as an example rather than the cobalt(II) chloride shown in the equation.

Candidates need more practice in answering extended questions such as **3(a)** (the reaction of sodium or iron with water or steam) and **4(a)** (relating properties to structure and bonding). Stronger candidates were able to note the bullet points provided and could select relevant information and organise ideas in a logical way. Other candidates need practice in answering questions relating to practical procedures such as those relating to crystallisation and describing a practical method for determining reaction rate.

Many candidates were able to extract information from tables and balance symbol equations but some candidates need more practice in writing word equations. Most candidates were able to undertake simple calculations of relative formula mass but weaker candidates did not always manage to do this successfully.

Comments on specific questions

Question 1

(a) (i) Most candidates identified nitrogen. The most common error was to suggest oxygen.

(ii) Many candidates correctly identified carbon dioxide. The most common incorrect answer was oxygen.

(iii) Only the strongest candidates gave the correct answer of aluminium. A wide variety of incorrect answers were given. Non-metals such as silicon, oxygen and sulfur were often given.

(iv) This question proved challenging with many candidates giving, chlorine, iodine or the noble gases as the answer. Of the metals, lithium was a common incorrect answer.

(v) This question was answered well by most candidates. Weaker candidates gave the incorrect answers of iron or lithium.

(b) (i) There were some good definitions given for this question. However, there were also statements which were contradictory e.g. 'compounds made of the same types of atoms'. The most common incorrect answers related to the same type of molecule, many atoms joining together or 'a single atom'.

(ii) Stronger candidates understood the isotopic notation. Other candidates suggested that the number of neutrons in the two isotopes was 43 and 48 respectively. A significant number of candidates suggested that there were 23 and 28 electrons (rather than 20 in each isotope) and a small number of candidates suggested a small number of neutrons e.g. 2 and 3 respectively.

(iii) Although this question was answered correctly by some candidates, it proved challenging for many. Candidates needed to realise that the calcium ion has two electrons fewer than the calcium atom and weaker candidates gave an incorrect answer of 20. A few candidates added the 2 electrons to give an incorrect answer 22.

Question 2

(a) Some candidates identified both electrolysis products correctly. Others either gave two correct products but at the wrong electrodes or gave bromide rather than bromine as the product at the positive electrode. A number of candidates suggested incorrect products not related to potassium bromide e.g. copper or iron.

(b) (i) Most candidates gave a suitable explanation for the use of graphite as an electrode. Some candidates suggested 'good conductor' but did not go on to refer to electricity. Other answers suggested that the electrodes are reactive.

(ii) A majority of the candidates gave a correct use for graphite. The most frequently seen incorrect answers were 'for drills' or 'for cutting'. Occasionally answers also suggested that graphite is used instead of coke in a blast furnace. Some candidates identified its use in steelmaking.

(c) Most candidates were able to identify bromine. Common incorrect answers were chloride or bromide. A few candidates suggested iodine even though no iodine was present in the reaction mixture.

(d) A few candidates recognised that a cream-coloured precipitate would be formed. However, many candidates stated that there is a 'colour change' without specifying the colour or precipitate. A small number of weaker candidates either just named the precipitate, suggested bubbles would be seen or that the solution would become acidic.

(e) This question proved challenging and many answers given were vague. Examples of these answers included 'kills cells', 'harmful' or 'causes infections'.

Question 3

(a) Stronger candidates gave well-written answers giving all relevant details. However, there were often vague statements which omitted the observations. Common incorrect answers included sodium oxide as a product; sodium bursts into flames or explodes; iron rusts or the iron melts and forms bubbles.

(b) Many candidates omitted the use of a stop clock or did not mention timing the reaction. The majority of candidates did not measure the volume of gas released and just suggested adding the iron to the acid until it dissolved, often omitting a mention of timing the disappearance. Some candidates drew a graph of rate against volume of gas rather than against time. A considerable number of weaker candidates suggested a titration.

(c) Stronger candidates realised that the rate of reaction was faster when the particle size was smaller. However, many candidates incorrectly stated that the iron powder reacted more slowly than the large or medium sized pieces of iron.

(d) (i) Very few candidates commented on the shape of the graph.

(ii) A majority of the candidates determined the rate of reaction correctly. The most common incorrect answer was 17 cm^3. A few candidates gave 24 cm^3 or 26 cm^3.

(e) Many candidates described the effect of concentration on rate of reaction correctly. A considerable minority did not appear to have read the question accurately and referred to the effect of temperature on rate or referred to time instead of rate.

Question 4

(a) This proved to be a challenging question for the majority of candidates. Many candidates did not discuss both the volatility and electrical conductivity of sodium chloride and nitrogen. A common error was to suggest that the more volatile a substance, the higher the boiling point is. Other common errors included the suggestion that sodium chloride is a simple covalent molecule or that sodium chloride conducts electricity as a solid. When referring to the electrical conduction of sodium chloride, many candidates did not mention the state. Stronger candidates mentioned that sodium chloride is a giant structure.

(b) (i) Nearly all candidates understood that a catalyst speeds up a reaction.

(ii) Many candidates balanced the equation correctly. The most common error was to balance the hydrogen with 2 rather than 3.

(iii) Many candidates completed the electronic structure. Common errors included: the addition of extra electrons on the hydrogen atoms; lack of two non-bonded electrons on the nitrogen atom (which did not have to be paired); one or three electrons in the bonding 'overlap' areas.

(iv) There was often a lack of precision in answers to this question. Many candidates gave copper as the answer, which was incorrect. Candidates also demonstrated that they were referring to the copper on the right hand side of the equation by writing incorrect answers such as 'the copper has reacted with the nitrogen'. A number of candidates suggested that either nitrogen or hydrogen or oxygen was being reduced.

Question 5

(a) (i) Many candidates were able to extract information from the table correctly and answered this question accurately. However, fewer gave a correct reason with density often given. Some answers were too vague and lacked reference to the good heat conduction. The most common incorrect metal selected was cobalt.

(ii) Most candidates selected a suitable property of a transition element from the table.

(iii) A significant minority selected copper or tin for use in aircraft bodies rather than magnesium and gave incorrect reasons such as good conductivity of heat. A few candidates gave imprecise answers such as 'less dense'.

(b) A majority of the candidates gave the correct order of reactivity. Weaker candidates reversed one pair of metals.

(c) The strongest candidates were able to give full answers to this question. Common errors included thinking that the residue after filtrate was cobalt(II) carbonate; suggesting heating the solution to dryness. Imprecise answers were also seen, such as 'crystallising the cobalt sulfate' or 'drying the crystals' without suggesting how to do these.

(d) (i) This was generally answered correctly.

(ii) Many candidates did not refer to the reaction shown in the question and wrote about hydration or dehydration without mentioning the chemicals involved or the colour change.

Question 6

(a) The strongest candidates made it clear that the Universal Indicator should be added to the lemon juice. Weaker candidates just referred to the citric acid turning red. Better answers related the range of colours to the pH, rather than just referring to a pH scale 1 to 14 and writing about colour matching. Many thought that the question was about the colour of the indicator in acid rather than finding the exact pH and gave answers referring to the indicator turning red. The indicator was also often confused, with litmus and methyl orange being mentioned.

(b) (i) Most candidates were able to identify the carboxylic acid group. The most common error was to include one or more adjacent carbon atoms.

(ii) This was generally well answered with many candidates giving ethanoic acid or butanoic acid. The most frequently seen incorrect answers were a mineral acid e.g. hydrochloric acid. Other common errors included ethanol and ethane.

(c) (i) This was generally answered correctly. Common errors included carbonate or carbon instead of carbon dioxide and oxygen or hydrogen instead of water.

(ii) This was fairly well answered. However, weaker candidates suggested either distillation or evaporation, not realising that the solution when evaporated would also contain solid calcium citrate.

(d) This question was challenging, with only the strongest candidates understanding the energy level diagram.

(e) (i) Many candidates balanced the equation correctly. The most common errors were $3CO_2$ or $4CO_2$.

(ii) Only a few candidates gave two suitable conditions for fermentation. There were a number of answers which were too vague, such as ‘temperature’. High pressure was often mentioned and many candidates thought that oxygen was necessary.

(iii) This was answered well by many candidates. The most common incorrect answer was 201 obtained using eight carbon atoms and only one hydrogen atom.

Question 7

(a) Many candidates produced good answers to this question and described at least two physical properties of transition elements. Common errors included describing chemical properties, describing properties of transition element compounds such as oxides or describing their position in the Periodic Table.

(b) This was often well answered. Weaker answers left the formula as Re_3Cl_9 or miscounted the atoms and suggested incorrect formulae such as $ReCl_2$ or did not count the atoms at all and gave ReCl.

(c) Most candidates were able to describe sublimation. Weaker candidates suggested either that ‘solids are broken down’ or ‘liquid to gas’. A few wrote vaguely that ‘it is a change of state’.

(d) (i) Nearly all candidates identified the correct pH value. The most common error was to suggest pH 7.

(ii) Many candidates recognised that water is formed when an acid reacts with a hydroxide. The most common error was to suggest hydrogen.

(iii) Most candidates answered this correctly. The most common errors were to suggest that either hydrochloric acid or sodium carbonate react with perrhenic acid.

(e) Better candidates realised that the test for oxygen involved a glowing splint. However, weaker candidates suggested that the splint should be lit. A greater number of candidates gave the correct result. Very few candidates mentioned popping or explosions. A minority of the candidates gave vague or incorrect answers such as ‘mix with a gas’, ‘heat’ or ‘use litmus’.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

- Candidates need to be aware of the distinction between intramolecular forces (which are covalent bonds) and intermolecular forces such as van der Waals forces. The terms were often used interchangeably or incorrectly.
- Candidates should learn how to name and draw the structures of organic molecules. The names and formulae of esters was required and it was evident that many candidates were unprepared for this.
- Candidates should learn how to write the formulae of ionic compounds. The incorrect formula of sodium carbonate was seen far more often than the correct version.
- Candidates should take more care in writing formulae. Upper case letters should be the same size as each other, e.g. Na_2CO_3 not Na_2co_3. Carbon dioxide is written CO_2 as opposed to Co_2.

General comments

- If a question asks for one answer, it is advisable for candidates to give one answer rather than more than one.
- Candidates are advised not to use abbreviations unless it is certain that they are recognised, e.g. atm for atmospheres is acceptable but atp is not recognised.
- Candidates who write outside the allocated space, e.g. on blank pages should indicate they have done so in the allocated space.
- When something is crossed out, candidates are advised not to write over the original.

Comments on specific questions

Question 1

(a) This question was usually answered very well.

(b) Some of the answers given were definitions of an atom rather than an element. Some candidates referred to elements as containing one atom rather than one kind of atom. Others thought that elements could not be broken down into anything smaller rather than simpler.

(c) This question was answered very well.

Question 2

(a) Candidates needed to recognise that all Group 1 elements have one electron in their outer shell rather than trying to deduce the electron configuration from the atomic number. Some candidates gave the answer 3 by attempting this.

(b) Many candidates gave physical properties, such as hardness or melting point, in which rubidium would be expected to differ from transition elements.

(c) Although this was answered better than **(b)** there was some confusion between chemical and physical properties**.** Some weaker candidates thought reactivity was a physical property.

(d) (i) Many candidates thought that the names of the products and the fact that the reaction was fast, vigorous or even violent were examples of observations. Although fizzing, bubbling or effervescence are all acceptable alternatives to each other, they are not different from each other.

(ii) Many candidates were either unaware that the solution was alkaline after the reaction or unaware that methyl orange was yellow in an alkaline solution.

(iii) Those who used correct formulae usually managed to balance the equation. Rubidium oxide (with both correct and incorrect formulae) was seen as an alternative to rubidium hydroxide. Hydrogen was sometimes absent as a product or its formula was given as H.

(iv) There were many correct answers to this question. The most common errors were to reverse the order or to make potassium the most reactive element, possibly because potassium was the most reactive Group 1 metal that candidates have seen for themselves.

(v) There were many correct answers to this question, including excellent suggestions regarding carrying out the reaction in the open air.

(e) This question was answered very well.

Question 3

(a) Many candidates produced good answers to this question. However, the structure of carbon dioxide proved the most problematic. The word micromolecular was often seen as an answer and is not an appropriate description.

(b) (i) This question was answered well by most candidates.

(ii) This question proved challenging for many candidates with only the strongest candidates providing a clear answer.

(iii) This question proved challenging for many candidates. A number of answers referred to covalent bonding or bonds between atoms being weak.

(iv) Only the strongest candidates were able to provide the correct answer to this question. There was some confusion in some answers with free or delocalised being referenced instead of mobile.

(c) $NaCO_3$ was seen far more often than the correct formula, Na_2CO_3. Hydrogen was frequently seen as a product, possibly because candidates saw this as a method of 'balancing' an equation with incorrect formulae.

(d) All parts of **(d)** were answered extremely well and were amongst the best answered questions on the paper.

Question 4

(a) This was answered quite well. However, some answers stated that catalysts alter the rate of a reaction without saying that they speed up a reaction.

(b) (i) Many candidates did not show an awareness that rate of reaction depends on the concentration of solutions, and that the concentration of solutions is highest at the start before any of the solution is used up. Some candidates interpreted the graph as being rate plotted against time and thought the rate was highest when the graph levelled off, which was when there was no hydrogen peroxide left.

(ii) Heating or increasing the temperature were very common correct answers. Despite the instructions of the question, a number of candidates referred to increasing the amount of hydrogen peroxide or increasing the amount of catalyst.

(c) (i) (ii) and **(iii)** were answered correctly.

(iv) This question was usually answered correctly, but some candidates thought that the volume would increase**.**

(v) Many candidates achieved the correct answer, although their method of calculation seemed to be more complicated than multiplying their answer to **(c)(iii)** by two as was required by the question.

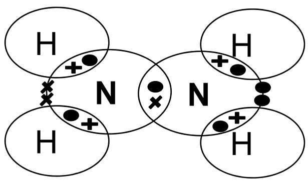
(d) Some candidates did not address the question in their answer and speculated which of the two catalysts would be the best. Either the volume or the concentration of hydrogen peroxide were often mentioned.

Question 5

(a) (i) There were many excellent answers to this question. Candidates did not always quote units for all physical quantities. Details of how hydrogen and nitrogen are obtained were not required. N and H were sometimes seen as incorrect formulae in the equation. Atp was seen occasionally as units of pressure instead of atm.

(ii) A range of correct answers were seen with fertilisers being a common response.

(b) Many excellent diagrams were seen. However, many candidates drew diagrams in which it was difficult to see which electrons were shared and which were not. Double bonds between the nitrogen atoms were drawn occasionally, despite the single 'stick' in the diagram referring to a single bond. Lewis structures of the type shown below are preferred and should be encouraged.



(c) (i) A considerable number of candidates knew that the definition of a base was as a proton acceptor. Some candidates included comments about hydroxide ions or reactions to this which was not required for the question.

(ii) This question proved challenging for most candidates. Hydrazine accepts a proton when it acts as a base. A proton has the symbol H^+. Therefore, N_2H_4 should have one H and one + charge added to it, therefore becoming $N_2H_5^+$. It was not unusual to see N_2H_5 without the positive charge. H_2O should have one H and one + charge removed from it, therefore becoming OH^-.

(d) (i) Most candidates knew that nitrogen dioxide caused acid rain, although there were many references to global warming and greenhouse gases.

(ii) There were many good answers to this question. However, several candidates thought that nitrogen came from the fuel rather than the air. In addition, catalytic converters were also thought to be involved in the production (rather than the removal) of oxides of nitrogen.

Question 6

(a) There were several correct answers, mainly S^-, although S^{2-} was also a common correct answer, possibly because of candidates' familiarity with the sulfide ion.

(b) A variety of methods were given to distinguish the two substances. Many candidates based their answers on comparison between iron and gold rather than by giving a differentiation between them.

(c) (i) There were several correct answers, although some candidates decided to use different formulae to those of the substances referred to in the question.

(ii) While many candidates answered correctly, a number of answers gave 'manufacture of paper' without giving enough detail.

Question 7

(a) (i) This was answered well, although some candidates did not state that the substances only contain carbon and hydrogen. Some weaker candidates thought that hydrocarbons were elements and others thought they were made from carbon and hydrogen molecules.

(ii) This question was answered very well.

(b) (i) Many candidates answered this question well. The most common error was not to divide by relative atomic masses and express the percentages as the smallest whole number ratio. The largest source of error was rounding up or down too much.

(ii) This question proved more challenging than **(b)(i)** but was answered correctly by stronger candidates.

(c) Candidates generally found this to be challenging and did not appear to be well prepared in this area. Many atoms with incorrect valencies were drawn. It was not unusual to see molecules with many more than three carbon atoms.

(d) This was answered much better than **(c)** by most candidates.

(e) (i) and **(ii)** Both of these questions were well answered by the majority of candidates.

(iii) Many represented the functional groups as –COOH and –OH. Although the C=O bond was occasionally shown, the O–H was very often missing.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- When required to choose an appropriate scale for the *x* or y-axis of a graph, at least half of the grid should be involved to plot the points. The axis does not have to start at 0. Points should be clearly plotted; minute dots are not suitable. Straight line graphs should not be drawn when a smooth line graph is requested.
- Candidates should make full use of the **NOTES FOR USE IN QUALITATIVE ANALYSIS** page of the question paper. This gives the formulae of many ions and gases and will help to avoid confusion between, for example, ammonia and ammonium and iodine and iodide.

General comments

The majority of candidates successfully completed all questions and there was no evidence that candidates were short of time. The complete range of marks was seen with some candidates producing very strong answers.

The results obtained by some supervisors and candidates suggested that some Centres did not use materials specified in the Confidential Instructions.

Comments on specific questions

Question 1

(a) Almost all candidates completed the table of results. Good results were obtained by the majority of candidates, with higher temperatures giving shorter reaction times and generally agreeing well with those obtained by the supervisors. A minority of candidates incorrectly recorded the times in minutes instead of seconds. A significant number of candidates incorrectly recorded the initial temperatures as room temperature for all four experiments, while others were unable to work out the average temperatures as required.

(b) Most candidates plotted all points correctly; choosing an appropriate scale on the vertical axis of the graph caused some problems. Most curves were good attempts and some best-fit straight lines were provided where appropriate. Some candidates drew a best-fit straight line, when a smooth curve was a better choice.

(c) Many candidates did not extrapolate their graph clearly and did not always show where they had read their answer from the grid. Some candidates misread their scale on the *y*-axis. Incorrect units were frequently given.

(d) (i) This question was generally correctly answered.

(ii) The strongest candidates were able to explain that the rate of reaction was greatest because particles had gained energy/moved faster with an increased chance or frequency of collisions. Most responses just referred to higher temperatures or less time of reaction.

(e) (i) Most candidates understood that using a burette to measure the volume of solution **J** would be more accurate. Better performing candidates made a comparison with a measuring cylinder. A minority of candidates thought that using a burette would be less accurate and that it would take a longer time to carry out the measurement.

(ii) Stronger candidates performed well on this question. However, in many answers the suggested improvements were not relevant to this experiment. Such answers included starting at a common temperature or using a regular swirling technique. Vague answers discussed using a stop watch instead of a stop clock or dipping the thermometer in a constant position in the conical flask, or using a different sized flask.

Candidates who performed well repeated the experiments and found the average/mean of the readings, or used insulation to reduce heat losses. Some candidates also used a pipette instead of a measuring cylinder, or a calorimeter or digital thermometer.

Question 2

(a) Most candidates correctly stated that the solid was green or blue. There were also some incorrect references to yellow.

(b) (i) The majority of candidates reported the formation of a blue precipitate, which dissolved in excess aqueous ammonia to form a deep blue solution. Some weaker answers referred to the blue precipitate dissolving to form a deep blue precipitate while others missed the initial formation of the blue precipitate.

(ii) The formation of a blue precipitate was often described as a blue solution. A number of candidates did not mention the blue precipitate and just described insolubility.

(iii) The formation of a white precipitate was often described. References to cloudy, solid formation were not relevant.

(iv) The formation of a white precipitate was often described, despite this being a test for sulfate ions. The expected observation was no change/precipitate or reaction. Many answers referred to the formation of a precipitate or coloured solution.

(c) Most candidates identified the presence of copper ions. However, a number stated that sulfate ions were present despite a positive test for chloride ions in **(b)(iii).** A number of candidates concluded that bromide ions were present.

(d) Candidates needed to record carefully during this qualitative analysis section and this was not always evident. Many candidates gave just one observation, usually that red litmus turned blue. Descriptions of sublimate formation and evolution of purple gas were rare. Some candidates described the pungent smell of the gas. Some candidates stated that ammonia was present and this is not an observation.

(e) (i) Many candidates did not mention the result of testing the gas and just stated that ammonia was formed.

(ii) The formation of a yellow precipitate was often stated. A significant number of candidates omitted precipitate and merely wrote a colour. Weaker candidates described the formation of a white or cream precipitate. This showed a possible lack of practical expertise and experience when carrying out the halide test.

(f) There were some strong answers to this question. Many candidates correctly identified both ions present in solid **M**, but there was some confusion between ammonia and ammonium. Other candidates confused iodine and iodide.

Question 3

There was a range of answers for this planning question with many candidates producing excellent responses. It was evident that many Centres had covered chromatography in great detail.

However, other candidates often failed to explain the use of the E number colours in the investigation. Many of these candidates made vague statements, such as ‘see if the orange drink contains two colours or only one colour’.

A minority of candidates used the wrong method, such as fractional distillation or testing with acid-base indicators. Some candidates tried mixing solutions of the E numbers and compared the colour obtained to the orange drink.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

On graphs, points should be clearly plotted. Very small dots are not suitable. Candidates should be reminded to pay attention to the specific requirements of graphs. Straight line graphs should not be drawn when a smooth line graph is requested. Extrapolation of a graph line should follow the expected path and not deviate markedly.

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used, the substances involved, and practical procedures clearly specified. Some idea of a conclusion should be given.

General comments

This was the first time that this Question Paper has been taken for the revised 0620 syllabus and the standard of answers was high. The majority of candidates successfully completed all questions and there was no evidence that candidates were short of time. Stronger candidates were able to demonstrate their ability well.

Comments on specific questions

Question 1

(a) This was well answered. Some candidates identified the tripod as a stand. A minority of candidates named the glass rod / stirrer as a thermometer, spatula or rod.

(b) (i) Weaker candidates described the steps in detail, often wrongly.

(ii) This was very well known and clearly understood.

(c) (i) Weaker answers referred to the calcium compounds instead of water.

(ii) Filtrate or solution was credited for the general name given to the liquid in the dish. Common wrong answers were solute, solvent, water and residue.

(d) Stronger candidates described the appearance of crystals, often describing the glass rod technique. A large number of candidates described evaporation to dryness which was not credited. There were a number of vague responses such as “the liquid starts to boil” or “when a gas is given off”.

Question 2

(a) Almost all candidates completed the table of results. A minority of candidates incorrectly recorded the time for Experiment 1 in minutes instead of seconds. Some candidates were unable to work out the average temperatures.

(b) Most candidates plotted all points correctly. Most curves were good attempts and dot-to-dot straight lines drawn with a ruler were rare. Some candidates drew a best fit straight line when a smooth curve was the correct choice.

(c) Many candidates clearly extrapolated their graph and showed where they had read their answer from the grid. Weaker candidates misread the scale on the *y*-axis. Incorrect units were frequently given.

(d) (i) This was generally correctly answered with Experiment 4 given.

(ii) Only the stronger candidates could explain that the rate of reaction was greatest because of the higher temperature and that particles had gained energy / moved faster resulting in an increased chance or frequency of collisions. Most responses referred to a shorter reaction time and were not be credited.

(e) (i) Most candidates understood that using a burette to measure the volume of solution **J** would be more accurate and scored partial credit. A minority of candidates thought that using a burette would be less accurate and that it would take a longer time to carry out the measurement.

(ii) Stronger candidates suggested repeating the experiments and found the average / mean of the readings, or used insulation to reduce heat losses. Using a pipette instead of a measuring cylinder, or a calorimeter or digital thermometer were common suggestions which scored partial credit.

Often suggested improvements were not relevant to this experiment such as starting at a common temperature or using a regular swirling technique. Weaker answers discussed using a stopwatch instead of a stop-clock or using a different sized flask.

Question 3

(a) Many candidates correctly stated that the solid was green or blue. References to white and black were common and were not credited. Some candidates described solid **L** as a precipitate or as a solution.

(b) (i) The majority of candidates reported the formation of a blue precipitate which dissolved in excess aqueous ammonia to form a deep blue solution. Some confused answers referred to the blue precipitate dissolving to form a deep blue precipitate, while others missed the initial formation of the blue precipitate.

(ii) The formation of a blue precipitate was often described as a blue solution. A number of candidates failed to mention the blue precipitate and just described insolubility.

(iii) The formation of a white precipitate was often described. References to “no reaction” were seen.

(iv) The formation of a white precipitate was often described, despite this being a test for sulfate ions. The expected observation was no change. A number of answers incorrectly referred to the formation of a precipitate.

(c) Many candidates correctly identified both ions present in solid **M**, but there was some confusion between ammonia and ammonium. Other candidates confused iodine and iodide. Solid **M** was ammonium iodide.

Question 4

A number of Centres had covered chromatography in great detail and there were some very strong answers to this question. Other candidates gained partial credit but often failed to explain the use of the E110 and E129 in the investigation. Many of these candidates made vague statements such as, “see if the orange drink contains two colours or only one colour”.

A minority of candidates used the wrong method such as fractional distillation or testing with acid-base indicators. Some candidates tried mixing solutions of E110 and E129 and compared the colour obtained to the orange drink.

Some clear and explicit diagrams were drawn and often full credit was given for these.

References to the use of a locating agent were ignored.