Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C410UA0-1

S19-C410UA0-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – Component 1
Concepts in Chemistry

HIGHER TIER

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**7**	
3.	**7**	
4.	**9**	
5.	**8**	
6.	**4**	
7.	**7**	
8.	**6**	
9.	**6**	
10.	**13**	
11.	**5**	
12.	**6**	
13.	**10**	
14.	**9**	
15.	**6**	
16.	**10**	
Total	**120**	

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ADDITIONAL MATERIALS

In addition to this paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **15** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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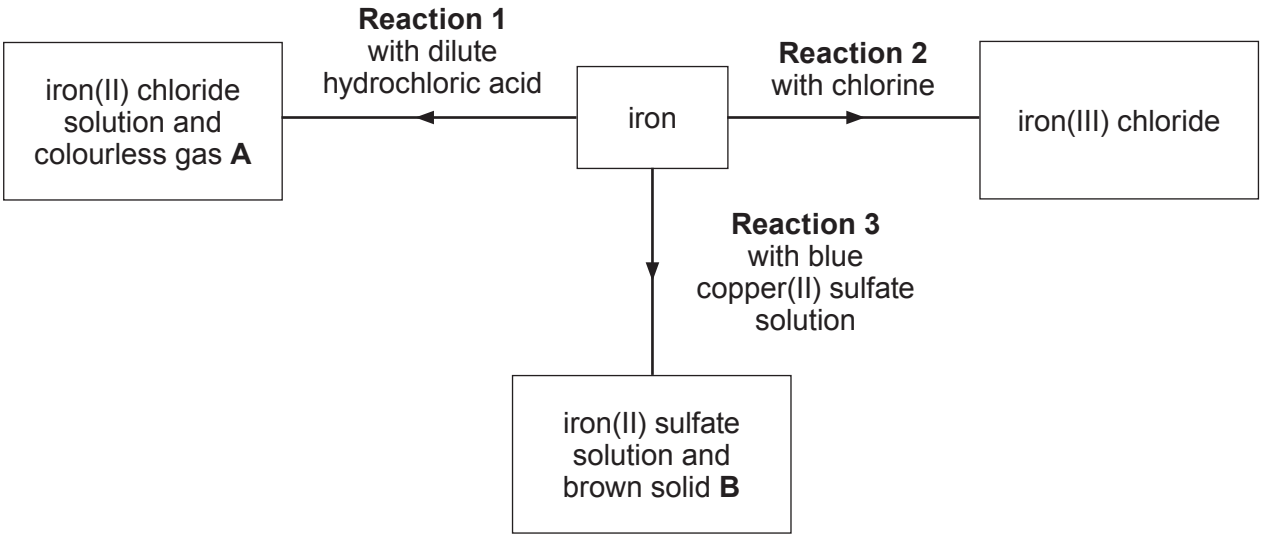
Answer **all** *questions*.

1. *(a)* The flow diagram shows some reactions of iron.



(i) Name the colourless gas **A** formed in reaction **1**. [1]

.....

(ii) Name the brown solid **B** formed in reaction **3**. [1]

.....

(iii) Complete and balance the symbol equation for reaction **2**. [2]

$2Fe + \square Cl_2 \longrightarrow \square$ .....

(b) When sodium hydroxide solution is added to iron(II) sulfate solution a green precipitate of iron(II) hydroxide is formed.

Complete the symbol equation for this reaction. Include **state symbols** in your answer. [3]

$2NaOH(aq) + FeSO_4(aq) \longrightarrow$ ..... + ...

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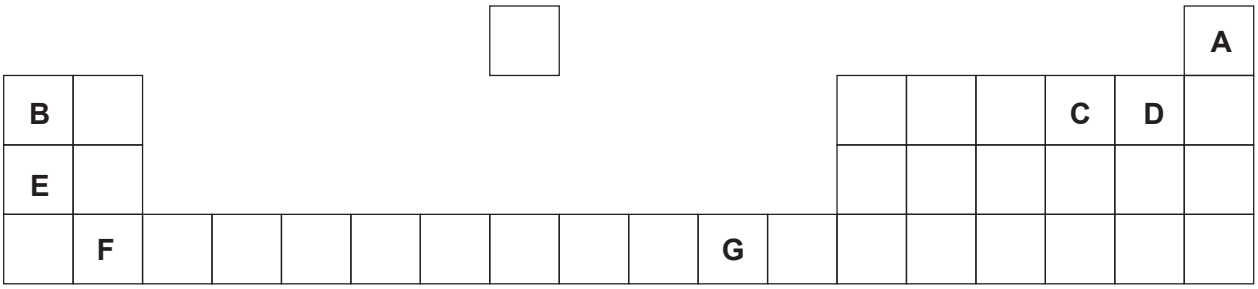
2. *(a)* The following diagram shows an outline of part of the Periodic Table.

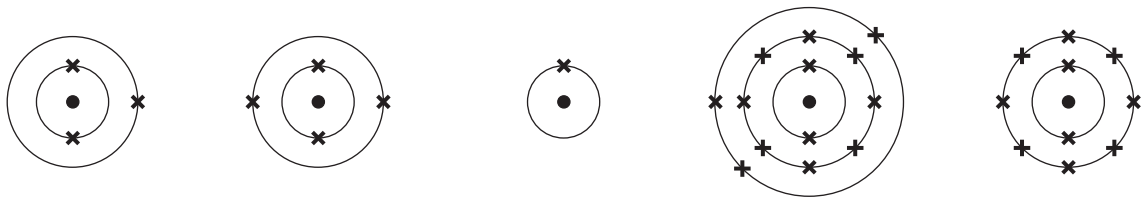
The letters shown are NOT the chemical symbols of the elements.



(i) Choose **letters** from the diagram to match the descriptions in the table below. [5]

	Letter
The element which is completely unreactive	.....
The element in Group 1 and Period 2	.....
The element which forms coloured ions	.....
The element which forms a 2^- ion	.....
The element with the electronic structure 2,8,1	.....

(ii) Diagrams **1**-**5** below show the electronic structure of five elements in the Periodic Table.



1 **2** **3** **4** **5**

Give the number of the diagram which shows the electronic structure of the element which lies directly **below** element **A**. [1]

Number .....

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(b) Complete the following table that shows information about an atom of fluorine. [1]

Mass number	Atomic number	Number of protons	Number of neutrons	Number of electrons
19	9	9	.....	.....

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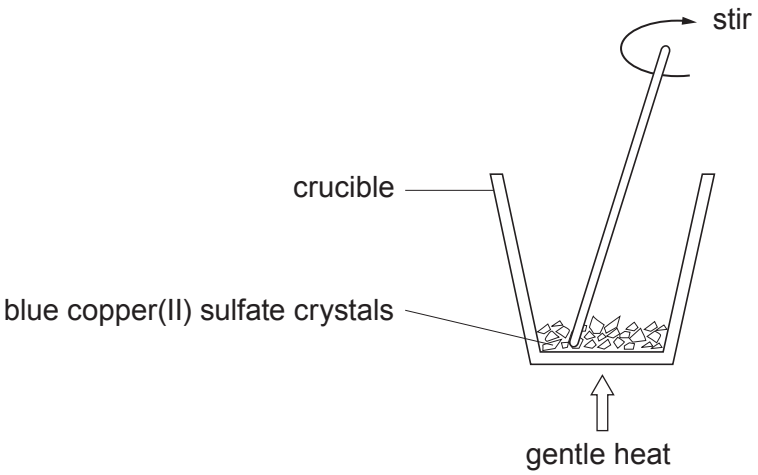
3. The blue colour of copper(II) sulfate crystals is due to the presence of water molecules. On gentle heating these water molecules can be removed, forming white copper(II) sulfate powder.

$$\text{blue copper(II) sulfate} \overset{\text{heat}}{\rightleftharpoons} \text{white copper(II) sulfate} + \text{water}$$

A student carried out an experiment to find the percentage of water in a sample of blue copper(II) sulfate. She gently heated a known mass of blue copper(II) sulfate crystals, stirring continuously, until the crystals turned white.



Mass of blue copper(II) sulfate = 6.25 g

Mass of white copper(II) sulfate after heating = 4.15 g

(a) Calculate the mass of water removed during heating. [1]

Mass of water = ... g

(b) Use the equation below to calculate the percentage of water in the blue copper(II) sulfate. [2]

$$\text{percentage of water in blue copper(II) sulfate} = \frac{\text{mass of water}}{\text{mass of blue copper(II) sulfate}} \times 100$$

Percentage of water = ... %

Examiner only

(c) The experimental value for the percentage of water is lower than the actual value although all the masses were accurately measured.

Suggest a reason for this difference. Describe what should be done to get a more accurate value. [2]

.....

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.....

(d) State how blue copper(II) sulfate could be reformed. Give the reason for your answer. [2]

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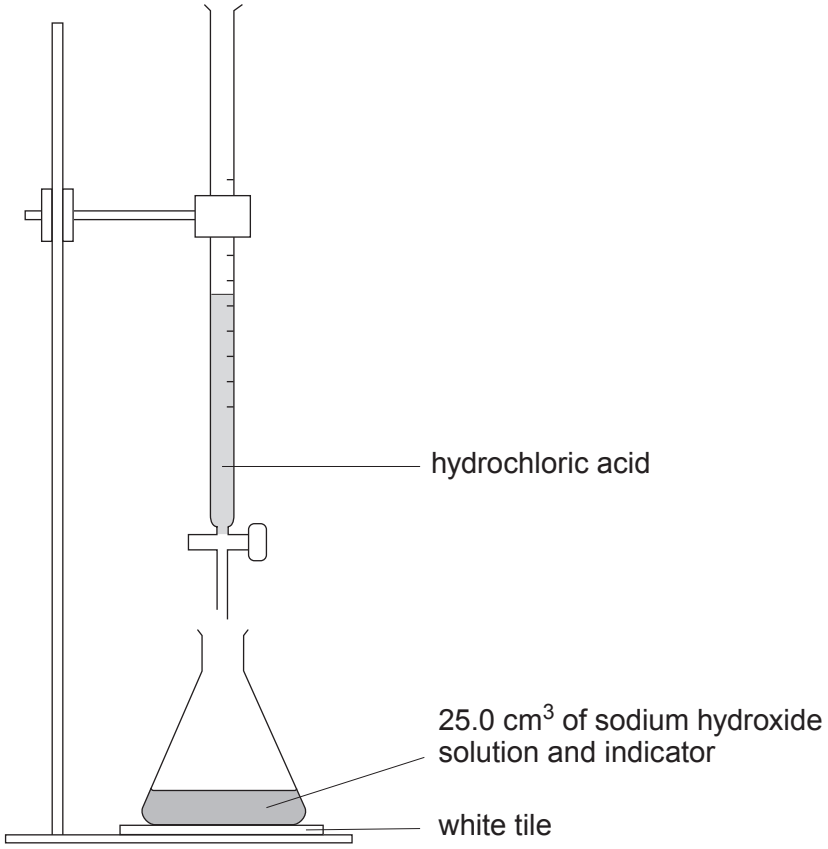
4. Hydrochloric acid neutralises sodium hydroxide solution to form sodium chloride and water only.

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

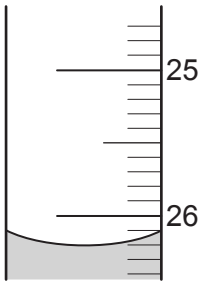
(a) Aleksandr was asked to find the volume of hydrochloric acid needed to neutralise 25.0 cm^3 of a sodium hydroxide solution. He titrated the sodium hydroxide solution with hydrochloric acid.



(i) Why was the conical flask placed on a white tile? [1]

.....

(ii) Aleksandr carried out a trial run. Give the final reading shown on the burette. [1]



Final reading ..... cm^3

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(iii) Aleksandr carried out three further titrations. His results are shown in the table.

	Titre		
	1	2	3
Volume of hydrochloric acid used (cm^3)	24.6	24.8	24.5

Calculate the mean volume of hydrochloric acid needed to neutralise 25.0 cm^3 of the sodium hydroxide solution. Give your answer to **one** decimal place. [2]

Mean volume = ... cm^3

(iv) Aleksandr evaporated all the water from one of his neutralised mixtures from part (iii) in an attempt to obtain pure crystals.

State why the crystals are **not** pure. [1]

.....

(v) Describe what he should do to prepare pure crystals. [2]

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(b) Aleksandr carried out further titration experiments using **different** concentrations of hydrochloric acid and sodium hydroxide.

Complete the table by giving the volume of acid needed to neutralise 20.0 cm^3 of alkali. [2]

Concentration of sodium hydroxide (mol/dm^3)	Concentration of hydrochloric acid (mol/dm^3)	Volume of sodium hydroxide (cm^3)	Volume of hydrochloric acid (cm^3)
1.0	1.0	20.0	20.0
1.0	0.5	20.0	.....
0.5	0.5	20.0	.....

9

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5. *(a)* The equations below show the reactions used to make three different salts in the laboratory.

Complete the equations. [3]

$CuO(s) + H_2SO_4(aq) \longrightarrow$ ..... $(aq) + H_2O(l)$

..... $(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$

$Zn(s) + 2$ ..... $(aq) \longrightarrow Zn(NO_3)_2(aq) + H_2(g)$

(b) Explain why water is left in the flask when a mixture of ethanol and water is distilled. [3]

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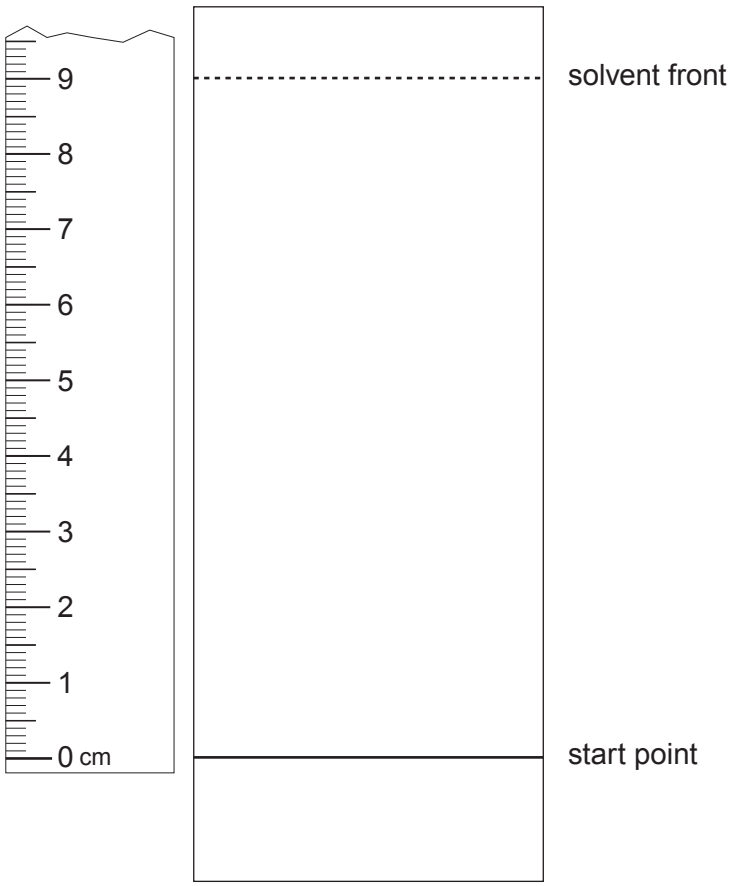
Examiner only

(c) Chromatography is used to separate coloured dyes. An orange food colouring contains soluble red and yellow dyes. The red dye has an R_f value of 0.4. The yellow dye is more soluble than the red dye.

Complete the chromatogram showing what you would expect to see once separation of the dyes has taken place. [2]



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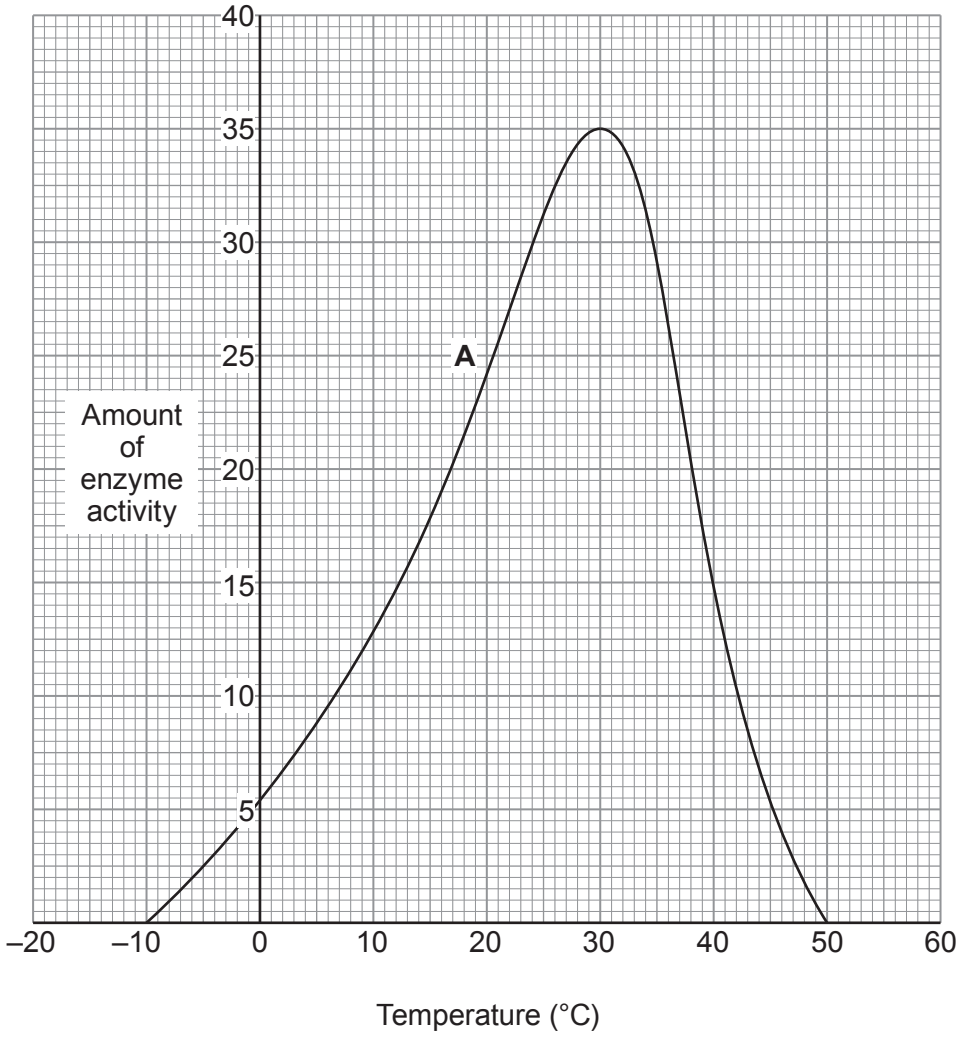
6. The graph shows the activity of enzyme **A** over a temperature range.



(a) Use the graph to give the temperature range where the enzyme activity is increasing. [1]

..... to ..... °C

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(b) Put a tick (✓) in the box next to the temperatures when enzyme **A** has **no activity**. [1]

> –10 and < 50 °C ☐

> –10 and > 50 °C ☐

< –10 and > 50 °C ☐

(c) **On the same grid**, draw a graph of the enzyme activity of enzyme **B** which is active between 0 and 60 °C and has the greatest amount of activity at 40 °C. [2]

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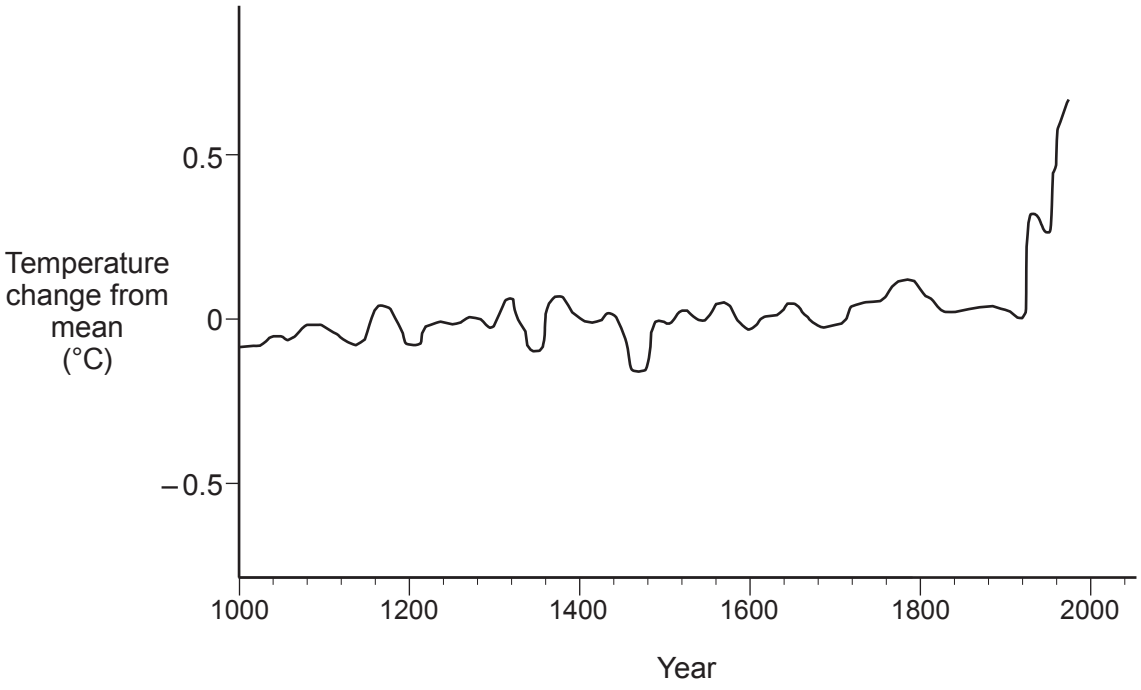
7. *(a)* The graph shows how the Earth's global atmospheric temperature has changed from its mean value over the last 1000 years.



(i) Estimate the year when the most significant change in the Earth's temperature **began** to occur. State what most scientists believe is the **main** human activity which caused this change. [2]

.....

.....

.....

(ii) Explain **one** environmental consequence if the trend in the graph continues as shown. [2]

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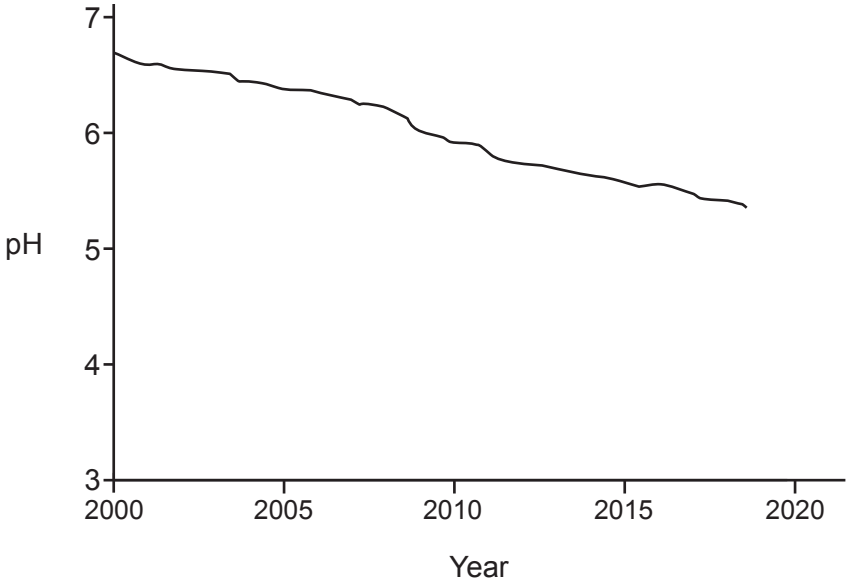
(b) One of the major consequences of sulfur dioxide emission is the formation of acid rain. The graph shows the effect of acid rain on the pH in a lake.



(i) Describe the trend in **acidity** between 2000 and 2018. [1]

.....

(ii) Powdered lime, calcium oxide, is used to treat lakes which have been affected by acid rain. Explain the effect on the **pH** of adding powdered lime to the lake. [2]

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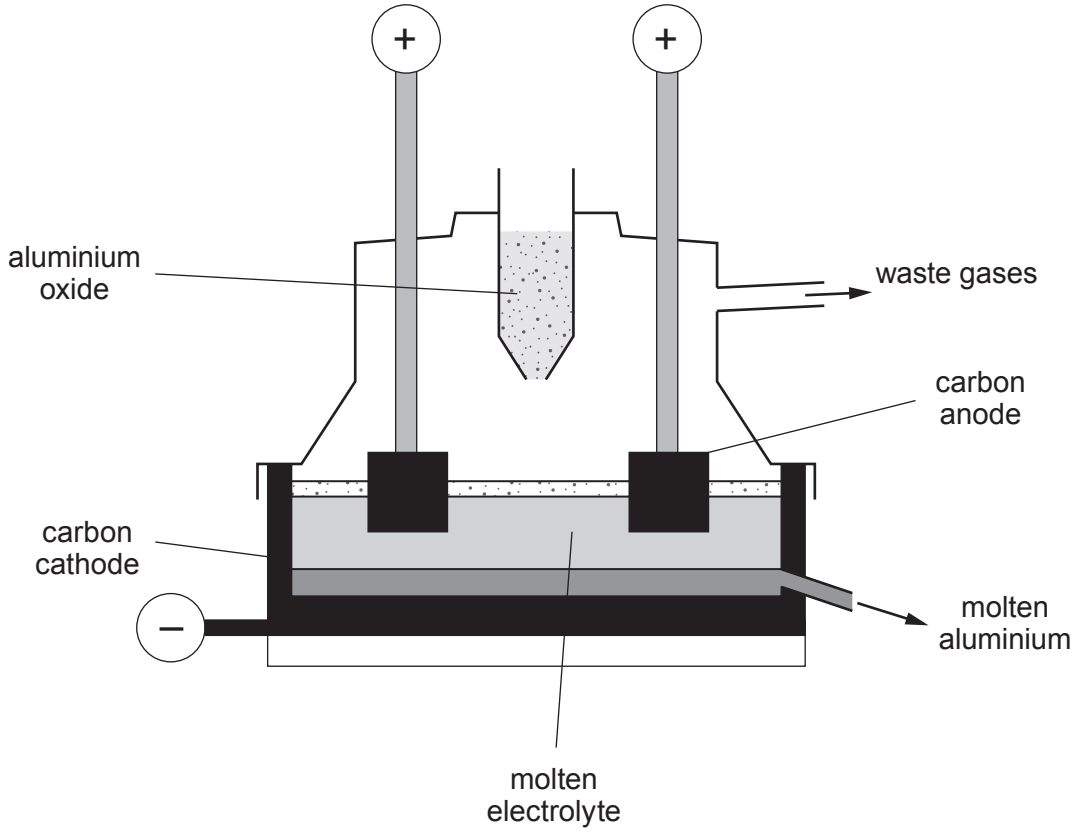
Turn over.

8. The diagram shows an industrial cell used to extract aluminium from aluminium oxide.



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(a) The electrolyte contains aluminium oxide and compound **A**. [2]

Name compound **A**. State the **main** reason why compound **A** is added to the electrolyte.

Compound **A** .....

Reason for its use .....

.....

(b) Write the half-equations for the processes occurring at the electrodes. [2]

At the cathode .....

At the anode .....

(c) Many factors such as available work force, road and rail links and distance from built-up areas are considered when locating any new chemical plant.

Explain **two** *other* factors that are important when locating a new **aluminium** extraction plant in the UK. [2]

Factor 1 .....

.....

Factor 2 .....

.....

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Turn over.

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9. Traditionally copper is extracted from copper-rich ores by heating the ores in a furnace.

$$Cu_2S(s) + O_2(g) \longrightarrow 2Cu(s) + SO_2(g)$$

Copper-rich ores are becoming scarce so new methods of extracting copper are being developed. One new method is called phytoextraction.

Phytoextraction uses plants to absorb copper compounds through their roots as they feed on the nutrients around them. The plants cannot get rid of the copper ions and they build up in their leaves. The plants are then harvested, dried and burned in a furnace to produce an ash that contains the metal's soluble compounds. The ash is dissolved in sulfuric acid to form aqueous copper(II) sulfate.

(a) Do you think phytoextraction will ever replace the traditional method for the extraction of copper? Give **two** reasons to support your answer. [2]

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(b) (i) State and explain **one** method you would use to obtain copper from aqueous copper(II) sulfate. [2]

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(ii) Explain the term *reduction* in terms of your method. [2]

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10. Megan and Harry investigated the effect of acid concentration on the reaction between hydrochloric acid and magnesium ribbon.

They added 5 cm pieces of magnesium ribbon to solutions of acid with four different concentrations and measured the time taken for the magnesium to react completely. The acid was in excess each time and each reaction was carried out at room temperature.

They used the times recorded to calculate the rate of each reaction.

The table shows their results.

Acid concentration (mol/dm^3)	Time for magnesium ribbon to react (s)	Rate (s^{-1})
0.2	199	0.0050
0.8	51	0.020
1.4	29	0.034
1.8	22	0.045

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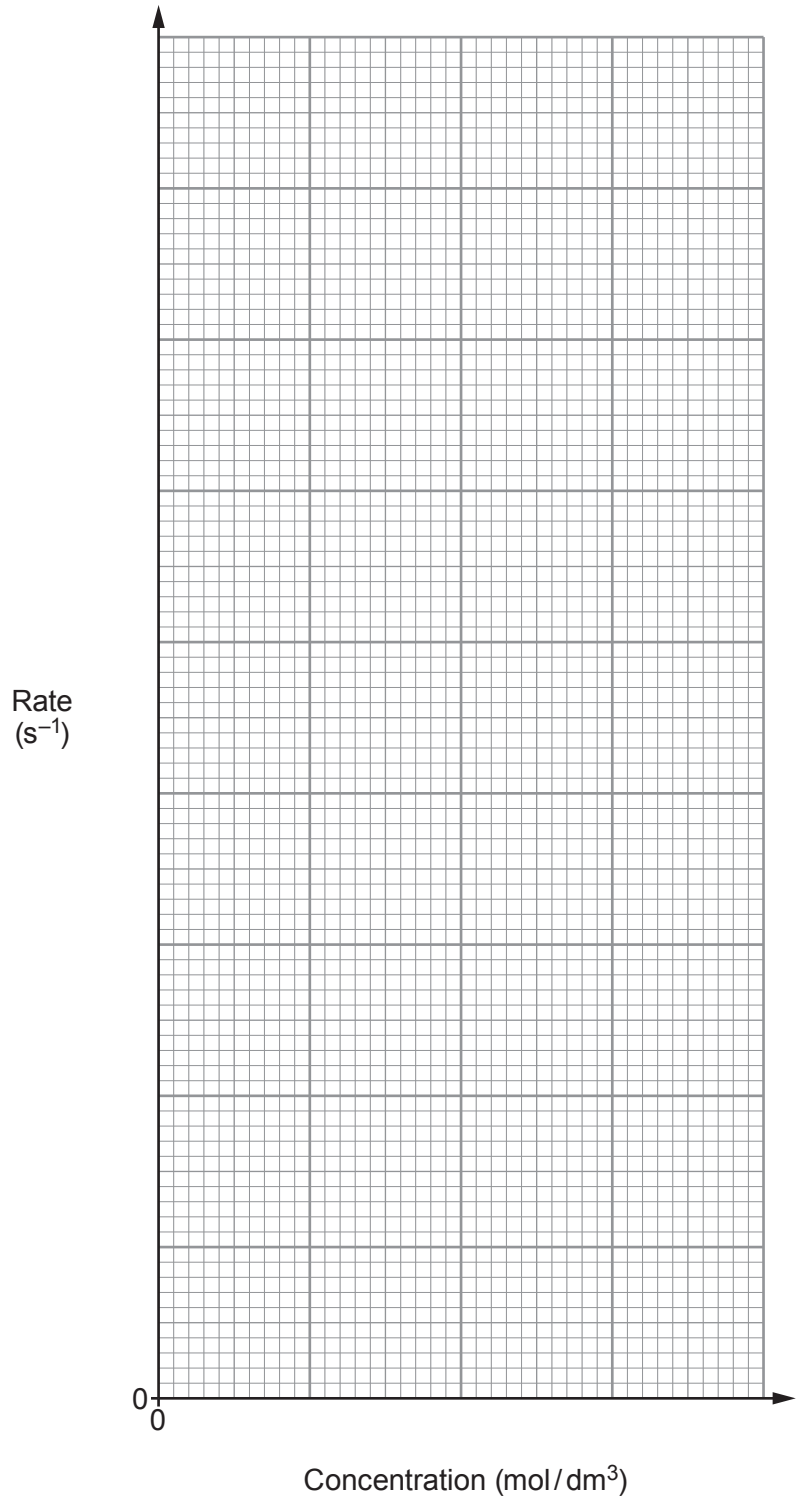
(a) Plot a graph of rate against concentration on the grid. Draw a suitable line from (0,0). [3]



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(b) **Use your graph** to calculate the **time** it would take for 5 cm of magnesium ribbon to completely react with 1.0 mol / dm^3 hydrochloric acid. [2]

Time = ... s

(c) The reaction rate is proportional to the concentration of the acid.

reaction rate $\propto$ concentration of acid

Use the particle model to explain how the reaction rate changes when the concentration of the acid is doubled. [2]

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.....

(d) Megan and Harry measured the time taken for 5 cm of magnesium to completely react with the acid.

State briefly how they could investigate the rate of this reaction using another method. [2]

.....

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(e) Explain, using the particle model, why the reaction rate would **increase** if

(i) magnesium **powder** were used instead of magnesium ribbon, [2]

.....

.....

.....

(ii) the investigation were carried out at a **higher** temperature. [2]

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Examiner only

11. *(a)* Ethene belongs to the alkene homologous series. All alkenes can undergo addition reactions.

Using the reaction between ethene and bromine, explain what happens during an addition reaction. [2]

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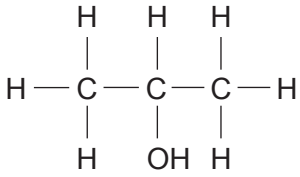
(b) (i) Draw the structure of but-2-ene. [1]

(ii) Give the systematic name of the compound with the following structure. [1]



Name .....

(c) Alcohols can be oxidised to form carboxylic acids.

Draw the structure of the **functional group** present in all carboxylic acids. [1]

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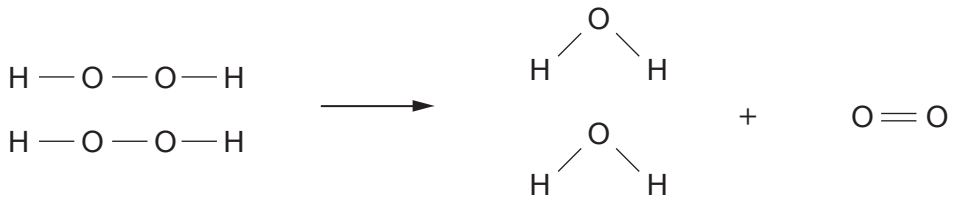
12. The following equation shows the rearrangement of atoms as hydrogen peroxide decomposes.



The energies of some of the bonds are given in the table.

Bond	Bond energy (kJ)
O — H	464
O = O	498

(a) (i) The **total** energy needed to break the bonds in the reactants is 2140 kJ.

Calculate the energy needed to break an O—O bond. [2]

Energy = ... kJ

(ii) Calculate the overall energy change for the reaction. [2]

Overall energy change = ... kJ

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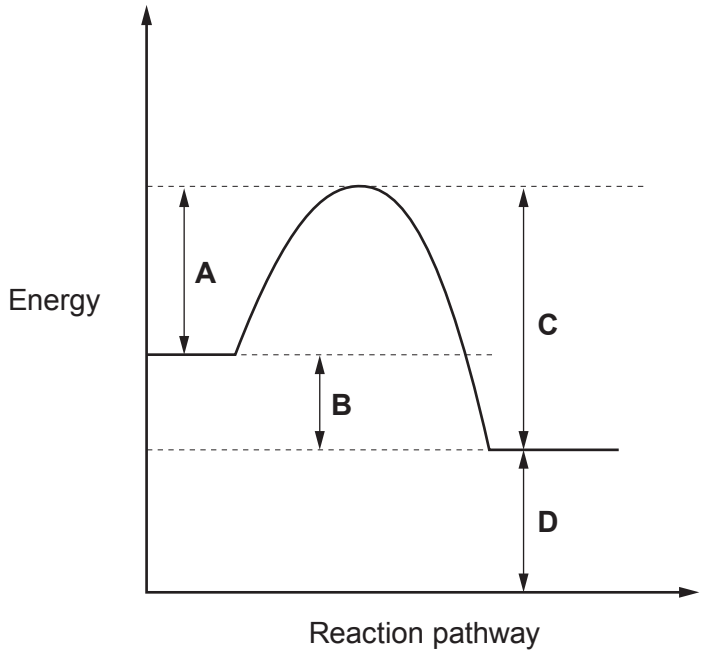
(b) The diagram shows the energy profile for the reaction.



(i) Give the **letter** of the energy change, **A**-**D**, which represents the activation energy. [1]

Letter .....

(ii) **On the diagram**, draw the energy profile for the reaction when a catalyst is added to hydrogen peroxide. [1]

6

Examiner only

13. *(a)* Ammonia is made industrially from nitrogen and hydrogen by the Haber process. The forward reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Explain how a low temperature and a low pressure affects the equilibrium position. [4]

Low temperature .....

.....

.....

.....

.....

Low pressure .....

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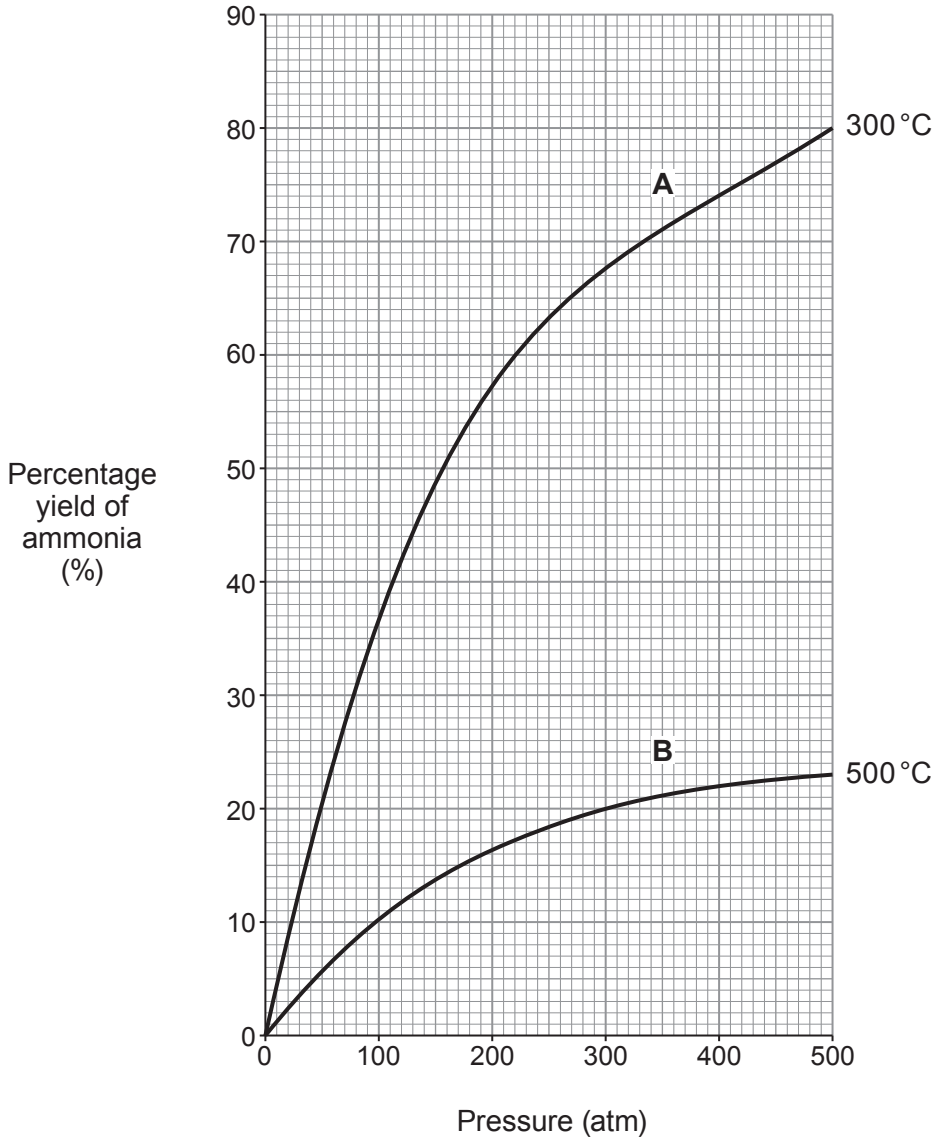
(b) The graphs show the percentage yield of ammonia at different pressures using two different temperatures.



(i) State the conditions required to give a 60 % yield of ammonia. [1]

Temperature ..... °C Pressure ..... atm

(ii) **On the grid**, sketch the curve you would expect for the percentage yield of ammonia at a temperature of 350 °C. [2]

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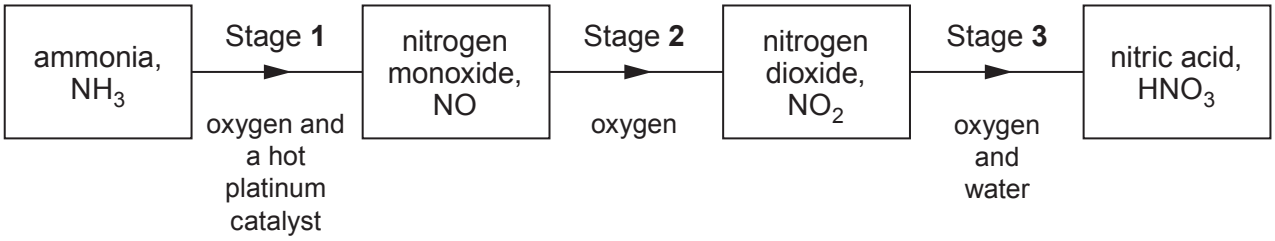
(c) Ammonia is used to form nitric acid in a three-stage reaction.



(i) Balance the equation that represents the reaction taking place in stage **1**. [1]

$$4NH_3(g) + \square\, O_2(g) \longrightarrow \square\, NO(g) + \square\, H_2O(g)$$

(ii) Write the balanced equation for the reaction taking place in stage **2**. [2]

.....

10

Examiner only

14. *(a)* Tests **1**-**4** can be used to identify ions.

1. Add silver nitrate solution

2. Add sodium hydroxide solution and warm, test the gas produced with damp litmus paper

3. Flame test

4. Add dilute hydrochloric acid, bubble the gas formed into limewater

Give the **number** of the test you would use to distinguish between the following pairs of substances. Explain how the observations would enable you to identify **each** substance.

Each test can be used once, more than once or not at all.

(i) Solid samples of calcium chloride and sodium chloride [2]

Test number .....

.....

.....

.....

(ii) Solutions of potassium chloride and potassium iodide [3]

Test number .....

.....

.....

.....

(iii) Solutions of ammonium chloride and magnesium chloride [3]

Test number .....

.....

.....

.....

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(b) Aqueous sodium sulfate forms a white precipitate when mixed with aqueous barium chloride. The equation for the reaction is as follows.

$$Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$$

Put a tick (✓) in the box next to the **ionic** equation which represents this reaction. [1]

$Na^+(aq) + Cl^-(aq) \longrightarrow NaCl(aq)$ ☐

$2Na^+(aq) + SO_4^{2-}(aq) + Ba^{2+}(aq) + 2Cl^-(aq) \longrightarrow Ba^{2+}(s) + SO_4^{2-}(s) + 2Na^+(aq) + 2Cl^-(aq)$ ☐

$2Na^+(aq) + Ba^{2+}(aq) \longrightarrow Ba^{2+}(s) + 2Na^+(aq)$ ☐

$Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$ ☐

☐

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Examiner only

15. The table shows the electronic structure of hydrogen, carbon, sodium and chlorine.

Element	Electronic structure
hydrogen	1
carbon	2,4
sodium	2,8,1
chlorine	2,8,7

Explain the bonding in sodium chloride and methane using the 'dot and cross' model. Describe the limitations of this model in predicting the structure of these compounds. [6 QER]

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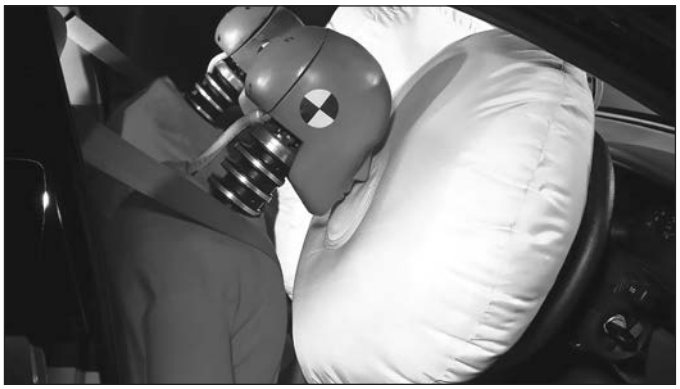
16. Modern cars are fitted with nylon airbags which cushion drivers and passengers from impact in an accident. The chemicals involved in inflation of an airbag are sodium azide, potassium nitrate and silicon(IV) oxide.



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There are three reactions which occur when an airbag inflates.

Reaction **1** On impact, a sensor creates an electrical charge forming heat which decomposes the sodium azide

$$2NaN_3 \longrightarrow 2Na + 3N_2$$

Reaction **2** Sodium reacts with potassium nitrate forming more nitrogen, potassium oxide and sodium oxide

Reaction **3** Silicon(IV) oxide, SiO_2, reacts with potassium oxide and sodium oxide forming a harmless silica glass, $Na_2K_2SiO_4$

(a) The airbag inflates due to the production of 75 dm^3 of nitrogen in 30 milliseconds.

Calculate the rate of nitrogen gas production in dm^3/s. Give your answer in standard form. [2]

Rate = ... dm^3/s

Examiner only

(b) A fully-inflated airbag has a total volume of 75 dm^3.

Calculate the amount of nitrogen gas, **in moles**, in a fully-inflated airbag.

The volume of 1 mol of gas at room temperature and pressure is 24 000 cm^3. [2]

Number of moles = ... mol

(c) Use your answer to part *(b)* and the equation for reaction **1** to calculate the mass, in grams, of sodium azide needed to produce 75 dm^3 of nitrogen gas. Give your answer to **one** decimal place. [3]

A_r(N) = 14 A_r(Na) = 23

Mass of sodium azide = ... g

(d) Complete and balance the equation for reaction **2**. [2]

10Na + ... ⟶ ..... + ... + ...

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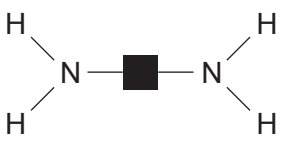
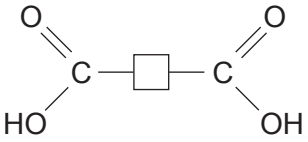
(e) The airbags are made of nylon which is condensation polymer.

Nylon is made from the following monomers.

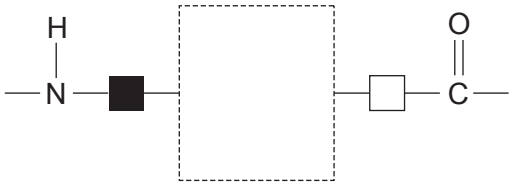




Many of these monomers join together to form nylon and water.

Draw the structure of the link formed between the two monomer units in the box below.

[1]



+ H_2O

10

END OF PAPER

Examiner only

Additional page.

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Additional page.

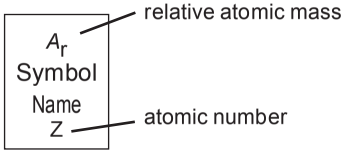
FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key



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