Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UE0-1

Z22-3430UE0-1

FRIDAY, 27 MAY 2022 – MORNING

SCIENCE (Double Award)

Unit 5 – CHEMISTRY 2

HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**8**	
3.	**9**	
4.	**15**	
5.	**8**	
6.	**6**	
7.	**7**	
Total	**60**	

3430UE01
01

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or ball-point pen. Do not use gel pen or correction fluid. You may use a pencil for graphs and diagrams only.

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 page 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 **7**(a) 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. Polymer gels are commonly used in disposable nappies.

A company that manufactures disposable nappies was investigating the effect of temperature on the mass of water the polymer gel in their nappies is able to absorb.

(a) The results collected using water at 40 °C are given below. The initial mass of the polymer gel bead was 0.035 g.

Time (hours)	Mass of bead (g)	Mass of water absorbed by bead (g) (to 1 decimal place)
0	0.035	0.0
2	4.048	4.0
4	6.030	6.0
6	7.280	7.2
8	7.891	7.9
10	8.181	8.1
12	8.181	8.1

(i) The percentage increase in the mass of the bead is calculated using the following equation.

$$\text{percentage increase} = \frac{\text{mass of water absorbed}}{\text{initial mass of bead}} \times 100$$

Calculate the percentage increase in the mass of the bead after 2 hours. Give your answer to the nearest whole number. [1]

Percentage increase = ... %

(ii) What property of polymer gels does the figure calculated in part (i) demonstrate? [1]

....

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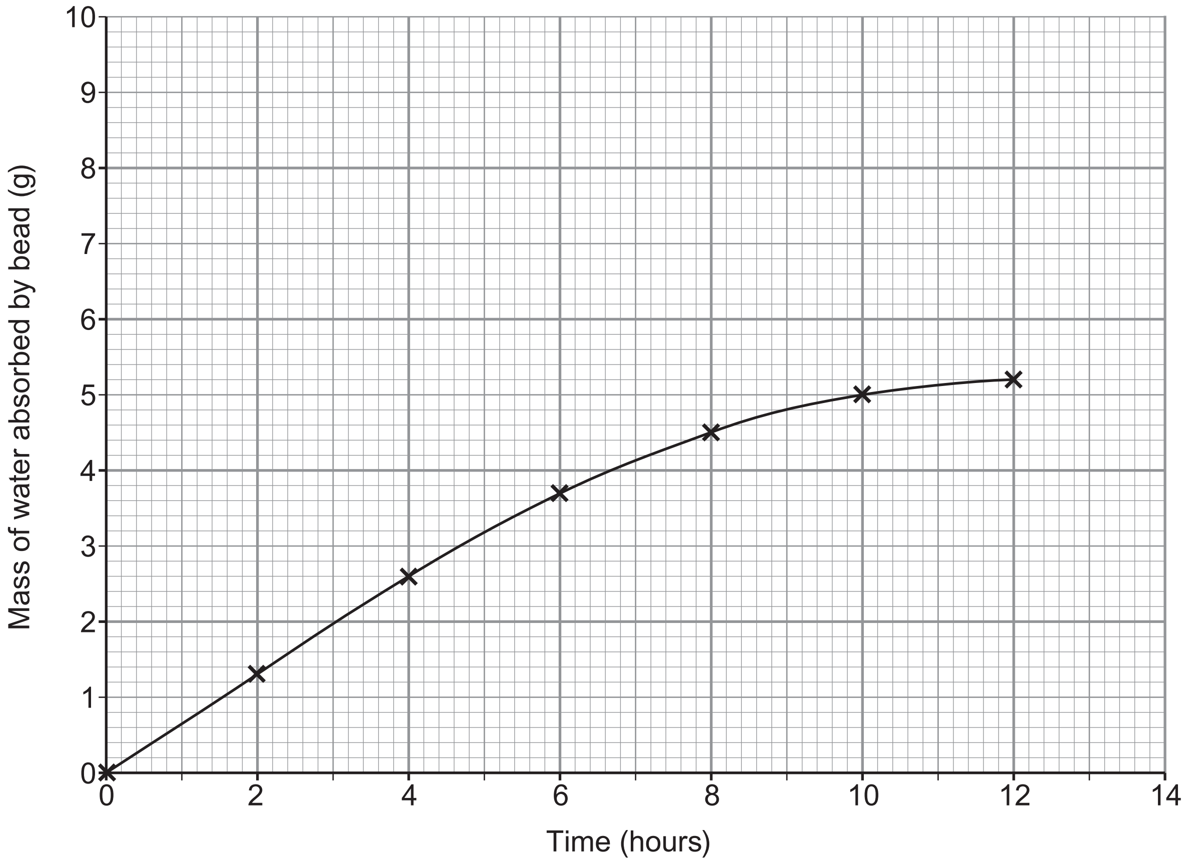
(b) (i) On the grid below, plot the results using water at 40 °C and draw a suitable line. Use the mass of water absorbed by the bead to 1 decimal place.

The results using water at 10 °C have already been plotted. [3]



(ii) Give **two** differences between the absorbing properties of the bead using water at 10 °C and at 40 °C. [2]

Difference 1 ....

....

Difference 2 ....

....

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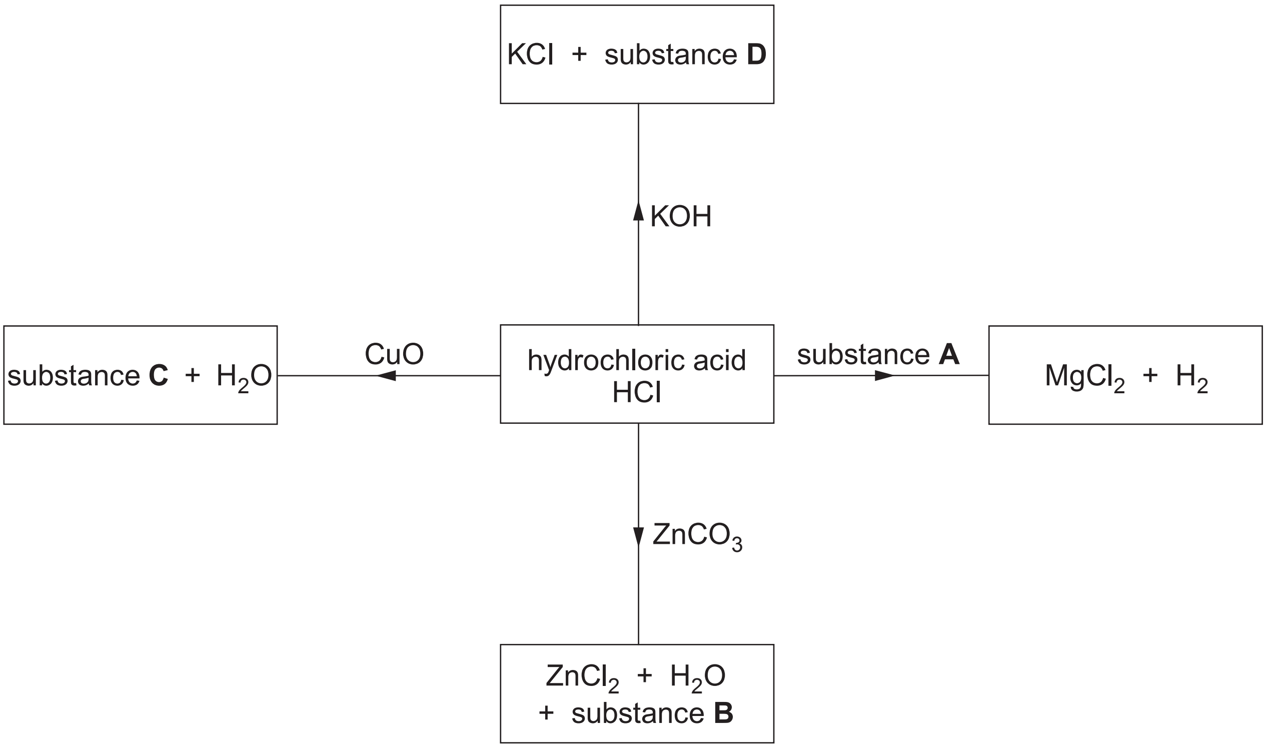
2. The reactions of acids with metals, bases and carbonates are summarised in the following equations.

- acid + metal → salt + hydrogen
- acid + base → salt + water
- acid + carbonate → salt + water + carbon dioxide

(a) The diagram shows some reactions of hydrochloric acid, HCl.



(i) Give the **names** of substances **A** and **B**. [2]

Substance **A** ....

Substance **B** ....

(ii) Give the **formulae** of substances **C** and **D**. [2]

Substance **C** ....

Substance **D** ....

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(b) Complete the equation for the reaction between hydrochloric acid and sodium carbonate by

- writing the formula of sodium carbonate on the dotted line
- putting a number into the box to balance the equation [2]

$\square$ HCl + ... $\longrightarrow$ 2NaCl + H_2O + CO_2

(c) Silver nitrate solution is used to identify the chloride ions present in hydrochloric acid.

(i) Give the observation made when silver nitrate solution is added to hydrochloric acid. [1]

....

(ii) Put a tick (✓) in the box next to the correct ionic equation for the reaction between silver nitrate and hydrochloric acid. [1]

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(aq)$ $\square$

$Ag^-(aq) + Cl^+(aq) \longrightarrow AgCl(aq)$ $\square$

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ $\square$

$Ag^+(s) + Cl^-(s) \longrightarrow AgCl(s)$ $\square$

$Ag^-(aq) + Cl^+(aq) \longrightarrow AgCl(s)$ $\square$

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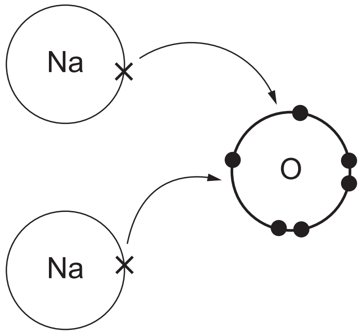
3. (a) The diagram shows the transfer of electrons that takes place during the formation of sodium oxide.



(i) Name the type of bonding present in sodium oxide. [1]

....

(ii) State what must be done to sodium oxide so that it will conduct electricity.

Explain your answer. [2]

....

....

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(b) (i) Draw a dot and cross diagram to show the bonding in a molecule of tetrafluoromethane, CF_4. [2]

carbon (C) 2,4 fluorine (F) 2,7

(ii) Tetrafluoromethane is a simple covalent substance and is a gas at room temperature.

Explain why it has a low boiling point. [2]

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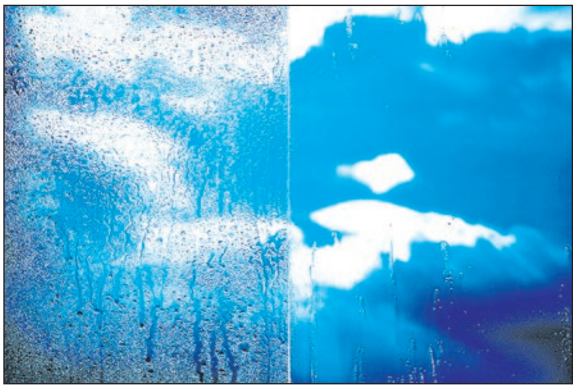
(c) Nanoparticles are extremely small particles that have different properties to the same material at bulk size.

Nano-scale titanium dioxide is commonly used in sunscreen and in self-cleaning windows.



Give the reason why nano-scale titanium dioxide is effective in each of these uses. [2]

Sunscreen

....

....

Self-cleaning windows

....

....

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4. (a) When a mixture of iron(III) oxide and aluminium powder is heated, the following reaction takes place.

iron(III) oxide + aluminium $\longrightarrow$ iron + aluminium oxide

The reaction is commonly called the thermite reaction. The photographs show the reaction taking place and how it is used in the repair of railway lines.

(i) Explain why iron is formed during the reaction. [2]

....

....

....

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

$$Fe_2O_3 \quad + \quad 2Al \quad \longrightarrow \quad \ldots\ldots\ldots\ldots\ldots\ldots$$

(iii) Calculate the percentage by mass of iron in iron(III) oxide, Fe_2O_3. [2]

$A_r(Fe) = 56 \qquad A_r(O) = 16$

Percentage = ... %

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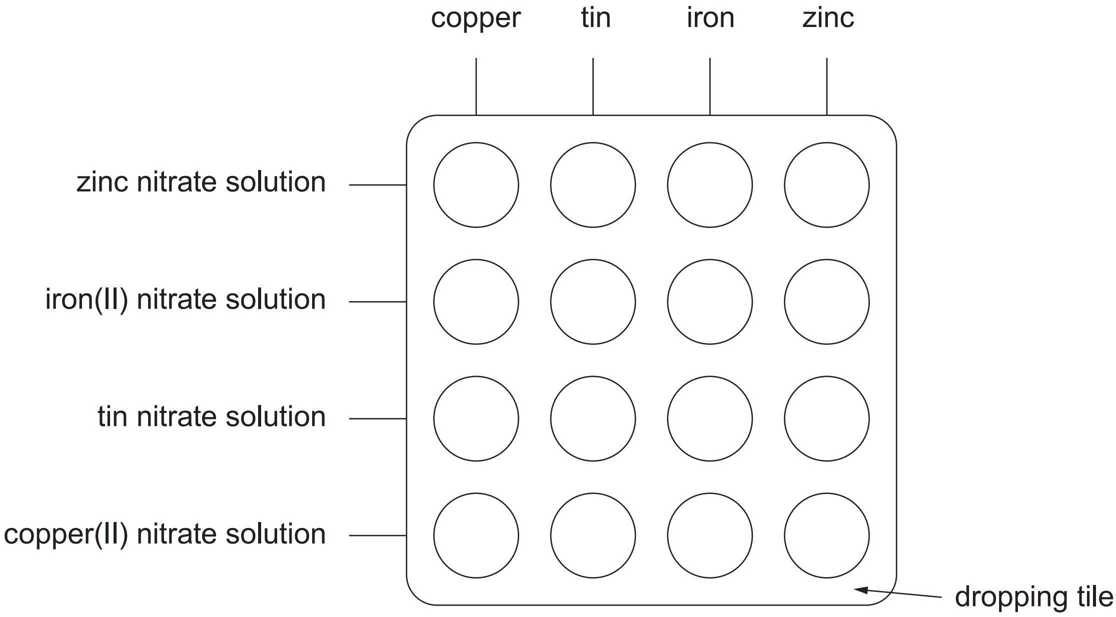
(b) Clare and Frankie were investigating the reactivity of metals. They carried out a series of displacement reactions in a dropping tile. In each test they placed a small piece of metal into a solution of the nitrate of a different metal as shown.



(i) It was not necessary to carry out **all** of the tests. Place crosses (**×**) on the diagram to show which tests did not need to be carried out.

Explain your choice. [2]

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(ii) The equation shows the reaction between iron and copper(II) nitrate solution.

$$2Fe + 3Cu(NO_3)_2 \longrightarrow 2Fe(NO_3)_3 + 3Cu$$

Use the equation to calculate the maximum mass of copper that you would expect to be formed when 0.224 g of iron is added to excess copper(II) nitrate solution. [3]

$A_r(Fe) = 56$ $\quad$ $A_r(Cu) = 63.5$

Maximum mass of copper = ... g

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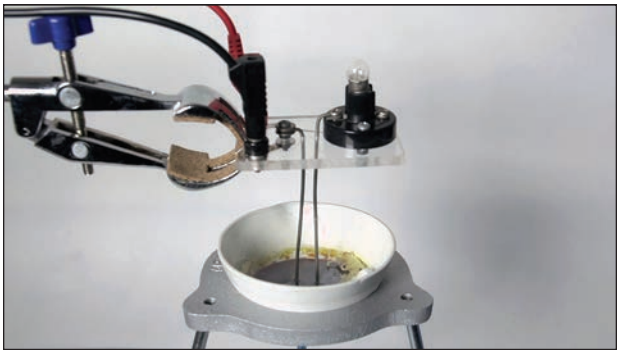
(c) The photograph shows how the electrolysis of zinc chloride can be carried out in the laboratory.



(i) Balance the equation that represents the reaction taking place at the anode.

Use the equation to explain the meaning of the term *oxidation*. [2]

$$\square\ Cl^- \longrightarrow Cl_2 + \square\ e^-$$

....

....

(ii) The following method can be used to calculate the mass of zinc produced during the process.

- Record the mass of the cathode before placing it into the electrolyte
- Allow the process to run to completion
- Remove the cathode from the electrolyte and record its new mass
- Calculate the increase in mass

I. It is often found that the increase in mass measured using this method is greater than expected. Suggest a reason for this. [1]

....

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II. Suggest why this method cannot be used to measure the mass of chlorine produced during the process. [1]

....

....

15

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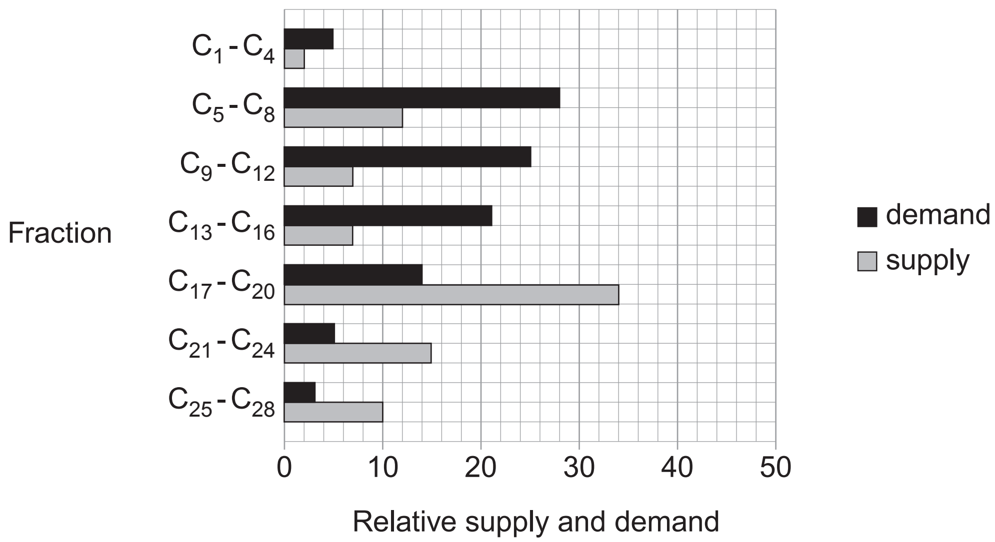
5. (a) The bar chart shows the relative supply and demand for some fractions obtained from crude oil.



(i) Use the chart to describe how the **difference** between supply and demand of the fractions changes as the chain length increases. [2]

....

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Examiner only

(ii) The process of cracking is used to overcome the problem of insufficient supply of some fractions.

I. State what is meant by *cracking* and give the conditions needed for the process. [2]

....

....

....

II. When hydrocarbon **X** is cracked, it forms hexene, ethene and butane.

Give the molecular formula of hydrocarbon **X** to complete the equation. [1]

....	$\longrightarrow$	C_6H_{12}	+	$2C_2H_4$	+	C_4H_{10}
hydrocarbon **X**		hexene		ethene		butane

(b) C_4H_{10} has two isomers.

(i) Give the meaning of the term *isomers*. [1]

....

....

....

(ii) Draw the structures of both isomers of C_4H_{10}. [2]

8

6. It is well known that plastic bags are a major source of litter. These bags can exist for a very long time, ranging from tens of years in the natural environment up to a thousand years in landfill.

The use of plastic bags is now banned in some countries. These countries commonly use bags made from paper or cotton, which do not cause the same litter problem as plastic bags.

Paper or plastic?

Most people assume that a paper bag is better for the environment, however because paper bags are almost ten times heavier than plastic bags, they produce a greater mass of waste. On the other hand, because paper bags are biodegradable they do not lead to the same problem with litter as plastic bags.

When deciding whether paper is more suitable than plastic for making shopping bags, information from life cycle assessments (LCAs) of both materials must be taken into consideration.

Some of the findings from LCAs of paper and plastic bags are shown below.

Plastic bags are toxic to aquatic environments and their production is more likely to deplete natural resources	Plastic bags use 70% less energy in their production compared to paper bags	The processes used in paper production cause atmospheric acidification and eutrophication
The production of 1 million paper bags produces 51 tonnes of carbon dioxide, compared to 31 tonnes for plastic bags	693 kJ of energy is needed to recycle 1 kg of paper bags compared to 8 kJ for the same mass of plastic bags	4 546 litres of water are used to produce 1 000 paper bags compared to 177 litres for the same number of plastic bags
Paper bags are made from trees and plastic bags are made from ethene	Paper bags are 10 times heavier than plastic bags and therefore have more associated costs	

On reading these findings it is important to consider all factors relating to sustainability when deciding on the most suitable material to make shopping bags. We should not just be thinking about what happens when we throw them away!

Examiner only

(a) Use the information in the passage to compare the mass of waste and volume of litter generated from the use of plastic and paper bags. [2]

....

....

....

....

(b) Use the information from the LCAs to tick (✓) whether each of the factors supports or opposes the use of paper bags in preference to plastic bags. [3]

	Supports use of paper bags	**Opposes use of paper bags**
Impact of waste on marine life	☐	☐
Water consumption in production	☐	☐
Energy used in production	☐	☐
Carbon footprint generated in production	☐	☐
Energy used in recycling	☐	☐
Cost of transporting waste	☐	☐

(c) The use of which type of bag is more likely to be linked to the erosion of limestone buildings?

Give a reason for your answer. [1]

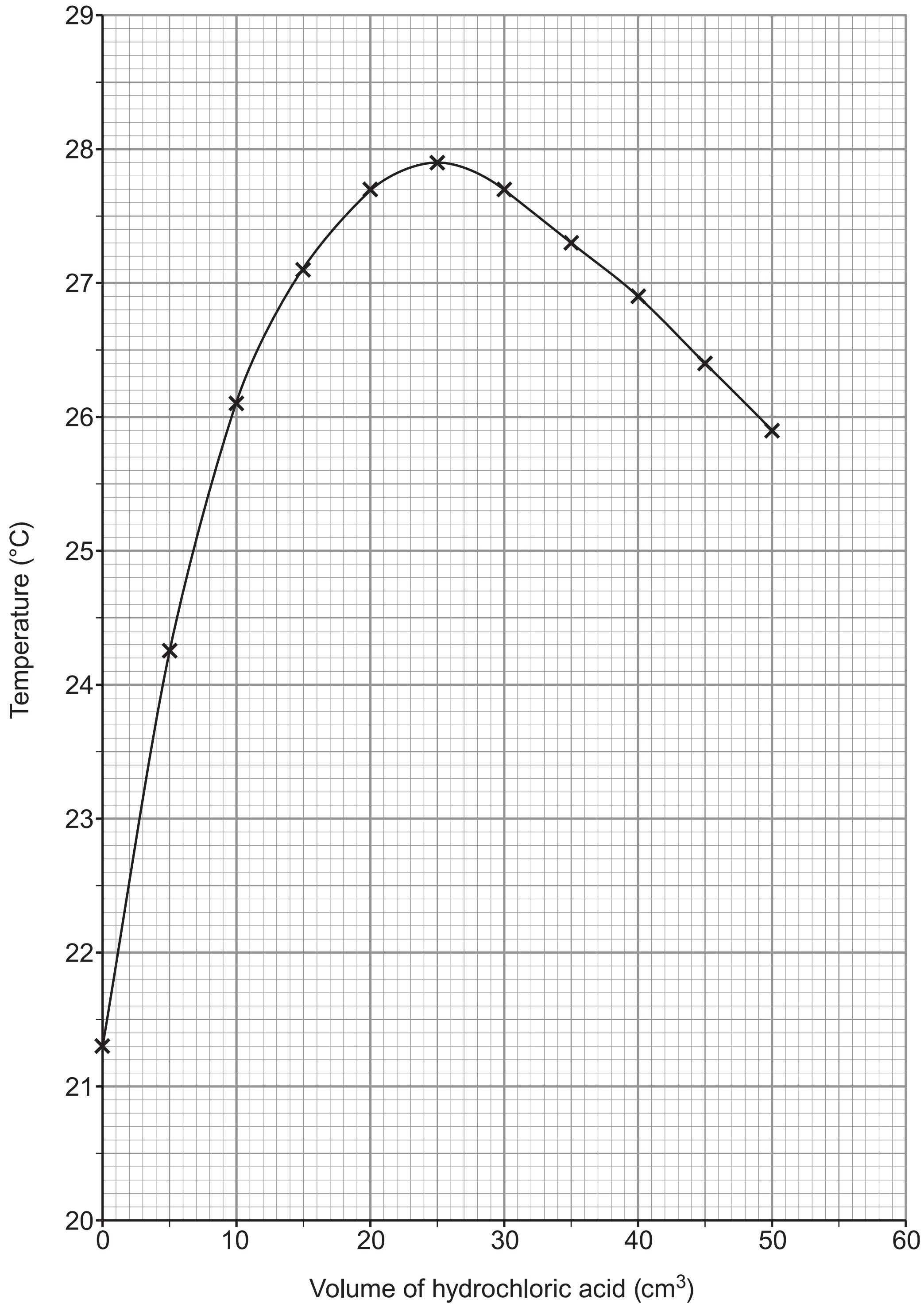
Type of bag ....

Reason ....

....

6

7. (a) The graph shows how the temperature changes when dilute hydrochloric acid is added gradually to sodium hydroxide solution.



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The pH of the solution also changes as the hydrochloric acid is added to the sodium hydroxide.

Explain the temperature changes shown on the graph and relate these to the change in pH during the reaction. You do **not** need to include equations in your answer. [6 QER]

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(b) The reaction between hydrochloric acid and sodium hydroxide produces sodium chloride and water.

Give the **ionic** equation to show how water is formed during this reaction. [1]

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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											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

A_r — relative atomic mass
Symbol
Name
Z — atomic number