Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S23-3430UE0-1

3430UE0-1

MONDAY, 22 MAY 2023 – 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.	**15**	
2.	**7**	
3.	**7**	
4.	**9**	
5.	**10**	
6.	**6**	
7.	**6**	
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 black 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** 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 molecular formulae of five carbon compounds, **A**, **B**, **C**, **D** and **E** are shown below.

C_3H_6	C_2H_5OH	C_4H_8	C_2H_6	C_3H_8
A	**B**	**C**	**D**	**E**

(i) Alkanes are compounds with the general formula C_nH_{2n+2}.

Give the **letters** of the **two** compounds that are alkanes. [1]

..... and .....

(ii) Give the **name** for compound **A**. [1]

.....

(iii) Draw the structural formula of compound **E**. [1]

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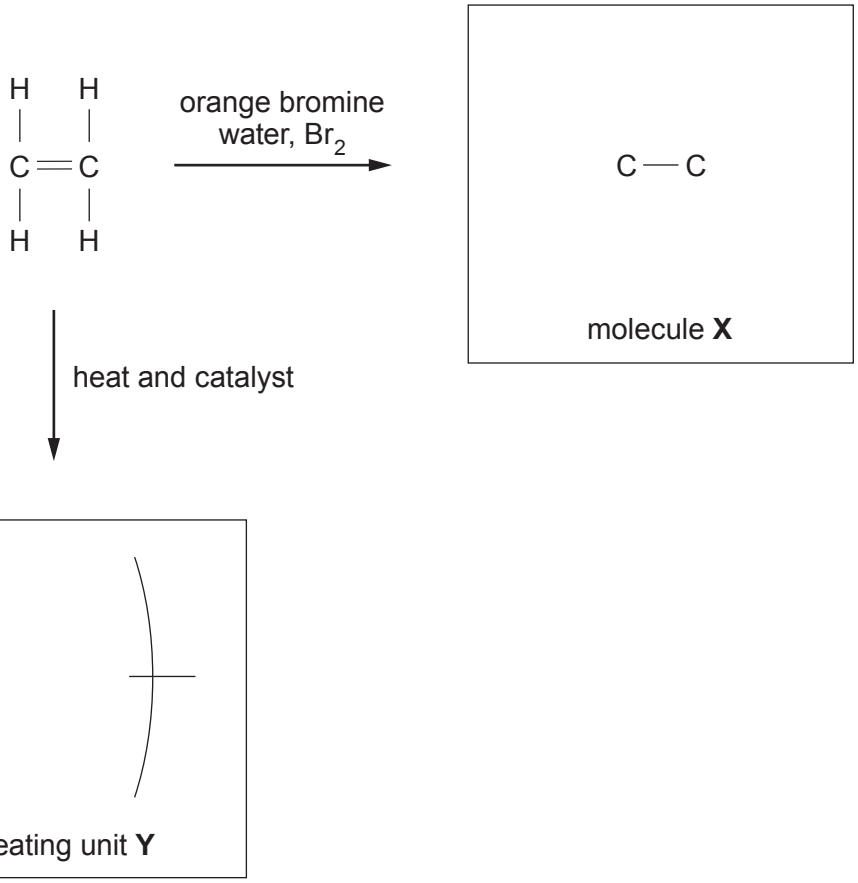
(b) The following diagram shows two reactions of ethene.



(i) **Complete the structural formulae** for molecule **X** and repeating unit **Y**. [2]

(ii) Describe the change that would be seen in the orange bromine water when molecule **X** is formed. [1]

.....

(iii) Name the type of reaction that takes place to form repeating unit **Y**. [1]

.....

3430UE01
03

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(c) Paper and plastic are both used to make disposable shopping bags.

The table compares the percentages of disposable paper and plastic bags used by consumers in a Welsh town between 1988 and 2018.

Type of bag	Percentage of disposable bags used (%)						
	1988	1993	1998	2003	2008	2013	2018
paper	73	63	31	12	8	13	21
plastic	27	37	69	88	92	87	79

(i) In 2003, the consumers of the town used a total of 1.25 million disposable bags.

Use the information in the table to calculate the number of **paper** bags used. [2]

Number of paper bags = ... million

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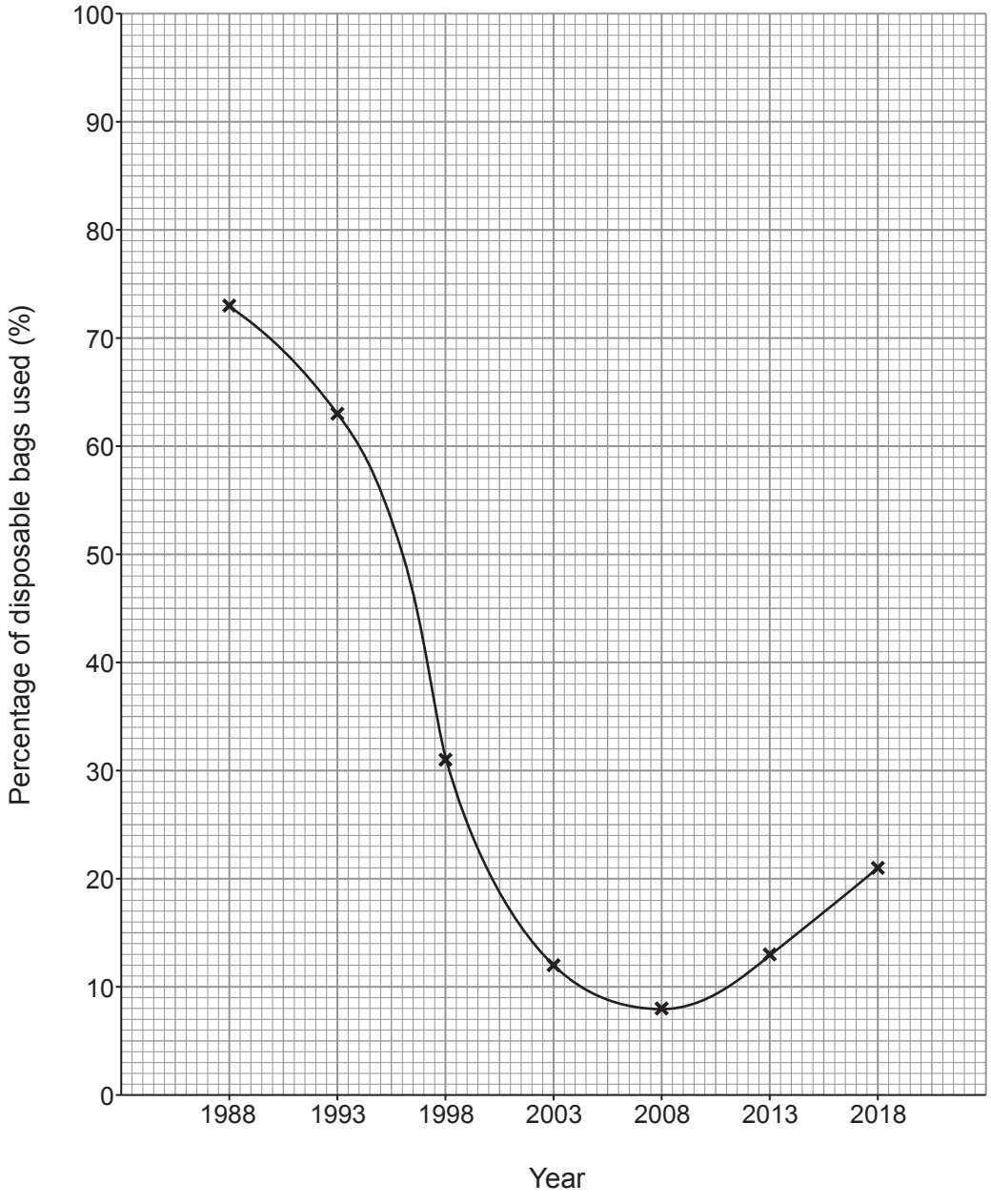
(ii) The graph below shows the percentage of **paper** bags used between 1988 and 2018.

Plot on the **same grid** the percentage of **plastic** bags used between 1988 and 2018. Draw a suitable line. [3]



3430UE01
05

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(iii) **Use the graph** to answer the following questions.

I. Give the year when **equal** numbers of plastic bags and paper bags were used. [1]

Year .....

II. Circle the **simplest** ratio that compares the use of paper bags to plastic bags in 2000. [1]

2 : 8 **1 : 4** **4 : 1** **8 : 2** **20 : 80**

(iv) Give **one** reason that explains the change seen in plastic bag usage in Wales between 2008 and 2018. [1]

.....

.....

15

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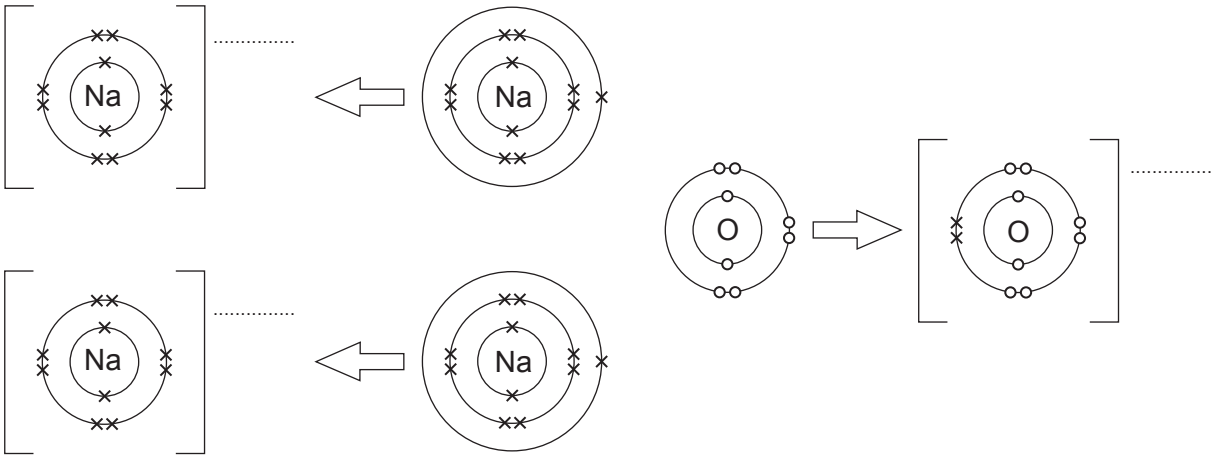
2. (a) The table gives the electronic structures of sodium and oxygen.

Element	Electronic structure
sodium	2,8,1
oxygen	2,6

(i) Sodium reacts with oxygen to give sodium oxide.

The diagram below can be used to show the electronic changes that occur as sodium oxide is formed.



Complete the diagram by

- **drawing arrows** to show the movement of electrons between the sodium and oxygen atoms,
- giving the **charges** of the sodium and oxide ions that are formed. [2]

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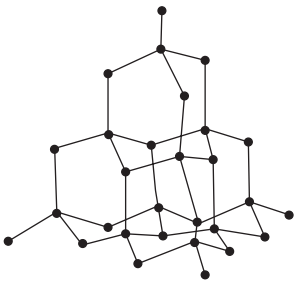
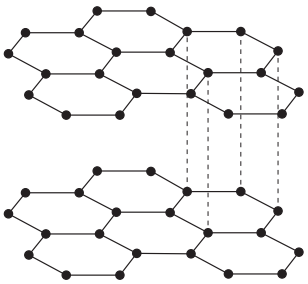
(ii) Draw a dot and cross diagram to show the bonding in an oxygen molecule, O_2. [2]

(b) (i) Diamond and graphite are both made from carbon atoms. Their structures are shown below.



diamond



graphite

I. State which structure is able to conduct electricity. Give a reason for your answer. [1]

.....

.....

II. State which structure is used as a lubricant. Give a reason for your answer. [1]

.....

.....

(ii) Give the name of another form of carbon that is used in drug delivery systems. [1]

.....

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3430UE01
09

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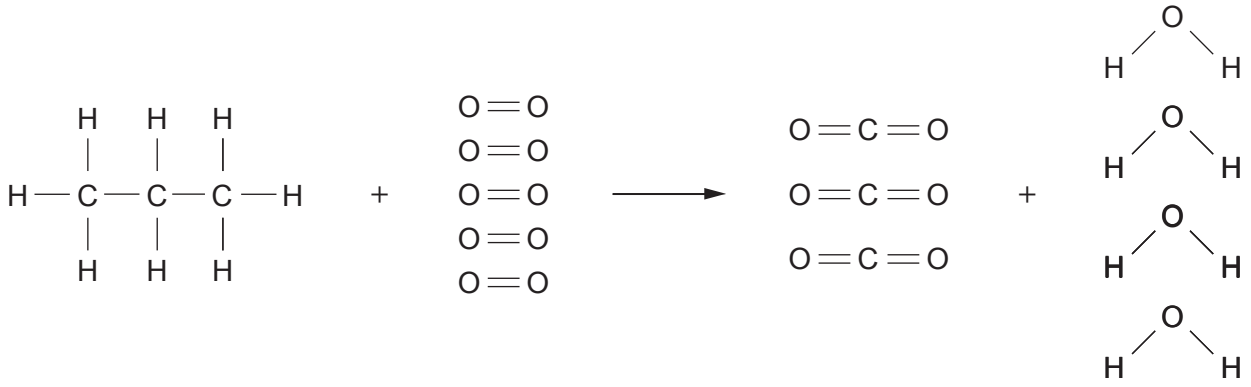
3. (a) Propane gas is commonly used as a fuel. The burning of propane gas is represented by the following equation.



The relative amounts of energy needed to break some of the bonds are given in the table.

Bond	Bond energy (kJ)
C—H	413
C—C	348

(i) The total energy needed to break all of the bonds in the reactants is 6490 kJ.

Calculate the energy needed to break **one** O = O bond. [3]

Energy needed = ... kJ

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(ii) The energy released when all of the bonds in the products are formed is 8542 kJ.

Tick (✓) the correct overall energy change for this reaction. [1]

2052 kJ taken in ☐

15032 kJ taken in ☐

15032 kJ given out ☐

2052 kJ given out ☐

3430UE01
11

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(b) Propane gas is commonly used in camping stoves.

The photograph shows a camping stove being used to heat 750 g of water.

When heated for 10 minutes, 220 kJ of energy was transferred to the water.

Use the following equation to calculate the temperature rise of the water. [1]

$$\text{temperature rise (°C)} = \frac{\text{energy transferred (J)}}{4.2 \times \text{mass of water (g)}}$$

Temperature rise = ... °C

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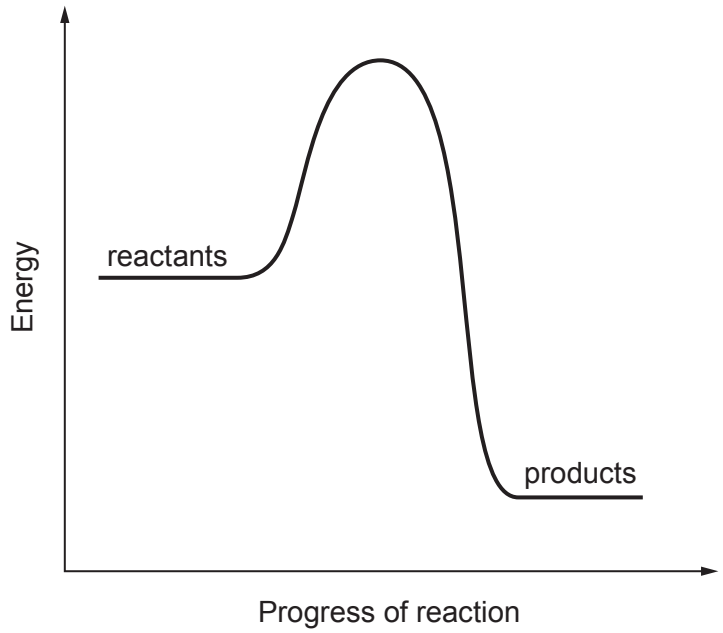
(c) The energy profile diagram for the combustion of propane is given below.



(i) Draw an **arrow** (↕) **on the diagram** to show the activation energy.

Label this **A**. [1]

(ii) Draw an **arrow** (↕) **on the diagram** to show the overall energy change.

Label this **B**.

[1]

7

3430UE01
13

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4. Iron is extracted from iron oxide inside the blast furnace.

Iron oxide, coke and limestone are all fed in at the top of the furnace.

(a) Describe the **two** main functions of coke in the furnace. [3]

.....

.....

.....

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.....

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(b) Limestone is added to the furnace to remove some of the impurities as slag. Their removal involves a two-stage process as shown in the following equations.

Stage 1 $CaCO_3 \longrightarrow CaO + CO_2$

Stage 2 $CaO + SiO_2 \longrightarrow$ slag

(i) A group of students were each asked to calculate the maximum mass of calcium oxide that could be produced from 8.0 g of calcium carbonate in stage 1.

The answers they calculated were as follows:

Student	Answer
Yena	4.4 g
Charlie	4.5 g
Tomasz	5.0 g

Give the name of the student that has correctly calculated the mass of calcium oxide to **one** decimal place.

You **must** show your working. [3]

$M_r(CaCO_3) = 100$ $M_r(CaO) = 56$

Student .....

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(ii) In stage 2, the slag that is formed contains calcium silicate.

Calcium silicate is formed when calcium oxide (CaO) combines with silicon dioxide (SiO_2) in a 1:1 ratio, with no other product formed.

Give the chemical formula of the calcium silicate formed in stage 2. [1]

.....

(c) Iron reacts with oxygen to form iron(III) oxide.

Complete and balance the equation for this reaction. [2]

$\square$ Fe + $3O_2$ $\longrightarrow$ $\square$ .....

9

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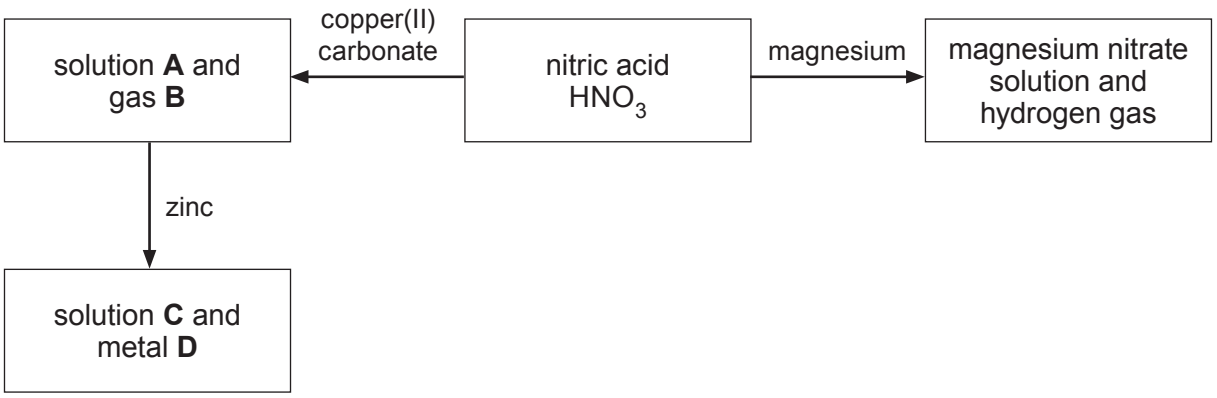
5. (a) The diagram shows a sequence of reactions from nitric acid.



(i) Use the information in the diagram to name the following substances. [3]

solution **A** .....

gas **B** .....

solution **C** .....

metal **D** .....

(ii) Write the balanced symbol equation for the reaction between magnesium and nitric acid. [3]

.....

(iii) Name the type of reaction that takes place between solution **A** and zinc. [1]

.....

Examiner only

(b) (i) The sulfate ions in sulfuric acid are identified using barium chloride solution. The equation for the reaction is shown below.

$$H_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2HCl(aq)$$

Tick (✓) the correct ionic equation for the formation of the precipitate. [1]

$H^+ + Cl^- \longrightarrow HCl$ ☐

$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$ ☐

$Ba^{2+} + S^{2-} + 4O^{2-} \longrightarrow BaSO_4$ ☐

$2H^+ + 2Cl^- \longrightarrow 2HCl$ ☐

$Ba^{2-} + SO_4^{2+} \longrightarrow BaSO_4$ ☐

(ii) A student was asked to identify the ions present in barium chloride solution.

I. Other than adding sulfate ions, state how the student would test for barium ions. Give the expected observation for a positive test. [1]

.....

.....

II. State how the student would test for chloride ions. Give the expected observation for a positive test. [1]

.....

.....

10

6. Hydrogels are macromolecules, meaning they contain very large numbers of atoms.

They are polymers made from hydrophilic polymer chains. This means that they readily mix with water.

Cross-links between the polymer chains enable hydrogels to form their three-dimensional shape.

The cross-links that join the individual polymer chains together are formed by small reactive molecules that contain one or more double bonds.

The interesting feature of hydrogels is their ability to swell and shrink, depending on their surroundings. When in contact with water, hydrogels are able to absorb water and swell to many times their original size and weight, whilst maintaining the same shape.

Being able to absorb water like this has enabled hydrogels to be used in a wide range of applications. For many of these applications it is important to understand how the properties of hydrogels change with temperature.

Table 1 and **Table 2** show how temperature affects the properties of hydrogel beads in water over time.

Time (hours)	Mass of bead (g)		
	10 °C	20 °C	40 °C
0	0.035	0.035	0.035
2	1.305	2.980	4.280
4	2.512	3.681	5.904
6	3.613	4.389	6.760
8	4.298	5.195	8.101
10	5.120	5.572	8.101
12	5.400	5.980	8.101

Table 1 – the effect of temperature on the mass of hydrogel beads

Time (hours)	Diameter of bead (mm)		
	10 °C	20 °C	40 °C
0	3.56	3.56	3.56
2	10.30	13.00	18.10
4	13.40	16.50	21.70
6	16.20	18.50	23.60
8	17.80	19.60	25.24
10	19.50	20.80	25.24
12	20.50	22.00	25.24

Table 2 – the effect of temperature on the diameter of hydrogel beads

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(a) Tick (✓) the statement that **best** describes the molecules that form the cross-links within hydrogels. [1]

they are macromolecules ☐

they are unsaturated ☐

they contain hydrophilic groups ☐

they are polymers ☐

(b) Give the phrase in the passage that shows the change the hydrogel undergoes is a physical rather than a chemical change. [1]

.....

.....

(c) Calculate the percentage increase in **mass** of a hydrogel bead when placed in water at 20 °C for 6 hours. [2]

Percentage increase = ... %

(d) Write a conclusion for the effect of **temperature** on the diameter of hydrogel beads in water over time. [2]

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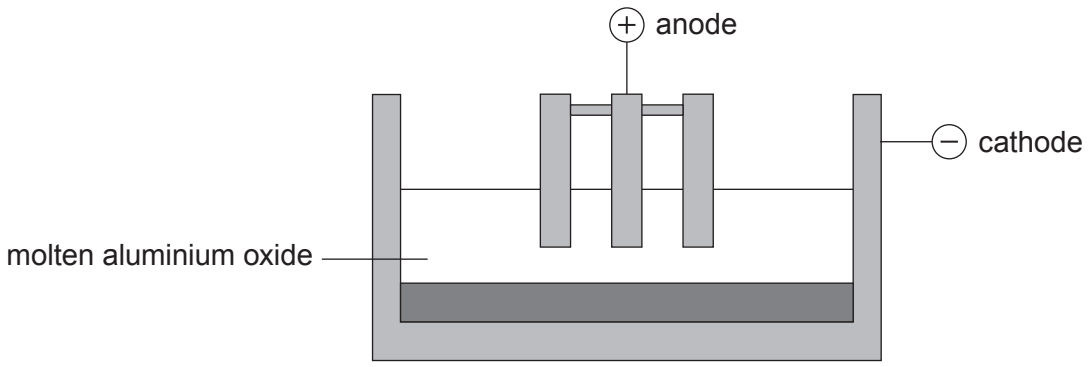
6

7. Aluminium is extracted from its ore by electrolysis. The diagram shows a cross-section of the cell used for the extraction.



The overall equation for the extraction taking place inside the cell is given below.

$$2Al_2O_3 \longrightarrow 4Al + 3O_2$$

Examiner only

Explain the movement of Al^{3+} and O^{2-} ions inside the cell and how the reactions at each electrode demonstrate oxidation and reduction. Include electrode equations in your answer.

[6 QER]

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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

Group 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