Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

GCSE CHEMISTRY

F

Foundation Tier Paper 1

Thursday 17 May 2018 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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0 1 This question is about mixtures.

0 1 . 1 Substances are separated from a mixture using different methods.

Draw **one** line from each substance and mixture to the best method of separation.

[3 marks]

Substance and mixture	**Method of separation**
	Chromatography
Ethanol from ethanol and water	
	Crystallisation
Salt from sea water	Electrolysis
	Filtration
The different colours in black ink	
	Fractional distillation

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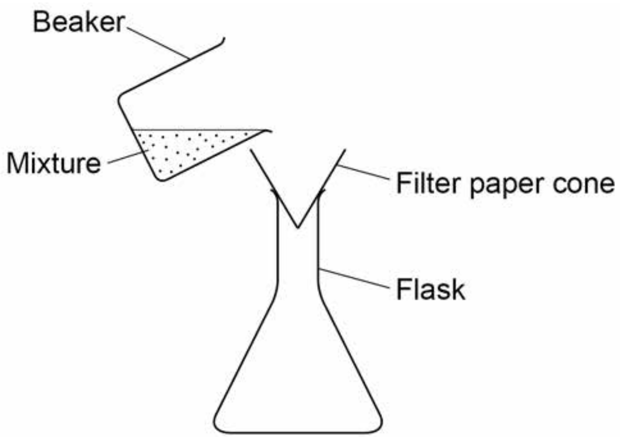
0 1 . 2 A student filters a mixture.

Figure 1 shows the apparatus.

Figure 1



Suggest **one** improvement to the apparatus.

[1 mark]

____

____

0 1 . 3 Complete the sentences.

Choose answers from the box.

[2 marks]

condense	**evaporate**	**freeze**	**melt**	**solidify**

In simple distillation, the mixture is heated to make the liquid ____________________.

The vapour is then cooled to make it ____________________.

Turn over ►

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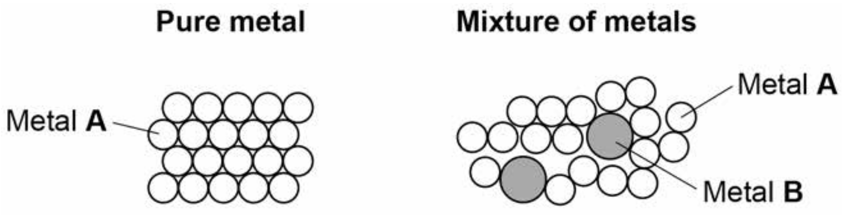
Figure 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 2



0 1 . 4 Calculate the percentage of metal **B** atoms in the mixture of metals shown in **Figure 2**.

[2 marks]

____

____

____

Percentage of metal **B** atoms = ________________ %

0 1 . 5 What is a mixture of metals called?

[1 mark]

Tick **one** box.

An alloy ☐

A compound ☐

A molecule ☐

A polymer ☐

Do not write outside the box

0 1 . 6 Why is the mixture of metals in **Figure 2** harder than the pure metal?

[1 mark]

Tick **one** box.

The atoms in the mixture are different shapes. ☐

The layers in the mixture are distorted. ☐

The layers in the mixture slide more easily. ☐

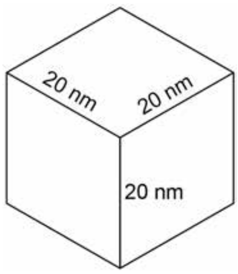
The mixture has a giant structure. ☐

0 1 . 7 A nanoparticle of pure metal **A** is a cube.

Each side of the cube has a length of 20 nm.

Figure 3 shows the cube.

Figure 3



What is the volume of the nanoparticle?

[1 mark]

Tick **one** box.

20 nm^3 ☐

60 nm^3 ☐

400 nm^3 ☐

8000 nm^3 ☐

11

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0 2 The halogens are elements in Group 7.

0 2 . 1 Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

[1 mark]

____

0 2 . 2 Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

[1 mark]

Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

0 2 . 3 What is the formula for fluorine gas?

[1 mark]

Tick **one** box.

F ☐

F_2 ☐

F^2 ☐

2F ☐

A student mixes solutions of halogens with solutions of their salts.

Table 1 shows the student's observations.

Table 1

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

0 2 . 4 Explain how the reactivity of the halogens changes going down Group 7.

Use the results in **Table 1**.

[3 marks]

Question 2 continues on the next page

A company uses chlorine to produce titanium chloride from titanium dioxide.

0 2 . 5 What is the relative formula mass (M_r) of titanium dioxide, TiO_2 ?

Relative atomic masses (A_r): O = 16 Ti = 48

[1 mark]

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

0 2 . 6 The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

[2 marks]

____

____

____

____

Percentage yield = ____________________ %

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 This question is about the structure of the atom.

0 3 . 1 Complete the sentences.

Choose answers from the box.

Each word may be used once, more than once, or not at all.

[5 marks]

electron	**ion**	**neutron**
nucleus	**proton**	

The centre of the atom is the ____________________________.

The two types of particle in the centre of the atom are the proton

and the ____________________________.

James Chadwick proved the existence of the ____________________________.

Niels Bohr suggested particles orbit the centre of the atom. This type of particle

is the ____________________________.

The two types of particle with the same mass are the neutron

and the ____________________________.

Table 2 shows information about two isotopes of element **X**.

Table 2

	Mass number	Percentage (%) abundance
Isotope 1	63	70
Isotope 2	65	30

Do not write outside the box

0 3 . 2 Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Use **Table 2**.

Give your answer to 1 decimal place.

[2 marks]

A_r = ____________________

0 3 . 3 Suggest the identity of element **X**.

Use the periodic table.

[1 mark]

Element **X** is ____________________

0 3 . 4 The radius of an atom of element **X** is 1.2×10^{-10} m

The radius of the centre of the atom is $\frac{1}{10\,000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element **X**.

Give your answer in standard form.

[2 marks]

Radius = ____________________ m

10

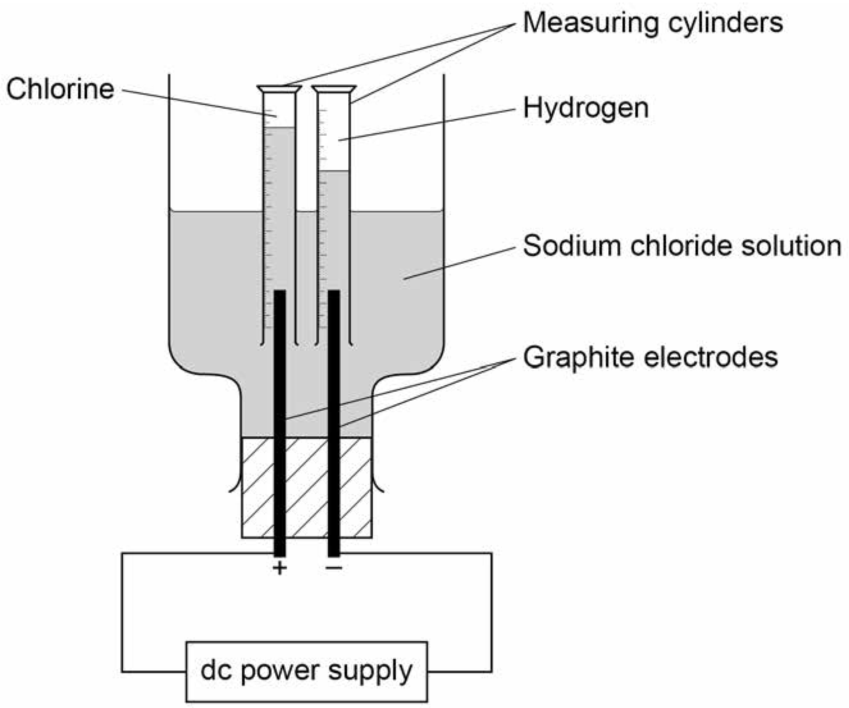
Turn over ►

Do not write outside the box

0 4 A student investigated the electrolysis of sodium chloride solution.

Figure 4 shows the apparatus.

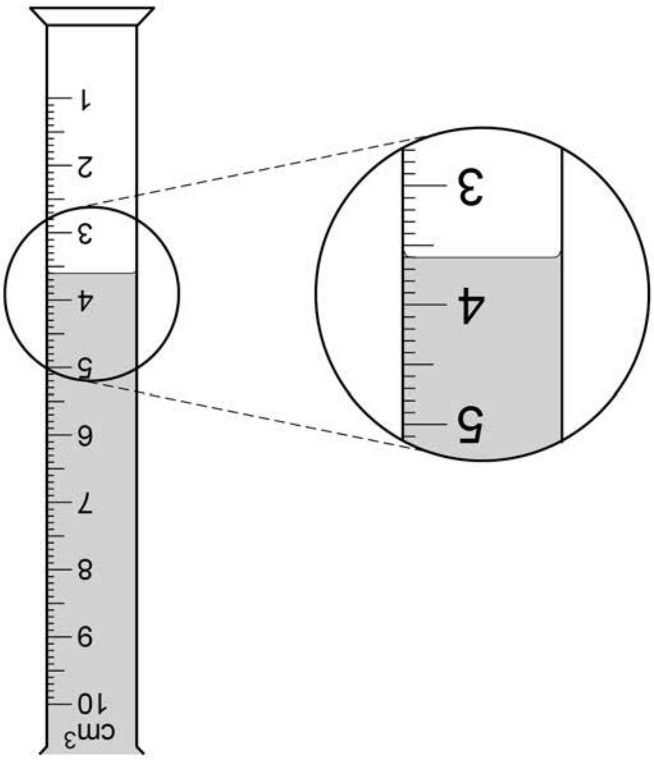
Figure 4



The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.

0 4 . 1 **Figure 5** shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

Figure 5



What is the volume of hydrogen gas collected?

[1 mark]

Volume = ______________________ cm^3

Question 4 continues on the next page

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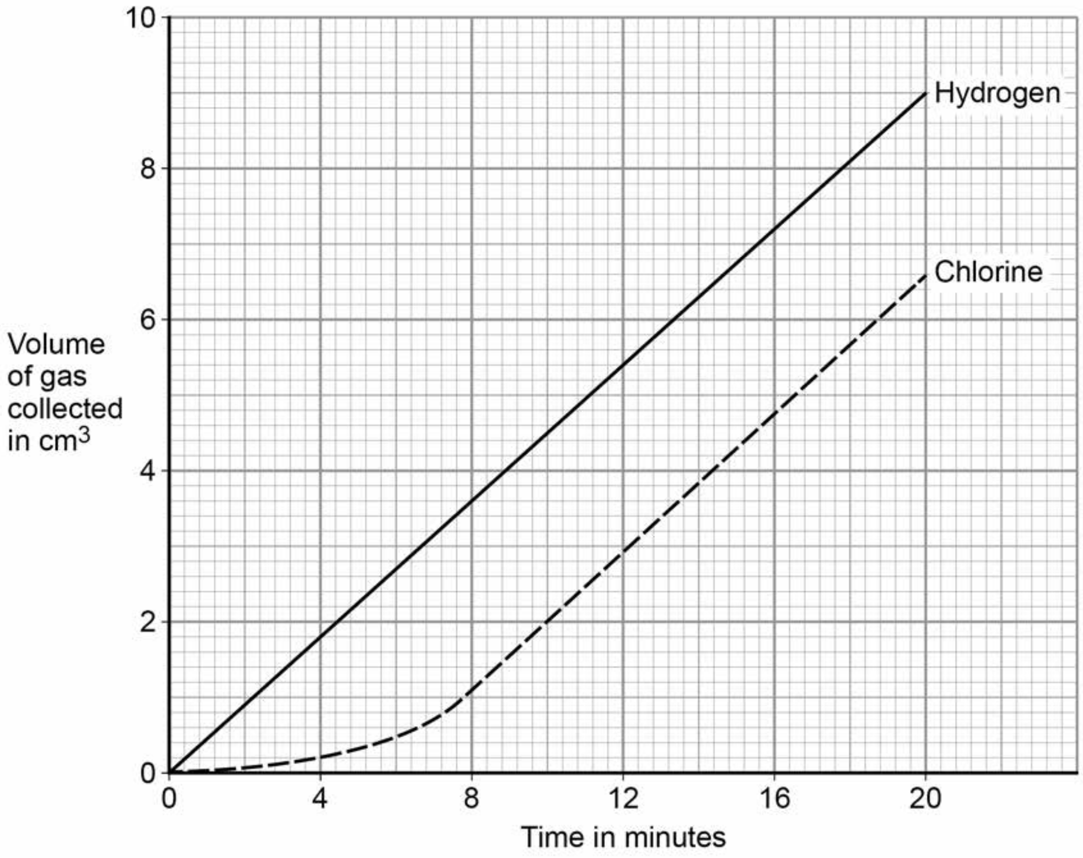
Figure 6 shows the results of the investigation.

Figure 6



0 4 . 2 Which of the lines on **Figure 6** show that the volume of gas collected is directly proportional to the time?

[1 mark]

Tick **one** box.

Both lines ☐

Chlorine line only ☐

Hydrogen line only ☐

Neither line ☐

Do not write outside the box

0 4 . 3 Which of the lines on **Figure 6** show a positive correlation between the volume of gas collected and time?

[1 mark]

Tick **one** box.

Both lines ☐

Chlorine line only ☐

Hydrogen line only ☐

Neither line ☐

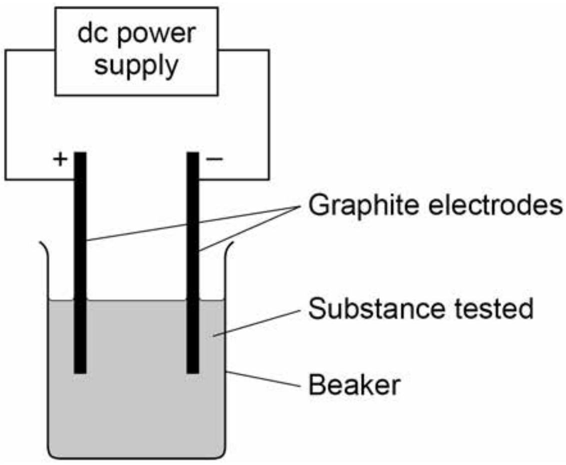
Question 4 continues on the next page

Do not write outside the box

A teacher demonstrates the electrolysis of different substances using graphite electrodes.

Figure 7 shows the apparatus used.

Figure 7



0 4 . 4 Why can graphite conduct electricity?

[1 mark]

Tick **one** box.

Graphite exists in layers of atoms. ☐

Graphite has a giant structure. ☐

Graphite has a high melting point. ☐

Graphite has delocalised electrons. ☐

Do not write outside the box

0 4 . 5 The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete **Table 3** to predict the products.

Choose answers from the box.

[4 marks]

chlorine	**bromine**	**hydrogen**	**oxygen**	**potassium**	**zinc**

Table 3

Substance electrolysed	Product at cathode (negative electrode)	Product at anode (positive electrode)
Molten zinc chloride		
Potassium bromide solution		

Turn over for the next question

8

Do not write outside the box

0 5 A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.
2. Weigh 2.00 g of copper carbonate into the test tube.
3. Heat the copper carbonate until there appears to be no further change.
4. Re-weigh the test tube and copper oxide produced.
5. Subtract the mass of the empty tube to find the mass of copper oxide.
6. Repeat steps 1–5 twice.
7. Repeat steps 1–6 with different masses of copper carbonate.

Table 4 shows the student's results.

Table 4

Mass of copper carbonate in g	Mass of copper oxide in g			
	Trial 1	Trial 2	Trial 3	Mean
2.00	1.29	1.27	1.31	1.29
4.00	2.89	2.57	2.59	2.58
6.00	3.85	3.90	3.87	3.87
8.00	5.12	5.15	5.09	**X**
10.00	6.42	6.45	6.45	6.44

The equation for the reaction is:

$$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$$

0 5 . 1 Complete the sentence.

[1 mark]

The state symbol shows carbon dioxide is a ____________________________.

0 5 . 2 Why do the contents of the test tube lose mass in the investigation?

[1 mark]

0 5 . 3 Calculate the mean mass **X** in **Table 4**.

[1 mark]

X = ____________ g

0 5 . 4 One of the results in **Table 4** is anomalous.

Which result is anomalous?

[1 mark]

Mass of copper carbonate ____________ g Trial ____________

0 5 . 5 Suggest how the investigation could be improved to make sure the reaction is complete.

[2 marks]

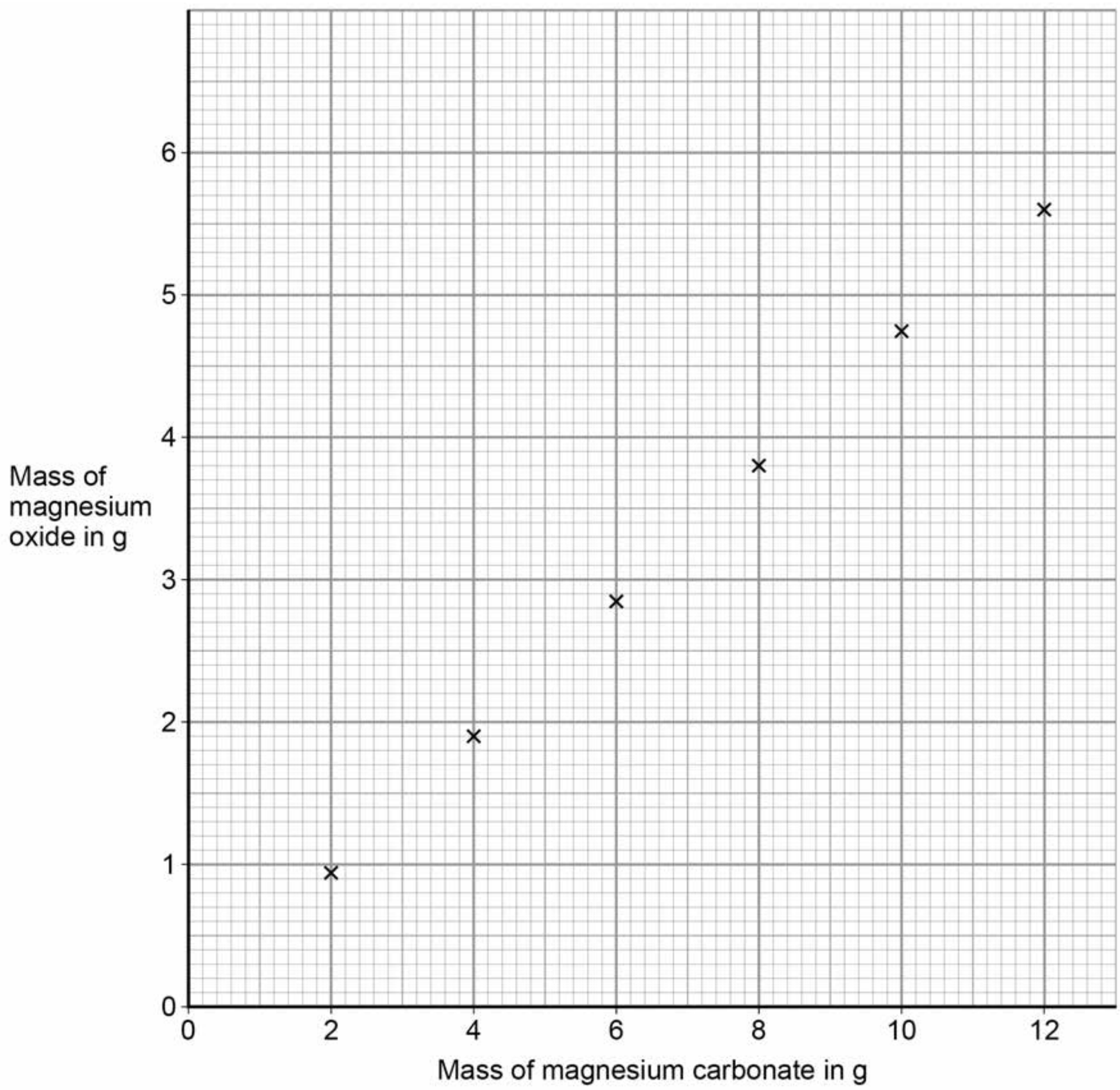
Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

The word equation for the reaction is:

magnesium carbonate → magnesium oxide + carbon dioxide

Figure 8 shows the results of the investigation.

Figure 8



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0 5 . 6 Draw a line of best fit on **Figure 8**.

[1 mark]

0 5 . 7 Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use **Figure 8**.

[1 mark]

Mass = ______________________ g

0 5 . 8 Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to Question **05.7**

[2 marks]

____

____

____

____

Mass of magnesium oxide produced = __________________ g

10

Turn over for the next question

Do not write outside the box

0 6 A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

This is the method used.

1. Measure 50 cm^3 of the copper sulfate solution into a polystyrene cup.
2. Record the starting temperature of the copper sulfate solution.
3. Add the metal and stir the solution.
4. Record the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1-5 with different metals.

0 6 . 1 Draw **one** line from each type of variable to the name of the variable in the investigation.

[2 marks]

Type of variable	**Name of variable in the investigation**
	Concentration of solution
Dependent variable	Particle size of solid
	Temperature change
Independent variable	Type of metal
	Volume of solution

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0 6 . 2 The student used a polystyrene cup and **not** a glass beaker.

Why did this make the investigation more accurate?

[1 mark]

Tick **one** box.

Glass is breakable ☐

Glass is transparent ☐

Polystyrene is a better insulator ☐

Polystyrene is less dense ☐

Question 6 continues on the next page

Turn over ►

Table 5 shows the student's results.

Table 5

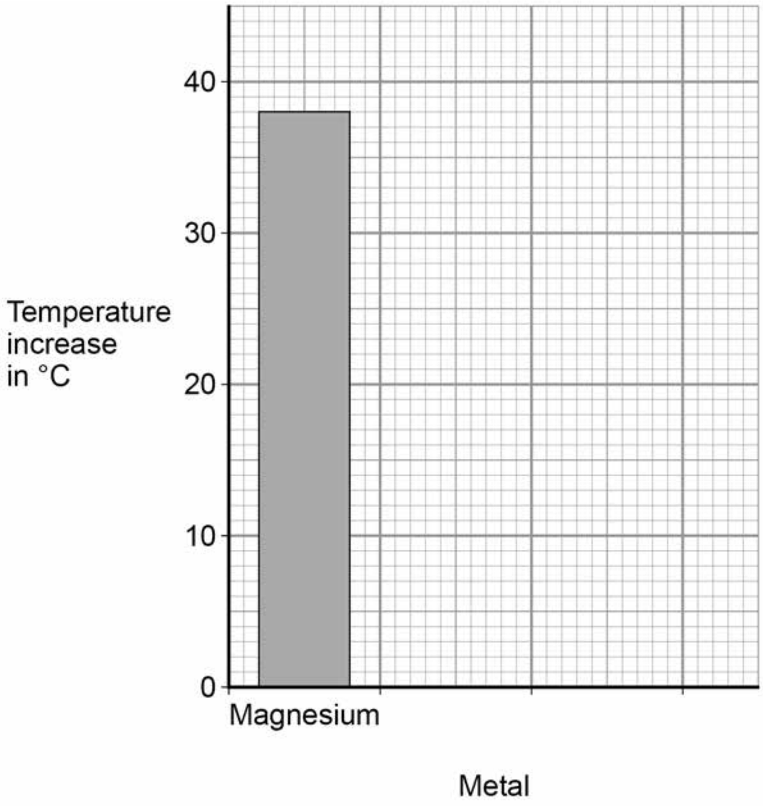
Metal	**Temperature increase in ° C**
Magnesium	38
Nickel	8
Zinc	16

0 6 . 3 Complete **Figure 9**.

Use data from **Table 5**.

[2 marks]

Figure 9



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0 6 . 4 The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

0 6 . 5 The temperature increase depends on the reactivity of the metal.

Write the metals magnesium, nickel and zinc in order of reactivity.

Use **Table 5**.

[1 mark]

Most reactive

Least reactive

0 6 . 6 **Y** is an unknown metal.

Describe a method to find the position of **Y** in the reactivity series in Question **06.5**

[3 marks]

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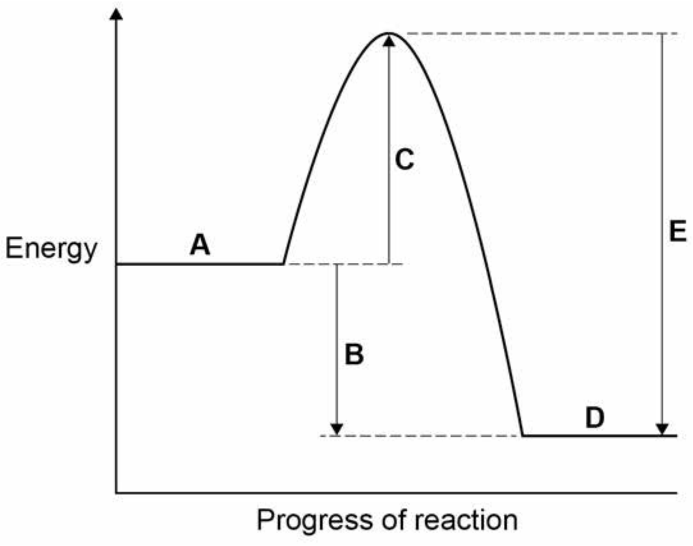
Figure 10 shows the reaction profile for the reaction between zinc and copper sulfate solution.

Figure 10



0 6 . 7 Which letter represents the products of the reaction?

[1 mark]

Tick **one** box.

A ☐	**B** ☐	**C** ☐	**D** ☐	**E** ☐

0 6 . 8 Which letter represents the activation energy?

[1 mark]

Tick **one** box.

A ☐	**B** ☐	**C** ☐	**D** ☐	**E** ☐

12

Turn over for the next question

0 7 This question is about elements in Group 1.

A teacher burns sodium in oxygen.

0 7 . 1 Complete the word equation for the reaction.

[1 mark]

sodium + oxygen → ________________________________

0 7 . 2 What is the name of this type of reaction?

[1 mark]

Tick **one** box.

Decomposition ☐

Electrolysis ☐

Oxidation ☐

Precipitation ☐

0 7 . 3 The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

[1 mark]

Tick **one** box.

1	☐	4	☐	7	☐	13	☐

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0 7 . 4 The solution contains a substance with the formula NaOH

Give the name of the substance.

[1 mark]

____

0 7 . 5 All alkalis contain the same ion.

What is the formula of this ion?

[1 mark]

Tick **one** box.

H^+ ☐

Na^+ ☐

OH^- ☐

O^{2-} ☐

0 7 . 6 A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

[2 marks]

____

____

____

____

Mass = ____________________ g

Turn over ►

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0 7 . 7 The melting points of the elements in Group 1 show a trend.

Table 6 shows the atomic numbers and melting points of the Group 1 elements.

Table 6

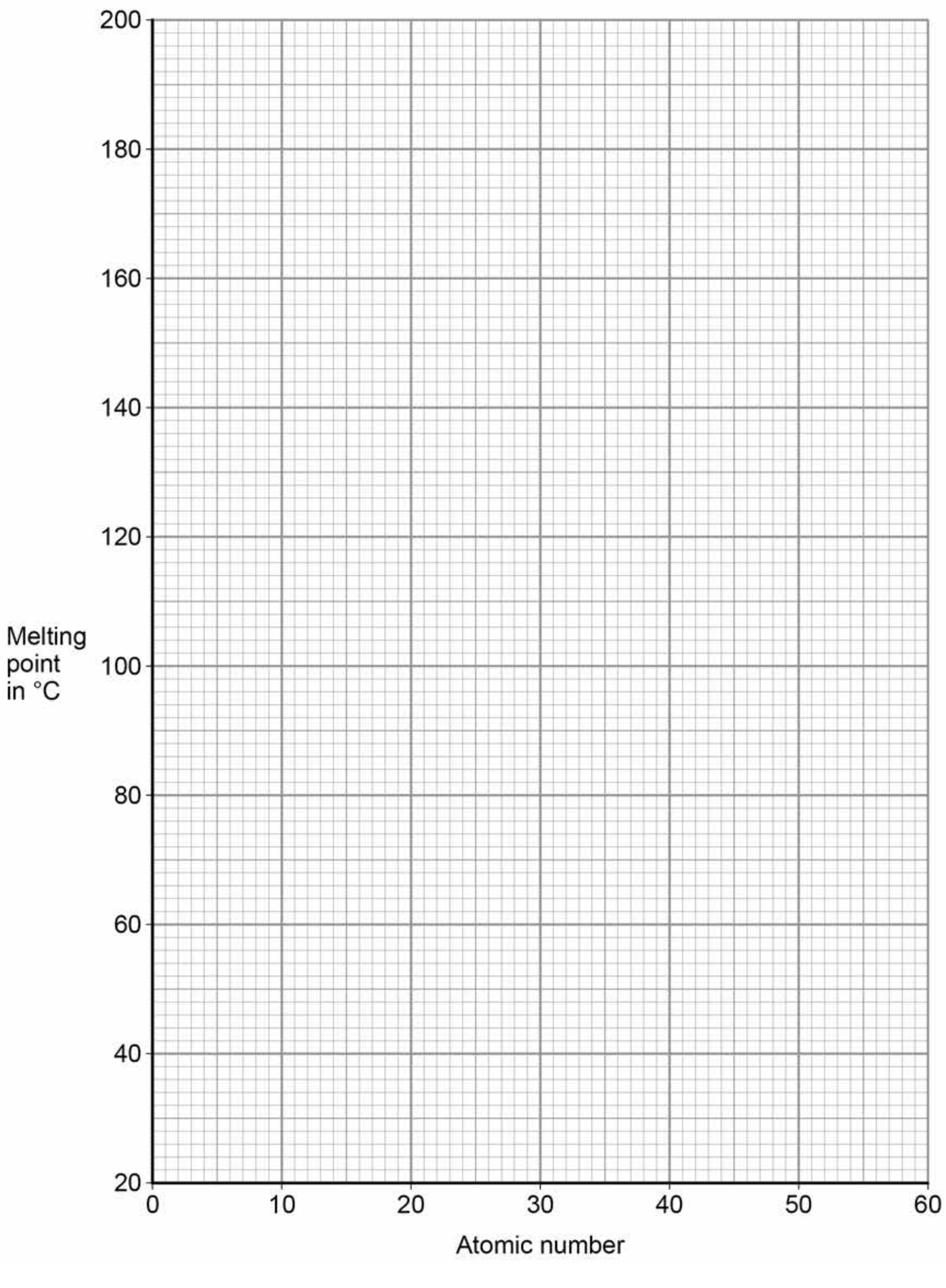
Element	**Atomic number**	**Melting point in °C**
Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	**X**
Caesium	55	29

Plot the data from **Table 6** on **Figure 11**.

[2 marks]

Do not write outside the box

Figure 11



0 7 . 8 Predict the melting point, **X**, of rubidium, atomic number 37

Use **Figure 11**.

[1 mark]

Melting point = ____________________ ºC

10

Turn over ►

Do not write outside the box

0 8 Soluble salts are formed by reacting metal oxides with acids.

0 8 . 1 Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

____

0 8 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

____

0 8 . 3 Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

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8

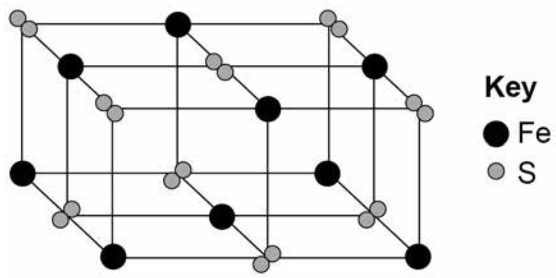
Turn over for the next question

0 9 This question is about metals and metal compounds.

0 9 . 1 Iron pyrites is an ionic compound.

Figure 12 shows a structure for iron pyrites.

Figure 12



Determine the formula of iron pyrites.

Use **Figure 12**.

[1 mark]

____

0 9 . 2 An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons ____________________

Number of neutrons ____________________

Number of electrons ____________________

0 9 . 3 Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 ____

____

2 ____

____

Do not write outside the box

Nickel is extracted from nickel oxide by reduction with carbon.

0 9 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 9 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = ____________ %

11

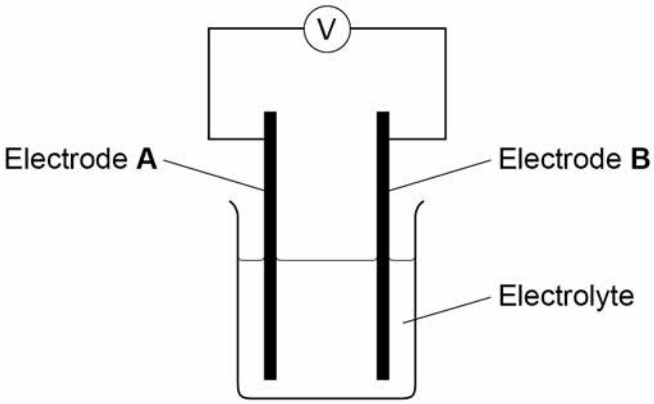
Turn over ►

Do not write outside the box

1 0 Chemical reactions can produce electricity.

1 0 . 1 **Figure 13** shows a simple cell.

Figure 13



Which of these combinations would **not** give a zero reading on the voltmeter in **Figure 13**?

[1 mark]

Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐

Alkaline batteries are non-rechargeable.

1 0 . 2 Why do alkaline batteries eventually stop working?

[1 mark]

1 0 . 3 Why can alkaline batteries **not** be recharged?

[1 mark]

Question 10 continues on the next page

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

1 0 . 4 Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]

$$\_\_\_\_\_ H_2 + \_\_\_\_\_ \rightarrow \_\_\_\_\_ H_2O$$

1 0 . 5 **Table 7** shows data about different ways to power electric cars.

Table 7

	Hydrogen fuel cell	**Rechargeable lithium-ion battery**
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use **Table 7** and your own knowledge.

[6 marks]

Do not write outside the box

11

END OF QUESTIONS

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