AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname

Forename(s)

Candidate signature

GCSE CHEMISTRY

F

Foundation Tier Paper 1

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.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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
- The maximum mark for this paper is 100.
- 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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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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0 1 This question is about elements, compounds and mixtures.

0 1 . 1 Substance **A** contains only one type of atom.

Substance **A** does **not** conduct electricity.

Which type of substance is **A**?

[1 mark]

Tick (✓) **one** box.

- Compound ☐
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☑

0 1 . 2 Substance **B** contains two types of atoms.

The atoms are chemically combined together in fixed proportions.

Which type of substance is **B**?

[1 mark]

Tick (✓) **one** box.

- Compound ☑
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☐

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0 1 . 3 What is the name of the elements in Group 0 of the periodic table?

[1 mark]

Tick (✓) **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☑
- Transition metals ☐

0 1 . 4 Which statement about the elements in Group 0 is correct?

[1 mark]

Tick (✓) **one** box.

- All elements in the group are very reactive. ☐
- All elements in the group form negative ions. ☐
- The boiling points increase down the group. ☑
- The relative atomic masses (A_r) decrease down the group. ☐

Do not write outside the box

0 1 . 5 Neon is in Group 0.

What type of particles are in a sample of neon?

[1 mark]

Tick (✓) **one** box.

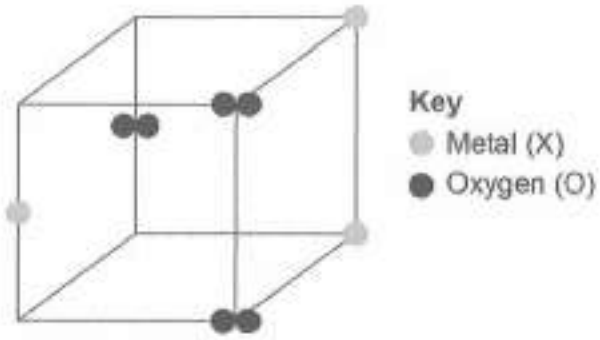
Atoms ☑

Ions ☐

Molecules ☐

0 1 . 6 **Figure 1** represents part of the structure of an oxide of a metal.

Figure 1



Determine the empirical formula of this oxide.

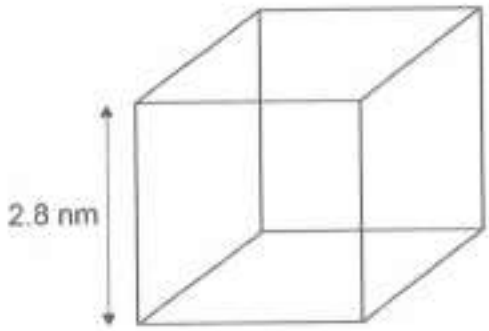
[1 mark]

Empirical formula = XO_2

A nanoparticle of a metallic element is a cube.

Figure 2 shows a diagram of the nanoparticle.

Figure 2



0 1 . 7 The surface area of a cube is given by the equation:

surface area = (length of side)^2 × 6

Calculate the surface area of the cube in **Figure 2**.

Give your answer to 2 significant figures.

[3 marks]

Surface Area = $2.8^2 \times 6$

$= 47.04 \text{ nm}^2$

$= 47 \text{ nm}^2$

Surface area (2 significant figures) = 47 nm^2

Do not write outside the box

0 1 . 8 Fine and coarse particles of the metallic element are also cubes.

The length of a fine particle cube is 10 times smaller than the length of a coarse particle cube.

How does the surface area to volume ratio of the fine particle cube compare with that of the coarse particle cube?

[1 mark]

Tick (✓) **one** box.

Both surface area to volume ratios are the same. ☐

The surface area to volume ratio of the fine particle is 10 times greater. ☑

The surface area to volume ratio of the fine particle is 10 times smaller. ☐

10

Turn over for the next question

Do not write outside the box

0 2 This question is about chemical cells and batteries.

0 2 . 1 Three different types of battery can be used to power a TV remote control.

Table 1 gives information about these batteries.

Table 1

	Zinc-carbon battery	Alkaline battery	Nickel-metal hydride battery
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give **one** advantage of each type of battery.

[3 marks]

Zinc-carbon Cheapest

Alkaline Longest lasting

Nickel-metal hydride Rechargeable

0 2 . 2 **Figure 3** shows a symbol printed on batteries.

Figure 3

This symbol shows that batteries should not be put in household waste.

Suggest why batteries should **not** be put in household waste.

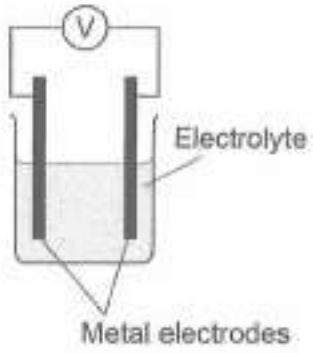
[1 mark]

The metal waste from batteries can be toxic and harmful

Do not write outside the box

Figure 4 shows a chemical cell.

Figure 4



0 2 . 3 The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in **Figure 4**?

[1 mark]

Tick (✓) **one** box.

Copper and iron ☑

Iron and tin ☐

Tin and copper ☐

0 2 . 4 The voltage produced by the cell in **Figure 4** depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

[1 mark]

Concentration of electolyte

Do not write outside the box

0 2 . 5 Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.

[2 marks]

Oxygen + Hydrogen → water

8

Do not write outside the box

0 3 This question is about Group 1 elements.

0 3 . 1 Complete **Table 2** to show the electronic structure of a potassium atom.

[1 mark]

Table 2

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	2,8,8,1

0 3 . 2 Why do Group 1 elements have similar chemical properties?

[1 mark]

Tick (✓) **one** box.

They have the same number of electron shells. ☐

They have the same number of outer shell electrons. ☑

They have two electrons in the first shell. ☐

0 3 . 3 What is the type of bonding in sodium?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☑

Do not write outside the box

Table 3 shows observations made when lithium, potassium and rubidium react with water.

Table 3

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 moves quickly 2 melts into a ball
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

0 3 . 4 Give **two** observations you could make when sodium reacts with water.

Write your answers in **Table 3**.

[2 marks]

Do not write outside the box

0 3 . 5 How does the reactivity of the elements change going down Group 1?

[1 mark]

reactivity increases down the Group

0 3 . 6 Give **two** ways in which the observations in **Table 3** show the change in reactivity going down Group 1.

[2 marks]

1 The metals move more quickly on the surface down the group

2 The reactions get more vident, going from no flame, to flames, to exploding

0 3 . 7 Which gas is produced when Group 1 elements react with water?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Hydrogen ☑
- Nitrogen ☐
- Oxygen ☐

Do not write outside the box

0 3 . 8 Sodium fluoride is an ionic compound.

Figure 5 shows dot and cross diagrams for a sodium atom and a fluorine atom.

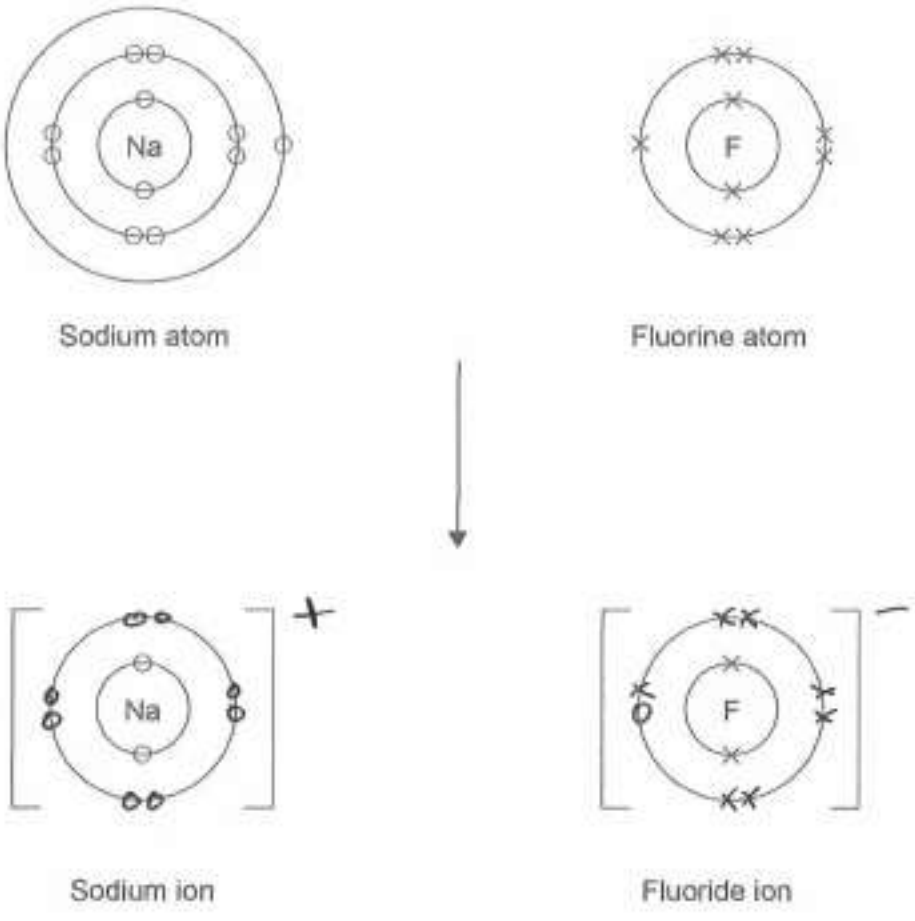
Complete **Figure 5** to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.

[3 marks]

Figure 5



12

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 4 A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

Table 4 shows the student's results.

Table 4

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	**X**
Zinc	18	16	18	20	18

0 4 . 1 Calculate the mean temperature increase **X** for magnesium in **Table 4**.

Do **not** include the anomalous result in your calculation.

[2 marks]

mean = $\frac{54 + 50 + 55}{3}$ = 53 °C

X = 53 °C

Do not write outside the box

0 4 . 2 Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use **Table 4**.

[1 mark]

Most reactive Magnesium

Zinc

Least reactive Cobalt

0 4 . 3 The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use **Table 4**.

[1 mark]

The mean temperature increase for zinc is 18 ± 2 °C

0 4 . 4 What type of variable is the volume of hydrochloric acid in this investigation?

[1 mark]

Tick (✓) **one** box.

Control ☑

Dependent ☐

Independent ☐

0 4 . 5 Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

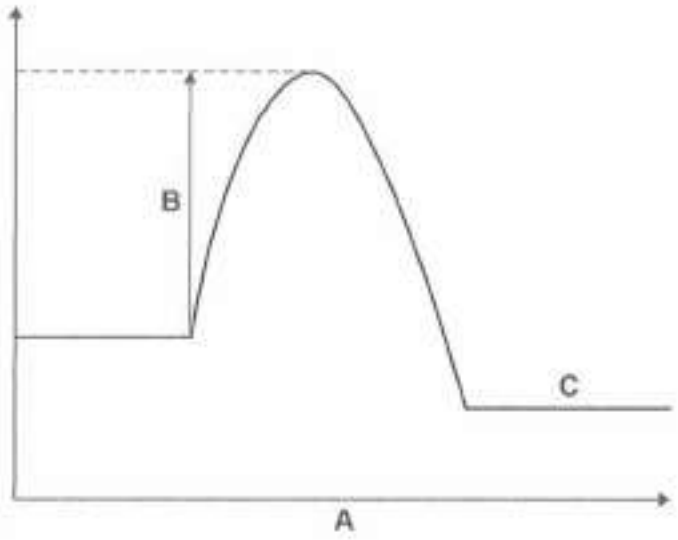
[1 mark]

use the same mass of metal for each experiment

Do not write outside the box

0 4 . 6 **Figure 6** shows a reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 6



What do labels **A**, **B** and **C** represent on **Figure 6**?

Choose answers from the box.

[3 marks]

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

A Progress of reaction

B activation energy

C Products.

9

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0 5 This question is about acids and alkalis.

0 5 . 1 Which ion do acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H^+ ☑ OH^- ☐ O^{2-} ☐

0 5 . 2 Acids react with alkalis.

What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

Decomposition ☐

Electrolysis ☐

Neutralisation ☑

Redox ☐

0 5 . 3 Balance the equation for the reaction between sulfuric acid and potassium hydroxide.

[1 mark]

$$H_2SO_4 + \underline{2}\ KOH \rightarrow K_2SO_4 + \underline{2}\ H_2O$$

0 5 . 4 Universal indicator turns purple in potassium hydroxide solution.

What is the pH of the solution?

[1 mark]

Tick (✓) **one** box.

1 ☐ 4 ☐ 7 ☐ 14 ☑

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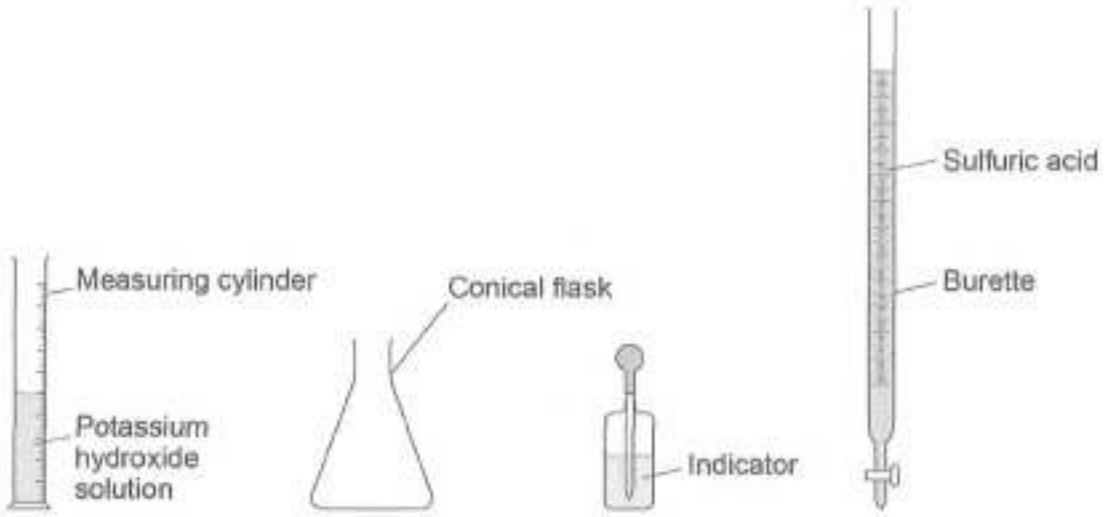
A student does a titration to find the volume of sulfuric acid that reacts with 25 cm^3 of potassium hydroxide solution.

Figure 7 shows the equipment used.

Figure 7



0 5 . 5 The 25 cm^3 of potassium hydroxide solution is measured with the measuring cylinder.

Which piece of equipment could the student use to measure the 25 cm^3 of potassium hydroxide solution more accurately?

[1 mark]

Tick (✓) **one** box.

- Beaker ☐
- Evaporating basin ☐
- Pipette ☑
- Test tube ☐

0 5 . 6 Describe how the student would use the equipment in **Figure 7** to complete the titration.

[5 marks]

Add 25 cm^3 of Potassium Hydroxide to the Conical flask. Add a few drops of indicator to the flask. Using the burette, slowly add the sulfuric ~~acid~~ acid to the solution in the flask. Do this until the indicator changes colour. Read off the volume from the burette to see how much sulfuric acid was added.

10

Do not write outside the box

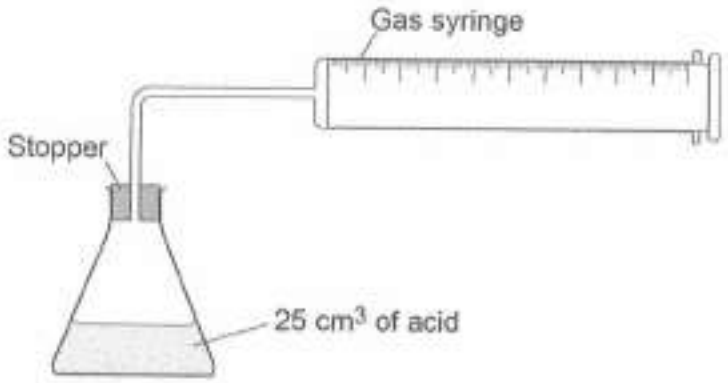
Turn over for the next question

0 6 This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 8 shows the apparatus.

Figure 8

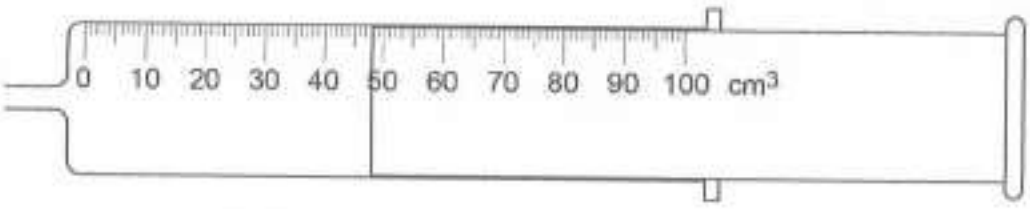


This is the method used.

1. Pour 25 cm^3 of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

0 6 . 1 **Figure 9** shows the gas syringe during the experiment.

Figure 9



What is the reading on the gas syringe?

[1 mark]

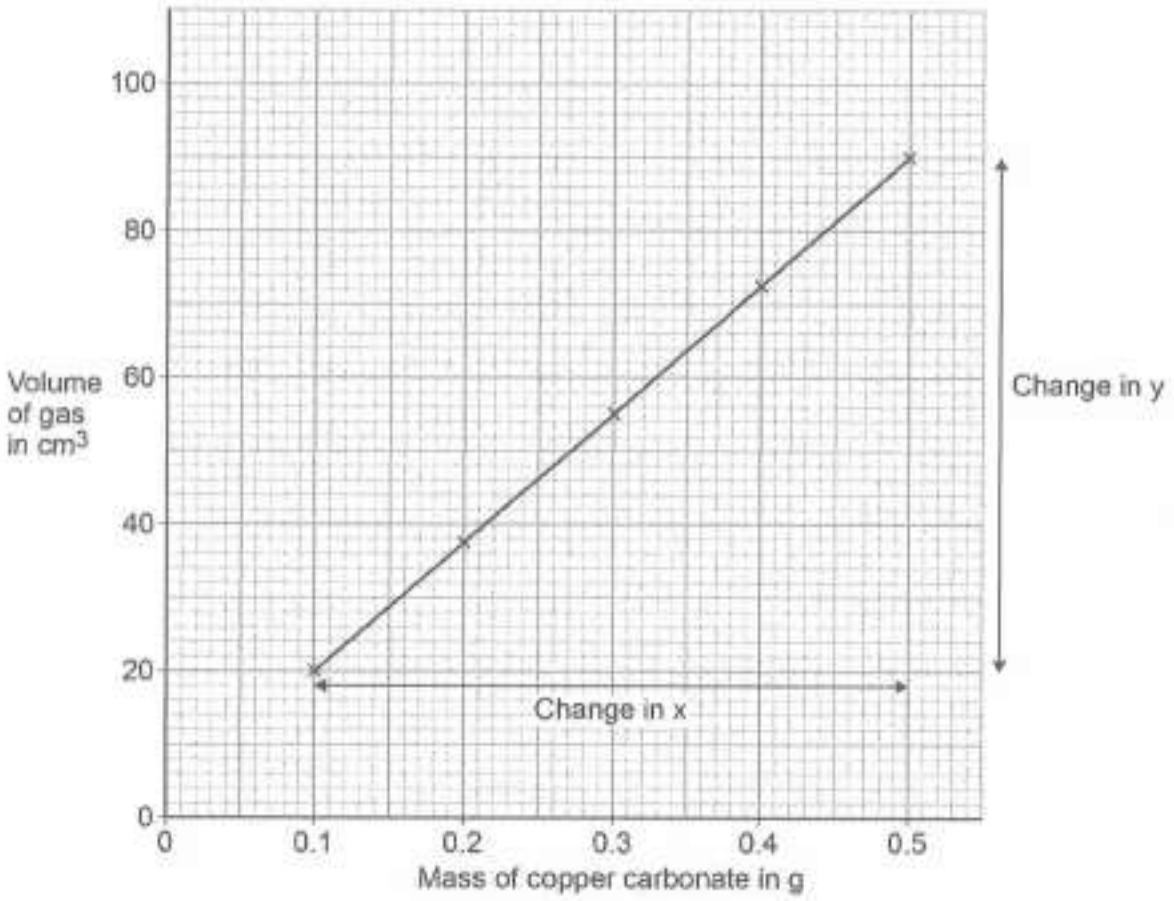
48 cm^3

Do not write outside the box

0 6 . 2 The student plotted the results on a graph.

Figure 10 shows the student's graph.

Figure 10



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

[4 marks]

Change in y = 70 cm^3

Change in x = 0.4 g

Gradient 70/0.4 = 175 $g\,cm^{+3}\,g^{-1}$

Gradient = 175 cm^3/g

Do not write outside the box

0 6 . 3 Copper chloride was produced in the reaction.

Which acid reacts with copper carbonate to produce copper chloride?

[1 mark]

Tick (✓) **one** box.

- Hydrochloric acid ☑
- Nitric acid ☐
- Sulfuric acid ☐

0 6 . 4 The reaction between copper carbonate and the acid produced a gas.

What was the gas?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☑
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

Do not write outside the box

A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

1. Add excess copper carbonate to the acid.

2. Filter the mixture.

3. Heat the solution gently until crystals start to form.

4. Leave for 24 hours.

5. Remove the crystals.

6. Rinse with water and dry the crystals.

0 6 . 5 Why was the solution heated gently in **step 3**?

[1 mark]

Tick (✓) **one** box.

- To evaporate acid ☐
- To evaporate copper carbonate ☐
- To evaporate water ☑

0 6 . 6 How should the solution be heated gently in **step 3**?

[1 mark]

using a water bath or an electric heater

9

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ANSWER IN THE SPACES PROVIDED

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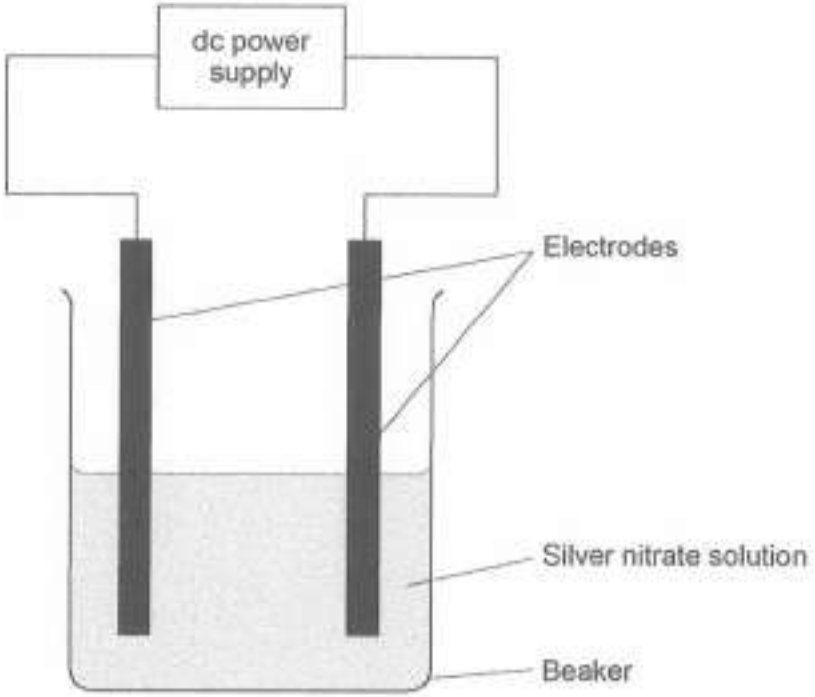
0 7 This question is about electrolysis.

Some students investigated the electrolysis of silver nitrate solution.

This electrolysis produces silver at the negative electrode.

Figure 11 shows the apparatus.

Figure 11



This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 11**.
3. Switch on the power supply.
4. Switch off the power supply after five minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.

Do not write outside the box

0 7 . 1 Some silver did not stick to the negative electrode but fell to the bottom of the beaker.

The students needed to weigh this silver.

How could the students separate the silver from the silver nitrate solution?

[1 mark]

Tick (✓) **one** box.

By chromatography ☐

By crystallisation ☐

By distillation ☐

By filtration ☑

Table 5 shows the students' results.

Table 5

Time in minutes	Mass of silver in g
0	0.00
5	0.06
10	0.12
15	0.18
20	0.24
25	0.30

Do not write outside the box

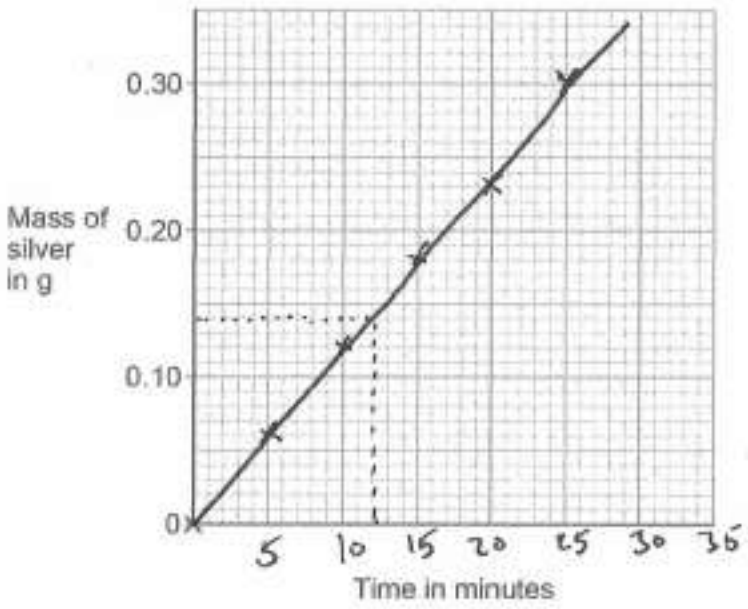
0 7 . 2 Draw a graph on **Figure 12**.

You should:

- use a suitable scale for the x-axis
- plot the data from **Table 5**
- draw a line of best fit.

[4 marks]

Figure 12



0 7 . 3 Determine the mass of silver that would be produced after 12 minutes.

Use **Figure 12**.

[1 mark]

Mass of silver = 14 g

Question 7 continues on the next page

Do not write outside the box

0 7 . 4 A student investigated the electrolysis of two aqueous salt solutions.

Hydrogen is produced at the negative electrode when the metal in the salt solution is more reactive than hydrogen.

Complete **Table 6** to show what the student would **observe** at the negative electrode for each salt solution.

[2 marks]

Table 6

Salt solution	Observation at negative electrode
Copper sulfate	Red solid of copper forming
Sodium chloride	effervescence

0 7 . 5 A teacher demonstrates the electrolysis of molten lead bromide.

The products at the electrodes are lead and bromine.

Why should the teacher do the demonstration in a fume cupboard?

[1 mark]

molten lead may produce toxic fumes

0 7 . 6 Two other molten compounds are electrolysed.

Complete **Table 7** to show the molten compounds and the products.

[3 marks]

Table 7

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
Zinc chloride	Zinc	Chlorine
Potasium Iodide	Potassium	Iodine

12

Turn over for the next question

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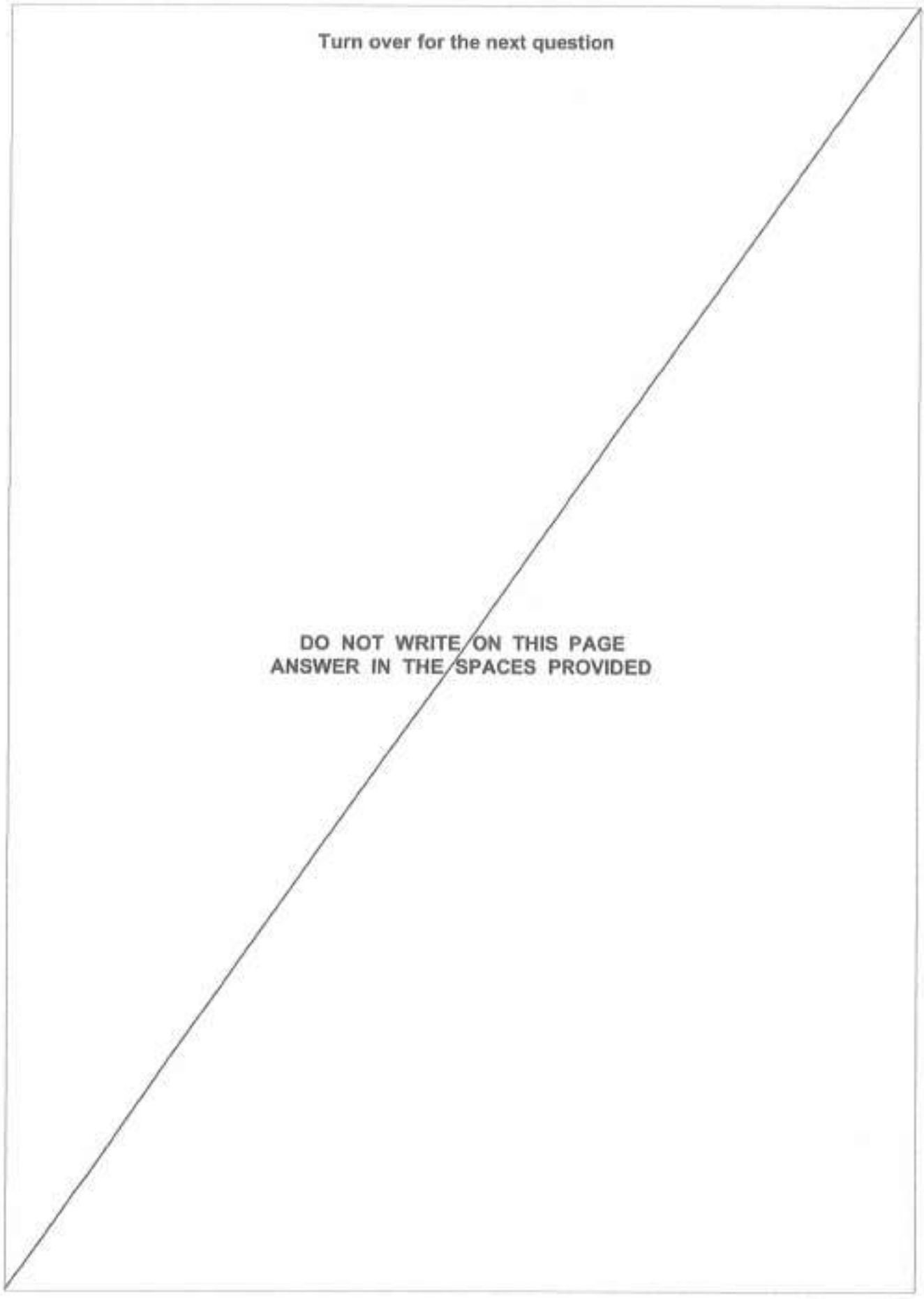
ANSWER IN THE SPACES PROVIDED



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0 8 This question is about carbon and its compounds.

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

0 8 . 1 What shape is a Buckminsterfullerene molecule?

[1 mark]

Spherical

0 8 . 2 Give **one** use of a fullerene.

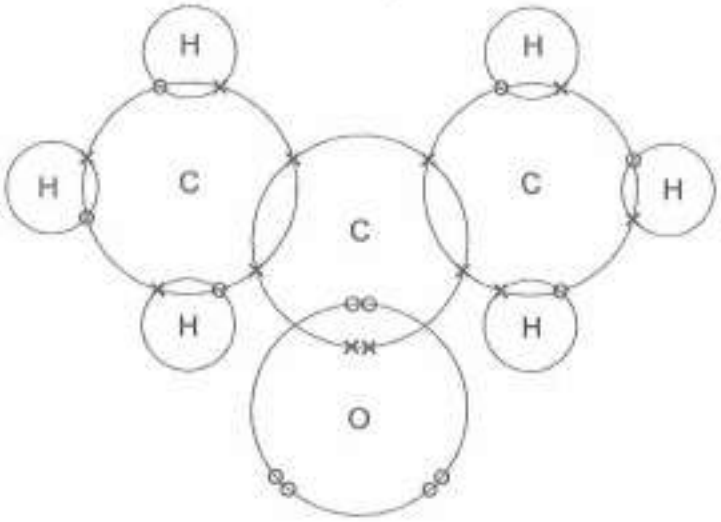
[1 mark]

Drug delivery within the body

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 13 shows the dot and cross diagram for a propanone molecule.

Figure 13



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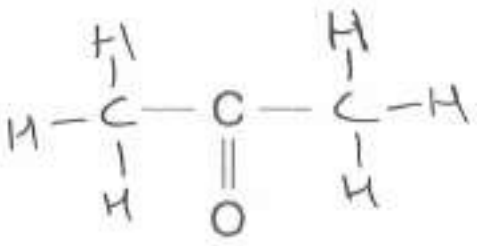
0 8 . 3 Complete **Figure 14** to show a propanone molecule.

Use a line to represent each single bond.

Use **Figure 13**.

[1 mark]

Figure 14



0 8 . 4 Determine the molecular formula of propanone.

Use **Figure 13**.

[1 mark]

Molecular formula = C_3H_6O

0 8 . 5 Propanone is a liquid with a low boiling point.

Why does propanone have a low boiling point?

[1 mark]

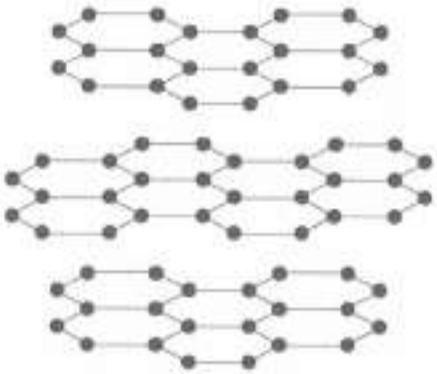
Tick (✓) **one** box.

- The covalent bonds are strong. ☐
- The covalent bonds are weak. ☐
- The intermolecular forces are strong. ☐
- The intermolecular forces are weak. ☑

Do not write outside the box

0 8 . 6 **Figure 15** represents the structure of graphite.

Figure 15



Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

[6 marks]

Graphite is slippery because of it's layered structure. The flat carbon sheets that make up graphite are held together by week intermolecular forces and slide easily over eachother, making graphite soft and slippery. Graphite is a good electrical conductor because it contains de-localised electrons. Each carbon atom in the sheet is bonded to 3 others, leaving one of its bonding electrons free. This means there are lots of free delocalised electrons that are able to move between the sheets to carry a charge.

11

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 9 This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

0 9 . 1 Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

Atoms with the same number of protons in the nucleus but a different number of neutrons

0 9 . 2 **Table 8** shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 8

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

$A_r = \frac{(69 \times 60) + (71 \times 40)}{100}$

$= 69.8$

Relative atomic mass (1 decimal place) = 69.8

Do not write outside the box

Gallium (Ga) is in Group 3 of the modern periodic table.

0 9 . 3 Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}Ga$

[2 marks]

Number of electrons 31

Number of neutrons 38

0 9 . 4 What is the most likely formula of a gallium ion?

[1 mark]

Tick (✓) **one** box.

- Ga^{+} ☐
- Ga^{-} ☐
- Ga^{3+} ☑
- Ga^{3-} ☐

0 9 . 5 Gallium was discovered six years after Mendeleev published his periodic table.

Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

[2 marks]

1 Gallium fitted into the gap Mendeleev had left in the table

2 Mendeleev had used the periodic table to correctly predict Gallium's properties

9

Do not write outside the box

10 This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3H_2 + RO_3 \rightarrow R + 3H_2O$$

10.1 The sum of the relative formula masses (M_r) of the reactants ($3H_2 + RO_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

$M_r\ H_2O = 18$ $M_r\ H_2 = 2$

$3(18) = 54$ $A_r\ R = 150 - 54 = 96$

Relative atomic mass (A_r) of **R** = 96

10.2 Identify element **R**.

You should use:

- your answer to **question 10.1**
- the periodic table.

[1 mark]

Identity of **R** = Molybdenum

Do not write outside the box

10.3 Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

M_r total = 119 + 2(16) + 12

reactants = 163

% atom economy = $\frac{119}{163} \times 100 = 73\%$

Percentage atom economy = 73 %

Question 10 continues on the next page

Do not write outside the box

1 0 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 9 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 9

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

Methods 1 and 3 both use cheap reactants. However in Both methods the tungsten solid must be seperated from another solid, either Tungsten Carbide or Iron oxide. This will add to costs overall. Method one will also lose some tungsten to tungsten carbide whilst also producing CO_2. Though Method 2 uses a more expensive reactant, no seperation is required as the water vapour will escape. This will cut seperation costs.

10

END OF QUESTIONS