A

Surname ____________________

Other Names ____________________

Centre Number ____________________

Candidate Number ____________________

Candidate Signature ____________________

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 1

8462/1H

Thursday 14 May 2020 Morning

Time allowed: 1 hour 45 minutes

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

J U N 2 0 8 4 6 2 1 H 0 1

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.**
- **Answer ALL questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

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0 1 This question is about structure and bonding.

0 1 . 1 Which TWO substances have intermolecular forces between particles? [2 marks]

Tick (✓) TWO boxes.

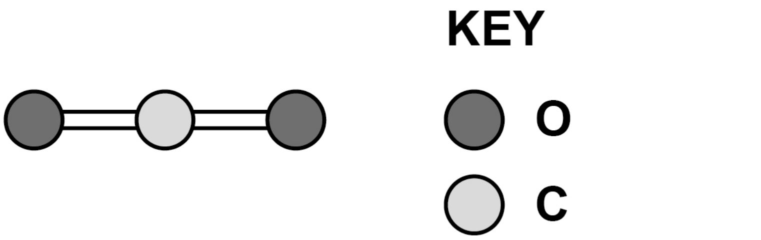
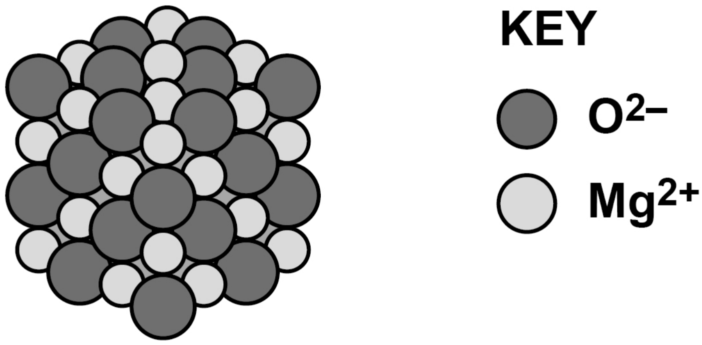
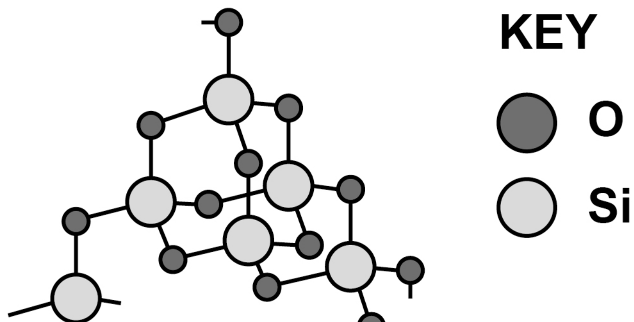
- [ ] Diamond
- [ ] Magnesium
- [ ] Poly(ethene)
- [ ] Sodium chloride
- [ ] Water

[Turn over]

0 1 . 2 TABLE 1 shows the structures of three compounds.

The diagrams are not drawn to scale.

TABLE 1

COMPOUND	STRUCTURE
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

Compare the structure and bonding of the three compounds:

- **carbon dioxide**
- **magnesium oxide**
- **silicon dioxide.**

[6 marks]

8

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[Turn over]

0 2 This question is about metals and the reactivity series.

0 2 . 1 Which TWO statements are properties of most transition metals? [2 marks]

Tick (✓) TWO boxes.

☐ They are soft metals.

☐ They form colourless compounds.

☐ They form ions with different charges.

☐ They have high melting points.

☐ They have low densities.

0 2 . 2 **A student added copper metal to colourless silver nitrate solution.**

The student observed:

- **pale grey crystals forming**
- **the solution turning blue.**

Explain how these observations show that silver is less reactive than copper. [3 marks]

[Turn over]

0 2 . 3 **A student is given three metals, X, Y and Z to identify.**

The metals are magnesium, iron and copper.

Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid.

Your plan should give valid results. [4 marks]

[Turn over]

0 2 . 4 **Metal M has two isotopes.**

TABLE 2 shows the mass numbers and percentage abundances of the isotopes.

TABLE 2

Mass number	Percentage abundance (%)
203	30
205	70

Calculate the relative atomic mass (A_r) of metal M.

Give your answer to 1 decimal place.
[2 marks]

Relative atomic mass (1 decimal place) =

[Turn over]

11

0 3 This question is about silver iodide.

Silver iodide is produced in the reaction between silver nitrate solution and sodium iodide solution.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \longrightarrow AgI(s) + NaNO_3(aq)$$

0 3 . 1 A student investigated the law of conservation of mass.

This is the method used.

1. Pour silver nitrate solution into a beaker labelled A.
2. Pour sodium iodide solution into a beaker labelled B.
3. Measure the masses of both beakers and their contents.
4. Pour the solution from beaker B into beaker A.
5. Measure the masses of both beakers and their contents again.

TABLE 3 shows the student's results.

TABLE 3

	Mass before mixing in g	Mass after mixing in g
Beaker A and contents	78.26	108.22
Beaker B and contents	78.50	48.54

Explain how the results demonstrate the law of conservation of mass.

You should use data from TABLE 3 in your answer. [2 marks]

0 3 . 2 **Suggest how the student could separate the insoluble silver iodide from the mixture at the end of the reaction. [1 mark]**

The student purified the separated silver iodide.

This is the method used.

1. **Rinse the silver iodide with distilled water.**
2. **Warm the silver iodide.**

0 3 . 3 **Suggest ONE impurity that was removed by rinsing with water. [1 mark]**

0 3 . 4 **Suggest why the student warmed the silver iodide. [1 mark]**

[Turn over]

0 3 . 5 Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:

$AgNO_3(aq) + NaI(aq) \longrightarrow$
$AgI(s) + NaNO_3(aq)$

Give your answer to 3 significant figures.

Relative formula masses (M_r):
$AgNO_3 = 170$ $NaI = 150$
$AgI = 235$ $NaNO_3 = 85$

[4 marks]

Percentage atom economy (3 significant figures) =

_______________ %

0 3 . 6 Give ONE reason why reactions with a high atom economy are used in industry. [1 mark]

[Turn over]

10

0 4 This question is about electrolysis.

A student investigated the electrolysis of copper chromate solution.

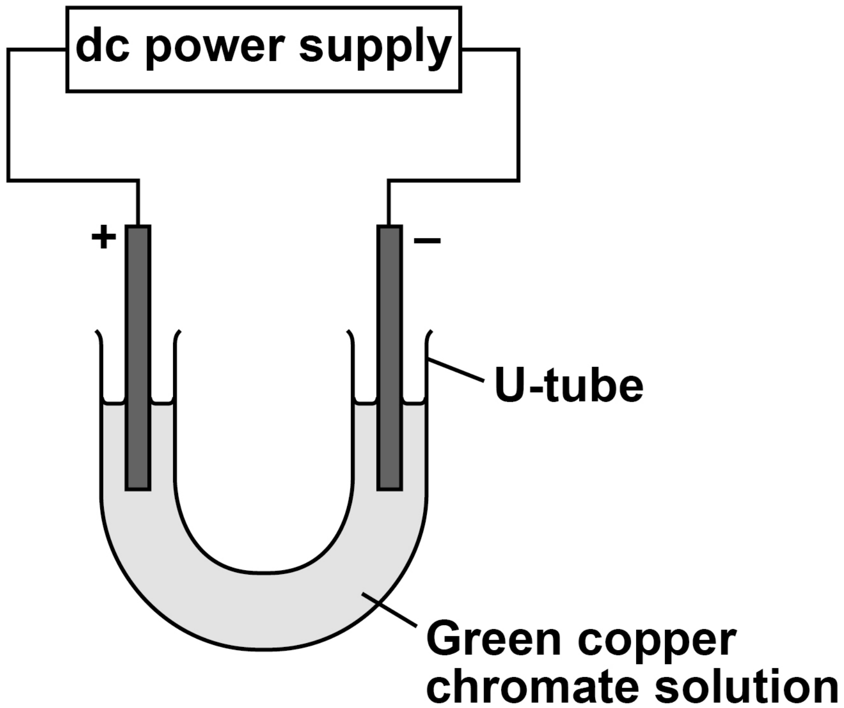
Copper chromate solution is green.

Copper chromate contains:

- blue coloured Cu^{2+} ions
- yellow coloured CrO_4^{2-} ions.

FIGURE 1 shows the apparatus used.

FIGURE 1



The student switched the power supply on.

The student observed the changes at each electrode.

TABLE 4 shows the student's observations.

TABLE 4

Changes at positive electrode	Changes at negative electrode
Solution turned yellow Bubbles formed at the electrode	Solution turned blue Solid formed on the electrode

0 4 . 1 Explain why the colour changed at the positive electrode. [2 marks]

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0 4 . 2 The gas produced at the positive electrode was oxygen.

The oxygen was produced from hydroxide ions.

Name the substance in the solution that provides the hydroxide ions. [1 mark]

0 4 . 3 Describe how the solid forms at the negative electrode. [3 marks]

0 4 . 4 **The student repeated the investigation using potassium iodide solution instead of copper chromate solution.**

Name the product at each electrode when potassium iodide solution is electrolysed.
[2 marks]

Negative electrode

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Positive electrode

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[Turn over]

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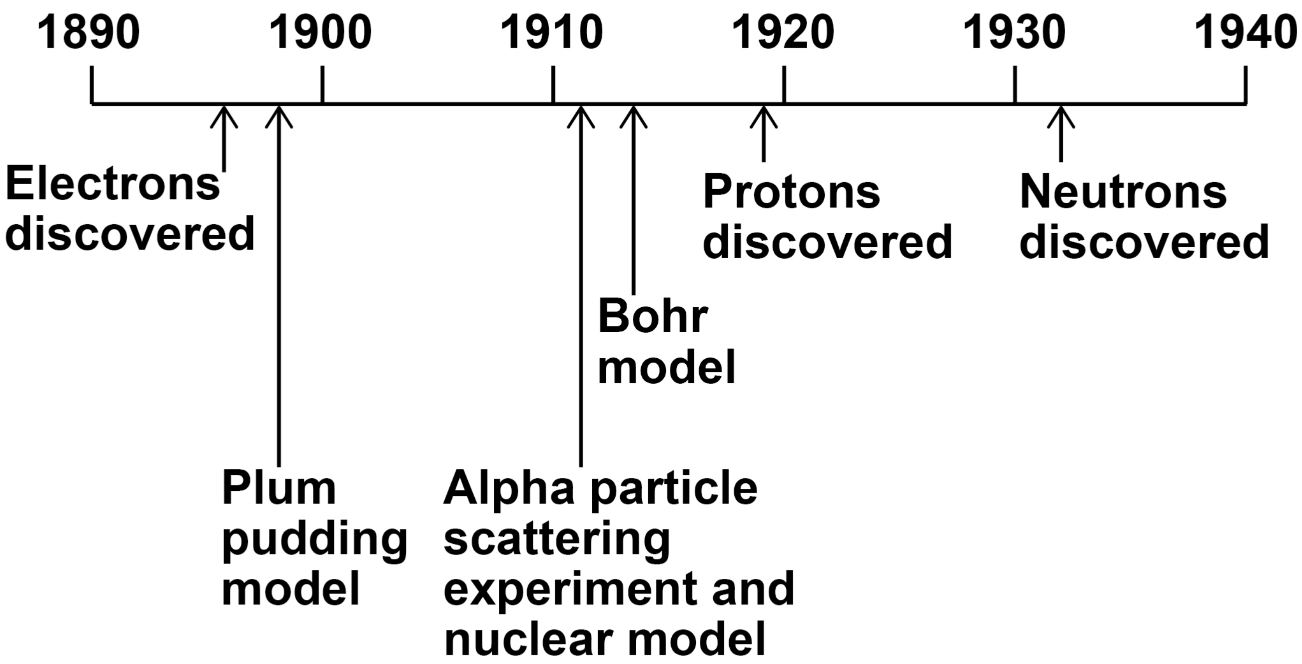
0 5 **This question is about the development of scientific theories.**

FIGURE 2 shows a timeline of some important steps in the development of the model of the atom.

FIGURE 2



05.1 **The plum pudding model did not have a nucleus.**

Describe THREE other differences between the nuclear model of the atom and the plum pudding model. [3 marks]

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3 ____________________

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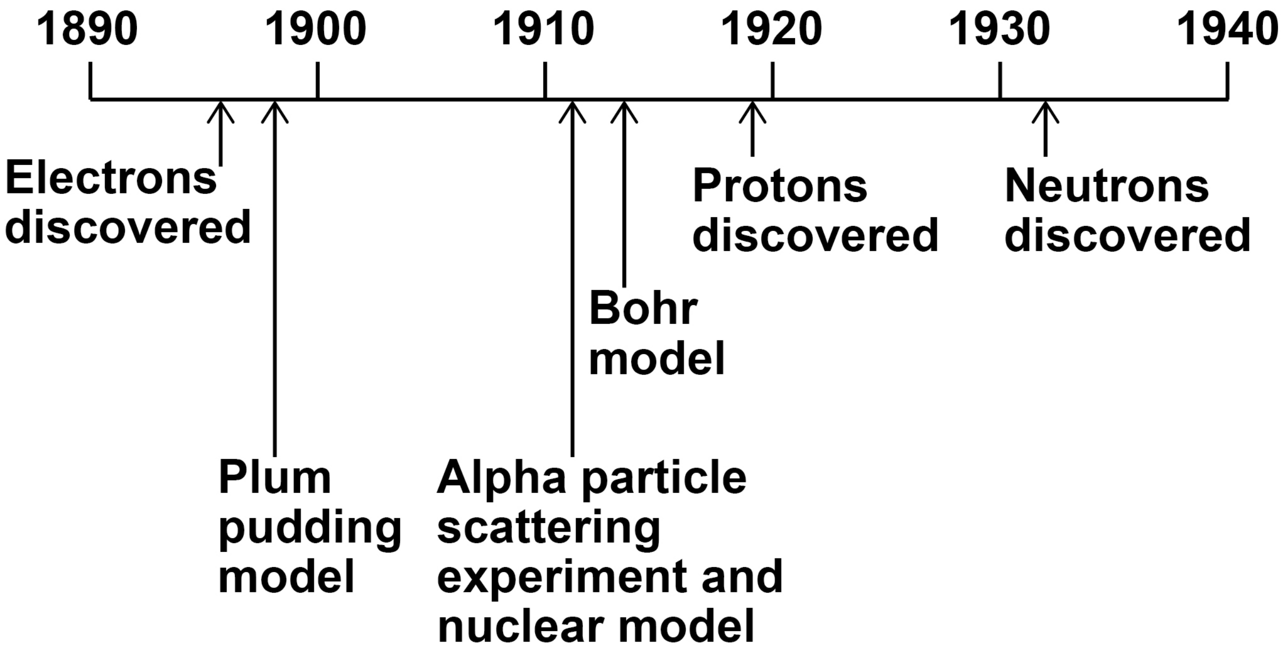
REPEAT OF FIGURE 2



0 5 . 2 Niels Bohr adapted the nuclear model.

Describe the change that Bohr made to the nuclear model. [2 marks]

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0 5 . 3 Mendeleev published his periodic table in 1869.

Mendeleev arranged the elements in order of atomic weight.

Mendeleev then reversed the order of some pairs of elements.

A student suggested Mendeleev's reason for reversing the order was to arrange the elements in order of atomic number.

Explain why the student's suggestion CANNOT be correct.

Use FIGURE 2. [2 marks]

0 5 . 4 **Give the correct reason why Mendeleev reversed the order of some pairs of elements.**
[1 mark]

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[Turn over]

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?
[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \longrightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r):
O = 16 Al = 27 Fe = 56

[4 marks]

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 **Complete the ionic equation for the reaction.**

You should include state symbols. [2 marks]

$Mg(s) + Zn^{2+}(aq) \longrightarrow$ __________ + __________

0 6 . 4 **Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction. [2 marks]**

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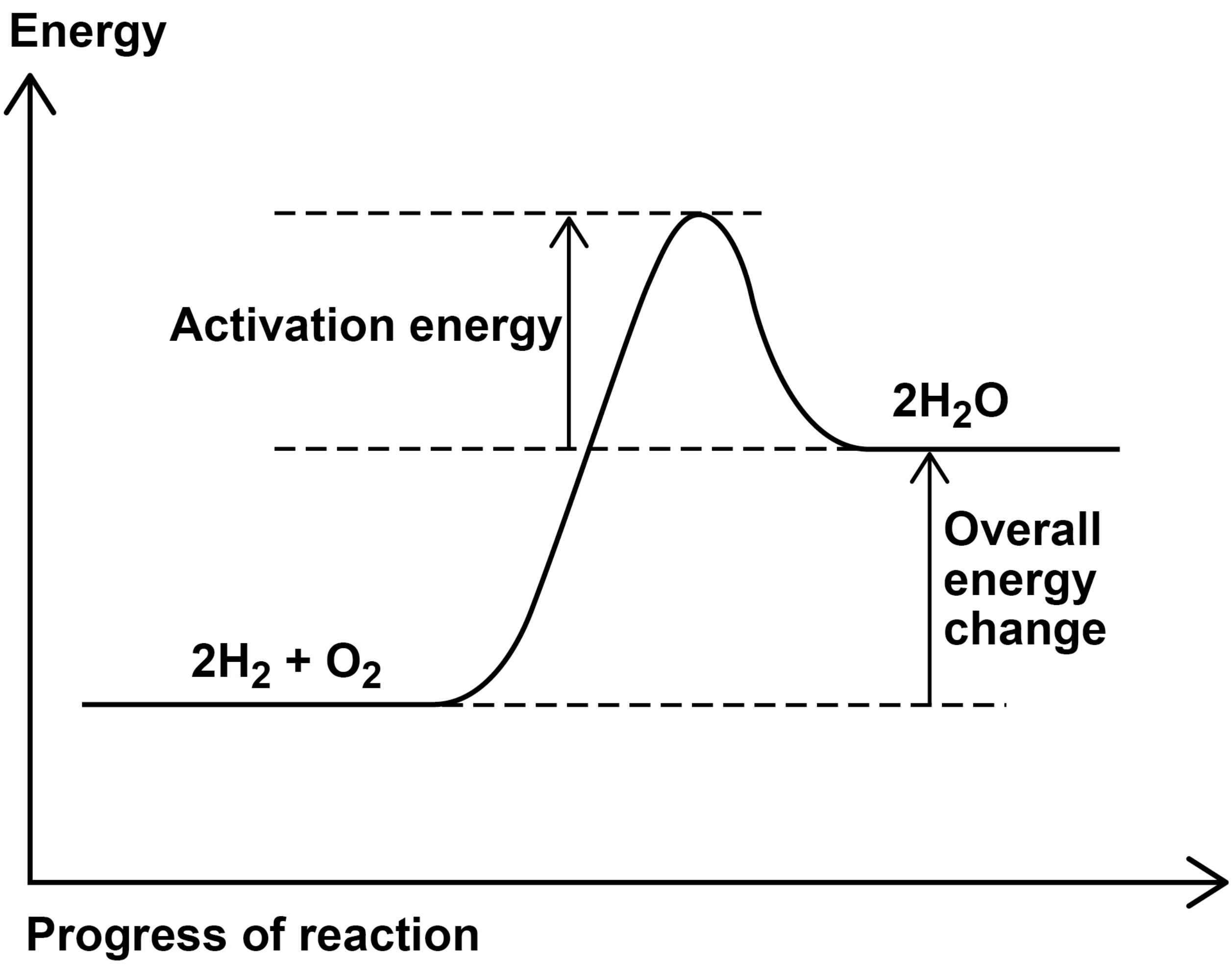
[Turn over]

0 7 The reaction between hydrogen and oxygen releases energy.

0 7 . 1 A student drew a reaction profile for the reaction between hydrogen and oxygen.

FIGURE 3 shows the student's reaction profile.

FIGURE 3



The student made TWO errors when drawing the reaction profile.

Describe the TWO errors. [2 marks]

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2 ____

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[Turn over]

0 7 . 2 **The reaction between hydrogen and oxygen in a hydrogen fuel cell is used to produce electricity.**

Hydrogen fuel cells and rechargeable cells are used to power some cars.

Give TWO advantages of using hydrogen fuel cells instead of using rechargeable cells to power cars. [2 marks]

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2 ______________________________________

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07.3 **Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell.**

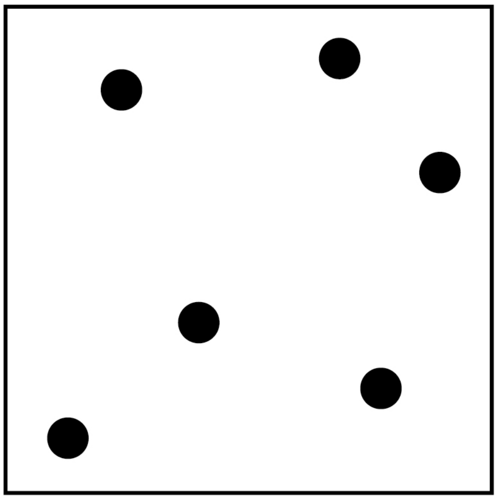
Write a half equation for ONE of these reactions. [1 mark]

[Turn over]

0 7 . 4 **The three states of matter can be represented by a simple particle model.**

FIGURE 4 shows a simple particle model for hydrogen gas.

FIGURE 4



Give TWO limitations of this simple particle model for hydrogen gas. [2 marks]

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2 ______________________________

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07.5 **The hydrogen gas needed to power a car for 400 km would occupy a large volume.**

Suggest ONE way that this volume can be reduced. [1 mark]

[Turn over]

07.6 **The energy needed for a car powered by a hydrogen fuel cell to travel 100 km is 58 megajoules (MJ).**

The energy released when 1 mole of hydrogen gas reacts with oxygen is 290 kJ

The volume of 1 mole of a gas at room temperature and pressure is 24 dm^3

Calculate the volume of hydrogen gas at room temperature and pressure needed for the car to travel 100 km [4 marks]

Volume of hydrogen gas =

______________________________ dm^3

[Turn over]

12

0 8 This question is about the halogens.

TABLE 5 shows the melting points and boiling points of some halogens.

TABLE 5

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 8 . 1 **What is the state of bromine at 0 °C AND at 100 °C? [1 mark]**

Tick (✓) ONE box.

	State at 0 °C	State at 100 °C
☐	Gas	Gas
☐	Gas	Liquid
☐	Liquid	Gas
☐	Liquid	Liquid
☐	Solid	Gas
☐	Solid	Liquid

[Turn over]

REPEAT OF TABLE 5

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 8 . 2 Explain the trend in boiling points of the halogens shown in TABLE 5. [4 marks]

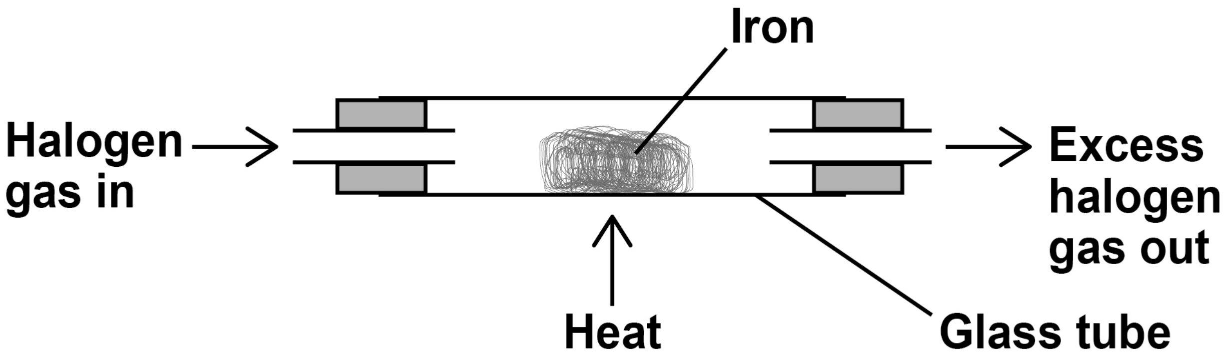
0 8 . 3 **Why is it NOT correct to say that the boiling point of a single bromine molecule is 59 °C?**
[1 mark]

[Turn over]

Iron reacts with each of the halogens in their gaseous form.

FIGURE 5 shows the apparatus used.

FIGURE 5



0 8 . 4 Give ONE reason why this experiment should be done in a fume cupboard. [1 mark]

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0 8 . 5 **Explain why the reactivity of the halogens decreases going down the group. [3 marks]**

[Turn over]

0 8 . 6 A teacher investigated the reaction of iron with chlorine using the apparatus in FIGURE 5, on page 48.

The word equation for the reaction is:

iron + chlorine $\longrightarrow$ iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

TABLE 6 shows the teacher's results.

TABLE 6

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

Relative atomic masses (A_r): Cl = 35.5 Fe = 56
[6 marks]

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Moles of iron atoms : moles of chlorine atoms =

____________________ : ____________________

Equation for the reaction ________________________

0 9 This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

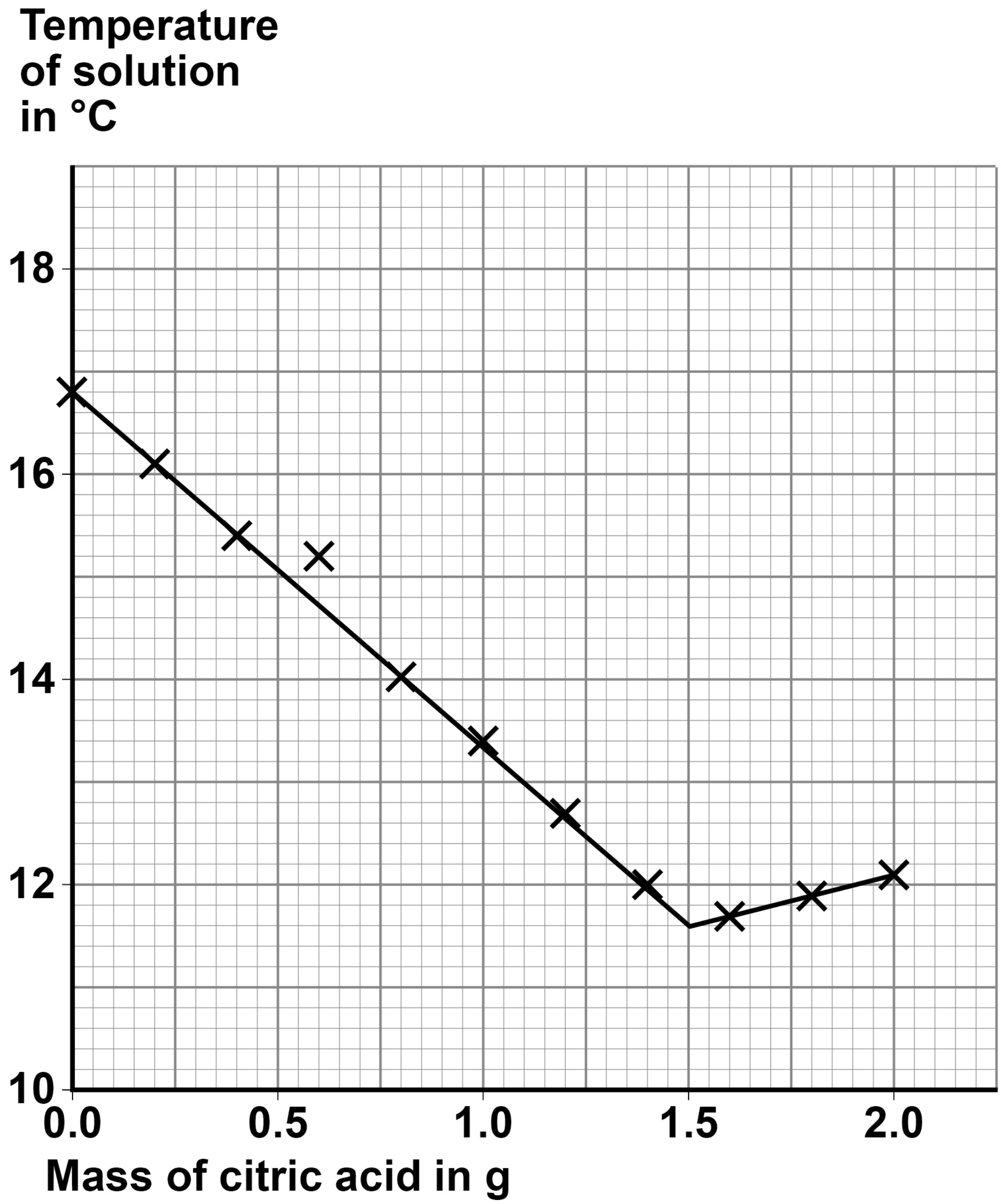
This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.20 g of citric acid to the polystyrene cup.
4. Stir the solution.
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

FIGURE 6, on the opposite page, shows the student's graph.

FIGURE 6



[Turn over]

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0 9 . 1 **FIGURE 6, on page 53, shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.**

The student correctly:

- **measured the mass of the citric acid**
- **read the thermometer**
- **plotted the point.**

Suggest ONE reason for the anomalous point. [1 mark]

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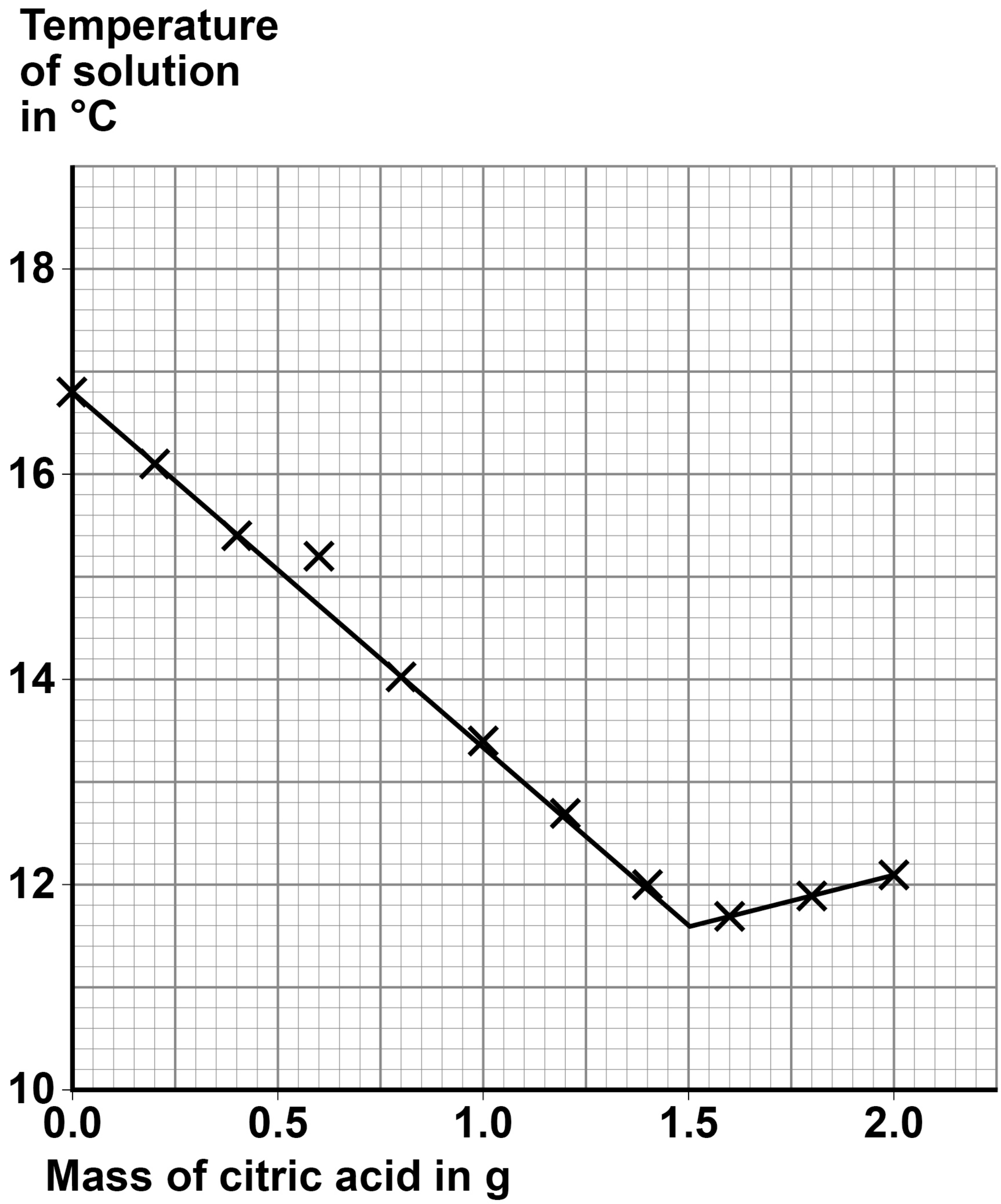
[Turn over]

REPEAT OF FIGURE 6

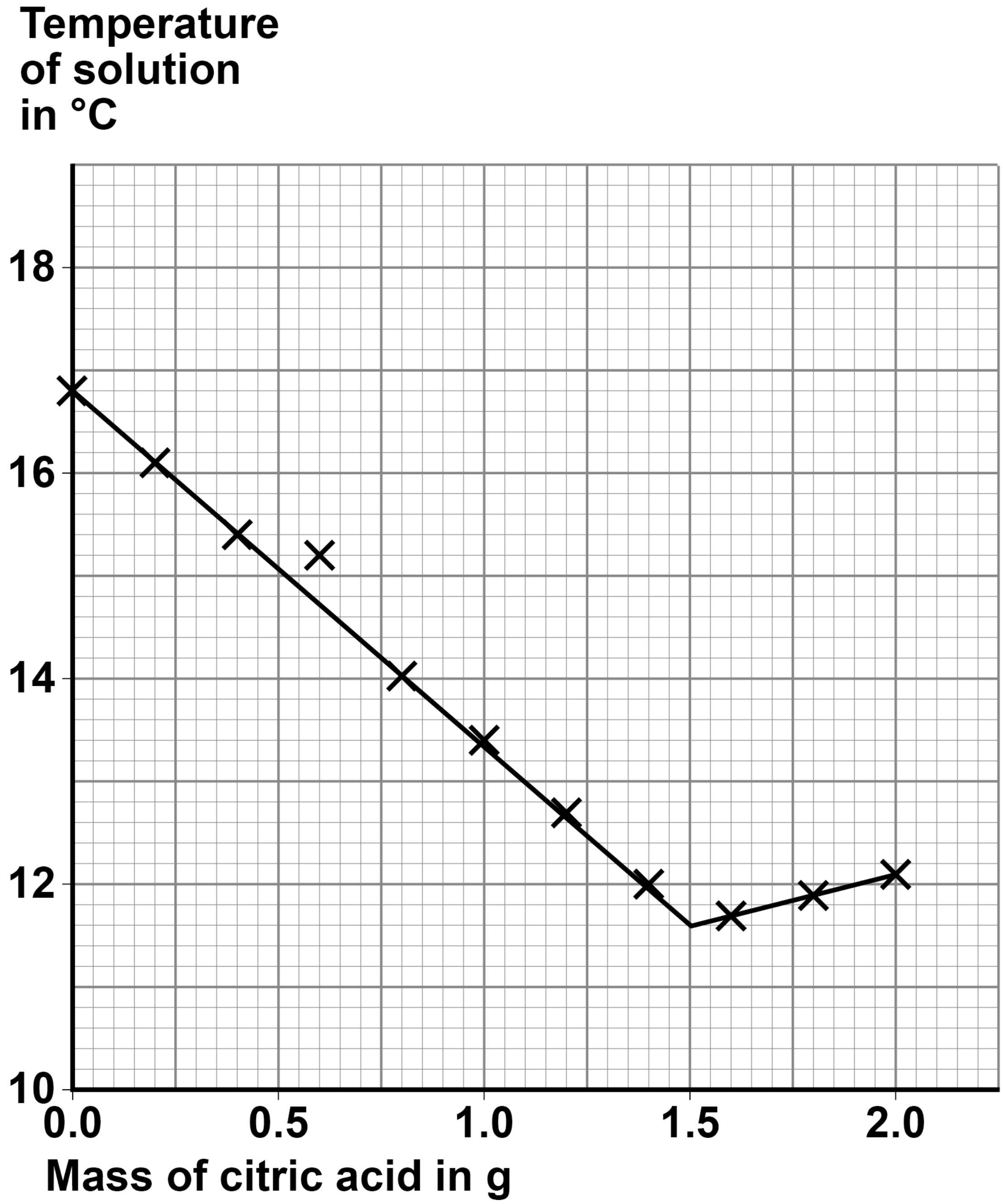


0 9 . 2 **Explain the shape of the graph in terms of the energy transfers taking place.**

You should use data from FIGURE 6, on page 56, in your answer. [3 marks]

[Turn over]

REPEAT OF FIGURE 6



0 9 . 3 **A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.**

Sketch a line on FIGURE 6, on page 58, to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer. [3 marks]

[Turn over]

The student used a solution of citric acid to determine the concentration of a solution of sodium hydroxide by titration.

0 9 . 4 **The student made 250 cm^3 of a solution of citric acid of concentration 0.0500 mol/dm^3**

Calculate the mass of citric acid ($C_6H_8O_7$) required.

Relative atomic masses (A_r):
H = 1 C = 12 O = 16

[3 marks]

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Mass = ______________________________ g

This is part of the method the student used for the titration.

1. **Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a pipette.**
2. **Add a few drops of indicator to the flask.**
3. **Fill a burette with citric acid solution.**

0 9 . 5 Describe how the student would complete the titration. [3 marks]

0 9 . 6 **Give TWO reasons why a burette is used for the citric acid solution. [2 marks]**

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2 ______________________________

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0 9 . 7 **13.3 cm^3 of 0.0500 mol/dm^3 citric acid solution was needed to neutralise 25.0 cm^3 of sodium hydroxide solution.**

The equation for the reaction is:

$$3\,NaOH + C_6H_8O_7 \longrightarrow C_6H_5O_7Na_3 + 3\,H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3 [3 marks]

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Concentration = ______________ mol/dm^3

END OF QUESTIONS

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Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
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