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]

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

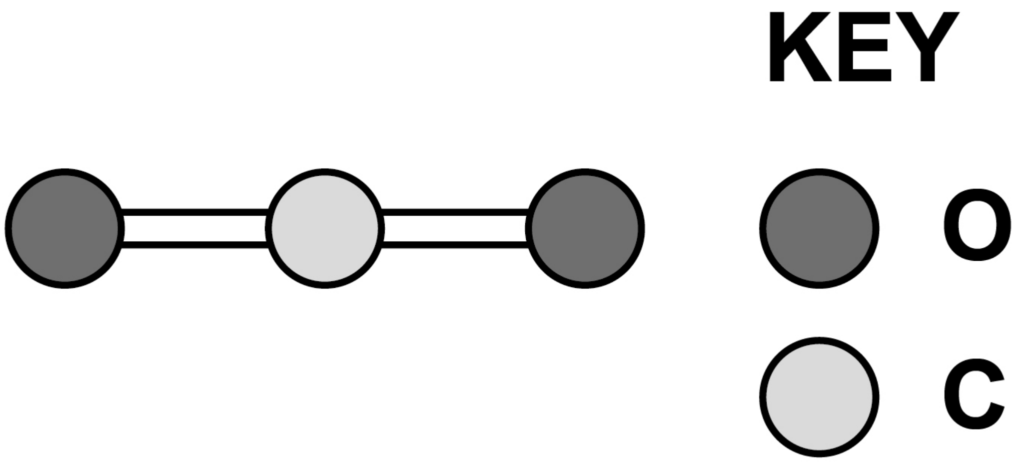
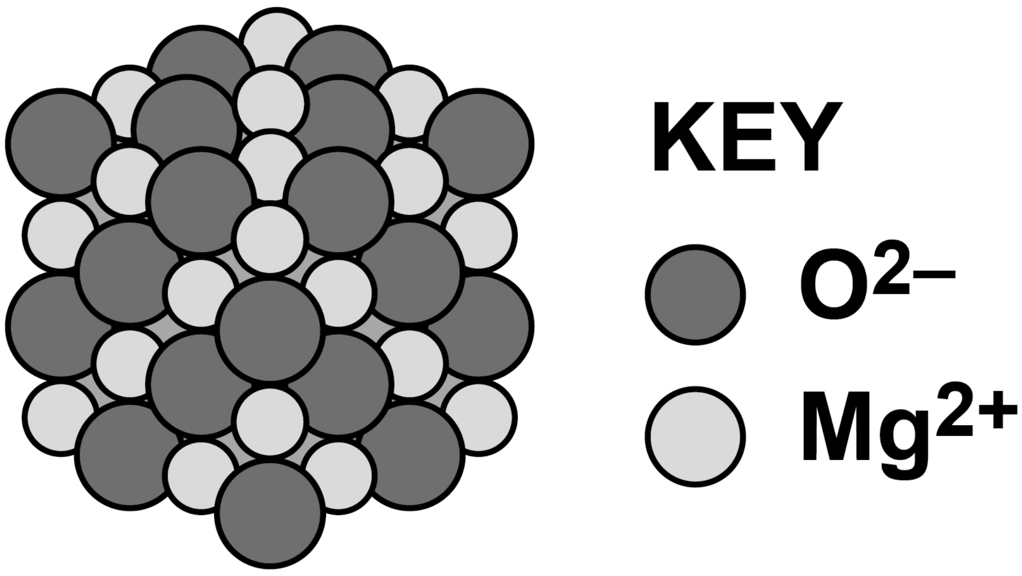
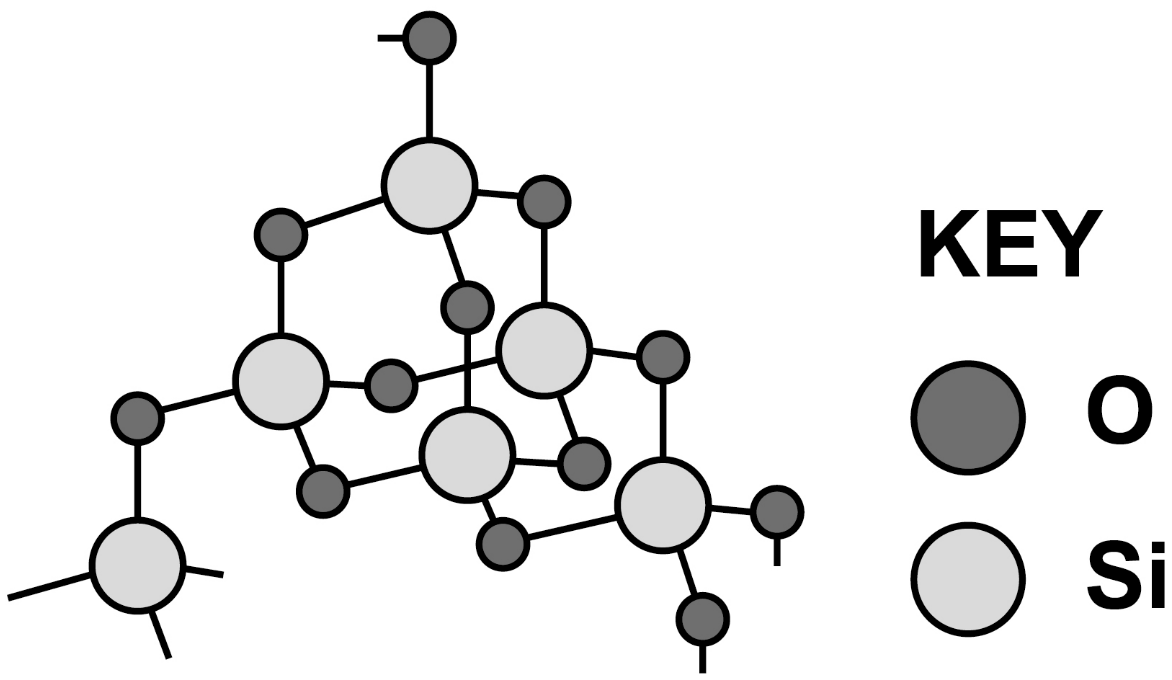
[Turn over]

0 1 . 2

TABLE 1, on the opposite page, shows the structures of three compounds.

The diagrams are not drawn to scale.

TABLE 1

<table>
<tr><th>COMPOUND</th><th>STRUCTURE</th></tr>
<tr><td>Carbon dioxide</td><td>
</td></tr>
<tr><td>Magnesium oxide</td><td>
</td></tr>
<tr><td>Silicon dioxide</td><td>
</td></tr>
</table>

[Turn over]

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Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

[6 marks]

[Turn over]

8

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.

[Turn over]

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]

02.4

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

[Turn over]

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

You should use data from TABLE 3, on page 19, in your answer. [2 marks]

[Turn over]

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.**

03.3

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

03.4

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) =

_____________________________ %

[Turn over]

0 3 . 6

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

10

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[Turn over]

0 4

This question is about electrolysis.

A student investigated the electrolysis of copper chromate solution.

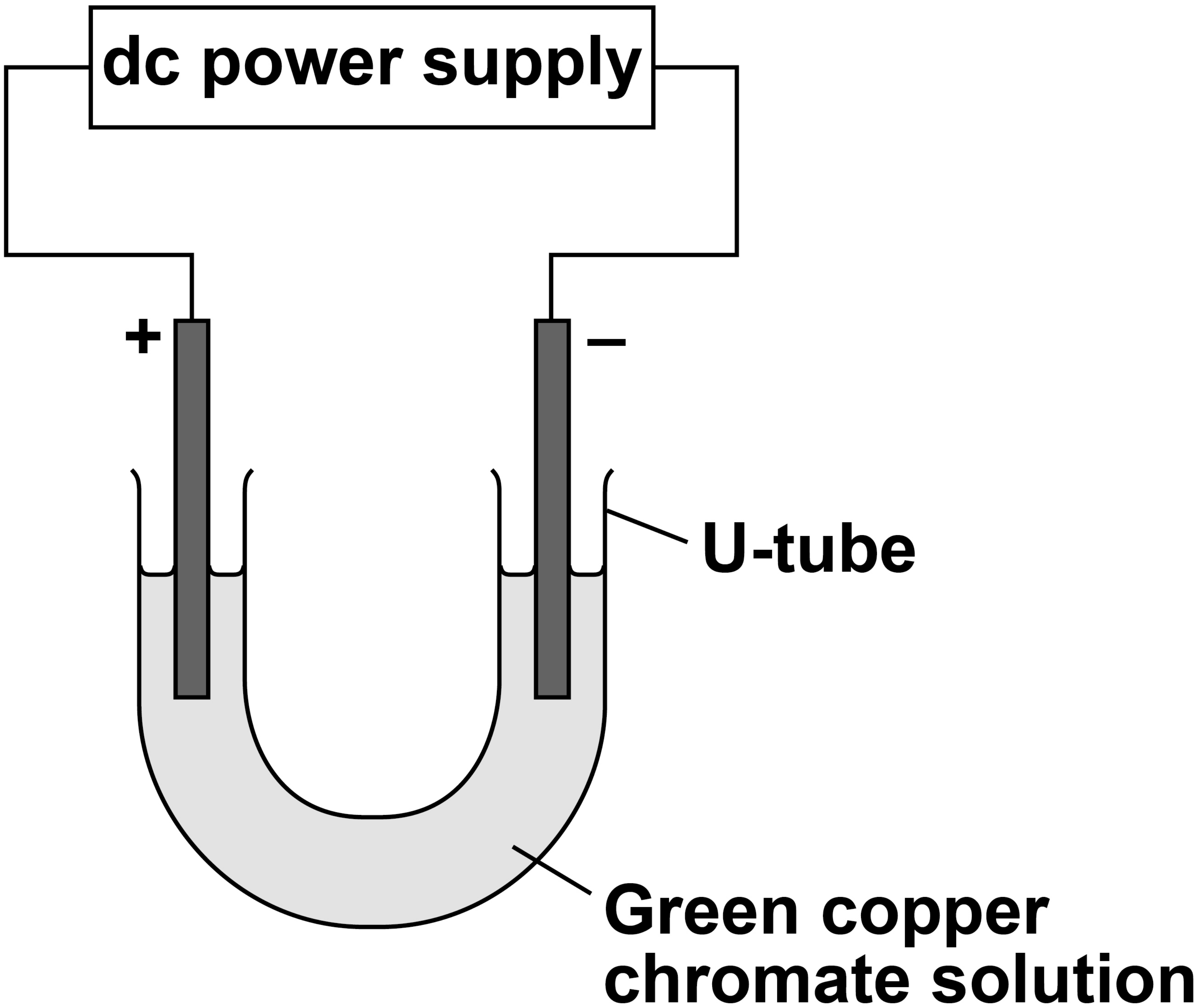
Copper chromate solution is green.

Copper chromate contains:

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

FIGURE 1, on the opposite page, shows the apparatus used.

FIGURE 1



[Turn over]

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]

[Turn over]

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

Positive electrode

[Turn over]

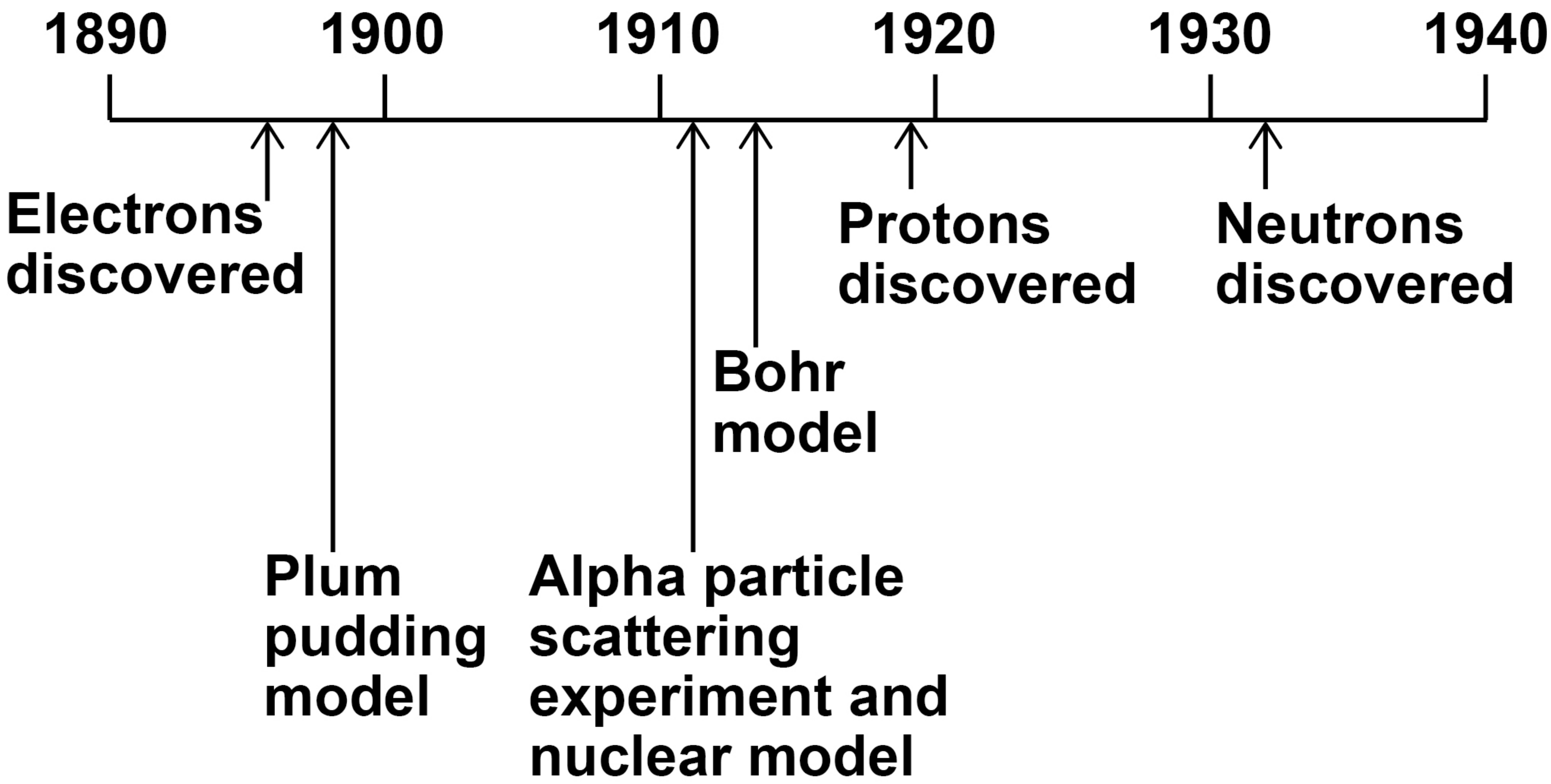
8

0 5

This question is about the development of scientific theories.

FIGURE 2, on the opposite page, shows a timeline of some important steps in the development of the model of the atom.

FIGURE 2



[Turn over]

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0 5 . 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]

1 ______________________________

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2 ______________________________

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____

3 ______________________________

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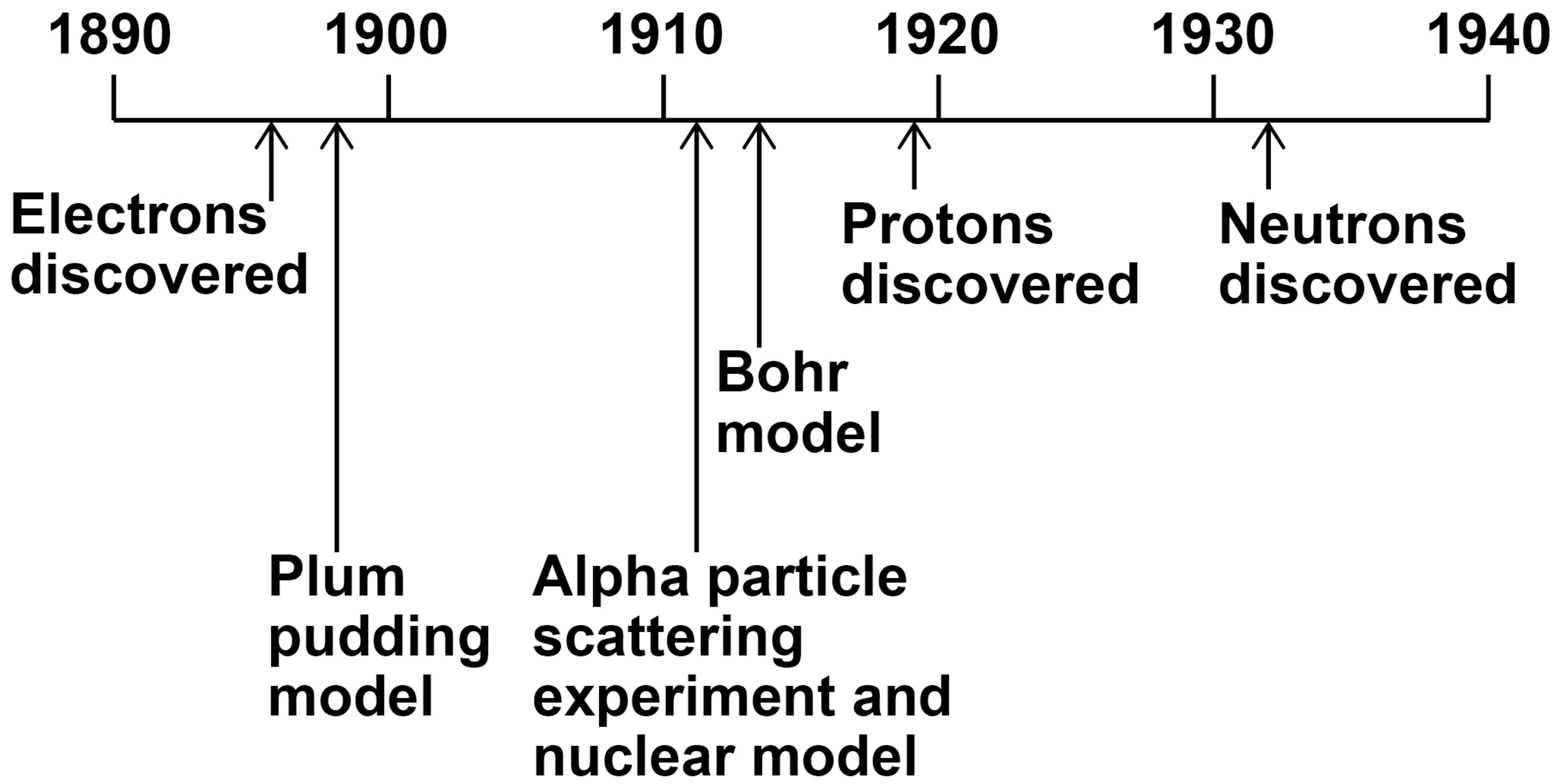
REPEAT OF FIGURE 2



0 5 . 2

Niels Bohr adapted the nuclear model.

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

[Turn over]

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, on page 38. [2 marks]

0 5 . 4

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

[Turn over]

/8

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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]

____

____

____

[Turn over]

06.2

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]

[Turn over]

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]

[Turn over]

9

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, on the opposite page, shows the student's reaction profile.

The student made TWO errors when drawing the reaction profile.

Describe the TWO errors. [2 marks]

1 ______________________________________

____

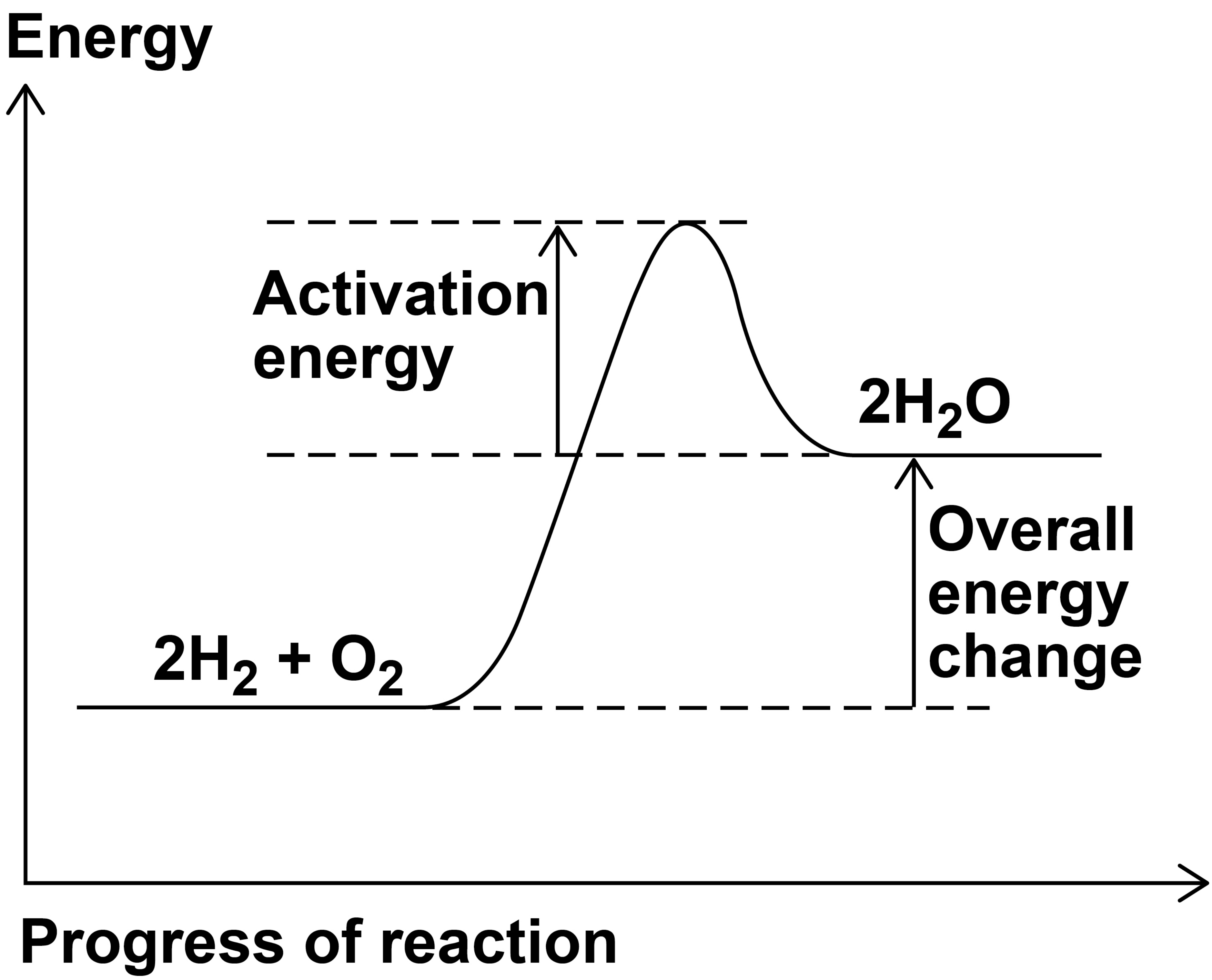
____

2 ______________________________________

____

____

FIGURE 3



[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]

1 ______________________________

____

____

2 ______________________________

____

____

0 7 . 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]

____

____

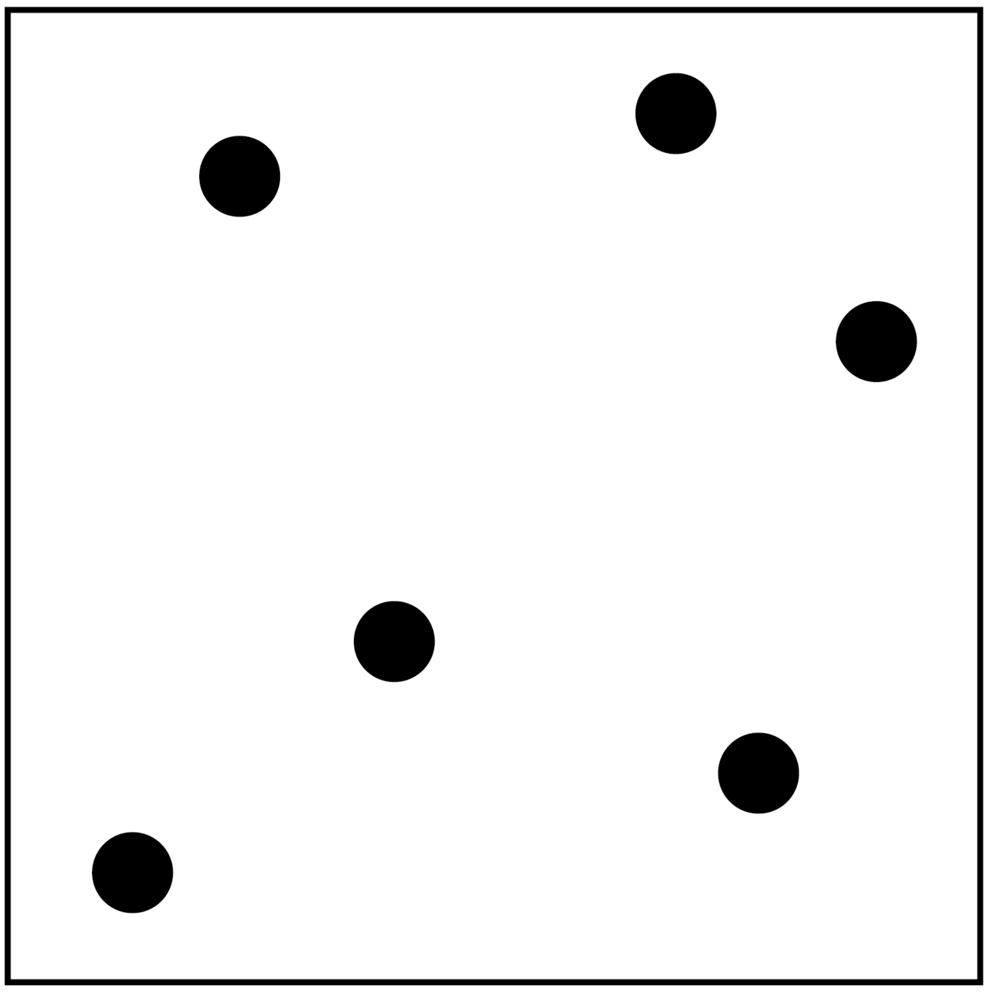
[Turn over]

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]

1 ____

____

____

2 ____

____

____

0 7 . 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

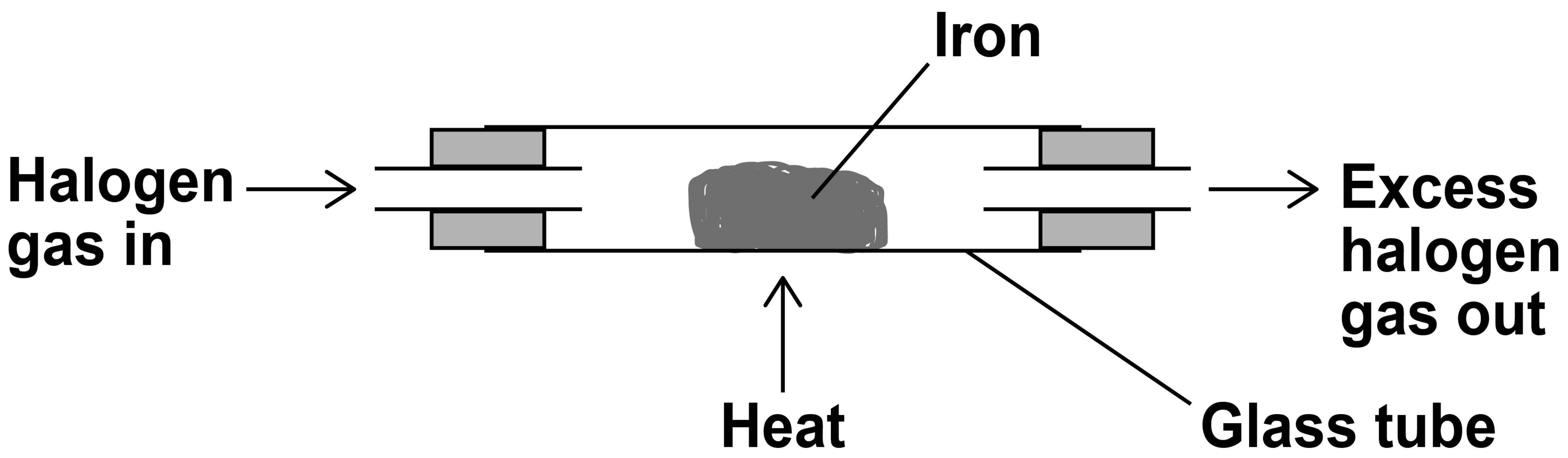
Why is it NOT correct to say that the boiling point of a single bromine molecule is 59 °C? [1 mark]

[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]

0 8 . 5

Explain why the reactivity of the halogens decreases going down the group. [3 marks]

[Turn over]

08.6

A teacher investigated the reaction of iron with chlorine using the apparatus in FIGURE 5, on page 60.

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, on page 64, shows the teacher's results.

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Question 8.6 continues on the next page

[Turn over]

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]

Moles of iron atoms : moles of chlorine atoms =

______________ : ______________

Equation for the reaction

____

[Turn over]

16

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.

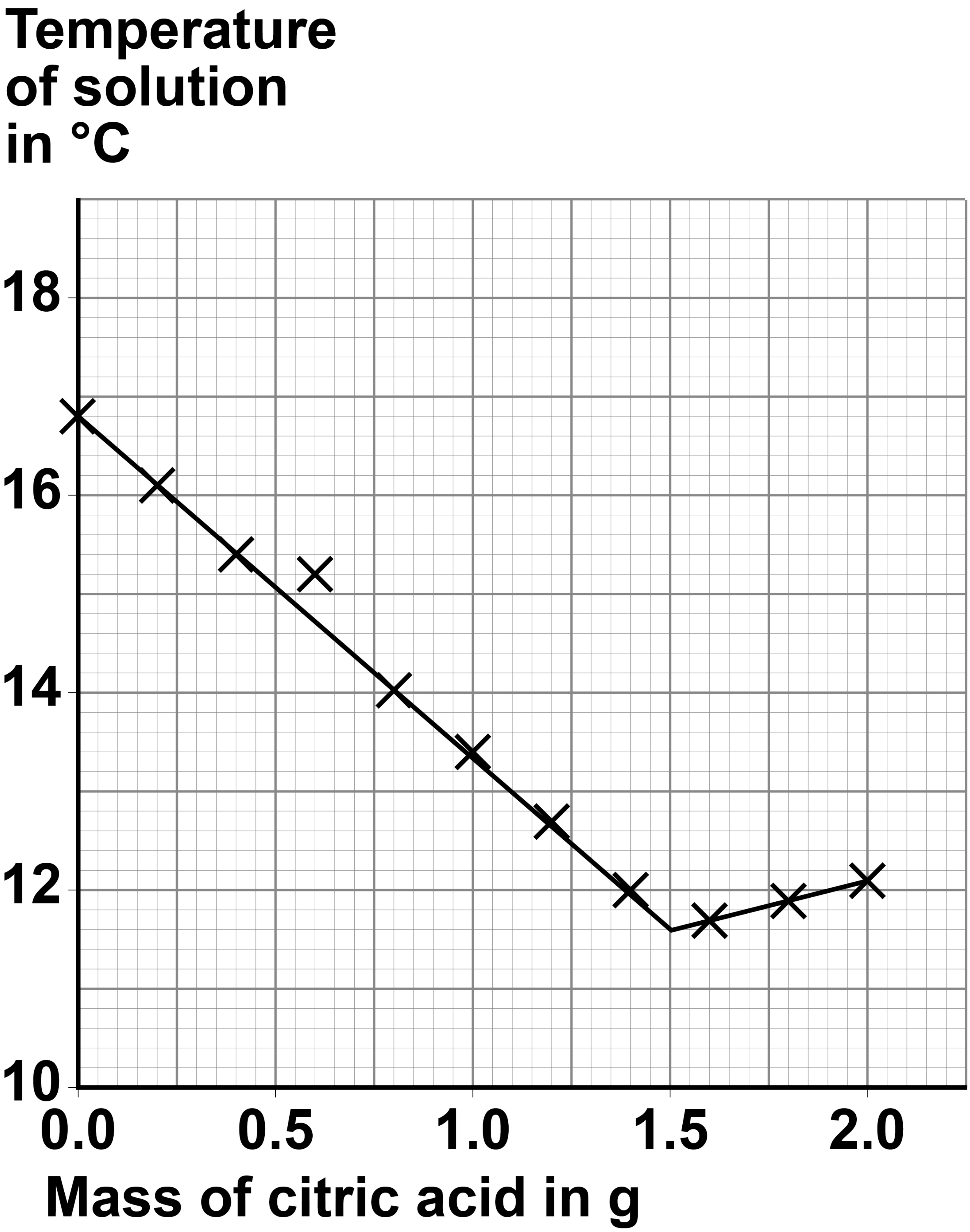
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

FIGURE 6, on page 68, shows the student's graph.

[Turn over]

FIGURE 6


Temperature of solution in °C
18
16
14
12
10
0.0
0.5
1.0
1.5
2.0
Mass of citric acid in g

0 9 . 1

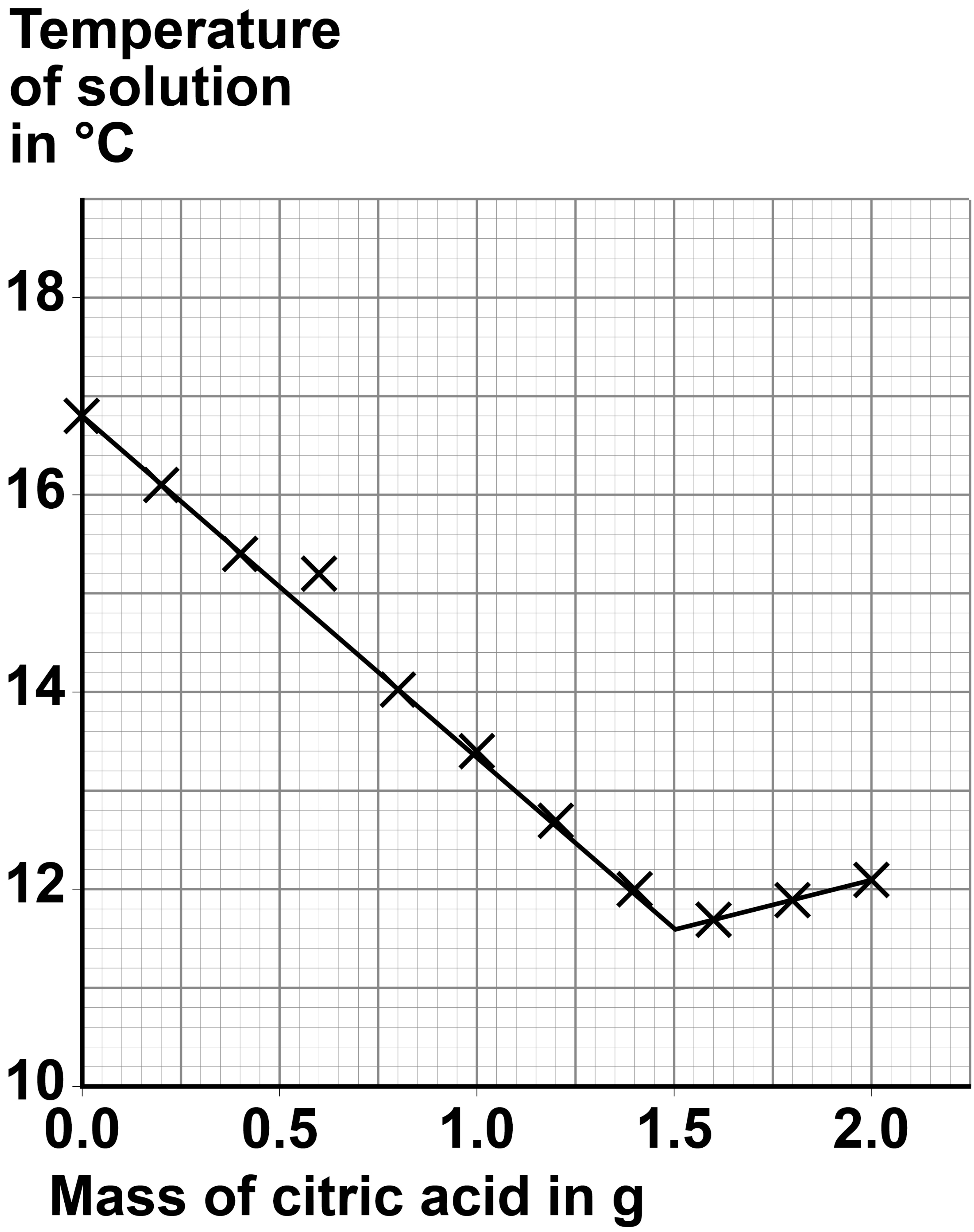
FIGURE 6 shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

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]

REPEAT OF FIGURE 6



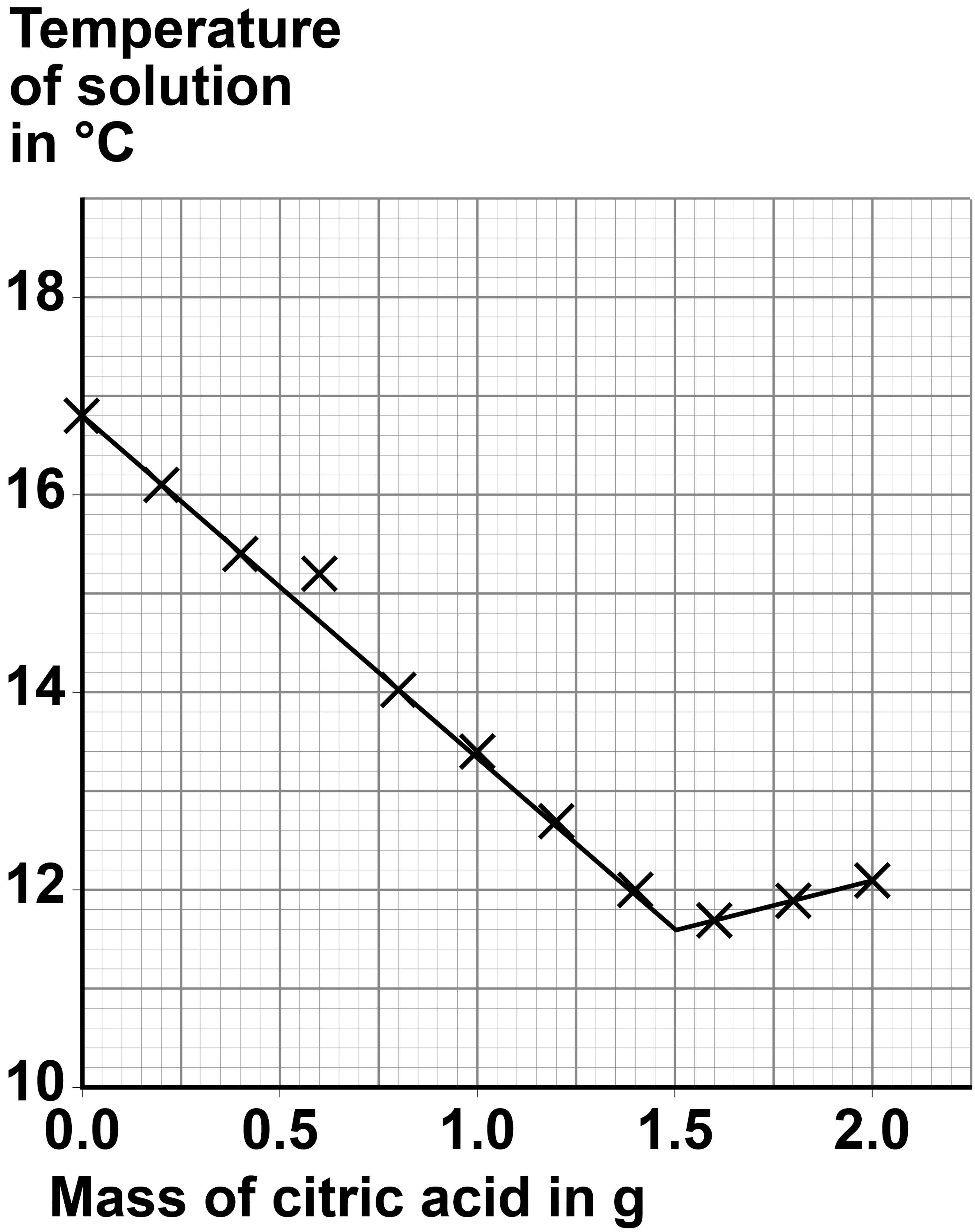
0 9 . 2

Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from FIGURE 6 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 72, 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]

Mass = ________________ g

[Turn over]

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]

[Turn over]

0 9 . 6

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

1 ____

____

____

2 ____

____

____

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[Turn over]

09.7

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]

Concentration = ________________ mol/dm^3

18

END OF QUESTIONS

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
1	
2	
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TOTAL	