A

Surname ______________________________

Forename(s) ______________________________

Centre Number ______________________________

Candidate Number ______________________________

Candidate Signature ______________________________

I declare this is my own work.

GCSE
CHEMISTRY

F

Foundation Tier Paper 1

8462/1F

Monday 22 May 2023 Morning

Time allowed: 1 hour 45 minutes

[Turn over]

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At the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

MATERIALS

For this paper you must have:

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

[Turn over]

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

0 1

This question is about atoms.

Atoms contain three types of particle:

- **electrons**
- **neutrons**
- **protons.**

0 1 . 1

Which particle has no electrical charge?
[1 mark]

Tick (✓) ONE box.

☐ **Electron**

☐ **Neutron**

☐ **Proton**

0 1 . 2

Which particles have the same relative mass? [1 mark]

Tick (✓) ONE box.

☐ An electron and a neutron

☐ An electron and a proton

☐ A neutron and a proton

[Turn over]

0 1 . 3

The formula of a compound is N_2O

How many of each type of atom are in one molecule of N_2O? [2 marks]

Nitrogen ______________________________

Oxygen ______________________________

An atom of element Z contains:

- 3 electrons
- 4 neutrons
- 3 protons.

0 1 . 4

Give the name of element Z.

Use the periodic table. [1 mark]

___

[Turn over]

0 1 . 5

Complete FIGURE 1, on the opposite page, to show the position of the particles in an atom of element Z.

Use the symbols:

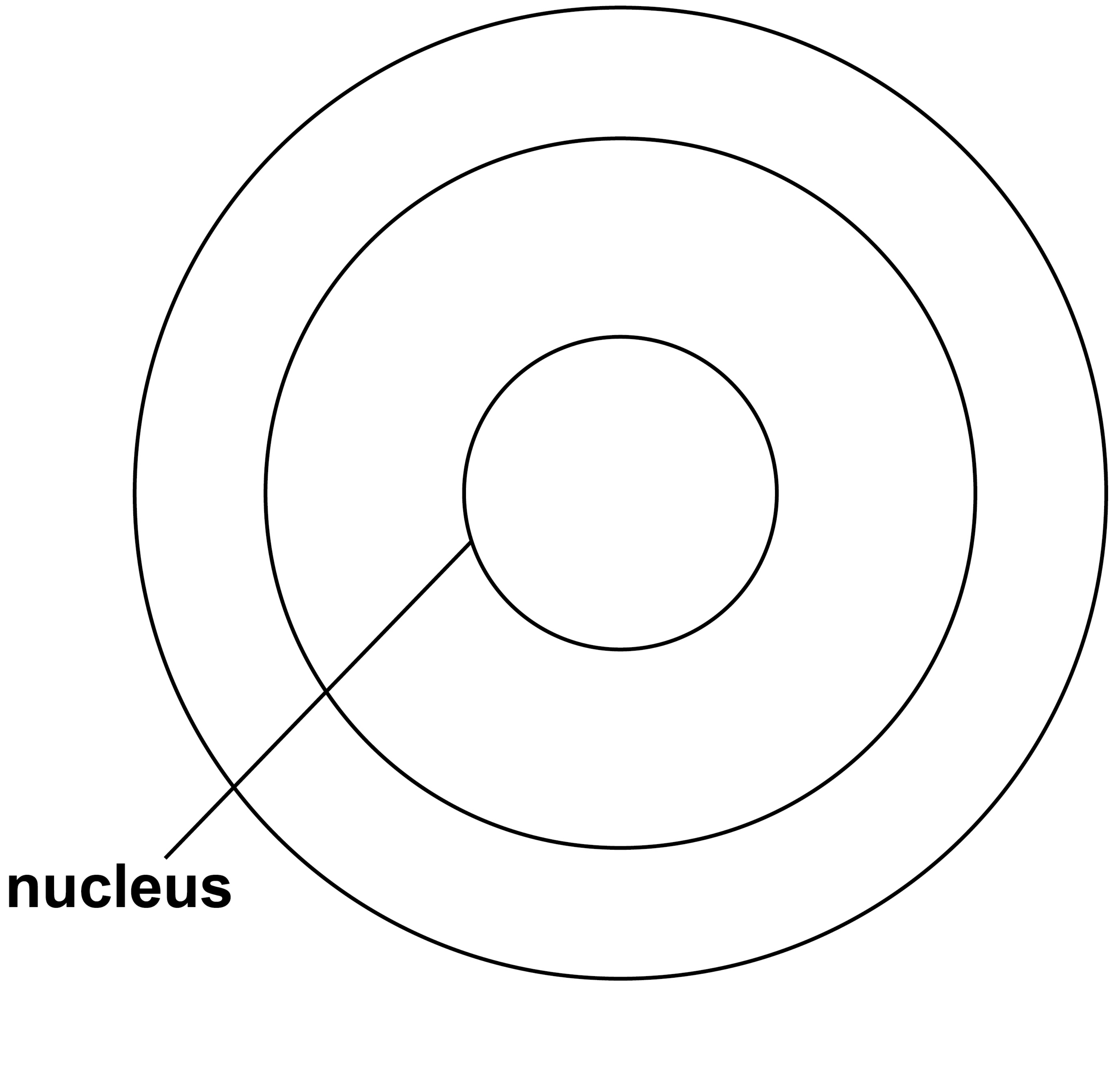
× = electron

● = neutron

○ = proton

[4 marks]

FIGURE 1



[Turn over]

9

0 2

This question is about acids and alkalis.

0 2 . 1

Acids and alkalis are substances that produce ions in aqueous solution.

On the opposite page, draw ONE line from each substance to the ion always produced by that substance in aqueous solution. [2 marks]

Substance	Ion always produced in aqueous solution
	Cl^-
Acid	H^+
	Na^+
Alkali	OH^-
	SO_4^{2-}

[Turn over]

0 2 . 2

What type of aqueous solution has a pH of 11? [1 mark]

Tick (✓) ONE box.

☐ **Acidic**

☐ **Alkaline**

☐ **Neutral**

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[Turn over]

A student determined the reacting volumes of hydrochloric acid and sodium hydroxide solution by titration.

This is the method used.

1. **Measure 25.0 cm^3 of the sodium hydroxide solution.**
2. **Add the sodium hydroxide solution to a conical flask.**
3. **Add 3 drops of indicator to the sodium hydroxide solution.**
4. **Add the hydrochloric acid drop by drop until the indicator changes colour.**
5. **Record the volume of the hydrochloric acid added.**
6. **Repeat steps 1 to 5 three more times.**

0 2 . 3

Which piece of equipment should be used to measure 25.0 cm^3 of the sodium hydroxide solution in step 1?
[1 mark]

Tick (✓) ONE box.

- [ ] **Beaker**
- [ ] **Pipette**
- [ ] **Ruler**

[Turn over]

0 2 . 4

Which piece of equipment should be used to add the hydrochloric acid drop by drop in step 4? [1 mark]

Tick (✓) ONE box.

☐ **Balance**

☐ **Burette**

☐ **Measuring cylinder**

BLANK PAGE

[Turn over]

TABLE 1 shows the results.

TABLE 1

Trial	1	2	3	4
Volume of hydrochloric acid added in cm^3	24.3	24.5	28.1	24.4

0 2 . 5

Which is the anomalous result in TABLE 1? [1 mark]

Tick (✓) ONE box.

- [ ] **Trial 1**
- [ ] **Trial 2**
- [ ] **Trial 3**
- [ ] **Trial 4**

0 2 . 6

Suggest ONE reason for the anomalous result in TABLE 1. [1 mark]

____

____

0 2 . 7

The student used a solution of sodium hydroxide of concentration 4.00 g/dm^3.

Calculate the mass of sodium hydroxide in 25.0 cm^3 of this solution.

1 dm^3 = 1000 cm^3

[3 marks]

____

____

____

____

____

____

____

____

Mass = ______________________ g

10

0 3

This question is about carbon.

0 3 . 1

Which type of substance is carbon?
[1 mark]

Tick (✓) ONE box.

- [ ] Compound
- [ ] Element
- [ ] Mixture

[Turn over]

0 3 . 2

Carbon has isotopes with mass numbers 12, 13 and 14.

Complete the sentences.

Choose answers from the list. [2 marks]

- **electrons**
- **ions**
- **molecules**
- **neutrons**
- **protons**

The isotopes of carbon have the same number of ________________________ .

The isotopes of carbon have a different number of ________________________ .

0 3 . 3

12 g of carbon contains 6.02×10^{23} atoms.

Which expression is used to calculate the mass of one atom of carbon? [1 mark]

Tick (✓) ONE box.

☐ $$\frac{12}{6.02 \times 10^{23}}$$

☐ $$\frac{6.02 \times 10^{23}}{12}$$

☐ $12 \times 6.02 \times 10^{23}$

0 3 . 4

FIGURE 2, on the opposite page, shows diagrams that represent different forms of carbon.

Which diagram in FIGURE 2 represents Buckminsterfullerene? [1 mark]

Tick (✓) ONE box.

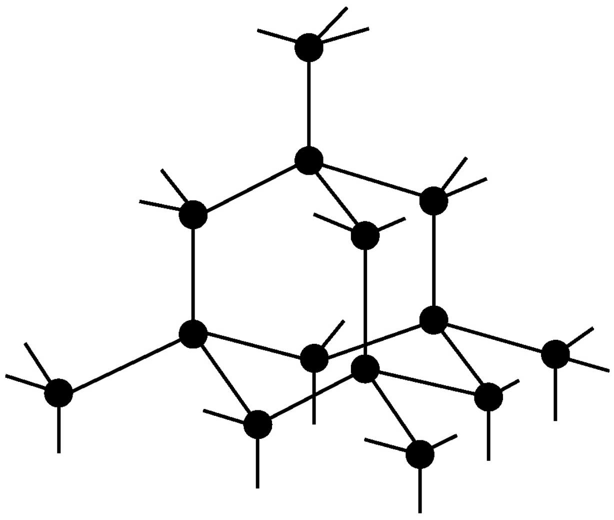
☐ **A**

☐ **B**

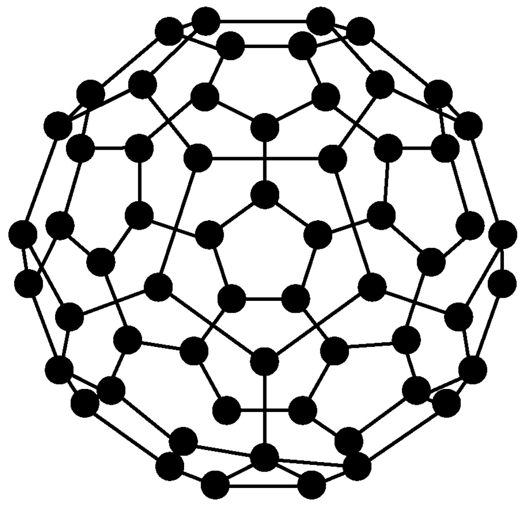
☐ **C**

FIGURE 2

A



B



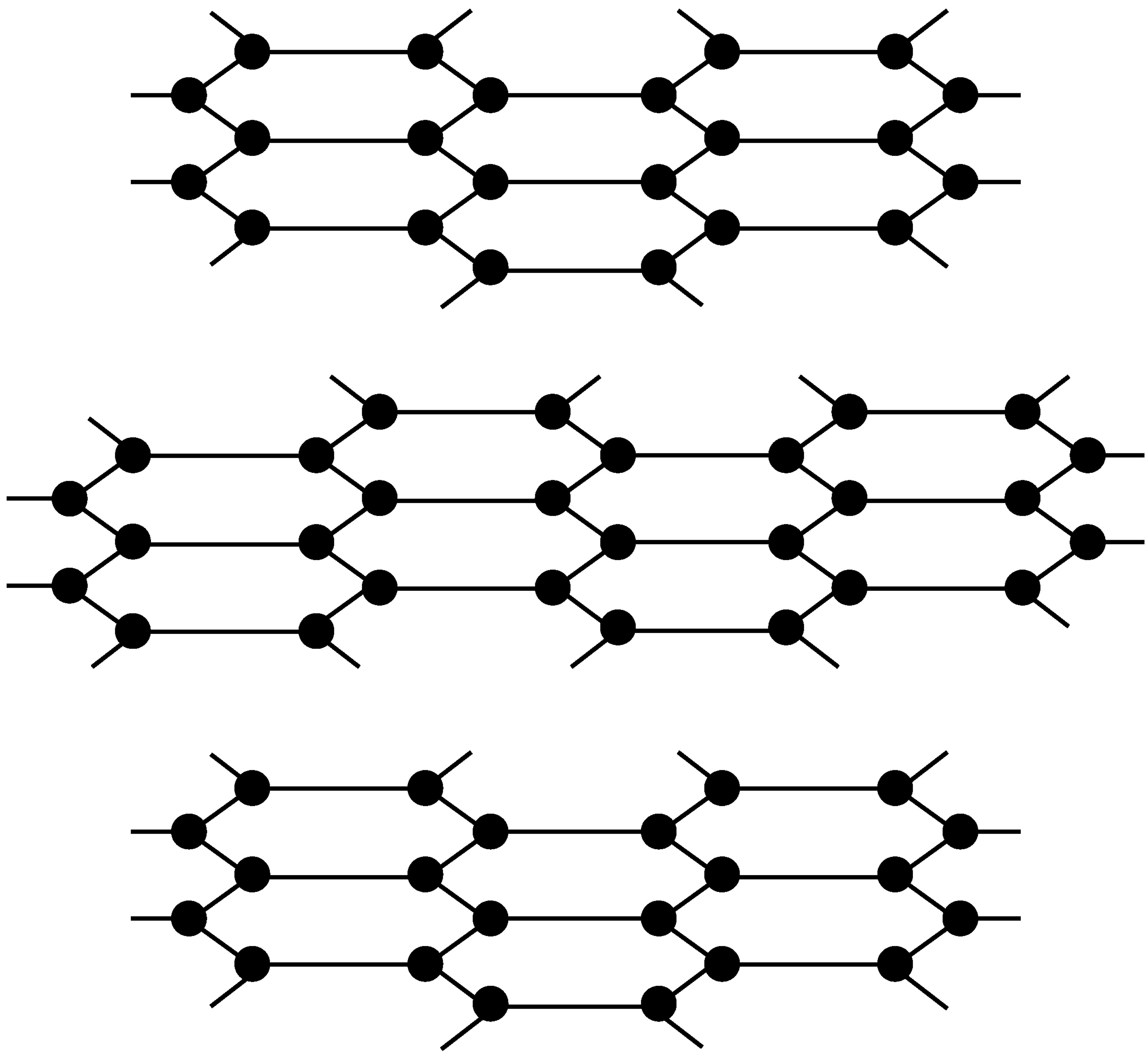
C

[Turn over]

0 3 . 5

FIGURE 3 represents part of the structure of graphite.

FIGURE 3



On the opposite page, draw ONE line from each property of graphite to the structural feature that is the reason for that property. [2 marks]

PROPERTY	STRUCTURAL FEATURE
	Graphite has hexagonal rings of carbon atoms.
Graphite conducts electricity.	
	The bonds between carbon atoms in the layers are strong.
Graphite is soft.	There are no covalent bonds between layers of atoms.
	There are delocalised electrons in graphite.

7

0 4

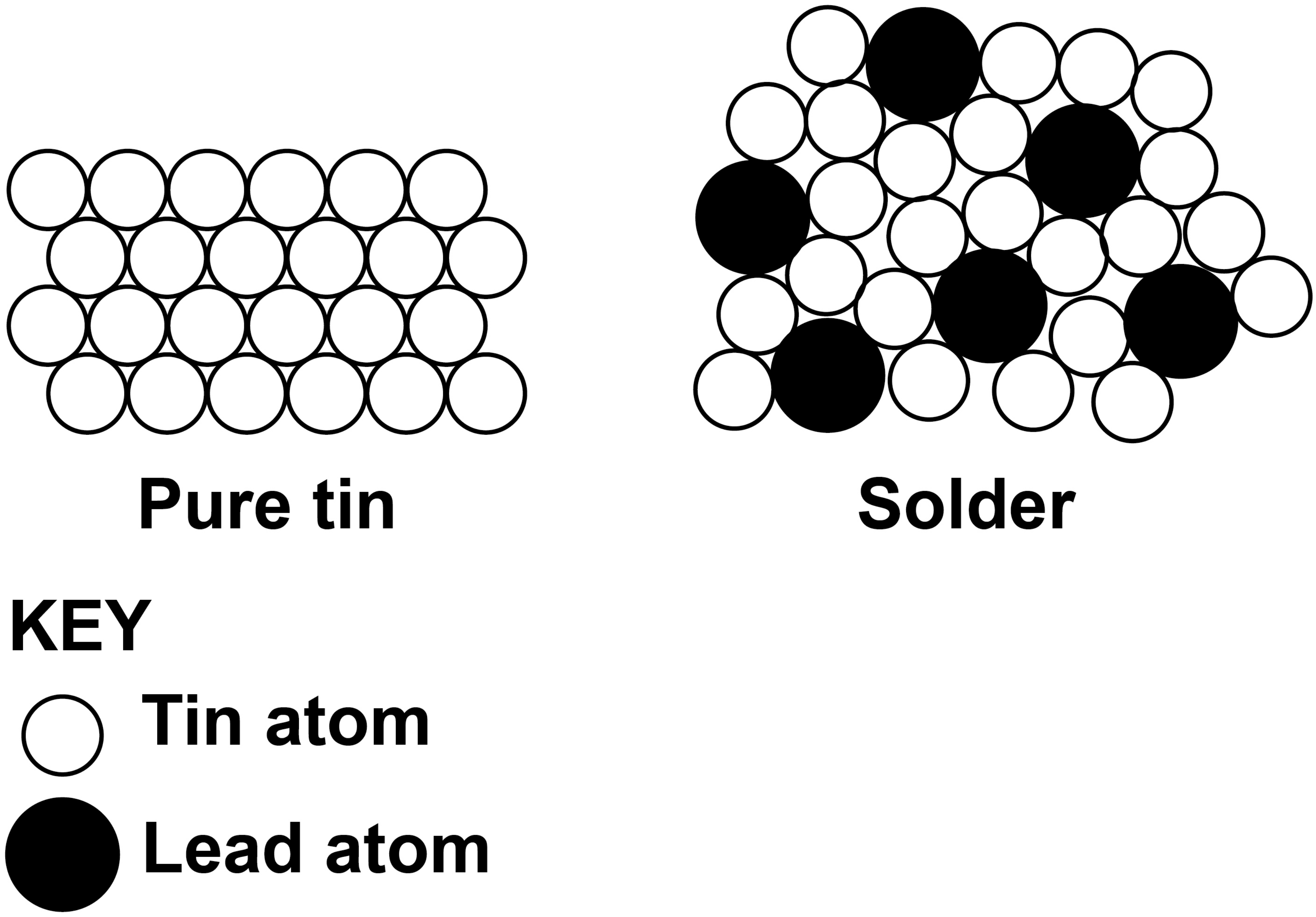
This question is about alloys.

Solders are alloys of tin and lead.

Different solders have different percentages of tin and lead.

FIGURE 4 shows the arrangement of atoms in pure tin and in a solder.

FIGURE 4



0 4 . 1

The solder in FIGURE 4 has 6 lead atoms for every 24 tin atoms.

Determine the percentage of atoms that are lead atoms in the solder in FIGURE 4.
[3 marks]

____

____

____

____

____

____

____

Percentage of lead atoms = ____________ %

[Turn over]

0 4 . 2

Explain why solder is harder than pure tin.

Complete the sentences.

Use FIGURE 4, on page 30. [2 marks]

In solder the layers are distorted.
This is because the atoms of tin and lead have different ________________________ .

Therefore the layers cannot easily

________________________________ .

BLANK PAGE

[Turn over]

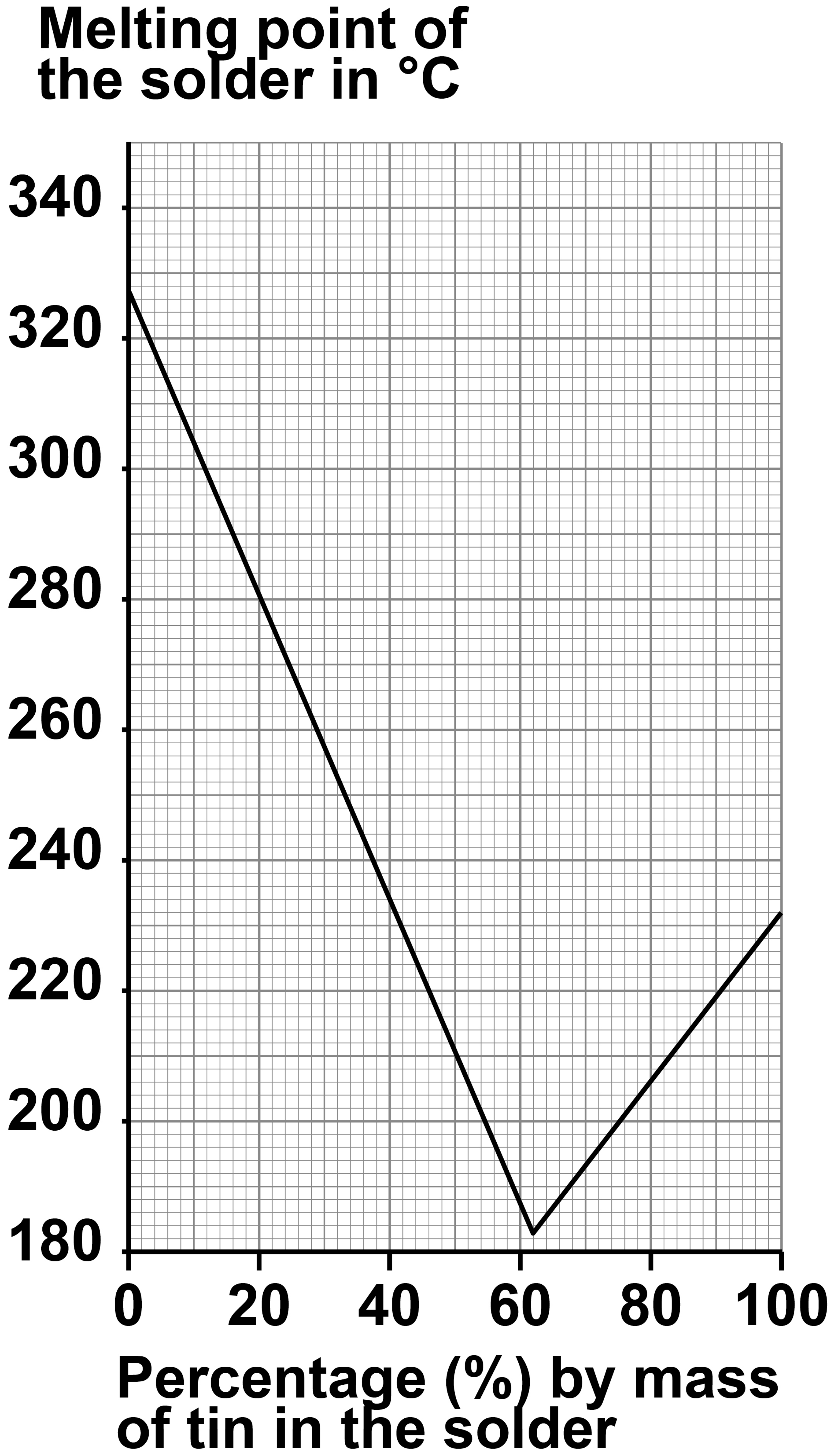
FIGURE 5, on the opposite page, shows how the melting point of the solder changes with the percentage by mass of tin in the solder.

0 4 . 3

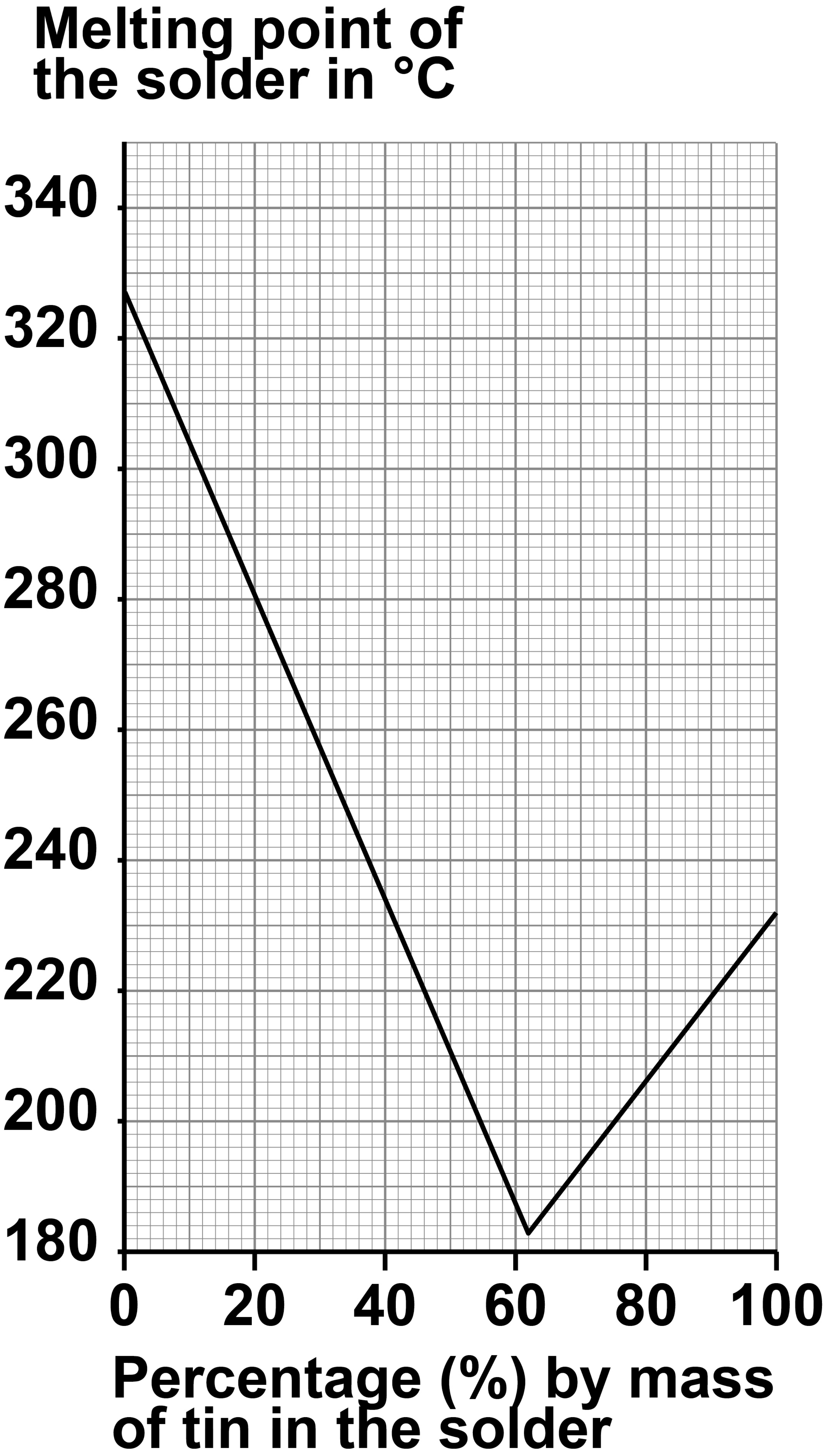
Describe what happens to the melting point of the solder as the percentage by mass of tin increases.

Use data from FIGURE 5. [3 marks]

FIGURE 5


Melting point of the solder in °C
340
320
300
280
260
240
220
200
180
0
20
40
60
80
100
Percentage (%) by mass of tin in the solder

REPEAT OF FIGURE 5



0 4 . 4

What is the melting point of pure tin?

Use FIGURE 5. [1 mark]

Melting point of pure tin = ____________ °C

[Turn over]

0 4 . 5

What happens to the atoms in pure tin as the tin melts? [1 mark]

Tick (✓) ONE box.

☐ **The atoms gain energy and their arrangement becomes less ordered.**

☐ **The atoms gain energy and their arrangement becomes more ordered.**

☐ **The atoms lose energy and their arrangement becomes less ordered.**

☐ **The atoms lose energy and their arrangement becomes more ordered.**

10

BLANK PAGE

[Turn over]

0 5

This question is about small particles.

0 5 . 1

Which type of particle is often referred to as dust? [1 mark]

Tick (✓) ONE box.

☐ **Coarse particle**

☐ **Fine particle**

☐ **Nanoparticle**

0 5 . 2

A spherical coarse particle has a diameter of 4000 nm.

A spherical fine particle has a diameter of 200 nm.

How many times larger is the diameter of the coarse particle than the diameter of the fine particle? [1 mark]

Tick (✓) ONE box.

☐ **2 times**

☐ **5 times**

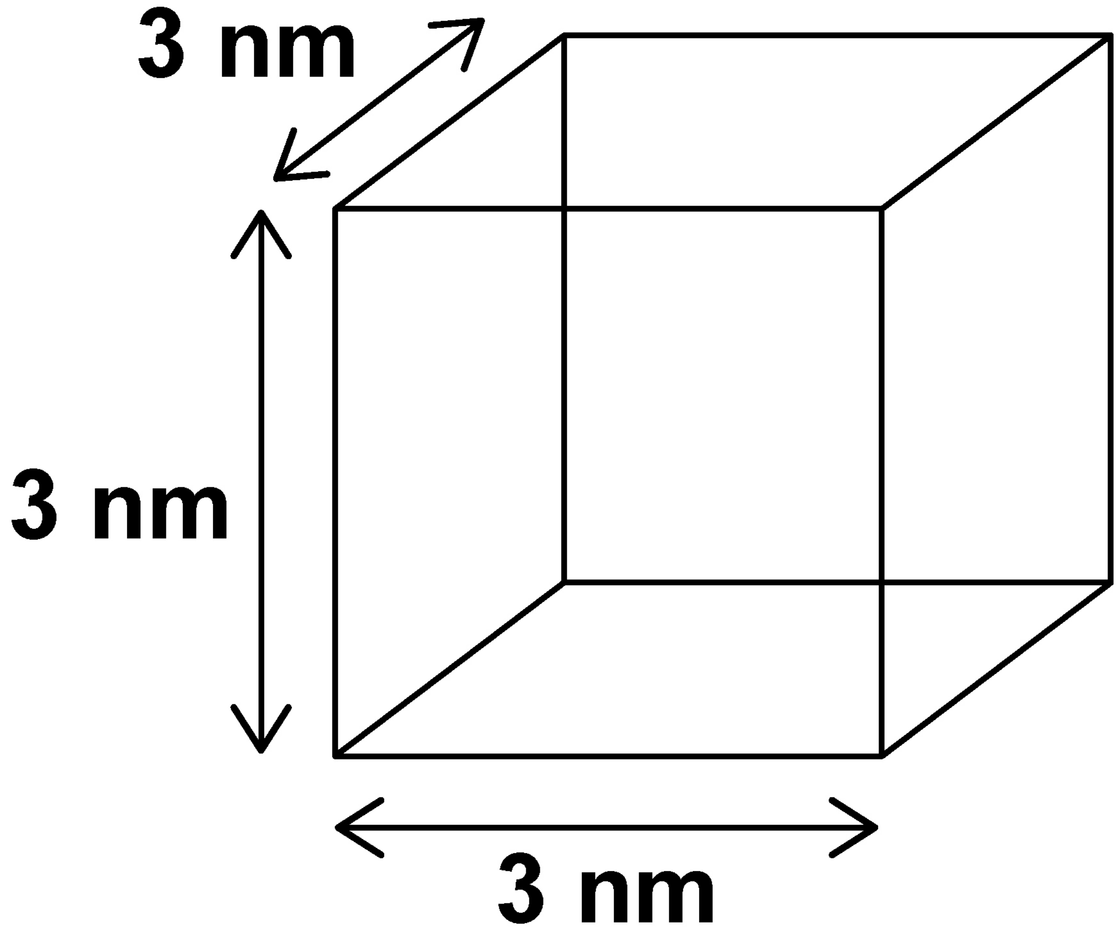
☐ **20 times**

☐ **50 times**

0 5 . 3

FIGURE 6 represents a cubic nanoparticle.

FIGURE 6



The volume of the cubic nanoparticle is 27 nm^3.

Calculate:

- the surface area of the cubic nanoparticle
- the simplest whole number ratio of surface area : volume for the cubic nanoparticle.

Use the equation:

surface area of cubic nanoparticle = 6 × surface area of one face

[4 marks]

____

____

____

Surface area of cubic nanoparticle =

______________________ nm^2

[Turn over]

____

____

____

Simplest whole number ratio of surface area : volume = ______________________ : 1

Titanium oxide is used in some sun creams.

0 5 . 4

Which is an advantage of using nanoparticles of titanium oxide rather than normal-sized particles of titanium oxide in sun creams? [1 mark]

Tick (✓) ONE box.

- [ ] **A smaller mass of nanoparticles is needed to be effective.**
- [ ] **Nanoparticles cost more than the same mass of normal-sized particles.**
- [ ] **Nanoparticles have a lower surface area to volume ratio than normal-sized particles.**

[Turn over]

0 5 . 5

Titanium oxide contains Ti^{4+} ions and O^{2-} ions.

What is the formula of titanium oxide?
[1 mark]

Tick (✓) ONE box.

☐ TiO_2

☐ TiO_4

☐ Ti_2O

☐ Ti_4O_2

8

0 6

This question is about metals.

0 6 . 1

Platinum is used to make jewellery.

Suggest ONE reason why platinum is used to make jewellery. [1 mark]

____

____

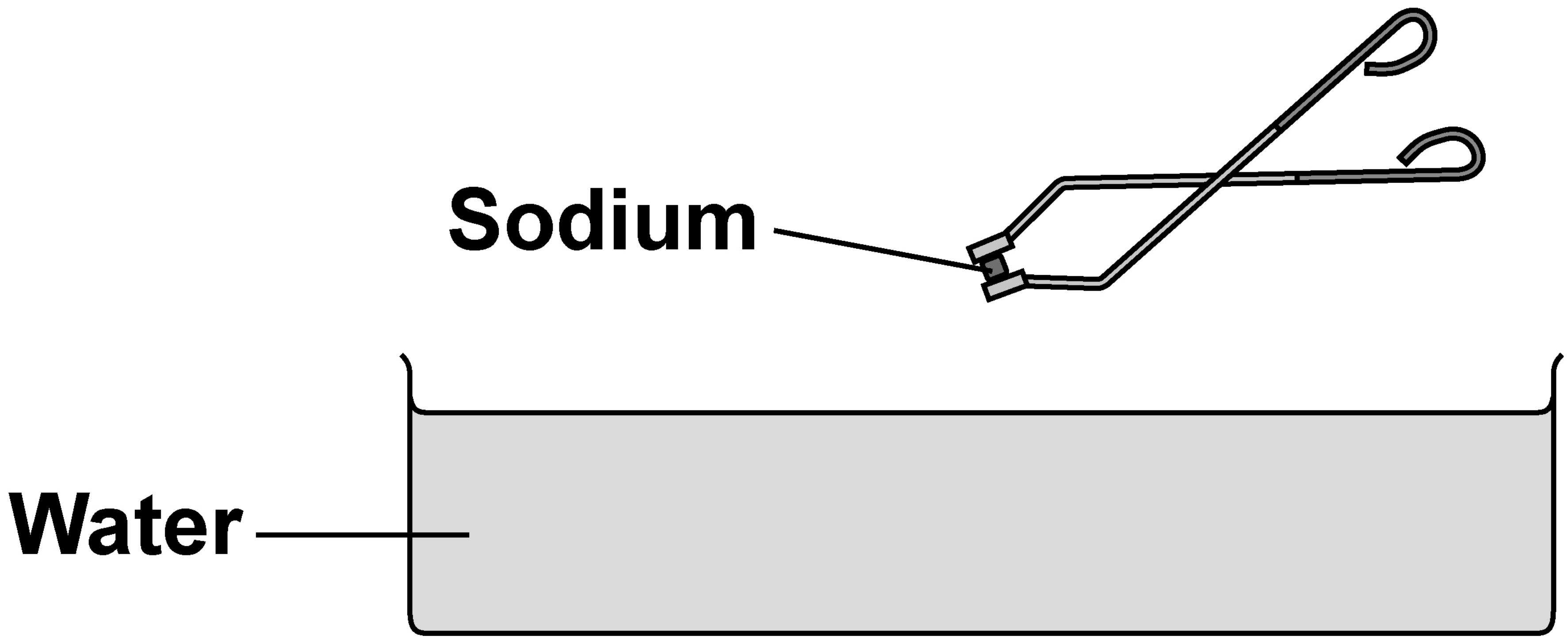
____

[Turn over]

0 6 . 2

FIGURE 7 shows a piece of sodium being added to water.

FIGURE 7



Give TWO observations that could be seen when sodium is added to water.
[2 marks]

1 ______________________________________

____

____

2 ______________________________________

____

____

[Turn over]

0 6 . 3

Copper is a transition element.

Sodium is a Group 1 element.

What are TWO differences between copper and sodium? [2 marks]

Tick (✓) TWO boxes.

- [ ] **Copper has a lower melting point.**
- [ ] **Copper is harder.**
- [ ] **Copper is less dense.**
- [ ] **Copper is less reactive.**
- [ ] **Copper is less strong.**

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[Turn over]

0 6 . 4

The metals aluminium and copper can be used to make pans for cooking.

TABLE 2 shows information about the two metals.

The higher the value for thermal conductivity, the better the metal conducts thermal energy.

TABLE 2

	ALUMINIUM	COPPER
Thermal conductivity in arbitrary units	250	400
Density in g/cm^3	2.7	8.9
Cost of metal per kg in £	1.50	7.00

Evaluate the use of pans made of aluminium and of copper.

Use TABLE 2. [4 marks]

[Turn over]

9

0 7

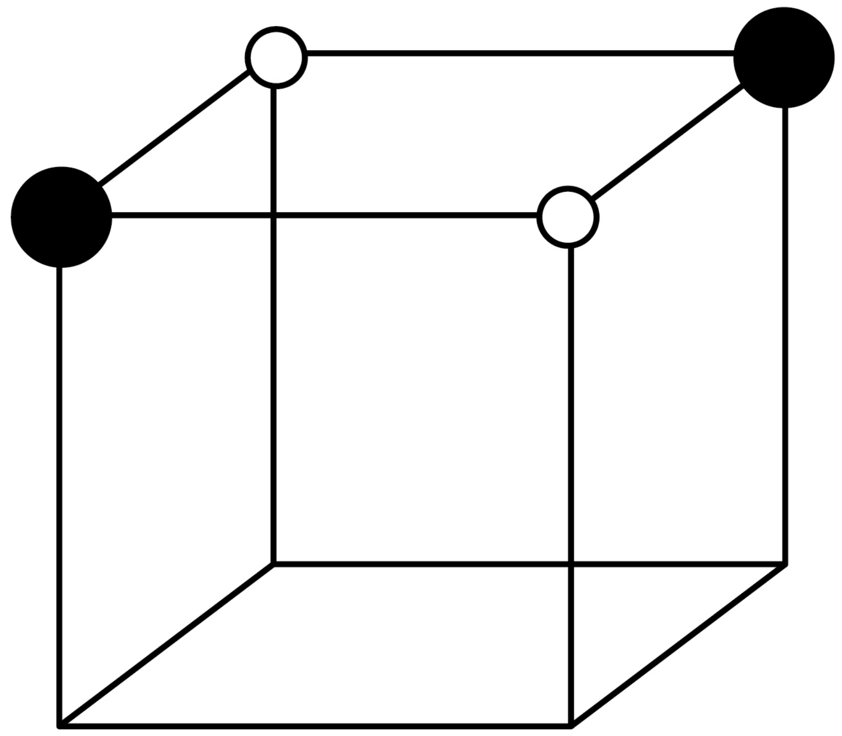
This question is about ionic compounds and electrolysis.

Sodium chloride is an ionic compound.

0 7 . 1

FIGURE 8, on the opposite page, represents part of the structure of solid sodium chloride.

FIGURE 8



KEY

○ Na^+ ion

● Cl^- ion

Complete FIGURE 8. [2 marks]

[Turn over]

0 7 . 2

Give ONE reason why molten sodium chloride conducts electricity.

Refer to ions in your answer. [1 mark]

0 7 . 3

TABLE 3 shows products of the electrolysis of two molten ionic compounds.

Complete TABLE 3. [2 marks]

TABLE 3

MOLTEN COMPOUND	PRODUCT AT THE NEGATIVE ELECTRODE	PRODUCT AT THE POSITIVE ELECTRODE
Magnesium bromide	Magnesium	______________
Potassium chloride	______________	Chlorine

[Turn over]

0 7 . 4

Aluminium is extracted by electrolysis.

The electrolyte is a molten mixture of aluminium oxide and cryolite.

Why is a mixture used instead of pure aluminium oxide as the electrolyte?
[1 mark]

Tick (✓) ONE box

☐ **The mixture has a lower melting point than pure aluminium oxide.**

☐ **The mixture has the same melting point as pure aluminium oxide.**

☐ **The mixture has a higher melting point than pure aluminium oxide.**

07.5

Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

What is the source of the hydrogen and the oxygen produced during the electrolysis of aqueous sodium sulfate solution? [1 mark]

Tick (✓) ONE box.

- ☐ **Air**
- ☐ **Sulfate ions**
- ☐ **Water**

[Turn over]

Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

0 7 . 6

Why is hydrogen produced instead of sodium in the electrolysis of aqueous sodium sulfate solution? [1 mark]

Tick (✓) ONE box.

☐ **Hydrogen is less reactive than sodium.**

☐ **Hydrogen has the same reactivity as sodium.**

☐ **Hydrogen is more reactive than sodium.**

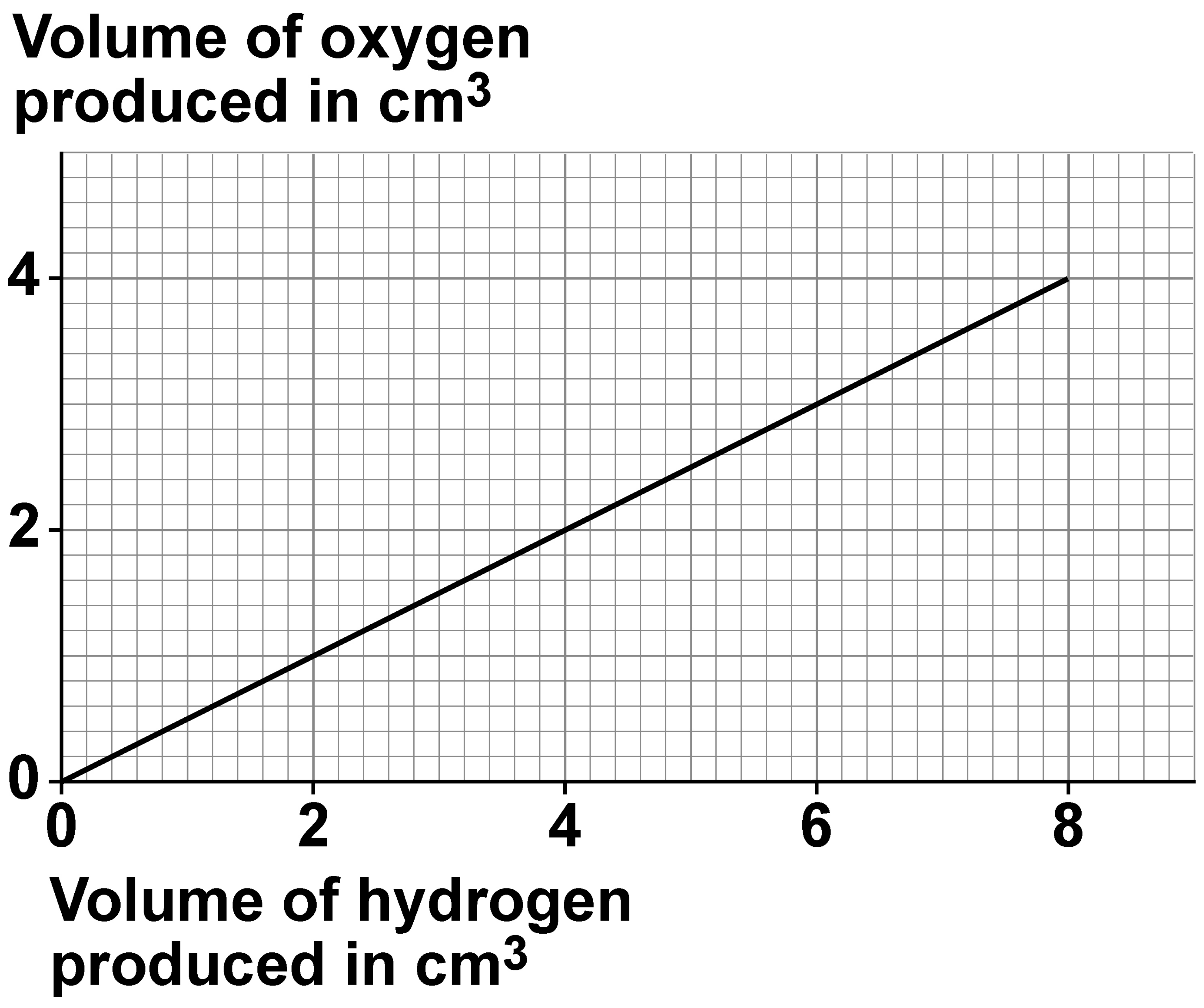
BLANK PAGE

[Turn over]

0 7 . 7

FIGURE 9 shows the relationship between the volume of hydrogen and the volume of oxygen produced during the electrolysis.

FIGURE 9



Give ONE conclusion that can be made about the volume of hydrogen produced compared to the volume of oxygen produced. [1 mark]

____

____

____

9

[Turn over]

0 8

This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

0 8 . 1

Balance the equation for the reaction. [2 marks]

$$Fe_2O_3 + 3\,C \longrightarrow \_\_\_\_\_\_\_\_\_\_\ Fe + \_\_\_\_\_\_\_\_\_\_\ CO$$

0 8 . 2

Iron oxide is reduced in this reaction.

How does the equation show that iron oxide is reduced?
[1 mark]

[Turn over]

0 8 . 3

Calculate the relative formula mass (M_r) of Fe_2O_3

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

[2 marks]

M_r = ______________________

BLANK PAGE

[Turn over]

0 8 . 4

Copper oxide reacts with hydrogen to produce copper.

The equation for the reaction is:

$$CuO + H_2 \longrightarrow Cu + H_2O$$

Calculate the percentage atom economy for obtaining copper from this reaction.

Use the equation:

$$\text{Percentage atom economy} = \frac{A_r \text{ of Cu}}{M_r \text{ of } H_2 + M_r \text{ of CuO}} \times 100$$

Relative atomic mass (A_r): Cu = 63.5

Relative formula masses (M_r): H_2 = 2 CuO = 79.5

[2 marks]

Percentage atom economy = ____________ %

[Turn over]

A student investigated the reactivity of four different metals, A, B, C and D.

The student:

- **added each metal to aqueous solutions of each of the metal sulfates**
- **observed whether a reaction took place.**

0 8 . 5

Give ONE observation that would show a reaction took place. [1 mark]

[Turn over]

0 8 . 6

TABLE 4 shows the results.

TABLE 4

	METAL SULFATE SOLUTION			
METAL	A sulfate	B sulfate	C sulfate	D sulfate
A	×	×	✓	×
B	✓	×	✓	×
C	×	×	×	×
D	✓	✓	✓	×

✓ shows that a displacement reaction took place.
× shows that a displacement reaction did not take place.

Write metals A, B, C and D in order of reactivity.

Give a reason for your order of reactivity. [2 marks]

Most reactive ______________

____

____

Least reactive ______________

Reason ____

____

10

[Turn over]

0 9

Discoveries in chemistry led to a better understanding of atomic structure.

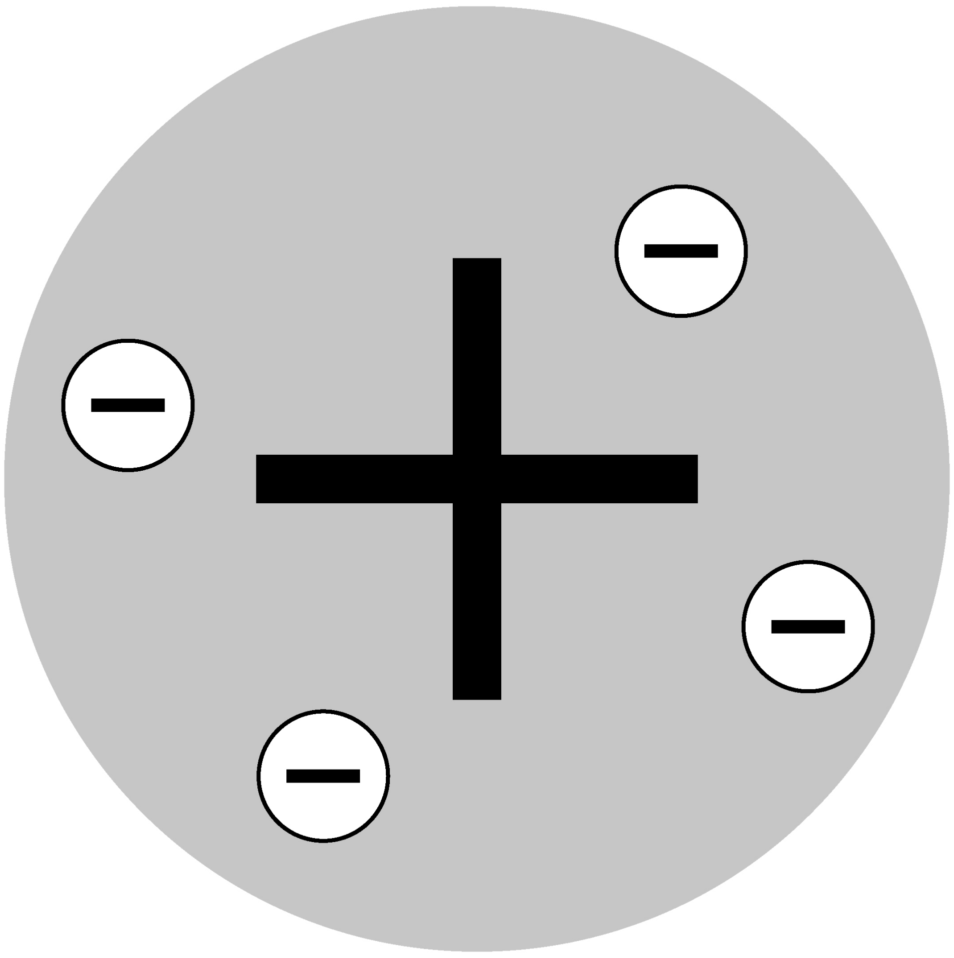
0 9 . 1

Atoms were originally thought to be tiny spheres that could not be divided.

The plum pudding model of the atom was then developed.

FIGURE 10, on the opposite page, represents the plum pudding model of the atom.

FIGURE 10



Describe the plum pudding model of the atom. [2 marks]

[Turn over]

0 9 . 2

Atoms contain electrons, neutrons and protons.

Write these three particles in order of their discovery. [1 mark]

Earliest ______________________________

____

Latest ______________________________

Very few atoms of the element tennessine (Ts) have ever been identified.

The atomic number of tennessine is 117

0 9 . 3

Predict the number of outer shell electrons in an atom of tennessine.

Give ONE reason for your answer.

Use the periodic table. [2 marks]

Number of outer shell electrons ____________

Reason ____

____

____

[Turn over]

0 9 . 4

Tennessine was first identified by a small group of scientists in 2010.

Suggest ONE reason why tennessine was NOT accepted as a new element by other scientists until 2015. [1 mark]

BLANK PAGE

[Turn over]

0 9 . 5

The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element R has two isotopes.

TABLE 5 shows the mass numbers and percentage abundances of the isotopes of element R.

TABLE 5

MASS NUMBER	PERCENTAGE ABUNDANCE (%)
6	7.6
7	92.4

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

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

Relative atomic mass (1 decimal place) =

9

[Turn over]

1 0

This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. **Measure 200 cm^3 of water into a polystyrene cup.**
2. **Measure the temperature of the water.**
3. **Add 4.0 g of ammonium nitrate to the water.**
4. **Stir the solution until all the ammonium nitrate has dissolved.**

5. Measure the lowest temperature reached by the solution.
6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

10.1

Give the independent variable and the dependent variable in the investigation. [2 marks]

Independent variable

____

Dependent variable

____

[Turn over]

TABLE 6 shows the results.

TABLE 6

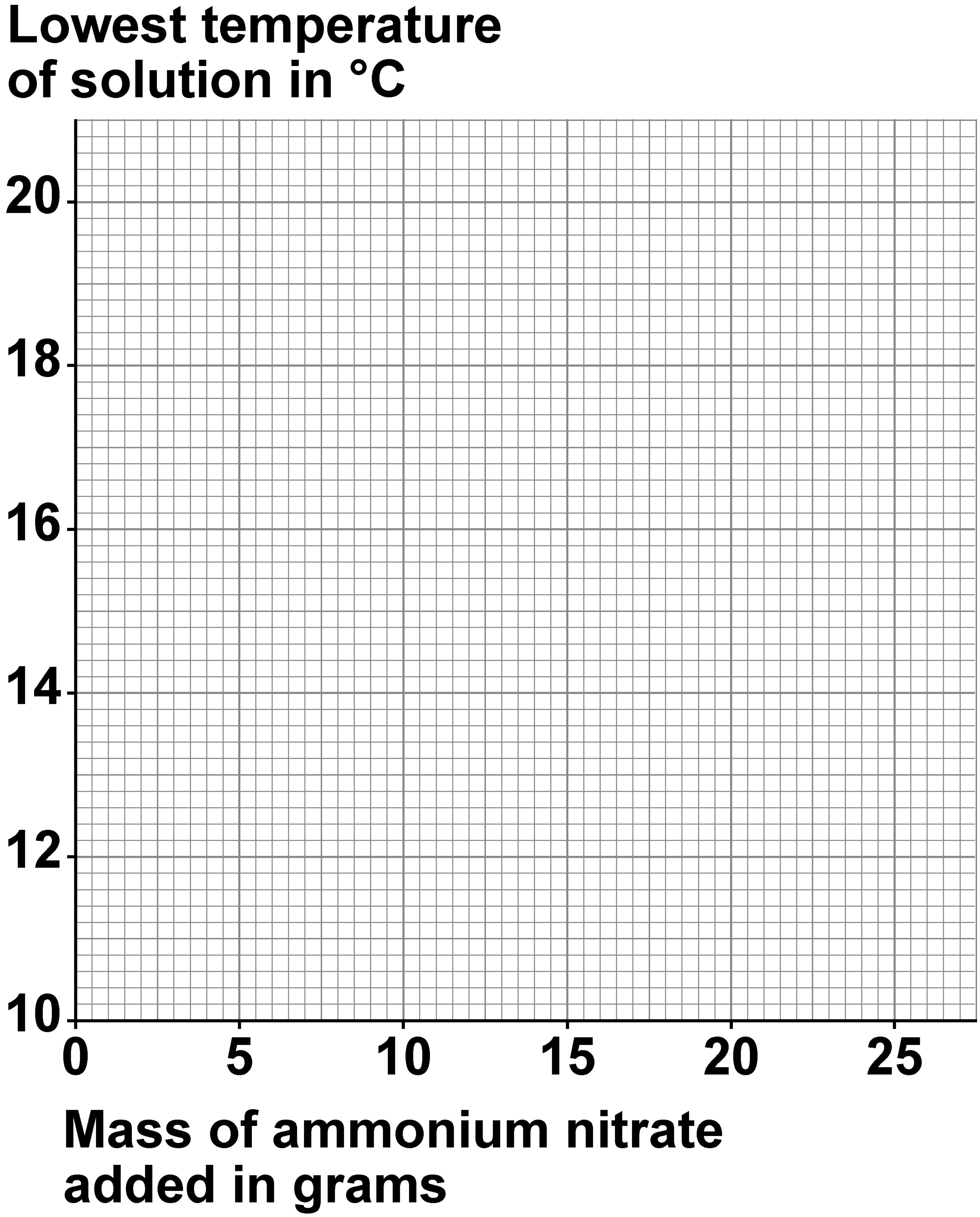
Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

1 0 . 2

Plot the data from TABLE 6 on FIGURE 11, on the opposite page.

Draw a line of best fit. [3 marks]

FIGURE 11



[Turn over]

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10.3

Determine the initial temperature of the water.

You should extend your line of best fit on FIGURE 11, on page 85. [2 marks]

Initial temperature of the water =

________________________ °C

10.4

How do the results show that dissolving ammonium nitrate in water is endothermic? [1 mark]

____

____

____

The student repeated the experiment three more times.

TABLE 7 shows the results for 8.0 g of ammonium nitrate.

TABLE 7

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in °C	16.2	16.6	16.8	16.4	16.5

1 0 . 5

The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 °C.

Explain why the student included ± 0.3 °C after the mean lowest temperature. [2 marks]

BLANK PAGE

10.6

What type of error is shown by the results in TABLE 7, on page 88?
[1 mark]

Tick (✓) ONE box.

- [ ] **Random error**
- [ ] **Systematic error**
- [ ] **Zero error**

[Turn over]

/11

1 1

This question is about making a soluble salt.

1 1 . 1

Plan a method to make pure, dry crystals of zinc chloride from zinc carbonate and a dilute acid. [6 marks]

11.2

Name TWO other substances that can each be reacted with a dilute acid to make zinc chloride.

Do NOT refer to zinc carbonate in your answer. [2 marks]

1 ____

2 ____

8

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.

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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