



Surname \_\_\_\_\_

Other Names \_\_\_\_\_

Centre Number \_\_\_\_\_

Candidate Number \_\_\_\_\_

Candidate Signature \_\_\_\_\_

I declare this is my own work.

**GCSE**  
**COMBINED SCIENCE: SYNERGY**  
**8465/3F**

**F**

**Foundation Tier**

**Paper 3 Physical Sciences**

**Time allowed: 1 hour 45 minutes**

**MATERIALS**

**For this paper you must have:**

- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- the Physics Equations Sheet (enclosed).

**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 1 8 4 6 5 3 F 0 1

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## 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**

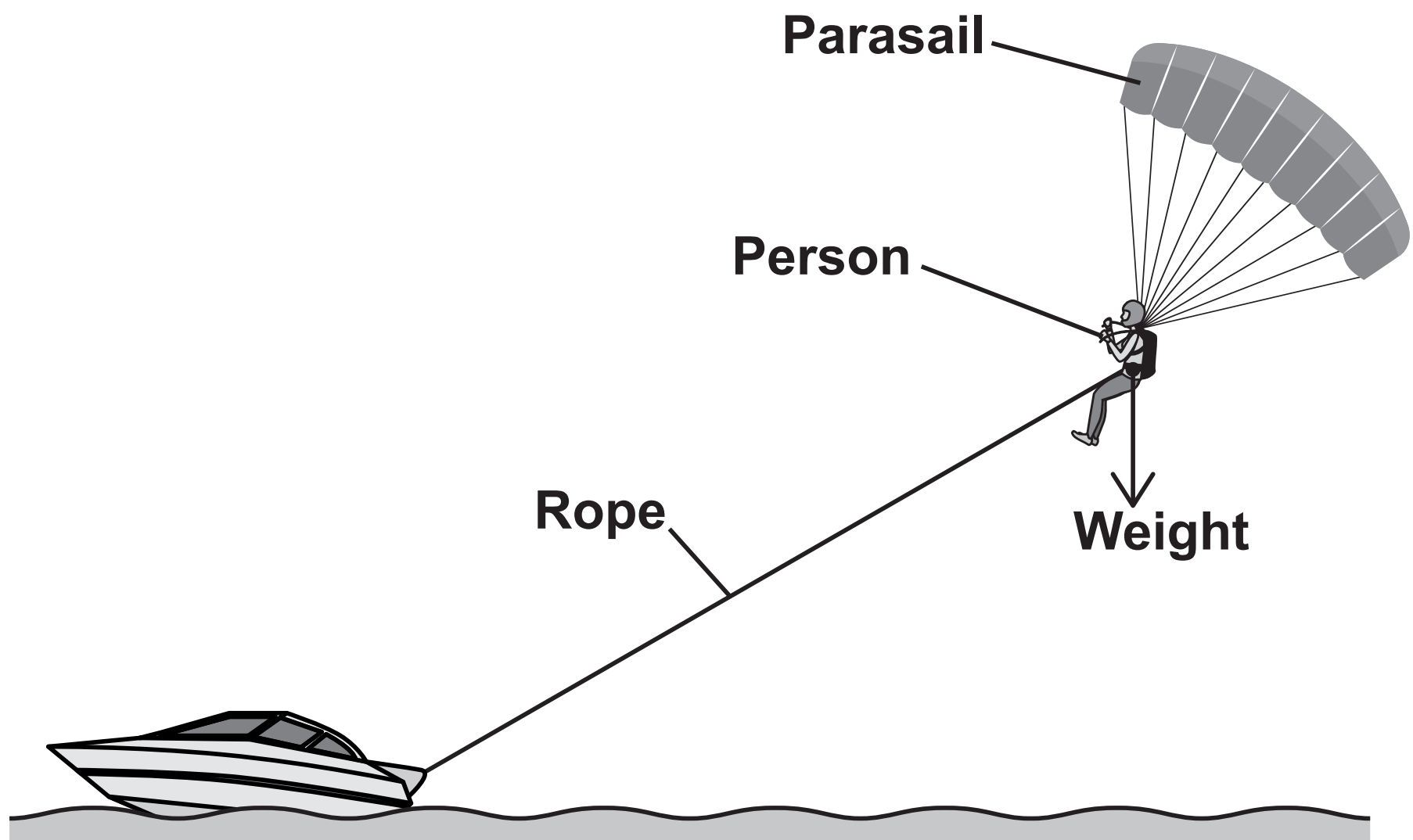


|   |   |
|---|---|
| 0 | 1 |
|---|---|

**FIGURE 1** shows a boat pulling a person parasailing.

A rope attaches the person to the boat.

**FIGURE 1**



|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 1 |
|---|---|---|---|

**What type of force is the weight? [1 mark]**

**Tick (✓) ONE box.**

☐

**Contact force**

☐

**Magnetic force**

☐

**Non-contact force**



0 1 . 2

The mass of the person is 75 kg.

Calculate the weight of the person.

gravitational field strength = 9.8 N/kg

Use the equation:

weight = mass  $\times$  gravitational field strength

[2 marks]

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Weight = \_\_\_\_\_ N

[Turn over]



01 . 3

The resultant force acting on the person is zero.

Which of the following describes the motion of the person? [1 mark]

Tick (✓) ONE box.

☐

Velocity decreasing

☐

Moving at constant velocity

☐

Velocity increasing



|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 4 |
|---|---|---|---|

The horizontal force on the person is 4300 N.

Calculate the work done by this force in moving the person a horizontal distance of 500 m.

Use the equation:

work done = force  $\times$  distance

Choose the unit from the list. [3 marks]

joules

metres/second

watts

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Work done = \_\_\_\_\_

Unit \_\_\_\_\_

[Turn over]



**01 . 5**

**The speed of the boat changes.**

**The height of the person above the water decreases by 18 m.**

**Calculate the decrease in gravitational potential energy of the person.**

**mass of person = 75 kg**

**gravitational field strength = 9.8 N/kg**

**Use the equation:**

**gravitational potential energy = mass**

**× gravitational field strength × height**

**[2 marks]**

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**Decrease in gravitational**

**potential energy = \_\_\_\_\_ J**



|   |   |
|---|---|
| 0 | 2 |
|---|---|

**This question is about reactions of metals.**

**A piece of magnesium reacts with dilute hydrochloric acid.**

**Magnesium chloride solution and a gas are produced.**

|   |   |   |   |
|---|---|---|---|
| 0 | 2 | . | 1 |
|---|---|---|---|

**Which gas is produced? [1 mark]**

**Tick (✓) ONE box.**

☐

**Chlorine**

☐

**Hydrogen**

☐

**Oxygen**

**[Turn over]**



**02 . 2**

**Give TWO observations seen during the reaction.  
[2 marks]**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**02 . 3**

**Magnesium chloride is formed from  $\text{Mg}^{2+}$  ions and  $\text{Cl}^-$  ions.**

**What is the formula of magnesium chloride? [1 mark]**

**Tick (✓) ONE box.**

☐**MgCl**☐**MgCl<sub>2</sub>**☐**Mg<sub>2</sub>Cl**☐**Mg<sub>2</sub>Cl<sub>2</sub>**

0 2 . 4

Calcium is in the same group as magnesium in the periodic table.

What is the symbol for a calcium ion? [1 mark]

Tick (✓) ONE box.

☐

Ca<sup>+</sup>

☐

Ca<sup>-</sup>

☐

Ca<sup>2+</sup>

☐

Ca<sup>2-</sup>

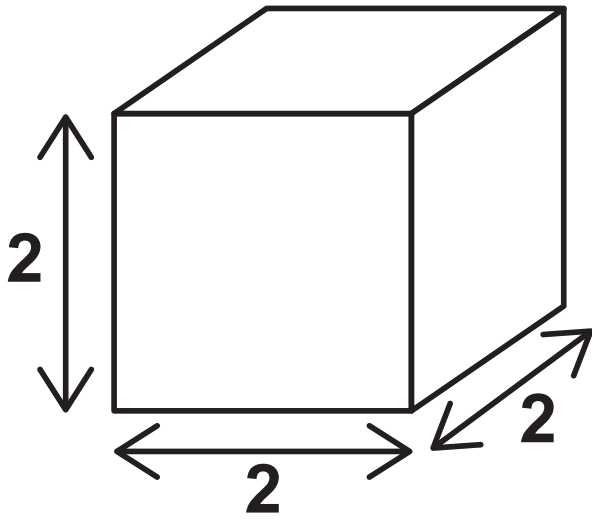
[Turn over]



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| 0 | 2 | . | 5 |
|---|---|---|---|

**FIGURE 2** shows a cube of calcium.

**FIGURE 2**



How would you calculate the total surface area of this cube? [1 mark]

Tick (✓) **ONE** box.

☐

**Total surface area =  $2 \times 2 \times 2$**

☐

**Total surface area =  $2 \times 2 \times 4$**

☐

**Total surface area =  $2 \times 2 \times 6$**

☐

**Total surface area =  $2 \times 4 \times 6$**



|   |   |   |   |
|---|---|---|---|
| 0 | 2 | . | 6 |
|---|---|---|---|

**Complete the sentence.**

**Choose the answer from the list. [1 mark]**

**decreases                      stays the same                      increases**

**When a cube of calcium is cut into smaller pieces the  
total surface area \_\_\_\_\_ .**

**A teacher investigated the reaction between calcium and  
water.**

**The teacher used the same mass of three different forms  
of calcium.**

**The different forms of calcium were:**

- **powder**
- **small lumps**
- **large lumps.**

**The teacher measured the time for each reaction to be  
complete.**

**[Turn over]**



**0 2 . 7**

**What is the independent variable in the investigation?**  
**[1 mark]**

**Tick (✓) ONE box.**

☐

**Form of calcium**

☐

**Mass of calcium**

☐

**Time for reaction to be complete**

**0 2 . 8**

**What is the independent variable in the investigation?**  
**[1 mark]**

**Tick (✓) ONE box.**

☐

**Powder**

☐

**Small lumps**

☐

**Large lumps**



02 . 9

Which is the best way to display the results for the three different forms of calcium? [1 mark]

Tick (✓) ONE box.

☐

Bar chart

☐

Line graph

☐

Pie chart

|    |
|----|
|    |
| 10 |

[Turn over]

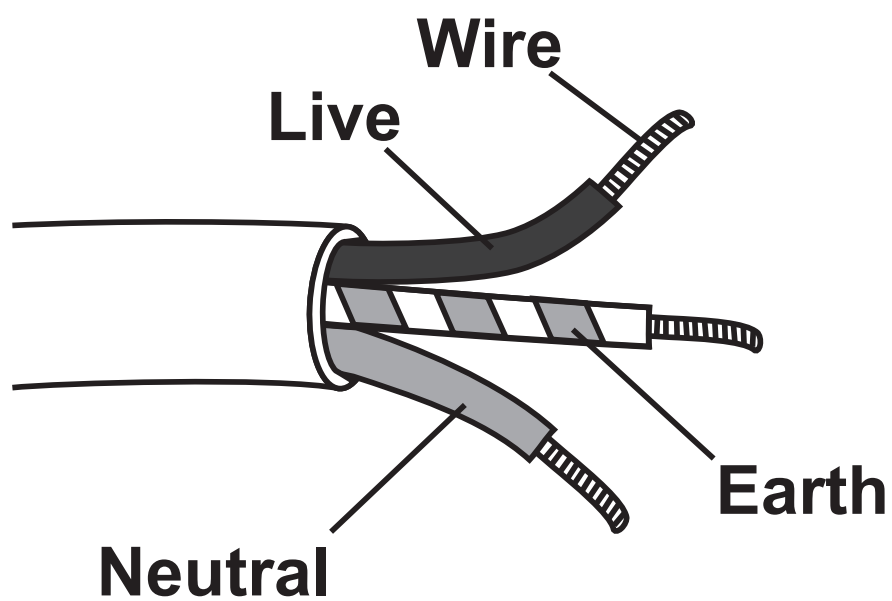


|   |   |
|---|---|
| 0 | 3 |
|---|---|

An oven is connected to the mains electricity supply using a three-core cable.

FIGURE 3 shows the three-core cable.

FIGURE 3



|   |   |   |   |
|---|---|---|---|
| 0 | 3 | . | 1 |
|---|---|---|---|

The insulation covering the earth wire has green and yellow stripes.

Give the colours of the insulation covering the live wire and the neutral wire. [2 marks]

Live wire \_\_\_\_\_

Neutral wire \_\_\_\_\_



A thermistor is used as part of a temperature sensor in the oven.

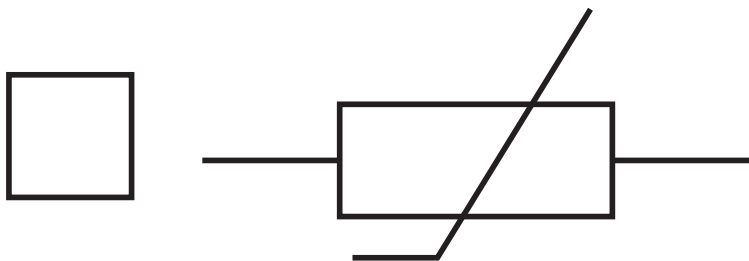
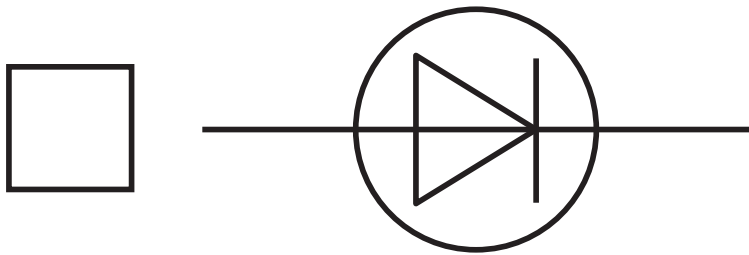
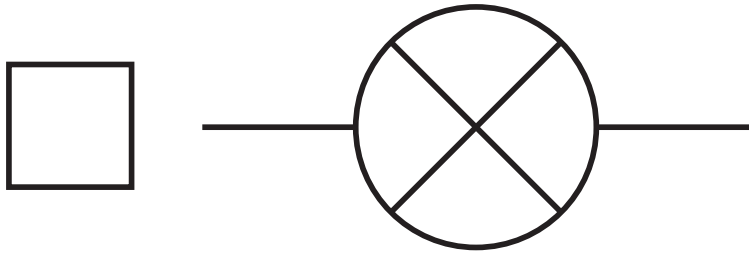
|   |   |
|---|---|
| 0 | 3 |
|---|---|

 . 

|   |
|---|
| 2 |
|---|

What is the circuit symbol for a thermistor? [1 mark]

Tick (✓) ONE box.



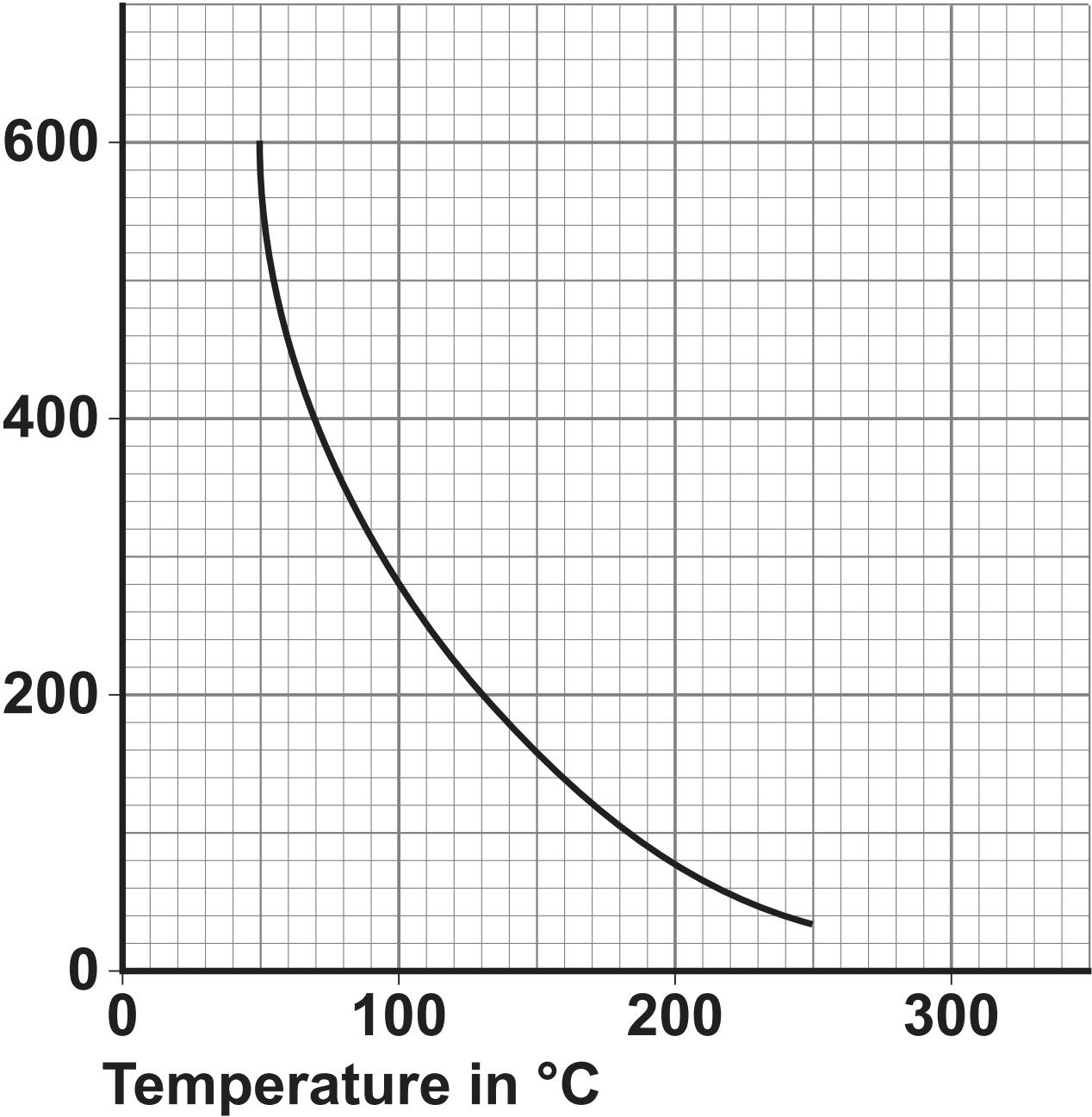
[Turn over]



FIGURE 4 shows how the resistance of the thermistor in the oven varies with temperature.

FIGURE 4

Resistance  
in ohms



**03 . 3**

**Which statement describes the relationship shown in FIGURE 4? [1 mark]**

**Tick (✓) ONE box.**

☐

**As temperature increases, resistance decreases.**

☐

**As temperature increases, resistance stays the same.**

☐

**As temperature increases, resistance increases.**

**03 . 4**

**Which temperature range shows the greatest decrease in the resistance of the thermistor? [1 mark]**

**Tick (✓) ONE box.**

☐

**Between 50 and 100 °C**

☐

**Between 100 and 150 °C**

☐

**Between 150 and 200 °C**

☐

**Between 200 and 250 °C**

**[Turn over]**



|   |   |   |   |
|---|---|---|---|
| 0 | 3 | . | 5 |
|---|---|---|---|

The resistance of the heating element in the oven is  $5.0\ \Omega$ .

The current in the heating element is  $12\ \text{A}$ .

Calculate the power output of the heating element.

Use the equation:

$$\text{power} = (\text{current})^2 \times \text{resistance}$$

[2 marks]

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Power = \_\_\_\_\_ W



|   |   |   |   |
|---|---|---|---|
| 0 | 3 | . | 6 |
|---|---|---|---|

Calculate the energy transferred by the oven when 8000 C of charge flows through the heating element.

The potential difference across the heating element is 230 V.

Use the equation:

energy transferred = charge flow  $\times$  potential difference

[2 marks]

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Energy transferred = \_\_\_\_\_ J

[Turn over]



03 . 7

An LED on the oven is connected to an alternating current supply.

When the supply is switched on, the LED flashes on and off continuously.

Explain why. [2 marks]

11



|   |   |
|---|---|
| 0 | 4 |
|---|---|

This question is about hydrocarbons.

Methane is a hydrocarbon.

The formula of methane is CH<sub>4</sub>

|   |   |   |   |
|---|---|---|---|
| 0 | 4 | . | 1 |
|---|---|---|---|

Name the TWO elements in methane. [2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

|   |   |   |   |
|---|---|---|---|
| 0 | 4 | . | 2 |
|---|---|---|---|

Complete FIGURE 5 to show the structure of a methane (CH<sub>4</sub>) molecule. [1 mark]

FIGURE 5

H – C

[Turn over]



04 . 3

What is the type of bonding in methane? [2 marks]

Tick (✓) ONE box.

☐

Covalent

☐

Ionic

☐

Metallic

04 . 4

Calculate the percentage by mass of element C in a  $\text{CH}_4$  molecule.

Relative atomic mass ( $A_r$ ): C = 12

Relative formula mass ( $M_r$ ):  $\text{CH}_4$  = 16

[2 marks]

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Percentage of C = \_\_\_\_\_ %



Cracking breaks down hydrocarbons into smaller molecules.

0 4 . 5

Name ONE method of cracking. [1 mark]

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$C_{13}H_{28}$  is a hydrocarbon.

0 4 . 6

$C_{13}H_{28}$  is cracked to produce  $C_8H_{18}$  and another product.

Complete the equation for the reaction. [1 mark]



[Turn over]



04 . 7

$\text{C}_8\text{H}_{18}$  and  $\text{C}_{13}\text{H}_{28}$  are both alkanes.

$\text{C}_8\text{H}_{18}$  is a smaller molecule than  $\text{C}_{13}\text{H}_{28}$

Give ONE use of alkanes that have small molecules.  
[1 mark]

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04 . 8

Cracking also produces alkenes.

Ethene is an alkene.

What is the formula of ethene? [1 mark]

Tick (✓) ONE box.

☐ $\text{C}_2\text{H}_4$ ☐ $\text{C}_2\text{H}_6$ ☐ $\text{C}_3\text{H}_6$ ☐ $\text{C}_3\text{H}_8$ 

04 . 9

Complete the sentence. [1 mark]

Ethene molecules join together to form a long-chain

molecule called \_\_\_\_\_ .



05

A life cycle assessment (LCA) is done to assess the environmental impact of a product.

05 . 1

An LCA has four stages.

Draw ONE line from each LCA stage to the description of what happens to the product at that stage. [3 marks]

LCA STAGE

DESCRIPTION

Stage 1

Disposal at end of useful life

Stage 2

Extracting and processing raw materials

Stage 3

Manufacturing and packaging

Stage 4

Use and operation during lifetime

[Turn over]



**05 . 2**

**Some information in an LCA is estimated.**

**This means that false claims may be made.**

**What is done to check the estimated information in an LCA? [1 mark]**

**Tick (✓) ONE box.**

☐

**Drawing graphs**

☐

**Making hypotheses**

☐

**Peer review**



A student has a cotton shirt.

TABLE 1 shows the percentage of the total water used at each stage in the LCA for the cotton shirt.

TABLE 1

| STAGE                                   | Percentage of total water used (%) |
|-----------------------------------------|------------------------------------|
| Disposal at end of useful life          | 1                                  |
| Extracting and processing raw materials | 22                                 |
| Manufacturing and packaging             | X                                  |
| Use and operation during lifetime       | 71                                 |

05 . 3

Calculate value X in TABLE 1. [1 mark]

X = \_\_\_\_\_ %

[Turn over]

05 . 4

The use and operation stage of the LCA uses 71% of the total water used.

Suggest the main use of water during this stage.  
[1 mark]

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05 . 5

Give TWO factors that need to be considered at the manufacturing and packaging stage of the LCA for the cotton shirt.

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

1

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2

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05 . 6

The student grows taller and the cotton shirt no longer fits the student.

Suggest how the student can reduce the impact of the cotton shirt on the environment.

Give ONE reason why this reduces the impact on the environment. [2 marks]

Suggestion \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Reason \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

|    |
|----|
|    |
| 10 |

[Turn over]



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|   |   |
|---|---|
| 0 | 6 |
|---|---|

A scalar quantity has size, but no direction.

|   |   |   |   |
|---|---|---|---|
| 0 | 6 | . | 1 |
|---|---|---|---|

Distance is a scalar quantity.

Which of the following is a scalar quantity? [1 mark]

Tick (✓) ONE box.

☐

Acceleration

☐

Speed

☐

Velocity

☐

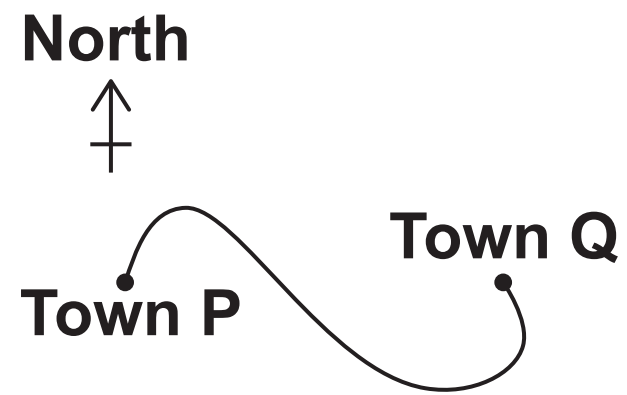
Weight

[Turn over]



**FIGURE 6** shows the route a car travelled from town P to town Q.

**FIGURE 6**



**Scale**



**1 cm represents 10 km**

**The displacement of the car is the straight-line distance from town P to town Q.**

0 6 . 2

Determine the displacement of the car when the car has travelled from town P to town Q.

Include the direction from north. [3 marks]

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Displacement = \_\_\_\_\_ km

Direction from north = \_\_\_\_\_ °

[Turn over]



06 . 3

At one point in the journey the car had an acceleration of 0.12 m/s<sup>2</sup>.

The car has a mass of 800 kg.

Calculate the resultant force on the car.

Use the equation:

resultant force = mass × acceleration

[2 marks]

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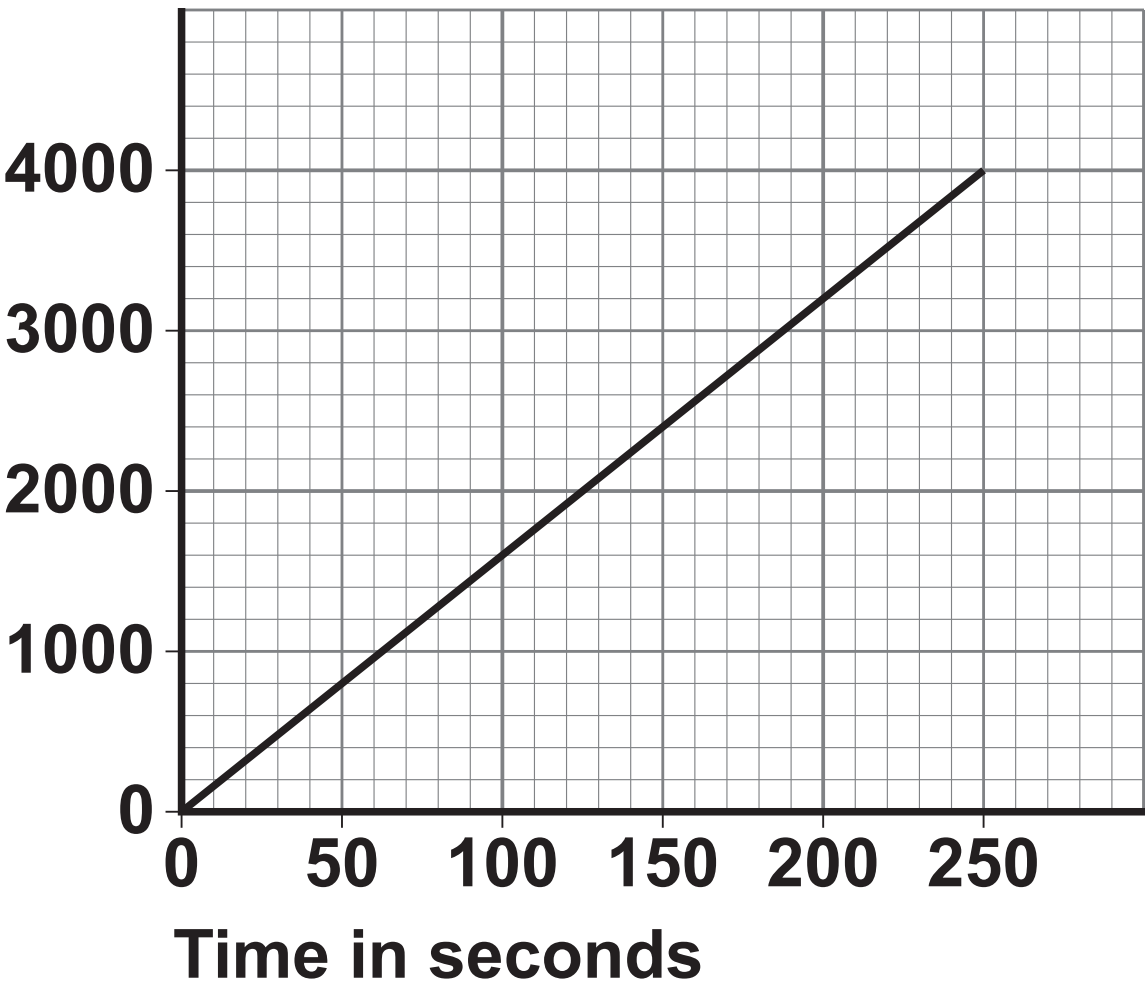
Resultant force = \_\_\_\_\_ N

06.4

FIGURE 7 shows a distance-time graph for a different part of the car’s journey.

FIGURE 7

Distance  
in metres



Determine the speed of the car. [2 marks]

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Speed = \_\_\_\_\_ m/s

8

[Turn over]



|   |   |
|---|---|
| 0 | 7 |
|---|---|

This question is about substances found in the Earth's crust.

|   |   |   |   |
|---|---|---|---|
| 0 | 7 | . | 1 |
|---|---|---|---|

Aluminium silicate is a compound found in the Earth's crust.

The formula of aluminium silicate is  $\text{Al}_2\text{SiO}_5$

What is the total number of atoms in the formula  $\text{Al}_2\text{SiO}_5$ ? [1 mark]

Tick (✓) ONE box.

☐

3

☐

5

☐

7

☐

8



07 . 2

TABLE 2 shows the percentage of some elements found in the Earth’s crust.

TABLE 2

| ELEMENT   | Percentage in the Earth’s crust (%) |
|-----------|-------------------------------------|
| Aluminium | 8                                   |
| Iron      | 5                                   |
| Oxygen    | 47                                  |
| Silicon   | 28                                  |

Calculate the simplest whole number ratio for the percentage of silicon to the percentage of aluminium in the Earth’s crust. [2 marks]

Simplest whole number ratio for:

percentage of silicon : percentage of aluminium =

 : 

[Turn over]



Iron is found as iron oxide in the Earth's crust.

Iron can be extracted by heating iron oxide with carbon.

07 . 3

Why is iron oxide reacted with carbon to extract iron?  
[1 mark]

Tick (✓) ONE box.

☐

Iron is less reactive than carbon.

☐

Iron has the same reactivity as carbon.

☐

Iron is more reactive than carbon.



07 . 4

The word equation for the reaction to extract iron is:

iron oxide + carbon  $\longrightarrow$  iron + carbon dioxide

Which reactant is reduced? [1 mark]

Tick (✓) ONE box.

☐

Carbon

☐

Carbon dioxide

☐

Iron

☐

Iron oxide

07 . 5

The symbol equation for the reaction to extract iron is:

$2 \text{Fe}_2\text{O}_3 + 3 \text{C} \longrightarrow 4 \text{Fe} + \text{X CO}_2$

What is the value of X? [1 mark]

Tick (✓) ONE box.

☐

2

☐

3

☐

4

☐

5

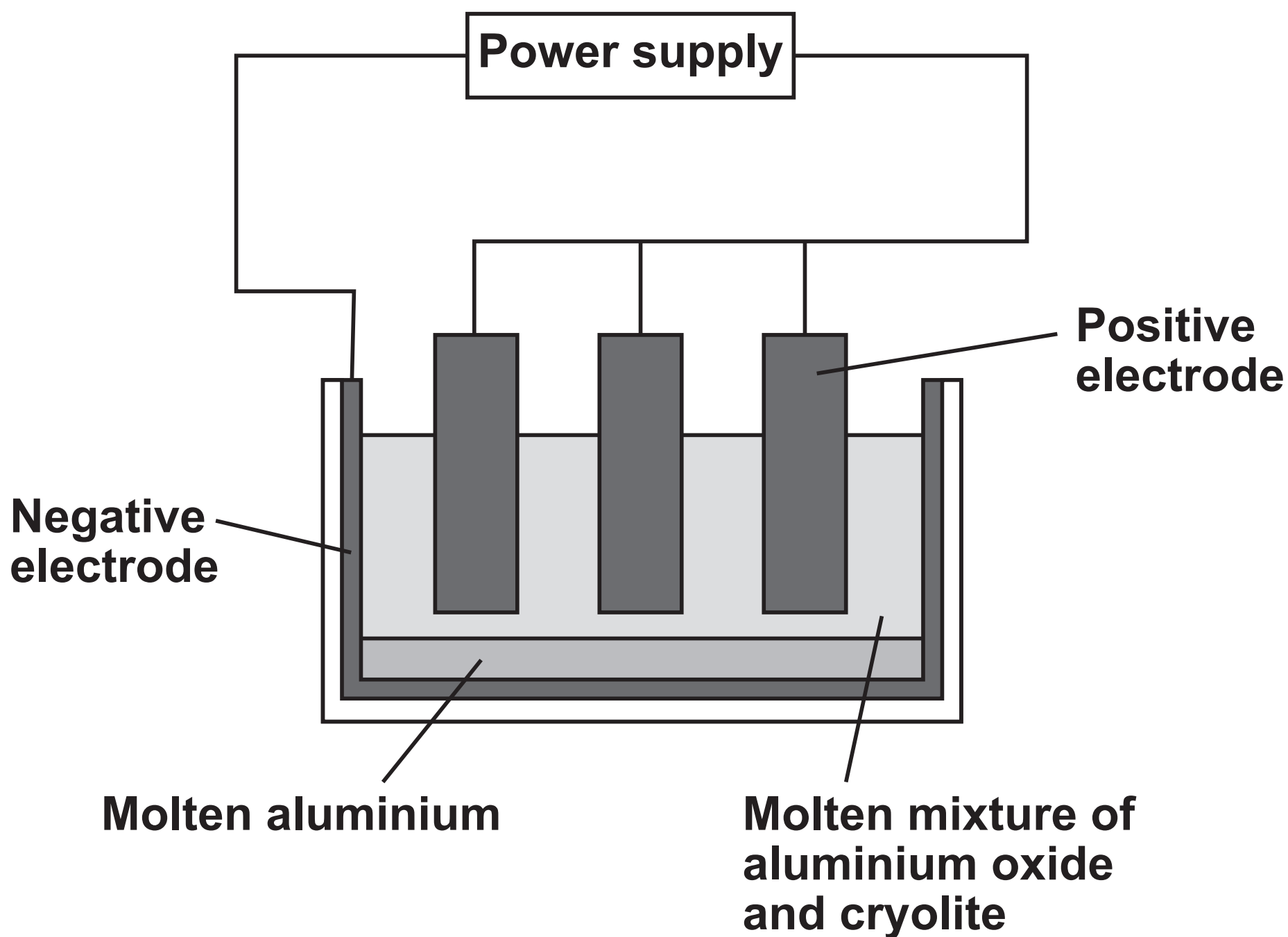
[Turn over]



Aluminium is found as aluminium oxide in the Earth's crust.

FIGURE 8 shows the apparatus used for the process to extract aluminium from aluminium oxide.

FIGURE 8



0 7 . 6

Name the process used to extract aluminium from aluminium oxide. [1 mark]

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07 . 7

What are the positive electrodes made of in this process?  
[1 mark]

Tick (✓) ONE box.

☐

Aluminium

☐

Carbon

☐

Copper

☐

Cryolite

07 . 8

Large amounts of energy are used in the process in  
FIGURE 8.

Give TWO ways energy is used in the process. [2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

[Turn over]

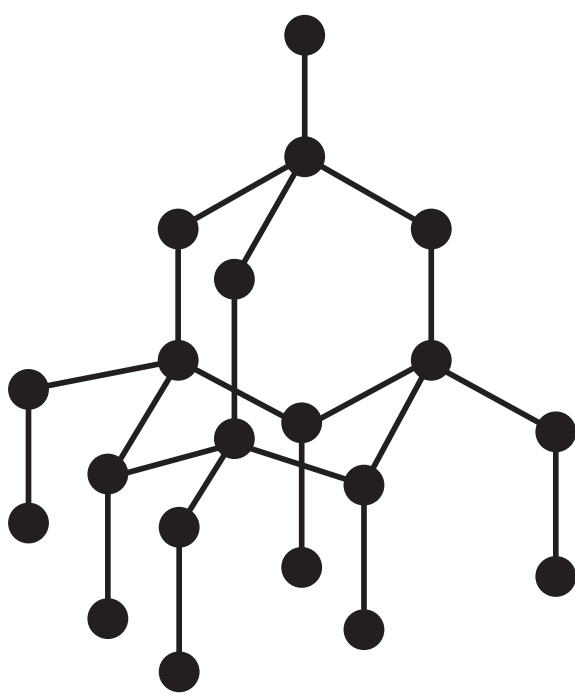


**07 . 9**

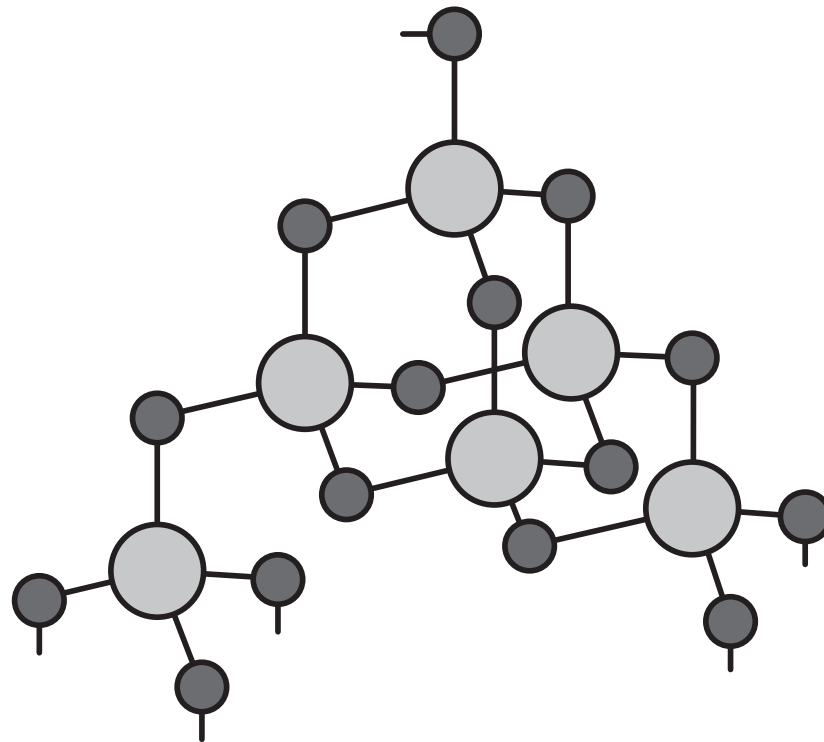
Diamond and silicon dioxide are also found in the Earth's crust.

FIGURE 9 represents the structure of diamond and the structure of silicon dioxide.

FIGURE 9



Diamond



Silicon dioxide

KEY

● C

● O

● Si



**Compare the structure and bonding of diamond with the structure and bonding of silicon dioxide. [4 marks]**

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4

**[Turn over]**



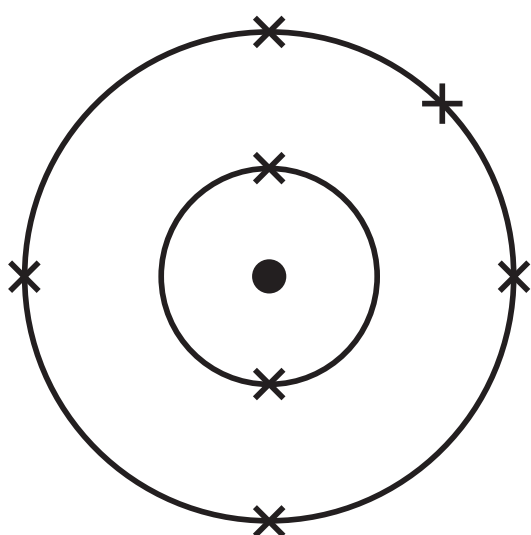
|   |   |
|---|---|
| 0 | 8 |
|---|---|

This question is about structure and bonding.

|   |   |   |   |
|---|---|---|---|
| 0 | 8 | . | 1 |
|---|---|---|---|

**FIGURE 10** represents the electronic structure of an atom of an element.

**FIGURE 10**



Name the element in **FIGURE 10**.

Give **ONE** reason for your answer.

Use the periodic table. [2 marks]

Element \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



Sodium reacts with fluorine to produce sodium fluoride.

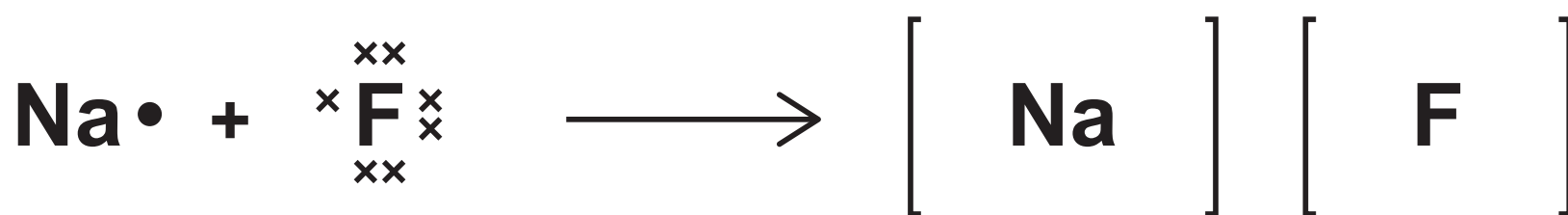
Sodium fluoride is an ionic compound.

0 8 . 2

An atom of sodium and an atom of fluorine react to form a sodium ion and a fluoride ion.

Complete the dot and cross diagram for the sodium ion and the fluoride ion.

Show the charges on the ions. [2 marks]



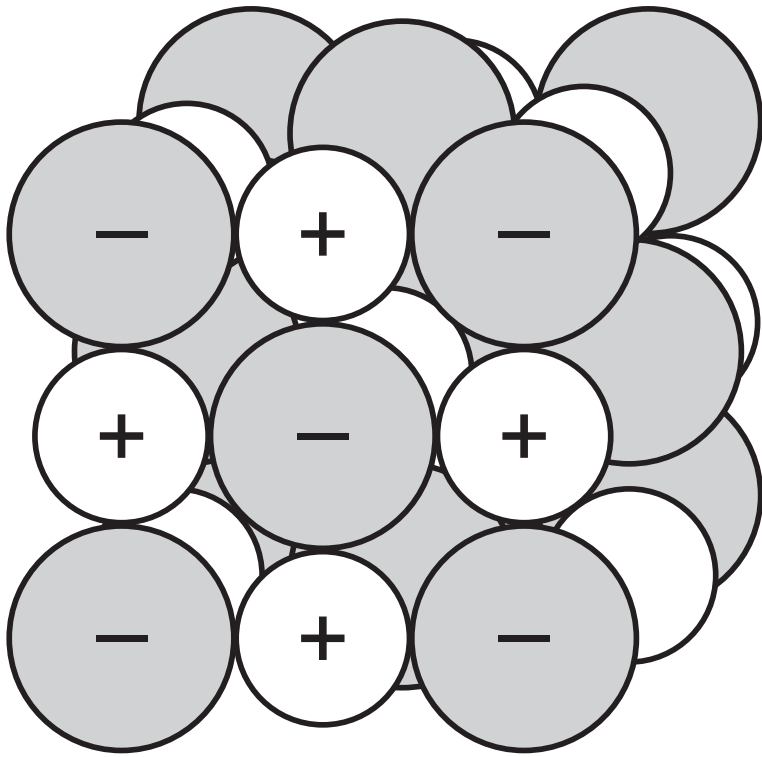
[Turn over]



|   |   |   |   |
|---|---|---|---|
| 0 | 8 | . | 3 |
|---|---|---|---|

**FIGURE 11** represents the structure of sodium fluoride.

**FIGURE 11**



**Describe how sodium ions and fluoride ions are held together in sodium fluoride. [3 marks]**

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|   |   |   |   |
|---|---|---|---|
| 0 | 8 | . | 4 |
|---|---|---|---|

What is a property of sodium fluoride? [1 mark]

Tick (✓) ONE box.

☐

Conducts electricity when solid

☐

High melting point

☐

Low boiling point

|   |
|---|
|   |
| 8 |

[Turn over]

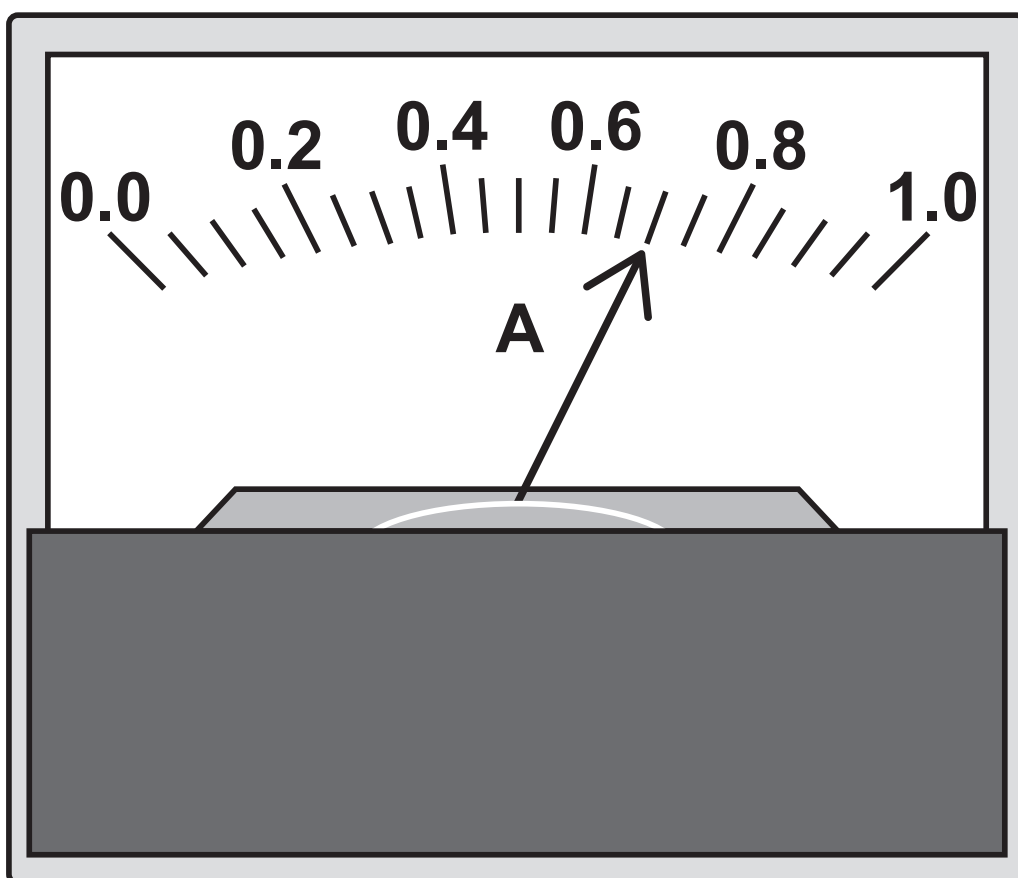


|   |   |
|---|---|
| 0 | 9 |
|---|---|

A student investigated how the resistance of a piece of wire varied with the length of the wire.

FIGURE 12 shows an ammeter the student could have used in the investigation.

FIGURE 12



|   |   |   |   |
|---|---|---|---|
| 0 | 9 | . | 1 |
|---|---|---|---|

What is the resolution of the ammeter? [1 mark]

Resolution = \_\_\_\_\_ A



**09 . 2**

**Which quantity must stay the same so the wire behaves as an ohmic conductor? [1 mark]**

**Tick (✓) ONE box.**

☐

**Air pressure**

☐

**Density of the wire**

☐

**Temperature of the wire**

**09 . 3**

**Write down the equation which links current ( $I$ ), potential difference ( $V$ ) and resistance ( $R$ ). [1 mark]**

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**[Turn over]**



0 9 . 4

For one length of wire the potential difference across the wire was 1.68 V.

The current in the wire was 0.70 A.

Calculate the resistance of this length of wire. [3 marks]

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Resistance = \_\_\_\_\_  $\Omega$

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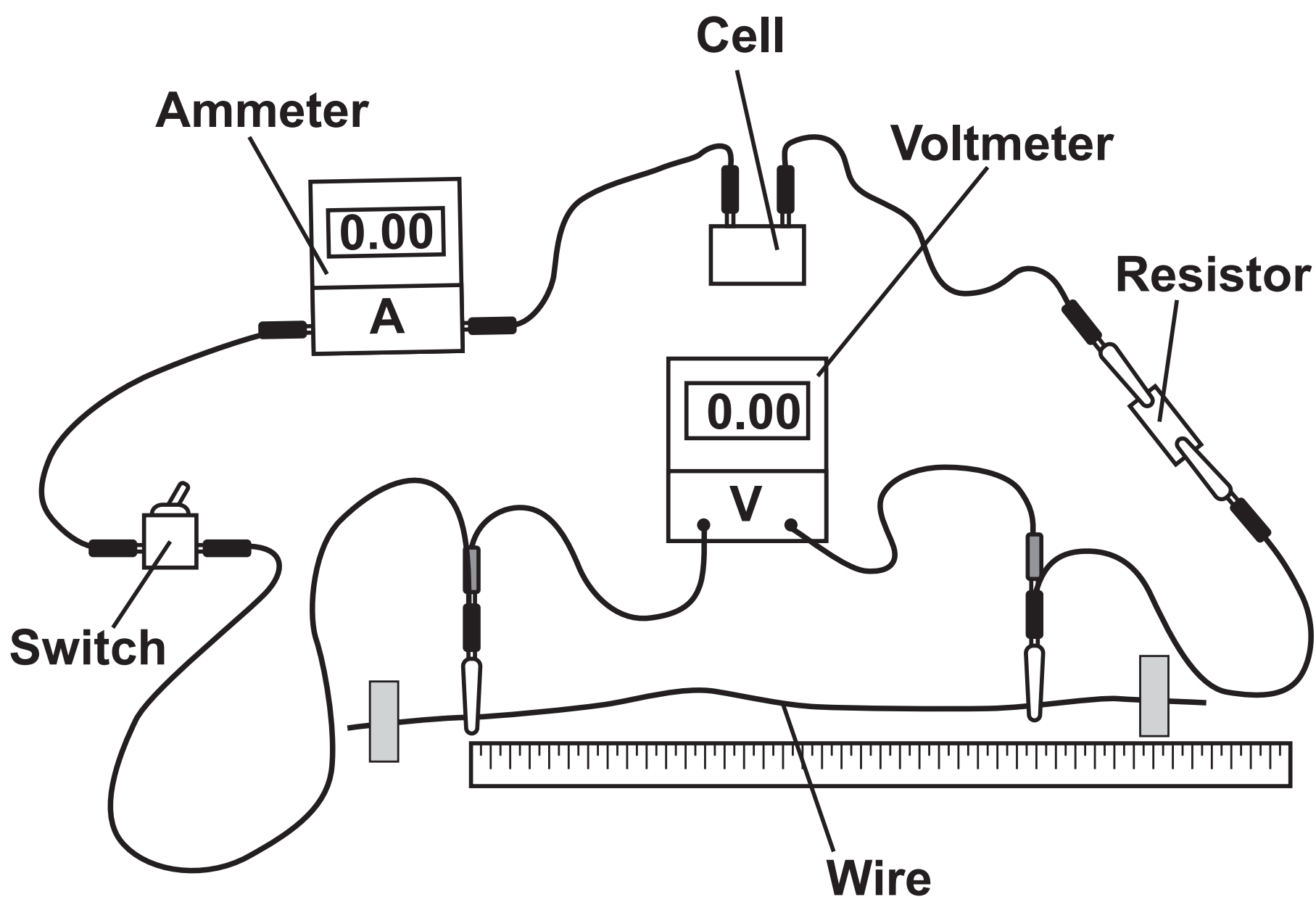
**[Turn over]**



09.5

FIGURE 13 shows the circuit used in the investigation.

FIGURE 13



The student plotted a graph of resistance against length of the wire.

Describe a method the student could use to obtain the data needed to plot the graph. [6 marks]

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|   |   |
|---|---|
| 1 | 0 |
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This question is about groups in the periodic table.

Neon and argon are Group 0 elements.

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What name is given to Group 0? [1 mark]

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Give ONE similarity of the electronic structure of neon and the electronic structure of argon. [1 mark]

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Give ONE difference between the electronic structure of neon and the electronic structure of argon. [1 mark]

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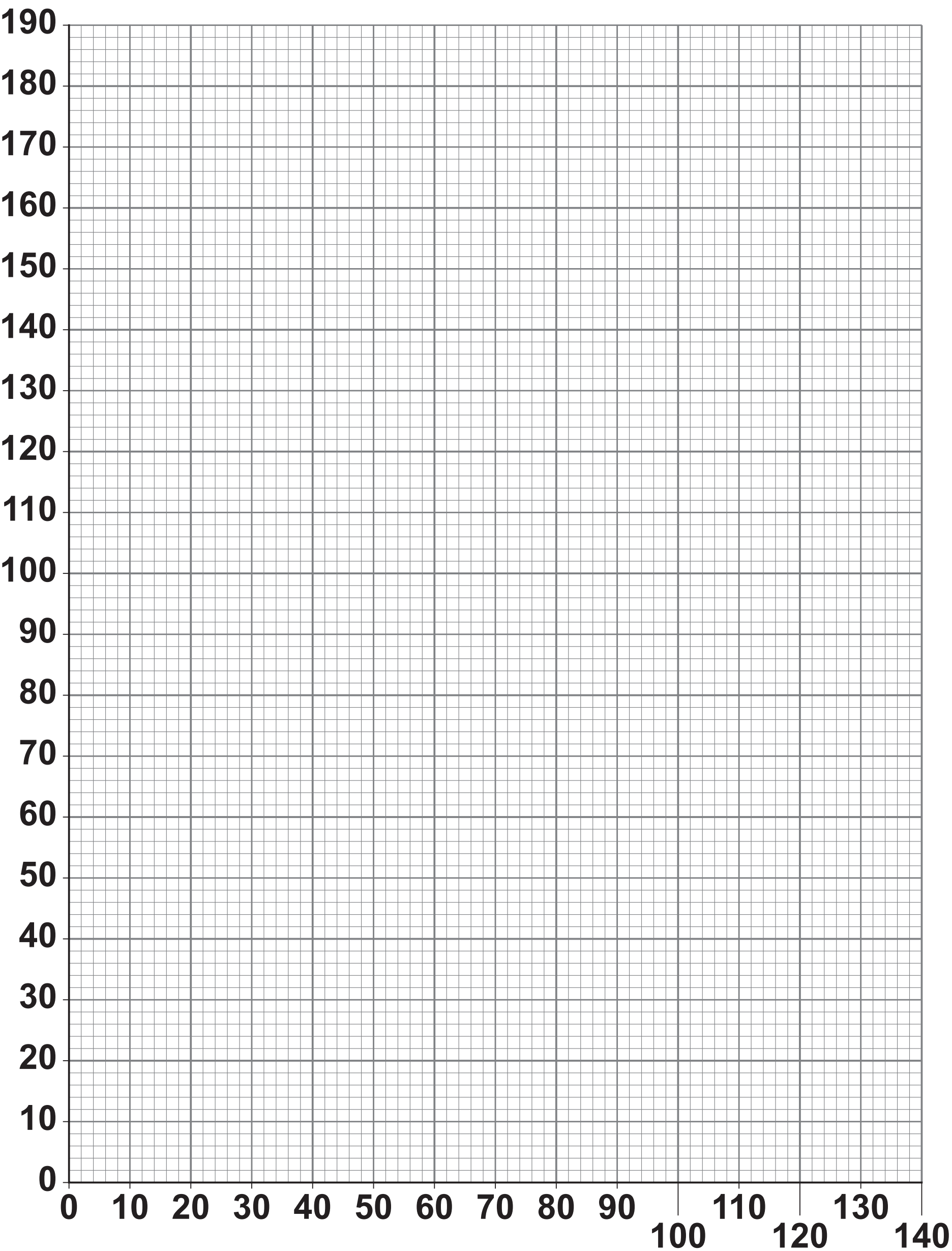


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**[Turn over]**



FIGURE 14



1 0 . 4

TABLE 3 shows information about elements in Group 1.

TABLE 3

| Element   | Relative atomic mass | Melting point in °C |
|-----------|----------------------|---------------------|
| Lithium   | 7                    | 181                 |
| Sodium    | 23                   | 98                  |
| Potassium | 39                   | 64                  |
| Rubidium  | 85                   | 39                  |
| Caesium   | 133                  | 29                  |

Complete FIGURE 14, on page 58.

You should:

- label both axes
- plot the data from TABLE 3.

[3 marks]

[Turn over]



10 . 5

Give ONE conclusion from the data in FIGURE 14 on page 58. [1 mark]

7

END OF QUESTIONS



**Additional page, if required.**

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