AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

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).

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

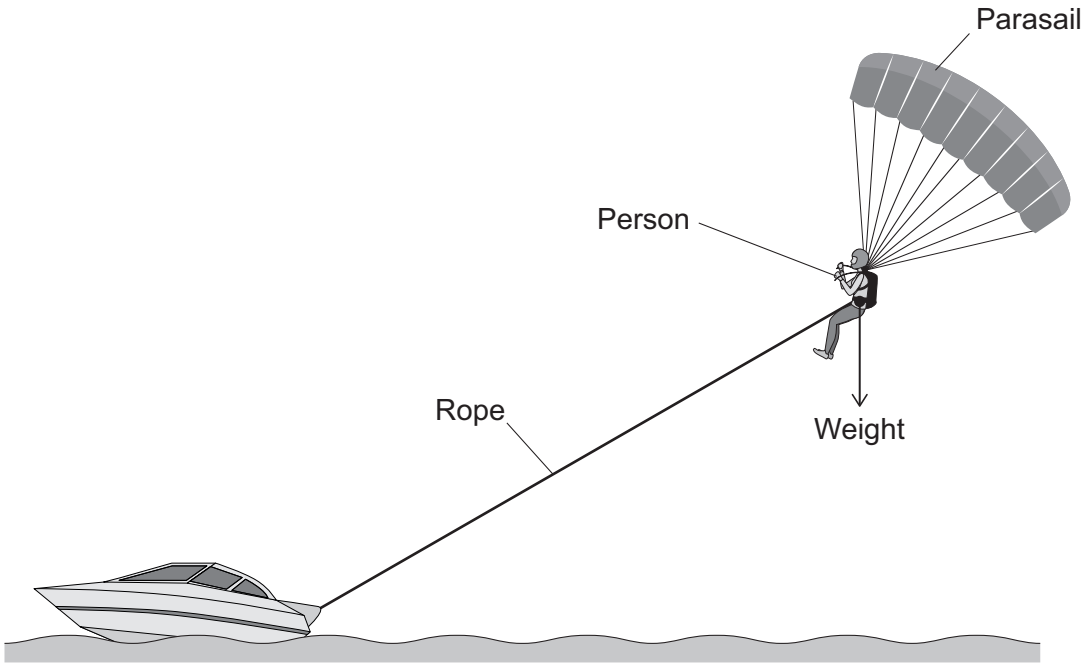
Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

Do not write outside the box

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 ☐

Do not write outside the box

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 × gravitational field strength

[2 marks]

_____

_____

_____

Weight = _____ N

0 1 . 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 ☐

Question 1 continues on the next page

Do not write outside the box

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 × distance

Choose the unit from the box.

[3 marks]

joules	**metres/second**	**watts**

Work done = _____

Unit _____

Do not write outside the box

0 1 . 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]

_____

_____

_____

Decrease in gravitational potential energy = _____ J

9

Turn over for the next question

Do not write outside the box

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 ☐

0 2 . 2 Give **two** observations seen during the reaction.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 2 . 3 Magnesium chloride is formed from Mg^{2+} ions and Cl^- ions.

What is the formula of magnesium chloride?

[1 mark]

Tick (✓) **one** box.

MgCl ☐ $MgCl_2$ ☐ Mg_2Cl ☐ Mg_2Cl_2 ☐

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.

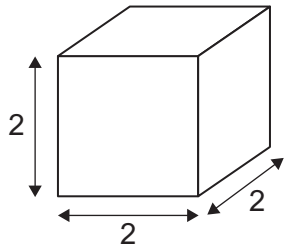
Ca^+ ☐ Ca^- ☐ Ca^{2+} ☐ Ca^{2-} ☐

Question 2 continues on the next page

Do not write outside the box

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 × 2 × 2 ☐

Total surface area = 2 × 2 × 4 ☐

Total surface area = 2 × 2 × 6 ☐

Total surface area = 2 × 4 × 6 ☐

0 2 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

When a cube of calcium is cut into smaller pieces the

total surface area _____ .

Do not write outside the box

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.

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 Which form of calcium will react the fastest?

[1 mark]

Tick (✓) **one** box.

Powder ☐

Small lumps ☐

Large lumps ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 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 ☐

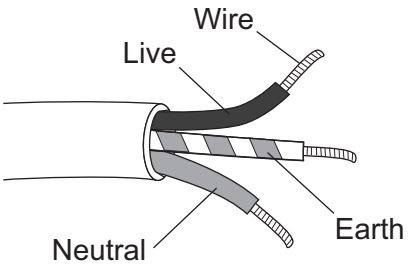
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0 3 An oven is connected to the mains electricity supply using a three-core cable.

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 _____

Question 3 continues on the next page

Do not write outside the box

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.

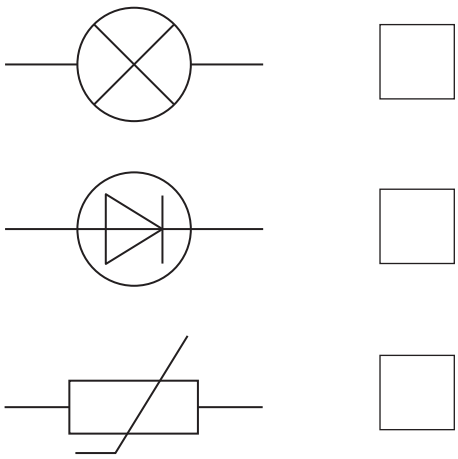
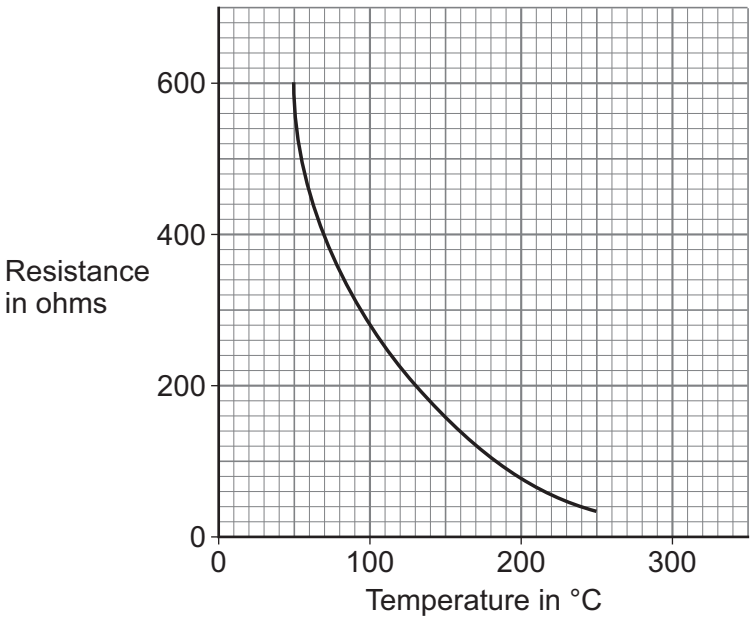


Figure 4 shows how the resistance of the thermistor in the oven varies with temperature.

Figure 4



Do not write outside the box

0 3 . 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. ☐

0 3 . 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 ☐

Question 3 continues on the next page

Do not write outside the box

0 3 . 5 The resistance of the heating element in the oven is 5.0 Ω.

The current in the heating element is 12 A.

Calculate the power output of the heating element.

Use the equation:

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

[2 marks]

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:

$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

[2 marks]

Energy transferred = _____ J

Do not write outside the box

0 3 . 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

Turn over for the next question

Do not write outside the box

0 4 This question is about hydrocarbons.

Methane is a hydrocarbon.

The formula of methane is CH_4

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_4) molecule.

[1 mark]

Figure 5

H – C

0 4 . 3 What is the type of bonding in methane?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

Do not write outside the box

0 4 . 4 Calculate the percentage by mass of element C in a CH_4 molecule.

Relative atomic mass (A_r): C = 12

Relative formula mass (M_r): CH_4 = 16

[2 marks]

Percentage of C = _____ %

Cracking breaks down hydrocarbons into smaller molecules.

0 4 . 5 Name **one** method of cracking.

[1 mark]

$C_{13}H_{28}$ 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]

$$C_{13}H_{28} \longrightarrow C_8H_{18} + C___ H___$$

Question 4 continues on the next page

Do not write outside the box

0 4 . 7 C_8H_{18} and $C_{13}H_{28}$ are both alkanes.

C_8H_{18} is a smaller molecule than $C_{13}H_{28}$

Give **one** use of alkanes that have small molecules.

[1 mark]

_____

_____

0 4 . 8 Cracking also produces alkenes.

Ethene is an alkene.

What is the formula of ethene?

[1 mark]

Tick (✓) **one** box.

C_2H_4 ☐ C_2H_6 ☐ C_3H_6 ☐ C_3H_8 ☐

0 4 . 9 Complete the sentence.

[1 mark]

Ethene molecules join together to form a long-chain molecule

called _____ .

11

Do not write outside the box

0 5 A life cycle assessment (LCA) is done to assess the environmental impact of a product.

0 5 . 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

0 5 . 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 ☐

Question 5 continues on the next page

Do not write outside the box

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

0 5 . 3 Calculate value **X** in **Table 1**.

[1 mark]

_____

_____

X = _____ %

0 5 . 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]

_____

_____

Do not write outside the box

0 5 . 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 _____

_____

2 _____

_____

0 5 . 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 for the next question

Do not write outside the box

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 ☐

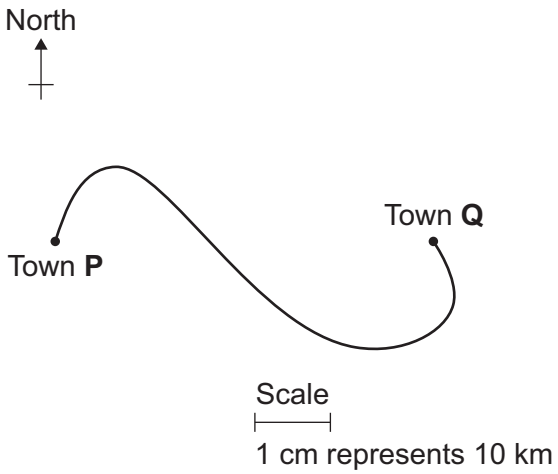
Velocity ☐

Weight ☐

Do not write outside the box

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

Figure 6



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]

Displacement = _____ km

Direction from north = _____ °

Question 6 continues on the next page

Do not write outside the box

0 6 . 3 At one point in the journey the car had an acceleration of 0.12 m/s^2.

The car has a mass of 800 kg.

Calculate the resultant force on the car.

Use the equation:

resultant force = mass × acceleration

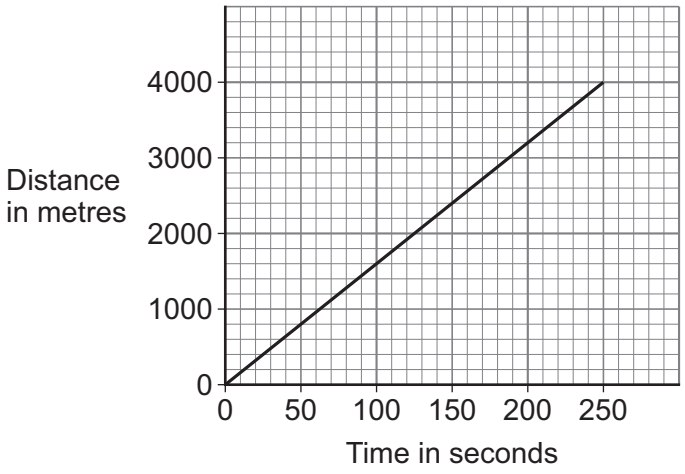
[2 marks]

Resultant force = _____ N

Do not write outside the box

0 6 . 4 **Figure 7** shows a distance-time graph for a different part of the car's journey.

Figure 7



Determine the speed of the car.

[2 marks]

_____

_____

_____

Speed = _____ m/s

8

Turn over for the next question

Do not write outside the box

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 Al_2SiO_5

What is the total number of atoms in the formula Al_2SiO_5?

[1 mark]

Tick (✓) **one** box.

3 ☐ 5 ☐ 7 ☐ 8 ☐

Do not write outside the box

0 7 . 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 = _____ : _____

Question 7 continues on the next page

Do not write outside the box

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

Iron can be extracted by heating iron oxide with carbon.

0 7 . 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. ☐

0 7 . 4 The word equation for the reaction to extract iron is:

iron oxide + carbon ⟶ iron + carbon dioxide

Which reactant is reduced?

[1 mark]

Tick (✓) **one** box.

Carbon ☐

Carbon dioxide ☐

Iron ☐

Iron oxide ☐

Do not write outside the box

0 7 . 5 The symbol equation for the reaction to extract iron is:

$$2Fe_2O_3 + 3C \longrightarrow 4Fe + \mathbf{X}CO_2$$

What is the value of **X**?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 5 ☐

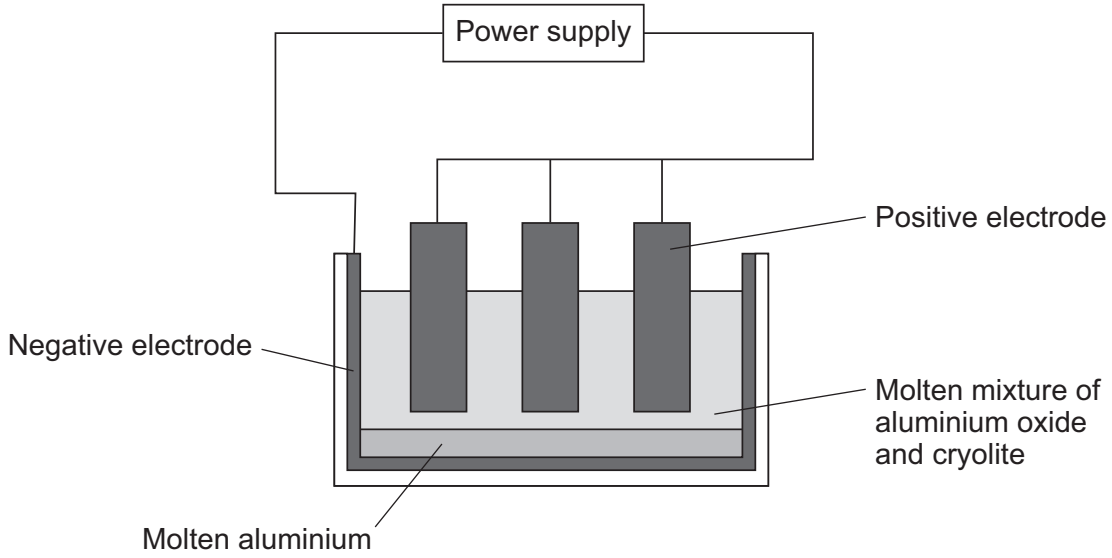
Question 7 continues on the next page

Do not write outside the box

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]

Do not write outside the box

0 7 . 7 What are the positive electrodes made of in this process?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Carbon ☐

Copper ☐

Cryolite ☐

0 7 . 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 _____

_____

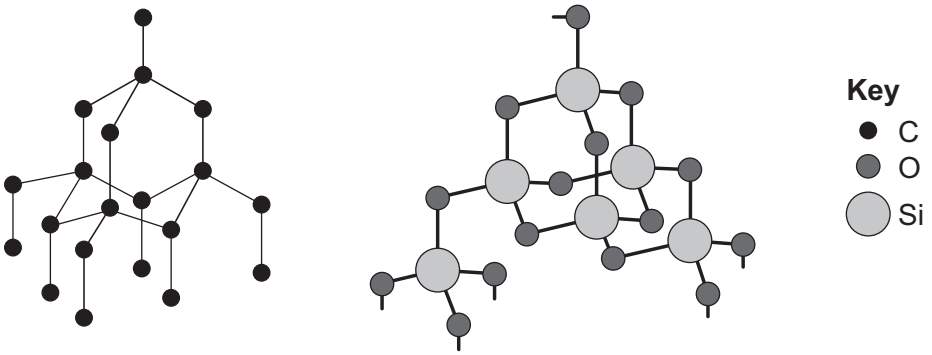
Question 7 continues on the next page

Do not write outside the box

0 7 . 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

Compare the structure and bonding of diamond with the structure and bonding of silicon dioxide.

[4 marks]

14

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Turn over for the next question

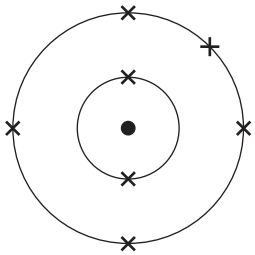
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ANSWER IN THE SPACES PROVIDED

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0 8 This question is about 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.

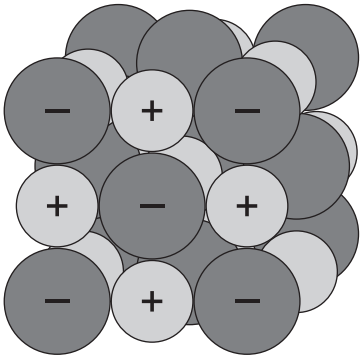
[2 marks]



Do not write outside the box

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]

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 ☐

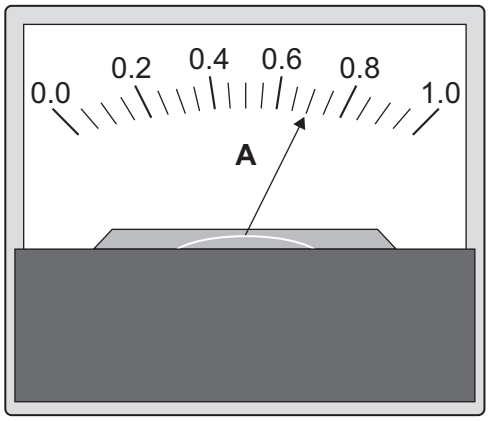
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Do not write outside the box

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

0 9 . 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 ☐

Do not write outside the box

0 9 . 3 Write down the equation which links current (I), potential difference (V) and resistance (R).

[1 mark]

_____

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]

_____

_____

_____

_____

_____

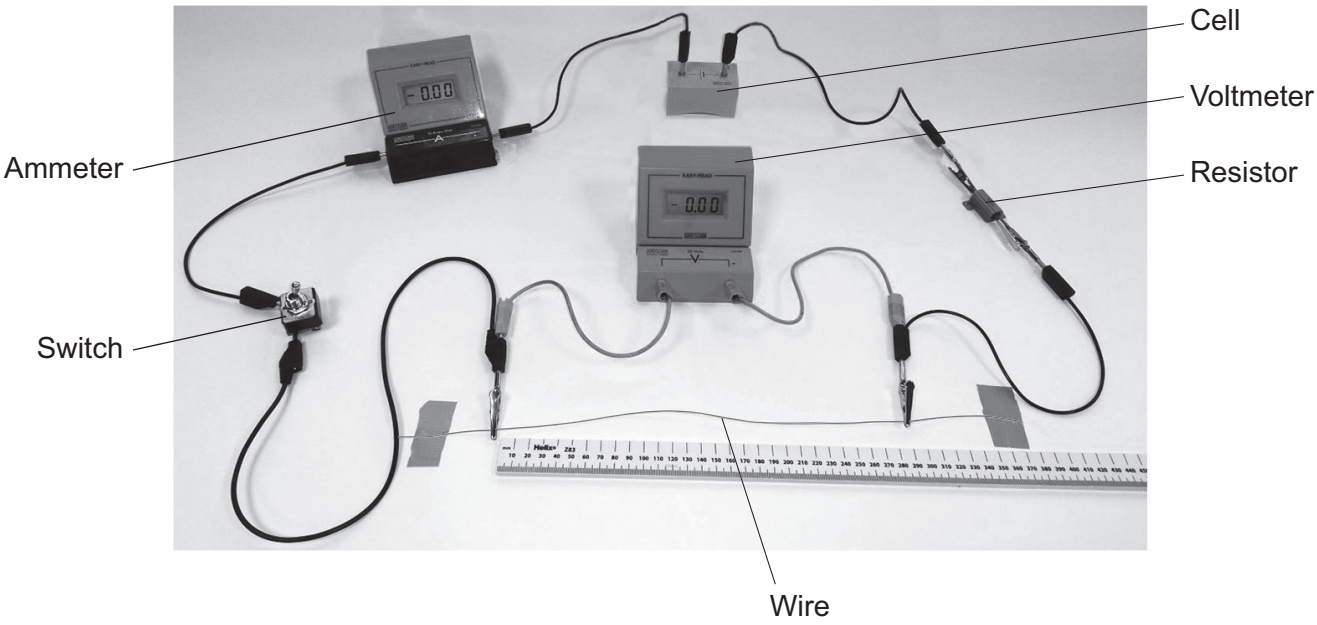
Resistance = _____ Ω

Question 9 continues on the next page

Do not write outside the box

0 9 . 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]

Do not write outside the box

12

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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

Neon and argon are Group 0 elements.

1 0 . 1 What name is given to Group 0?

[1 mark]

_____

1 0 . 2 Give **one** similarity of the electronic structure of neon and the electronic structure of argon.

[1 mark]

_____

_____

1 0 . 3 Give **one** difference between the electronic structure of neon and the electronic structure of argon.

[1 mark]

_____

_____

Question 10 continues on the next page

Do not write outside the box

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**.

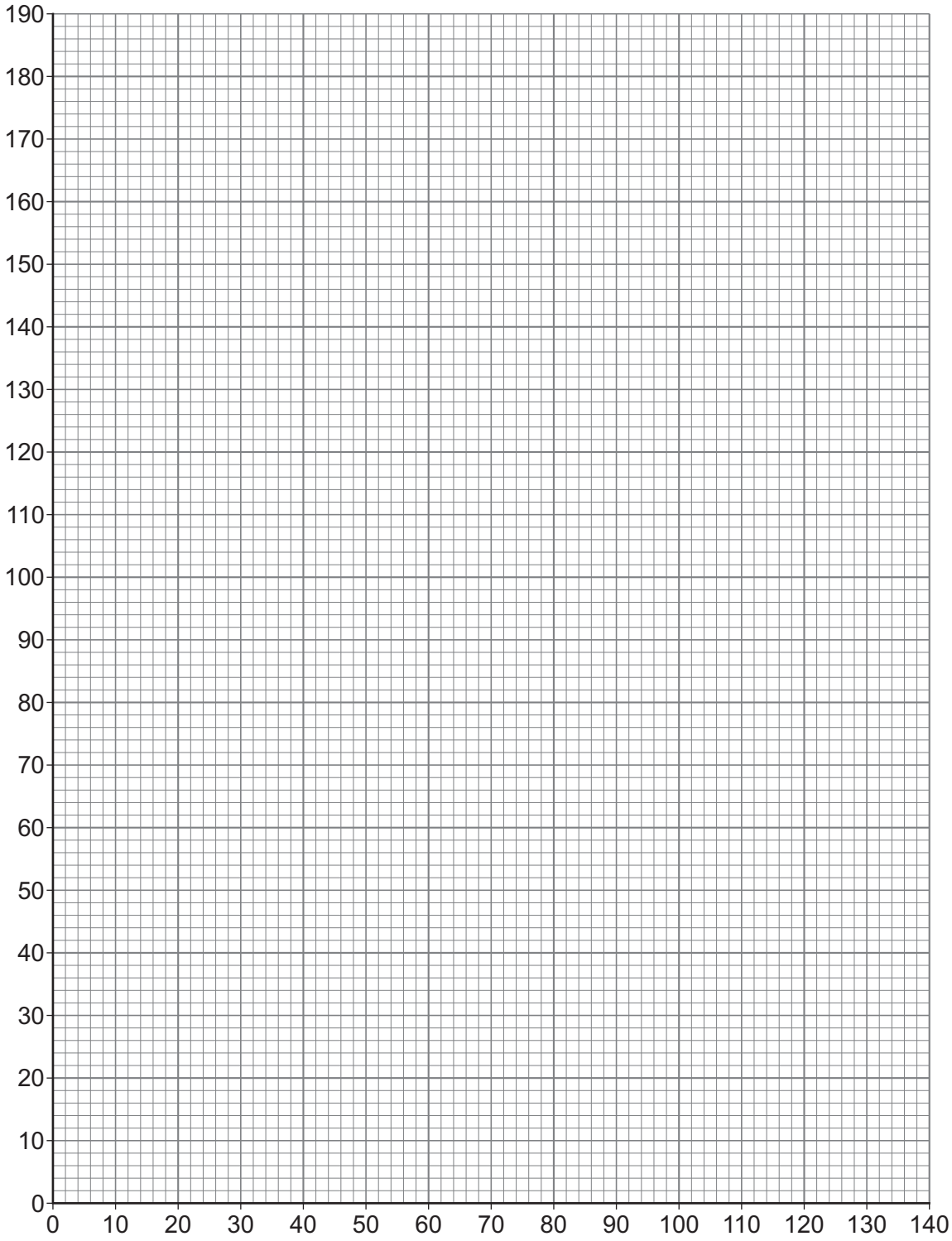
You should:

- label both axes
- plot the data from **Table 3**.

[3 marks]

Do not write outside the box

Figure 14



Question 10 continues on the next page

Do not write outside the box

1 0 . 5 Give **one** conclusion from the data in **Figure 14** on page 43.

[1 mark]

_____

_____

7

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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