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

H

Higher 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.

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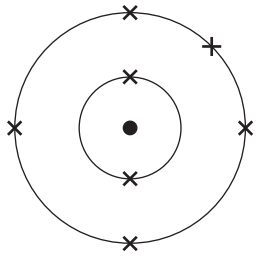
0 1 This question is about structure and bonding.

0 1 . 1 **Figure 1** represents the electronic structure of an atom of an element.

Figure 1



Name the element in **Figure 1**.

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 1 . 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.

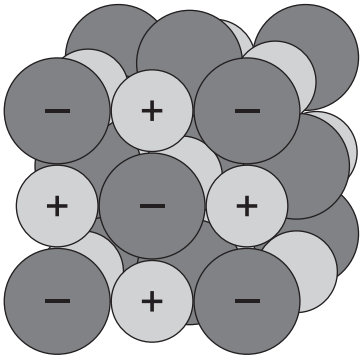
Show the charges on the ions.

[2 marks]

Do not write outside the box

0 1 . 3 **Figure 2** represents the structure of sodium fluoride.

Figure 2



Describe how sodium ions and fluoride ions are held together in sodium fluoride.

[3 marks]

0 1 . 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 ▶

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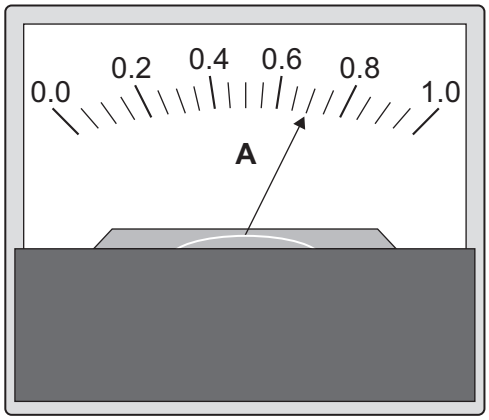
0 2 A student investigated how the resistance of a piece of wire varied with the length of the wire.

Figure 3 shows an ammeter the student could have used in the investigation.

Figure 3



0 2 . 1 What is the resolution of the ammeter?

[1 mark]

Resolution = _____ A

0 2 . 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 2 . 3 Write down the equation which links current (I), potential difference (V) and resistance (R).

[1 mark]

_____

0 2 . 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]

_____

_____

_____

_____

_____

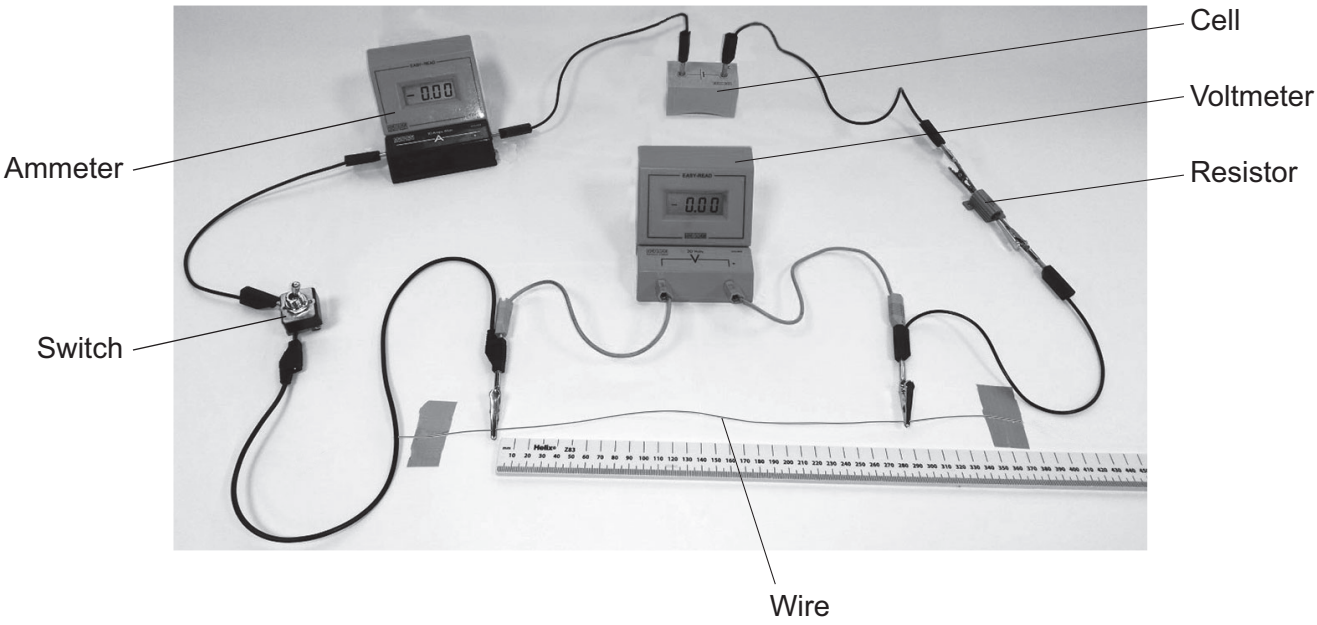
Resistance = _____ Ω

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 **Figure 4** shows the circuit used in the investigation.

Figure 4



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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12

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 This question is about groups in the periodic table.

Neon and argon are Group 0 elements.

0 3 . 1 What name is given to Group 0?

[1 mark]

_____

0 3 . 2 Give **one** similarity of the electronic structure of neon and the electronic structure of argon.

[1 mark]

_____

_____

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

[1 mark]

_____

_____

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 **Table 1** shows information about elements in Group 1.

Table 1

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 5**.

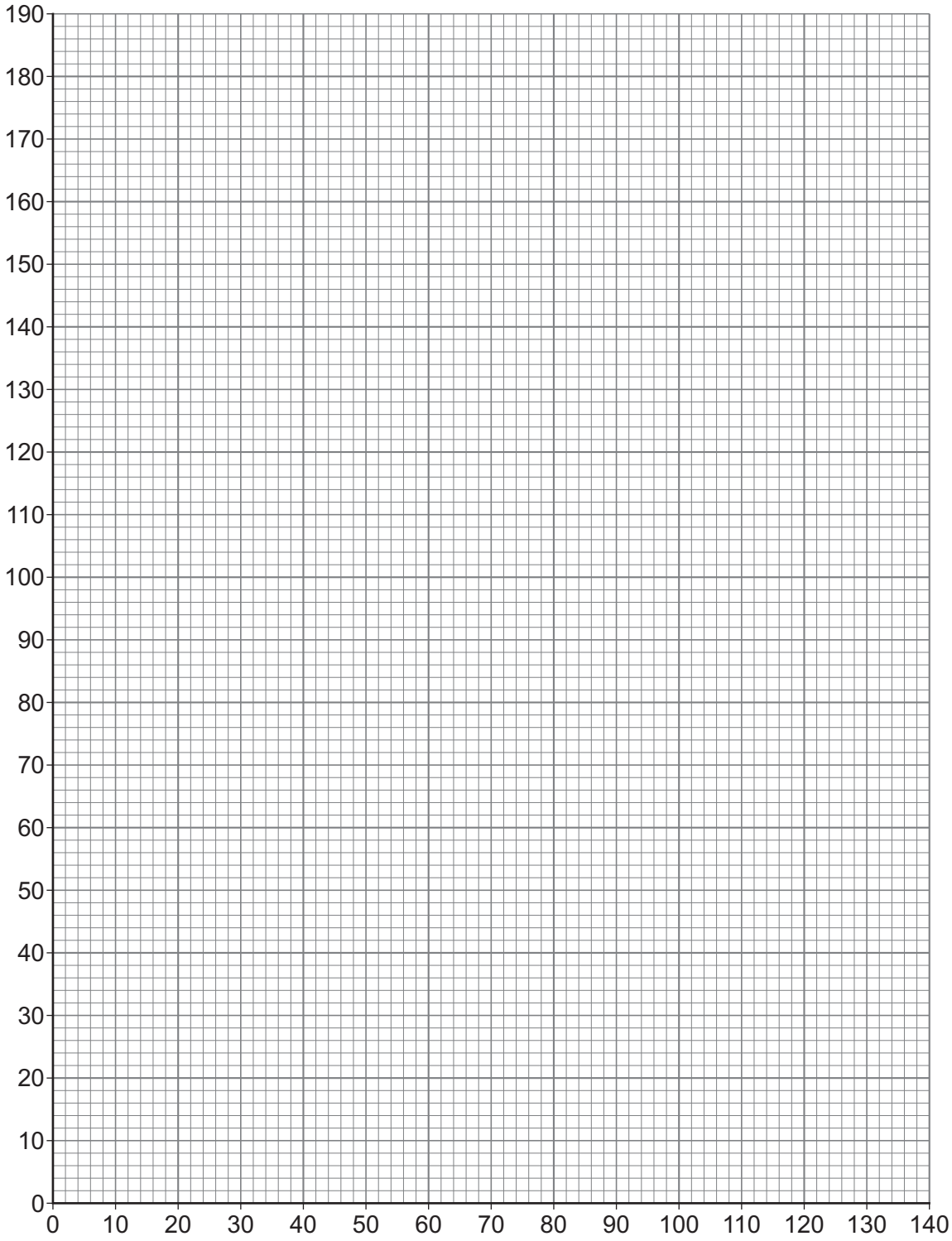
You should:

- label both axes
- plot the data from **Table 1**.

[3 marks]

Do not write outside the box

Figure 5



Question 3 continues on the next page

Do not write outside the box

0 3 . 5 Give **one** conclusion from the data in **Figure 5** on page 11.

[1 mark]

_____

_____

7

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ANSWER IN THE SPACES PROVIDED

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0 4 Magnesium and hydrochloric acid react to produce magnesium chloride and hydrogen.

0 4 . 1 Give the test for hydrogen gas.

Give the result of the test if hydrogen gas is present.

[2 marks]

Test _____

_____

Result _____

_____

0 4 . 2 During the reaction between magnesium and hydrochloric acid, hydrogen ions form hydrogen molecules.

The half equation for this process is:

$$2H^+ + 2e^- \longrightarrow H_2$$

What type of reaction does this half equation show?

Give the reason for your answer.

[2 marks]

Type of reaction _____

Reason _____

_____

Do not write outside the box

0 4 . 3 0.72 g of magnesium reacted completely with dilute hydrochloric acid.

The equation for the reaction is:

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

Calculate the mass of magnesium chloride produced.

Relative atomic masses (A_r): Mg = 24 Cl = 35.5

[4 marks]

Mass = _____ g

8

Turn over for the next question

Do not write outside the box

0 5 This question is about the extraction of metals.

Traditional mining methods extract copper from high-grade copper ores.

Phytomining is a method used to extract copper from low-grade copper ores.

0 5 . 1 Explain **one** advantage of using phytomining compared with using traditional mining methods to extract copper.

Do **not** refer to cost in your answer.

[2 marks]

0 5 . 2 Describe how copper **compounds** are obtained by phytomining.

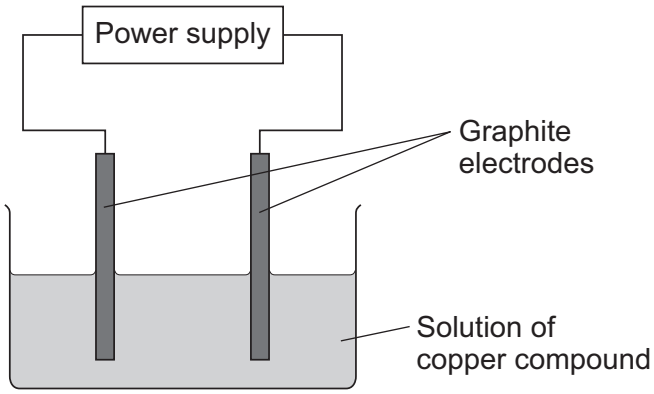
[3 marks]

Do not write outside the box

Electrolysis is one method of obtaining copper from solutions of copper compounds.

Figure 6 shows the apparatus used.

Figure 6



0 5 . 3 Graphite is a good conductor of electricity.

Give **one** other reason why graphite is used for the electrodes.

[1 mark]

_____

_____

0 5 . 4 A gas is produced at the positive electrode.

- The gas is tested with damp litmus paper.
- The gas bleaches the damp litmus paper.

Identify the copper compound in solution.

Give **one** reason for your answer.

[2 marks]

Copper compound _____

Reason _____

_____

Question 5 continues on the next page

Do not write outside the box

0 5 . 5 Scrap iron is used in a reaction to obtain copper from solutions of copper compounds.

Name this type of reaction.

[1 mark]

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

0 5 . 6 Explain why a mixture rather than pure aluminium oxide is electrolysed.

[2 marks]

0 5 . 7 The positive electrodes are made of carbon.

Explain why the positive electrodes wear away during the process.

[3 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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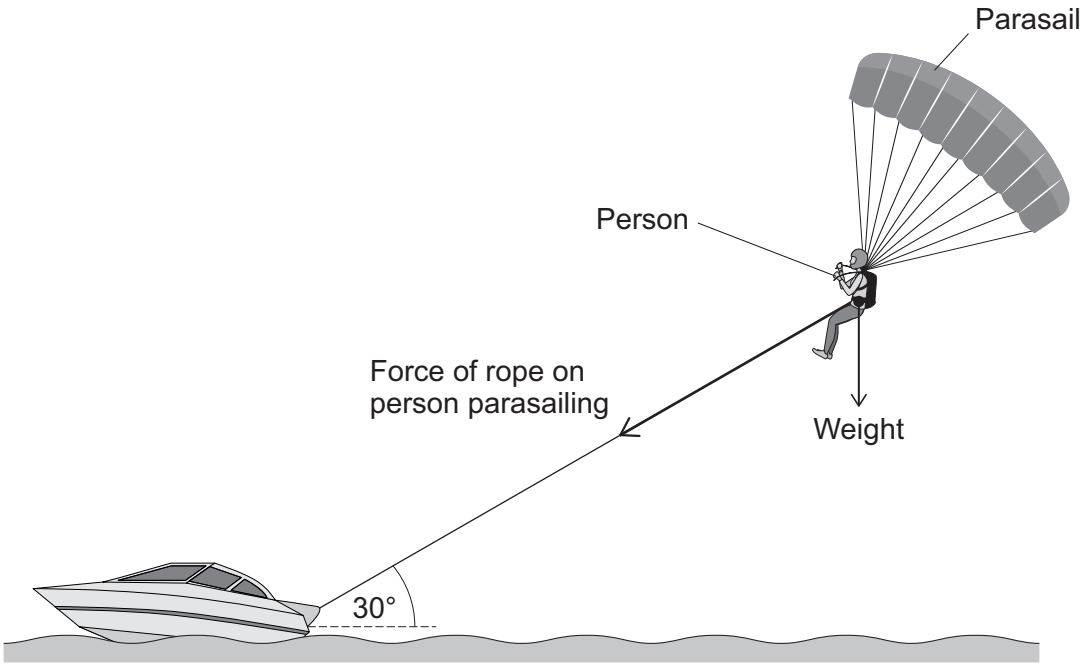
0 6 **Figure 7** shows a boat pulling a person parasailing.

Figure 7 is not drawn to scale.

Figure 7



0 6 . 1 Write down the equation which links gravitational field strength (g), mass (m) and weight (W).

[1 mark]

_____

Do not write outside the box

0 6 . 2 The weight of the person is 735 N.

Calculate the mass of the person.

gravitational field strength = 9.8 N/kg

[3 marks]

Mass = _____ kg

0 6 . 3 The person is moving at a constant velocity.

What is the resultant force acting on the person?

[1 mark]

Question 6 continues on the next page

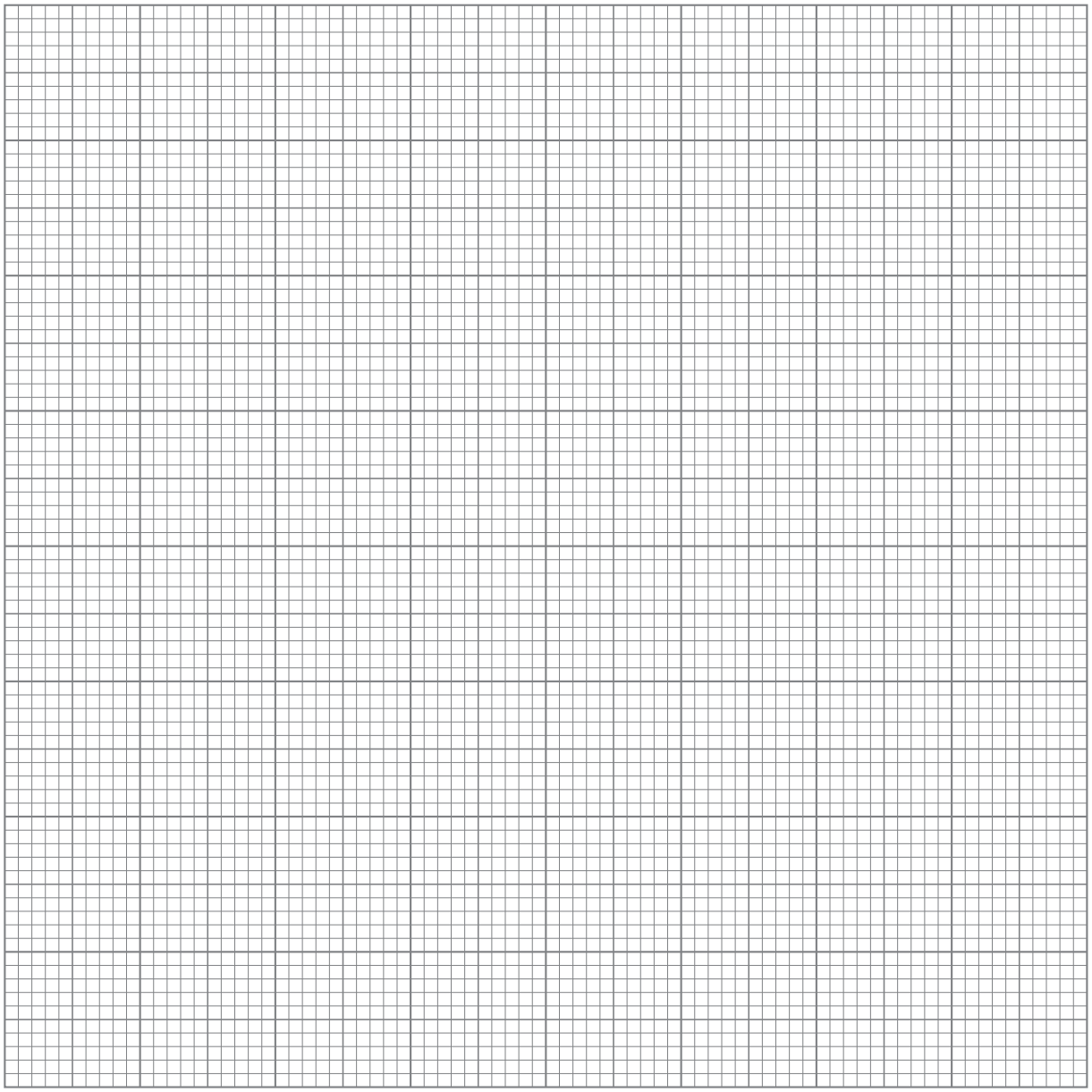
Do not write outside the box

0 6 . 4 The magnitude of the force of the rope on the person is 5000 N.

Draw a vector diagram on **Figure 8** to determine the vertical component and the horizontal component of the force on the rope.

[3 marks]

Figure 8



Vertical component = _____ N

Horizontal component = _____ N

Do not write outside the box

0 6 . 5 The force of the rope on the person parasailing is 5000 N.

The boat pulls the person for a horizontal distance of 1000 m.

The work done by the force of the rope on the person is **not** calculated by multiplying 5000 N by 1000 m.

Explain how the work done by the force of the rope on the person could be calculated.

[2 marks]

_____

_____

_____

_____

10

Turn over for the next question

Do not write outside the box

0 7 This question is about carbon and carbon compounds.

0 7 . 1 Carbon forms compounds called alkanes.

Which formula represents an alkane molecule with 8 carbon atoms?

[1 mark]

Tick (✓) **one** box.

C_8H_{10} ☐

C_8H_{14} ☐

C_8H_{16} ☐

C_8H_{18} ☐

Alkanes can be cracked.

0 7 . 2 Name **one** method of cracking alkanes.

[1 mark]

_____

0 7 . 3 Explain how cracking alkanes helps to meet the demand for fuels.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 7 . 4 Ethene can be produced when alkanes are cracked.

The formula of ethene is C_2H_4

Calculate the simplest whole number ratio **by mass** of carbon to hydrogen in ethene.

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

[2 marks]

Ratio by mass of carbon : hydrogen = _____ : _____

0 7 . 5 Carbon exists in different forms.

Which form has each carbon atom bonding with four other carbon atoms?

[1 mark]

Tick (✓) **one** box.

Diamond ☐

Graphene ☐

Graphite ☐

Question 7 continues on the next page

Do not write outside the box

0 7 . 6 Fullerene molecules are made of carbon atoms.

Give **two** other features of the structure of fullerene molecules.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 7 A carbon nanotube has:

- a diameter of 14 nm
- a length to diameter ratio of 6 900 000 : 1

Calculate the length of the carbon nanotube in nm.

[2 marks]

_____

_____

_____

Length = _____ nm

0 7 . 8 Explain why carbon nanotubes are good conductors of electricity.

[2 marks]

_____

_____

_____

_____

13

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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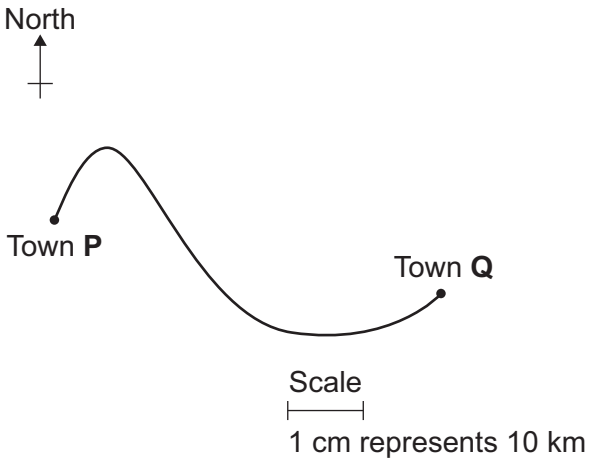
0 8 **Figure 9** shows a plan view of the route a car travelled from town **P** to town **Q**.

Figure 9



0 8 . 1 The distance the car travelled is a scalar quantity.

The displacement of the car is a vector quantity.

Describe what is meant by a scalar quantity and a vector quantity.

[2 marks]

Scalar quantity _____

_____

Vector quantity _____

_____

0 8 . 2 Determine the displacement of the car when the car has travelled from town **P** to town **Q**.

[2 marks]

_____

_____

Displacement = _____ km

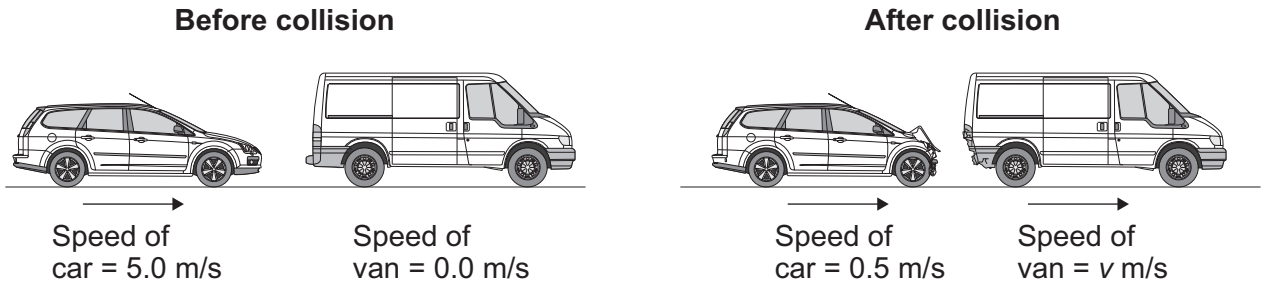
Direction from north = _____ °

Do not write outside the box

0 8 . 3 At town **Q**, the car collided with a stationary van.

Figure 10 shows the two vehicles before and after the collision.

Figure 10



Total momentum was conserved in the collision.

mass of car = 1250 kg
mass of van = 3000 kg

Calculate the speed *v* of the van after the collision.

[4 marks]

Speed *v* = _____ m/s

8

Turn over for the next question

Do not write outside the box

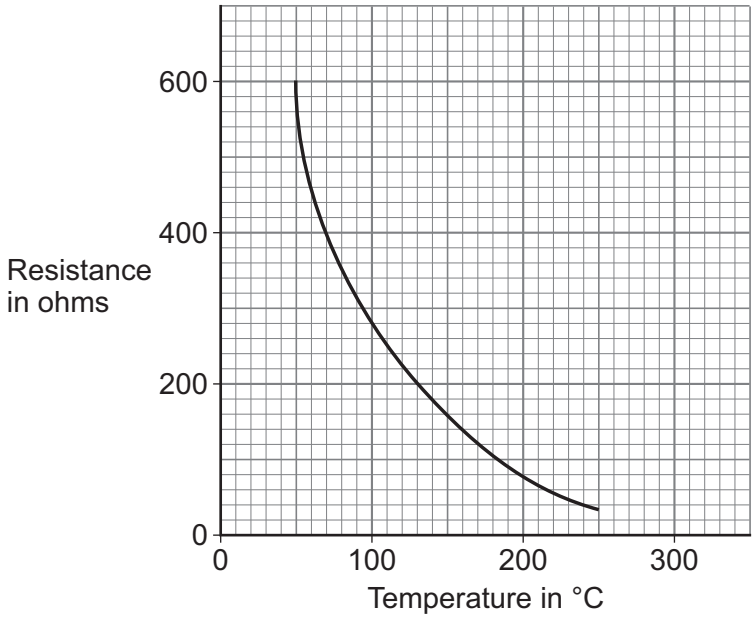
0 9 A thermistor is used in an oven as part of a temperature sensor.

0 9 . 1 Draw the circuit symbol for a thermistor.

[1 mark]

Figure 11 shows how the resistance of the thermistor varies with temperature.

Figure 11



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0 9 . 2 Identify the temperature range when the thermistor is most sensitive to temperature change.

[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 ☐

0 9 . 3 The potential difference across the thermistor is 15 V.

The current in the thermistor is 0.015 A.

Calculate the energy transferred by the thermistor in 20 minutes.

[5 marks]

Energy transferred = _____ J

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 The power output of the heating element in the oven is 0.72 kW.

The current in the heating element in the oven is 12 A.

Calculate the resistance of the heating element.

[4 marks]

Resistance = _____ Ω

11

Do not write outside the box

Turn over for the next question

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1 0 This question is about bonds.

1 0 . 1 Compare the bonding in hydrogen gas (H_2) with the bonding in copper metal.

[4 marks]

Do not write outside the box

1 0 . 2 Hydrogen reacts with oxygen to produce water.

The equation for the reaction is:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

The energy released in forming new bonds is 486 kJ/mol greater than the energy needed to break the existing bonds.

Table 2 shows some bond energy values.

Table 2

Bond	Bond energy in kJ/mol
H–H	**Y**
O=O	498
O–H	464

Y is the bond energy of a H–H bond.

Calculate **Y**.

[5 marks]

Y = _____ kJ/mol

9

END OF QUESTIONS

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