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	
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

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 1 This question is about hydrocarbons.

0 1 . 1 Complete the sentence.

[1 mark]

Hydrocarbons are made from atoms of carbon and

atoms of ______________________________ .

0 1 . 2 What is the maximum number of bonds that one carbon atom can form?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 6 ☐

Question 1 continues on the next page

Most of the compounds in crude oil are hydrocarbons.

0 1 . 3 Crude oil is the remains of an ancient biomass.

What did the ancient biomass mainly consist of?

[1 mark]

Tick (✓) **one** box.

Methane ☐

Plankton ☐

Rocks ☐

0 1 . 4 Fractional distillation is used to separate the hydrocarbons in crude oil into fractions.

Which property of hydrocarbons is used to separate them?

[1 mark]

Tick (✓) **one** box.

Boiling point ☐

Flammability ☐

Viscosity ☐

0 1 . 5 Name **one** fuel produced from the fractional distillation of crude oil.

[1 mark]

____

Do not write outside the box

0 1 . 6 What are the **two** products of the complete combustion of a hydrocarbon?

[2 marks]

Tick (✓) **two** boxes.

Ammonia ☐

Carbon dioxide ☐

Nitrogen ☐

Oxygen ☐

Water ☐

0 1 . 7 How does the size of the molecules affect the viscosity of hydrocarbons?

[1 mark]

Tick (✓) **one** box.

Smaller hydrocarbon molecules have greater viscosity. ☐

The size of the hydrocarbon molecules does not affect the viscosity. ☐

Larger hydrocarbon molecules have greater viscosity. ☐

8

Turn over ▶

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 2 This question is about acids and alkalis.

0 2 . 1 Which ion is produced by all acids in aqueous solution?

[1 mark]

Tick (✓) **one** box.

Cl^- ☐ H^+ ☐ Na^+ ☐ OH^- ☐

0 2 . 2 The pH scale is a measure of the acidity or alkalinity of a solution.

What is used to measure the pH of a solution?

[1 mark]

Tick (✓) **one** box.

Iodine solution ☐

Limewater ☐

Universal indicator ☐

0 2 . 3 Give **one** safety precaution used when measuring the pH of an acid.

[1 mark]

____

____

Question 2 continues on the next page

Turn over ▶

Sodium hydroxide solution reacts with sulfuric acid to produce a salt and one other product.

0 2 . 4 Which salt is produced when sodium hydroxide solution reacts with sulfuric acid?

[1 mark]

Tick (✓) **one** box.

Sodium chloride ☐

Sodium nitrate ☐

Sodium sulfate ☐

0 2 . 5 What is the other product when sodium hydroxide solution reacts with sulfuric acid?

[1 mark]

Tick (✓) **one** box.

Oxygen ☐

Sodium ☐

Water ☐

0 2 . 6 Draw **one** line from each solution to the pH of that solution.

[2 marks]

Solution	**pH of solution**
	2
Sodium hydroxide	
	7
Sulfuric acid	
	13

0 2 . 7 What is the type of reaction when sodium hydroxide solution reacts with sulfuric acid?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Neutralisation ☐

8

Turn over for the next question

Do not write outside the box

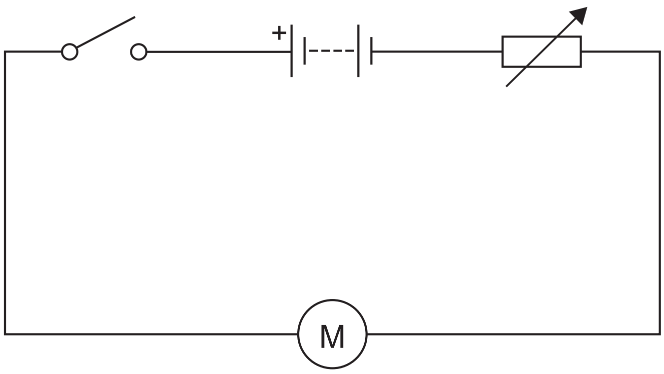
0 3 A normal bicycle can be converted into an electric bicycle.

Figure 1 shows a converted bicycle.

Figure 1

Figure 2 shows the circuit diagram for the bicycle.

Figure 2



The circuit symbol for a motor is: (M)

0 3 . 1 The switch is used to turn the motor on or off.

The variable resistor is used to change the speed of the motor.

Complete the sentences.

Choose answers from the box.

[3 marks]

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

When the resistance of the variable resistor decreases, the potential difference across the battery ______________________________ .

When the resistance of the variable resistor decreases, the current in the circuit ______________________________ .

The speed of the motor increases when the resistance of the variable resistor ______________________________ .

0 3 . 2 The potential difference across the motor is 36 V.

The power output of the motor is 252 W.

Calculate the current in the motor.

Use the equation:

$$\text{current} = \frac{\text{power}}{\text{potential difference}}$$

[2 marks]

____

____

____

Current = ______________ A

The bicycle battery can be recharged using the mains electricity supply.

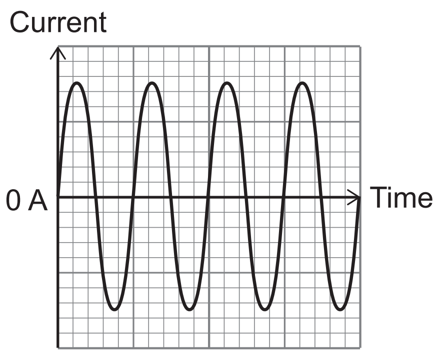
A battery supplies direct current.

Mains electricity supplies alternating current.

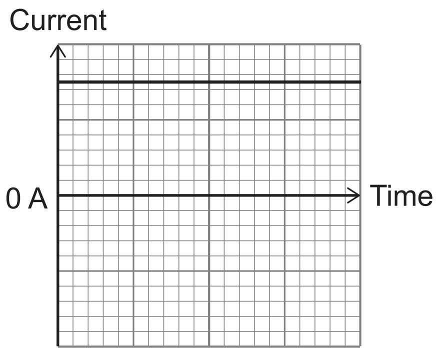
0 3 . 3 Which graph shows an alternating current?

[1 mark]

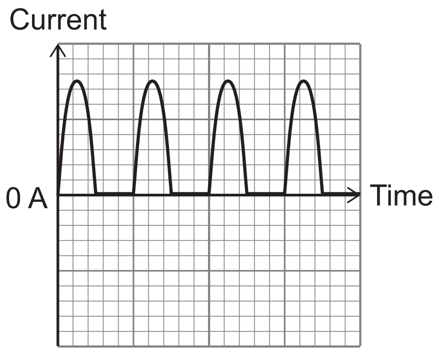
Tick (✓) **one** box.



☐



☐



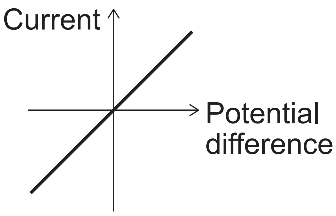
☐

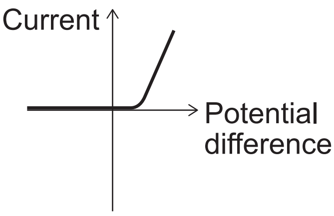
0 3 . 4 A diode is used to change the alternating current to a direct current.

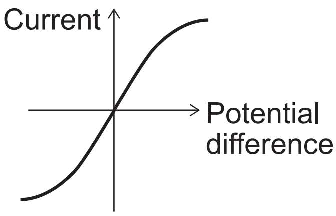
Which graph shows how the current in a diode varies with potential difference?

[1 mark]

Tick (✓) **one** box.







☐ ☐ ☐

0 3 . 5 The mean charging current from the mains is 5.0 A for 7200 seconds.

Calculate the charge flow to the battery.

Use the equation:

charge flow = current × time

Choose the unit from the box.

[3 marks]

amps	**coulombs**	**ohms**	**volts**

____

____

____

Charge flow = ________________ Unit ____________________

Question 3 continues on the next page

Turn over ▶

0 3 . 6 Calculate the work done in charging the battery when the power input is 1150 W for 7200 seconds.

Use the equation:

$$\text{work done} = \text{power} \times \text{time}$$

[2 marks]

____

____

____

Work done = ____________________________ J

12

Do not write outside the box

0 4 This question is about metals reacting with oxygen.

Calcium (Ca) reacts with oxygen (O_2) to produce calcium oxide (CaO).

0 4 . 1 Balance the equation for the reaction.

[1 mark]

$$\_\_\_\_ \ Ca + O_2 \rightarrow 2CaO$$

0 4 . 2 40 g of calcium reacts completely with oxygen to produce 56 g of calcium oxide.

Calculate the maximum mass of calcium oxide that could be produced from 10 g of calcium.

[2 marks]

____

____

____

Mass of calcium oxide = ________________ g

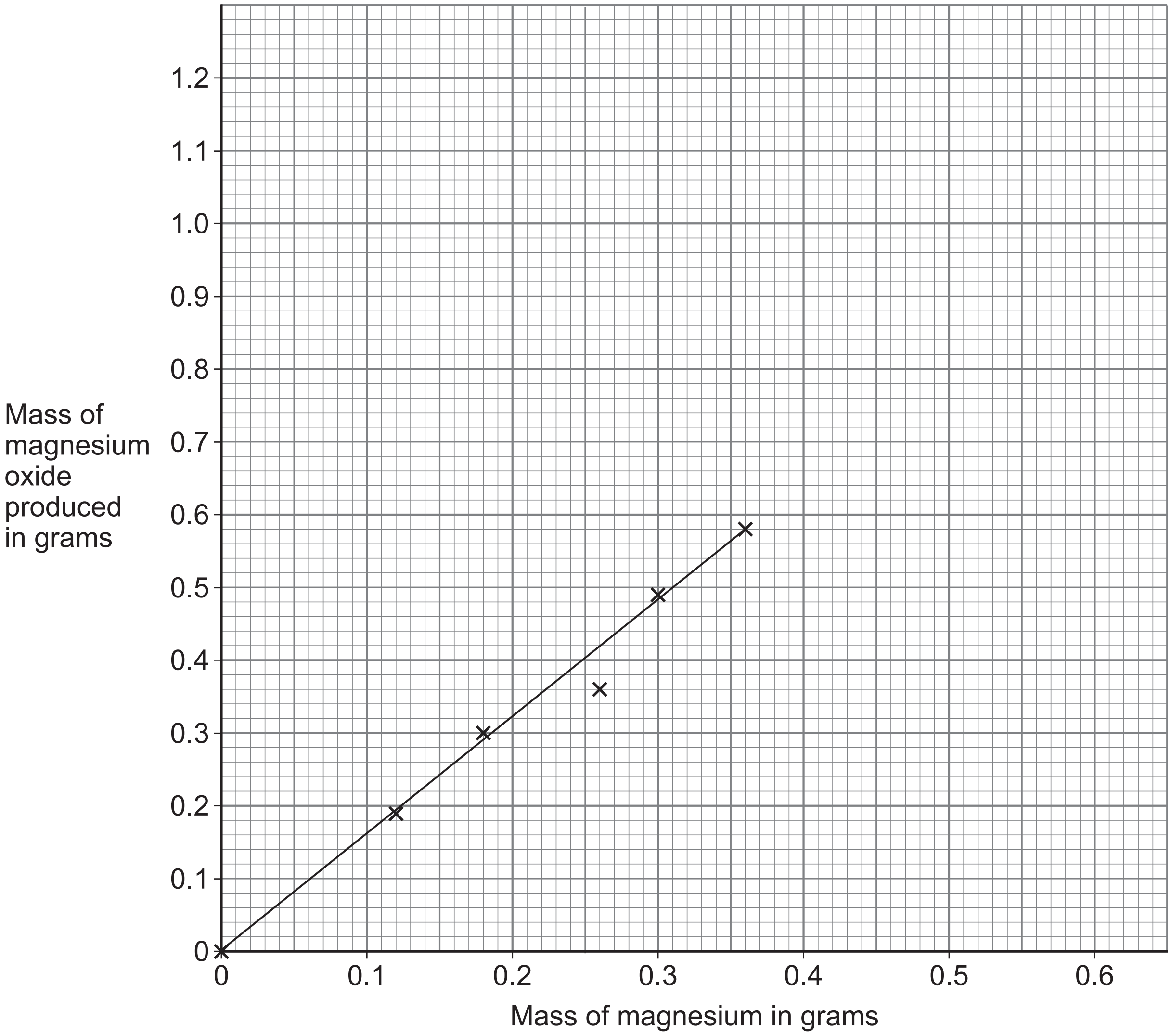
Question 4 continues on the next page

Do not write outside the box

A student reacted different masses of magnesium with oxygen and measured the mass of magnesium oxide produced.

Figure 3 shows the results.

Figure 3



0 4 . 3 Why did the student ignore one of the points when drawing the line of best fit on **Figure 3**?

[1 mark]

____

____

0 4 . 4 What trend is shown by the results on **Figure 3**?

Complete the sentence.

[1 mark]

As the mass of magnesium increases ______________________________

____

0 4 . 5 Predict the mass of magnesium oxide produced from 0.5 g of magnesium.

You should extend the line of best fit on **Figure 3**.

[2 marks]

Mass of magnesium oxide = ______________ g

Question 4 continues on the next page

A different student reacted copper with oxygen and measured the mass of copper oxide produced.

The student did repeat measurements for each mass of copper.

Table 1 shows the results when 0.42 g of copper was reacted.

Table 1

Mass of copper in grams	**Mass of copper oxide produced in grams**				
	Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
0.42	0.51	0.47	0.48	0.50	**X**

0 4 . 6 Calculate mean value **X** in **Table 1**.

[2 marks]

____

____

____

Mean value **X** = ____________________ g

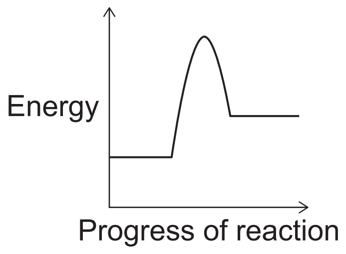
Do not write outside the box

0 4 . 7 The reaction between copper and oxygen is exothermic.

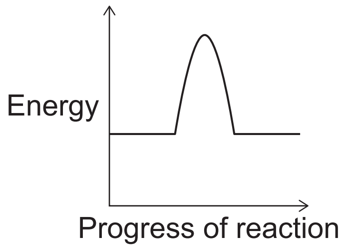
Which reaction profile represents this reaction?

[1 mark]

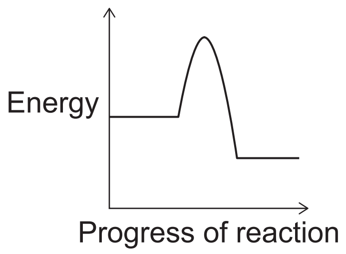
Tick (✓) **one** box.



☐



☐



☐

0 4 . 8 Complete the sentence.

[1 mark]

The minimum amount of energy that particles must have to react is

called the ______________________________________ .

11

Turn over ▶

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 5 This question is about chemical processes.

Iron can be extracted from iron oxide using carbon.

The word equation for the reaction is:

iron oxide + carbon → iron + carbon dioxide

0 5 . 1 Why can iron be extracted from iron oxide using carbon?

[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 5 . 2 Which reactant is reduced?

[1 mark]

Tick (✓) **one** box.

Carbon ☐

Carbon dioxide ☐

Iron ☐

Iron oxide ☐

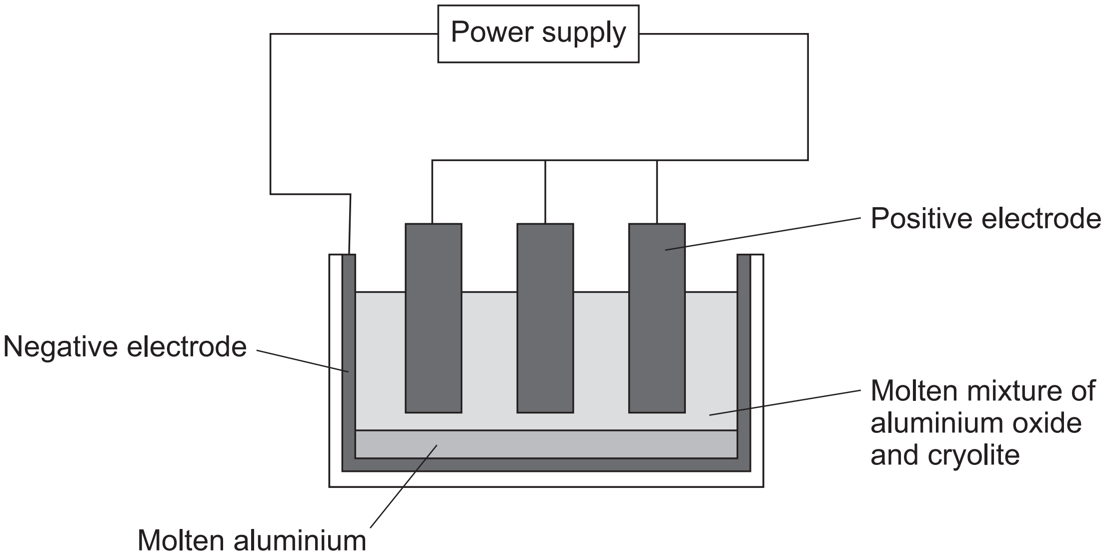
Question 5 continues on the next page

Do not write outside the box

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

Figure 4 shows the apparatus.

Figure 4



0 5 . 3 What are the positive electrodes in **Figure 4** made of?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Carbon ☐

Copper ☐

Iron ☐

Do not write outside the box

0 5 . 4 Large amounts of energy are used in the extraction of aluminium from aluminium oxide.

Give **two** reasons why.

[2 marks]

1 ____

____

2 ____

____

0 5 . 5 Electrolysis is only possible when an ionic compound is molten or in aqueous solution.

Explain why.

You should refer to ions **and** charge in your answer.

[2 marks]

____

____

____

____

Question 5 continues on the next page

An aqueous solution of copper chloride is electrolysed using inert electrodes.

0 5 . 6 What is meant by 'inert'?

[1 mark]

____

____

0 5 . 7 **Table 2** shows information about the products of the electrolysis of an aqueous solution of copper chloride.

Table 2

	Product at positive electrode	**Product at negative electrode**
Name of product	Chlorine	
State of product		Solid

Complete **Table 2**.

[2 marks]

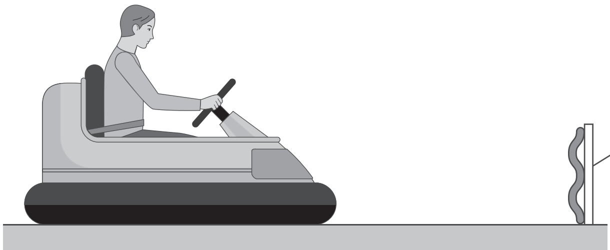
10

Turn over for the next question

Turn over ▶

0 6 **Figure 5** shows a person driving a bumper car at a theme park.

Figure 5



0 6 . 1 The mass of the bumper car and driver is 360 kg.

The bumper car moves with a speed of 1.50 m/s.

Calculate the kinetic energy of the bumper car and driver.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

[2 marks]

____

____

____

Kinetic energy = ____________________ J

Use the Physics Equations Sheet to answer questions **06.2** and **06.3**.

0 6 . 2 Write down the equation which links efficiency, total power input and useful power output.

[1 mark]

____

0 6 . 3 The motor of the bumper car has an efficiency of 0.80

The total power input to the motor is 220 W.

Calculate the useful power output of the motor.

[3 marks]

____

____

____

____

____

Useful power output = ____________________ W

0 6 . 4 The bumper car collides with a stationary barrier and stops.

What happens to the velocity of the bumper car during the collision?

[1 mark]

____

Question 6 continues on the next page

Turn over ▶

Do not write outside the box

0 6 . 5 Another bumper car slows down and stops to avoid a collision.

Complete the sentences.

Choose answers from the box.

[2 marks]

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

As the bumper car slows down, its kinetic

energy ________________________________ .

As the bumper car slows down, the thermal energy of the

surroundings ________________________________ .

9

Turn over for the next question

Turn over ▶

0 7 Calcium carbonate reacts with hydrochloric acid.

The word equation for the reaction is:

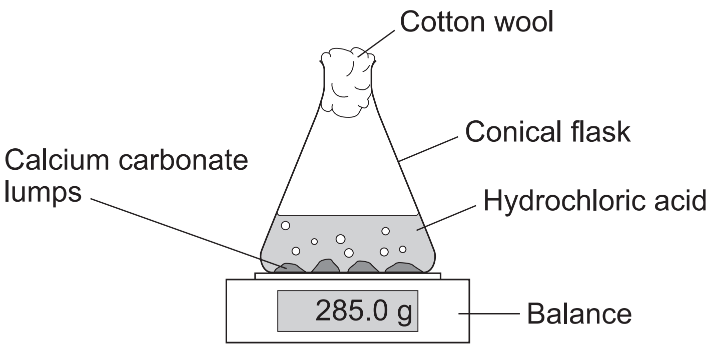
calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

A student investigated the effect of changing the surface area of the calcium carbonate on the rate of this reaction.

The student changed the surface area of the calcium carbonate by using different-sized lumps.

Figure 6 shows the apparatus.

Figure 6



The rate of reaction is determined by measuring the decrease in mass of the conical flask and contents at regular time intervals.

This is the method used.

1. Place a conical flask on a balance.
2. Add 50 cm^3 of hydrochloric acid to the conical flask.
3. Add 2 g of small lumps of calcium carbonate to the hydrochloric acid.
4. Put cotton wool in the top of the conical flask.
5. Record the mass every 60 seconds until the mass remains constant.
6. Repeat steps 1 to 5 with 2 g of large lumps of calcium carbonate.

0 7 . 1 Why was cotton wool put in the top of the conical flask?

[1 mark]

Tick (✓) **one** box.

To slow down the reaction ☐

To stop acid splashing out of the conical flask ☐

To stop carbon dioxide gas escaping ☐

0 7 . 2 What was the independent variable in this investigation?

[1 mark]

____

____

0 7 . 3 Give **one** control variable used in this investigation.

[1 mark]

____

____

Question 7 continues on the next page

Table 3 shows some of the results.

Table 3

Size of calcium carbonate lumps	**Decrease in mass after 60 seconds in grams**
Small	0.09
Large	0.06

0 7 . 4 Calculate the mean rate of reaction from 0 to 60 seconds for the small lumps.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{decrease in mass}}{\text{time taken}}$$

Use **Table 3**.

[2 marks]

____

____

____

Mean rate of reaction = ____________________ g/s

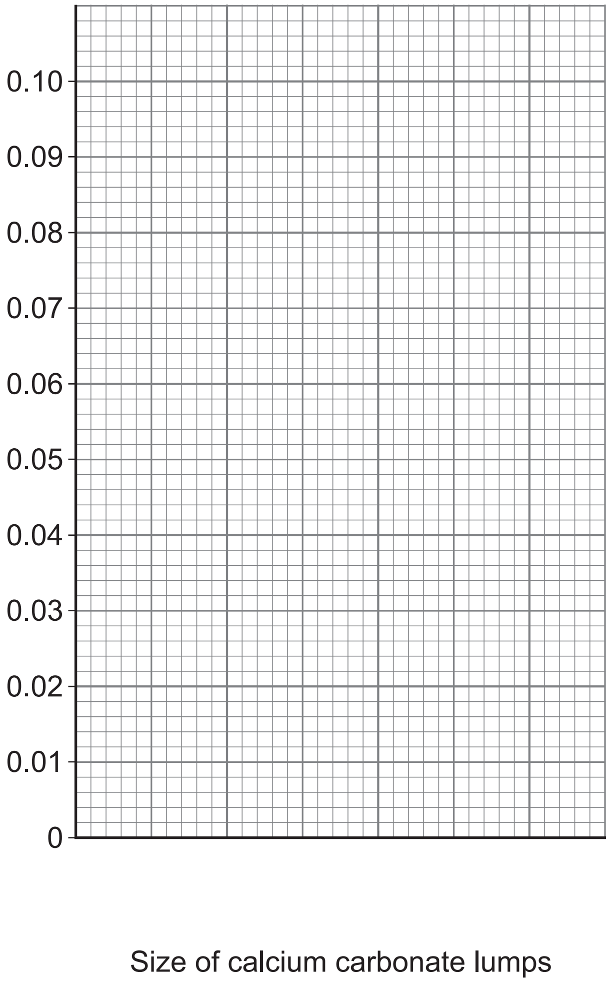
0 7 . 5 Complete **Figure 7**.

You should:

- label the *y*-axis
- plot the data from **Table 3** as a bar chart
- label each bar.

[3 marks]

Figure 7



0 7 . 6 Why are the results plotted as a bar chart and **not** as a line graph?

[1 mark]

____

____

Question 7 continues on the next page

Turn over ▶

Table 3 is repeated below.

Table 3

Size of calcium carbonate lumps	**Decrease in mass after 60 seconds in grams**
Small	0.09
Large	0.06

0 7 . 7 What effect does the size of the calcium carbonate lumps have on the **rate** of reaction?

Use **Table 3**.

[1 mark]

Tick (✓) **one** box.

Increasing the size of the lumps decreases the rate of reaction. ☐

Increasing the size of the lumps does not affect the rate of reaction. ☐

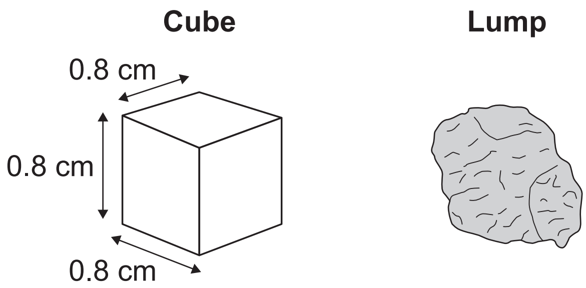
Increasing the size of the lumps increases the rate of reaction. ☐

Do not write outside the box

The surface area of a calcium carbonate lump can be estimated by comparing the lump with a cube.

Figure 8 shows a cube and a similar-sized calcium carbonate lump.

Figure 8



0 7 . 8 Calculate the total surface area of the cube in **Figure 8**.

Use the equation:

total surface area of cube = 6 × length of one side × length of one side

[2 marks]

____

____

____

Total surface area of cube = ____________________ cm^2

0 7 . 9 Suggest **one** reason why the total surface area of the lump in **Figure 8** is estimated rather than measured.

[1 mark]

____

____

13

0 8 This question is about structure and bonding.

0 8 . 1 Why can metals be shaped?

[1 mark]

Tick (✓) **one** box.

Different-sized atoms distort the structure. ☐

Layers of atoms slide over each other. ☐

Metallic bonds are weak. ☐

Metals have low melting points. ☐

0 8 . 2 Explain how metals conduct electricity.

You should answer in terms of electrons.

[3 marks]

____

____

____

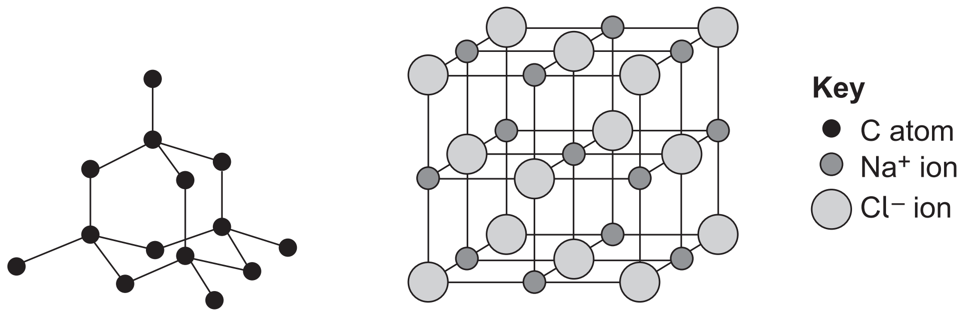
____

____

____

0 8 . 3 **Figure 9** represents the structure of diamond and of sodium chloride.

Figure 9



Diamond **Sodium chloride**

Compare the structure and bonding of diamond with the structure and bonding of sodium chloride.

[6 marks]

____

____

____

____

____

____

____

____

____

____

____

____

Question 8 continues on the next page

Do not write outside the box

Ethene (C_2H_4) is a small molecule.

0 8 . 4 Calculate the relative formula mass (M_r) of ethene.

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

[2 marks]

____

____

____

Relative formula mass = ____________________

0 8 . 5 Ethene molecules join together to form long-chain poly(ethene) molecules.

Explain why poly(ethene) has a higher melting point than ethene.

You should refer to the:

- size of the molecules
- intermolecular forces.

[3 marks]

____

____

____

____

____

____

15

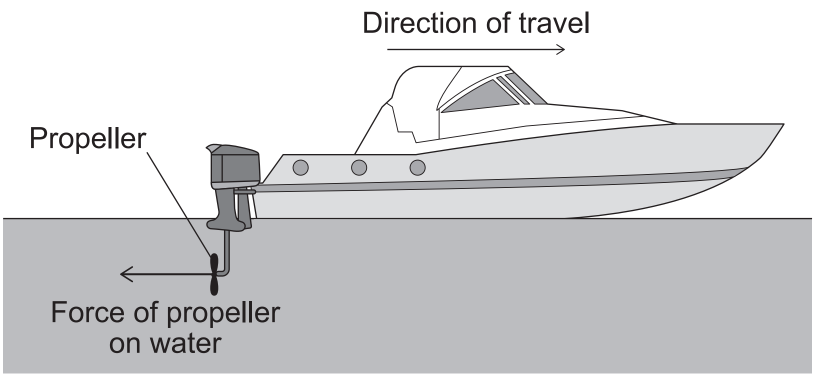
Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 9 **Figure 10** shows a boat on the sea.

Figure 10



The boat is travelling at a constant speed.

0 9 . 1 Draw an arrow on **Figure 10** to show the size and direction of the force of the water on the propeller.

[2 marks]

0 9 . 2 A quantity can be a scalar quantity or a vector quantity.

Identify which quantities are scalar quantities and which quantities are vector quantities.

[2 marks]

Tick (✓) **one** box in **each** row.

Quantity	Scalar	Vector
Speed		
Velocity		
Mass		
Weight		

Do not write outside the box

0 9 . 3 Which equation links distance (s), speed (v) and time (t)?

[1 mark]

Tick (✓) **one** box.

$s = \frac{v}{t}$ ☐ $s = \frac{t}{v}$ ☐ $v = \frac{s}{t}$ ☐ $v = s \times t$ ☐

0 9 . 4 The speed of the boat is 12 m/s.

Calculate the time taken to travel 6000 m.

Use the Physics Equations Sheet.

[3 marks]

____

____

____

____

____

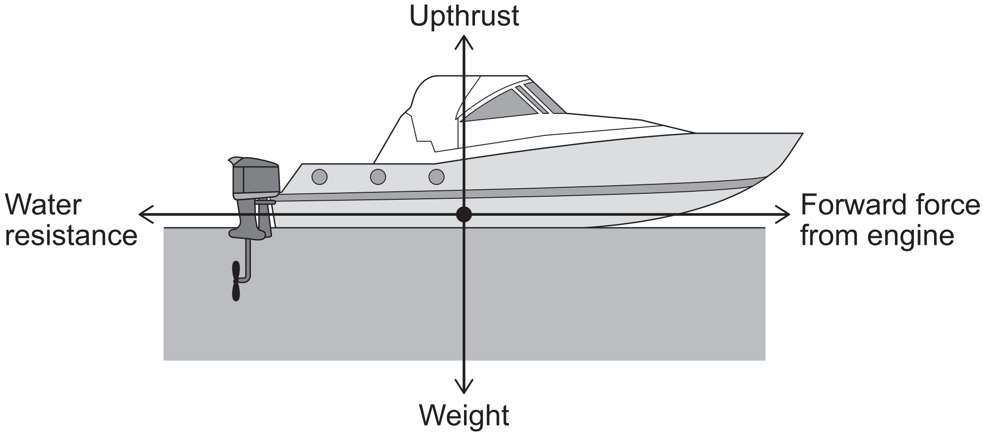
Time = ____________________ s

Question 9 continues on the next page

Do not write outside the box

0 9 . 5 **Figure 11** shows the forces acting on the boat when it is moving at a constant speed.

Figure 11



The engine of the boat is turned off. The boat slows down and stops.

Explain what happens to the forces acting on the boat.

[6 marks]

____

____

____

____

____

____

____

____

____

____

____

____

14

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED