A

Surname ______________________________

Other Names ______________________________

Centre Number ______________________________

Candidate Number ______________________________

Candidate Signature ______________________________

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

F

8465/3F

Foundation Tier

Paper 3 Physical Sciences

Time allowed: 1 hour 45 minutes

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]

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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

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**

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

[Turn over]

01.4

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**

01.5

Name ONE fuel produced from the fractional distillation of crude oil. [1 mark]

____

____

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**

[Turn over]

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

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[Turn over]

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]

____

____

____

[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**

[Turn over]

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]

0 3

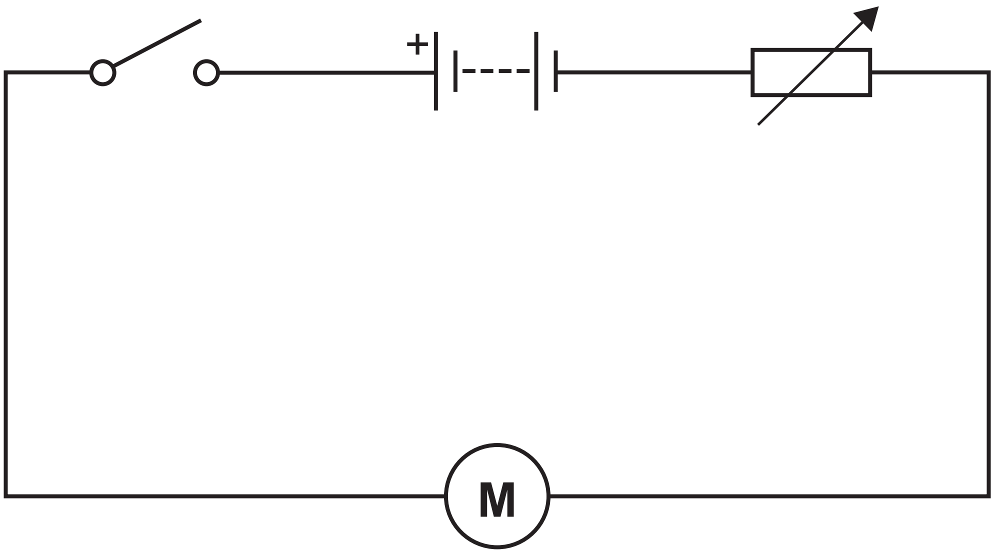
A normal bicycle can be converted into an electric bicycle.

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: 

[Turn over]

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 list. [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

[Turn over]

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

A battery supplies direct current.

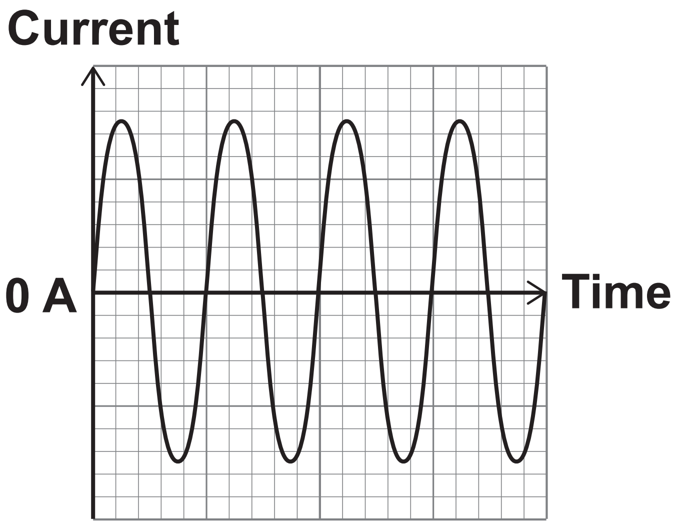
Mains electricity supplies alternating current.

0 3 . 3

Which graph shows an alternating current? [1 mark]

Tick (✓) ONE box.

☐



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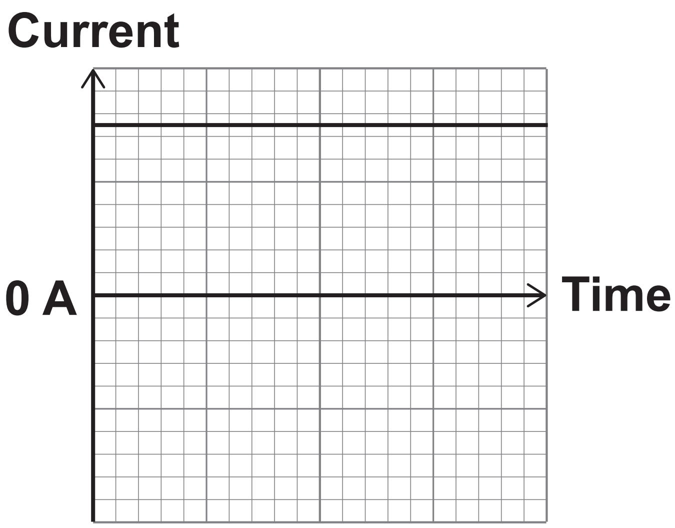
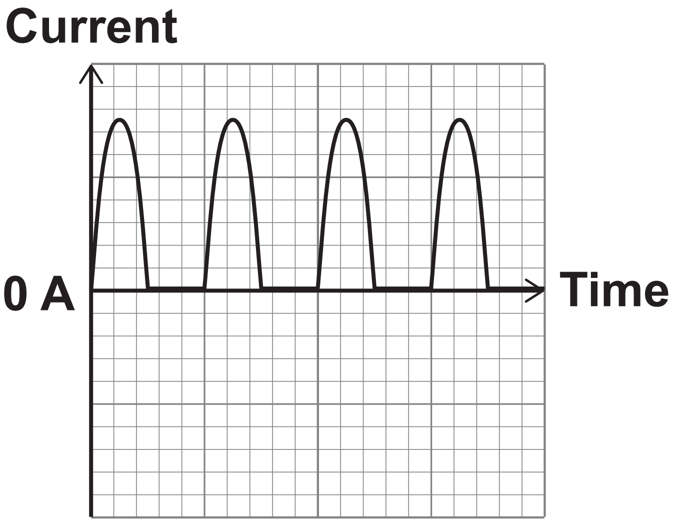




[Turn over]

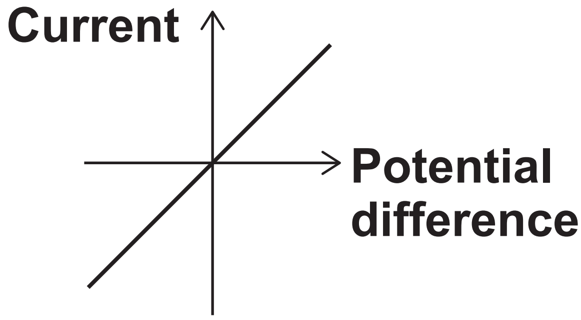
0 3 . 4

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.

☐



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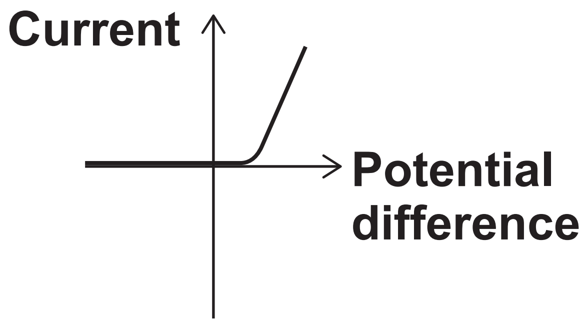

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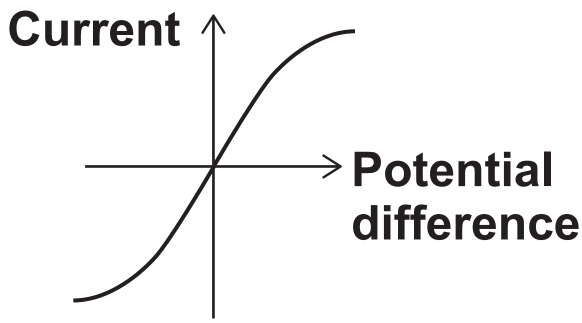

0 3 . 5

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 list. [3 marks]

amps

coulombs

ohms

volts

____

____

____

____

Charge flow = ____________________ Unit

[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:

work done = power × time

[2 marks]

Work done = ______________________ J

12

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[Turn over]

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]

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

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]

____

____

____

____

____

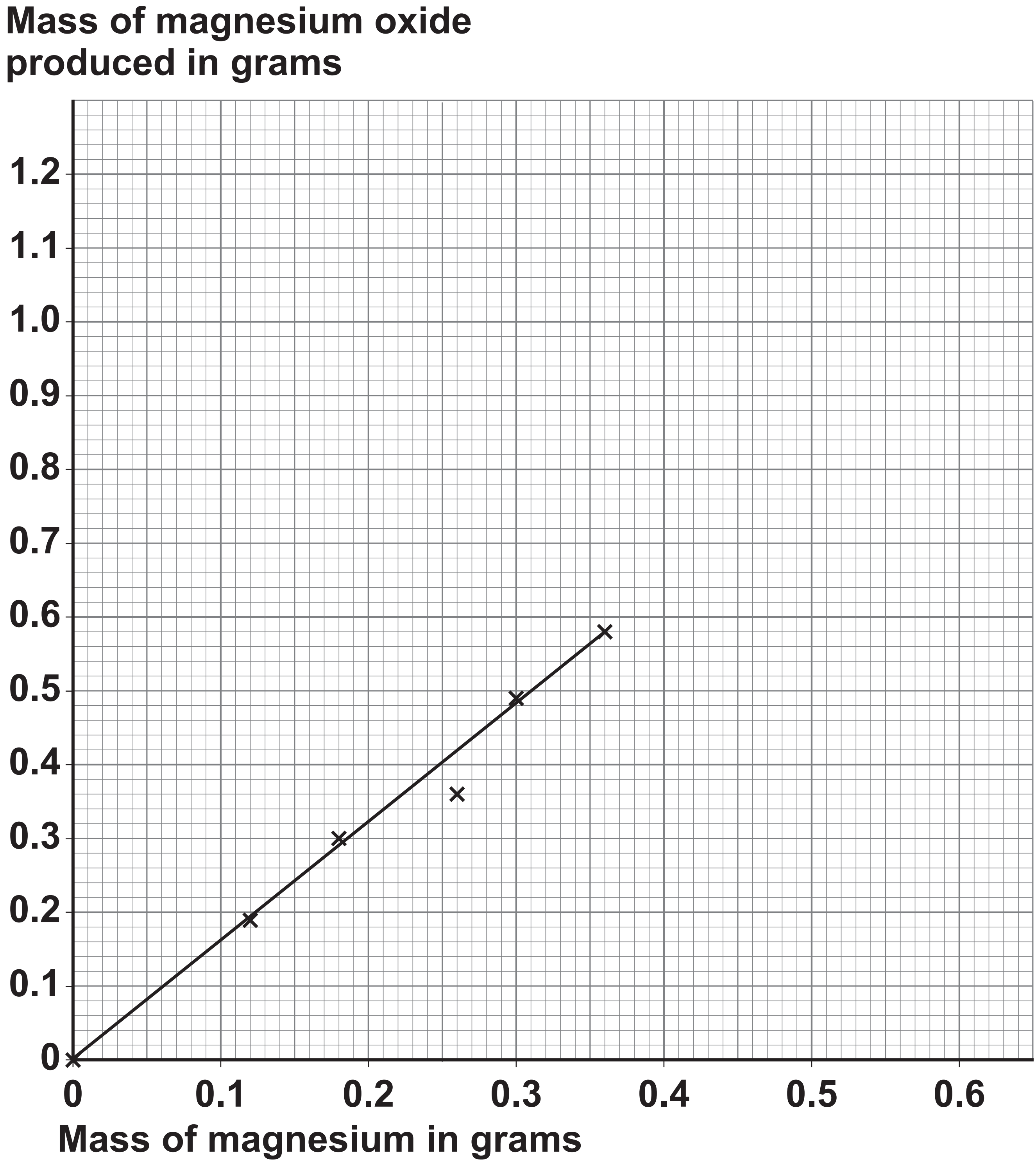
Mass of calcium oxide = ______________________ g

[Turn over]

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

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]

____

____

____

____

____

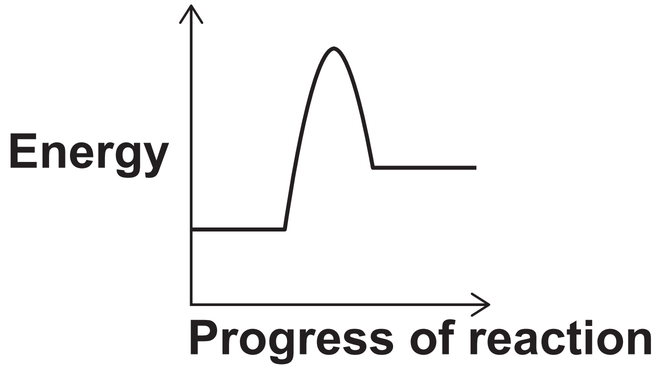
Mean value X = ____________________________ g

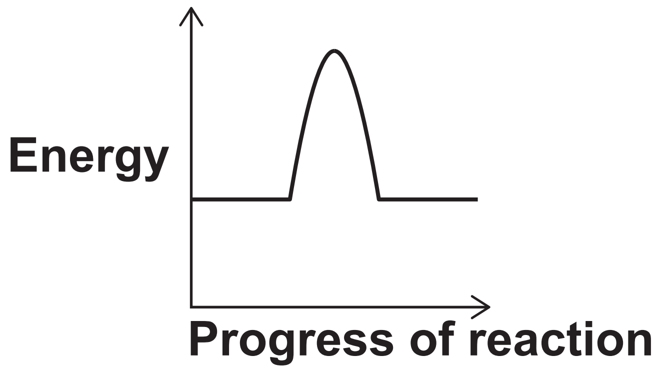
04.7

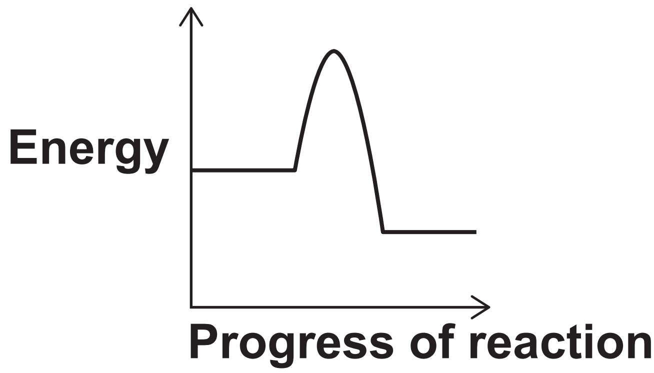
The reaction between copper and oxygen is exothermic.

Which reaction profile represents this reaction?
[1 mark]

Tick (✓) ONE box.







[Turn over]

0 4 . 8

Complete the sentence. [1 mark]

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

____ .

11

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[Turn over]

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 $\rightarrow$ 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.

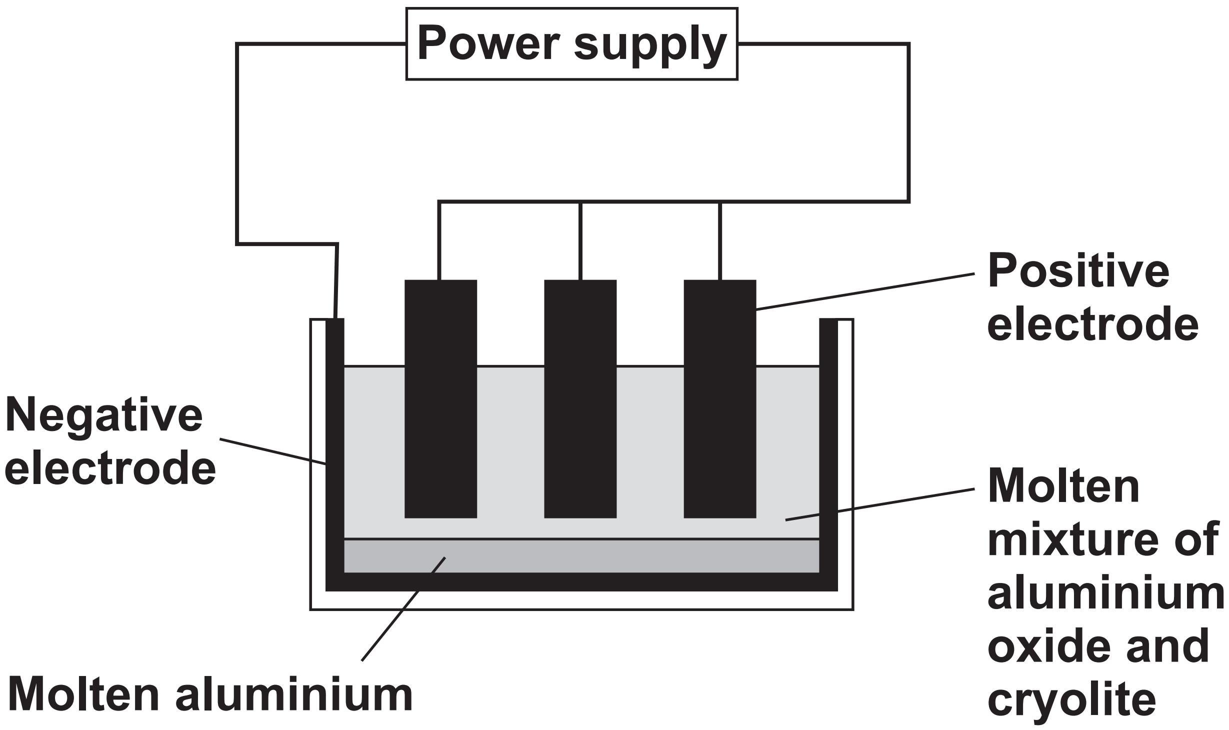
- [ ] **Carbon**
- [ ] **Carbon dioxide**
- [ ] **Iron**
- [ ] **Iron oxide**

[Turn over]

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**

[Turn over]

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]

[Turn over]

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

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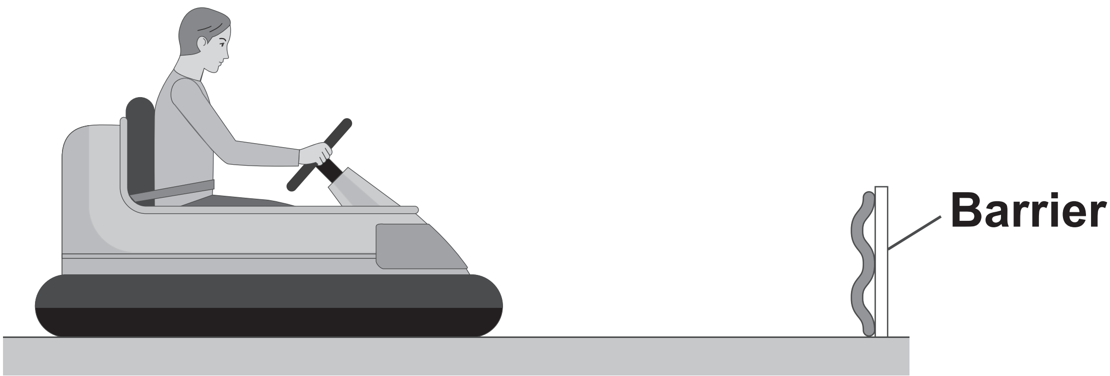
[Turn over]

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:

kinetic energy = 0.5 × mass × $(\text{speed})^2$ [2 marks]

____

____

____

____

____

Kinetic energy = ______________________ J

[Turn over]

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]

[Turn over]

0 6 . 5

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

Complete the sentences.

Choose answers from the list. [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

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[Turn over]

0 7

Calcium carbonate reacts with hydrochloric acid.

The word equation for the reaction is:

calcium carbonate + hydrochloric acid $\longrightarrow$

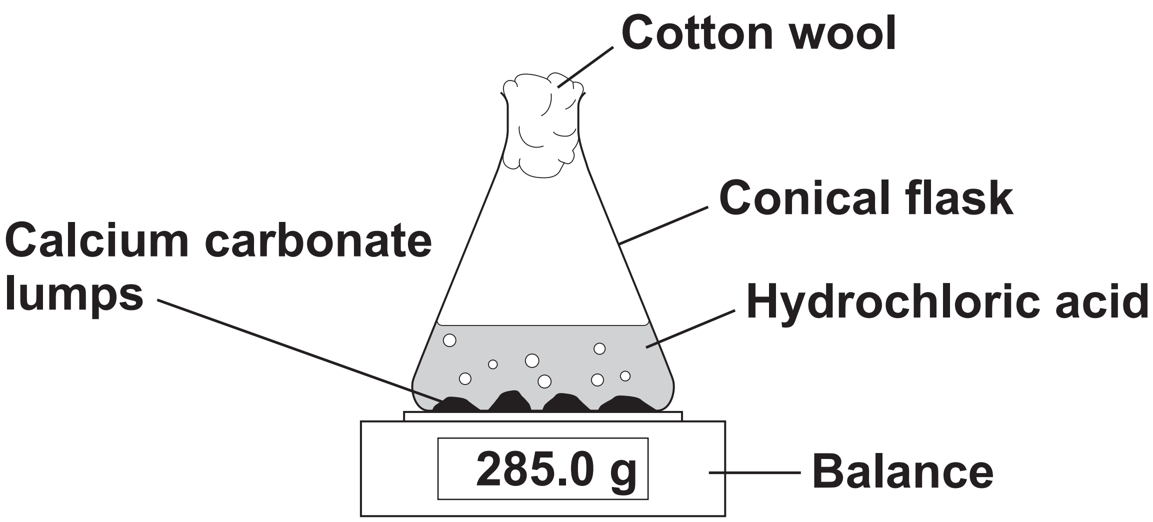
calcium chloride + water + carbon dioxide

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.**

[Turn over]

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]

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

[Turn over]

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, on page 54.

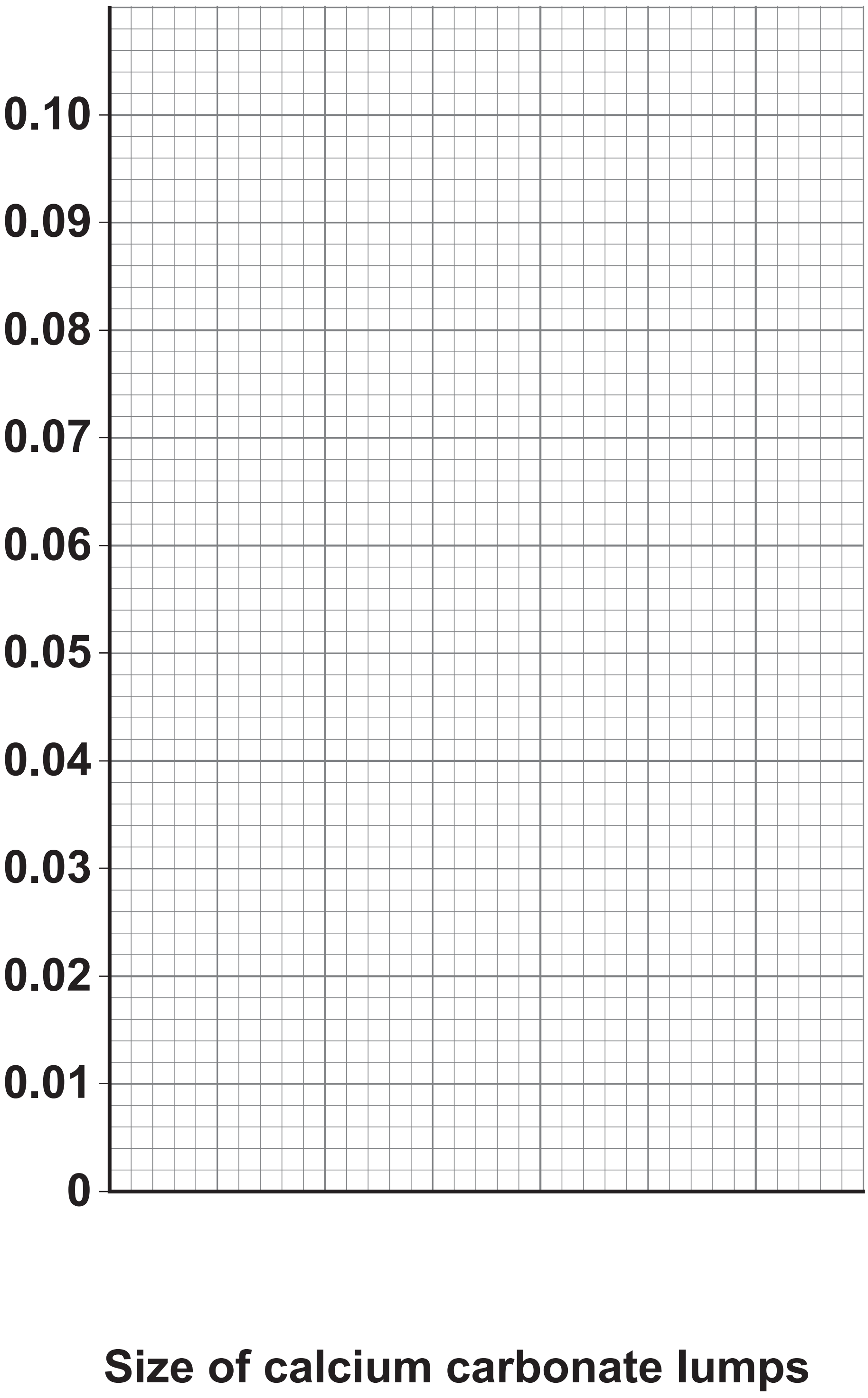
You should:

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

[3 marks]

[Turn over]

FIGURE 7


0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Size of calcium carbonate lumps

0 7 . 6

Why are the results plotted as a bar chart and NOT as a line graph? [1 mark]

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

[Turn over]

0 7 . 7

What effect does the size of the calcium carbonate lumps have on the RATE of reaction?

Use TABLE 3, on page 55. [1 mark]

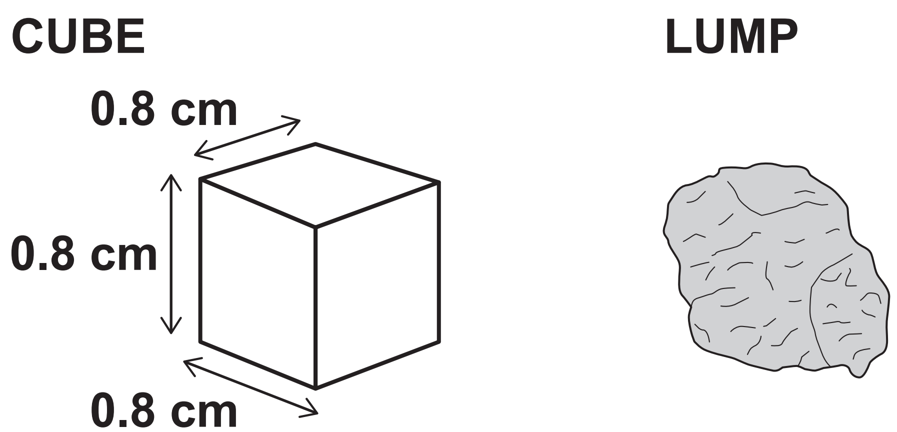
Tick (✓) ONE box.

- [ ] **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.**

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



[Turn over]

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

BLANK PAGE

[Turn over]

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.

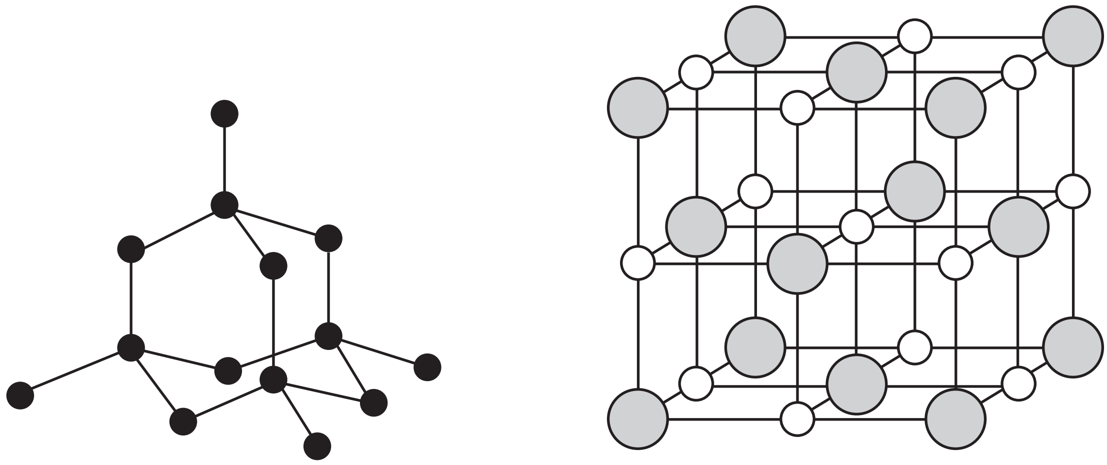
You should answer in terms of electrons. [3 marks]

[Turn over]

0 8 . 3

FIGURE 9 represents the structure of diamond and of sodium chloride.

FIGURE 9



DIAMOND **SODIUM CHLORIDE**

KEY

● C atom ○ Na^+ ion ◯ Cl^- ion

Compare the structure and bonding of diamond with the structure and bonding of sodium chloride. [6 marks]

[Turn over]

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.**

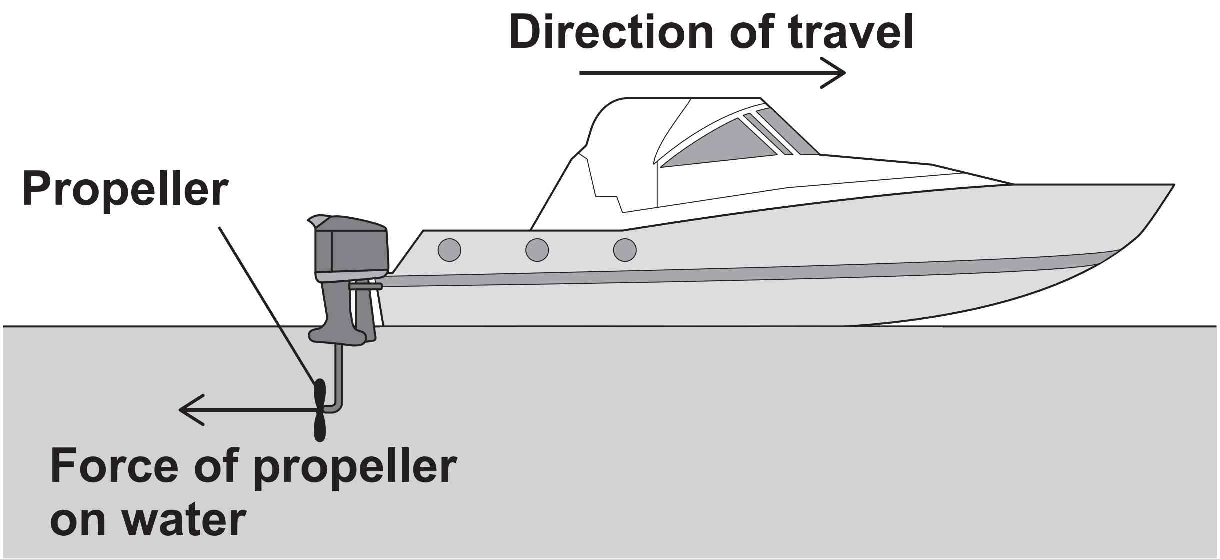
[3 marks]

15

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		

[Turn over]

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]

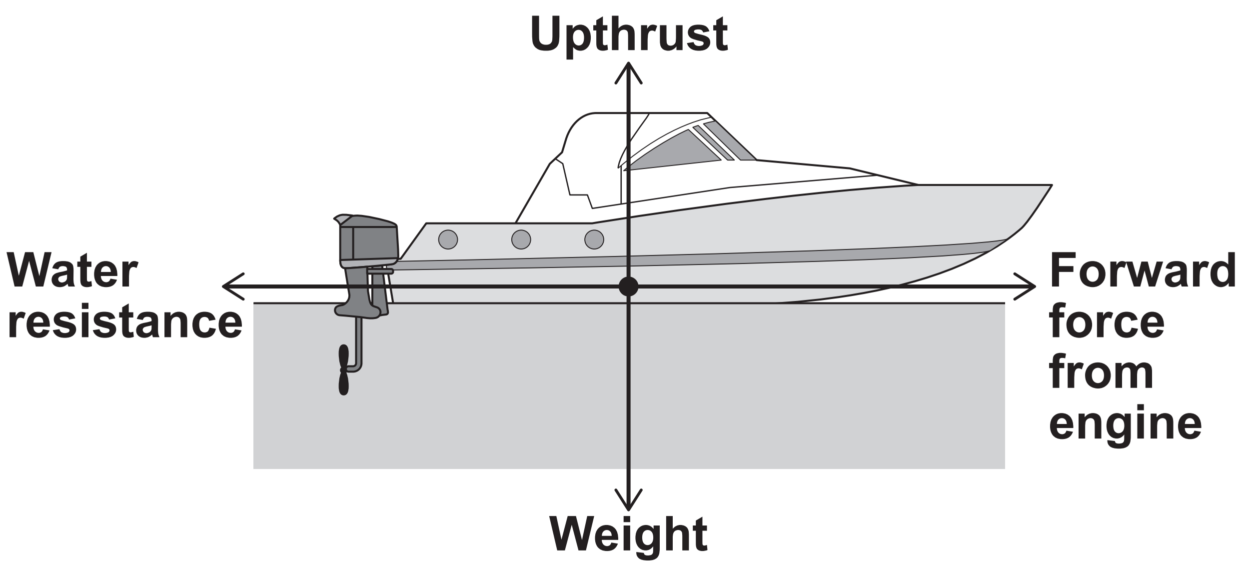
Time = ______________________ s

[Turn over]

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

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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Write the question numbers in the left-hand margin.

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