



**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**

**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 2 8 4 6 5 3 F 0 1

## **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.**
- **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**

---



**01 . 2**

**What is the maximum number of bonds that one carbon atom can form?**

**[1 mark]**

**Tick (✓) ONE box.**

☐

**2**

☐

**3**

☐

**4**

☐

**6**

**[Turn over]**



**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**

**[Turn over]**



0	1	.	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]**



01 . 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.**

<input type="checkbox"/>
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**Cl<sup>-</sup>**

<input type="checkbox"/>
--------------------------

**H<sup>+</sup>**

<input type="checkbox"/>
--------------------------

**Na<sup>+</sup>**

<input type="checkbox"/>
--------------------------

**OH<sup>-</sup>**

**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**

**[Turn over]**



0	2	.	3
---	---	---	---

**Give ONE safety precaution used when measuring the pH of an acid. [1 mark]**

---

---

---



**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**

**[Turn over]**



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

**What is the other product when sodium hydroxide solution reacts with sulfuric acid? [1 mark]**

**Tick (✓) ONE box.**

☐

**Oxygen**

☐

**Sodium**

☐

**Water**





02 . 6

Draw ONE line from each solution to the pH of that solution. [2 marks]

Solution	pH of solution
Sodium hydroxide	2
	7
Sulfuric acid	13

[Turn over]



02 . 7

**What is the type of reaction when sodium hydroxide solution reacts with sulfuric acid? [1 mark]**

**Tick (✓) ONE box.**

☐

**Combustion**

☐

**Decomposition**

☐

**Neutralisation**

8



**BLANK PAGE**

**[Turn over]**



0	3
---	---

**A normal bicycle can be converted into an electric bicycle.**

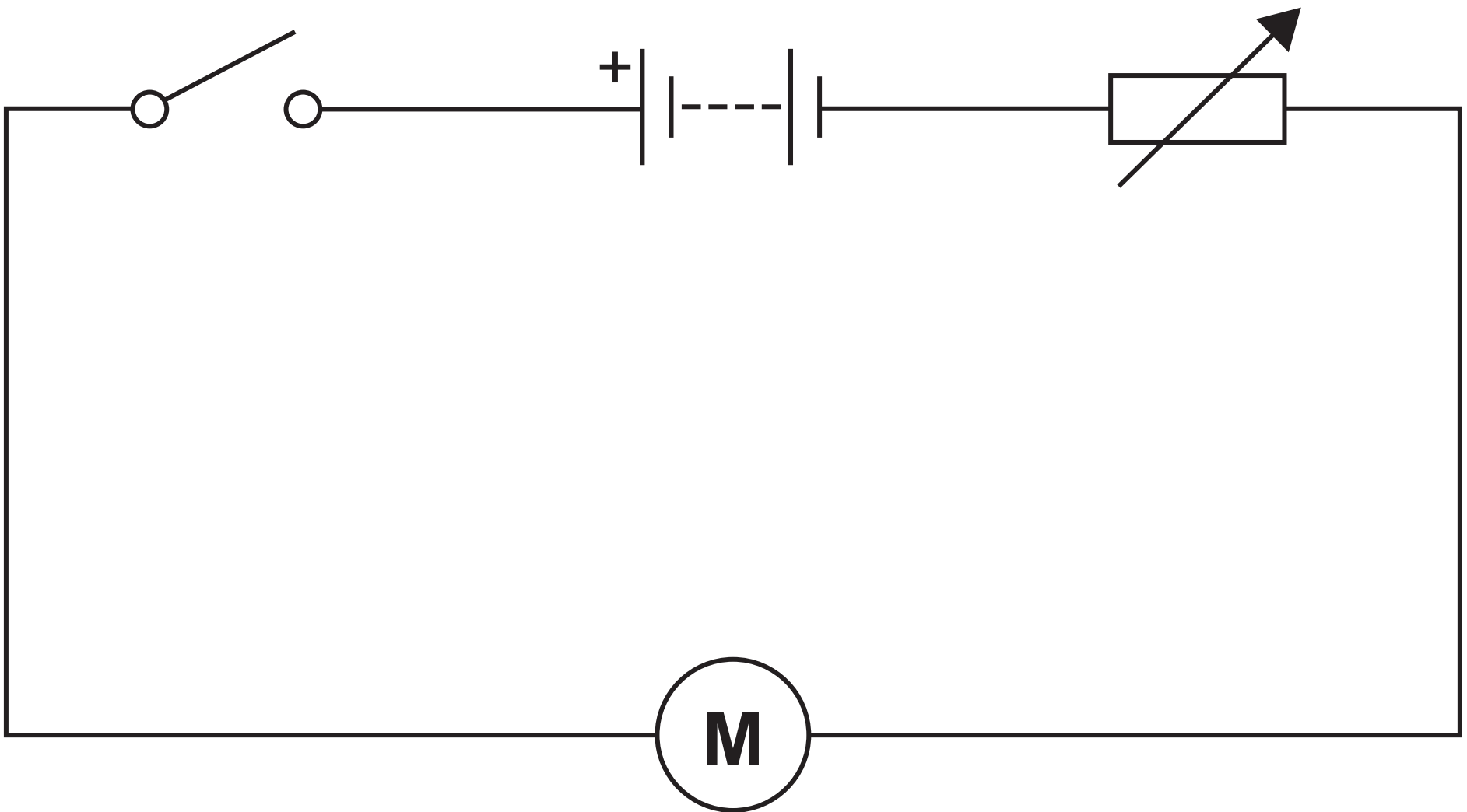
**FIGURE 1 shows a converted bicycle.**

**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**

---

**[Turn over]**



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]

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Current = \_\_\_\_\_ A

[Turn over]



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

A battery supplies direct current.

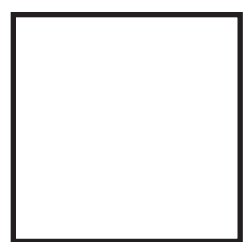
Mains electricity supplies alternating current.

0 3 . 3

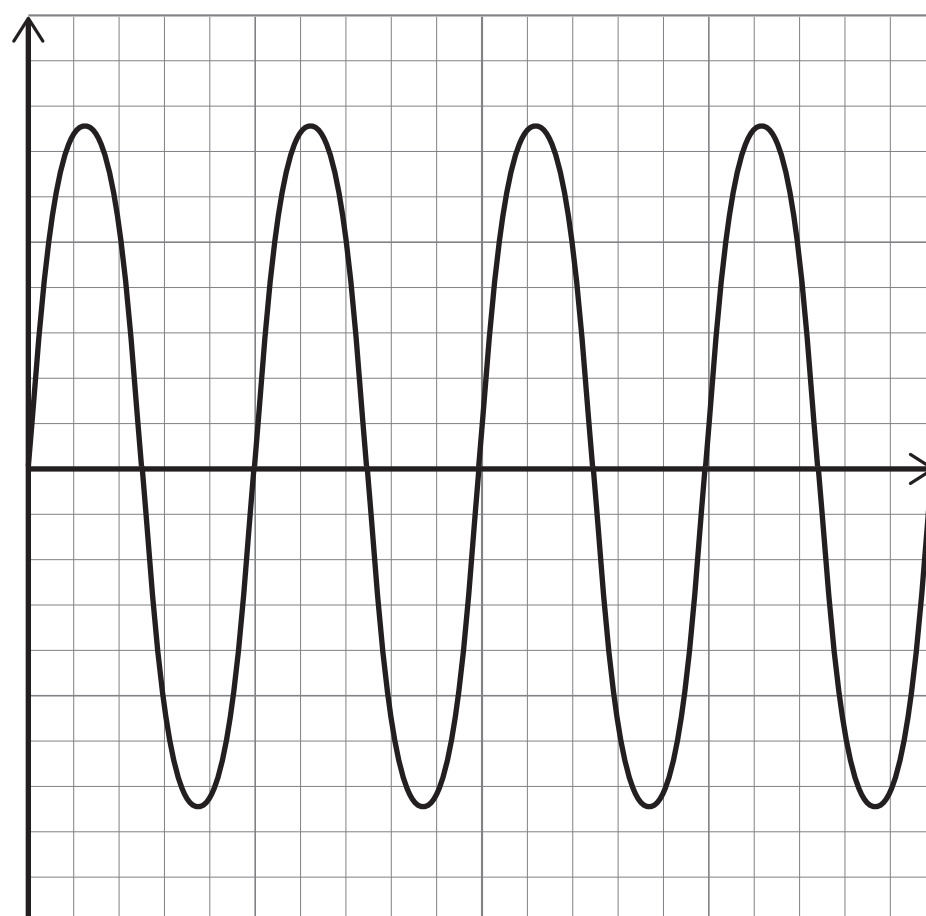
Which graph shows an alternating current? [1 mark]

Tick (✓) ONE box.

Current



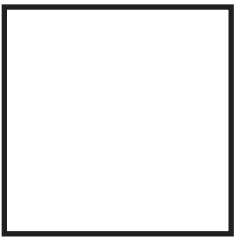
0 A



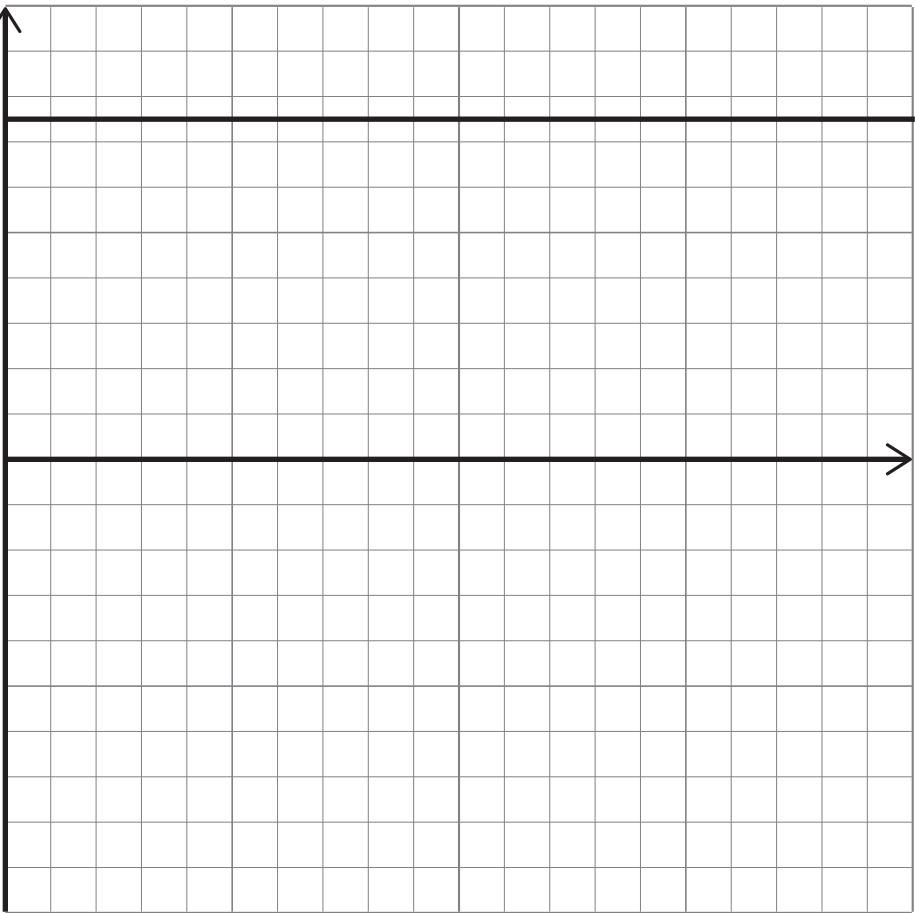
Time



Current

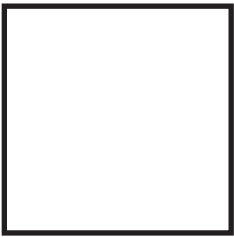


0 A

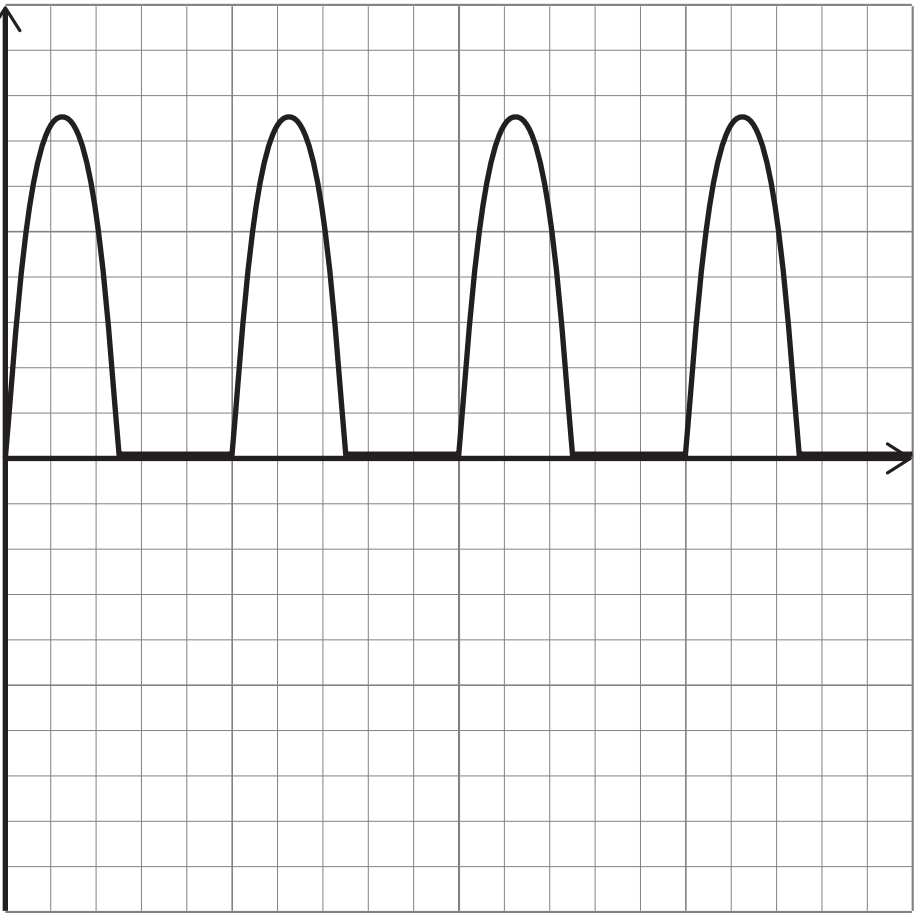


Time

Current



0 A



Time

[Turn over]



0	3	.	4
---	---	---	---

**A diode is used to change the alternating current to a direct current.**

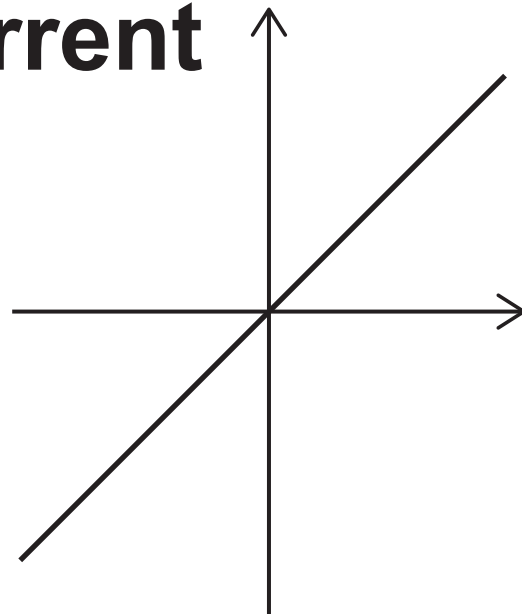
**Which graph shows how the current in a diode varies with potential difference?**  
**[1 mark]**



Tick (✓) ONE box.

☐

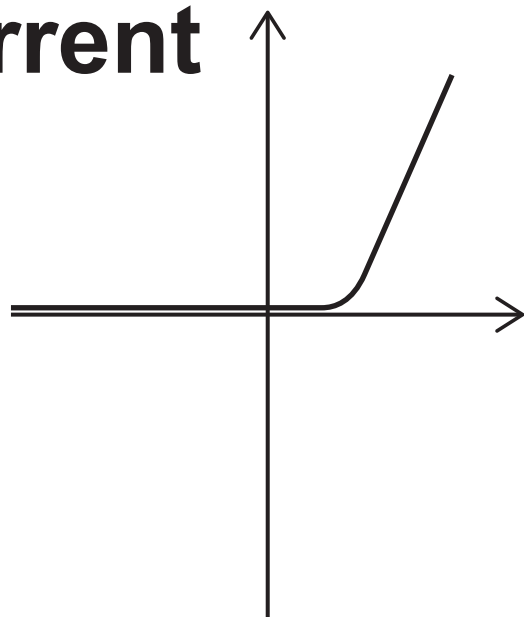
**Current**



**Potential difference**

☐

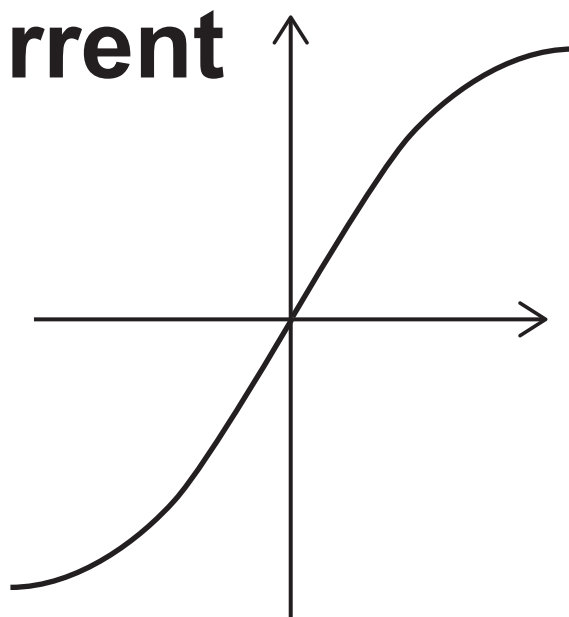
**Current**



**Potential difference**

☐

**Current**



**Potential difference**

**[Turn over]**



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]**

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**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<sub>2</sub>) to produce calcium oxide (CaO).**

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

**Balance the equation for the reaction.**  
**[1 mark]**



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]

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Mass of calcium oxide =

\_\_\_\_\_ g

[Turn over]



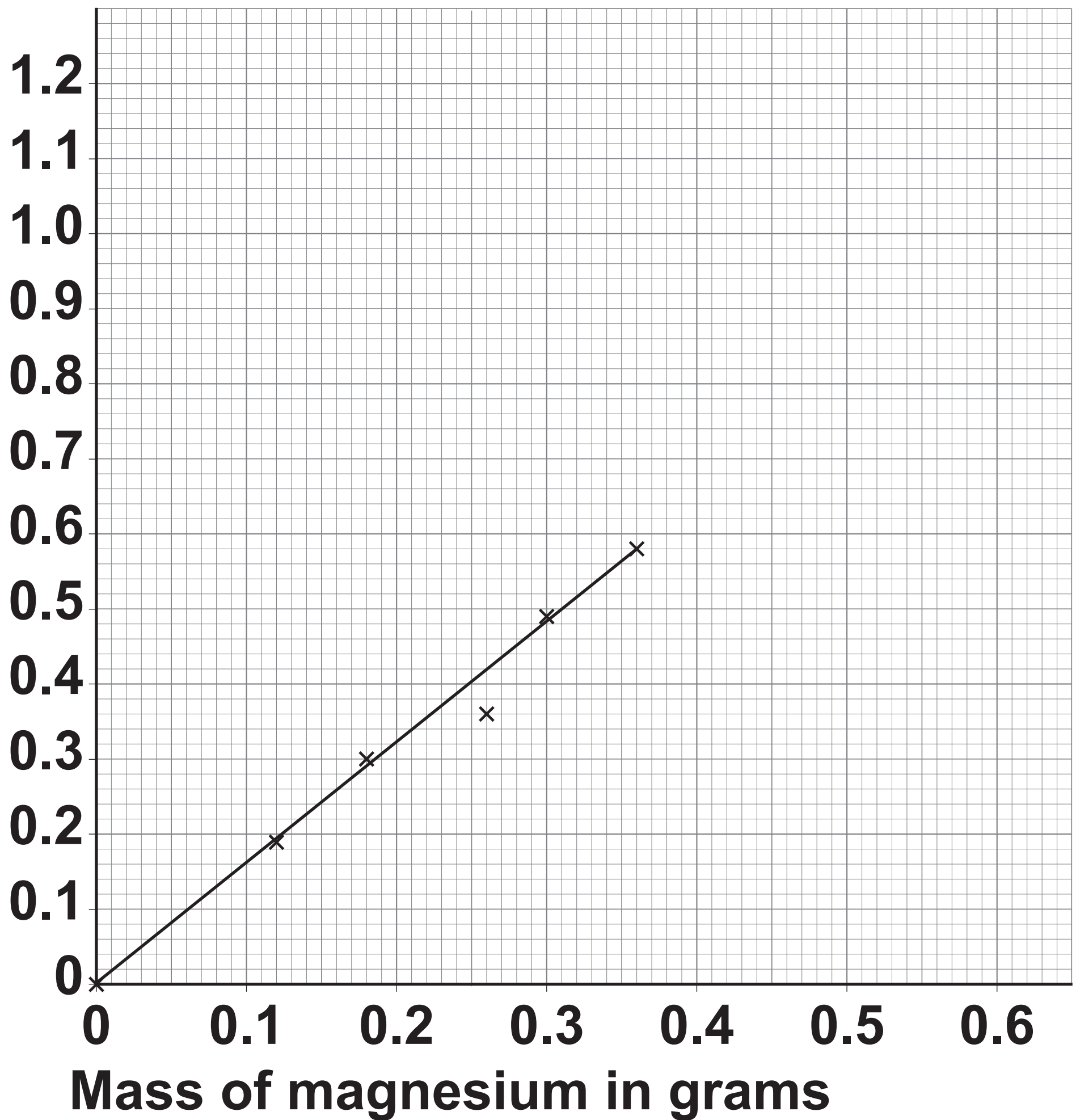
**A student reacted different masses of magnesium with oxygen and measured the mass of magnesium oxide produced.**

**FIGURE 3 shows the results.**



**FIGURE 3**

**Mass of magnesium oxide  
produced in grams**



**[Turn over]**



0	4	.	3
---	---	---	---

**Why did the student ignore one of the points when drawing the line of best fit on FIGURE 3? [1 mark]**

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0	4	.	4
---	---	---	---

**What trend is shown by the results on FIGURE 3?**

**Complete the sentence. [1 mark]**

**As the mass of magnesium increases**

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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

**[Turn over]**





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





4 1

04.6

Calculate mean value X in TABLE 1. [2 marks]

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---

41

Mean value X = \_\_\_\_\_ 9

[Turn over]

0	4	.	7
---	---	---	---

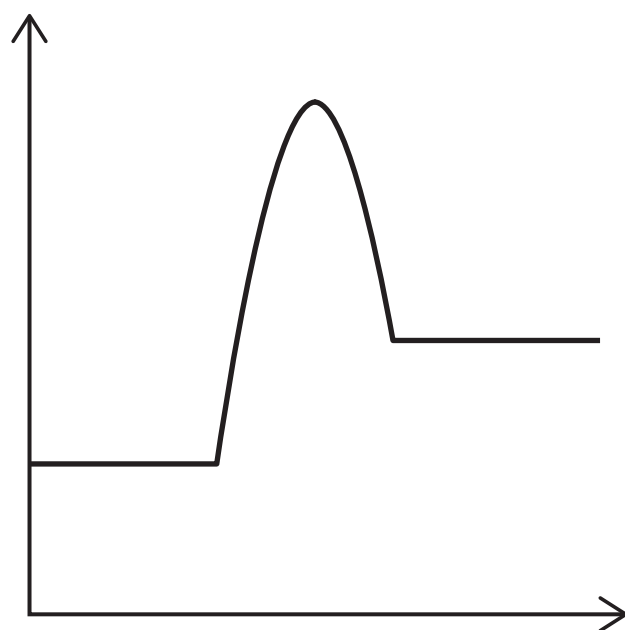
The reaction between copper and oxygen is exothermic.

Which reaction profile represents this reaction? [1 mark]

Tick (✓) ONE box.

☐

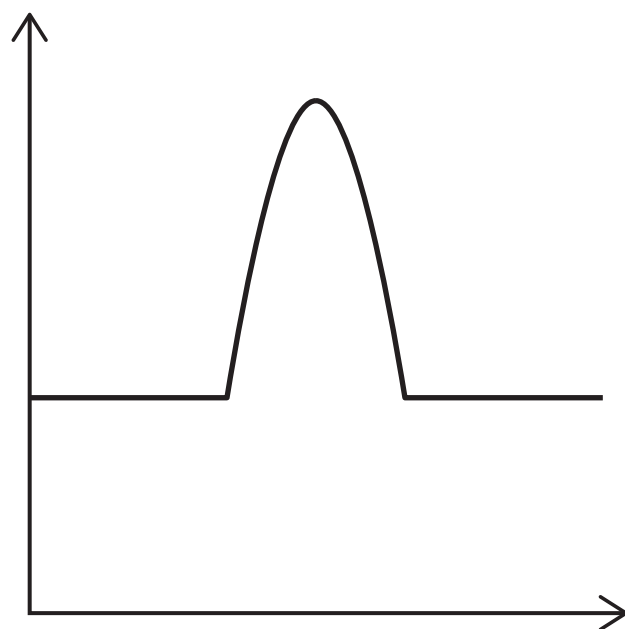
Energy



Progress of reaction

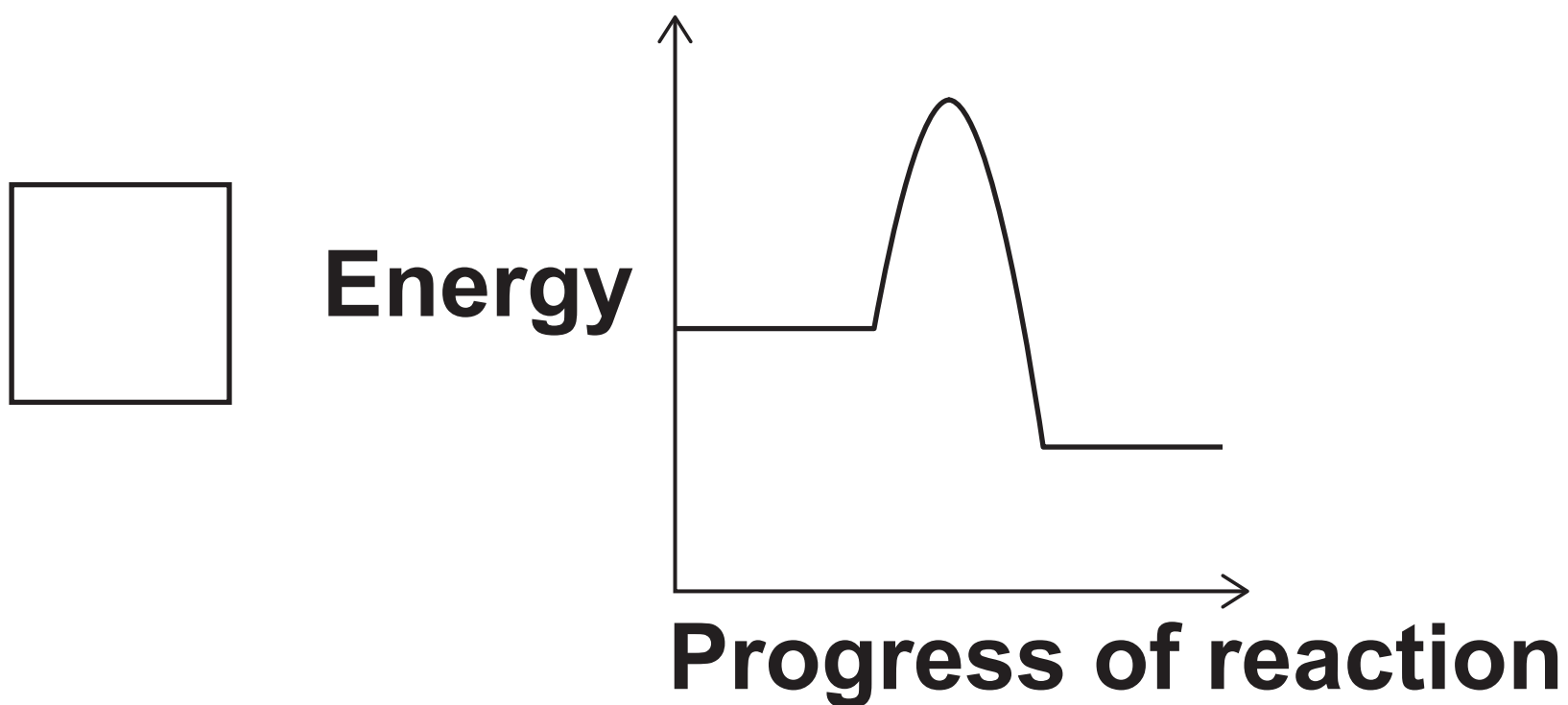
☐

Energy



Progress of reaction





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]**



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.**

**[Turn over]**



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

**Which reactant is reduced? [1 mark]**

**Tick (✓) ONE box.**

☐

**Carbon**

☐

**Carbon dioxide**

☐

**Iron**

☐

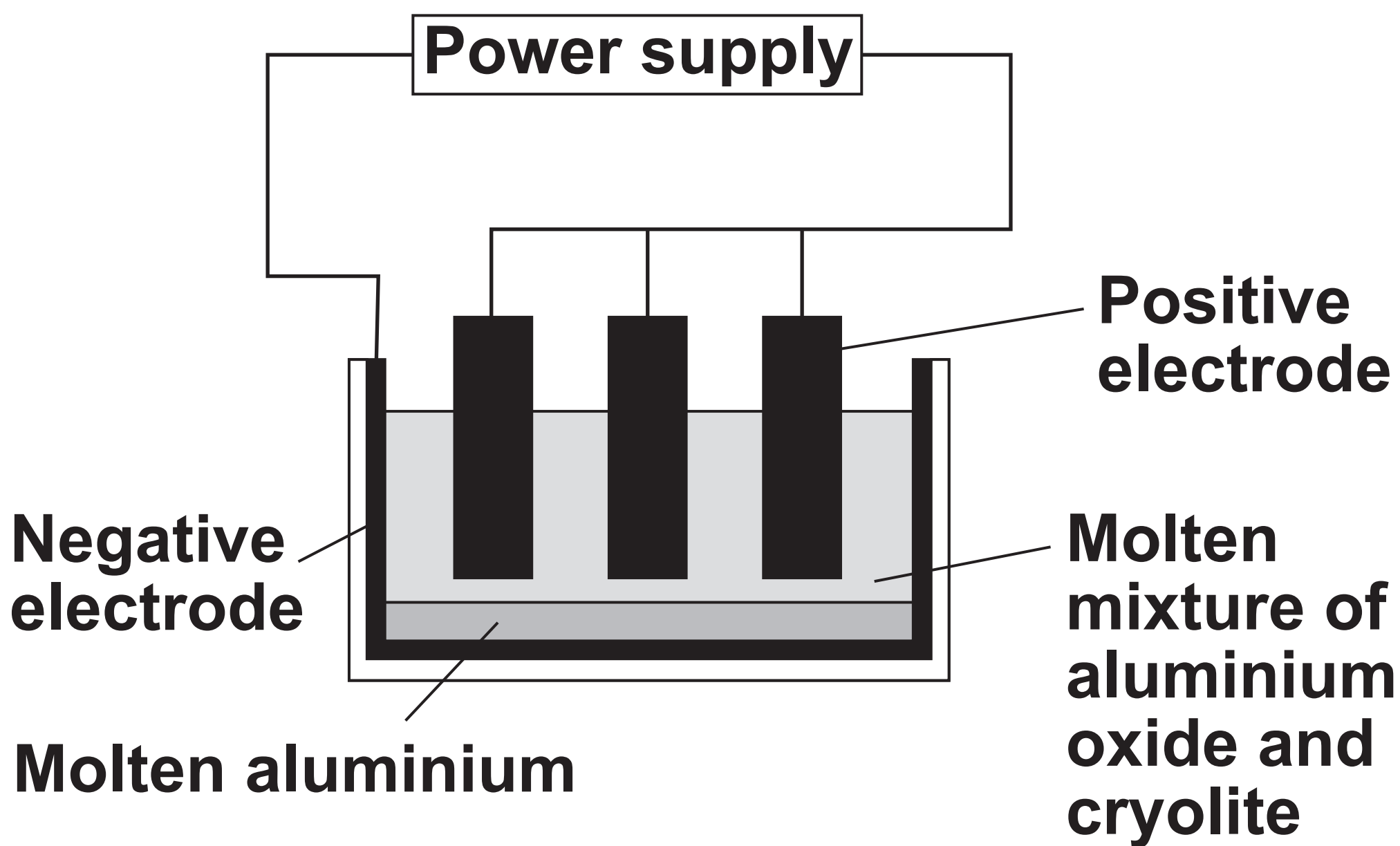
**Iron oxide**



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

FIGURE 4 shows the apparatus.

FIGURE 4



[Turn over]

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

**What are the positive electrodes in  
FIGURE 4 made of? [1 mark]**

**Tick (✓) ONE box.**

☐

**Aluminium**

☐

**Carbon**

☐

**Copper**

☐

**Iron**





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** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**[Turn over]**



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]**

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

**0 5 . 6**

**What is meant by ‘inert’? [1 mark]**

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**[Turn over]**



05 . 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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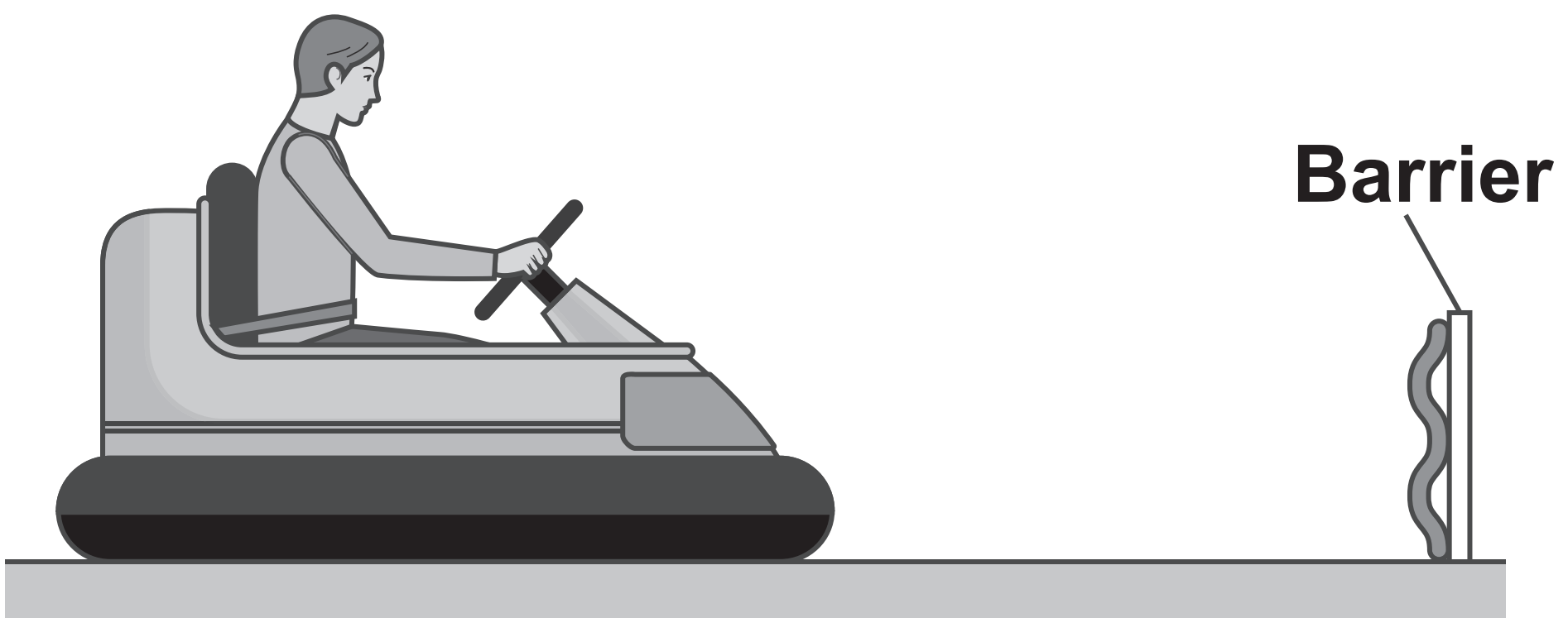
**[Turn over]**



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 =  $0.5 \times \text{mass} \times (\text{speed})^2$**   
**[2 marks]**

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**Kinetic energy =**

**\_\_\_\_\_ J**

**[Turn over]**



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

**06 . 2**

**Write down the equation which links efficiency, total power input and useful power output. [1 mark]**

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**06 . 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]**

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**Useful power output =**

**\_\_\_\_\_ W**

**[Turn over]**



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]**

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---

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
---

[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**

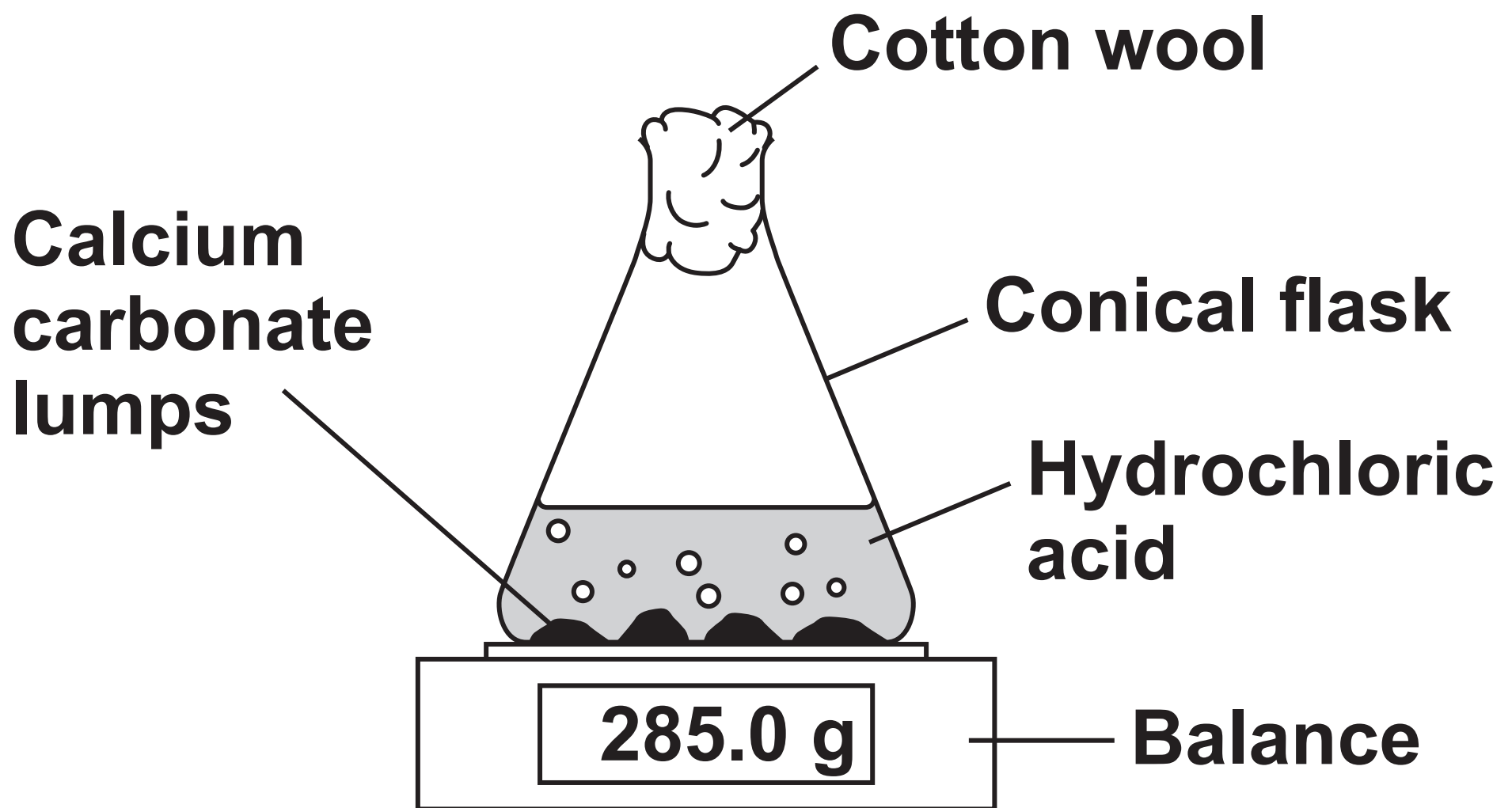
**A student investigated the effect of changing the surface area of the calcium carbonate on the rate of this reaction.**

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



**FIGURE 6** shows the apparatus.

**FIGURE 6**



**[Turn over]**



**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<sup>3</sup> 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**

**[Turn over]**



07 . 2

What was the independent variable in this investigation? [1 mark]

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---



07.3

Give ONE control variable used in this investigation. [1 mark]

---

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---

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 on page 65. [2 marks]**

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**Mean rate of reaction =**

**\_\_\_\_\_ g/s**



0	7	.	5
---	---	---	---

**Complete FIGURE 7, on page 68.**

**You should:**

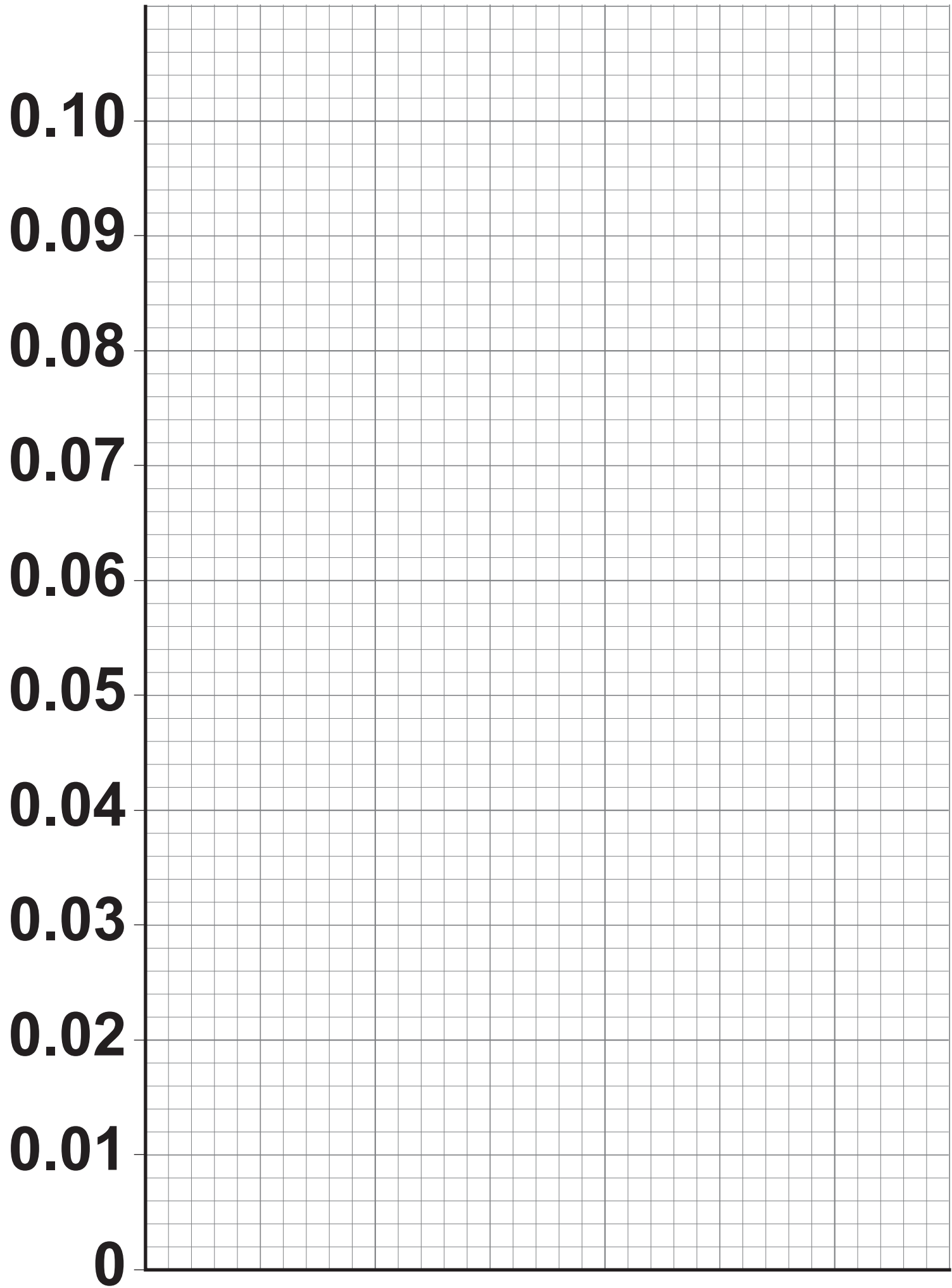
- **label the y-axis**
- **plot the data from TABLE 3 as a bar chart**
- **label each bar.**

**[3 marks]**

**[Turn over]**



FIGURE 7



Size of calcium carbonate lumps



07.6

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

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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 69. [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.**

☐

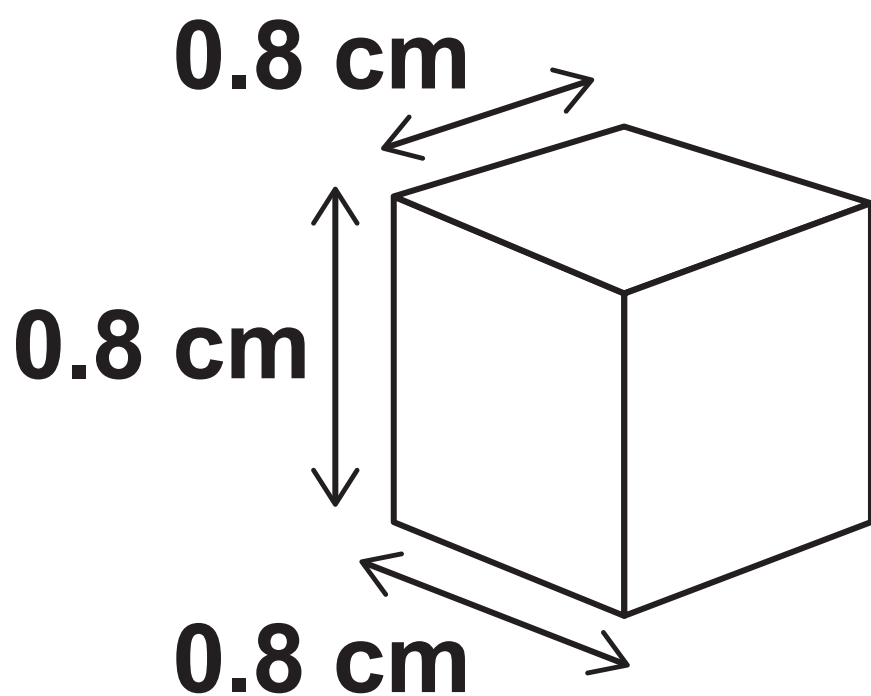
**Increasing the size of the lumps increases the rate of reaction.**

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

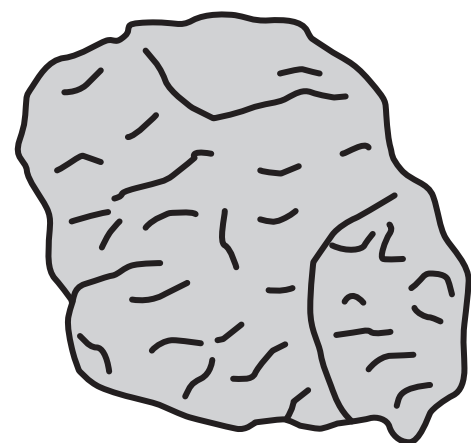
FIGURE 8 shows a cube and a similar-sized calcium carbonate lump.

FIGURE 8

CUBE



LUMP



[Turn over]



0	7	.	8
---	---	---	---

**Calculate the total surface area of the cube in FIGURE 8.**

**Use the equation:**

**total surface area of cube =  
 $6 \times \text{length of one side} \times \text{length of one side}$**

**[2 marks]**

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**Total surface area of cube =**

**\_\_\_\_\_ cm<sup>2</sup>**





0	7	.	9
---	---	---	---

**Suggest ONE reason why the total surface area of the lump in FIGURE 8 is estimated rather than measured.**

**[1 mark]**

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13
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**[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]**

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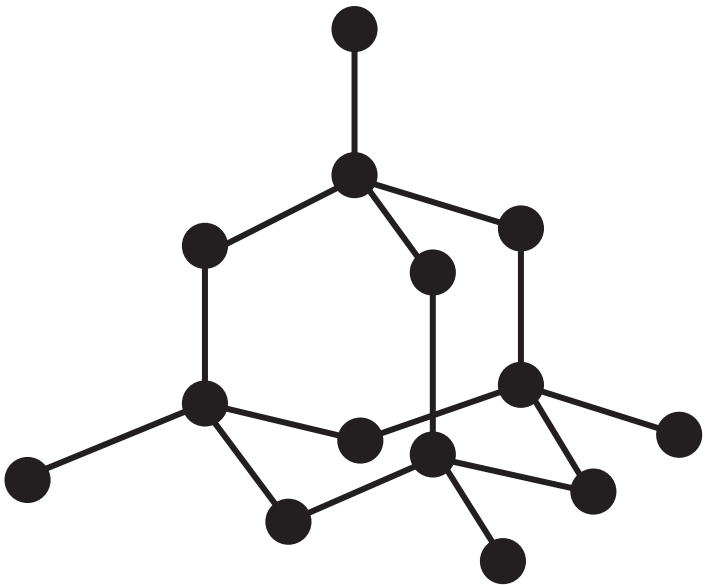
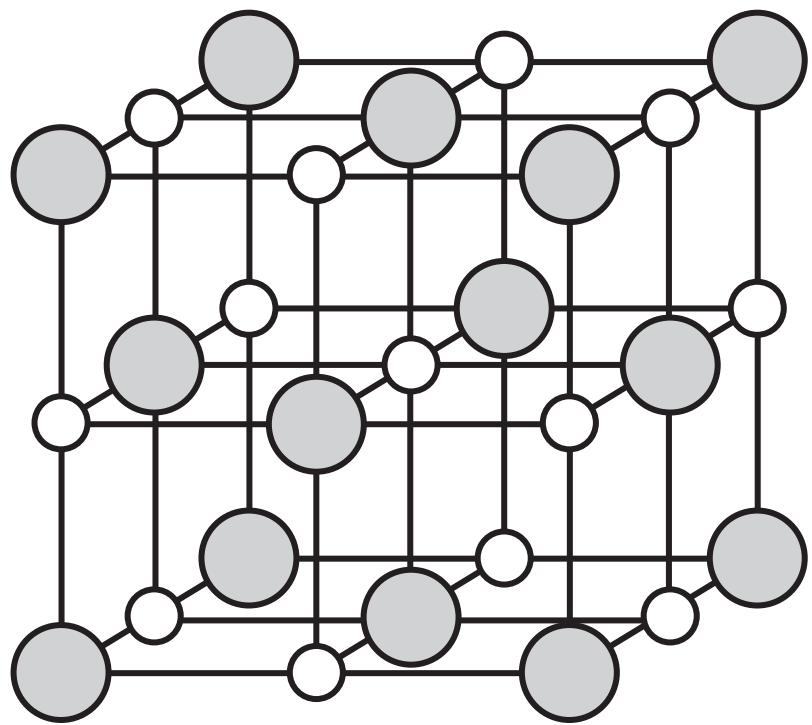
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**[Turn over]**



08 . 3

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

**FIGURE 9****DIAMOND****SODIUM CHLORIDE****KEY**

● C atom    ○ Na<sup>+</sup> ion    ● Cl<sup>-</sup> ion

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

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**[Turn over]**



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Ethene ( $\text{C}_2\text{H}_4$ ) 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]

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---

Relative formula mass =

---

[Turn over]



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]**

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15

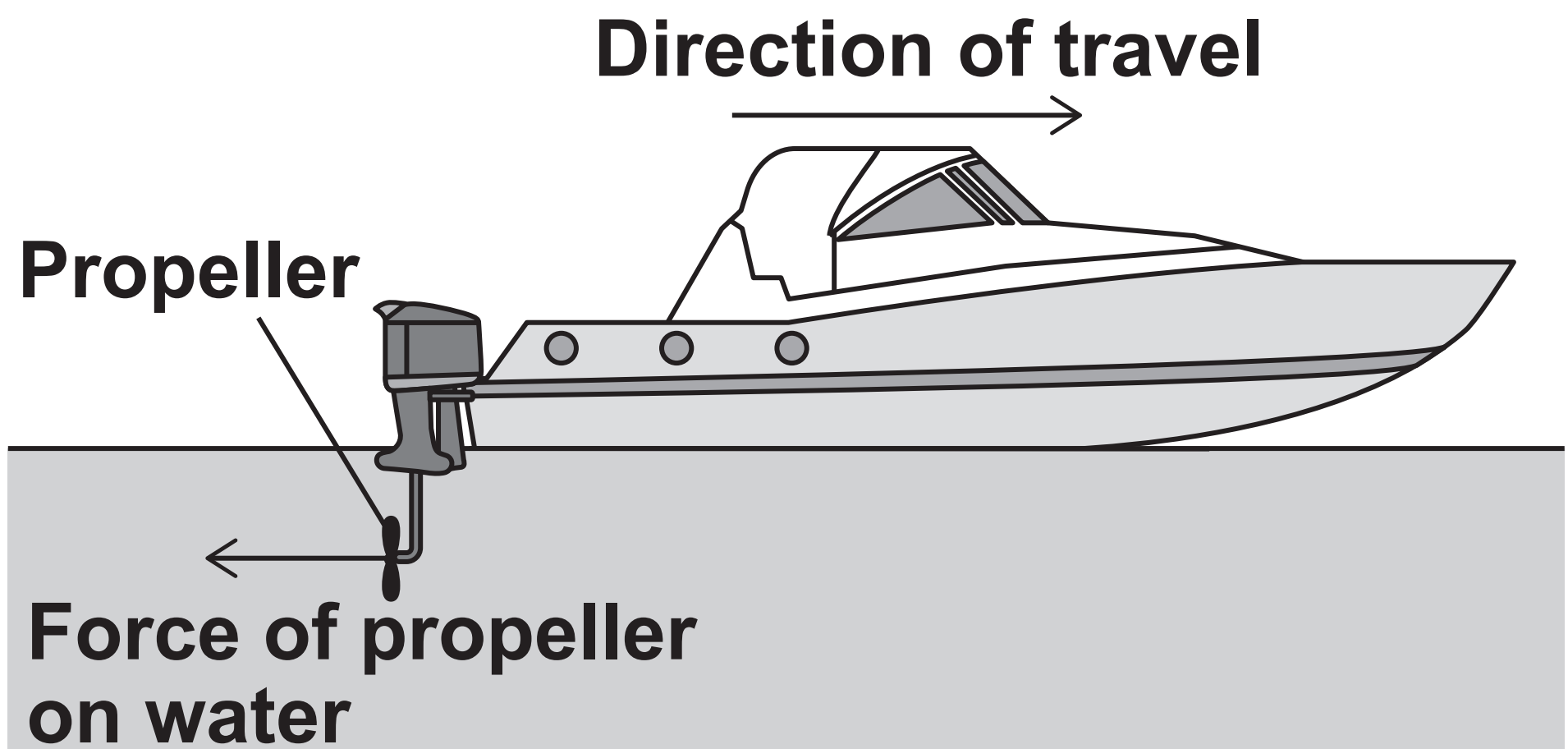
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**FIGURE 10** shows a boat on the sea.

**FIGURE 10**



**The boat is travelling at a constant speed.**



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**Draw an arrow on FIGURE 10 to show the size and direction of the force of the water on the propeller. [2 marks]**

**[Turn over]**



09 . 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		

0	9	.	3
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Which equation links distance ( $s$ ), speed ( $v$ ) and time ( $t$ )? [1 mark]

Tick (✓) ONE box.

☐

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

☐

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

☐

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

☐

$$v = s \times t$$

[Turn over]



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

Calculate the time taken to travel 6000 m.

Use the Physics Equations Sheet.  
[3 marks]

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Time = \_\_\_\_\_ s



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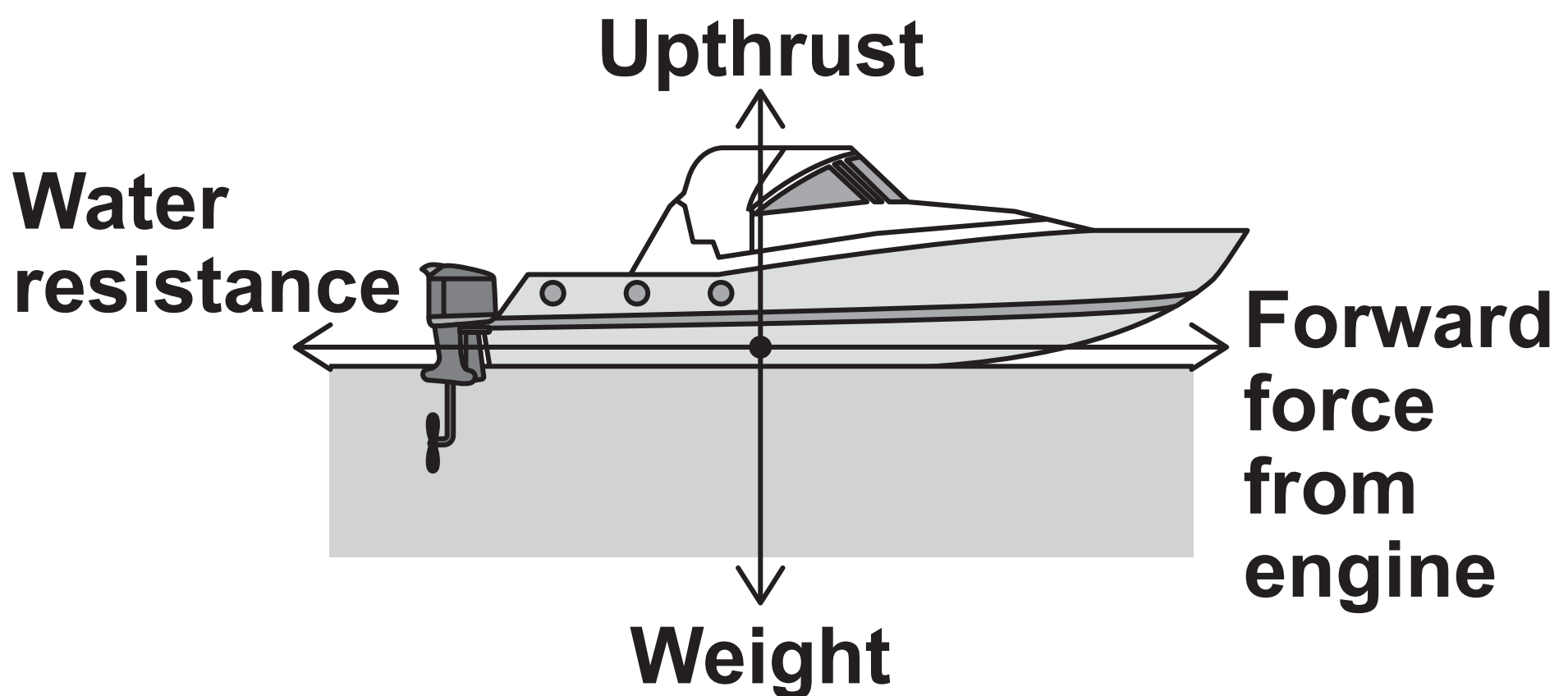
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09 . 5

**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]**

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**[Turn over]**



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END OF QUESTIONS



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