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 4 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 Energy resources are renewable or non-renewable.

0 1 . 1 Which **two** energy resources are non-renewable?

[2 marks]

Tick (✓) **two** boxes.

Coal ☐

Nuclear ☐

Tidal ☐

Wave ☐

Wind ☐

0 1 . 2 Why has the electricity demand per person in the UK decreased over the past five years?

[1 mark]

Tick (✓) **one** box.

Energy-efficient appliances are being bought. ☐

Power stations are generating more electricity. ☐

The number of electric cars in the UK has increased. ☐

Do not write outside the box

0 1 . 3 Which energy resource releases carbon dioxide when burnt?

[1 mark]

Tick (✓) **one** box.

Crude oil ☐

Hydroelectric ☐

Solar ☐

Uranium ☐

Question 1 continues on the next page

Do not write outside the box

Some heating appliances burn natural gas.

Burning natural gas produces a third of the UK's carbon dioxide emissions.

Scientists are investigating whether these heating appliances can burn a mixture of hydrogen gas and natural gas.

0 1 . 4 In a 2.0 kg mixture of hydrogen gas and natural gas there is 0.4 kg of hydrogen gas.

Calculate the percentage by mass of hydrogen gas in this mixture.

[2 marks]

Percentage by mass of hydrogen gas = _____ %

0 1 . 5 Burning a mixture of hydrogen gas and natural gas releases less carbon dioxide compared with burning only natural gas.

Explain **one** advantage of releasing less carbon dioxide into the atmosphere.

[2 marks]

8

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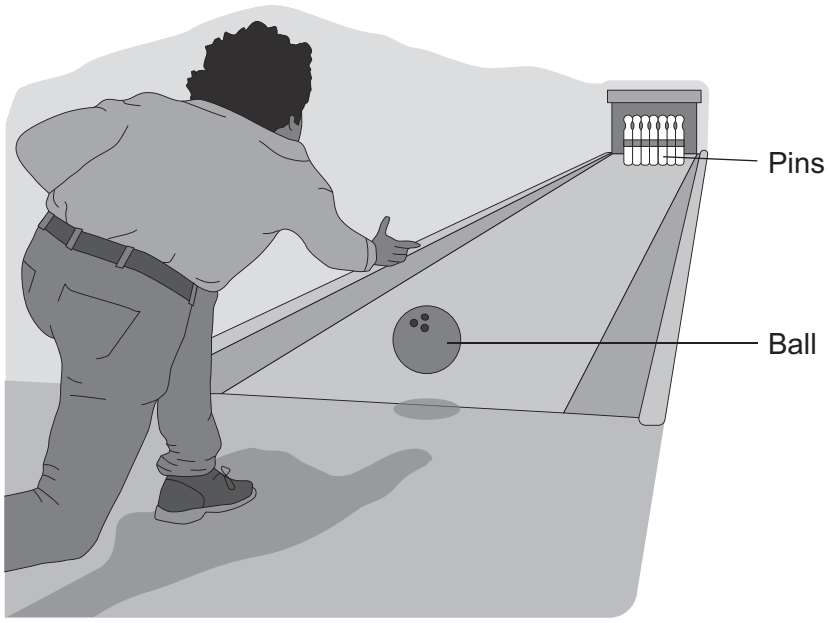
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ANSWER IN THE SPACES PROVIDED

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0 2 Ten-pin bowling is a game where a ball is rolled along the floor to knock over some wooden pins.

Figure 1 shows a person ten-pin bowling.

Figure 1



0 2 . 1 The speed of the ball was 8.0 m/s just after leaving the person's hand.

The mass of the ball was 5.5 kg.

Calculate the kinetic energy of the ball.

Use the equation:

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

[2 marks]

Kinetic energy = _____ J

Do not write outside the box

0 2 . 2 When the ball collides with the pins, energy is conserved.

What is meant by 'conservation of energy' when the ball collides with the pins?

[1 mark]

Tick (✓) **one** box.

The gravitational potential energy of the pins is the same before and after the collision. ☐

The kinetic energy of the ball is the same before and after the collision. ☐

The total energy of the ball and pins is the same before and after the collision. ☐

A machine returns the ball to the person.

0 2 . 3 The machine takes 25.0 s to return the ball to the person.

The useful power output of the machine is 660 W.

Calculate the work done by the machine in returning the ball to the person.

Use the equation:

work done = power × time

[2 marks]

Work done = _____ J

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 The machine has an efficiency of 0.60

The useful power output of the machine is 660 W.

Calculate the total power input to the machine.

Use the equation:

$$\text{total power input} = \frac{\text{useful power output}}{\text{efficiency}}$$

[2 marks]

Total power input = _____ W

0 2 . 5 The machine has several moving parts.

What is the name of the force caused by the moving parts rubbing together?

[1 mark]

0 2 . 6 What happens to the wasted energy from the machine?

[1 mark]

Tick (✓) **one** box.

The wasted energy cools the surroundings. ☐

The wasted energy heats the surroundings. ☐

The wasted energy is destroyed. ☐

9

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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 the reaction between hydrochloric acid and sodium hydroxide solution.

A student investigated the effect of changing the volume of sodium hydroxide solution on the temperature change during the reaction.

This is the method used.

1. Measure 30 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add 5 cm^3 of sodium hydroxide solution.
4. Stir the mixture.
5. Measure the highest temperature the mixture reaches.
6. Repeat steps 1 to 5 three more times and calculate the mean temperature change.
7. Repeat steps 1 to 6 with different volumes of sodium hydroxide solution.

0 3 . 1 What **two** pieces of equipment should be used in this investigation?

[2 marks]

Tick (✓) **two** boxes.

- Balance ☐
- Measuring cylinder ☐
- Ruler ☐
- Stopclock ☐
- Thermometer ☐

Do not write outside the box

0 3 . 2 **Table 1** shows the results for one volume of sodium hydroxide solution.

Table 1

Temperature change in ºC				
Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
7.0	7.2	6.6	6.8	**X**

Calculate value **X** in **Table 1**.

[2 marks]

_____

_____

_____

X = _____ °C

0 3 . 3 Which type of error is reduced by repeating the tests and calculating the mean?

[1 mark]

Tick (✓) **one** box.

Random ☐

Systematic ☐

Zero ☐

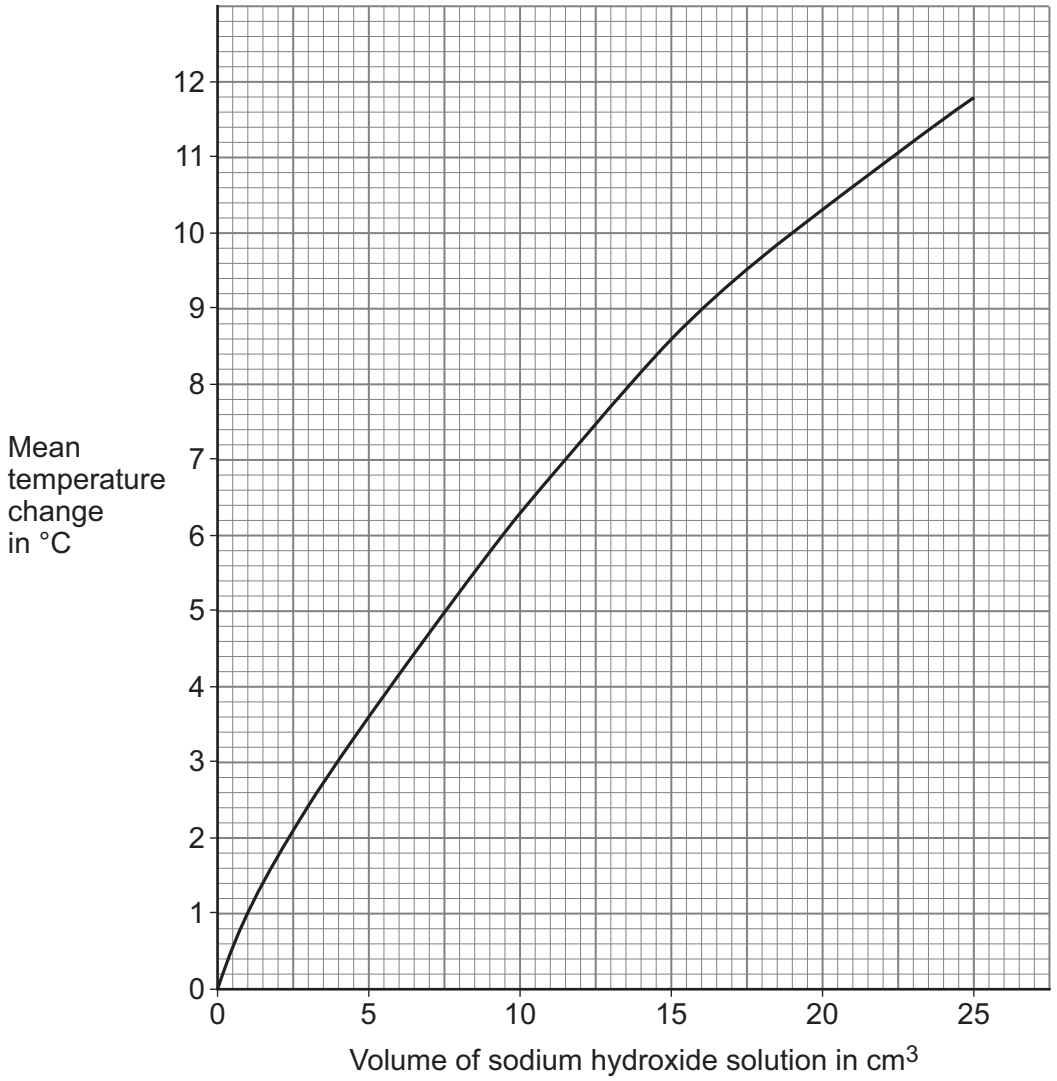
Question 3 continues on the next page

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A different student did the same investigation.

Figure 2 shows the results.

Figure 2



Do not write outside the box

0 3 . 4 What was the mean temperature change when the volume of sodium hydroxide solution was 15 cm^3?

Use **Figure 2**.

[1 mark]

Mean temperature change = _____ °C

0 3 . 5 Give **one** conclusion from the results in **Figure 2**.

[1 mark]

_____

_____

_____

Question 3 continues on the next page

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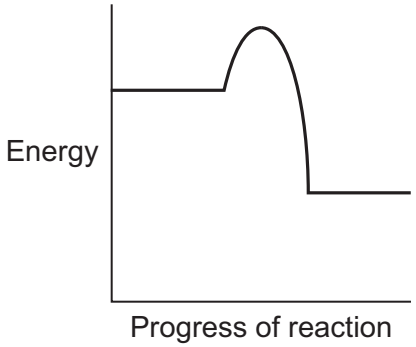
0 3 . 6 The reaction between hydrochloric acid and sodium hydroxide is exothermic.

Exothermic reactions give out energy.

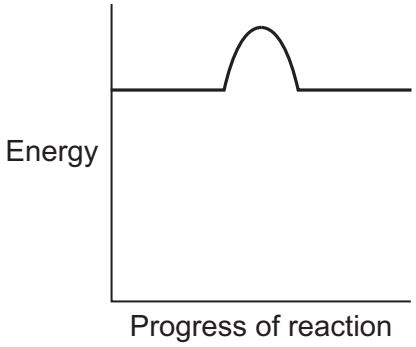
Which reaction profile shows an exothermic reaction?

[1 mark]

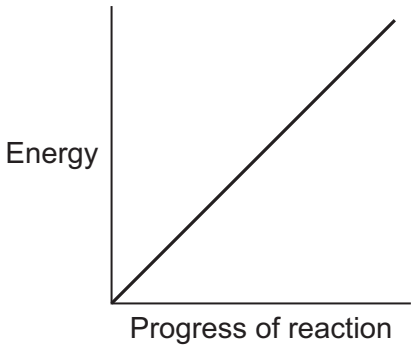
Tick (✓) **one** box.



☐



☐



☐

Do not write outside the box

0 3 . 7 Calculate the relative formula mass (M_r) of sodium hydroxide (NaOH).

Relative atomic masses (A_r): Na = 23 O = 16 H = 1

[2 marks]

_____

_____

_____

Relative formula mass = _____

10

Turn over for the next question

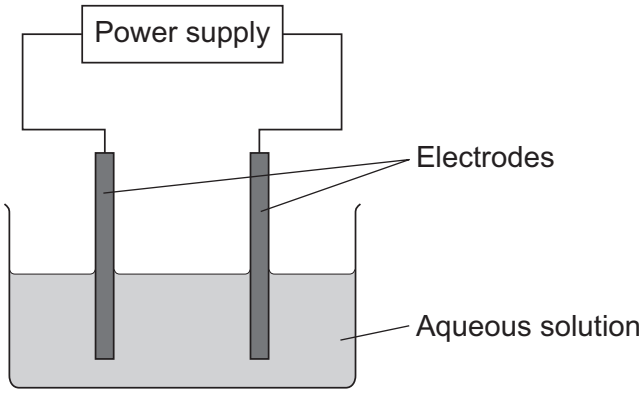
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0 4 This question is about electrolysis.

A student investigated the electrolysis of aqueous solutions using inert electrodes.

Figure 3 shows the apparatus used.

Figure 3



0 4 . 1 The electrodes are made of graphite.

Which element is graphite a form of?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Carbon ☐

Copper ☐

Silicon ☐

Do not write outside the box

0 4 . 2 The electrodes are inert.

What does 'inert' mean?

[1 mark]

_____

_____

0 4 . 3 What is meant by an 'aqueous solution'?

[1 mark]

_____

Question 4 continues on the next page

Do not write outside the box

The student electrolysed four aqueous solutions.

Table 2 shows some of the results.

Table 2

Aqueous solution	Product at negative electrode	Product at positive electrode
Copper bromide		bromine
Copper chloride	copper	chlorine
Sodium bromide	hydrogen	
Sodium sulfate		oxygen

0 4 . 4 Complete **Table 2**.

Choose answers from the box.

[3 marks]

bromine	**chlorine**	**copper**	**hydrogen**	**oxygen**	**sodium**

Do not write outside the box

0 4 . 5 An aqueous solution of copper chloride was electrolysed.

Give **one** observation seen at the:

- negative electrode
- positive electrode.

Use **Table 2**.

[2 marks]

Negative electrode _____

_____

Positive electrode _____

_____

0 4 . 6 What would you use to test for chlorine gas?

[1 mark]

Tick (✓) **one** box.

A burning splint ☐

A glowing splint ☐

Damp litmus paper ☐

0 4 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

gaseous	**molten**	**solid**

Copper chloride can conduct electricity when in aqueous solution

or when _____ .

10

Turn over ▶

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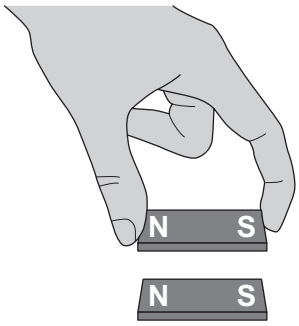
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ANSWER IN THE SPACES PROVIDED

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0 5 **Figure 4** shows a student holding a magnet near another magnet.

Figure 4



0 5 . 1 Which of the following describes the force between the two magnets?

[1 mark]

Tick (✓) **one** box.

An electrostatic force ☐

A frictional force ☐

A non-contact force ☐

Question 5 continues on the next page

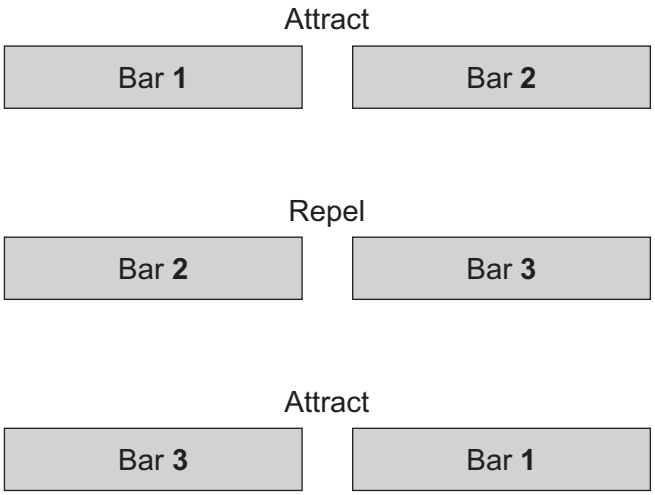
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0 5 . 2 **Figure 5** shows three metal bars, **1**, **2** and **3**.

Two of the bars are permanent magnets and the other bar is made of iron.

The student recorded whether the bars were attracted or repelled when different ends were placed near to each other.

Figure 5



Which metal bars are magnets?

[2 marks]

Tick (✓) **one** box.

Bars **1** and **2** ☐

Bars **2** and **3** ☐

Bars **3** and **1** ☐

Give a reason for your answer.

_____

_____

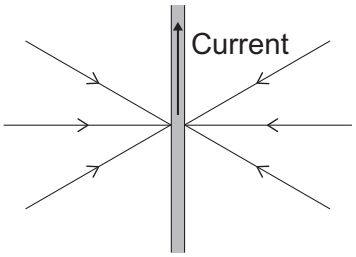
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0 5 . 3 When there is a current in a wire there is a magnetic field around the wire.

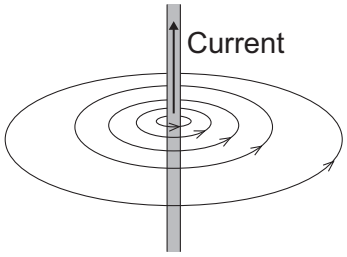
Which diagram shows the magnetic field around the wire?

[1 mark]

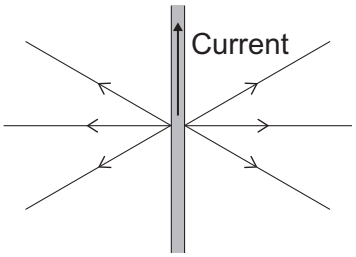
Tick (✓) **one** box.



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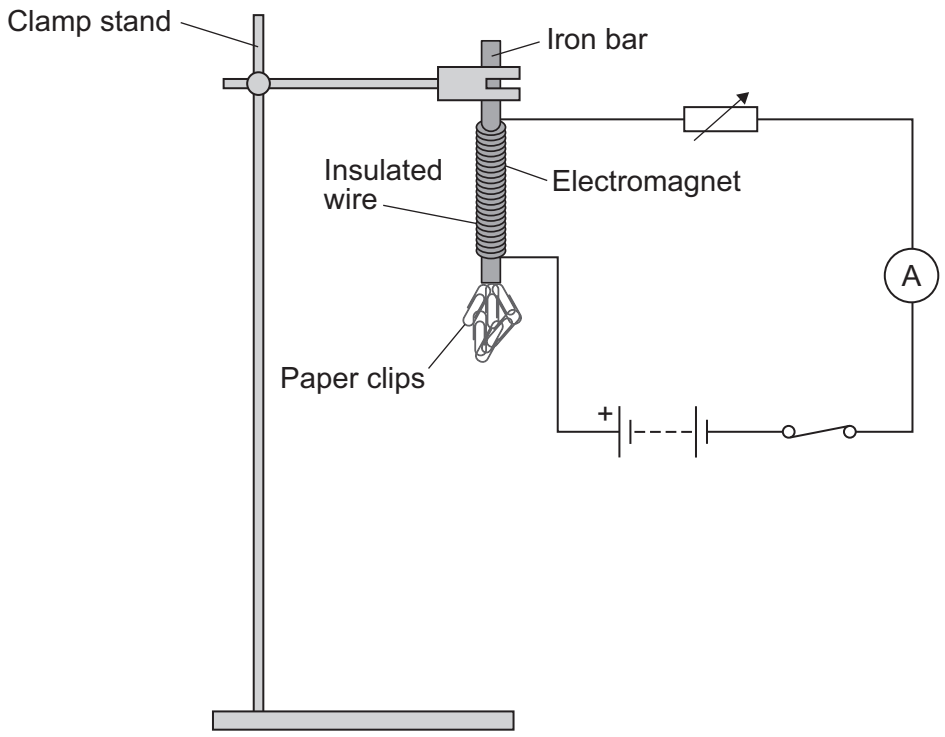
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Question 5 continues on the next page

Do not write outside the box

Figure 6 shows the equipment a student used to investigate the strength of an electromagnet.

Figure 6



This is the method used.

1. Wrap insulated wire around an iron bar.
2. Connect the wire to a battery to make an electromagnet.
3. Hold paperclips near to the bottom of the electromagnet.
4. Count the number of paper clips the electromagnet picks up.
5. Repeat steps 3 and 4 for different values of current.

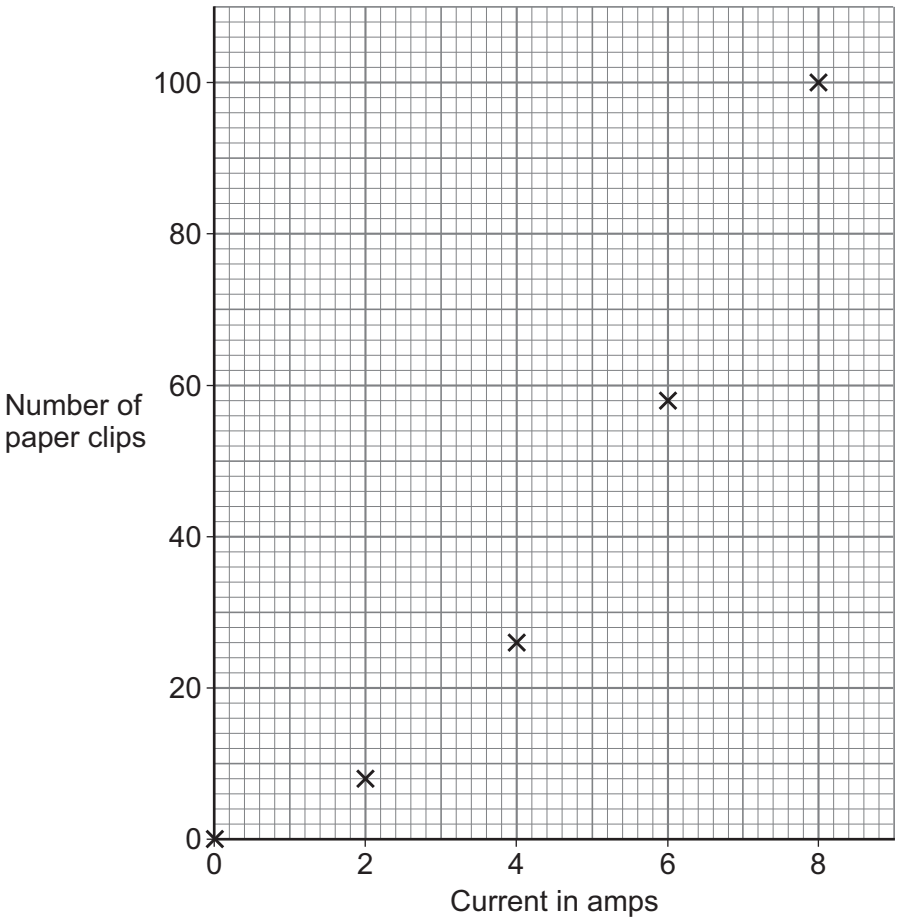
0 5 . 4 Give **one** way the size of the current in the circuit in **Figure 6** can be changed.

[1 mark]

Do not write outside the box

Figure 7 shows the results.

Figure 7



0 5 . 5 Draw a line of best fit on **Figure 7**.

[1 mark]

0 5 . 6 The student used an interval of 2 A for current in the investigation.

Explain why the student should have used a smaller interval for current.

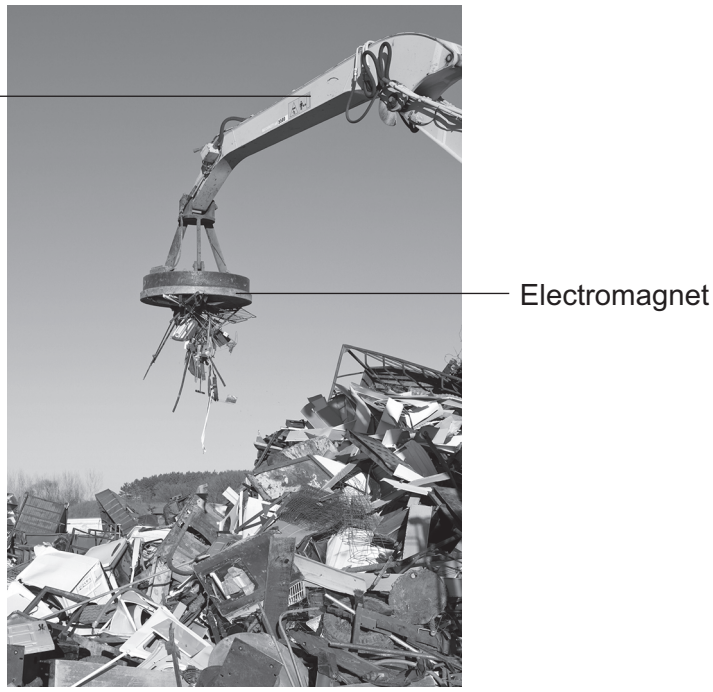
[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 7 **Figure 8** shows an electromagnet being used to separate metals to be recycled.

Figure 8



Explain the advantage of using an electromagnet instead of a permanent magnet.

[2 marks]

10

Do not write outside the box

0 6 This question is about magnesium oxide.

0 6 . 1 What type of substance is magnesium oxide?

[1 mark]

Tick (✓) **one** box.

Compound ☐

Element ☐

Mixture ☐

0 6 . 2 Magnesium reacts with oxygen to produce magnesium oxide.

Balance the equation for the reaction.

[1 mark]

$$2\,Mg(s) + O_2(g) \longrightarrow ____ MgO(s)$$

0 6 . 3 What does the state symbol '(s)' represent?

[1 mark]

_____

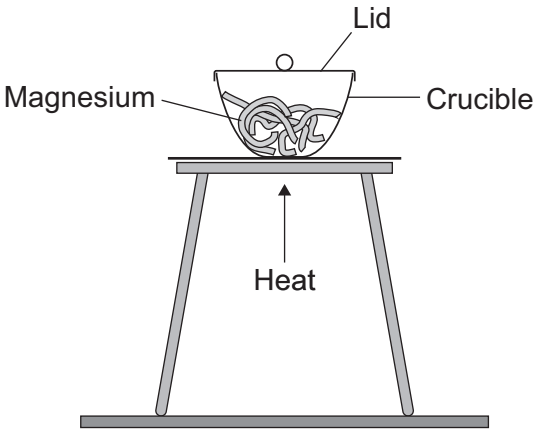
Question 6 continues on the next page

Do not write outside the box

A student reacted magnesium with oxygen.

Figure 9 shows the apparatus used.

Figure 9



This is the method used.

1. Measure the mass of the empty crucible and lid.
2. Put magnesium into the crucible.
3. Measure the mass of the crucible, lid and magnesium.
4. Heat the crucible strongly.
5. Lift the lid occasionally.
6. Heat until the magnesium stops glowing.
7. Measure the mass of the crucible, lid and magnesium oxide.

Do not write outside the box

0 6 . 4 Give **one** safety precaution the student should use.

[1 mark]

_____

_____

0 6 . 5 The magnesium reacted with oxygen.

Suggest where the oxygen comes from.

[1 mark]

_____

0 6 . 6 The student lifted the lid several times.

Why did lifting the lid allow the magnesium to react completely?

[1 mark]

_____

_____

Question 6 continues on the next page

Do not write outside the box

Table 3 shows the results.

Table 3

	Mass in g
Crucible and lid	48.0
Crucible, lid and magnesium	48.3
Crucible, lid and magnesium oxide	48.5

0 6 . 7 Calculate the mass of magnesium put into the crucible.

Use **Table 3**.

[1 mark]

Mass of magnesium = _____ g

0 6 . 8 Calculate the mass of oxygen that reacted with the magnesium.

Use **Table 3**.

[1 mark]

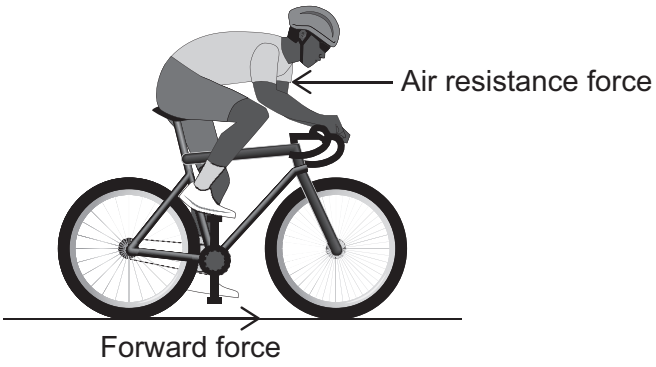
Mass of oxygen = _____ g

8

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0 7 **Figure 10** shows a cyclist on a straight, level road.

Figure 10



0 7 . 1 Complete the sentences.

Choose answers from the box.

[2 marks]

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

When the forward force is greater than the air resistance force, the speed of the cyclist _____ .

When the forward force is equal to the air resistance force, the speed of the cyclist _____ .

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 At one point in the journey the cyclist's velocity changed from 5.0 m/s to 9.0 m/s in a time of 2.5 s.

Calculate the acceleration of the cyclist.

Use the equation:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Choose the unit from the box.

[3 marks]

J/kg	m/s	m/s^2	N/kg

Acceleration = _____

Unit _____

0 7 . 3 The maximum speed of the cyclist was 15 m/s.

The cyclist travelled at this speed for 60 s.

Calculate the distance travelled by the cyclist during this time.

Use the equation:

distance travelled = speed × time

[2 marks]

Distance travelled = _____ m

Do not write outside the box

0 7 . 4 The maximum speed of this cyclist is much higher than the typical mean speed of a cyclist.

What is the typical mean speed of a cyclist?

[1 mark]

Tick (✓) **one** box.

1.5 m/s ☐ 3.0 m/s ☐ 6.0 m/s ☐

0 7 . 5 Give **two** factors that would decrease the maximum speed of a cyclist on a journey.

[2 marks]

1 _____

2 _____

0 7 . 6 At the end of the journey the cyclist decelerates from a speed of 15 m/s and stops.

The deceleration of the cyclist is 5 m/s^2.

Calculate the distance travelled while decelerating.

Use the Physics Equations Sheet.

[3 marks]

_____

_____

_____

_____

_____

Distance travelled = _____ m

13

Turn over ▶

Do not write outside the box

0 8 **Figure 11** shows a steam engine pulling a train.

Figure 11



0 8 . 1 One type of steam engine burns coal as the fuel source.

The energy from the coal is used to accelerate a train.

Describe how the energy stores of the coal and the train change as the train accelerates.

[2 marks]

Do not write outside the box

0 8 . 2 Which equation links energy (E), power (P) and time (t)?

[1 mark]

Tick (✓) **one** box.

$E = \frac{P}{t}$ ☐ $P = \frac{E}{t}$ ☐ $P = Et^2$ ☐ $P = \frac{E^2}{t}$ ☐

0 8 . 3 A steam engine has a power output of 8000 W.

Calculate the energy output of the steam engine in 3600 seconds.

[3 marks]

Energy output = _____ J

0 8 . 4 In the 18th century the power output of steam engines was measured in a unit called 'horsepower'.

Suggest why the unit of horsepower was used.

[2 marks]

8

Do not write outside the box

0 9 This question is about the reaction between copper carbonate and nitric acid.

0 9 . 1 Carbon dioxide is produced when copper carbonate reacts with nitric acid.

Give the test for carbon dioxide gas.

Give the result of the test if carbon dioxide is present.

[2 marks]

Test _____

_____

Result _____

_____

0 9 . 2 The word equation for the reaction between copper carbonate and nitric acid is:

copper carbonate + nitric acid ⟶ **X** + **Y** + carbon dioxide

Name the products **X** and **Y**.

[2 marks]

X _____

Y _____

Do not write outside the box

A student investigated the rate of the reaction between copper carbonate and nitric acid.

0 9 . 3 Describe a method to show the effect of changing the temperature of the nitric acid on the rate of reaction.

Your method should include measuring the volume of carbon dioxide gas produced.

[6 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 The student concluded that:

'An increase in temperature increases the rate of reaction.'

The student's conclusion was correct.

Explain why an increase in temperature increases the rate of reaction.

You should refer to particles and collisions in your answer.

[2 marks]

_____

_____

_____

_____

_____

_____

12

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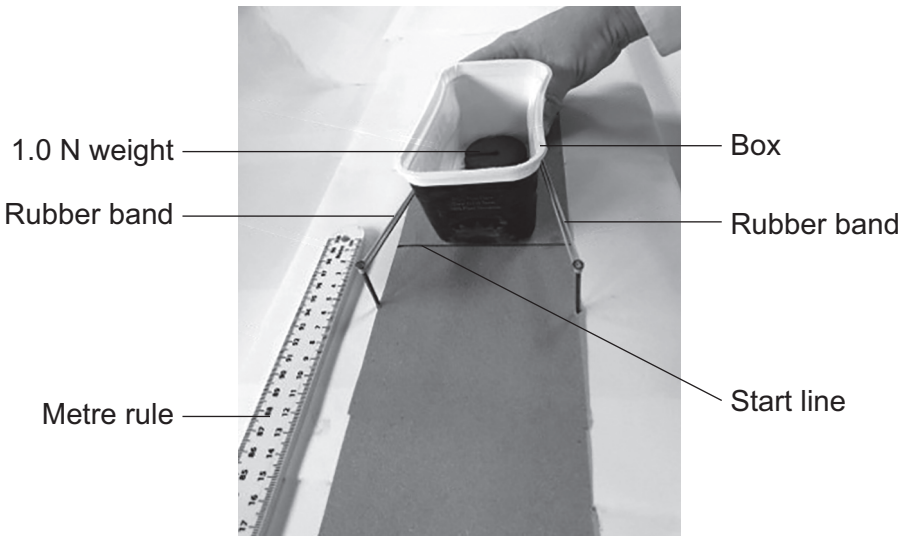
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ANSWER IN THE SPACES PROVIDED

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1 0 **Figure 12** shows the equipment a student used to investigate the effect of weight on the distance a box slides.

Figure 12



This is the method used.

1. Put a 1.0 N weight in the box.
2. Pull the box backwards until it reaches the start line, extending the rubber band by 10 cm.
3. Release the box.
4. When the box stops moving, measure the distance the box has slid using the metre rule.
5. Repeat steps 2 to 4 using a weight of 2.0 N and then 3.0 N.

Do not write outside the box

1 0 . 1 Identify the variables in the investigation.

[2 marks]

Independent variable _____

Dependent variable _____

1 0 . 2 The extension of the rubber band was a control variable in the investigation.

Suggest **one other** control variable in the investigation.

[1 mark]

_____

_____

1 0 . 3 **Table 4** shows the results when the weight inside the box was 1.0 N.

Table 4

Weight inside box in N	Distance the box slides in cm			
	Trial 1	Trial 2	Trial 3	Mean
1.0	12.6	13.1	13.4	13.0

What was the uncertainty in the distance measurements when the weight inside the box was 1.0 N?

[1 mark]

Tick (✓) **one** box.

±0.1 cm ☐ ±0.4 cm ☐ ±0.8 cm ☐ ±1.0 cm ☐

Question 10 continues on the next page

Do not write outside the box

1 0 . 4 The rubber band was extended by 10 cm.

The rubber band behaves like a spring with a spring constant of 36 N/m.

Calculate the elastic potential energy stored by the rubber band.

Use the Physics Equations Sheet.

[3 marks]

Elastic potential energy = _____ J

1 0 . 5 What is the maximum possible value for the kinetic energy of the box?

[1 mark]

Maximum possible kinetic energy = _____ J

Do not write outside the box

1 0 . 6 **Table 5** shows the student's results.

Table 5

Weight inside box in N	Distance the box slides in cm			
	Trial 1	Trial 2	Trial 3	Mean
1.0	12.6	13.1	13.4	13.0
2.0	10.4	9.4	10.0	9.9
3.0	7.9	7.3	6.8	7.3

Describe improvements the student could make to the method.

Use information from:

- **Figure 12**, on page 40
- **Table 5**.

[4 marks]

12

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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