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# GCSE COMBINED SCIENCE: SYNERGY

# H

Higher Tier Paper 4 Physical sciences

Wednesday 12 June 2019

Morning

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.
- 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.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
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<b>TOTAL</b>	



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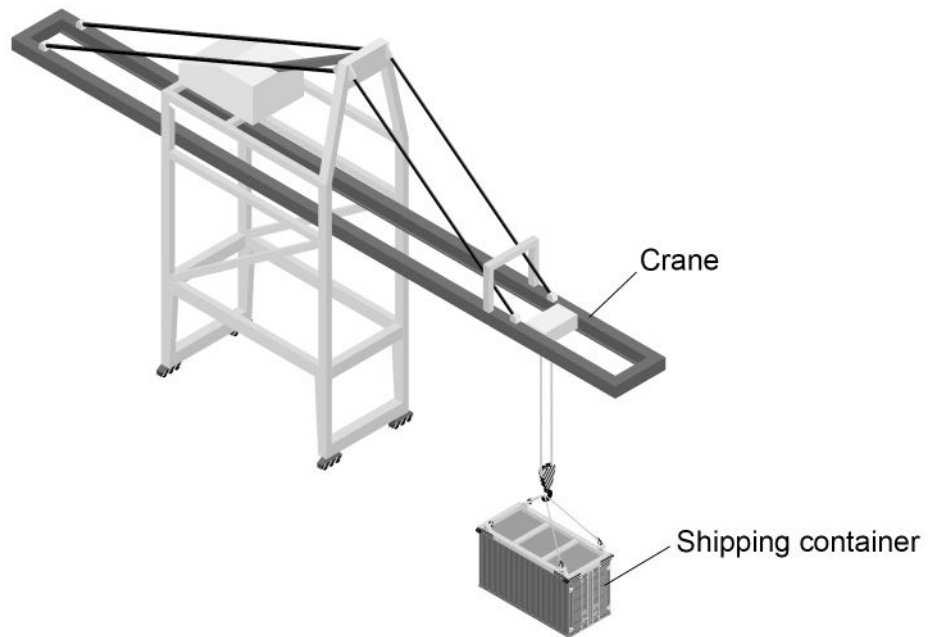
Answer **all** questions in the spaces provided.

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0 1

**Figure 1** shows a crane being used to lift a shipping container.

**Figure 1**



0 1 . 1

Write the equation which links distance, force and work done.

**[1 mark]**

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**0 1 . 2** The container was lifted a height of 14 m

The crane did 3 430 000 J of work on the container.

Calculate the force exerted by the crane on the container.

**[3 marks]**

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Force = \_\_\_\_\_ N

**0 1 . 3** Write the equation which links power, time and work done.

**[1 mark]**

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**0 1 . 4** The power of the crane was 68 600 W

Calculate the time taken for the crane to do 3 430 000 J of work.

Give the unit.

**[4 marks]**

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Time taken = \_\_\_\_\_ Unit \_\_\_\_\_



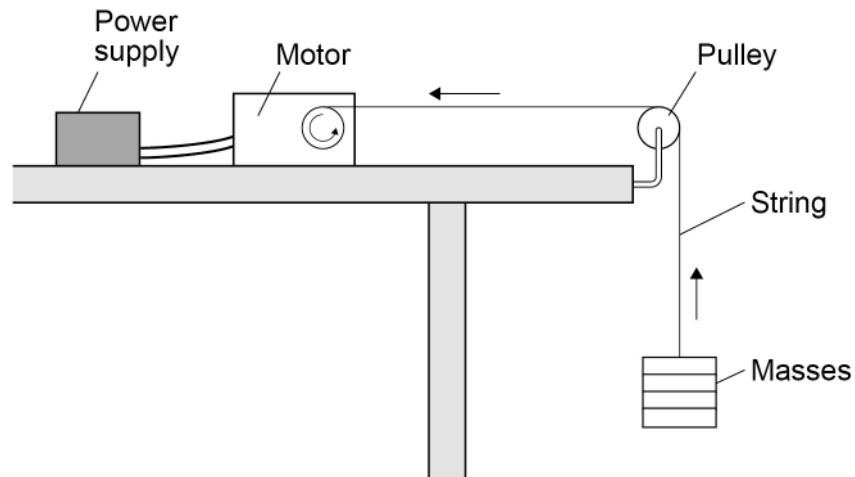
0 2

A student used an electric motor to lift a mass.

He investigated how the efficiency of the motor varied with the mass lifted.

**Figure 2** shows the apparatus used.

**Figure 2**



0 2 . 1

Energy is transferred to the electric motor by the power supply.

Why is the energy transferred to the motor greater than the gravitational potential energy gained by the mass?

**[2 marks]**

Tick (✓) **two** boxes.

Energy is not conserved

Friction in the motor causes energy transfer to the surroundings

The temperature of the motor increases

Thermal energy from the surroundings is transferred to the mass

Wasted energy is destroyed



0 2 . 2

The student calculated the gravitational potential energy gained by different masses as they were lifted.

The student used the equation:

$$\text{gravitational potential energy} = \text{mass} \times 9.8 \times \text{height}$$

Describe how the student could make accurate measurements to use in the calculations.

**[4 marks]**

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**Question 2 continues on the next page**

**Turn over ►**



0 2 . 3

Write the equation which links efficiency, total input energy transfer and useful output energy transfer.

**[1 mark]**

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0 2 . 4

The efficiency of the motor was 15%.

The student calculated that the useful output energy transfer was 1.20 J

Calculate the total input energy transfer.

**[4 marks]**

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Total input energy transfer = \_\_\_\_\_ J

11



0 3

Some drinks containers are made from aluminium. Other drinks containers are made from a polymer called PET.

Both aluminium and PET can be recycled.

0 3 . 1

**Figure 3** shows the recycling symbol for PET.

**Figure 3**



Suggest why this symbol is used on a PET bottle.

**[1 mark]**

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0 3 . 2

50 000 000 kg of aluminium are used each year to make drinks cans.

70% of these aluminium cans are recycled.

Calculate the mass of aluminium that is recycled each year from drinks cans.

Give your answer in standard form.

**[3 marks]**

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Mass = \_\_\_\_\_ kg

**Question 3 continues on the next page**

**Turn over ►**



**0 3 . 3**

**Table 1** gives information about the Life Cycle Assessments (LCAs) of two types of drinks containers.

**Table 1**

The following table cannot be reproduced here due to third-party copyright restrictions.





Evaluate the use of aluminium compared with the use of PET for drinks containers.

Your answer should include supporting calculations.

**[6 marks]**

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<b>10</b>

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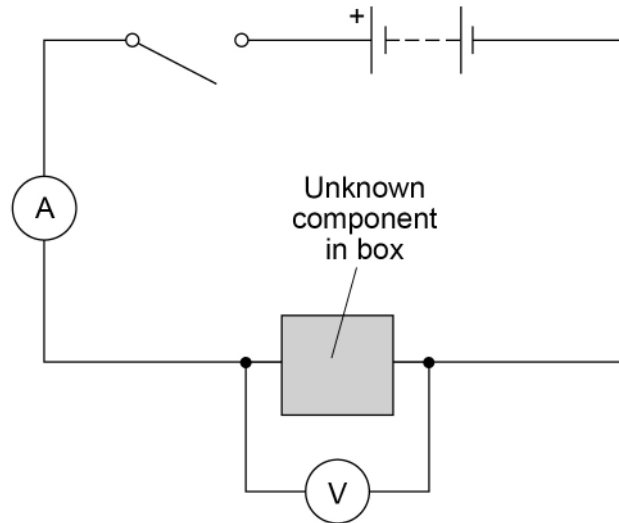


0 4

A teacher gave a student an unknown electrical component hidden in a box.

The student connected the box in the circuit shown in **Figure 4**.

**Figure 4**



0 4 . 1

The student measured the potential difference across the component and the current in the component.

She repeated this for several values of potential difference.

Give **one** way the circuit could be altered so that the potential difference across the component could be varied.

[1 mark]

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0 4 . 2

Explain why the student needed to switch the circuit off between readings.

[2 marks]

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Turn over ►



**Table 2** shows the student's results.

**Table 2**

Potential difference in volts	Current in amps
0.00	0.00
0.20	0.00
0.40	0.00
0.60	0.13
0.80	0.68
1.00	1.50

**0 4 . 3** What was the resolution of the ammeter?

**[1 mark]**

Tick (✓) **one** box.

- 0.01 A
- 0.05 A
- 0.10 A
- 1.50 A

**0 4 . 4** Complete **Figure 5**.

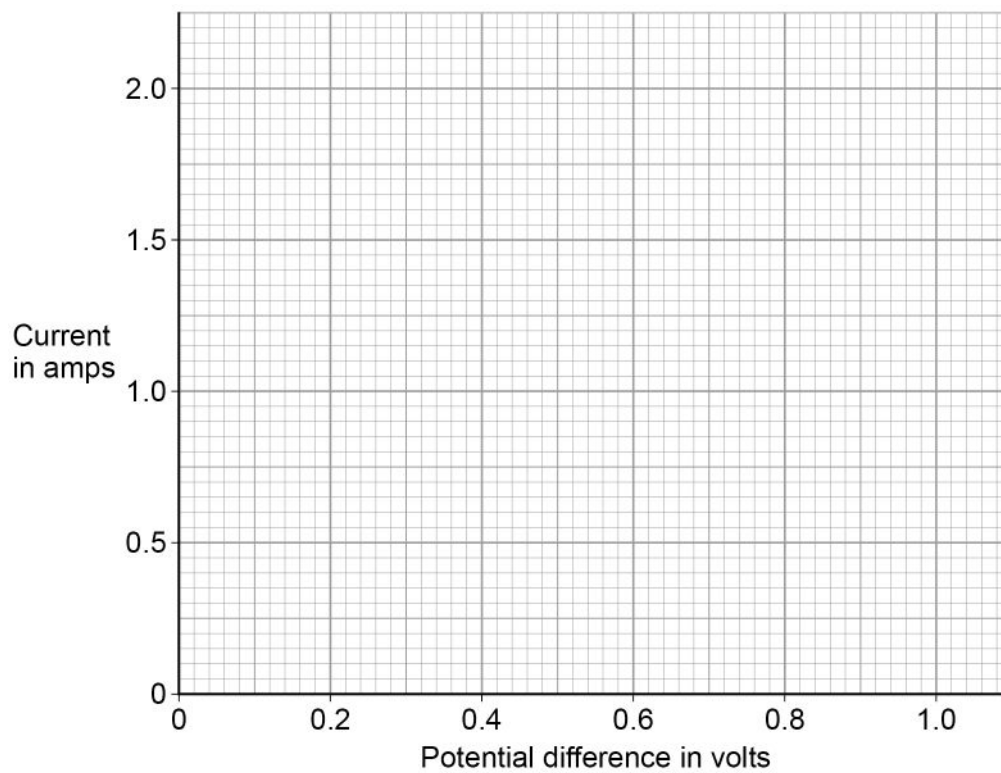
You should:

- plot the data from **Table 2**
- draw a line of best fit.

**[3 marks]**



Figure 5



**0 4 . 5** What was the unknown electrical component given to the student?

[1 mark]

Tick (✓) **one** box.

Diode

Filament lamp

Resistor

Thermistor

Question 4 continues on the next page

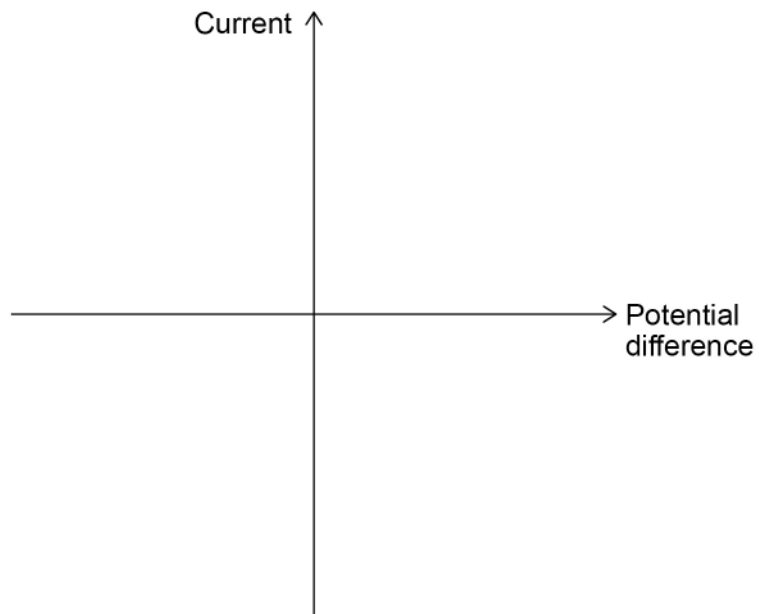
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0 4 . 6

An ohmic conductor has constant resistance when its temperature is constant.

Sketch a current-potential difference graph for an ohmic conductor at constant temperature on **Figure 6**.

**[2 marks]****Figure 6**

10



0 5

One type of indigestion tablet contains:

- calcium carbonate
- magnesium carbonate
- non-active ingredients.

0 5 . 1

Peppermint oil is one of the non-active ingredients in the tablet.

Suggest why peppermint oil is used in the tablet.

[1 mark]

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0 5 . 2

In one indigestion tablet the mass of magnesium carbonate is 64.0 mg

Calculate the number of moles of magnesium carbonate in this indigestion tablet.

Give your answer to 3 significant figures.

Relative formula mass ( $M_r$ ) of magnesium carbonate = 84

[3 marks]

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Number of moles = \_\_\_\_\_

0 5 . 3

Magnesium carbonate ( $\text{MgCO}_3$ ) in the tablet reacts with hydrochloric acid (HCl) in the stomach.

Write a balanced chemical equation for the reaction.

[3 marks]

\_\_\_\_\_ + \_\_\_\_\_  $\longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_

**Question 5 continues on the next page**

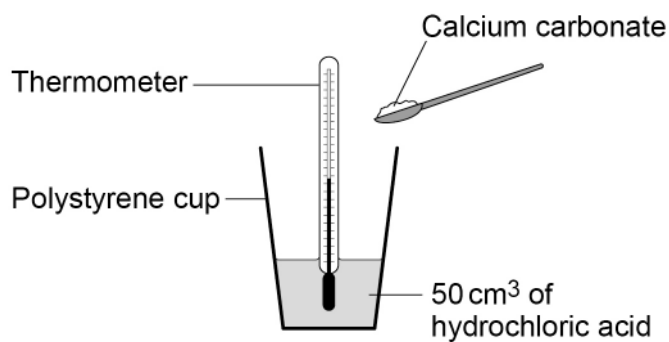
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A student investigated the temperature change when different masses of calcium carbonate were reacted with hydrochloric acid.

**Figure 7** shows the apparatus used.

**Figure 7**



This is the method used.

1. Add 50 cm<sup>3</sup> of hydrochloric acid to a polystyrene cup.
2. Record the temperature of the hydrochloric acid.
3. Add 1 g of calcium carbonate to the hydrochloric acid.
4. Stir the mixture.
5. Record the highest temperature of the mixture.
6. Repeat steps 1–5 with different masses of calcium carbonate.

0 5 . 4

What was the dependent variable in this investigation?

[1 mark]

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0 5 . 5

Suggest **two** changes to the investigation that would improve the accuracy of the results.

Give a reason why each change would improve the accuracy.

**[4 marks]**

Change 1 \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

Change 2 \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

0 5 . 6

How should the results of the investigation be displayed?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

Bar chart

Histogram

Line graph

Pie chart

Reason \_\_\_\_\_

\_\_\_\_\_

14

**Turn over for the next question**

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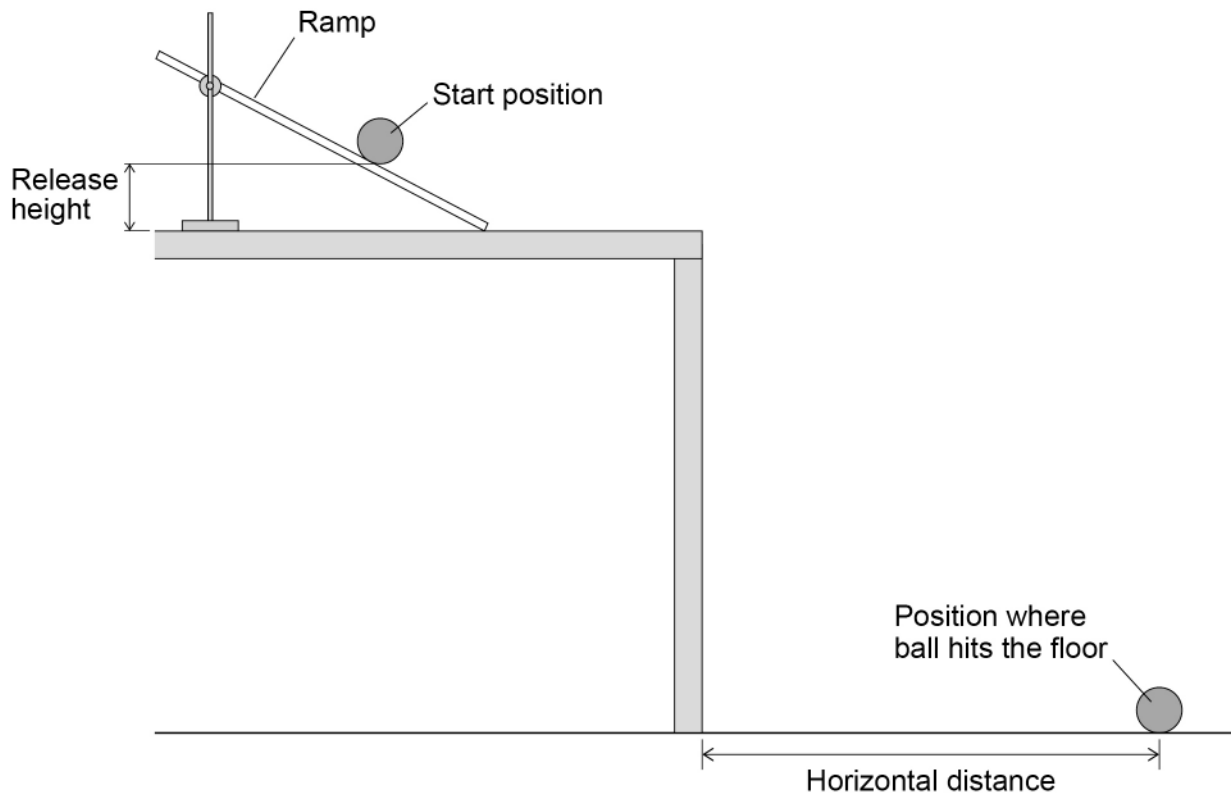
0 6

A student investigated how the horizontal distance travelled by a ball varied with release height.

The student used a ramp to launch the ball horizontally from the edge of a table.

**Figure 8** shows some of the equipment the student used.

**Figure 8**



The ball was released from a point on the ramp and the student recorded where the ball hit the floor. The student measured the release height and the horizontal distance travelled by the ball.



0 6 . 1

Describe what the student should do to make the measurements for this investigation as accurate as possible.

**[6 marks]**

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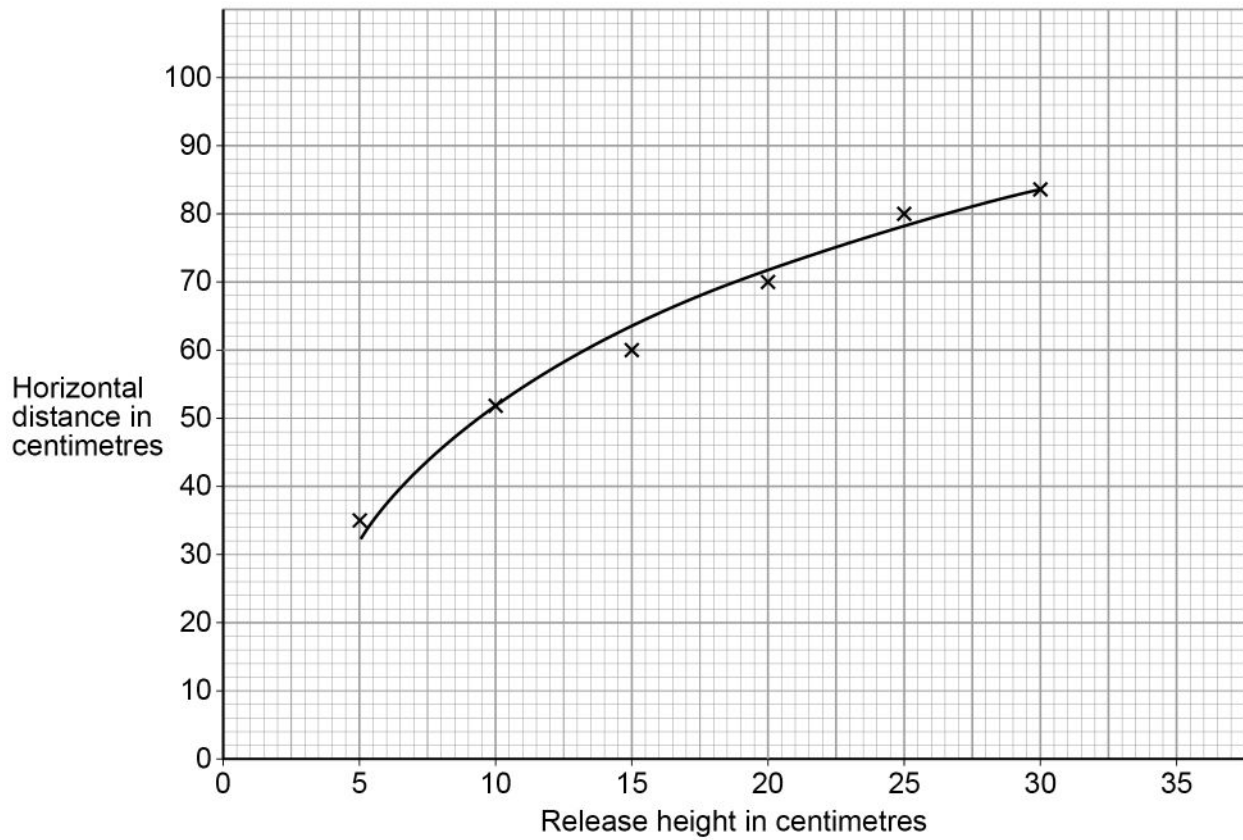
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Question 6 continues on the next page

**Turn over ►**

Figure 9 shows the student's results.

Figure 9



0 6 . 2

Give **one** reason why some of the points in **Figure 9** are **not** on the line of best fit.

[1 mark]

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0 6 . 3

The student concluded that the horizontal distance was directly proportional to the release height.

Explain why the student was incorrect.

[2 marks]

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9

**Turn over for the next question**

**Turn over ►**



**0 7**

Conservation of momentum can be used to understand what happens during collisions.

**0 7 . 1**

Momentum is a vector quantity.

Explain the difference between a vector quantity and a scalar quantity.

**[2 marks]**

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**0 7 . 2**

Describe what is meant by 'conservation of momentum'.

**[2 marks]**

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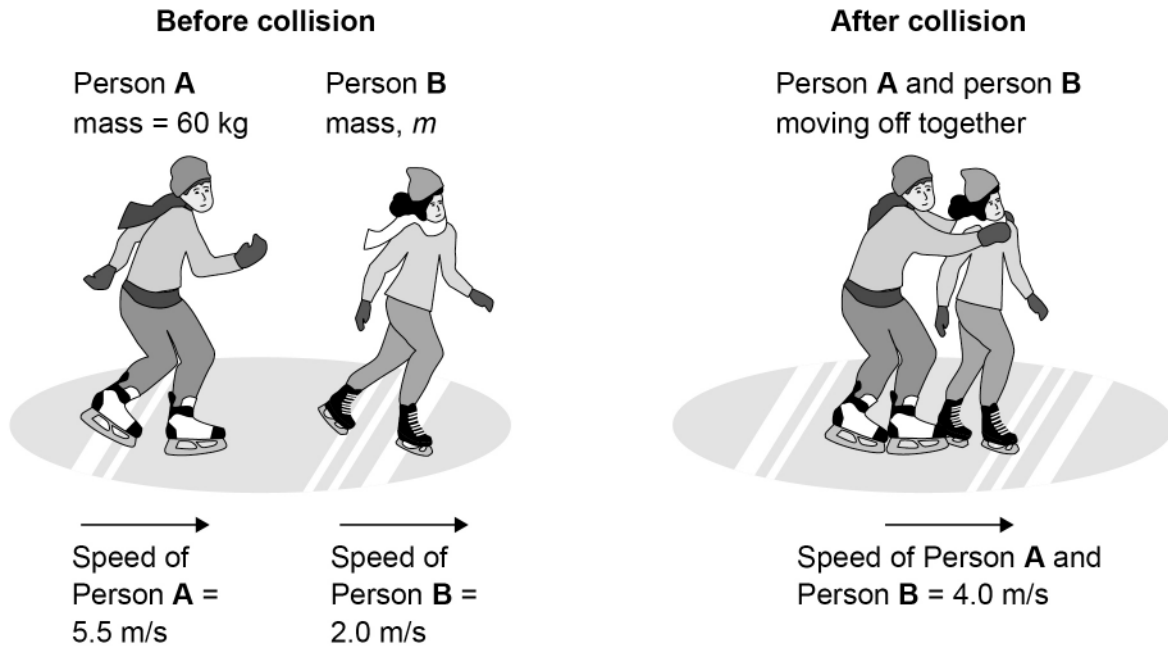
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**0 7 . 3** Figure 10 shows two people ice-skating.

Person **A** collides with person **B**. After the collision they move together with the same velocity.

Figure 10



Calculate the mass,  $m$ , of person **B**.

[5 marks]

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Mass,  $m$  = \_\_\_\_\_ kg

Turn over ►



**0 8** Iceland is a country with many waterfalls.

**0 8 . 1** Which energy resource uses falling water to generate electricity?

**[1 mark]**

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**0 8 . 2** Most of the electricity generated in Iceland is used in the production of aluminium.

Aluminium ore is imported and used to produce aluminium. The aluminium is then exported.

Suggest **one** advantage of producing aluminium in Iceland.

**[1 mark]**

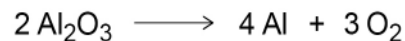
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Aluminium is produced from aluminium oxide by electrolysis.

The equation for the reaction is:



**0 8 . 3** Calculate the mass of aluminium produced from 1000 kg of aluminium oxide.

Relative atomic masses ( $A_r$ ): Al = 27 O = 16

**[4 marks]**

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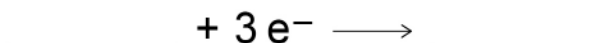
Mass of aluminium = \_\_\_\_\_ kg





**0 8 . 4** Complete the half equation for the production of aluminium at the negative electrode.

**[1 mark]**



**0 8 . 5** Explain why the electrolyte used is a mixture of aluminium oxide and cryolite.

**[2 marks]**

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**0 8 . 6** Explain why the electrolysis of aluminium oxide produces large quantities of carbon dioxide.

**[3 marks]**

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**Question 8 continues on the next page**

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0 8 . 7

A ceramic material could be used as the positive electrode in the electrolysis of aluminium oxide.

The ceramic material must be a good conductor of electricity.

Suggest **two** other properties the ceramic material must have for use in the electrolysis of aluminium oxide.

Give a reason why each property is needed.

**[4 marks]**

Property 1 \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

Property 2 \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

16



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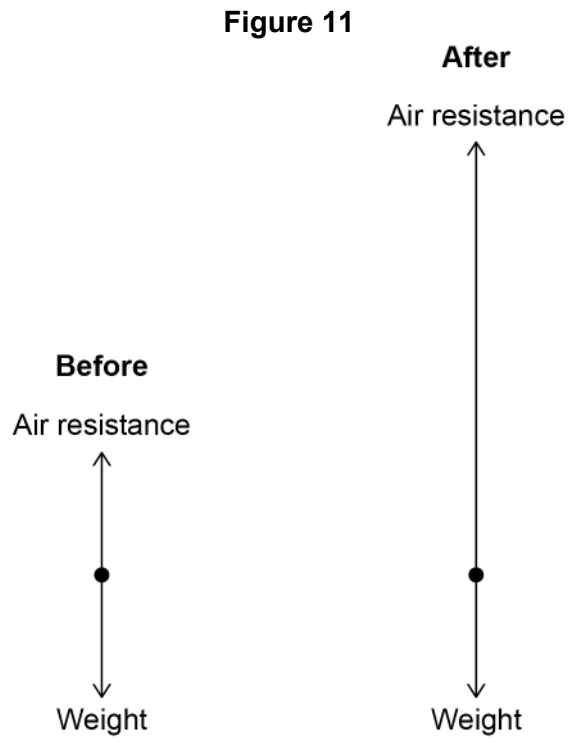
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0 9

**Figure 11** shows free body diagrams for a skydiver before and after her parachute opened.

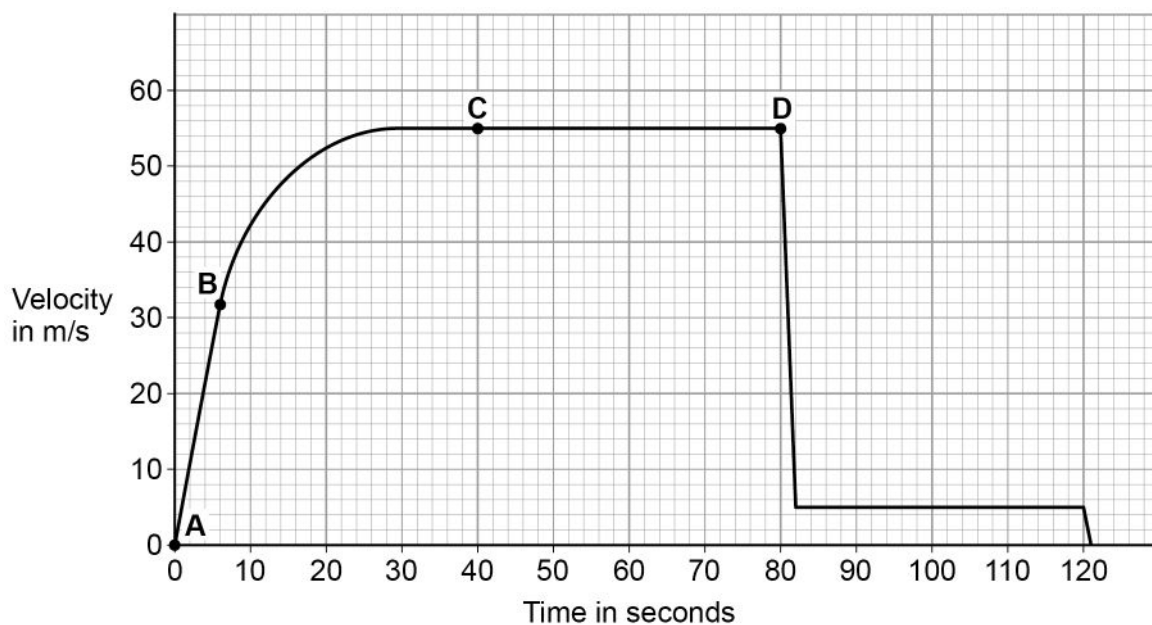


**Figure 12** shows the velocity-time graph for the skydiver.

The skydiver:

- left the plane at 0 s
- opened her parachute at 80 s
- landed on the ground at 120 s

**Figure 12**



**0 9 . 1** What does the area under the graph represent?

**[1 mark]**

Tick (✓) **one** box.

The acceleration of the skydiver

The gravitational field strength of the Earth

The height from which the skydiver jumped

The mass of the skydiver

**0 9 . 2** Explain why the velocity of the skydiver changed between **A** and **C** on **Figure 12**.

Your answer should refer to the forces on the skydiver.

**[6 marks]**

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**0 9 . 3**

Between leaving the plane and opening her parachute, the change in gravitational potential energy of the skydiver was 3.50 MJ

The speed of the skydiver when she opened her parachute was 55 m/s

The mass of the skydiver was 80 kg

Calculate the energy transferred to the surroundings.

**[5 marks]**

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Energy transferred to surroundings = \_\_\_\_\_ J

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**END OF QUESTIONS**



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