Oxford Cambridge and RSA

Wednesday 22 May 2024 – Morning

GCSE (9–1) in Combined Science B (Twenty First Century Science)

J260/07 Physics (Higher Tier)

Time allowed: 1 hour 45 minutes

H

You must have:
- a ruler (cm/mm)
- the Equation Sheet for GCSE (9–1) Combined Science Physics B (inside this document)

You can use:
- an HB pencil
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) ______________________________

Last name ______________________________

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

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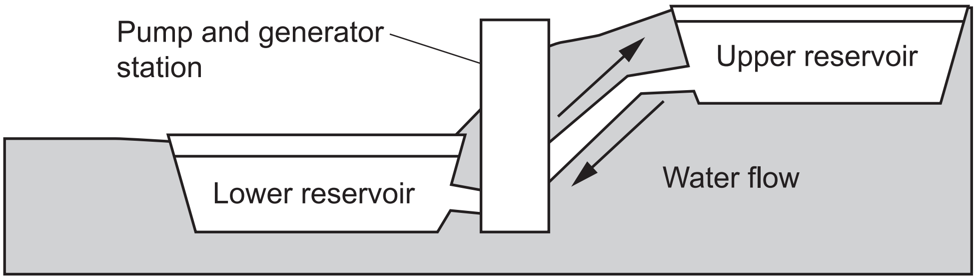
1* The diagram shows a pumped storage system.



Electricity is used to pump water from the lower reservoir to the upper reservoir. When the water flows back down, its kinetic energy store is used to generate electricity.

Describe the benefits and risks of replacing fossil fuel power stations with wind farms and solar panels **and** explain how pumped storage systems can help to reduce the risks.

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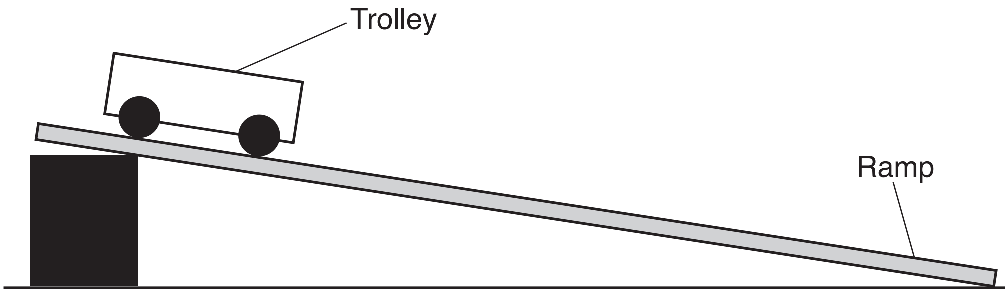
.... **[6]**

2

(a) A student is investigating the motion of a trolley travelling down a ramp, using the equipment shown in **Fig. 2.1**.

Fig. 2.1



Describe how the student can use a metre ruler and a stopwatch to find out the average speed of the trolley down the ramp.

Use the idea that average speed = $\frac{\text{distance}}{\text{time}}$

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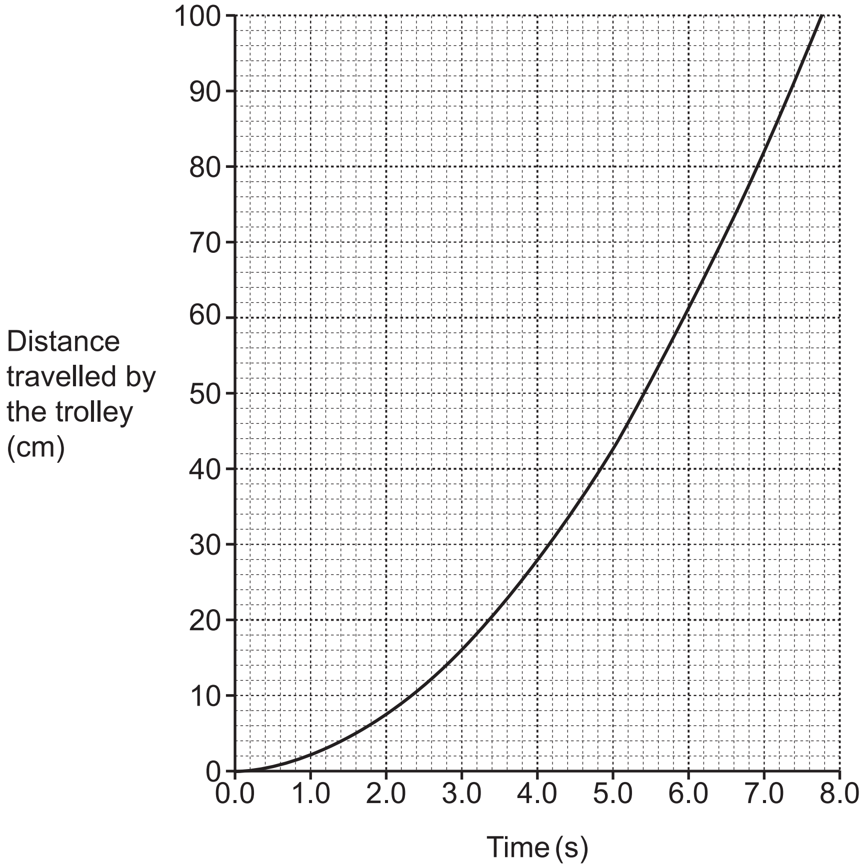
.... **[2]**

(b) **Fig. 2.2** shows how far the trolley travels down the ramp in a given time.

Fig. 2.2



(i) Explain how **Fig. 2.2** shows that the trolley accelerates down the slope.

Use the idea that acceleration = $\frac{\text{change in speed}}{\text{time taken}}$

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.... **[2]**

(ii) **Draw** a tangent on **Fig. 2.2** at Time = 5.0 s and use it to **calculate** the gradient at this time.

Gradient = ... cm/s **[4]**

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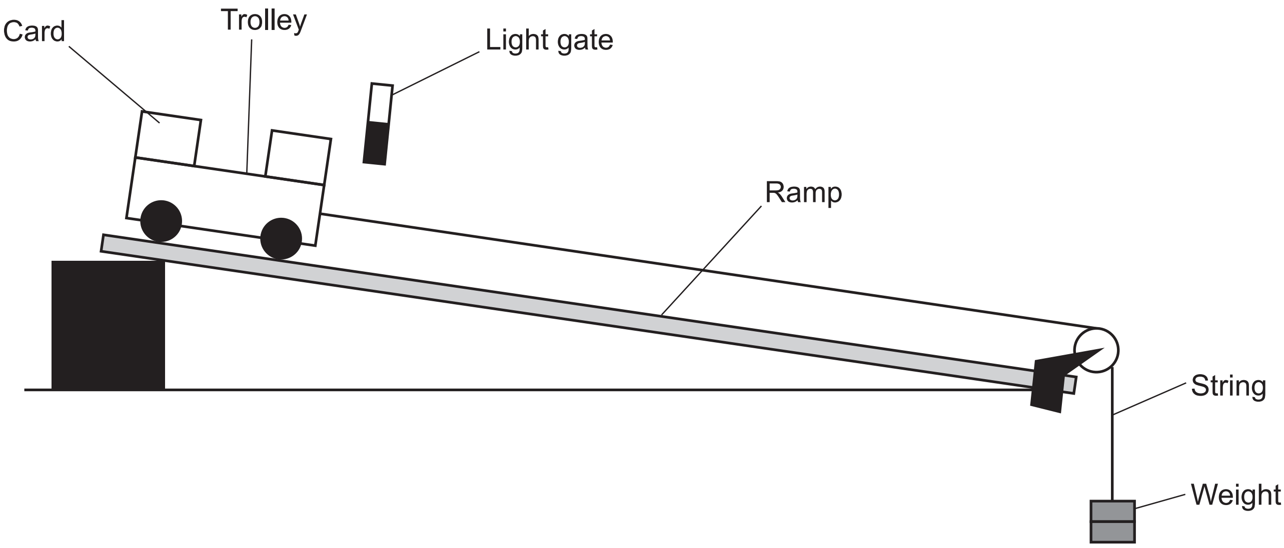
(c) The student then investigates how the size of a pulling force affects the motion of the trolley down the ramp.

Fig. 2.3 shows the equipment used.

Fig. 2.3

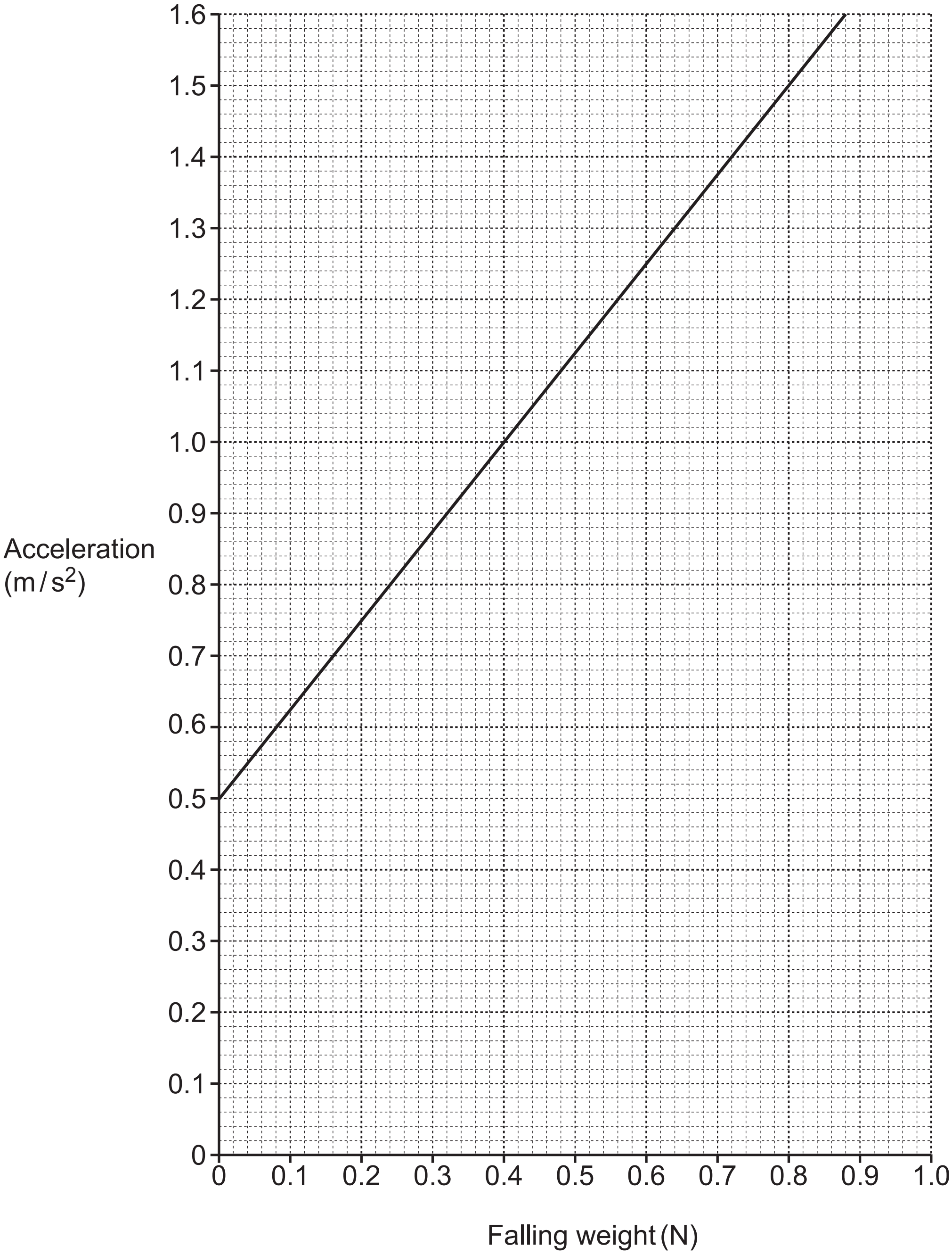


The pulling force on the trolley is provided by a falling weight attached to the trolley by a string.

The student measures the acceleration of the trolley when different weights are used.

Fig. 2.4 shows the student's results.

Fig. 2.4



(i) Calculate the resultant force acting on the trolley when the falling weight is 0.50 N.

The mass of the trolley is 0.80 kg.

Use **Fig. 2.4** and the Equation Sheet.

Resultant force = ... N **[4]**

(ii) A student writes an equation for the graph in **Fig. 2.4**

Underneath the student writes the general equation for a straight line.

The student's equation: **acceleration = m × falling weight + c**

A straight line: **y = m × x + c**

What does **c** represent on the graph in **Fig. 2.4**?

Tick (✓) **one** box.

The acceleration caused by the slope of the ramp	
The initial speed of the trolley	
The mass of the trolley	
The resultant force on the trolley	

[1]

3 Two students learn about waves.

(a)

(i) Which **two** statements are true for light waves?

Tick (✓) **two** boxes.

Light waves are electromagnetic waves. ☐

Light waves are longitudinal waves. ☐

Light waves are transverse waves. ☐

Light waves only travel through a vacuum. ☐

Light waves travel faster through water than through a vacuum. ☐

[2]

(ii) When white sunlight shines on grass, the grass looks green.

Complete the sentences to explain why.

Put a (ring) around each correct option.

The green light in sunlight has different **amplitudes / electrons / wavelengths** to the other colours.

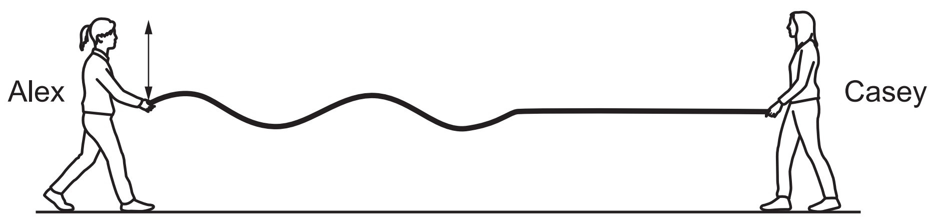
Those from the green region are **absorbed / transmitted / reflected**

and those from other regions are **absorbed / transmitted / reflected**.

[2]

(b) The diagram shows the two students, **Alex** and **Casey**, with a rope.

Each student holds one end of the rope.



Alex moves the end of the rope up and down to send waves along the rope to Casey.
Alex also talks to Casey. This sends sound waves through the air.

(i) Describe the differences between the **waves on the rope** and the **sound waves in the air**.

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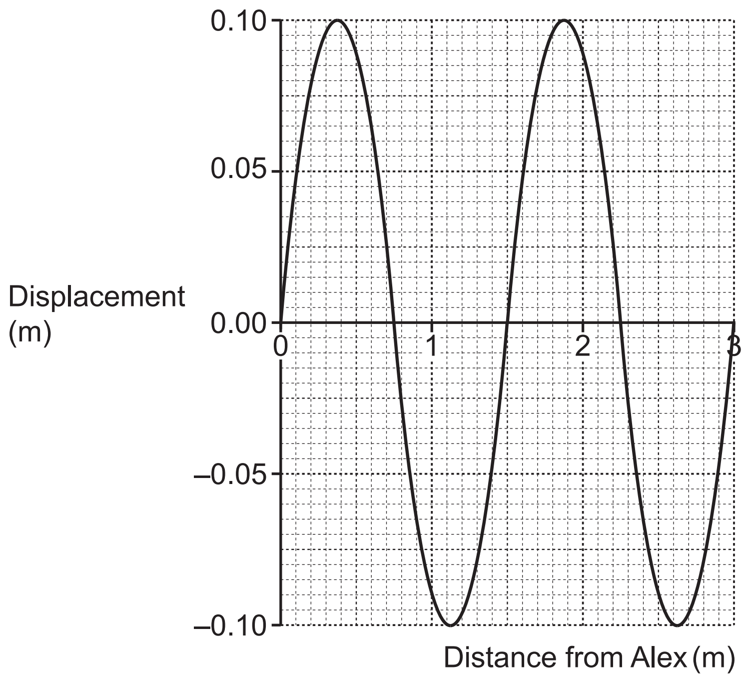
.... **[3]**

(ii) The graph shows how the displacement of the rope changes with the distance along the rope from Alex.



Complete the table, using information from the graph.

Amplitude (m)	
Wavelength (m)	

[2]

(iii) Two complete waves reach Casey's hand in one second.

What is the frequency and the period of the wave?

Frequency = ... Hz

Period = ... s

[2]

4 (a) (i) A student investigates the reflection of light from a plane mirror.

These are the steps in the investigation. They are **not** in the correct order:

A Direct the ray from a ray box at the mirror, so that it hits the mirror where the normal and the mirror line cross.

B Mark the rays on the paper with crosses.

C Measure the angles of incidence and reflection with a protractor.

D Remove the ray box.

E Stand a plane mirror on the line.

F Use a pencil and ruler to join the crosses.

G Use a ruler to draw a line on a piece of paper, and a protractor to draw a normal at right angles to the line.

Write the letters in the boxes to show the correct order of the steps.

Two have been completed for you.

G						**C**

[2]

(ii) It is a sunny day so the student cannot see the rays clearly.

Suggest **two** ways the student could improve the experiment to see the rays more clearly.

1 ....

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2 ....

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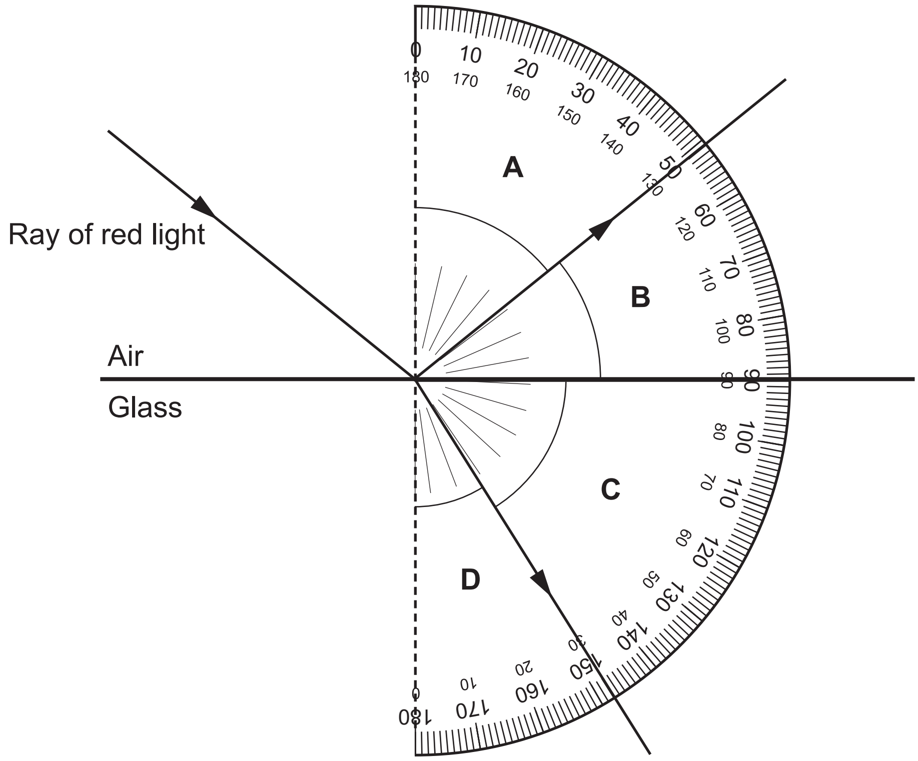
[2]

(b) The diagram shows a ray of red light incident on a glass surface. Some of the incident light is reflected and some is refracted.

A protractor is used to measure the angles of reflection and refraction.



(i) Which angles in the diagram are the angles of reflection and refraction?

Choose from **A**, **B**, **C** or **D**.

Angle of reflection = ☐

Angle of refraction = ☐

[2]

(ii) Measure the angle of **refraction** on the diagram.

Angle of refraction = ... ° **[1]**

(c) The speed of the red light is 2.0×10^8 m/s in the glass block.
The frequency is 4.7×10^{14} Hz.

Calculate the wavelength of the light in the glass block.

Use the equation: wavelength = $\frac{\text{wave speed}}{\text{frequency}}$

Give your answer to **2** significant figures.

Wavelength = ... m **[3]**

(d) Complete the sentences to explain what happens to the wavelength of the red light when it enters the glass block from the air.

Put a (ring) around the correct option to help you complete the first sentence.

When it enters the glass block, the wavelength of the red light

decreases / does not change / increases.

This is because ....

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.... **[3]**

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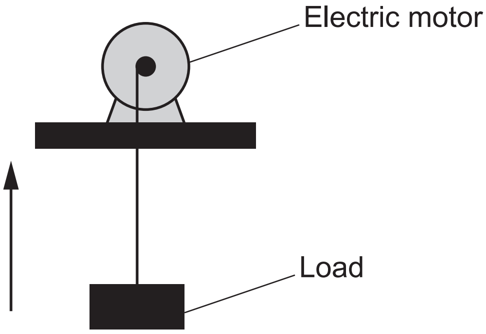
Turn over for the next question

5 The diagram shows an electric motor lifting a load.



(a)
(i) Describe the **useful** energy transfers that take place while the electric motor lifts the load.

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.... **[2]**

(ii) Describe how some energy is **wasted** in the electric motor.

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.... **[2]**

(b) A student investigates how the upward speed of the load changes with the mass of the load.

The student measures:

- the time taken for the mass to be lifted a vertical height of 1 m.
- the potential difference across the electric motor and the current through it when it is lifting the mass.

The table shows one set of results:

Mass (kg)	0.1
Time for load to rise 1m (s)	1.8
Potential difference (V)	3.0
Current (A)	2.0

(i) Calculate the total energy transferred by the electric motor.

Use: power = potential difference × current

and energy transferred = power × time.

Total energy transferred = ... J **[3]**

(ii) The gravitational potential energy store of the load increases by 8.1 J when it is lifted 1 m.

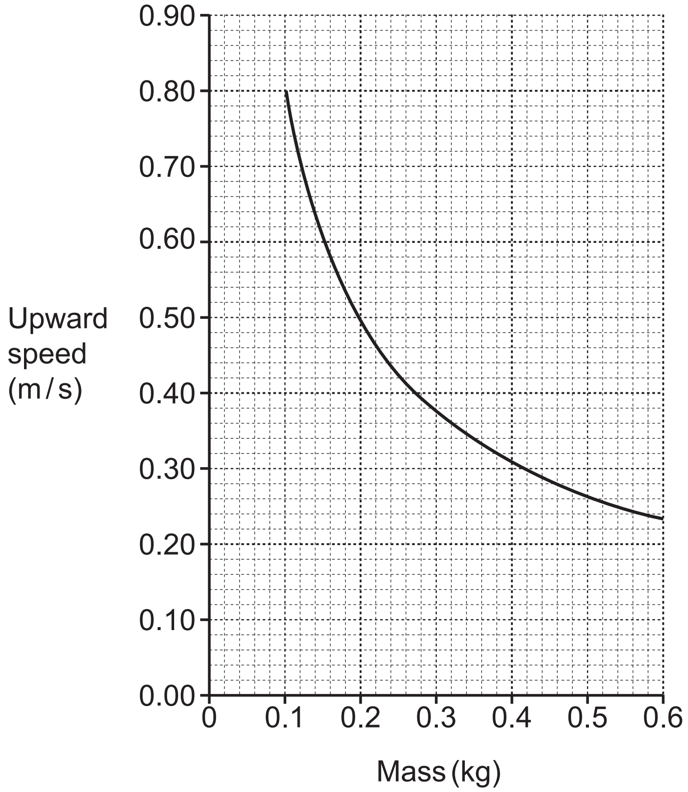
Calculate the efficiency of the electric motor.

Use the equation: efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$

and your answer to **(b)(i)**.

Efficiency = ... **[2]**

(c) The student repeats the experiment with different masses and measures the upward speed of the load each time. The graph shows the results.



The student writes this conclusion based on the graph:

The speed is proportional to $\frac{1}{\text{mass}}$ used.

speed $\propto \frac{1}{\text{mass}}$

Evaluate the student's conclusion.

Use data from the graph.

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Turn over for the next question

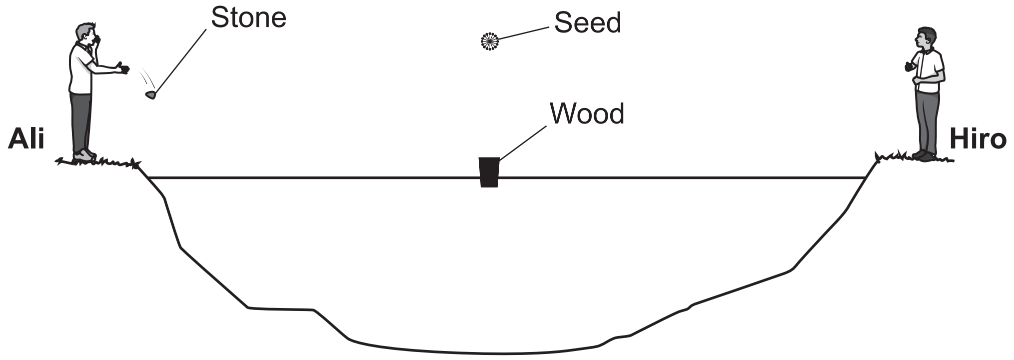
6

(a) **Ali** and **Hiro** stand on opposite sides of a lake.

A small piece of wood floats on the surface of the lake and a small seed floats in the air above the lake.

Ali shouts to **Hiro**. This starts the seed moving.

At the same time **Ali** drops a stone into the water, which sends ripples across the surface of the lake. This starts the wood moving.



The arrows show some possible ways for the wood and the seed to move.

(i) Which arrow shows the movement of the piece of wood when the ripples on the surface of the water reach it?

Put a (ring) around the correct option.

A **B** **C** **D**

[1]

(ii) Which arrow shows the movement of the seed when the sound waves reach it?

Put a (ring) around the correct option.

A **B** **C** **D**

[1]

(b) Ali and Hiro do another experiment to determine the speed of sound in air.

(i) The steps of their experiment are listed below, but not in the correct order.

A Ali claps two pieces of wood together.

B Hiro starts the stopwatch when he sees the two pieces of wood clapped together.

C They repeat the experiment at 100 m, 150 m, 200 m and 250 m.

D They stand 50 m apart on a flat field.

E When he hears the sound, Hiro stops the stopwatch.

Write the letters in the boxes to show the correct order of the steps.
The first one has been completed for you.

D				

[2]

(ii) Ali and Hiro repeat the experiment three times for each distance and calculate the speed of sound. The table shows their results:

Distance (m)	**Time** (s)				**Speed** (m/s)
	Repeat 1	Repeat 2	Repeat 3	Mean	
50	0.25	0.21	0.31	0.26	190
100	0.33	0.35	0.31	0.33	300
150	0.49	0.51	0.48	0.49	310
200	0.64	0.62	0.62	0.63	320
250	0.81	0.75	0.77	0.78	320

The speed of sound in air is approximately 330 m/s.

Describe how the measured distance affects the accuracy of the calculated speed **and** suggest a reason for this effect.

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.... **[3]**

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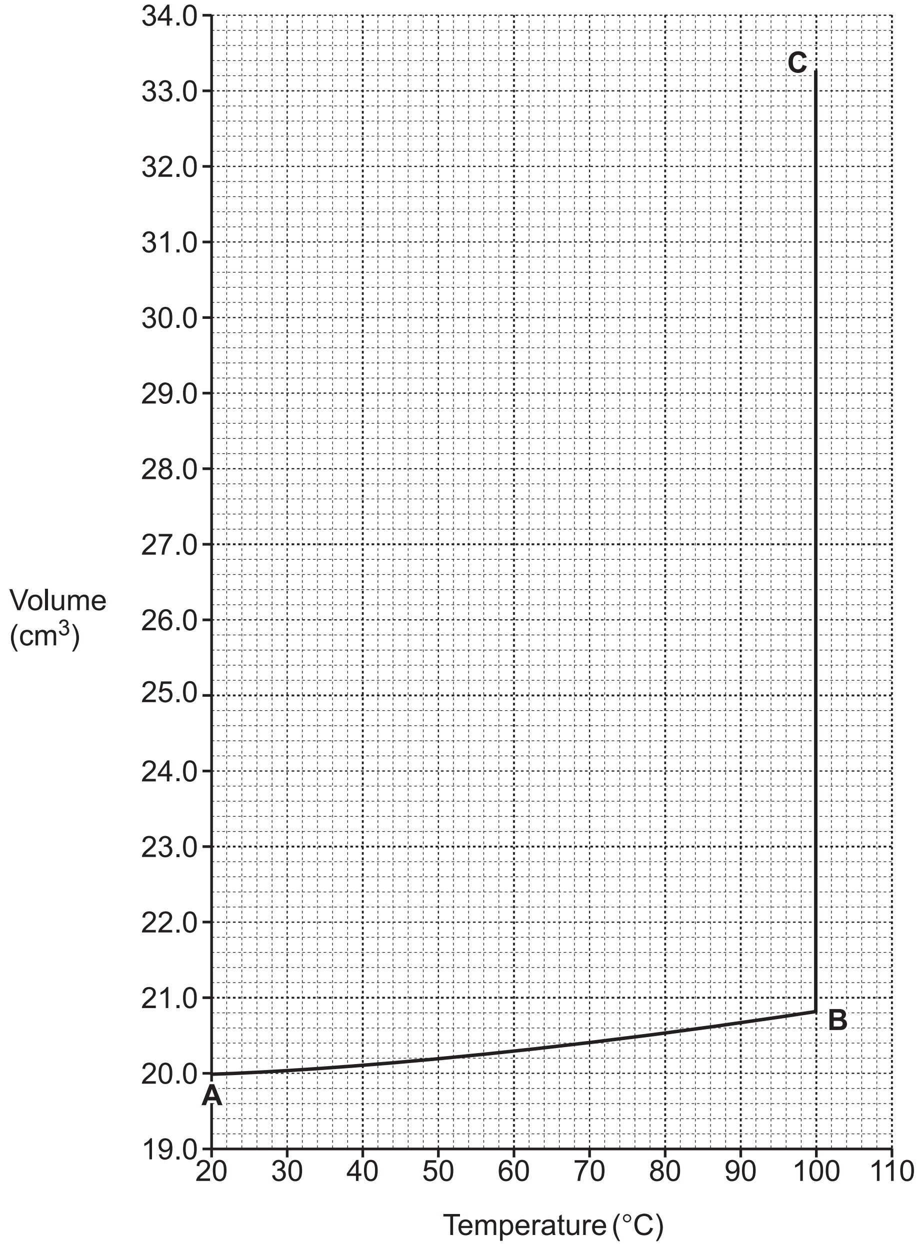
7 Some students experiment with heating water until it boils.

(a) Draw lines to connect each **term** with its correct **definition**.

Term	**Definition**
	Thermal energy required to change the state of 1 kg of a substance at constant temperature.
Specific heat capacity	Thermal energy required to raise the temperature of 1 kg of a substance by 1 °C.
Specific latent heat	Thermal energy required to raise the temperature of 1 kg of a substance to its boiling point.
	Thermal energy required to raise the temperature of 1 kg of a substance to make it change state.

[2]

(b) A constant mass of water is heated from 20 °C until it boils. The graph shows how the volume of the water changes with temperature.



(i) The mass of the water is 20 g.

The density of the water at point **A** is 1 g / cm^3.

Calculate the change in density of the water between **A** and **B**.

Use the graph and the equation: density = $\frac{\text{mass}}{\text{volume}}$

Change in density = ... g / cm^3 **[4]**

(ii) Describe how the mass of the water is conserved as the volume changes between **B** and **C**.

Use the particle model.

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.... **[2]**

(iii) Explain what happens to the density between points **B** and **C** on the graph.

You do **not** need to calculate the density.

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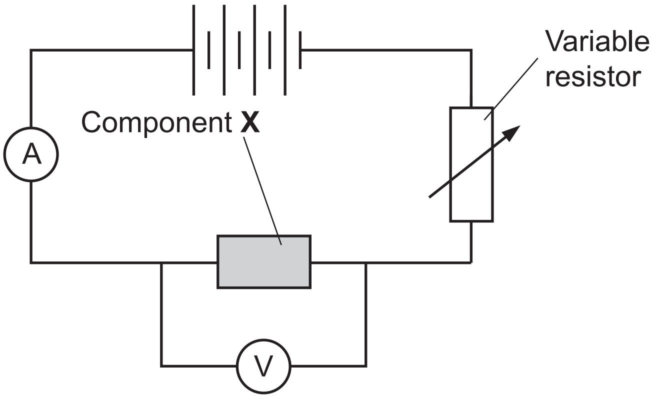
.... **[3]**

8 A student is given an unknown electrical component **X**. The student investigates how the current through **X** varies with the potential difference across it.

The diagram shows the circuit used by the student.



(a) Explain the effect of the student changing the resistance of the variable resistor.

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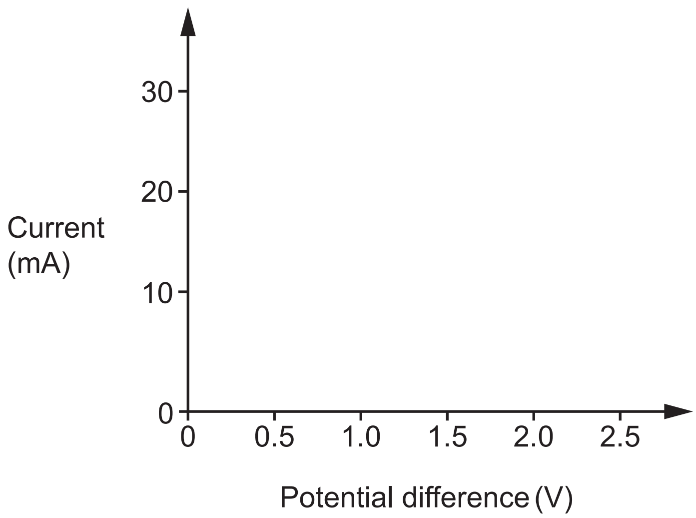
(b) The table shows the student's results.

Potential difference (V)	**Current (mA)**
0	0
0.5	0
1.0	4.8
1.5	12.8
2.0	20.8
2.5	28.8

(i) Sketch the graph of current against potential difference for these results.



[2]

(ii) Suggest what component **X** is.

.... **[1]**

(c) Calculate the charge that flows through component **X** in 300 seconds when the potential difference across it is 1.5 V.

Use the equation: charge = current × time

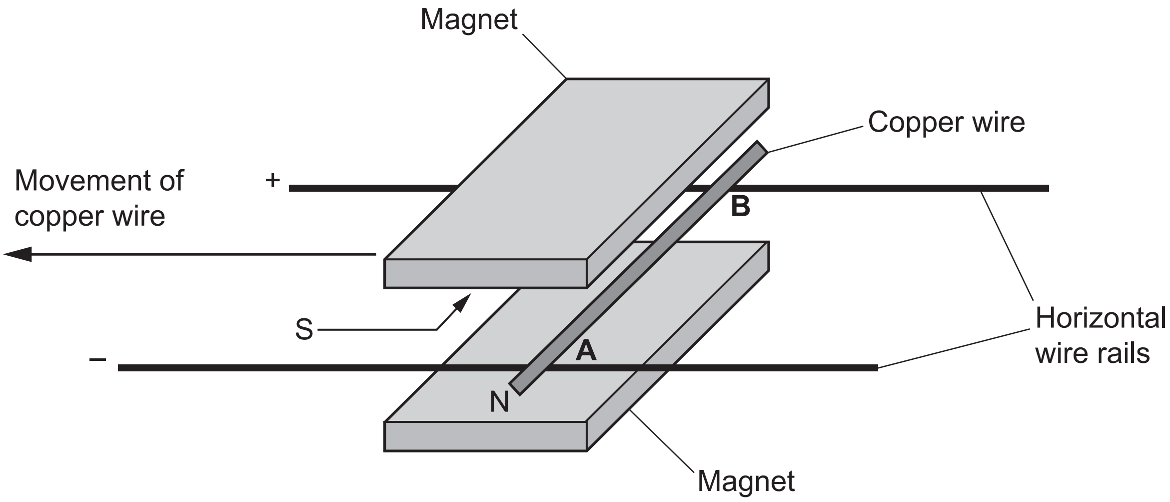
Charge = ... C **[3]**

9 A machine accelerates an object to a high speed. The machine uses the force experienced by a conductor carrying a current in a magnetic field. This is the motor effect.

Fig. 9.1 shows the machine. This is how it works:

- Two horizontal straight wire rails are connected to the positive and negative terminals of a d.c. power supply.
- The two wire rails pass between two flat magnets.
- The two flat magnets provide a vertical magnetic field.
- A piece of copper wire sits on the two wire rails, making contact with the wire rails at points **A** and **B**.

Fig. 9.1



(a) When the power supply is switched on, the copper wire moves to the left as shown.

Explain why the wire moves to the left.

Use Fleming's left hand rule.

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.... **[2]**

(b) Suggest **two** ways in which the student could increase the force applied to the copper wire.

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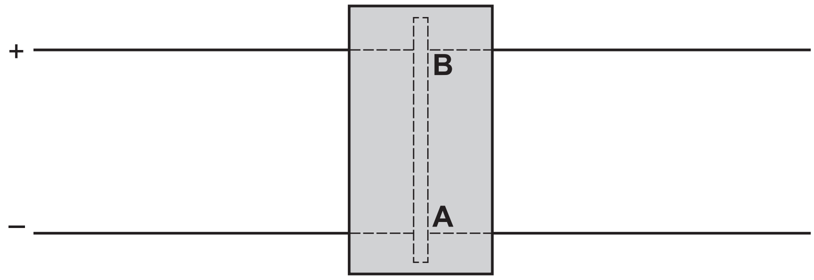
[2]

(c) **Fig. 9.2** shows the machine when viewed from above.

Fig. 9.2



The strength of the magnetic field between the two flat magnets is 0.10 T.
The mass of the copper wire is 0.20 g.
The current in the copper wire is 1.5 A.
The force on the copper wire is 0.0060 N.

You can assume there is no friction between the copper wire and the two wire rails.

(i) Calculate the length of the copper wire between points **A** and **B**.

Use the equation: force = magnetic flux density × current × length of conductor

Length = ... m **[3]**

(ii) Calculate the acceleration of the copper wire while it is in the magnetic field.

Use the equation: force = mass × acceleration

Acceleration = ... m / s^2 **[4]**

(iii) The current is changed so the new acceleration is 36 m / s^2.
When the current is switched on the copper wire accelerates from rest.

Calculate the speed of the copper wire after it has accelerated through a distance of 0.02 m.

Use the Equation Sheet.

Speed = ... m / s **[3]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.