Oxford Cambridge and RSA

Wednesday 22 May 2024 – Morning

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

J260/03 Physics (Foundation Tier)

Time allowed: 1 hour 45 minutes

F

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.

1 The table shows some of the main groupings of the electromagnetic spectrum.

(a) Complete the table.

Low frequency ⟶ High frequency Long wavelength ⟶ Short wavelength						
Radio wave	Microwave	Infrared	Visible light	Ultraviolet	X-rays	....

[1]

(b) Which statement correctly compares a radio wave and an X-ray?

Tick (✓) **one** box.

A radio wave has a **longer** wavelength than an X-ray. ☐

A radio wave has a **shorter** wavelength than an X-ray. ☐

A radio wave has **the same** wavelength as an X-ray. ☐

[1]

(c) X-rays can remove electrons from atoms.

What is the removal of an outer electron from an atom called?

Tick (✓) **one** box.

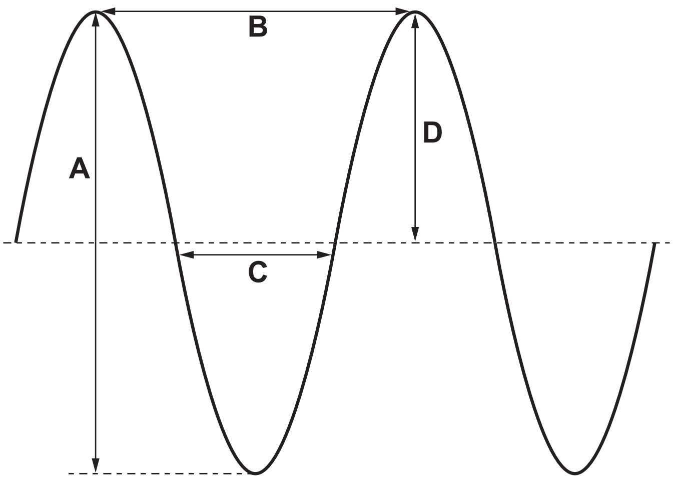
Absorption ☐

Conduction ☐

Ionisation ☐

[1]

2
(a) The diagram shows some ocean waves.



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

(i) Which distance is the wavelength of the wave? ☐ **[1]**

(ii) Which distance is the amplitude of the wave? ☐ **[1]**

(b) The speed of some water waves on the ocean is 2.8 m/s.
The frequency of the waves is 0.35 Hz.

Calculate the wavelength of the waves.

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

Wavelength = ... m **[2]**

3 A student wants to know how different energy resources are used to generate electricity.

(a) Complete the table about the generation of electricity.

Use words from the list:

Coal	**Solar radiation**	**Wind**

Energy resource	**How the energy resource generates electricity.**
	Steam is produced. The steam drives a turbine, which is connected to a generator.
	The energy resource turns the turbine directly. The turbine is connected to a generator.
	Panels are used which generate electricity directly.

[2]

(b) Wind and solar radiation are examples of renewable energy resources. Coal is a non-renewable energy resource.

State **one other** renewable energy resource **and** one other non-renewable energy resource.

Renewable energy resource: ....

Non-renewable energy resource: ....
[2]

(c) Complete the sentences about global warming.

Put a (ring) around each correct option.

One of the main greenhouse gases in the Earth's atmosphere is **carbon dioxide / nitrogen / oxygen**.

The amounts of greenhouse gases in the atmosphere have been increasing over the past two hundred years mostly because of the increasing use of **biofuels / fossil fuels / nuclear fuels**.
[2]

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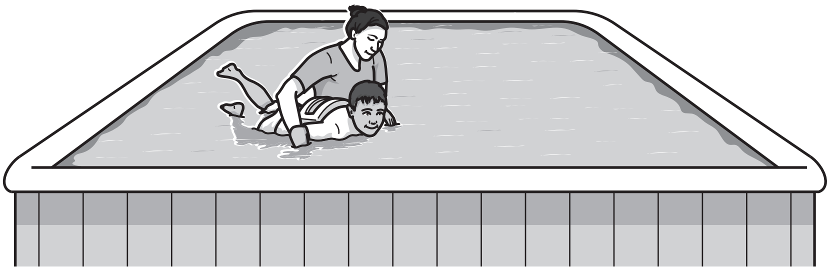
Turn over for the next question

4 A hydrotherapy pool contains hot water. It is used to help people with some medical conditions.



(a) A water heater in a pool has a power of 2300 W. It is switched on for 6 hours.

Calculate the total energy transferred to the pool in 6 hours.

Give your answer in kWh.

Use the Equation Sheet.

Energy transferred = ... kWh **[4]**

(b) Suggest **one** reason for using the kilowatt-hour rather than the joule on electricity bills.

....

.... **[1]**

(c) The pool contains 1250 kg of water. A water heater inside the pool heats up the water. Over 6 hours the temperature of the water rises from 32 °C to 36 °C.

(i) Calculate the increase in the internal energy store of the water over 6 hours.

Use the Equation Sheet.

Specific heat capacity of water = 4200 J / kg / °C

Increase in internal energy = ... J **[3]**

(ii) On another day, the total energy transferred by the water heater is 15 kWh and the increase in internal energy of the water is 10.8 kWh.

Calculate the efficiency of the water heater.

Use the equation:

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy transferred}}$$

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

(d) When the pool is not being used the water cools down.

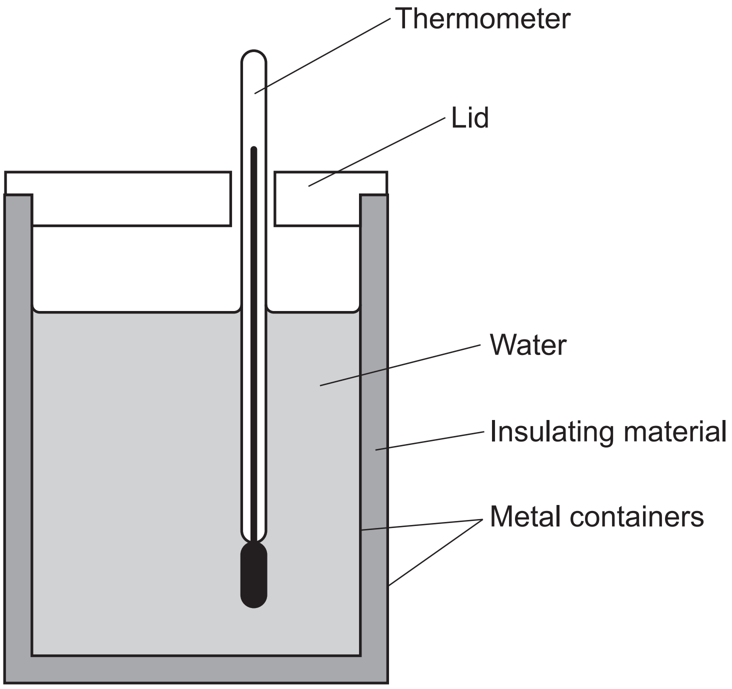
Suggest how the cooling effect can be reduced.

....

.... **[1]**

5 A student does an experiment to compare three materials as thermal insulators.

The diagram shows the equipment used.



(a) This is the method:

- Fill the space between the metal containers with the insulating material.
- Pour 100 cm^3 boiling water into the inner container and place a lid on the container.
- Place a thermometer in the water.
- Start a stopwatch when the temperature drops to 80 °C.
- After **5 minutes** measure the final temperature of the water.
- Repeat the experiment with different insulating materials.

List **three** factors that need to be controlled in this experiment.

1 ....

2 ....

3 ....

[3]

(b) The table shows the results of the experiment.

Insulating material	**Initial temperature (°C) at time = 0 minutes**	**Final temperature (°C) at time = 5 minutes**
Straw	80	69
Shredded paper	80	71
Sawdust	80	67

(i) Which material is the best thermal insulator?

....

Explain your answer.

....

....

....

....

.... **[3]**

(ii) Calculate the rate of change of temperature for **straw**, in degrees celsius per **second**.

Use the data from the table and the equation:

$$\text{Rate of change of temperature} = \frac{\text{change in temperature}}{\text{time taken}}$$

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

Rate of change of temperature for straw = ... °C / s **[4]**

6

(a) A physical quantity is something that can be measured and given a value.

Complete the table by writing in the unit for each physical quantity.

Quantity	**Unit**
Electric charge	
Specific latent heat	
Work done	

[3]

(b) A physical quantity can be a vector quantity or a scalar quantity.

Complete the table.

Tick (✓) **one** box in each row.

Quantity	**Scalar**	**Vector**
Displacement		
Force		
Speed		

[2]

(c) A car travels at a constant speed of 13.4 m / s.

Calculate the distance travelled by the car in 15 seconds.

Use the equation: average speed = $\frac{\text{distance}}{\text{time}}$

Distance = ... m **[3]**

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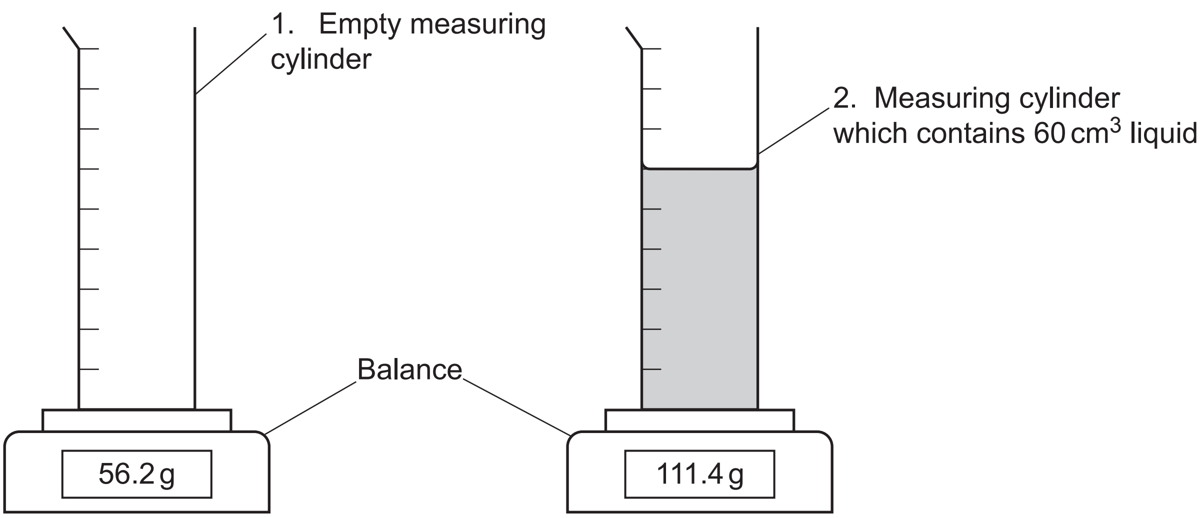
7

(a) **Fig. 7.1** shows some equipment used to find the density of a liquid.

Fig. 7.1



(i) Calculate the mass of the 60 cm^3 of liquid.

Use **Fig. 7.1**.

Mass = ... g **[1]**

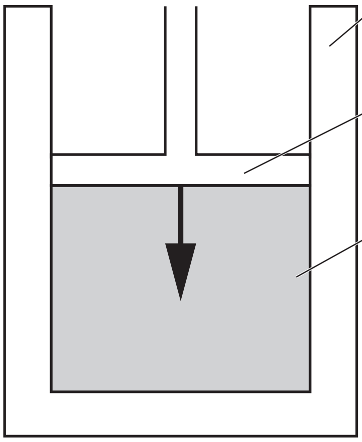
(ii) Calculate the density of the liquid.

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

Density = ... g/cm^3 **[2]**

(b) **Fig. 7.2** shows a fixed mass of gas trapped in a cylinder by a piston.
The piston can be moved up and down.

Fig. 7.2



(i) Complete the sentence to explain what happens to the density of the trapped gas when the piston is moved downwards.

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

The density of the gas **decreases / increases / stays the same**

because ....

....

....

....

.... **[3]**

(ii) The piston is then fixed in place so that it cannot move.

The trapped gas is heated. This causes the pressure inside the cylinder to increase.

Explain why the gas molecules apply a larger pressure on the cylinder when the trapped gas is heated.

....

....

....

....

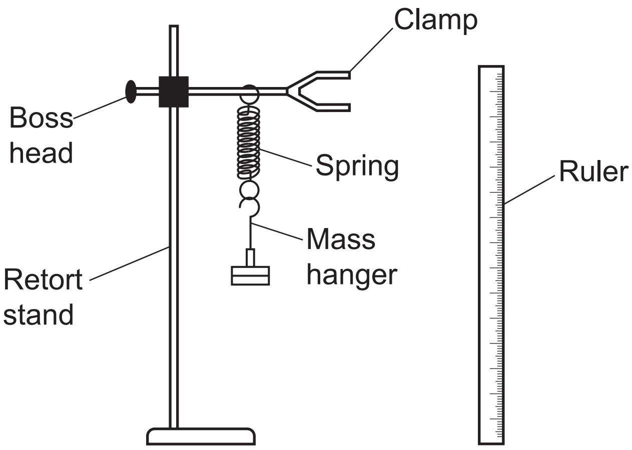
....

.... **[3]**

8 A student investigates how the length of a spring changes when masses are added to it, using the equipment in **Fig. 8.1**.

The results are shown in **the table**.

Fig. 8.1



Mass (g)	**Weight (N)**	**Length (cm)**	**Extension (cm)**
0	0	4.0	0
100	1.0	6.4	2.4
200	2.0	8.8	4.8
300	3.0	11.2	7.2
400	4.0	13.6	....
500	5.0	16.0	12.0
600	6.0	18.4	14.4

(a)

(i) Calculate the extension of the spring when the mass is 400 g.

Write your answer in the table. **[1]**

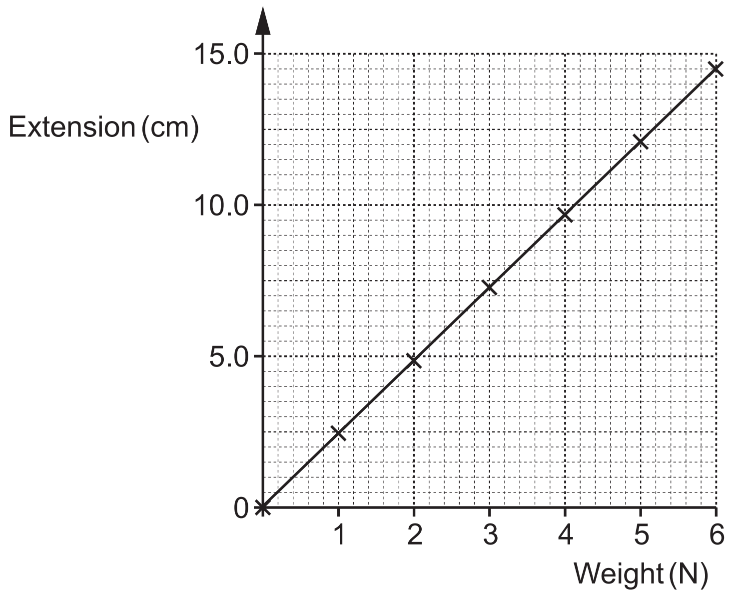
(ii) Calculate the spring constant when the mass is **300 g**.

Use the table and the equation: weight = spring constant × extension

Give your answer to **2** decimal places.

Spring constant = ... N / cm **[4]**

(b) The graph shows the results of the experiment.



Describe the relationship between the weight and the extension of the spring.

Use data from the graph or the table to support your answer.

....

....

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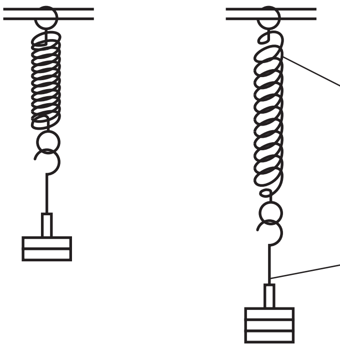
.... **[2]**

(c) When a mass is added to the spring, the spring stretches and the masses move down and stop at a lower position, as shown in **Fig. 8.2**.

Fig. 8.2



Energy is transferred.

Explain how energy has been conserved even though the spring has stretched and the masses are in a different position.

Use ideas about gravitational potential and elastic potential energy stores.

....

....

....

....

....

.... **[3]**

(d) The energy stored in a stretched spring is given by the equation:

Energy stored in a stretched spring = $\frac{1}{2}$ × spring constant × (extension)^2

(i) What happens to the energy stored in a stretched spring when the extension is doubled?

Put a (ring) around the correct option.

The energy stored increases by:

less than two times / two times / more than two times.

[1]

(ii) Explain your answer to **(d)(i)**.

....

.... **[1]**

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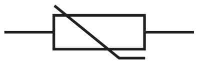
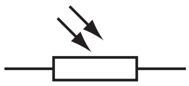
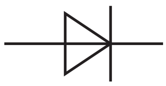
9

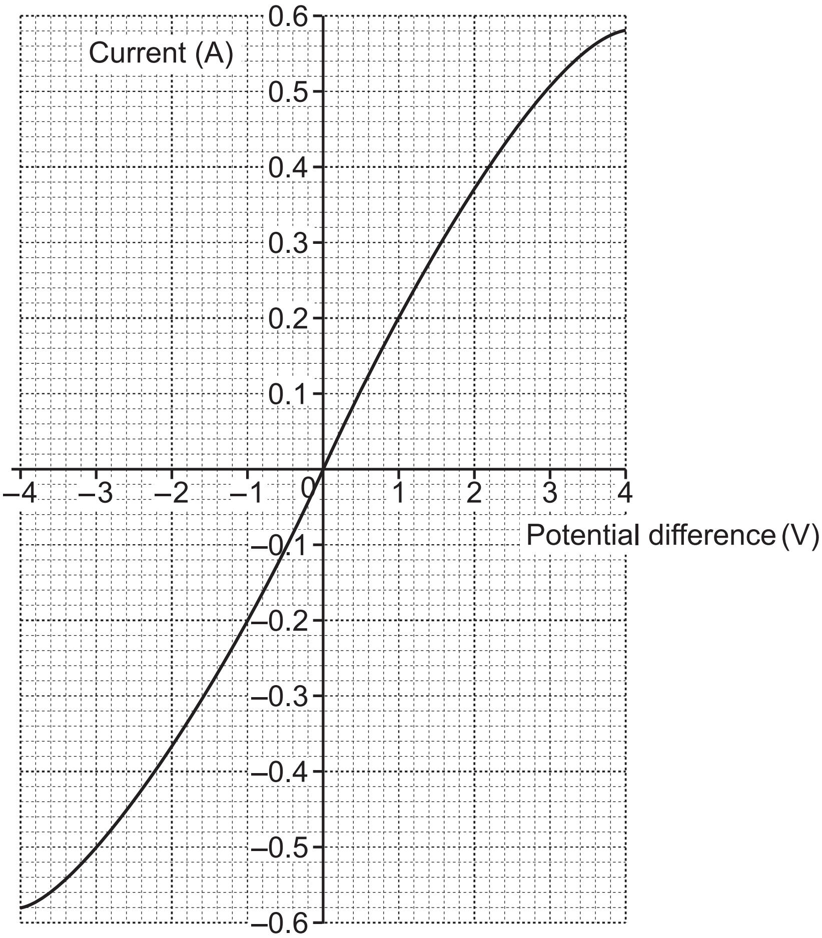
(a) Electric circuits are represented by symbols.

Draw lines to connect each **symbol** to its **name** and its **use**.

Symbol	**Name**	**Use**
	Diode	Allows current to flow in one direction only
	Thermistor	Detects changes in light intensity
	Light-dependent resistor	Detects changes in temperature

[4]

(b) The graph shows how the current through a filament lamp varies with the potential difference across it.



(i) Describe how the current in the filament lamp changes as the potential difference across it increases from 0 V to 4 V.

....

....

....

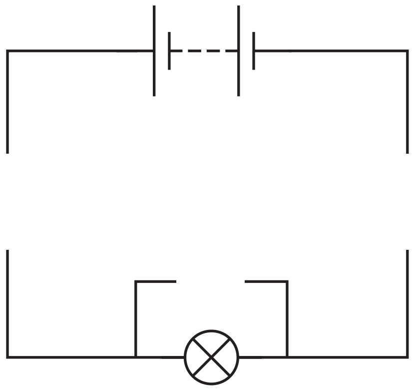
.... **[2]**

(ii) Calculate the resistance of the filament lamp when the potential difference across it is 2.2 V.

Use the graph and the Equation Sheet.

Resistance = ... Ω **[4]**

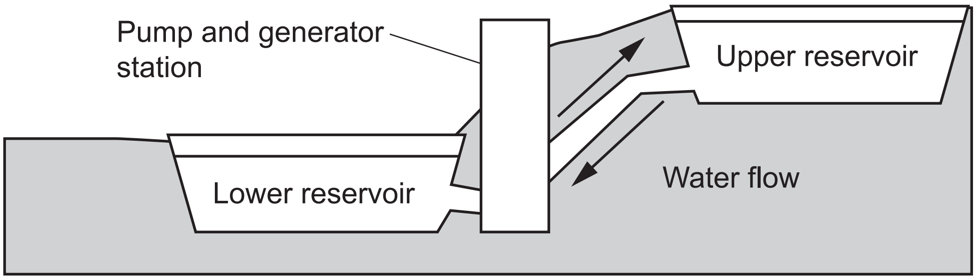
(iii) The diagram shows part of the circuit that a student uses to obtain these results.



Complete the circuit diagram by adding a variable resistor, voltmeter and an ammeter to the circuit.

[3]

10* 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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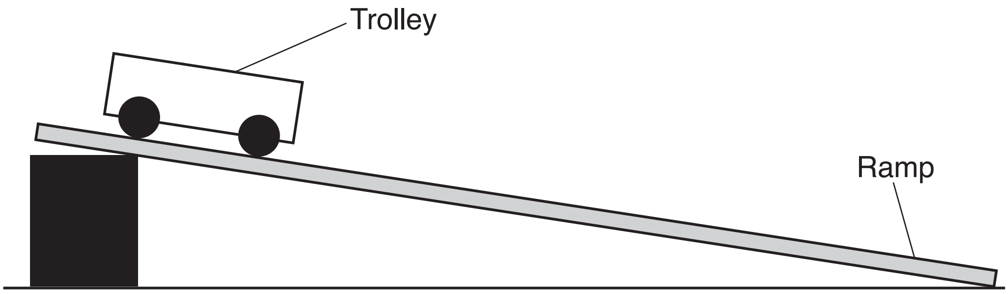
.... **[6]**

11

(a) A student is investigating the motion of a trolley travelling down a ramp, using the equipment shown in **Fig. 11.1**.

Fig. 11.1



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 = $\frac{\text{distance}}{\text{time}}$

....

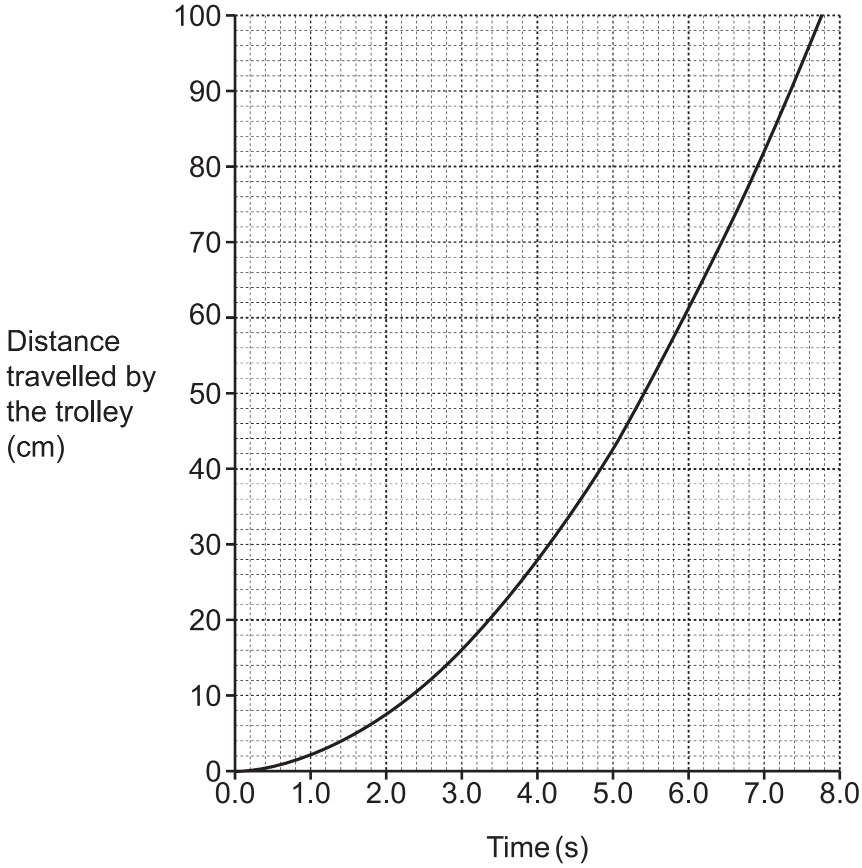
....

....

.... **[2]**

(b) **Fig. 11.2** shows how far the trolley travels down the ramp in a given time.

Fig. 11.2



(i) Explain how **Fig. 11.2** shows that the trolley accelerates down the slope.

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

....

....

....

.... **[2]**

(ii) **Draw** a tangent on **Fig. 11.2** at Time = 5.0 s and use it to **calculate** the gradient at this time.

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

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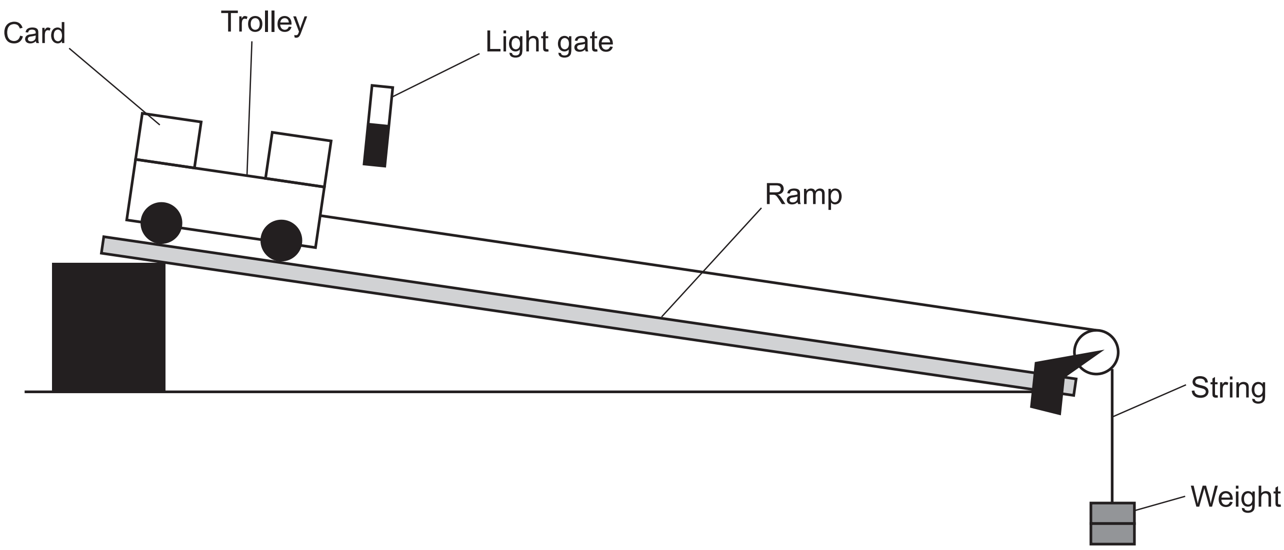
(c) The student then investigates how the size of a pulling force affects the motion of the trolley down the ramp.

Fig. 11.3 shows the equipment used.

Fig. 11.3

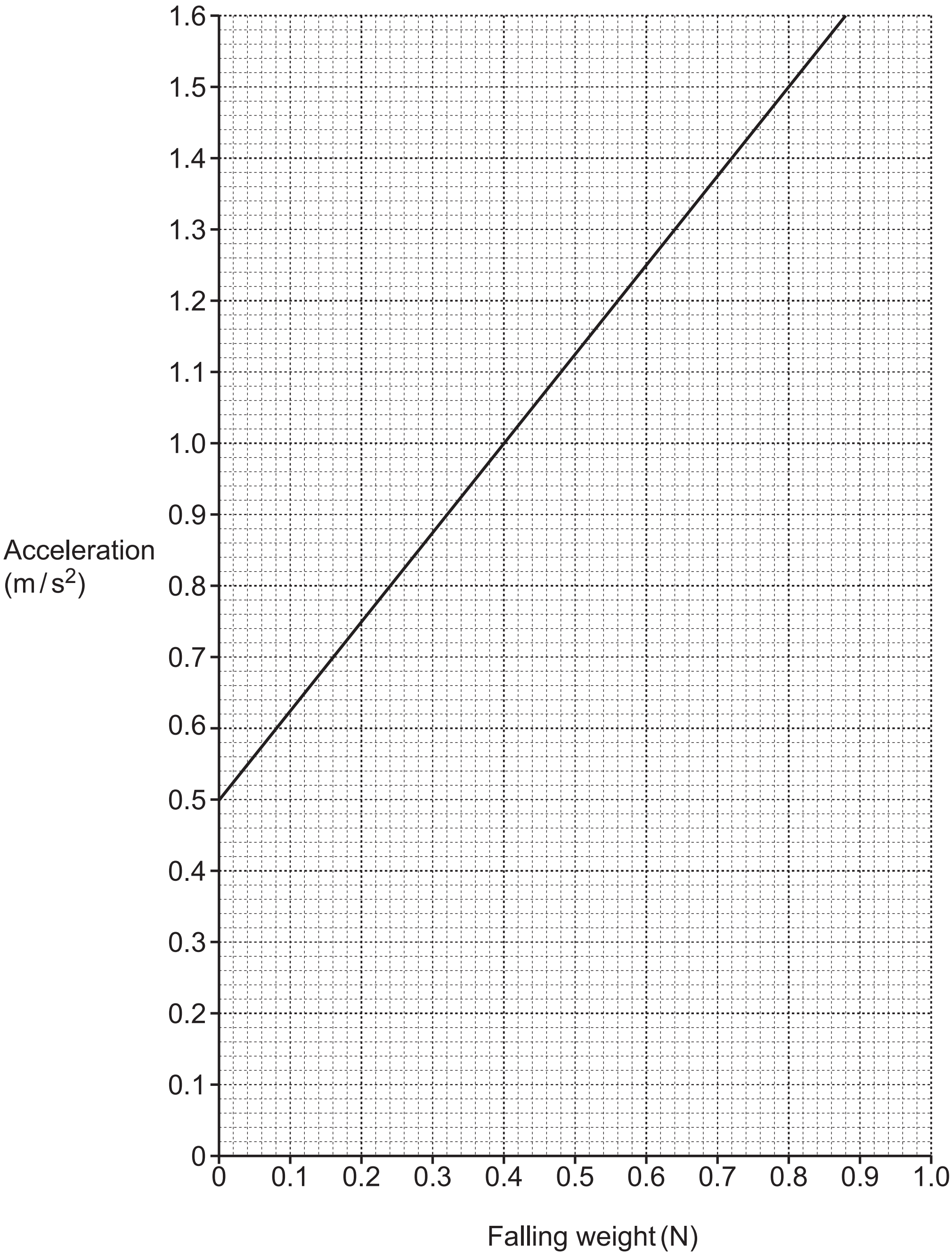


The pulling force on the trolley is provided by a falling weight attached to the trolley by a string.

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

Fig. 11.4 shows the student's results.

Fig. 11.4



(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. 11.4** and the Equation Sheet.

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

(ii) A student writes an equation for the graph in **Fig. 11.4**

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. 11.4**?

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]

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.

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