



SERANGOON GARDEN SECONDARY SCHOOL

PRELIMINARY EXAMINATION

CANDIDATE
NAME

CLASS

INDEX
NUMBER

PHYSICS

6091/02

20 August 2026
1 hour 45 minutes

Paper 2
Secondary 4 Express

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A

Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B

Answer **one** out of the two questions.
Write your answers in the spaces provided on the question paper.

You are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
You are advised to show all your working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
A	70
B	10
Total	80

Section A [70 marks]

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

- 1** Fig. 1.1 shows the vertical velocity of a ball. The 1.0 kg ball is launched upwards from the ground at time $t = 0$ s, and it reaches a platform above the ground at $t = 3.5$ s.

You may assume that air resistance is negligible.

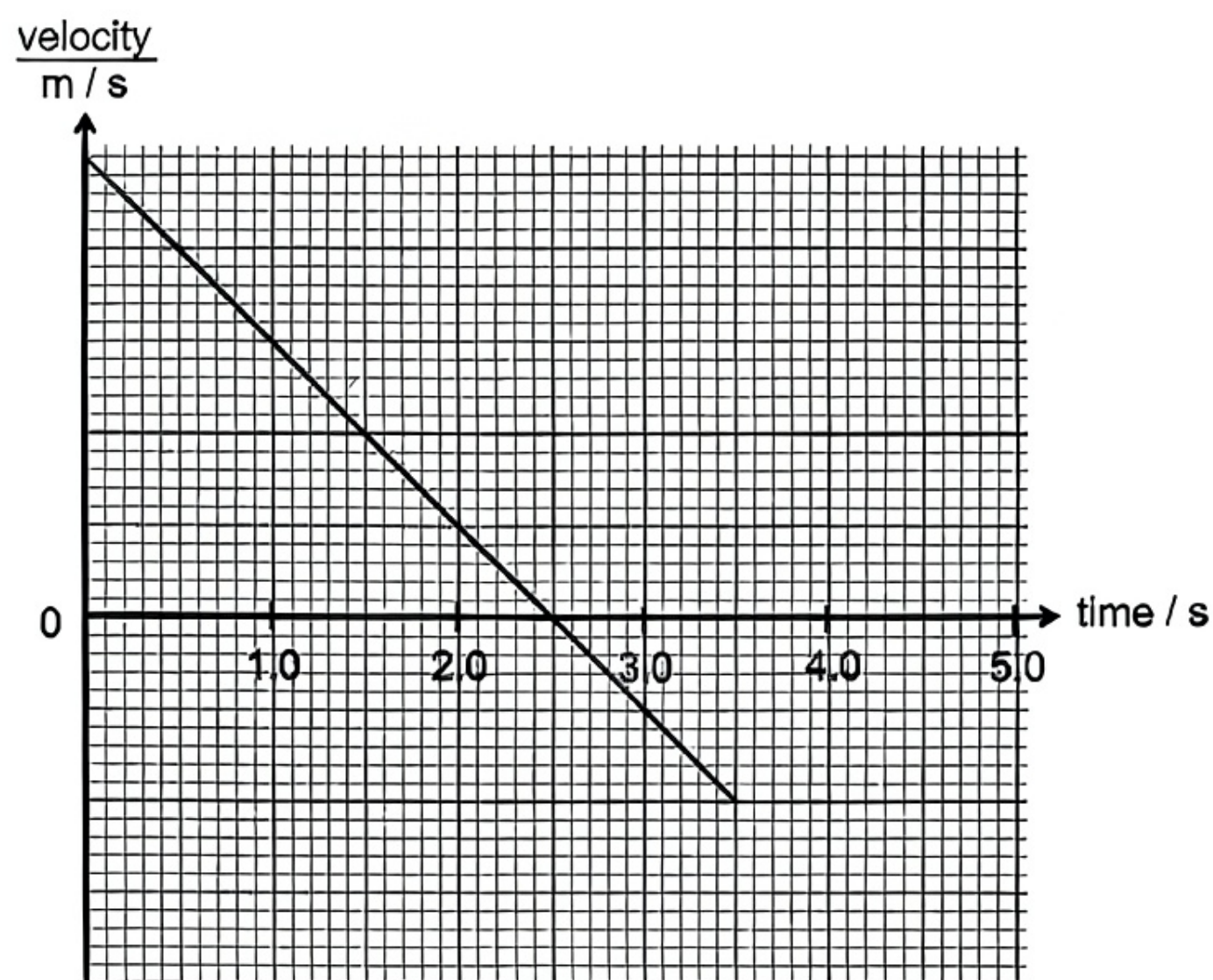


Fig. 1.1

- (a) (i) Show that the initial velocity of the ball is 25.0 m / s.

[1]

- (ii) Hence, calculate the height of the platform from the ground level.

height = [2]

- (b) The ball lands on a shock-absorbent mat on the platform and decelerates at a constant rate and comes to rest in 0.1s.

On Fig 1.1, draw a line to complete the velocity-time graph of the ball.

[1]

- (c) Using ideas about energy, determine the average force acting on the ball by the shock-absorbent mat as it comes to rest.

average force = [3]

[Total: 7]

- 2 To accommodate a longer string for the load, the heavy base of the retort stand can be rotated 180° so that it faces away from the direction of the clamp.

This arrangement is shown in Fig. 2.1. The typical arrangement of the boss and clamp on the retort stand is shown in Fig. 2.2.

Both diagrams are not drawn to scale.

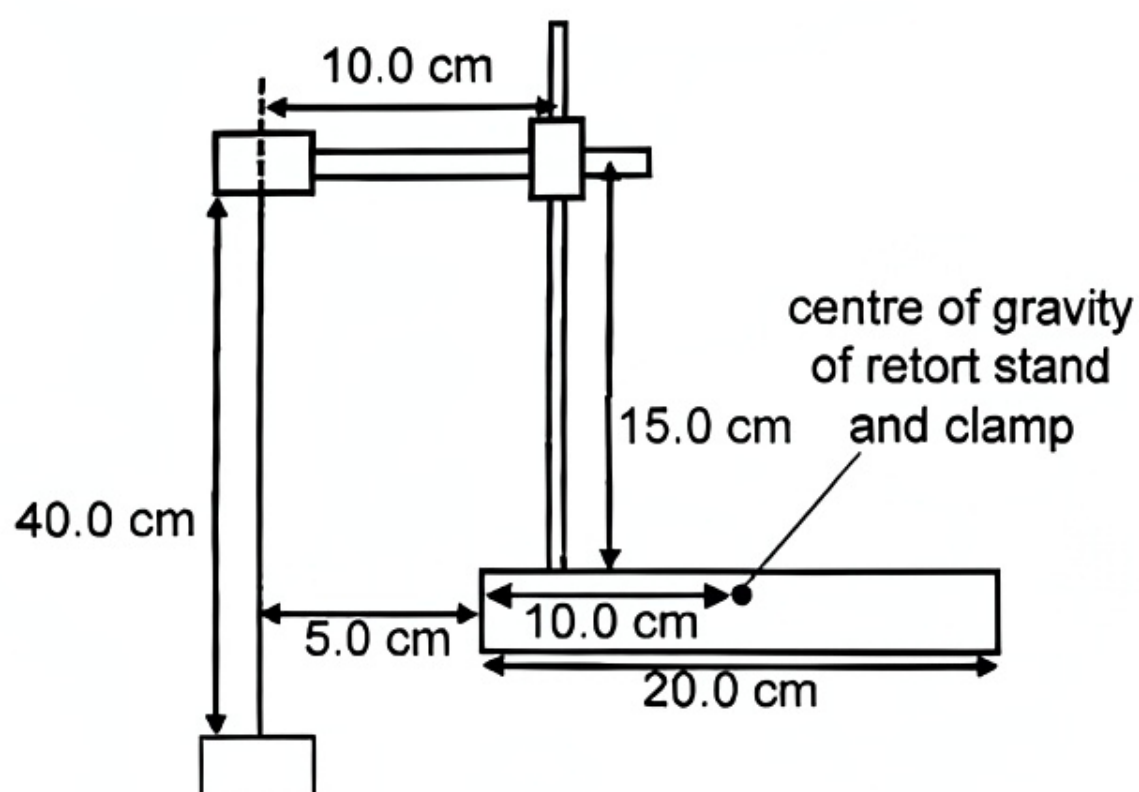


Fig. 2.1

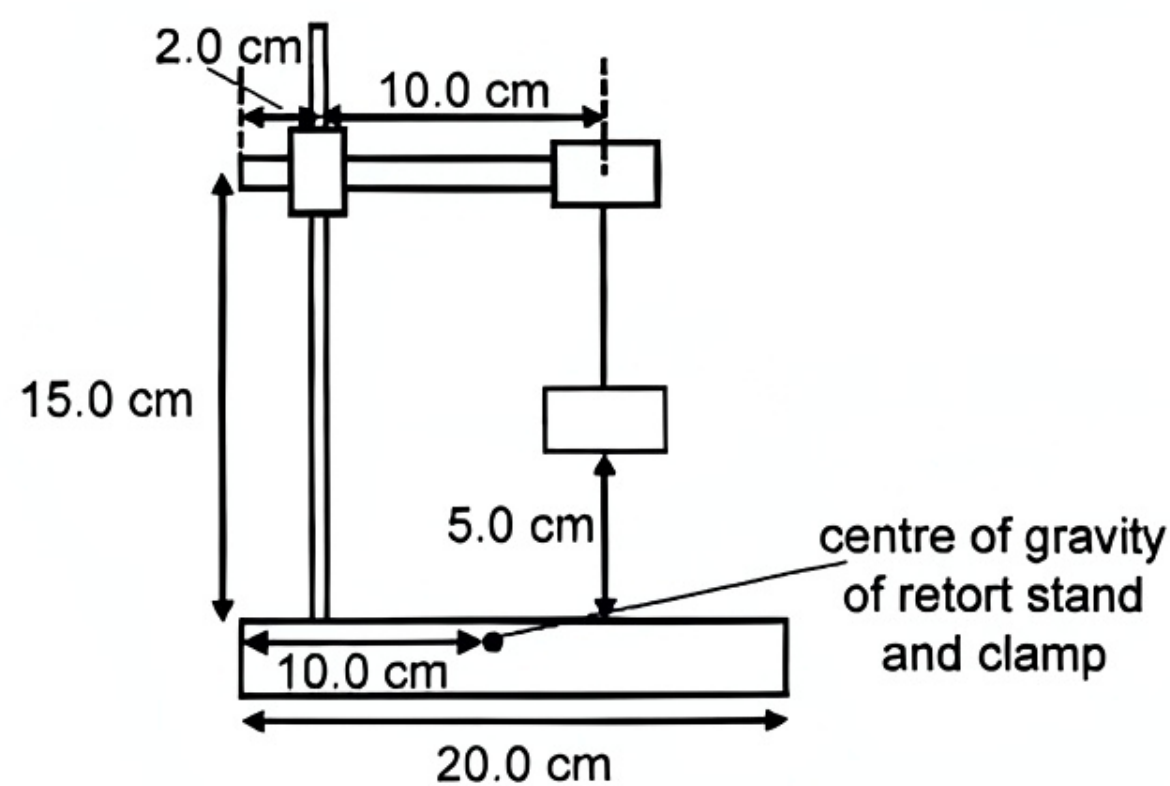


Fig. 2.2

- (a) State the *principle of moments*.

.....

 [2]

- (b) The weight of the retort stand is 15.0 N.

Using Fig. 2.1, calculate the maximum mass of the load that can be hung from the clamp without the retort stand toppling over.

mass = [3]

- (c) State the force that is the action-reaction pair of the weight of the load in Fig. 2.2.

.....
..... [1]

- (d) The rod and clamp in Fig. 2.2 is now replaced with a heavy-duty rod and clamp so that it can support greater loads. The heavy-duty rod and clamp have the same volume but are made of a material of greater density.

Explain the changes, if any, to the stability of the retort stand.

.....
.....
..... [2]

[Total: 8]

- 3 Fig. 3.1 shows a mercury manometer attached to a gas supply in a container to measure its pressure.

One end of the tube is connected to the gas supply, and the other end is open. The atmospheric pressure is $1.0 \times 10^5 \text{ Pa}$ and the density of mercury is 13600 kg / m^3 .

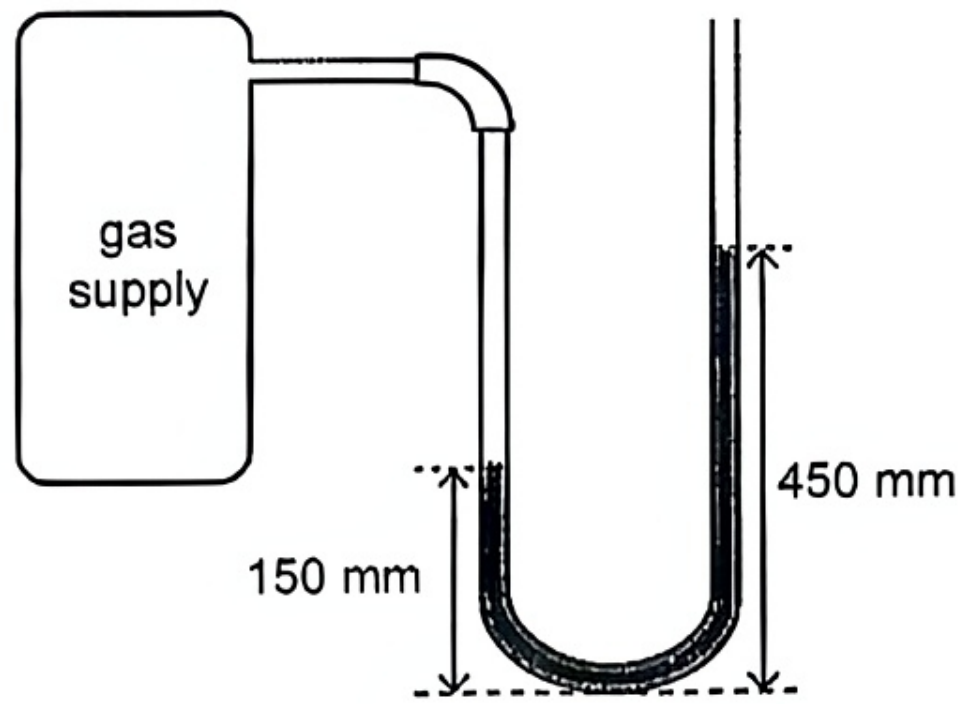


Fig. 3.1

- (a) Determine the pressure of the gas supply in pascal.

[2]

- (b) The gas supply is heated up to a higher temperature.

Describe and explain the changes to the difference in mercury levels in the manometer.

.....

 [3]

- (c) After the measurement, the gas supply is disconnected from the manometer. Both ends of the manometer reach the same level after some time.

Explain why this happens.

.....

 [2]

[Total: 7]

- 4 (a) On Fig. 4.1, draw and label the object, the ray diagram and its corresponding image to show how a converging lens is used in a photo enlarger to produce a magnified image, projected on a screen.

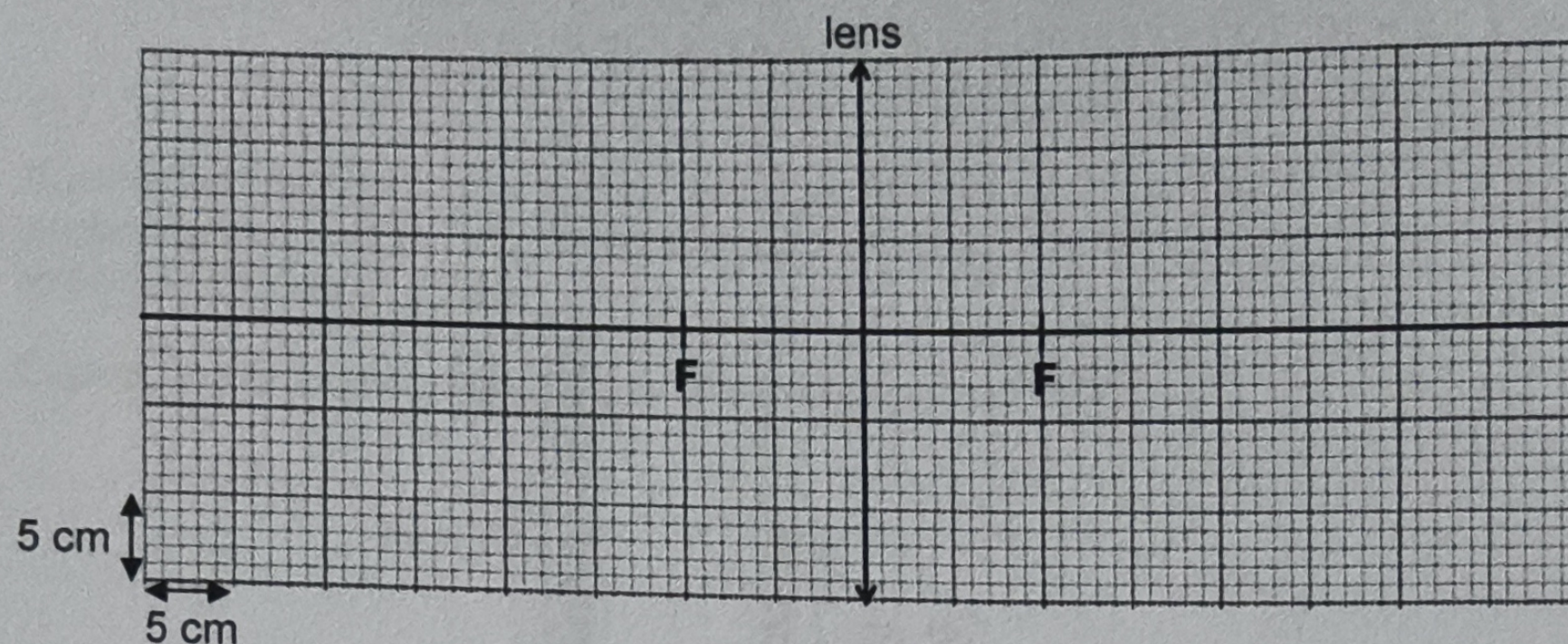


Fig. 4.1

[3]

- (b) The object from (a) is removed. A new object is placed along the principal axis of the lens, 30 cm away from it.

Describe the change, if any, of the characteristics of the image of an object after the object is moved 5 cm towards the lens.

.....

.....

.....

..... [2]

[Total: 5]

- 5 Fig. 5.1 shows a conducting sphere carrying excess negative charge. The sphere is mounted on an insulating stand.

An electrically neutral aluminium ball of weight 3.0 N is suspended from a newton meter. The ball is brought close to, but does not touch the conducting sphere. The ball is attracted towards the sphere, and the equilibrium position is shown in Fig. 5.1.

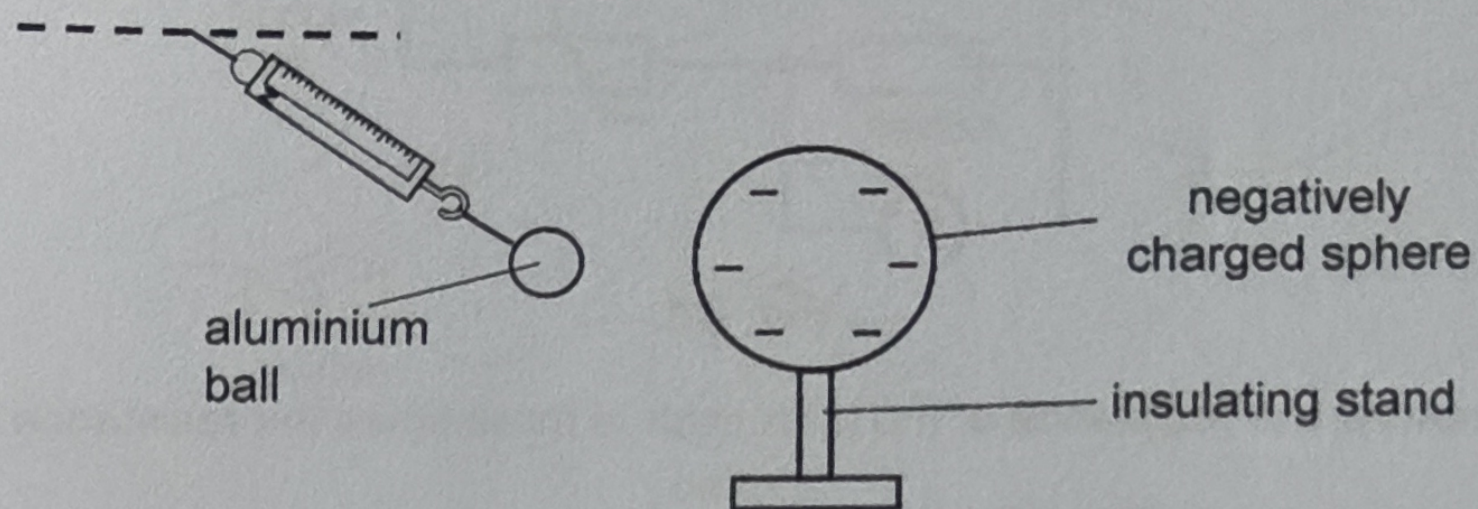


Fig. 5.1

The negatively charged sphere attracts the aluminium ball with a 5.0 N force.

Draw a scaled vector diagram to determine:

- (i) the reading of the newton meter, and
- (ii) the angle between the newton meter and the ceiling.

Show your working clearly.

scale:

magnitude of the force:

angle between the newton meter and the ceiling : [3]

[Total: 3]

- 6 A potential divider circuit is set up as shown in Fig. 6.1.

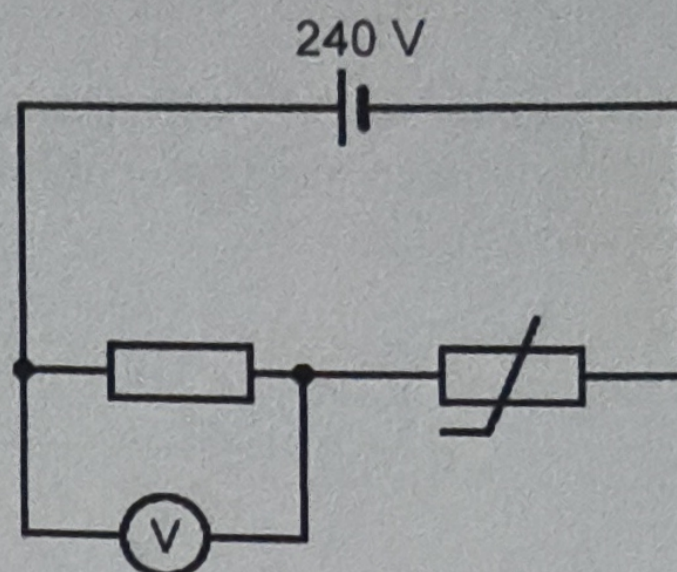


Fig. 6.1

At room temperature, the resistance of the thermistor is three times the resistance of the fixed resistor.

- (a) (i) Determine the potential difference across the thermistor.

potential difference = [2]

- (ii) The temperature of the room and the thermistor increases.

State and explain what happens to the reading of the voltmeter.

.....

 [2]

- (b) An air-conditioner is to be connected in parallel with either the fixed resistor or the thermistor. The air-conditioner should operate at a higher power when the room temperature increases.

- (i) State the component that should be in parallel with the air-conditioner.

..... [1]

- (ii) Explain why your choice in (b)(i) allows the power of the air-conditioner to increase as the room temperature increases.

.....

 [2]

[Total: 7]

- 7 Fig. 7.1 shows a coil of wire connected by flexible leads to a switch and a battery.

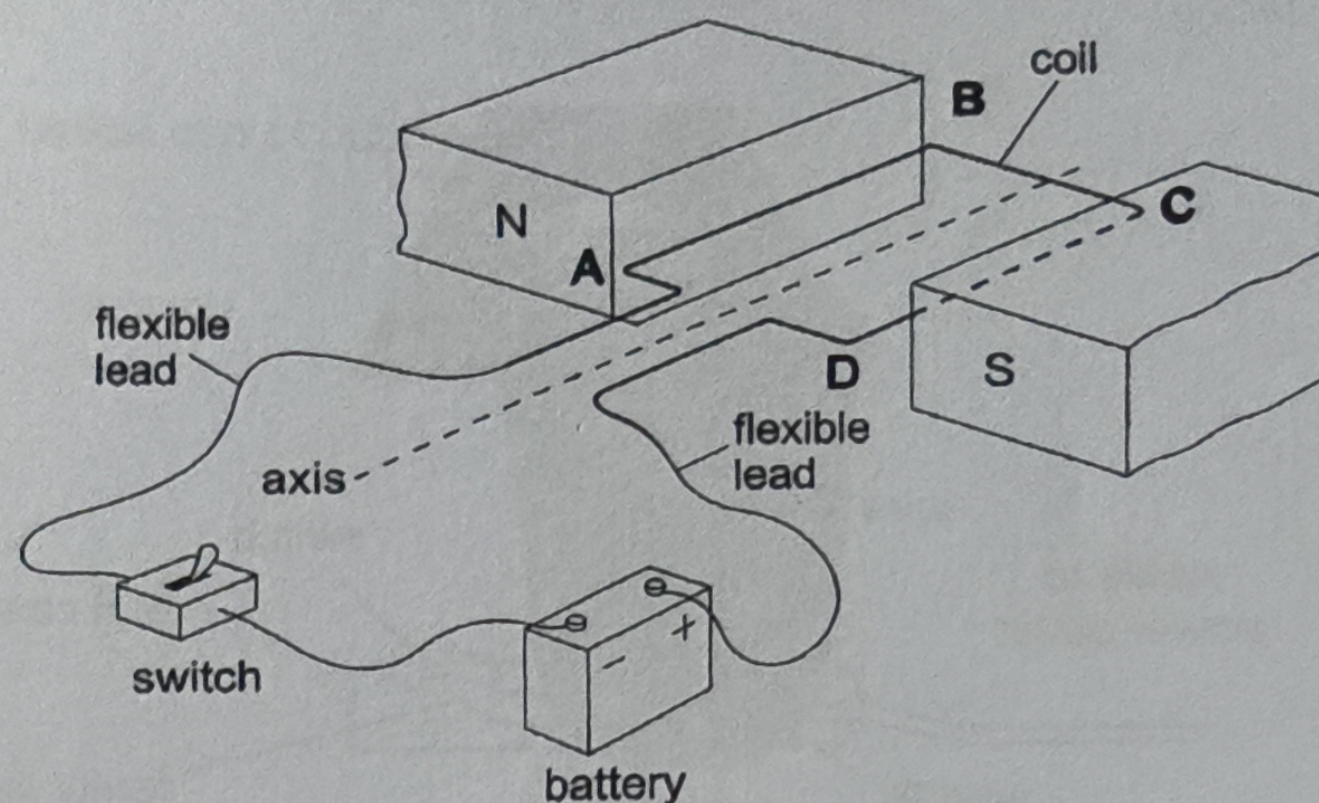


Fig. 7.1

The coil is placed between the poles of a permanent magnet and is free to rotate about its axis. When the switch is closed, current flows through the coil, producing forces on its sides.

- (a) On Fig. 7.1, draw and label
- the direction of current flowing on side **CD** of the coil, [1]
 - the force that acts on side **CD** of the coil. [1]
- (b) Describe and explain the motion of the coil after the switch is closed.
- [3]
- (c) The flexible leads are replaced by a split-ring commutator and carbon brushes.
- Describe and explain the changes, if any, to the motion of the coil after the switch is closed.
- [2]

[Total: 7]

- 8 Fig. 8.1 shows the electrical wiring of a table lamp. A fault causes the live wire inside the table lamp to touch the metal casing.

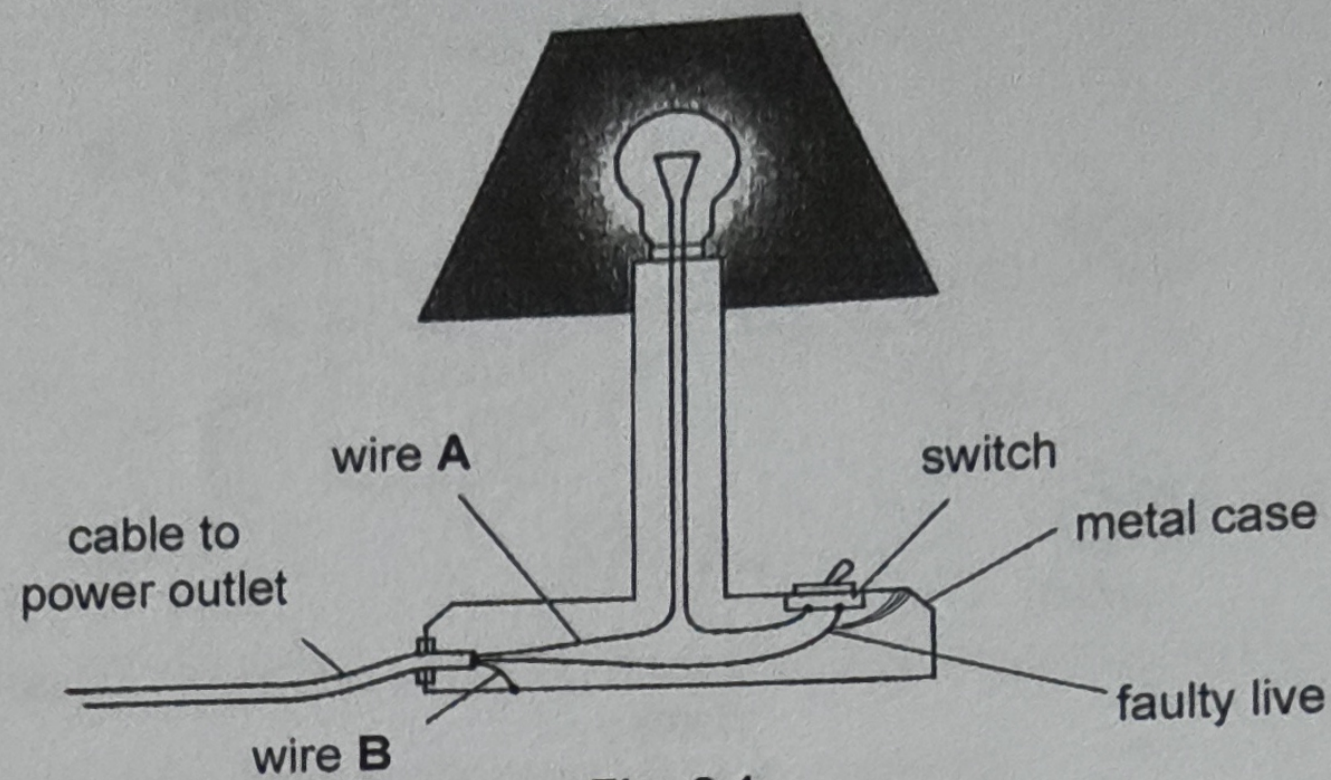


Fig. 8.1

- (a) Describe and explain what happens if a person touches the metal case of the lamp. Make references to the wires in Fig. 8.1 in your answer.

.....

 [2]

- (b) The table lamp draws a current of 0.30 A from a 230 V mains supply.
 Calculate the resistance of the lamp when it is operating normally.

resistance = [2]

- (c) The table lamp is switched on for 8.0 hours each day. The cost of electricity is 40.0 cents per kWh.
 Calculate the cost of operating the table lamp for 30 days.

cost = \$ [2]

[Total: 6]

- 9 Bubble tea is prepared by mixing fixed volumes of flavored syrup, tea, ice cubes, and chewy starch balls called *pearls*.

Fig. 9.1 shows a typical cup of bubble tea.



Fig. 9.1

Table 9.2 shows the volume of each ingredient used to prepare bubble tea of different sizes. It also shows the specific heat capacities and the specific latent heat of fusion of the ingredients, together with their initial temperatures before mixing.

Table 9.2

	milk tea		pearls		ice	
size	small	large	small	large	small	large
mass added / g	400	550	120	150	300	450
specific heat capacity / J / (g K)	4.1		3.5		2.1	
specific latent heat of fusion / J / g	310		200		330	
temperature before mixing / $^{\circ}\text{C}$	30		36		-15	

- (a) Explain what is meant by a *specific latent heat of fusion of 330 J / g* .

.....
 [1]

- (b) Calculate the amount of energy required to reduce the temperature of the milk tea and pearls in a small cup, to the ideal temperature of drinking, 10°C .

energy = [2]

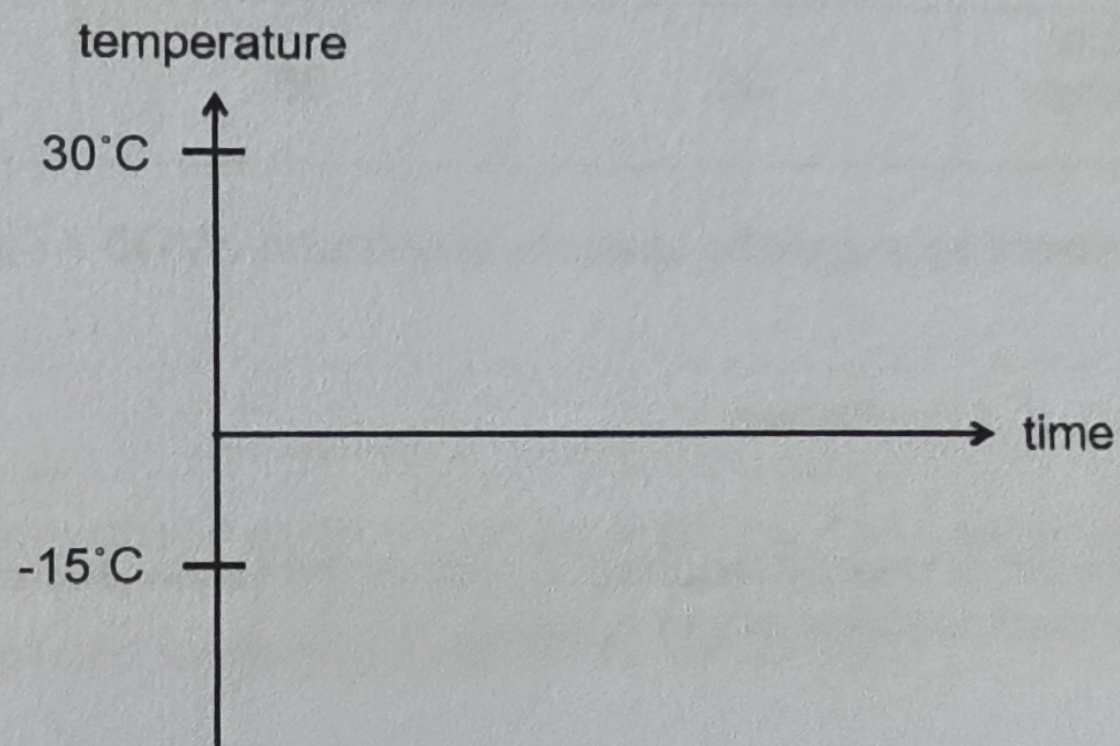
- (c) The specific heat capacity of water is 4.2 J / g K .
Determine the minimum mass of ice required to allow the entire drink to reach 10°C .

mass of ice = [3]

- (d) The minimum amount of ice determined in (c) was added to the cup of milk tea.

On the same axes below, sketch the variation of temperature with time for the milk tea and the ice from the time they are mixed until thermal equilibrium is reached.

Label each graph clearly.



[2]

[Total: 8]

14) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.



(a) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(b) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(c) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(d) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

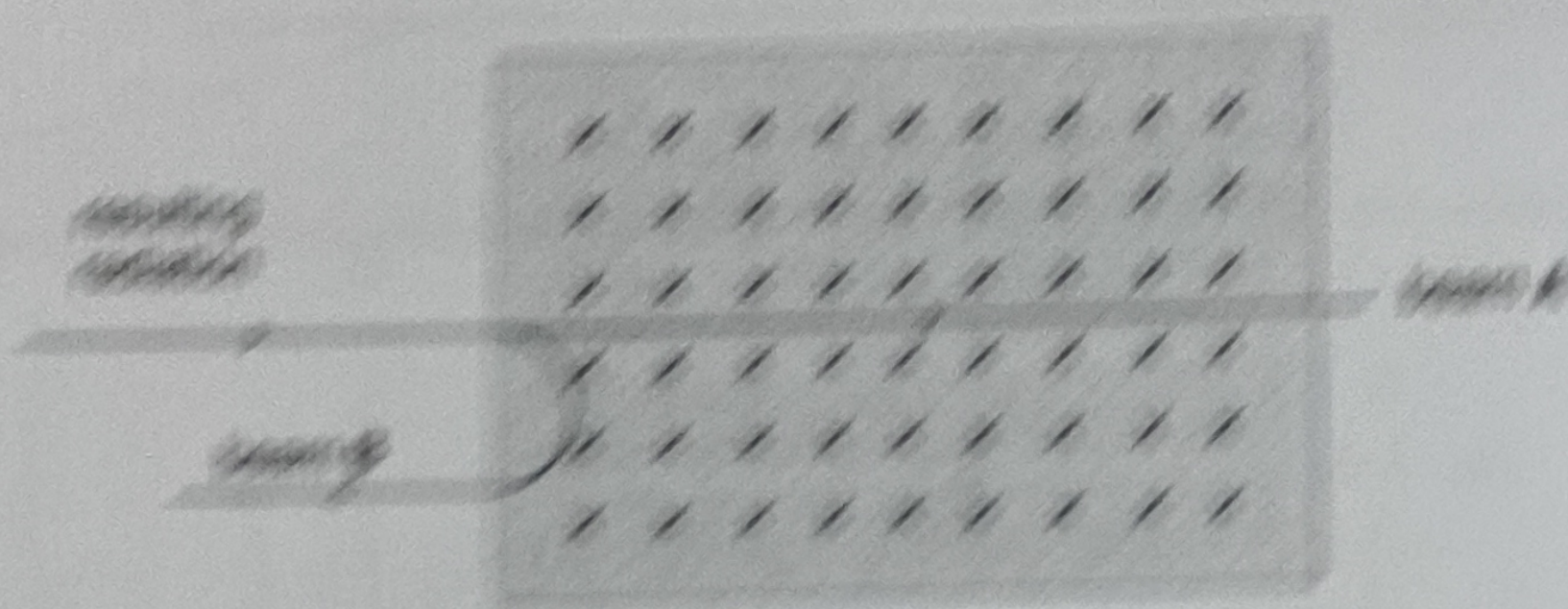


Fig. 14.1

Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(a) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(b) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(c) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(d) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(e) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(f) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(g) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(h) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(i) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

(j) Write the balanced chemical equation for the reaction of phosphorus with oxygen to form phosphorus pentoxide.

- (e) After correcting for background radiation, the count rate of the radioactive isotope is measured at regular time intervals. Fig. 10.2 shows the variation of count rate with time.

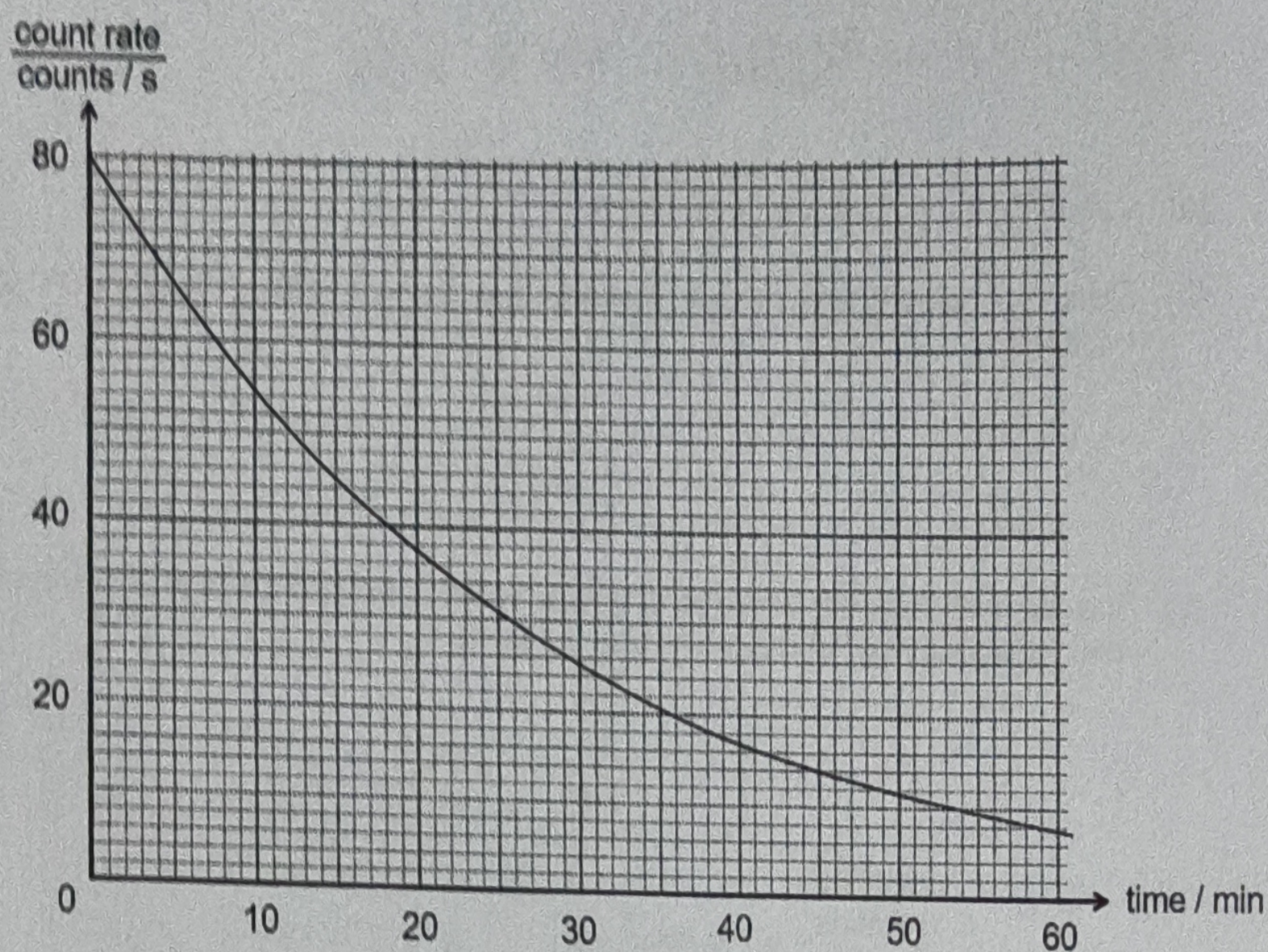


Fig. 10.2

- (i) Suggest one source of background radiation.

..... [1]

- (ii) Determine the half-life of the radioactive isotope. Show your working on Fig. 10.2 clearly.

half-life = [2]

- (f) State one precaution that should be taken when handling the barium-141 sample and explain why the precaution is necessary.

.....

 [2]

[Total: 12]

Section B [10 marks]

Answer **one** question from this section.

- 11 Ultrasound is used in the construction industry to detect cracks inside metal blocks.

Fig. 11.1 shows a transmitter and a detector placed on the front surface of the metal block. The transmitter emits short pulses of ultrasound into the metal block.

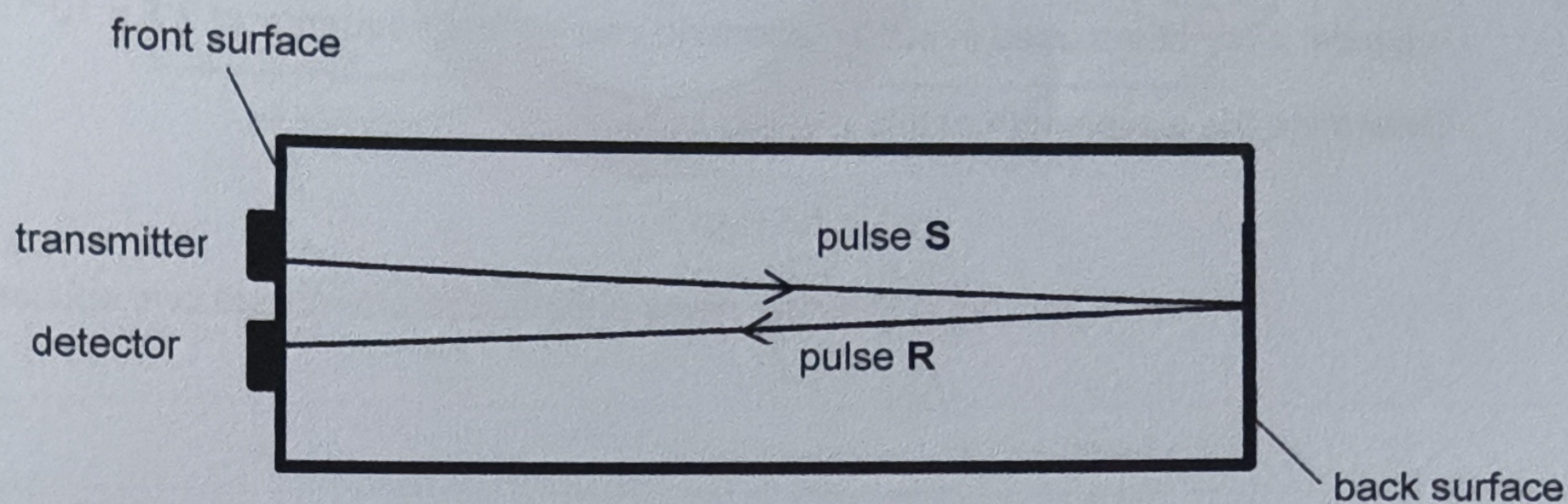


Fig. 11.1

Fig. 11.2 shows the cathode-ray oscilloscope (c.r.o.) trace obtained when the metal block contains no cracks.

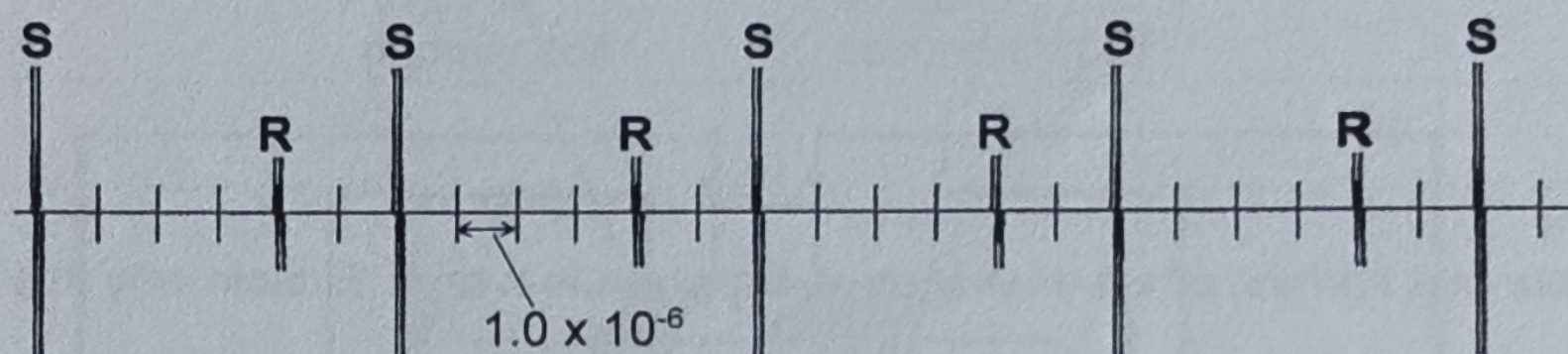


Fig. 11.2

Each interval in the trace obtained is set to 1.0×10^{-6} s / division.

Pulses labelled **S** are pulses initially sent out by the transmitter. Each pulse labelled **R** is the reflection from the back surface of the metal block from the previous pulse **S**.

- (a) Suggest a possible frequency for the ultrasound wave used.

..... [1]

- (b) State and explain why the amplitude of **R** is less than the amplitude of **S**.

.....

 [2]

- (c) The metal block is tested again after its performance led to suspicions that a small crack has formed halfway between the front surface and the back surface.

On Fig. 11.2, draw the positions and sizes of all pulses reflected by the crack.

[2]

Label each of these pulses C.

- (d) In a medical context, x-rays are used to produce images of bones.

A typical x-ray beam used in such a scenario can have a frequency of 2.5×10^{18} Hz.

Determine the wavelength of this x-ray in vacuum.

wavelength = [2]

- (e) Other than the speed of the waves in vacuum, state one property in which X-rays differ from ultrasound.

..... [1]

- (f) State one harmful effect of excessive exposure to x-rays. Explain why this happens.

..... [2]

[Total: 10]

- 12 (a) Fig. 12.1 shows the set-up for Faraday's iron ring experiment.

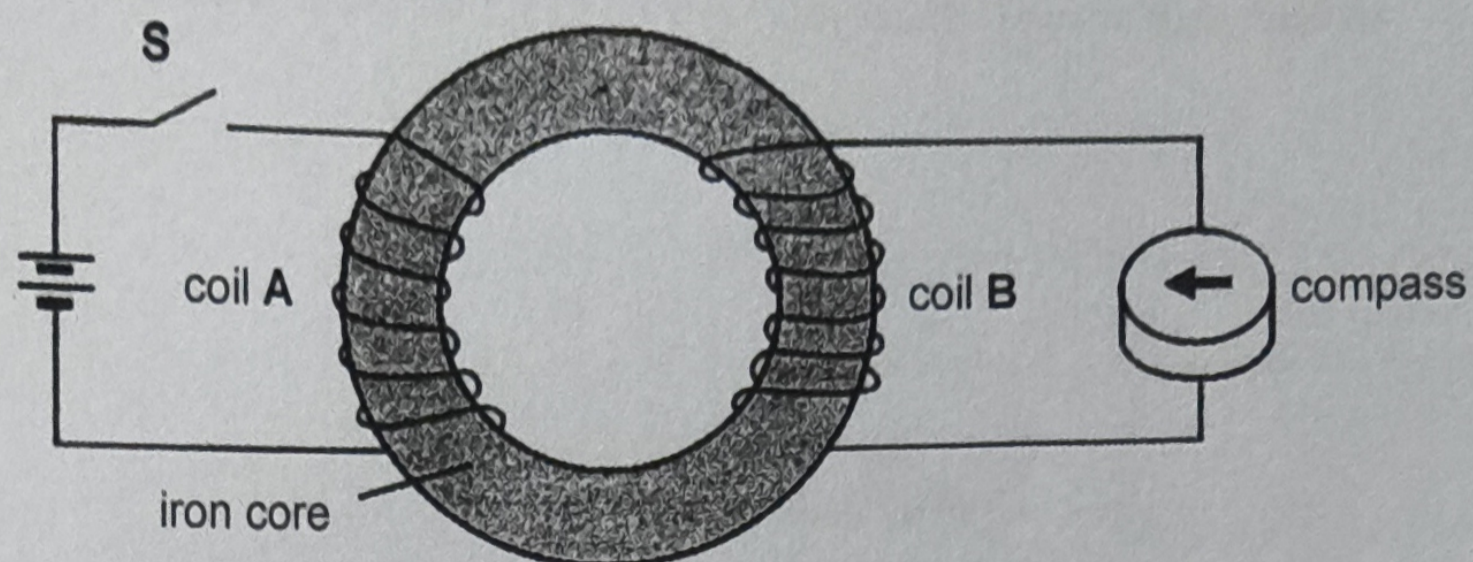


Fig. 12.1

Describe and explain the observation when switch S is closed.

.....

.....

..... [2]

- (b) A student sets up a model transformer and connects it to two lamps P and Q, as shown in Fig. 12.2.

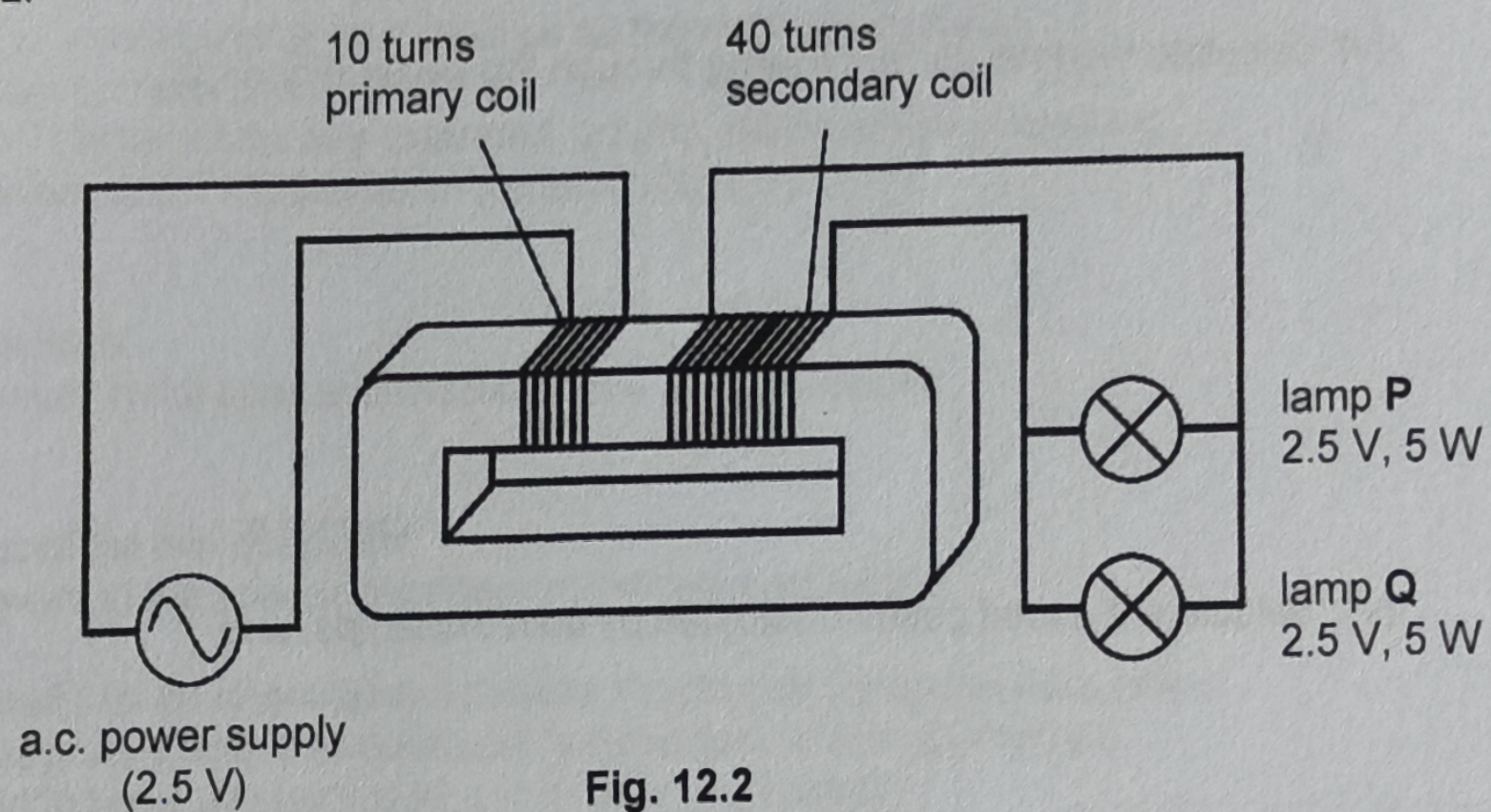


Fig. 12.2

The a.c. power supply is a 2.5 V supply, and both lamps P and Q are rated at 2.5 V, 5.0 W.

- (i) Explain what it means for a lamp to be rated at 2.5 V, 5.0 W.

.....

..... [1]

- (ii) Describe the brightness of lamp **P** and **Q** relative to their normal brightness.

Explain your answer. Show your working to support your explanation.

.....
 [2]

Assuming that the model transformer is 100% efficient,

- (iii) calculate the resistance of each lamp,

resistance = [1]

- (iv) calculate the total current flowing through the secondary circuit,

current = [2]

- (v) calculate the total power dissipated by both the lamps, and

power = [1]

- (vi) calculate the current flowing through the primary circuit.

current in primary circuit = [1]

[Total: 10]

– END OF PAPER –