MS_11_JUN_9188-3_PHYSICS

QP_11_NOV_9188-3_PHYSICS

QP_12_JUN_9188-3_PHYSICS

MS_12_JUN_9188-3_PHYSICS

QP_12_NOV_9188-3_PHYSICS

MS_12_NOV_9188-3_PHYSICS

QP_13_JUN_9188-3_PHYSICS

MS_13_JUN_9188-3_PHYSICS

QP_13_NOV_9188-3

MS_13_NOV_9188-3_PHYSICS

2014_JUN_9188-3_qp

2014_JUN_9188-3_ms

N2014 P3

JUNE_2015_PHYSICS_P3

QP_15_NOV_9188-3

2015 NOVEMBER P3 MS

Physics_NOV 2015_P3_Marking_Scheme

2016_june_P3

2016_JUN_MS_3

9188_nov_2016_P3-1

NOV 2016 QP3

2016_NOV_MS_3

QP_17_JUN_9188-3

june_2017_p3 MS

Phycs_nov_2017_p3

NOV2017_MS3

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MS_18_JUN_9188-3

nov 2018 physics_P3

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General Certificate of Education Advanced Level

MARKING SCHEME

JUNE 2011

PHYSICS

9188/3

1 (a) (i) Any two with correct units B1

(ii) magnitude and unit/error of the quantity B1

(iii) units have the same meaning everywhere in the world/AW B1

(iv) There is an incorrect coefficient/missing term/extra terms /angles B1

Experimental/Practical verification /AW. B1

(v) Precision: closeness to mean value /'small deviation' close to each other 'low random error' B1
Accuracy: closeness to true value / far from true value B1
Deviation true value is large / large systematic error.

(b) (i) Body changes direction, so there is a resultant force B1B1

(ii) Greatest: tension and weight act against each other but resultant in direction of tension/$T - mg = \frac{mv^2}{r}$ /AW. M1

Lowest: tension and weight act in same direction/$T + mg = \frac{mv^2}{r}$ /AW M1

Greatest: vertically below centre /AW – at bottom
Lowest: vertically above centre /AW – at top A1

(iii) ΔE_k = work done / E_p lost = E_{k} gained

= F × d B1

$F = \frac{GMm}{R^2}$, (since h <<R) B1

$\Delta E_k = \frac{GMmh}{R^2}$, $(d = h)$ AO

(c) (i) 1. Kinetic energy
2. potential energy Both to be correct B1

(ii) 1. $\frac{1}{2}mv^2 = 2.5$

$\therefore v = 50ms^{-1}$ A1

2. k = ~~w^2m~~ = $\omega^2 m$

$= \left(\frac{50}{0.35}\right)^2 (2.0 \times 10^{-3})$ C1

= 40.8 Nm^{-1} A1

A – with 1 more s.f.

Ⓐ- amp

(iii) Amplitude increases (to a maximum) as frequency approaches natural frequency /AwS B1

Amplitude decreases after resonance /AW B1

A - diagrams

2 (a) (i) Damped – Amplitude decreases with time (till oscillations die) B1

accept definitions.

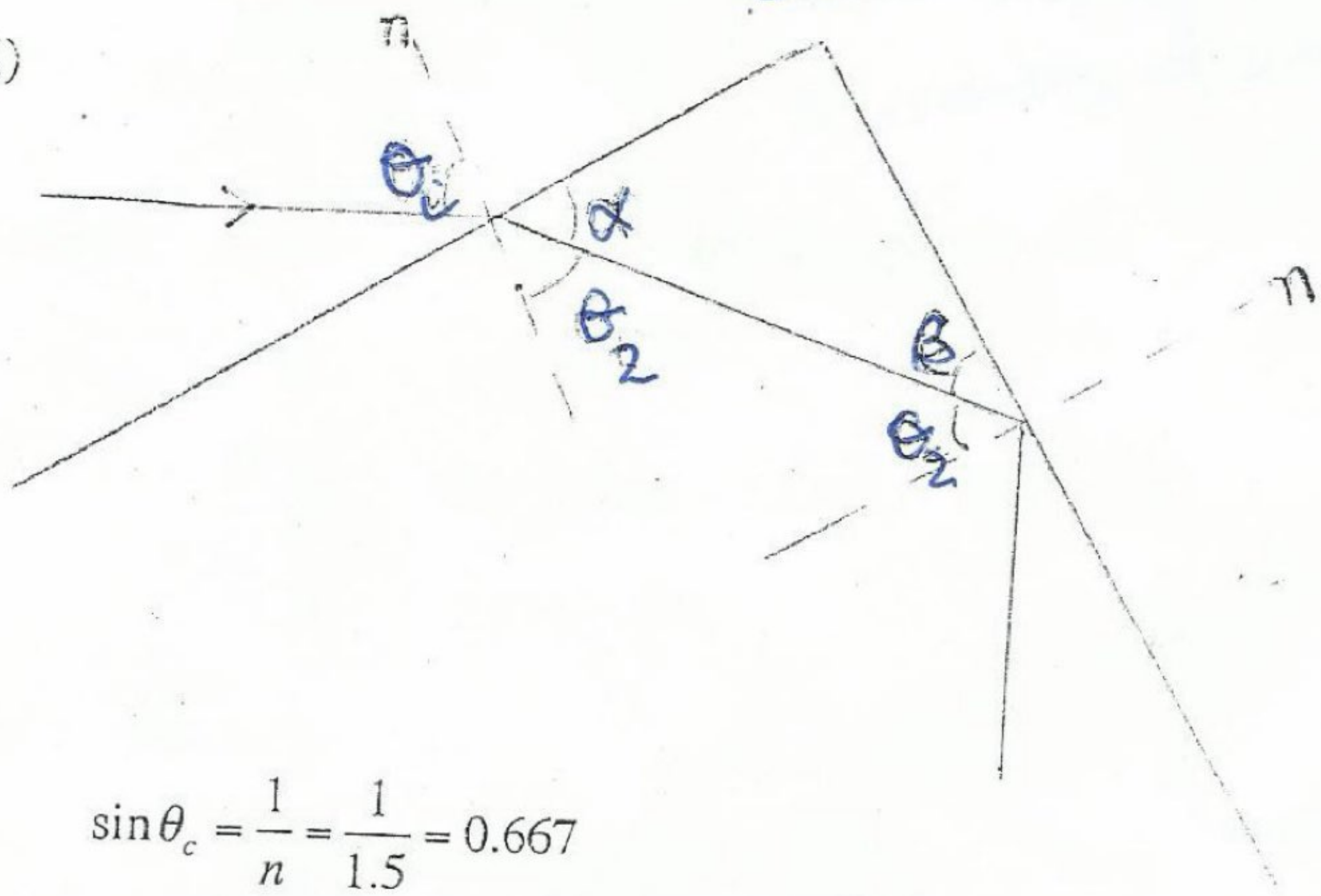
Forced: Amplitude may remain constant since lost energy is replenished with external driving force /AW B1

If, forcing frequency = natural frequency, **resonance occurs** B1

(ii) Reduces magnitude of amplitude OR Reduces resonance frequency / Graphs showing a - forcing frequency. B1

(b) (i) $\frac{\sin i}{\sin r}$ = constant/ n A - $\frac{\sin i}{\sin r}$ = refractive index = n. B1

(ii)



$\sin\theta_c = \frac{1}{n} = \frac{1}{1.5} = 0.667$

θ_c = ~~46.5°~~ 41,8 C1

41,8 48,2

$\beta = 90 -$ ~~46.5~~ = ~~43.5°~~

48,2 . 71,8°

$\propto = 180 - (60 +$ ~~43.5)~~ = ~~76.5°~~ C1

71,8

$\theta_t = 90 -$ ~~76.5~~ = ~~13.5~~ = 18,2° C1

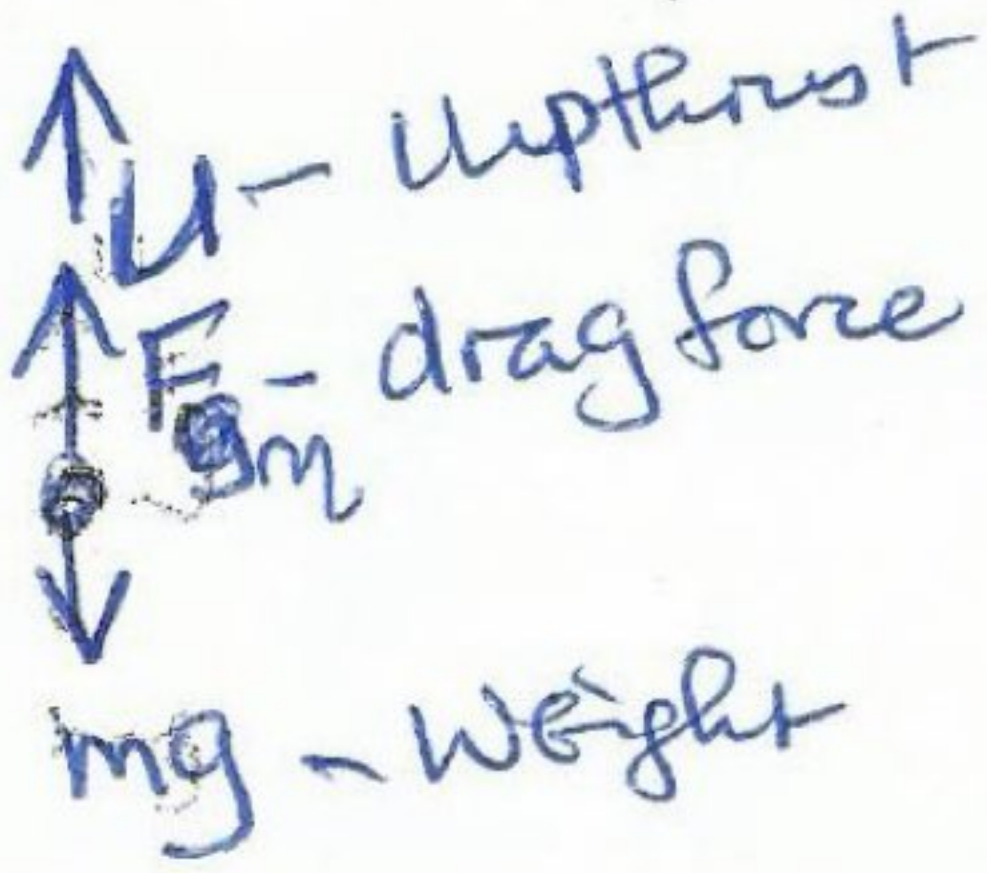
$\therefore \frac{\sin\theta i}{\sin\theta t} = n$ C1

8,2

$\sin\theta i = 1.5 \times \sin 13.$~~5~~ = ~~0.316~~ 0,4685

θ_i = ~~20.45°~~ 28,00° A1

3 (a) (i)



forces, directions B1

names of forces B1

(ii) Initially $W > u + F_g$ B1

F_η → $F_{d\eta}$ increases with velocity B1
(Until $W = u + F_\eta$)

When $W = u + F_\eta$ then terminal velocity achieved B1

$$\frac{4}{3}\pi r^2 \rho g = \frac{4}{3}\pi r^3 \sigma g + 6\pi\eta r V_t$$ B1

$$V_t = \frac{2r^2(\rho - \sigma)g}{9\eta}$$ A1

ρ – density of stee
σ – density of viscous fluid.

(b) upthrust = weight/weight of displaced fluid C1

= ρvg

= 860 × 0.03 × 0.1 × 0.1× 9.81 C1

= 2.53 N A1

4 (a) (i) *similarity*

- Both involve change of direction of wave B1 – common point of incidence
- No change of frequency

Difference: reflection – no change of medium
Refraction – change of medium B1

/ Reflection: No change of speed
/ Refraction: change of speed.

Reflection – No change in energy
Reffraction – Change in energy

(ii) Longitudinal: vibrations are parallel to direction of travel of wave B1

(b) (i) Spreading of waves as they pass through an aperture or round an obstacle (of comparable to the wavelength) B1

(ii) 1. Gradient = $\frac{d}{3}$ C1

$n\lambda = d\sin\theta$.
$n = 3$

$\frac{\lambda}{\sin\theta} = \frac{d}{n}$.

Gradient calculation
With correct substitution C1

$$\frac{630 - 454}{0{,}576 - 0{,}444}$$
$$= \frac{176 \times 10^{-9}}{0{,}132}$$

d = 3.96×10^{-6}m A1
OR N = 252 lines/mm $\left(\frac{1}{d}\right)$

Ⓡ calculations

Ⓡ - Use the graph

~~OR $d\sin\theta = n\lambda \Rightarrow \sin\theta = \frac{n\lambda}{d} = \frac{3 \times 556 \times 10^{-9}}{3,96 \times 10^{-6}} = \frac{1,67 \times 10^{-8}}{3,96 \times 10^{-6}}$~~

~~$= 0,42$~~

~~$\therefore \theta = 24,8°$~~

2. $\sin\theta = 0.521$ ✓ C1
$\therefore \theta = 31.4°$ ✓ A1

(c) Reduces the fractional uncertainty of the angle B1

~~$\theta \Rightarrow 24,8° - 31,4°$~~

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

9188/3

NOVEMBER 2011 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

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All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

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*Answer **question 1** and **any other 2** from the remaining questions.*

1 **(a)** **Fig.1.1** shows a car moving on top of a hill with a constant speed, v.

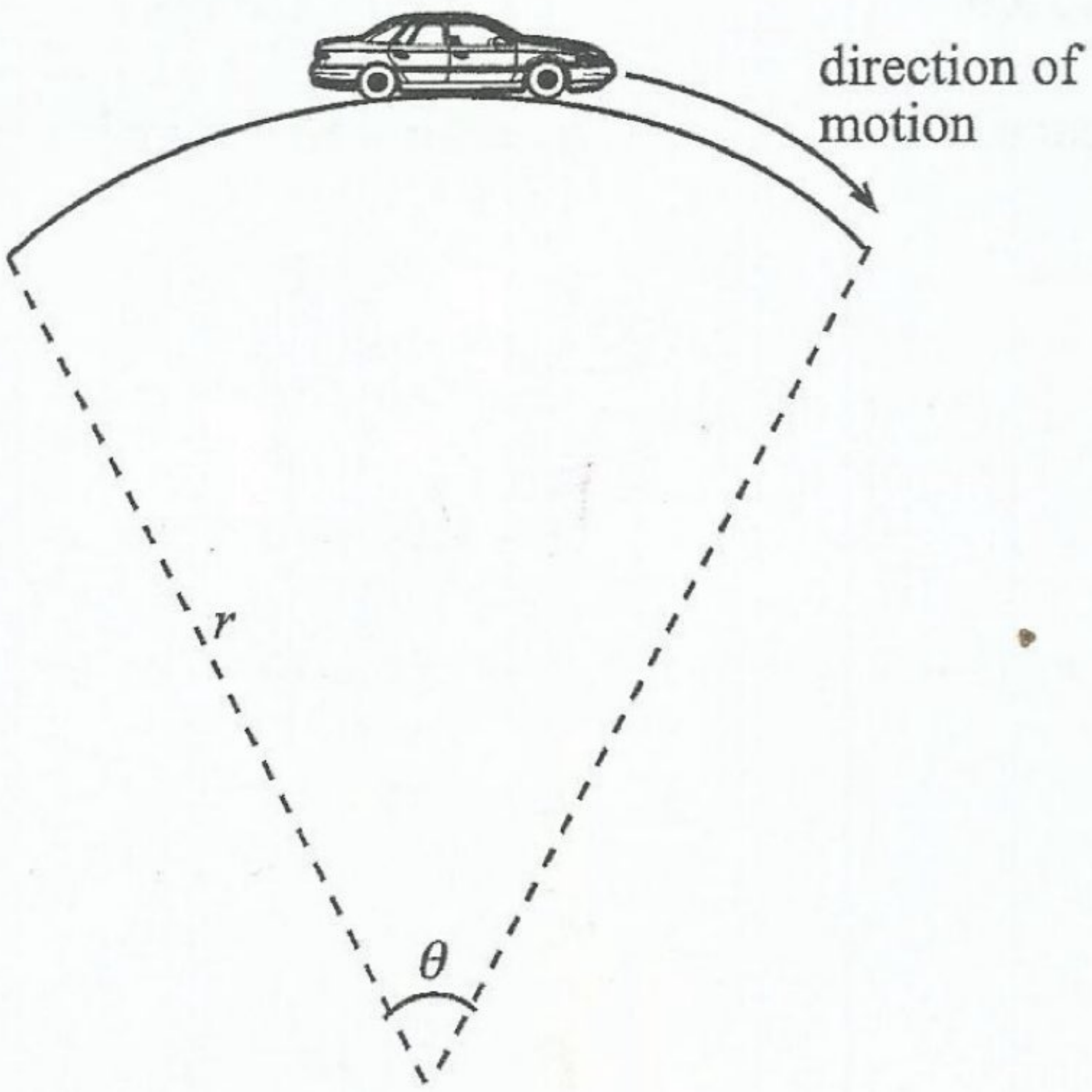

Fig. 1.1

(i) Show that the steady speed v of the car is given by $v = \omega r$ where ω is the angular velocity and r the radius of curvature.

(ii) Explain why the car experiences

1. a normal reaction less than its weight,

2. an acceleration. [5]

(b) **(i)** Define *gravitational potential.*

(ii) Use the universal law of Gravitation to show that the S.I. unit for gravitational constant, G, is $\text{Nm}^2\text{kg}^{-2}$.

(iii) Explain why

1. inside a planet, the gravitational field falls to zero at the centre,

2. a satellite in a geostationary orbit, appears to be in a fixed position when viewed from the Earth. [7]

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(c) A sprinkler fires a water-jet into the air with a speed u ms^{-1} at an angle of θ to the horizontal.

(i) Draw the path taken by the water-jet.

(ii) Show that the maximum height, S_y, and the time, t, of flight are given by $S_y = \dfrac{u^2 \sin^2 \theta}{2g}$ and $t = \dfrac{2uSin\theta}{g}$ respectively. [4]

(d) **(i)** 'It is easier to cut meat using a sharp knife than a blunt knife.'

Use your knowledge of pressure to explain this observation.

(ii) 'Boxers wear hand gloves to reduce injuries during a fight.'

Use your knowledge of momentum transfer to explain this observation. [4]

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2 (a) State any **two** conditions for the establishment of a stationary wave, using two separate sound waves. [2]

(b) Distinguish between the motion of air molecules in a stationary wave and a progressive wave with reference to their phases, amplitudes, frequencies and kinetic energies. [4]

(c) (i) State one similarity between **Radio** and **TV** waves.

(ii) 1. State how the wavelength of TV waves may differ from that of Radio waves.

2. Explain how the difference in **(ii)** 1. may result in a good radio reception **but** a poor TV reception for areas near hills. [4]

3 (a) Define *deceleration* and *velocity*. [2]

(b) An underground train moved between two stations. It started from rest and accelerated uniformly for 51 seconds until it reached 20 ms^{-1}. It then maintained this velocity for the next 78 seconds and then decelerated uniformly to rest for 21 seconds.

Sketch a

(i) velocity-time graph,

(ii) distance-time graph for the train. [4]

(c) Objects falling towards the Earth's surface under gravity are said to be in free fall.

State and give a reason whether the following are in free fall.

(i) A parachutist falling with the parachute open.

(ii) A steel ball bearing falling in air. [4]

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4 **(a)** A boat normally travels at 10 km/h in still water.

Calculate the velocity of the boat observed from the shore if the boat moves

(i) down a river,

(ii) up a river, 0

(iii) across a river,

flowing at 10 km/h. [6]

(b) A jumbo jet cruises at a constant velocity of 1 000 km/h when the thrusting force of its engine is constant at 100 kN.

State with a reason the

(i) acceleration of the jet,

(ii) force of air resistance on the jet. [4]

$V=41$

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

9188/3

JUNE 2012 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

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*Answer **question 1** and **any other 2** from the remaining questions.*

1 (a) (i) List **six** base quantities and their units.

(ii) Distinguish between *derived* and *base* units.

(iii) Express the units of *coefficient of viscocity* in terms of base units. [7]

(b) (i) Define simple harmonic motion.

(ii) Show that for simple oscillations, the acceleration is given by $-\omega^2 x$, where symbols have their usual meanings. [6]

(c) (i) State the *principle of conservation of linear momentum.*

(ii) A particle O, of mass, U, travelling with a velocity of $3.0 \times 10^7 \text{ ms}^{-1}$, collides elastically with another particle, P, of mass $16U$, initially at rest. After collision particle O moves in a direction at 90° from its original path.

Using resolution of vectors and the principle of conservation of momentum, calculate the speed of P after collision. [7]

2 (a) (i) Give **one** example of a *systematic error*.

(ii) State how the error in (i) can be minimised. [2]

(b) The electric potential, V, is given by the formula, $V = \dfrac{Q}{4\pi\varepsilon_o r}$.

Values of Q and r are $(3.2 \pm 0.1) \times 10^{-16}\text{ C}$ and $(1.3 \pm 0.02) \times 10^{-17}\text{ m}$ respectively.

Calculate the error in the electric potential. [2]

(c) (i) Explain the term *vector quantity.*

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(ii) A sign post of mass 5.0 kg is hung from the end B of a uniform bar AB, of mass 2.0 kg as shown in **Fig.2.1**. The bar is hinged to a wall at A and held horizontally by a wire joining B to a point C.

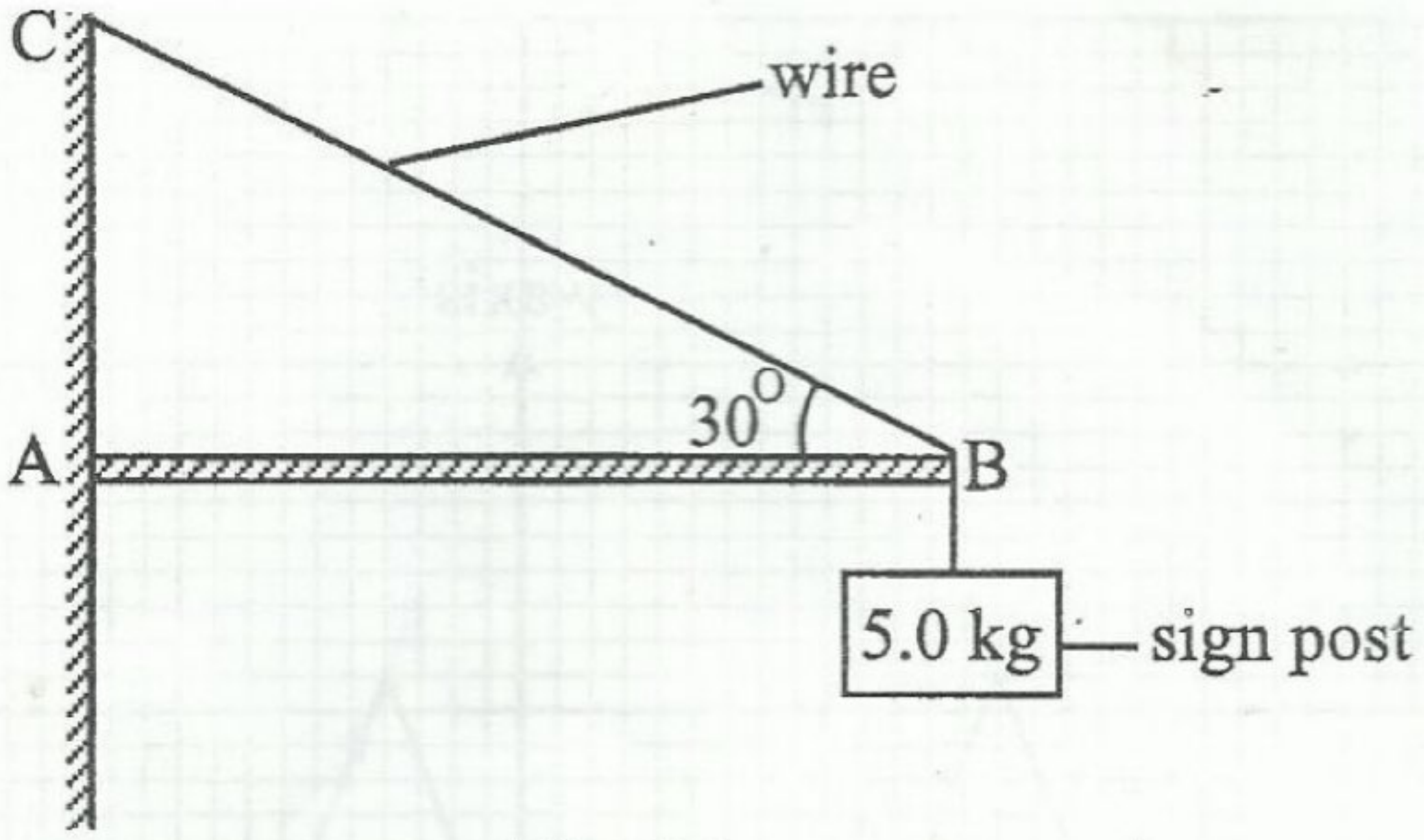

Fig. 2.1

Find

1. the force in the wire,
2. the force exerted by the hinge. [6]

3 (a) Show that the gravitational field strength, g, at any point inside the earth is given by

$$g = 2.8 \times 10^{-10} \rho r,$$

if the earth is assumed to be a perfect sphere of uniform density ρ.(r is the distance from the earth's centre to the point). [3]

(b) Determine the value of g at a point 250 km below the earth's surface. (Take the radius of the earth as 6.36×10^{6} m).

Suggest why this value is less than the true value at this point. [3]

(c) Sketch a graph to show the variation of g with displacement from the earth's centre to a 500 kg satellite that is orbiting the earth at a height of 350 km. [4]

4 (a) Two lengths were recorded as (1.873 ± 0.005) mm and (1.582 ± 0.005) mm.

Calculate the fractional uncertainty in the sum and the difference of the lengths. [3]

(b) Explain how a cathode ray oscilloscope can be used to measure time-interval. [3]

[Turn over

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(c) **Fig. 4.1** shows the display on the screen of a C.R.O used to measure some properties of a triangular wave. The voltage gain was set at 5 V per division and the time-base at 5 ms per division.

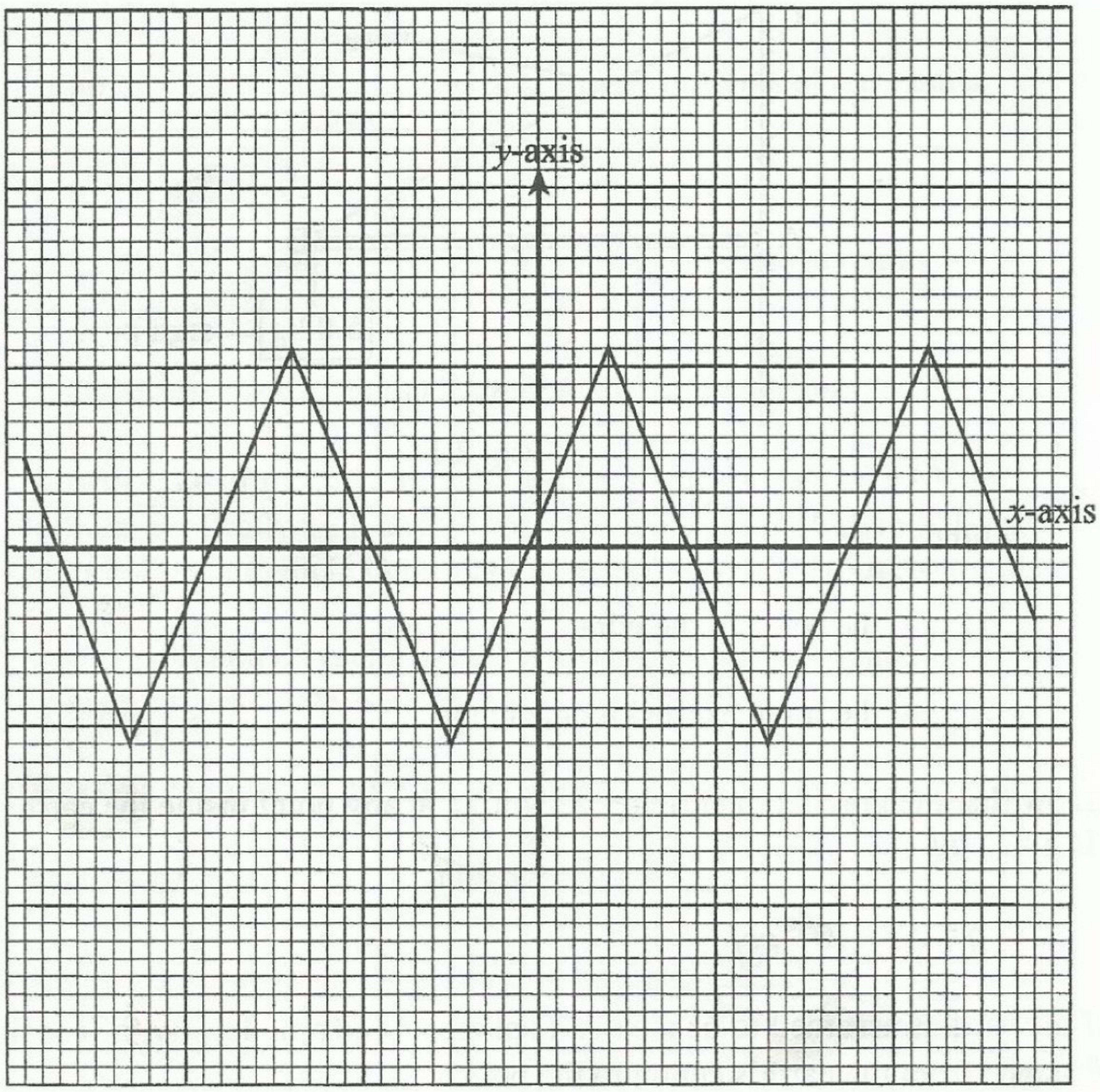


Fig. 4.1

(i) Determine the period and the amplitude of the wave.

(ii) The time-base is now set at 2.5 ms per division.

Explain any changes that will be observed on the C.R.O. [4]

C. B. MUTER (101)

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Ordinary Level

MARKING SCHEME

JUNE 2012

PHYSICS 9188/3

1 (a) (i)

Quantity	**Unit**
Length	metre
Mass	kilogram
Time	second
Current	Ampere
Temperature	Kelvin
Amount of substance	mole
~~Luminous intensity~~	~~candela~~

6 Pairs correct
→ 3 marks
4-5 Pairs correct → 2 marks
3 Pairs correct
– 1 Mark

For [illegible] & its base unit
6 [illegible]
4-5 [illegible]
3 correct — 1

1 mark for base qty and its correct base unit.
Max 3.

B3 ~~[illegible]~~

(ii) *Base unit*: simplest unit of system of measurements from which other units are desired B1

Derived: one which can be expressed as multiple or quotient of base units B1

(iii) units of $\eta = \frac{\mathrm{N}}{\mathrm{mms^{-1}}} = \frac{\mathrm{kgms^{-2}}}{\mathrm{m^2\,s^{-1}}}$ C1

$= \mathrm{kgm^{-1}\,s^{-1}}$ A1

(b) (i) acceleration directed towards fixed point B1

acceleration ~~and~~ proportional to displacement B1

(ii) acceleration directly ~~apportioned~~ proportional to displacement from fixed point. * Choice of system [illegible]

If x = displacement, ℓ = pendulum length and

θ = angular displacement

F = ma

$\therefore -\mathrm{mg}\,\sin\theta = \mathrm{ma}$ B1

$\theta \to 0,\ \sin\theta \to \theta$ B1

$\theta = \frac{x}{\ell}$ C1

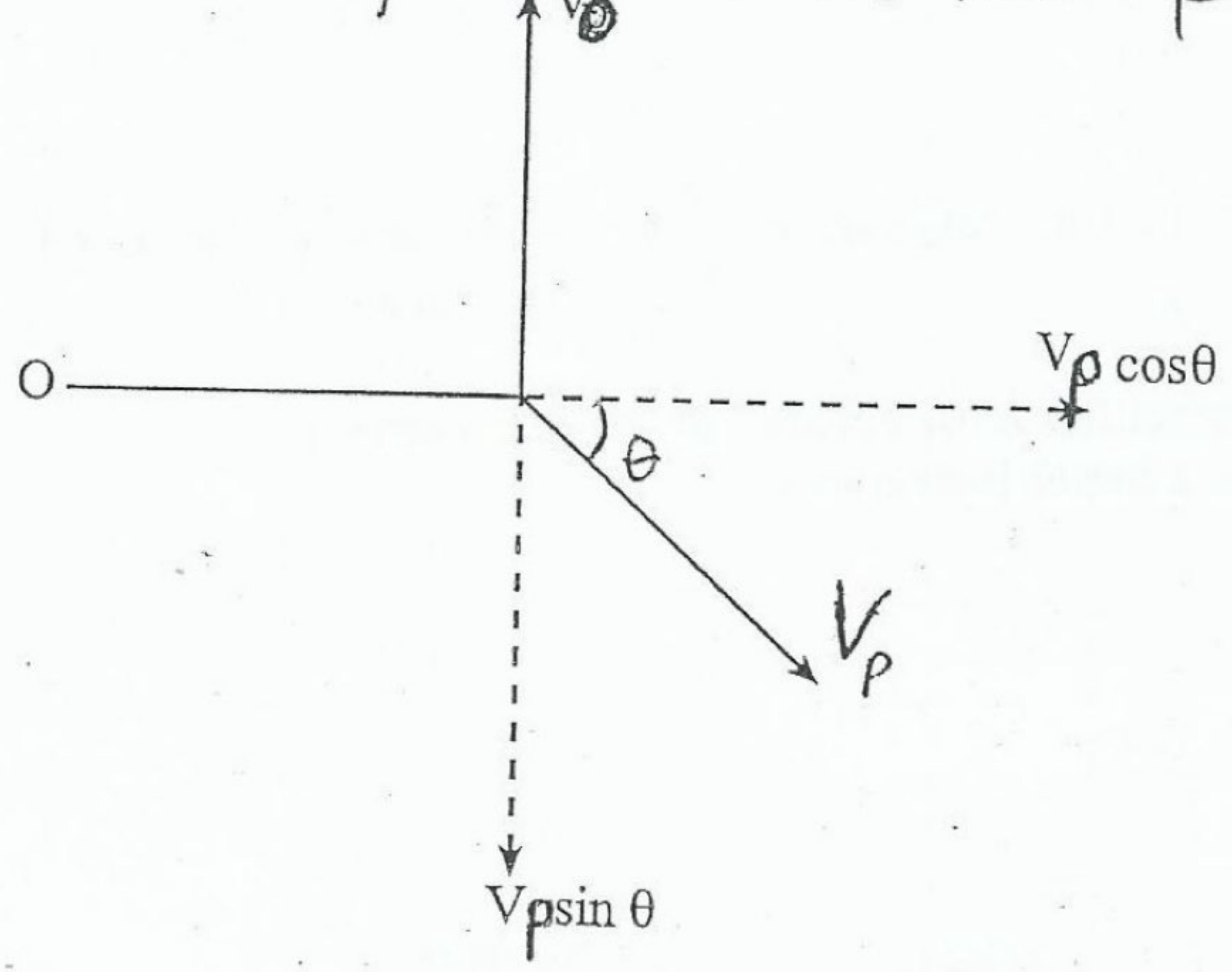
Spring - mass system or differentiation of $x = x_0 \sin\omega t$ twice.

Reject determination from Centripetal acceleration.

Restoring force = $-ma = mg\frac{x}{\ell}$ B1

a $= -\frac{s}{\ell}x = w^2x$ ~~B1~~

(c) (i) Total momentum of a system of colliding bodies is always constant if no external force acts on the system B1



$3.0\times10^7U = 16\ U\ V_p\ \cos\theta$ C1

$3.0\times10^7 = 16\ V_p\ \cos\theta$

$V_p\ Cos\theta = 1.88\times10^6$ (i)

$U\ V_o = 16U\ V_p Sin\theta$ C1

~~$V_p Sin\theta = 6.25\times10^{-2}V_p$~~ $V_p \sin\theta = \frac{V_o}{16}$ (ii) ---- (ii)

$\frac{1}{2}U\times\left(3.0\times10^7\right)^2 = \frac{1}{2}UV_o^2 + \frac{1}{2}16U\ V_p^2$ (iii) C1

$9\times10^{14} = V_o^2 + 16V_p^2$

squaring (i) and (ii) then adding

$(V_p \sin\theta)^2 = \left(\frac{V_o}{16}\right)^2$ $(1.88\times10^6)^2 = V_p^2\cos^2\theta$

$V_p^2(\sin^2\theta + \cos^2\theta) = \left(\frac{V_o}{16}\right)^2 + (1.88\times10^6)^2$

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$$\left(1.88\times10^{6}\right)^{2}+\left(\frac{V_o}{16}\right)^{2}4=V_p^{2}$$

~~$V_o^2=\left(1.88\times10^{6}\right)^{2}+\left(6.25\times10^{-2}\right)^{2}V_p^2$~~ (iv) C1

$$16^{2}\left(1.88\times10^{6}\right)^{2}+V_o^{2}=16^{2}V_p^{2}$$

solving for V_p in (iii) and (iv)

$$16^{2}\left(1.88\times10^{6}\right)+9\times10^{14}-V_o^{2}=16V_p^{2}$$

~~$1.0624V_0^2=7.04\times10^{12}$~~ C1

$$16^{2}\left(1.88\times10^{6}\right)+9\times10^{14}=\left(16^{2}+16\right)V_p^{2}$$

$$V_o=\sqrt{\frac{7.0\cancel{4}\times10^{12}}{\cancel{1}.0624}}\qquad\sqrt{\frac{16^{2}\left(1.88\times10^{6}\right)^{2}+9\times10^{14}}{16^{2}+16}}$$

$$= \quad =2.57\times10^{6}ms^{-1}$$ A1

(a) (i) Zero error / calibration (Accept any correct alternative.) B1

(ii) correct the error before / after measurement B1
use a better instrument B1
[Max 1]

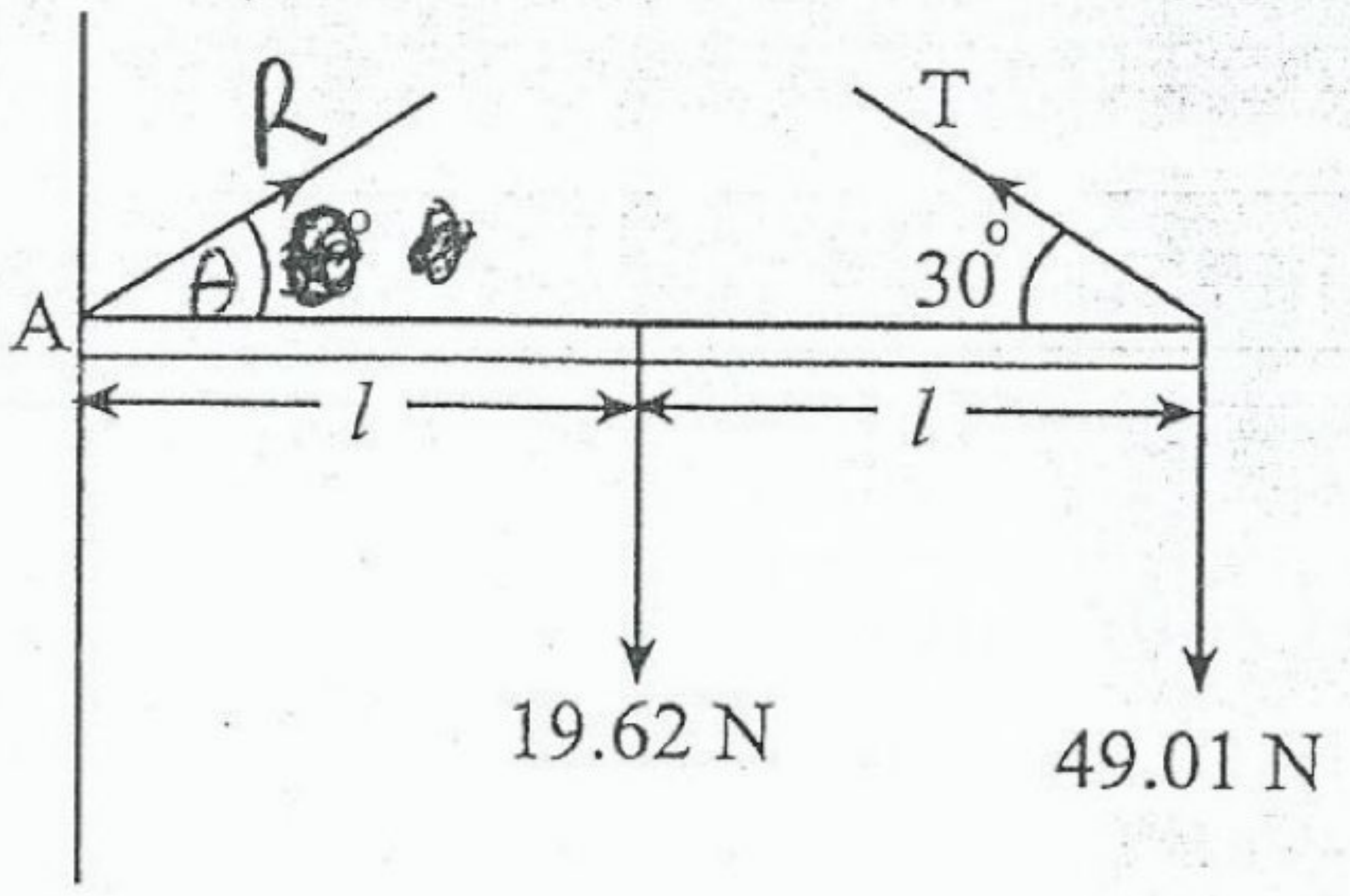
(b) $\frac{\Delta V}{V}=\frac{\Delta Q}{Q}+\frac{\Delta r}{r}$

$$V\ \mathrm{x}\ \frac{\Delta V}{V}=\left(\frac{0.1}{3.2}+\frac{0.02}{1.34}\right)\times\frac{3.2\times10^{-16}}{4\pi\times8.85\times10^{-12}\times1.3\cancel{4}\times10^{-17}}$$ C1

ΔV = ~~$9.92+10^{9}V/m$~~ $1.03\times10^{10}V$ A1

(c) (i) Quantity defined by magnitude and detection B1

(ii)



Taking moments about A

$$19.62 \text{ x } L+49.05 \text{ x } 2L = T \text{ x } 2L \text{ Sin } 30 \qquad C1$$

$$117.72\,L = TL$$

$$T = \underline{\underline{117.72N}} \qquad A1$$

Resolving forces

Vertically

$$R \text{ Sin}\,\theta + T Sin \;\; 30 = 19.62 + 49.05$$

$$R \text{ Sin}\,\theta = 9.81 \qquad \text{(i)} \qquad C1$$

Horizontally

$$R \text{ Cos }\; \theta = T \text{ Cos } 30$$

$$R \text{ Cos }\; \theta = \; 101.95 \qquad \text{(ii)}$$

Solving (i) and (ii)

$$\text{Tan }\; \theta = 0.0962$$

$$\theta = 5\text{-}5° \qquad A1$$

$$R = \; 102.4 \text{ N} \qquad A1$$

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3 (a) $g = \frac{GM}{r^2}$ B1

$M = \frac{4}{3}\pi r^3 \rho$ B1

$\therefore\ g = \frac{4}{3}\pi \times 6.6 \times 10^{-11} \times \rho\ r$ B1

$= 2.8 \times 10^{-10} \rho\ r$ A0

(b) $g \propto r \left(\text{Reject } g = \frac{GM}{r^2}\right)$

$g^1 = \frac{9.81(6.36 \times 10^6 - 250 \times 10^3)}{6.36X10^6}$ C1

$= 9.42Nkg^{-1-1} (\text{Reject } ms^{-2})$ A1

The earth is denser near the centre than elsewhere / AW B1

(c) $g \text{ on satellite } = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.36 \times 10^6 + 350 \times 10^3)^2}$

$= 8.89NKg^{-1}$ A1

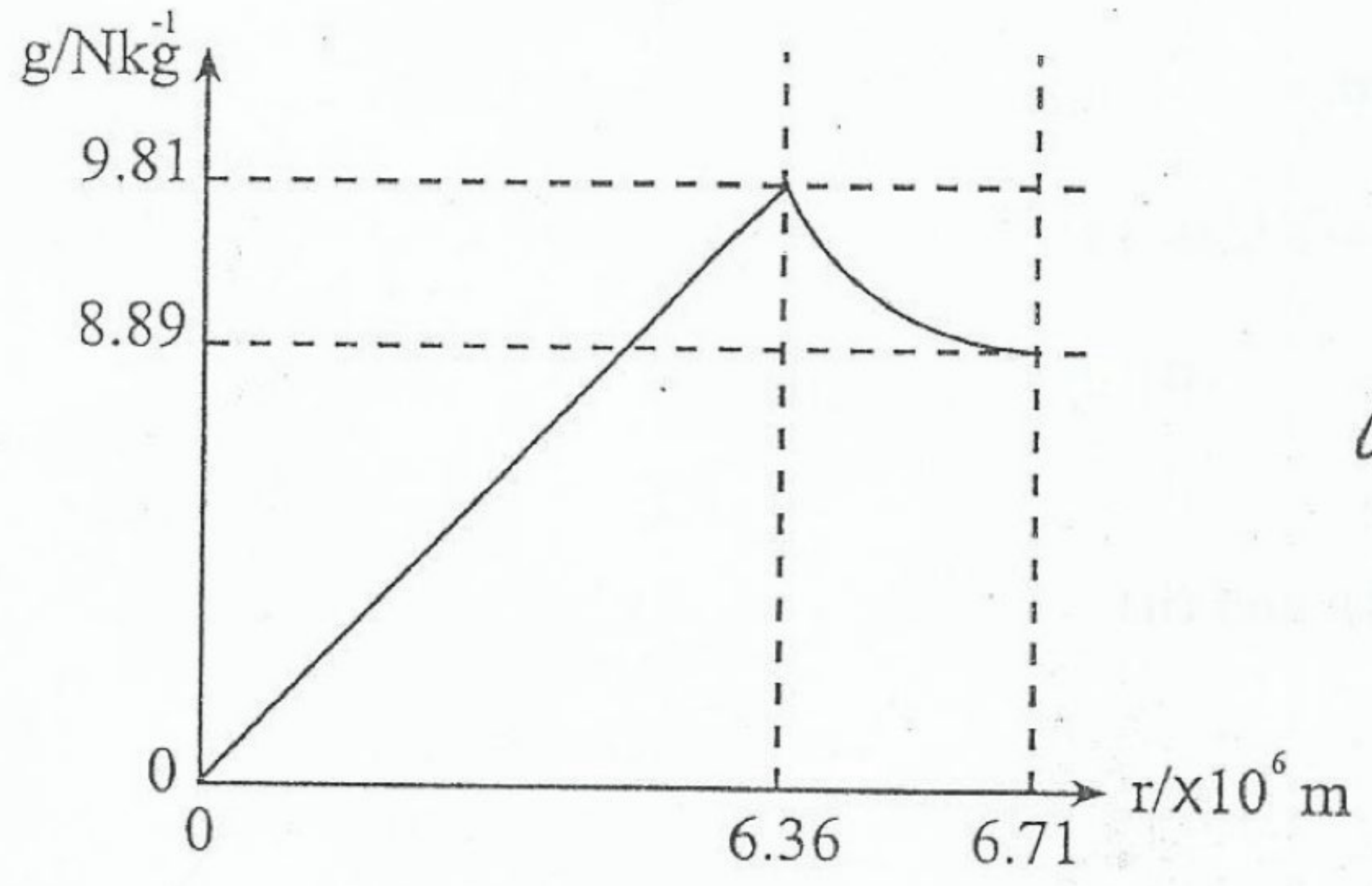

Fig. 3.1

Correct shape (B1)

Correct coordinate pairs for critical values B2

Correct shape B1

Correct coordinate pairs for critical values

$(6.3\times10^6;9.81)$ $(6.71\times10^6;8.89)$ B2

4 (a) SUM: $= 1.873 + 1.582 \pm (0.005\text{x}2)$

$= (3.46 \pm 0.01)$ mm

fractional uncertainty = $\frac{0.01}{3.46}$

= 0.0029 A1

diff. 1.873 – 1.582 = 0.291mm (Reject 2 sig. fig.) A1

fractional uncert. = $\frac{0.01}{0.291} = 0.034$ A1

(b) desired interval marked on x-axis

number of squares in interval B1
counted and B1
then multiplied by time-base setting B1

$T = \frac{5ms}{10} \times 18$

(c) (i) T = 1.8 x 5ms = 9.0×10^{-3} s Ⓐ 9ms C1A1

$V = \frac{11\times5}{10} = 5.5V$ A1

(ii) ~~(iii)~~ – 6 complete wave forms seen B1

– Number of complete cycles increases.

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

9188/3

NOVEMBER 2012 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

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[Turn over

*Answer **question 1** and **any other 2** from the remaining questions.*

1 **(a)** **(i)** Define the term *friction.*

(ii) A granite block is static on a flatbed trailer. If the coefficient of static friction is μ_s, write an expression for the friction when the block is about to move.

(iii) Explain whether an unsecured granite block will shift on the flatbed trailer if the trailer driver

1. takes off gradually,

2. stops suddenly.

[6]

(b) According to Newton's Law of gravitation there is always attraction between objects.

Explain why people do not feel themselves being pulled towards massive buildings in their vicinity. [2]

(c) **Fig. 1.1** shows the variation of potential energy, U, with position, x, of a 4 kg particle executing simple harmonic motion.

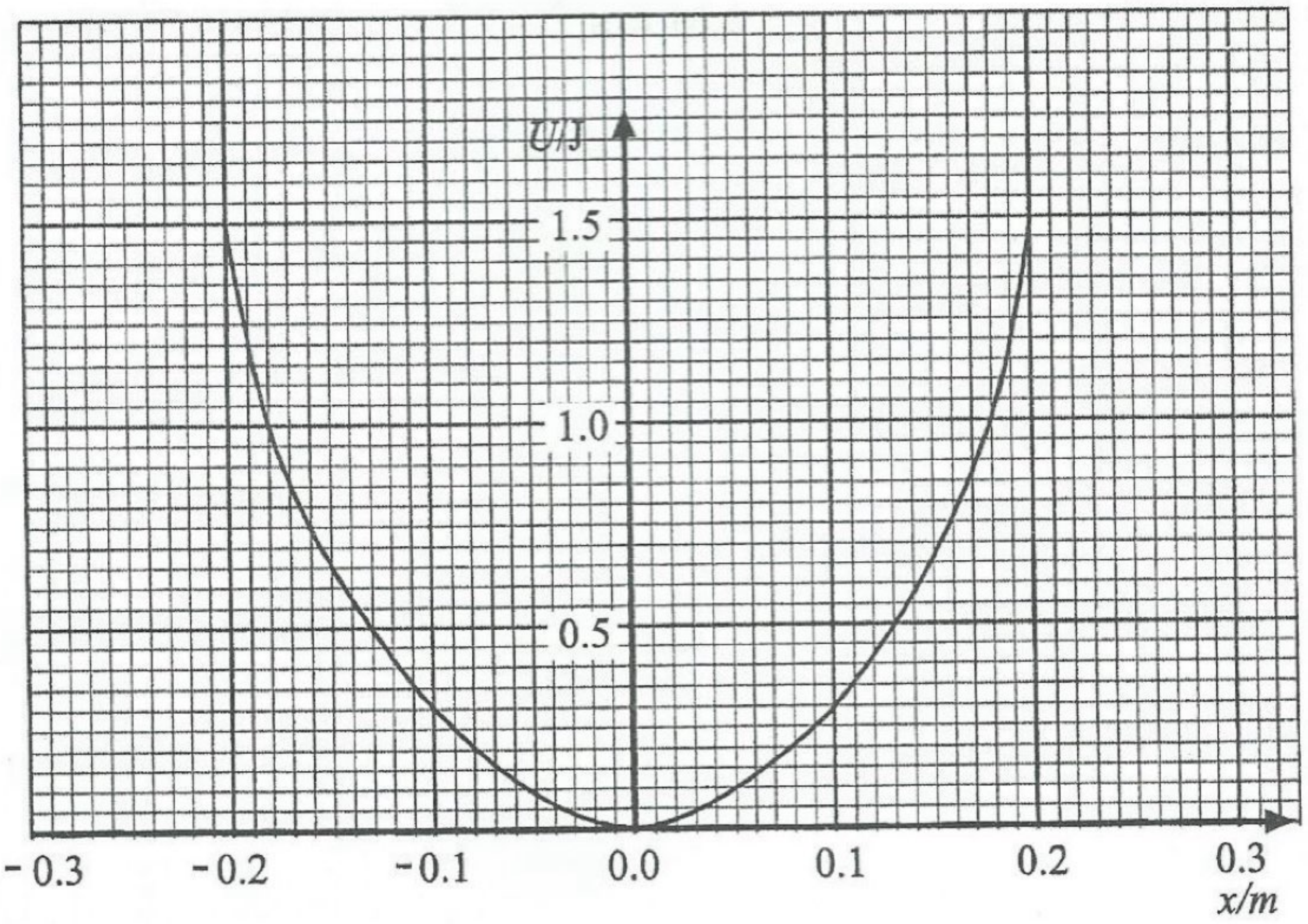

Fig. 1.1

(i) State the amplitude of oscillation.

(ii) Determine the period of oscillation.

[4]

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(d) (i) Explain the term *resonance*.

(ii) A well with vertical walls resonates with a sound note of frequency 7.0 Hz and does not resonate at lower frequencies.

Estimate the depth of the well, if the speed of sound in air is 350 ms^{-1}.

[4]

(e) Express each of the following quantities in base units:

(i) resistance

(ii) Young Modulus

[4]

[Turn over

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2 (a) State *the principle of conservation of linear momentum.* [2]

(b) A stationery ball of mass, 6.0×10^{-2} kg is hit horizontally with a tennis racket. The ball is in contact with the racket for 30 ms and leaves the racket with a speed of 27 ms^{-1}.

(i) Calculate the

1. change in momentum of the ball,

2. average force which the racket exerts on the ball,

3. horizontal distance travelled by the ball before it hits the ground if it leaves the racket at a vertical height of 2.5 m.

(ii) Explain what is meant by *an inelastic collision.*

(iii) Suggest a reason why the collision between the ball and the racket is inelastic.

[8]

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3 (a) Give a simple description of the production of X-rays. [4]

(b) State the approximate wavelength of

(i) the visible,

(ii) the X-ray,

region of the electromagnetic spectrum. [2]

(c) (i) Give a reason why laser light is ideal for diffraction and interference in double slit experiments.

(ii) In the diffraction pattern of a single slit the separation between the the first minimum on one side and the first minimum on the other side is 5.2 mm. The distance of the screen from the slit is 80.0 cm and the wavelength of the light used is 546 nm.

Calculate the width of the slit.

[4]

[Turn over

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4 (a) (i) Define *power*.

(ii) Using the definition in **(i)** show that power, P, is given by $P = Fv$, where F is the force and v is the velocity.

[3]

(b) A metal block of mass 5 kg is inclined at an angle of 30°C to the horizontal. The block slides, from rest, down the plane a distance of 100 cm in 2.0 s.

(i) Sketch a free body diagram for the block.

(ii) Calculate the frictional force between the block and the plane when the block is sliding.

(iii) Calculate the work done by the block.

[7]

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Ordinary Level

MARKING SCHEME

* Omission of units:- penalise one per question. Indicate 'ECF' where mark is award for omission of units.

NOVEMBER 2012

ubric:- candidates answers all questions.
- mark all and record all
- delete list scored question and write 'Rubric Infringement'

→ Transcription error.
- penalise where the error occurs
- follow working. If correct award remaining marks.

Error carried forward.
- discredite where the error occurs.
- If the answer is used in the next part question correctly, award marks with 'ECF'.

credit:- Concept needed in 1st question

ICS

9188/3

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1 (a) (i) (A frictional force is a) force that opposes (relative) motion between bodies in contact (Reject ~~formula with terms/symbols defined.~~ formula) B1

(ii) friction = $\mu_s N$ = μ_s mg where N = mg (Accept R for N) Accept μ. A1

(iii) 1. By Newton first Law, granite block resists to start to move when already at rest; A/W (Concept of inertia) B1

≥ * Block will ~~move~~ shift forward

If friction > inertial force, the block will move forward. A/W. (a < μg) A1 B1

2. Block will resist to stop when already in motion. /Concept of inertia. B1

Will shift forward ~~Remains stationery (when it was at rest)~~ (a > μg). B1

(b) The forces between people and the buildings is very small (compared to earth's gravity) B1

The masses are small compared to the mass of the Earth. B1

(c) (i) Amplitude of oscillation $x_0 = 0.2$m / Ignore negative sign A1

(ii) Maximum potential energy = 1.5J

Potential energy = $\frac{1}{2}m\omega^2x^2$ B1

$$\therefore \frac{1}{2}m\omega^2x^2 = 1.5J$$

$$\omega^2 = \frac{1.5}{\frac{1}{2}(4)(0.2)^2}$$ B1

$$\omega = \sqrt{\frac{1.5}{0.08}}$$

$$T = \frac{2\lambda}{\varpi}$$

$$T = \frac{2\lambda}{\sqrt{\frac{1,5}{0,08}}}$$

$$T = 1,45 \text{ s}$$ Ⓐ 1s

(d) (i) The effect where a system to oscillate is driven at a frequency very close to its natural frequency if displaced. A/W B1

At resonance amplitude is maximum B1

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(ii) Fundamental frequency $f_o = \frac{4V}{\lambda}$

depth of well $h = \frac{V}{4f_o} = \frac{350}{4 \times 7.0}$ C1

$= \underline{\underline{12.5\text{m}}}$ A1

(e) (i) Base units of resistance $=$ Base units of $\frac{V}{I}$

$[V] = \frac{(\text{kgms}^{-2})(\text{m})}{\text{As}(\text{A})}$ C1

$= \text{kgm}^2\text{s}^{-3}\text{A}^{-2}$ $\underline{\text{kgm}^2\text{A}^{-2}\text{s}^{-3}}$ A1

(ii) Base units of Young Modulus $=$ Base units $\frac{Fl}{Ae}$

$= \frac{(\text{kgms}^{-2})(\text{m})}{\text{m}^2(\text{m})}$ C1

$= \text{kgm}^{-1}\text{s}^{-2}$ A1

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B1 b1

2 (a) Total linear momentum is conserved provided no external forces acts on the system. / AW.

(b) (i) 1. change in momentum $= 6.0 \times 10^{-2} \times 27 - 0$

1,6(2) Ns

$= 1.6(2)\text{Ns}$

2. $\text{force} = \dfrac{\text{change in momentum}}{\text{time}}$ / $\dfrac{m(v-u)}{t}$

$= \dfrac{1.6\text{Ns}}{30 \times 10^{-3}\text{ s}}$

$= 54\text{N}$ (Accept 53 N)

3. $s = ut + \frac{1}{2}at^2$

$2.5 = 0 + \frac{1}{2}at^2$

$2.5 = 0 + \frac{1}{2} \times 9.81t^2$

$t = 0.713$ / 0,714

$R = u \times t$

$= 27 \times 0.713$

$= 19.3\text{ m}$ → Accept [illegible]

(ii) (Total) momentum is conserved / AW

Kinetic energy is not conserved / AW.

(iii) Some of the kinetic energy is lost as sound. heat / AW

Reject: kinetic energy is not [illegible]
kinetic energy is [illegible]

→

3 (a) Electrons are emitted by thermionic emission; / Description Diagramatically B1

Max 2 marks.

and are accelerated by an electric field/AW; B1

On diagram look for vacuum and stream of electrons from cathode to a

in a vacuum; B1

The fast electrons interact with target metal which changes their direction of Motion/AW; B1

(b) Any value in the range

visible light 4×10^{-7} m to 7×10^{-7} m Accept value of λ from (4 to 7)x B1

x-rays 10^{-9} m to 7×10^{-16} m Accept order 10^{-6} m to 10^{-16} m. B1

If units missing maximum 1 mark awarded.

(c) (i) Laser light is monochromatic (and parallel for a long distance). B1

(ii) Central maximum $x = \frac{1}{2}(5.2\ \text{mm})$

$= 2.6\text{mm} = 2.6 \times 10^{-3}\ \text{m}$ C1

Slit width $a = \frac{D\lambda}{x} = \frac{D\lambda}{x}$

$= \frac{80.0 \times 10^{-2} \times 546 \times 10^{-9}}{2.6 \times 10^{-3}}$ C1

$= 1.68 \times 10^{-4}\ \text{m}$ A1

Accept $a = \frac{2D\lambda}{x}$ where $x = 5.2$mm.

4 (a) (i) Rate of doing work ✓ Formula with [illegible]
AW,

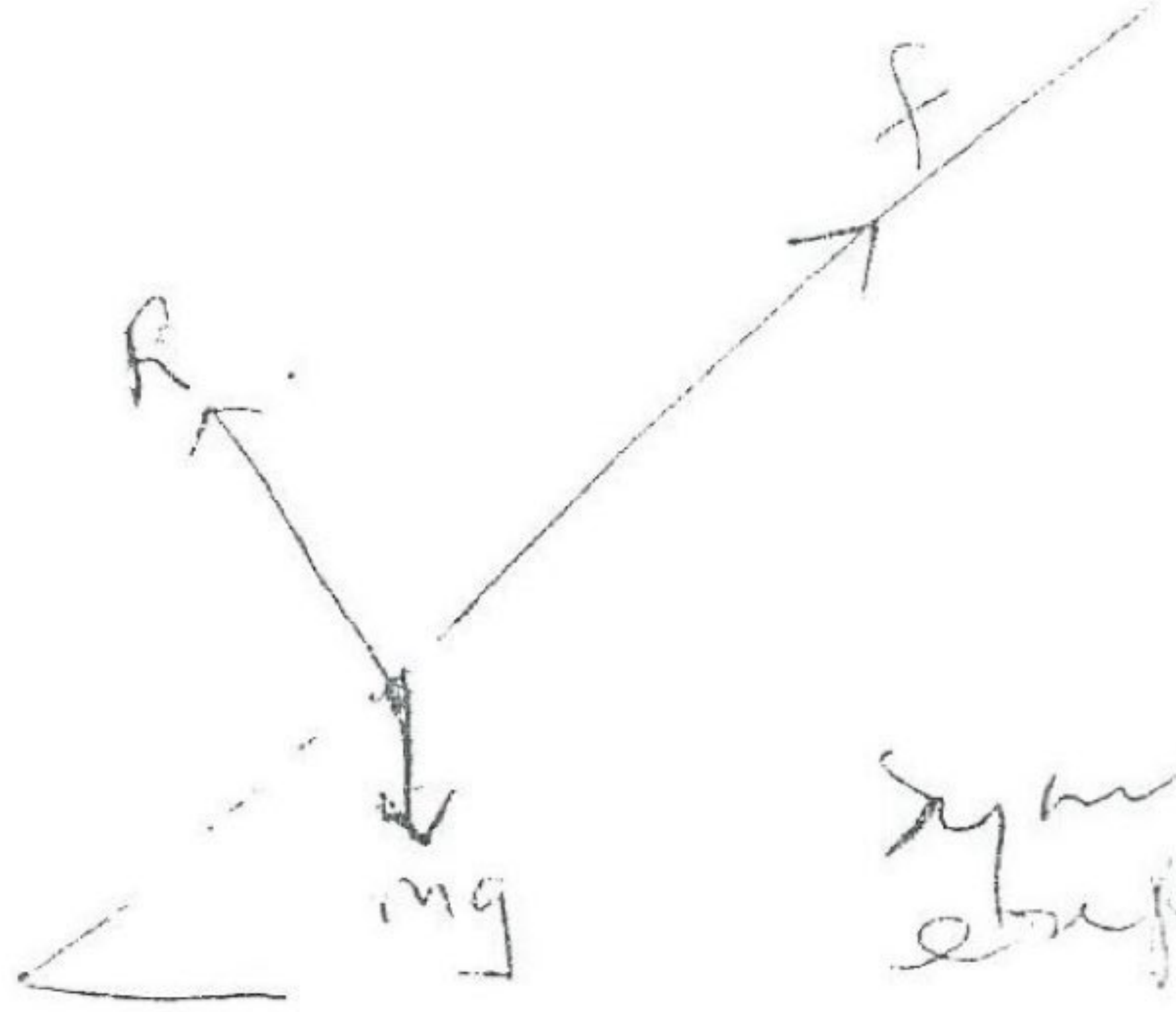
(ii) Power $P = \dfrac{\text{work done}(w)}{\text{time}(t)}$

$$= \frac{f \times s}{t}$$

$$\frac{s}{t} = v$$

$$\therefore \; P = Fv$$

(b) (i)



Symbols explained

R - reaction
f - friction
mg - weight

at least 2 [illegible]
Award 3 marks [illegible]
μR or μN
are used [illegible]

(ii) $S = ut + \frac{1}{2}at^2$

$1.0 = 0 + \frac{1}{2}(a)(2.0)^2$ OR

$a = 0.5 \; ms^{-2}$

2

Using $f = ma = mg\sin\theta - f$

$\therefore f = mg\sin\theta - ma$

$= 5(9.81 \sin 30 - 0.5)$ ✓ $5(9.81\sin\theta$ − [illegible]

$= 22.03$ N Accept 2 [illegible]

(b) (iii) work done by block = (5.0) (1.0 sin 30°) (9.81

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

9188/3

JUNE 2013 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1**.

This question paper consists of 8 printed pages.

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[Turn over

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\dfrac{Gm}{r}$
refractive index,	$n = \dfrac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \dfrac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\dfrac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \dfrac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \dfrac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^8\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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Answer ***question 1*** *and* ***any other 2*** *from the remaining questions.*

1 **(a)** (i) Give any **two** distinctions between random and systematic errors.

(ii) A student used a micrometer screw-gauge to measure the diameter of a thin wire. He did not recognise that the reading was not zero when the gauge was fully closed.

1. Outline how the random error in the measurement of the diameter of a thin wire is reduced.
2. Explain why the readings obtained by the student may be precise but not accurate.

[5]

(b) **Fig. 1.1** shows a textbook resting on a table.

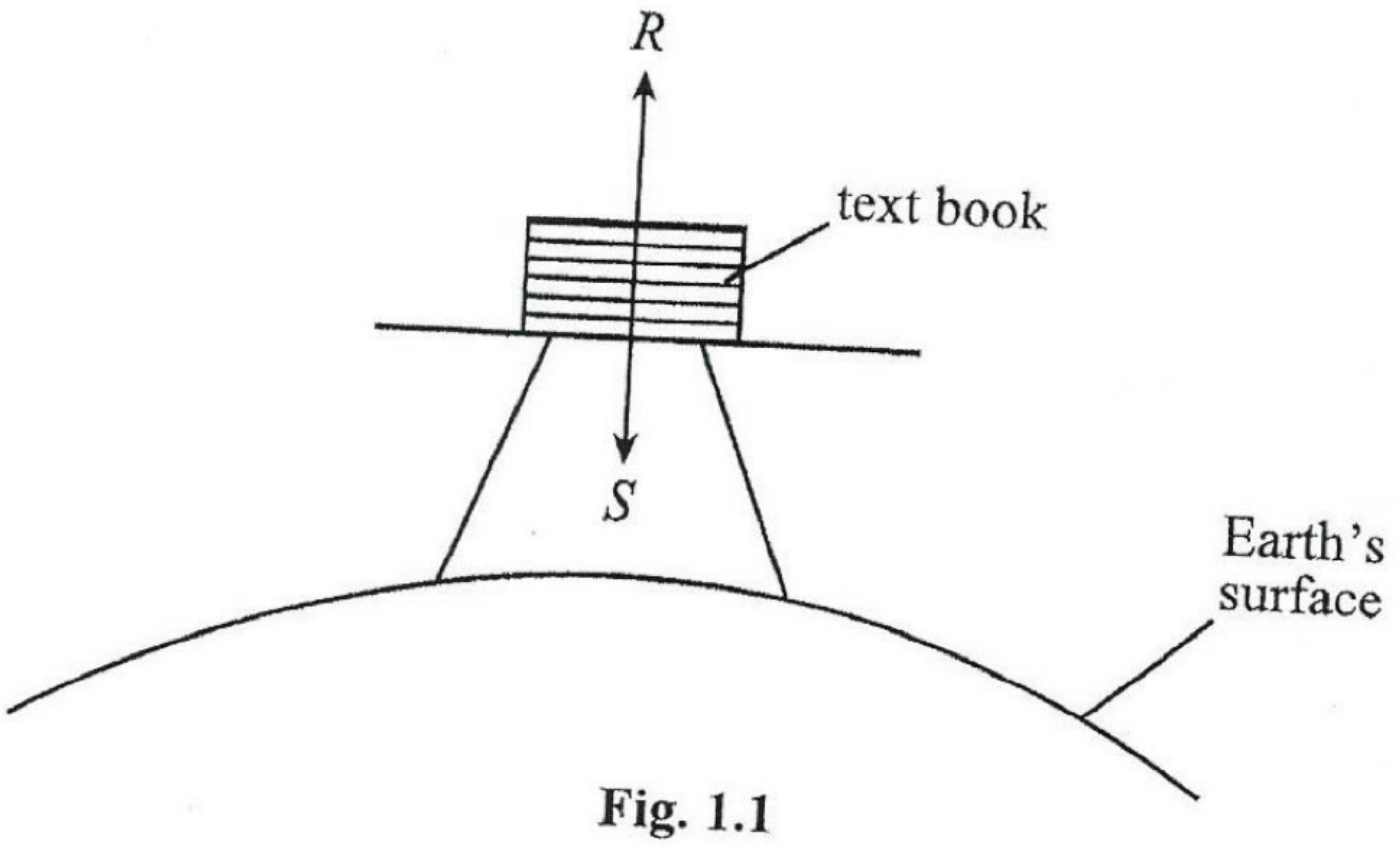

Fig. 1.1

R and *S* are two forces acting on the text book.

(i) 1. From Newton's third law of motion, state the body on which the force that pairs with *S* acts.

2. State **one** way in which *S* and the force which pairs with it are similar.

(ii) If the mass of the text book is 700 g, calculate *S*.

(iii) With reference to Newton's second law of motion and your answer in **(ii)**, comment on the effect of the force which pairs with *S* on the body on which it acts.

[5]

(c) **(i)** Define gravitational field strength at a point in a gravitational field.

(ii) A body of mass 4.0 kg is held 5.0 m above the surface of the Earth.

1. State the gravitational field strength at the position of the body, given that the gravitational field strength near the earth's surface is a constant.

2. Calculate the gravitational potential at the position of the body.

(iii) Gravitational potential, $\underline{\overline{\phi}}$, is a scalar given by

$$\frac{W}{m} = \underline{\overline{\phi}},$$

where *W* is the work done in moving a mass, *m*, from infinity to a point in a gravitational field. Elsewhere the gravitational potential is negative while it is zero at infinity.

Explain why it is negative elsewhere.

(d) **(i)** Define *simple harmonic motion.* [5]

(ii) A mass at the end of a helical spring is given a vertical downward displacement of 2.0 cm from its rest position and released.

If the mass moves with simple harmonic motion of period 2.0 seconds, calculate the displacement of the mass during the first 0.75 seconds.

(iii) Simple harmonic motion may be used in wall clocks.

Explain why the oscillating system is normally enclosed inside the clock.

[5]

[Turn over

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2 **(a)** Define the term *elastic collision*. [2]

(b) A motorist travelling at 15 m/s on a busy day approaches a traffic light which turns red when he is 20 m away from the stop line.

Given that his reaction time, to start slowing down, is 0.3 seconds and he slows down at 4.5 m/s ^{2}, determine the distance the car stops from the stop line. [6]

(c) From your solution in **(b)** deduce whether an accident is likely to occur. [2]

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3 **(a)** Define the term

(i) *inertia,*

(ii) *velocity.*

[2]

(b) **(i)** A ball was projected at an angle of 30° above the horizontal with an initial velocity, V, in a vacuum. Another identical ball was projected at 60° to the horizontal from the same point in a vacuum.

1. Show that both balls had the same range.

2. Sketch, on the same axes, the path followed by each ball.

(ii) A boy at the top of a tower, 4.905 m high, threw a ball horizontally as shown in **Fig. 3.1**

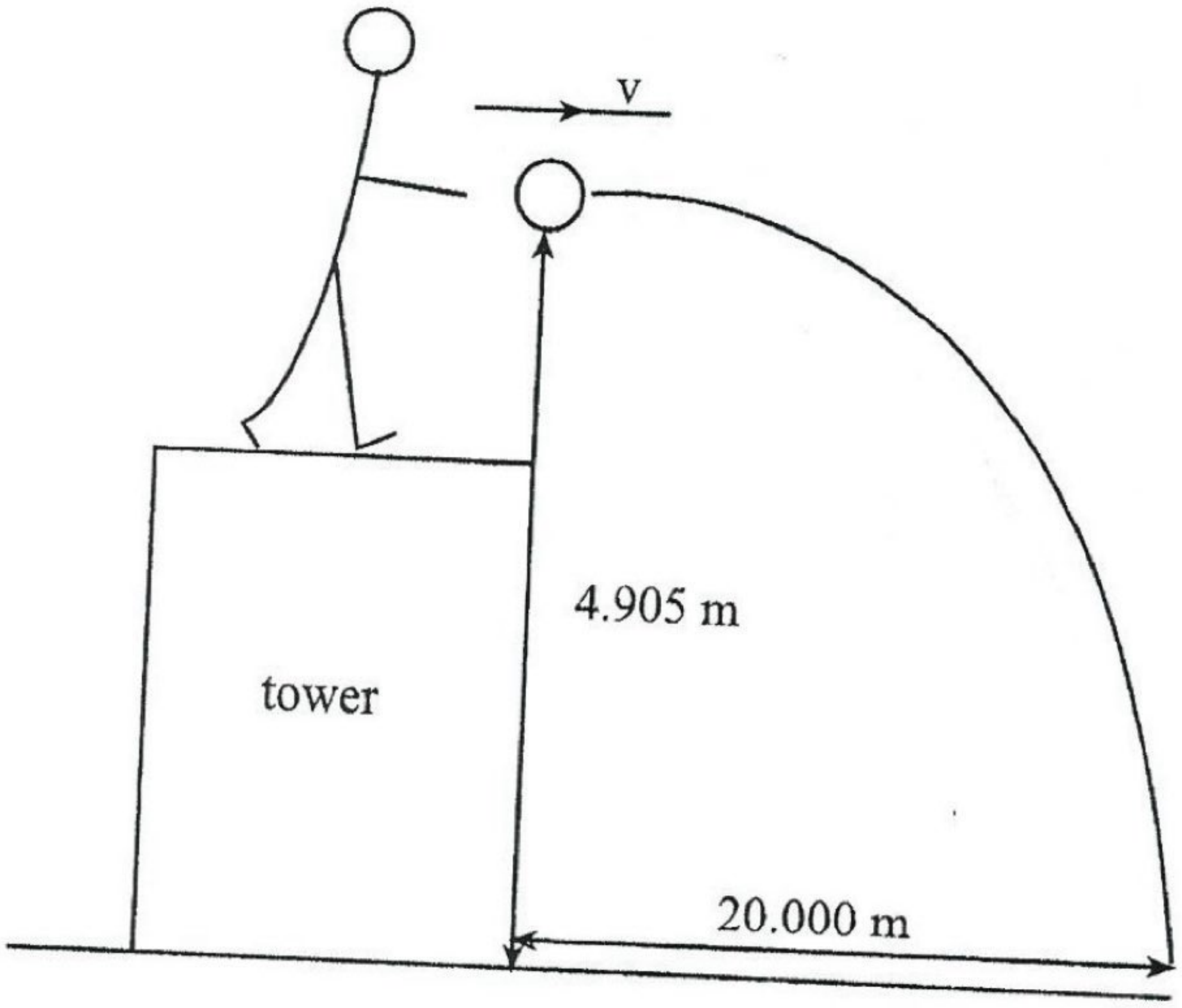

Fig. 3.1

Calculate the velocity, v, of the ball as it left the hand of the boy.

[6]

(c) A ball was launched in the earth's atmosphere at an angle θ to the horizontal.

Describe, with the aid of a diagram or otherwise, the effects of the atmosphere on the range and maximum height of projection. [2]

4 (a) (i) Imaging is one of the uses of X-rays in Medicine.

Give **two** kinds of cases where X-rays would produce the best images.

(ii) In medical diagnosis, X-rays are passed through a filter before they pass through a patient. After the patient, the rays pass through a grid before they reach the X-ray film as shown in **Fig.4.1**

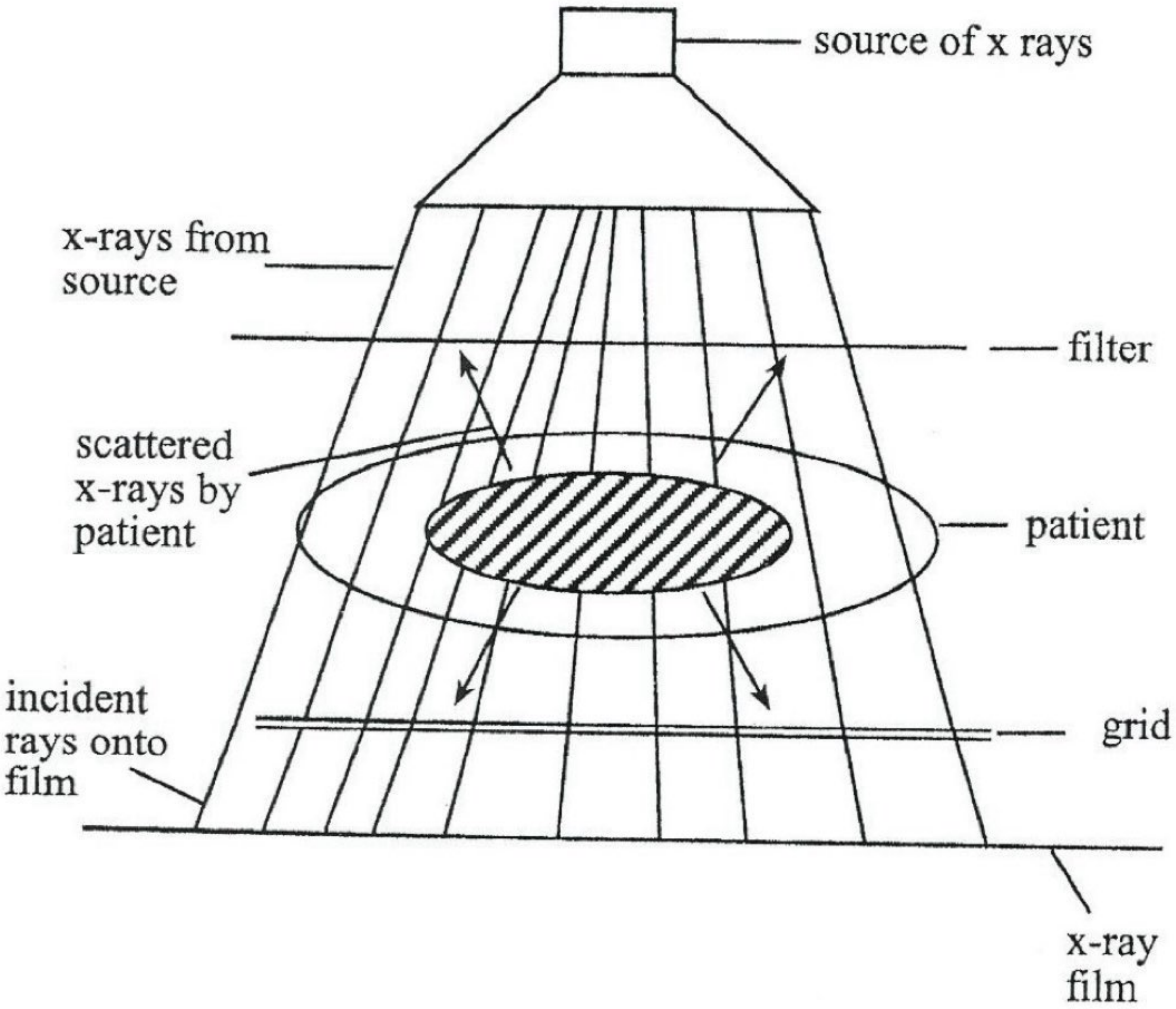

Fig. 4.1

State and explain the advantages of this procedure regarding the patient and quality of the image.

[8]

(b) Lasers are used in medical treatment in a variety of ways.

(i) State any **one** common medical use of lasers.

(ii) Briefly explain how lasers are used in **(i).**

[2]

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

JUNE 2013

PHYSICS **9188/3**

1 (a) (i)

Random error	Systematic error	
- due to judgement by experimenter	- due to faulty apparatus	B1
~~-cannot be eliminated-~~	~~- can be eliminated~~	~~B1~~
- causes measured values to fluctuate about a mean value	- causes measured values to be incorrect by the same size in the same direction	B1 Max 2

Any plausible distinctions

(ii) 1. Measure the diameter several times along the wire and find the average value

2. As taking many readings and finding average value reduces random error, the readings are precise. B1

- As the zero – error was not taken into account, the readings are not accurate B1

(b) (i) 1. The force acts on the earth / Table / book. A1

2. - They are equal in magnitude B1
   - They are both gravitational B1
   Max 1

(ii) S (weight = mg = 0,7 × 9.81) = 6.87 N A1

(iii) No effect / Effect is neglible A1
From F = ma mass of Earth (m), is very large M1

(c) (i) Gravitional force per unit mass / $g = \frac{Force}{Mass}$ B1

(ii) 1. $g = 9.81Nkg^{-1}$ ~~(m/s²)~~ A1

2. Gravitational potential $\underline{\phi} = -gh = -9.81 \times 5$ C1

$= -49,05Jkg^{-1}$ A1

Ⓐ $\phi = -\frac{GM}{r} = (-6.67\times10^{-11} \times 6\times10^{24}) \div (6.4\times10^{6} + 5)$

(iii) - work is done on the point mass as it is pulled from infinity to the point by attractive gravitational force. B1

(d) (i) Motion in which the acceleration is directly proportional to displacement from a fixed point and it is always directed towards the fixed point / motion which satisfies the equation $a = -w^2x$ (terms defined) B1

(ii) $x = -x_0\cos\left(\frac{2\Pi}{T}\right)t = -2\times10^{-2}\cos 0,75\Pi$ (ignore minus sign) C1

$\underline{= 0,014}$ m A1

damping ; air resistance

(iii) Since air resistance affects the amplitude of the oscillating system, B1
it must be shielded from air resistance B1

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(a) Mechanical energy is conserved; / Kinetic energy is conserved B1
Momentum is conserved

Bodies separate after collision; B1

(b) Distance travelled during reaction time $x = ut$

$$x_1 = 15 \times 0.3 = 4.5 \text{ m}$$ C1

using $v^2 = u^2 - 2ax_2$ *where* x_2 = *distance travelled after breaking.*

$$x_2 = \frac{u^2 - v^2}{2a} = \frac{15^2 - 0^2}{2 \times 4{,}5}$$ C1

$$= 25 \text{ m}$$ A1

Distance from stop line = $(x_1 + x_2) - 20$ C1

$$= (25 + 4{,}5) - 20$$ C1

$$= \underline{9.5 \text{ m}}$$ A1

(c) Since 29.5 m > 20 m he stops after passing the stopline A/W B1

An accident may occur. (e.c.f) A1

Sifakange Sibandy at yahoo.com

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3 (a) (i) Resistance of a body to change its dynamic state B1

(ii) Velocity is rate of change of displacement. B1

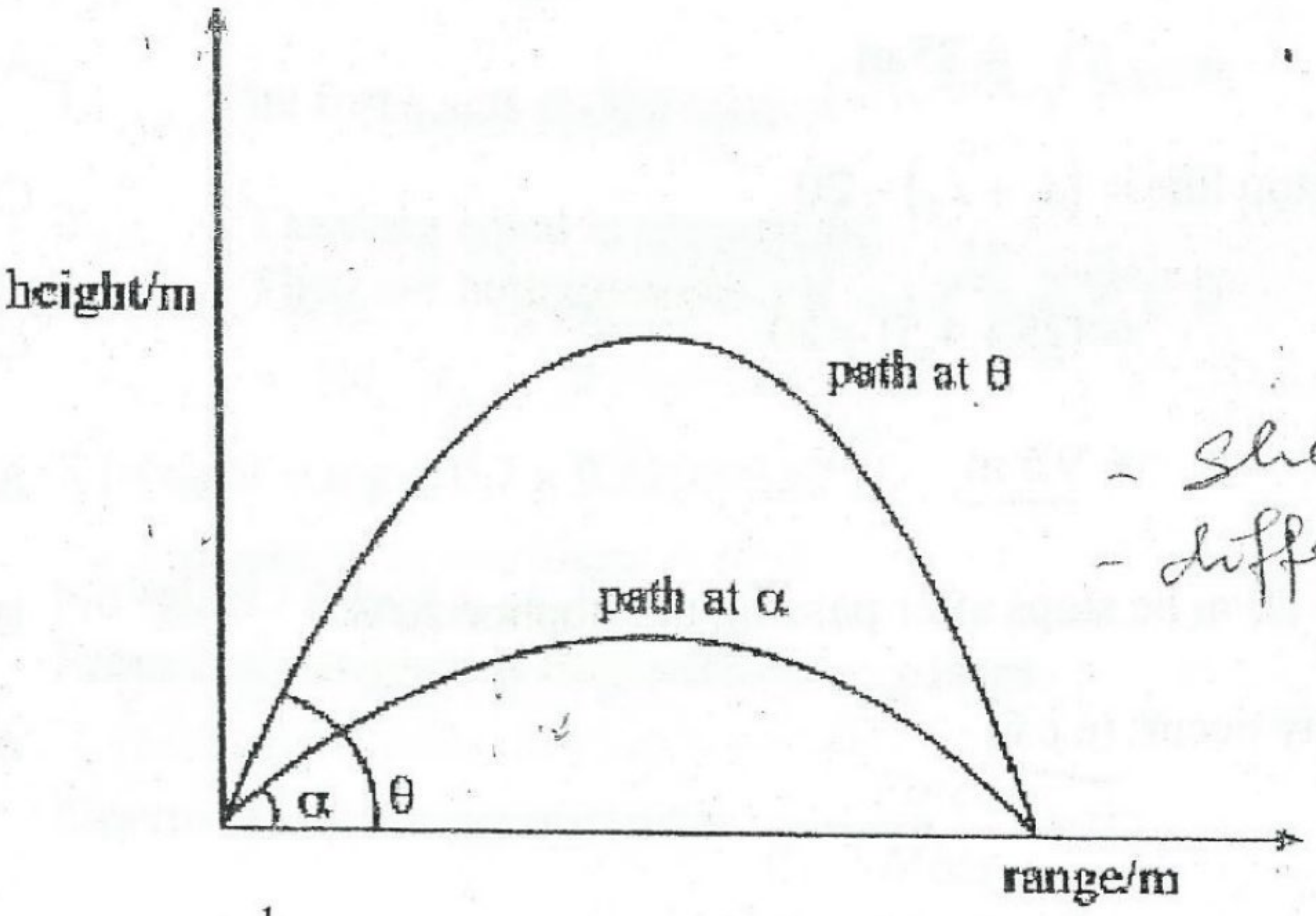
Reject: rate of change of displacement with time.

(b) (i) 1. $R_\theta = \dfrac{v^2 \sin 2\theta}{g}$ C1

$R_{30} = \dfrac{v^2 \sin 60}{g} / R_{60} = \dfrac{v^2 \sin 120}{g}$ C1

$R_{30} = R_{60} = \dfrac{V^2\sqrt{3}}{2g}$ A0

2. B2



- shape B1
- different amplitudes B1

(ii) $S = ut + \frac{1}{2}at^2$

$-4{,}905 = -\frac{1}{2}(9{,}81)t^2$ C1

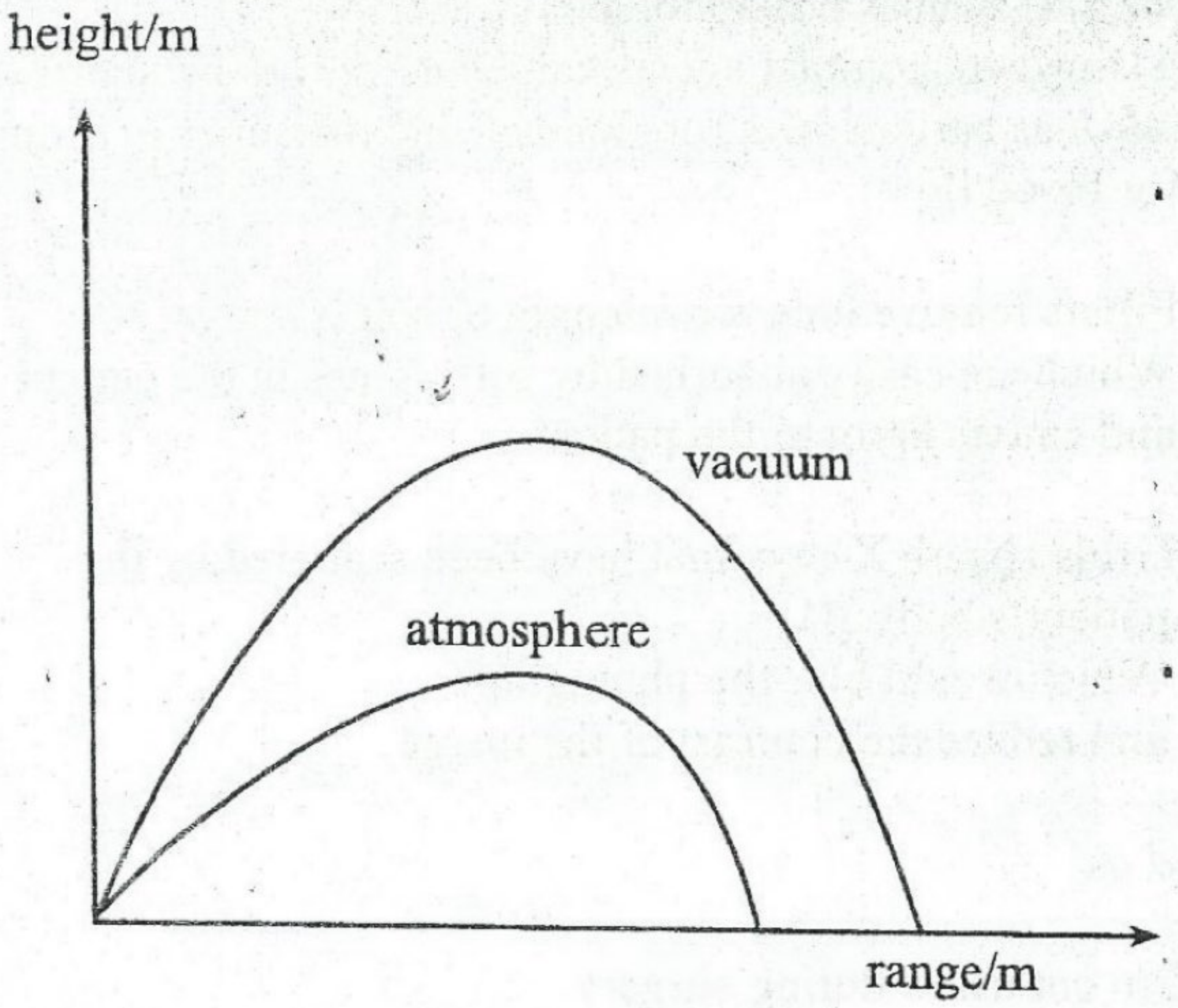
$\therefore t = 1\text{ s}$

Range = $v.t\cos\theta$, $\theta = 0$

$20{,}000 = v.1$ Ⓡ 20ms^{-1}

$v = 20{,}000\text{ ms}^{-1}$ A1

(c)



B2

OR

The atmosphere has air resistance that reduces the range and maximum height.

B1
B1
[Max 2]

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4 (a) 1.

- Cases in which contrast between tissues is clear using X-rays (such as broken bones). B1
- Also where contrast agents can be used to show actual / (sûch as barium salts for stomach and intestines or iodine for blood flow). B1

2.

- Filters remove long wavelength or soft X - rays B1
  Which are easily absorbed by soft tissues in the patient B1
  and causes harm to the patient. B1
- Grids absorb X-rays that have been scattered by the patient's body B1
  Which would blur the photograph B1
  and reduce the contrast of the image. B1

(b) *Lasers are used as*

(i) Scalpel to cut tissue during surgery. A1

(ii) The light is focused on required target and the high energy in it cuts the spot. B1

OR

(i) a coagulator to seal blood vessels. A1

(ii) The high heat energy content causes the tissue in the region cut to shrink and harden, closing the blood vessels. B1

[Max 2]

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS **9188/3**

PAPER 3

NOVEMBER 2013 SESSION 50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1**.

This question paper consists of 8 printed pages.

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Answer question 1 and any other 2 from the remaining questions.

1 **(a)** **(i)** Define *frequency*.

(ii) Derive the wave equation $v = f\lambda$.

(iii) Give any **two** similarities between transverse and longitudinal waves.

[5]

(b) **(i)** Starting from the definition of acceleration, show that the distance moved by a uniformly accelerated body is given by

$s = ut + \frac{1}{2}at^2$, where symbols have usual meanings.

(ii) **Fig. 1.1** shows a glass cage with a spring attached. The other end of the spring has a mass, *m*, fixed to it. A scale calibrated to read weight is adjacent to the spring.

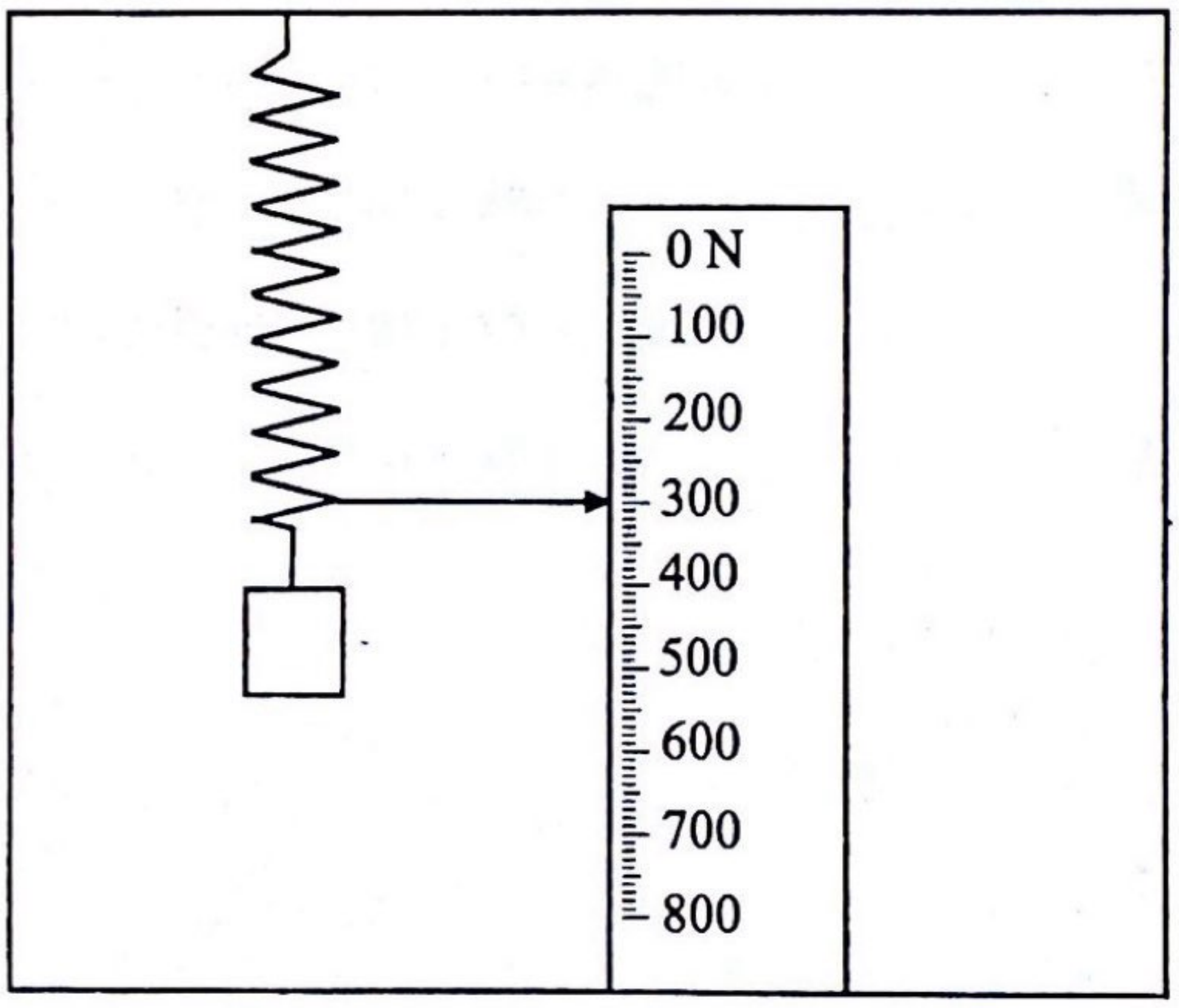

Fig. 1.1

When the cage is stationary, the pointer on the spring shows 300 N.

State and explain the reading of the pointer when the cage is moving down

1. at constant velocity,

2. with an acceleration equal to the acceleration due to gravity.

[7]

(c) (i) Give estimates of the following quantities:

1. mass of a standard size brick
2. average speed of a vehicle on Zimbabwean tarred roads
3. average height of a human male in Zimbabwe

(ii) A cathode ray oscilloscope is a very versatile instrument. One of its uses is in the measurement of small time intervals.

Describe how a cathode ray oscilloscope can be used to recalibrate the scale on a signal generator.

[8]

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2 (a) (i) Define *gravitational potential.*

(ii) Explain why values of gravitational potential are given as negatives.

[4]

(b) A satellite of mass 750 kg moves from a height where the gravitational potential is – 113 MJ/kg to another level where the gravitational potential is – 50 MJ/kg.

(i) Determine the

1. work done in raising the satellite,
2. change in height.

(Take mass of earth as 6.0×10^{24} kg)

(ii) State **any** assumption made in your calculations in **(i)**.

[6]

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3 **(a)** Derive, from the equations of motion, that $E_k = \frac{1}{2}mv^2$. [2]

(b) A free-wheeling car of mass 500 kg accelerates from rest down a uniform incline at 20° to the horizontal, then onto a level road as shown in **Fig. 3.1**. The car takes 15 s to travel 100 m from rest to the bottom.

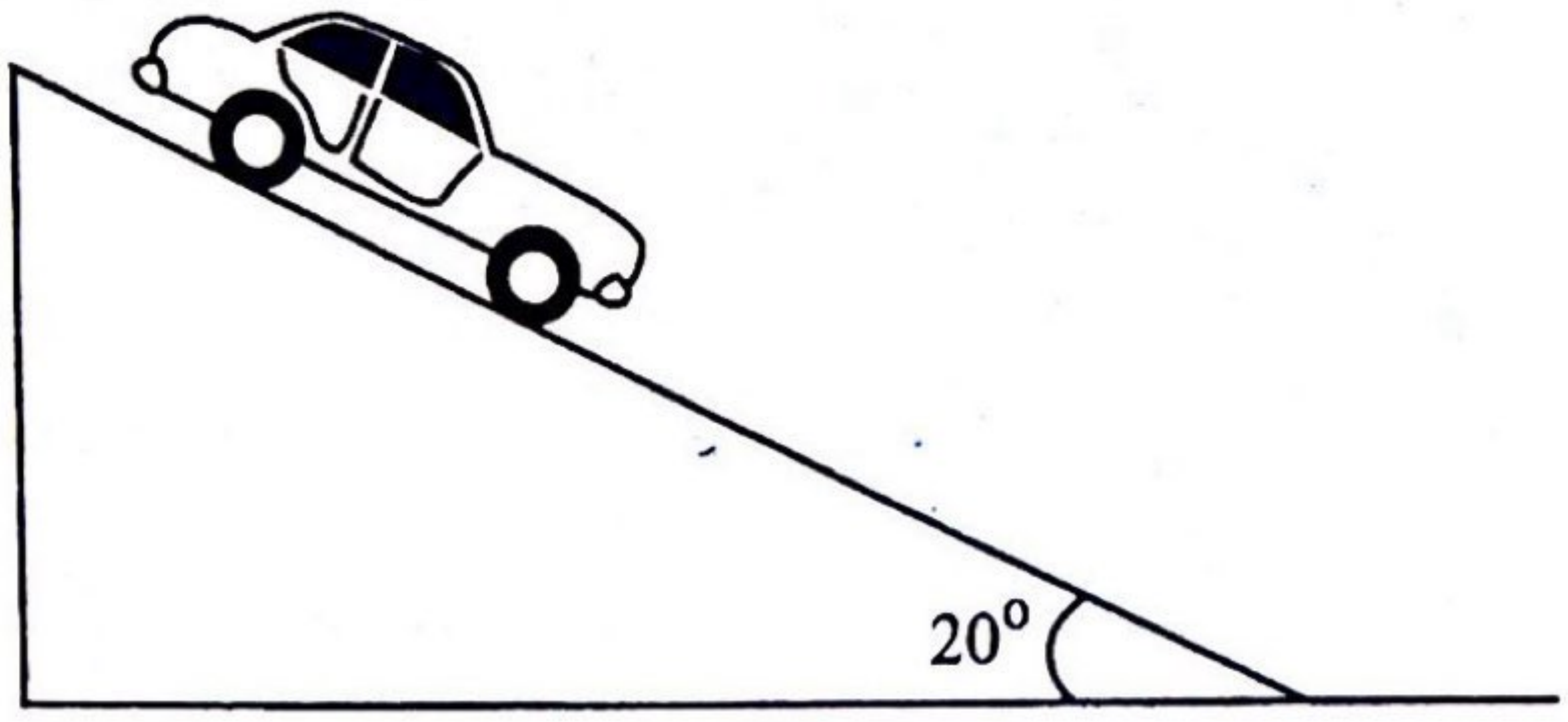

Fig. 3.1

Calculate

(i) the kinetic energy of the car at the bottom,

(ii) the loss in potential energy,

(iii) the work done against friction,

(iv) the co-efficient of friction.

[8]

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4 **(a)** **(i)** State *Snell's law.*

(ii) **Fig.4.1** shows a light ray entering a glass prism.

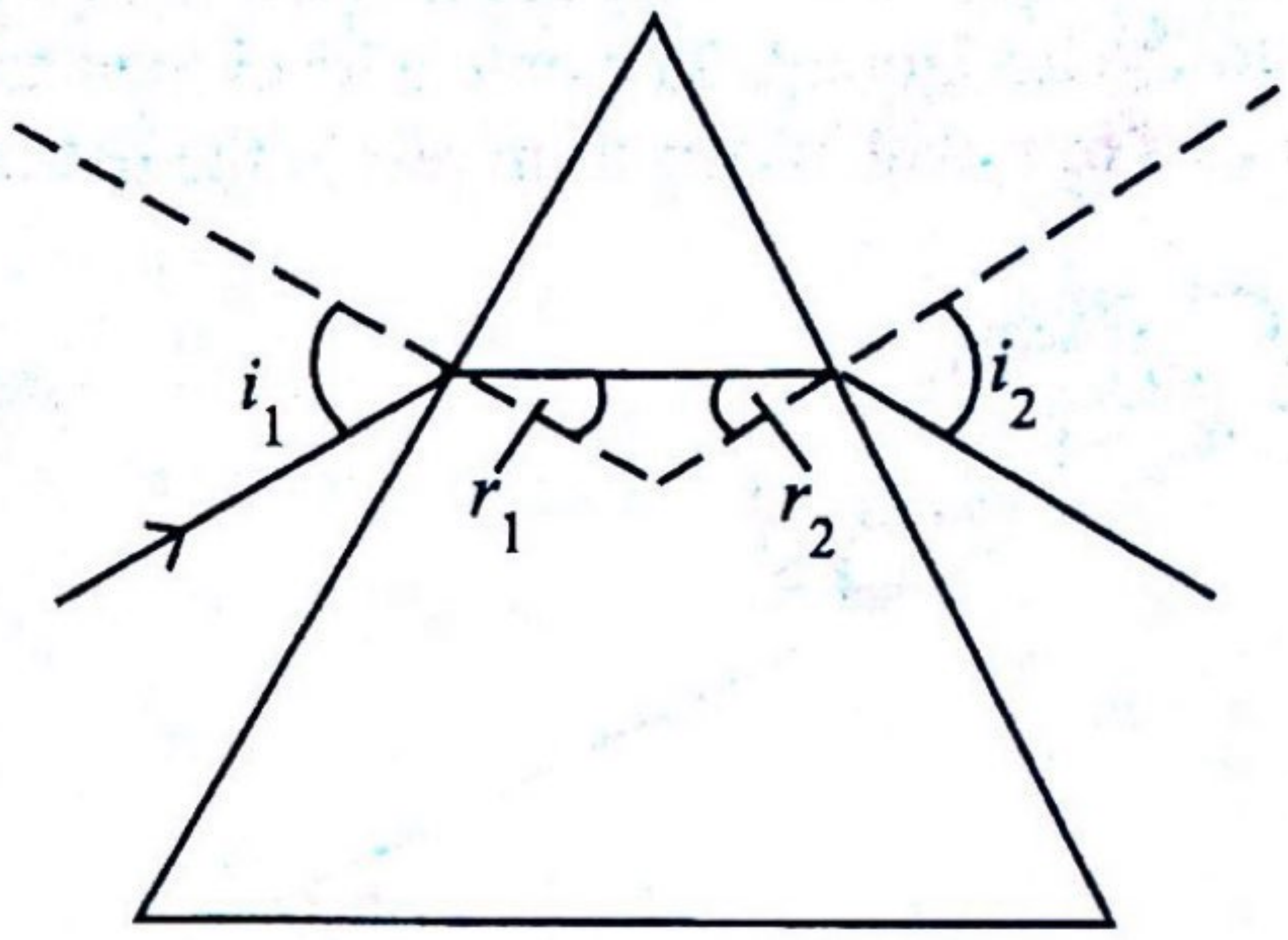

Fig. 4.1

Show that the angle $i_1 =$ angle i_2.

[4]

(b) A ray of light is entering a spherical glass of refractive index 1.45 as shown in **Fig. 4.2**.

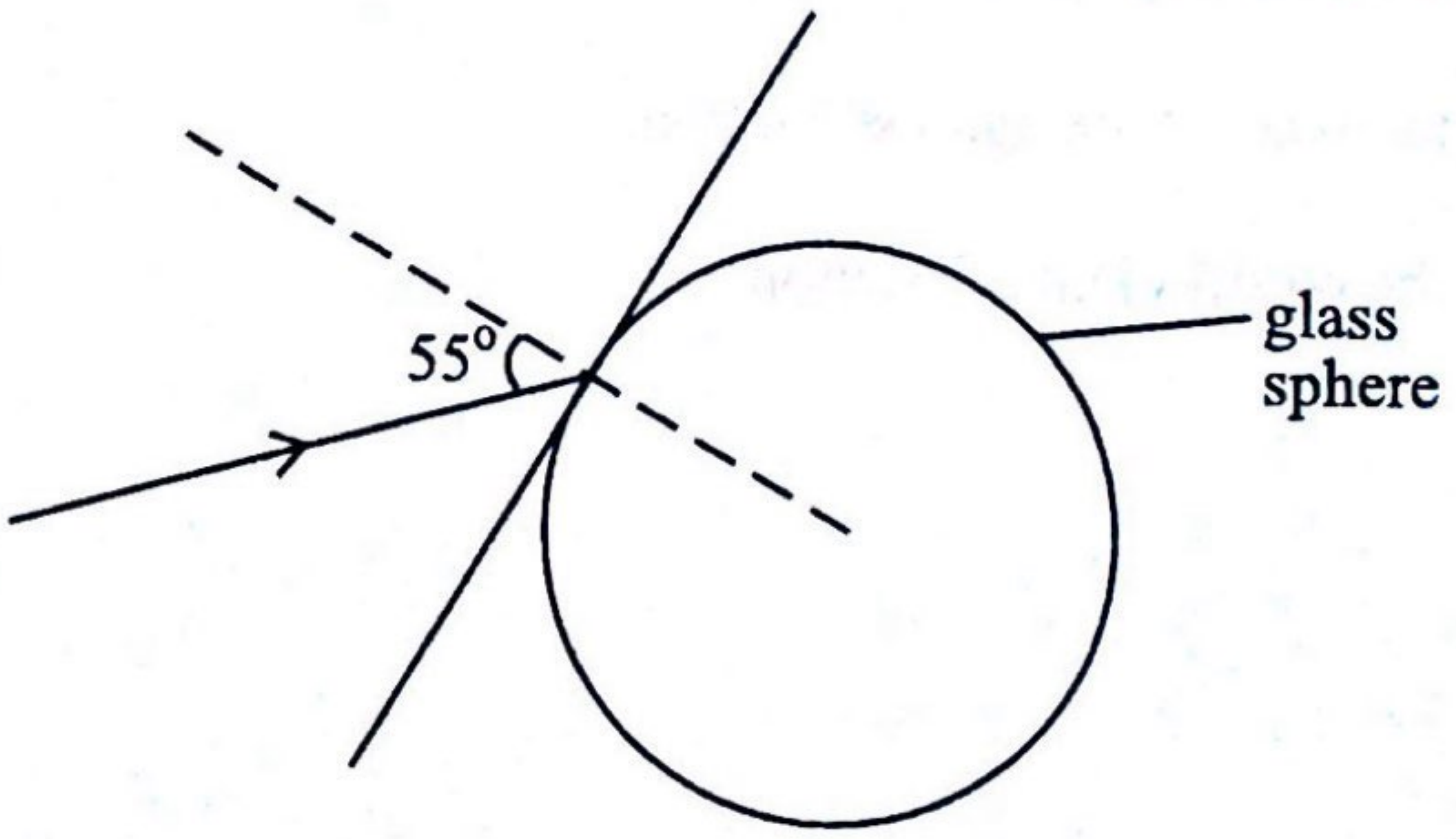

Fig. 4.2

(i) Copy and complete the path of the ray.

(ii) Show that there **cannot** be total internal reflection in the sphere for light coming from outside.

[6]

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

NOVEMBER 2013

PHYSICS **9188/3**

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1 (a) (i) Number of complete cycles per ~~second~~ AW – unit time B1

(ii) $f = \frac{1}{T}$; λ = distance travelled by a wave in time T. B1

$V = \frac{\text{Distance}}{T} = \frac{\lambda}{1/f}$ / $V = \lambda(\frac{1}{T})$ $= \lambda f$ B1

(iii) (both)-propagate / transmit energy /AW B2

Have definite λ, f, & satisfy v = fλ.

- reflected
- refracted
- interfere / superpose / progressive waves.
- deffracted (any possible answer) max 2

(b) (i) $a = \frac{v - u}{t}$ / AW. B1

$s = \left(\frac{u + v}{2}\right)t$ / $v = u + at$ B1

$= \left(\frac{u + u + at}{2}\right)t$ B1

$s = ut + \frac{1}{2}at^2$ A0

(ii) 1. 300 N because tension A1
in spring equals weight of object. /AW M1
(No resultant force / forces balance)
Rej. reading without unit.

2. 0N, Body experiences weightlessness (because no
acceleration) A1
relative to cage.) / AW, Tension = 0 M1
= mg − T = ma (a = g).

(c) (i) 1. 2 - 4 kg B1

2. 80-100 km / hr B1
60 - 120 km/hr (17 - 30) ms^{-1}

3. 1.50-1.70m B1

reject if no unit B3

(ii) Output from signal generator is fed to CRO / AW. B1

For CRO:

- Voltage gain is (initially set at maximum which may be) adjusted depending on output B1
- Time base setting is adjusted to produce a fine wave on screen / Sinusoidal wave is seen on screen. B1

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- Number of squares **m** covered by n complete cycles is read B1
- Frequency calculated from $f = \dfrac{n}{mx\ \text{timebase}}$ AW B1

grav. force is opp. to displacement time

2 (a) (i) Work done per unit mass in moving a body from infinity to a point; B1

Ⓐ Syllabus definition of potential

(ii) Potential at infinity is taken as zero; / Reference of potential 0 is at B1

Ⓐ Gravitational force is attractive

Bodies do not fall away from the earth but towards earth; / Potential decrease we move towards Earth. B1

Attractive forces are associated with negative potential

This means earth is at lower potential than at infinity; B1

(b) 1. (i) $W = m\Delta\varphi = m(\phi_2 - \phi_1)$.

$= 750 \times (-50 - (-113))10^6$ C1

$= 4.72(5) \times 10^{10}\text{J}$ $\longrightarrow$ Ⓐ 2 s.f or more A1

2. $\Delta h = \dfrac{GM}{\Delta\varphi}$ C1

$\Delta h = 6.67 \times 10^{-11} \times 6 \times 10^{24}\left(\dfrac{1}{50} - \dfrac{1}{113}\right) \times 10^{-6}$ C1

$= 4.46 \times 10^6$ m Ⓐ 2 sig. fig. or more A1

(ii) The earth and satellite are taken as point masses B1

Ⓐ Earth is a perfect sphere with mass concentrated at the centre.

3 (a) $\Delta E_k = \overset{ma}{F}.S = mas$ t^2 B1

$as = \dfrac{v^2 - u^2}{2}$ B1

$\therefore \quad E_k = \dfrac{1}{2}mv^2$ when $u^2 = 0$ A0

$a = \dfrac{2 \times 100}{15^2}$

$= 0,89 ms^{-2}$

$V = \cancel{u} + at$

$= 0.89t$

$= 13,3 ms^{-1}$

$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 500 \times 13,3^2$

$= 4,44 \times 10^4 J$

(b) (i) $E_k = \dfrac{1}{2}mv^2$

$v^2 = \dfrac{4s^2}{t^2}$

$\therefore \quad E_K = \dfrac{1}{2} \times \dfrac{500 \times 4 \times (100)^2}{15^2}$ C1

$= 4.44 \times 10^4 J$ A1

2 sig. fig. or more

(Rej $4,5 \times 10^4 J$)

(ii) $\Delta PE = 500 \times 9.81 \times 100 \sin 20$ C1

$= 1.68 \times 10^5 J$ Ⓐ $1\,67760,8803 J$ A1

(iii) $W_F = \Delta PE - \Delta E_K$

$= 1.68 \times 10^5 - 4.44 \times 10^4$ C1

$= 1.24 \times 10^5 J$ Ⓐ $123\,360,88 J$ A1

(iv) $\mu = \dfrac{F_+}{N} = \dfrac{1.24 \times 10^5}{100} \times \dfrac{1}{500 \times 9.81 \times \cancel{\sin}\cos 20}$ C1

$\mu = 0.\cancel{24}69 / 0,73534$ A1

$= 0,2769 / 0,27$

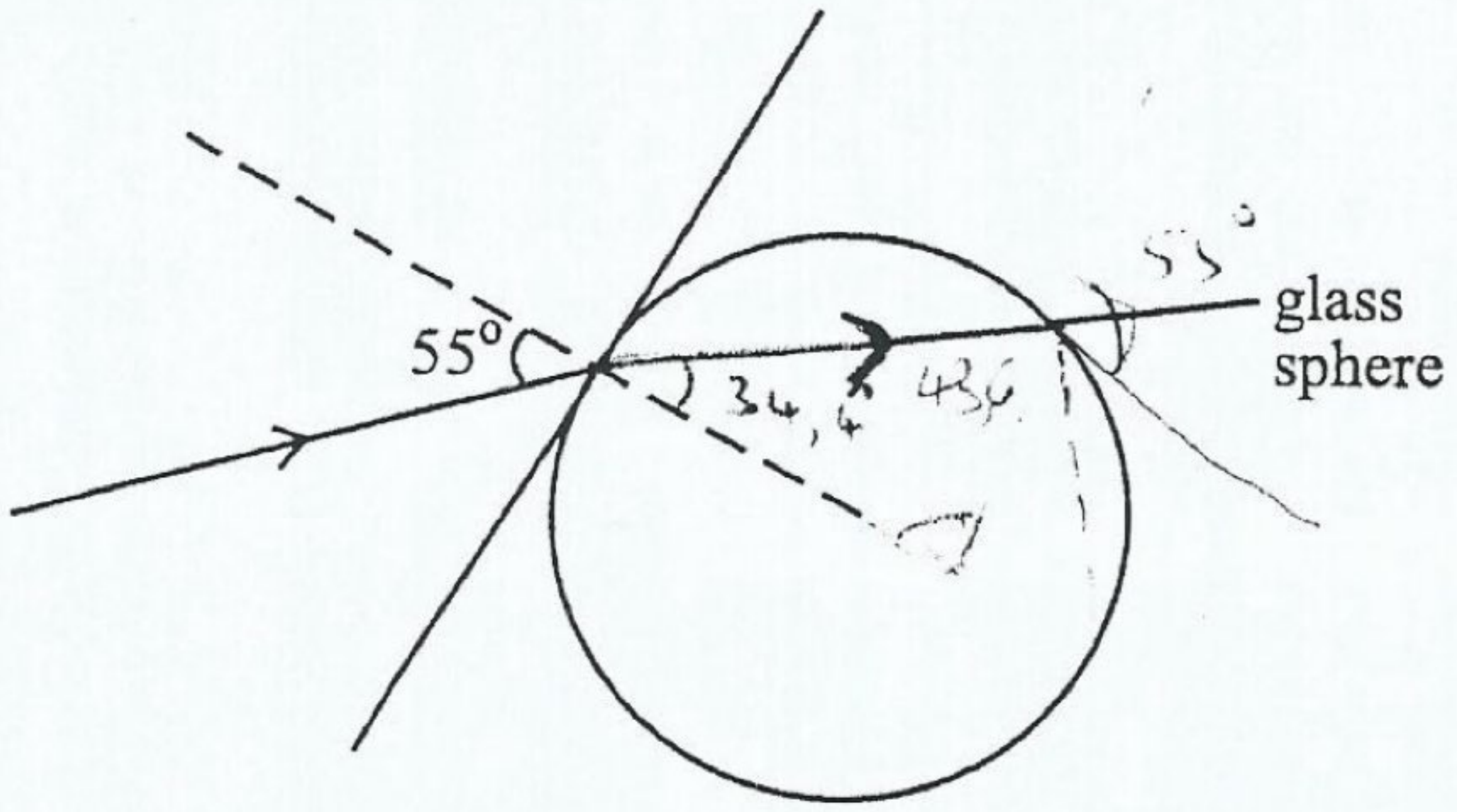
4 (a) (i) $\frac{\sin i}{\sin r}$ = constant / $\frac{\sin i}{\sin r} = n$ (n = refractive index). B1

(ii) $\frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin r_2}$ = constant / using Reversibility of light. B1

reason - same material, constant the same AW B1

ray of light in reverse follow samepath AW. B1

(b) (i)



correct path B1

$$\frac{\sin 55}{\sin \theta} = 1.45$$ C1

θ = 34.4° A1

(ii) Sin θc = $\frac{1}{1.45}$ [redacted] $\theta_c = 43.6^\circ$ ~~B1~~ A1

For an angle of refraction 90° the angle of incident in the sphere is 43.6° B1

For total internal reflection angle of incident inside > 43.6°
which requires Sin i of the angle of incident outside > 1 B1

which is impossible A0

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

9188/3

PAPER 3

JUNE 2014 SESSION

50 minutes

Additional materials:
  Answer paper
  Electronic Calculator and / or Mathematical tables
  Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1**.

This question paper consists of 8 printed pages.

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Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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Answer ***question 1*** *and* ***any other 2*** *from the remaining questions.*

1 (a) (i) Define the terms *systematic error* and *random error.*

(ii) Suggest **one** way of reducing each type of the errors in **(i)**.

(iii) When performing an experiment to determine a constant, E, of a material a student recorded the following values:

length of wire, l = (3.255 ± 0.005) m
diameter of wire, d = (0.63 ± 0.02) mm
force applied to wire, F = (26.5 ± 0.1) N
extension of wire, e = (1.40 ± 0.05) mm

The constant, E, of the wire is related to the measured values above by the relation

$$E = \frac{Fl}{Ae}$$

where A is cross-sectional area of the wire.

Calculate the fractional uncertainty in the value of E.

[6]

(b) (i) State Newton's second law of motion.

(ii) Hence deduce how **The newton** is defined from this law.

(iii) A rocket is propelled by the emission of hot gases from the combustion of fuel. *The hot gases and the rocket gain momentum during the firing of the rocket.*

Discuss the statement in italics in relation to the principle of conservation of momentum.

[6]

(c) (i) Define *resonance*.

(ii) Soldiers on a parade march in phase crossing a suspension bridge.

Given that the soldiers can vary their frequency of marching, sketch a graph to show the variation of the amplitude of the bridge as a result of the frequency of the marching soldiers.

(iii) Suggest what might occur to the bridge at resonance.

[4]

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(d) A simple pendulum set to oscillate in air eventually comes to rest.

(i) State the effect of air on the motion of the pendulum.

(ii) Describe what happens to the kinetic energy of the pendulum as a result of the effect you stated in **(i)**.

(iii) In everyday life passengers prefer cars with good working shock absorbers in their suspension systems.

Explain why passengers avoid cars with poor shock absorbers.

[4]

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2 **(a)** Define the terms *work* and *moment of a force*. [2]

(b) **Fig. 2.1** shows a uniform plank of weight 500 N and length 12 m resting on a smooth platform. Halfway up the plank is a bale of cotton of weight 2 500 N.

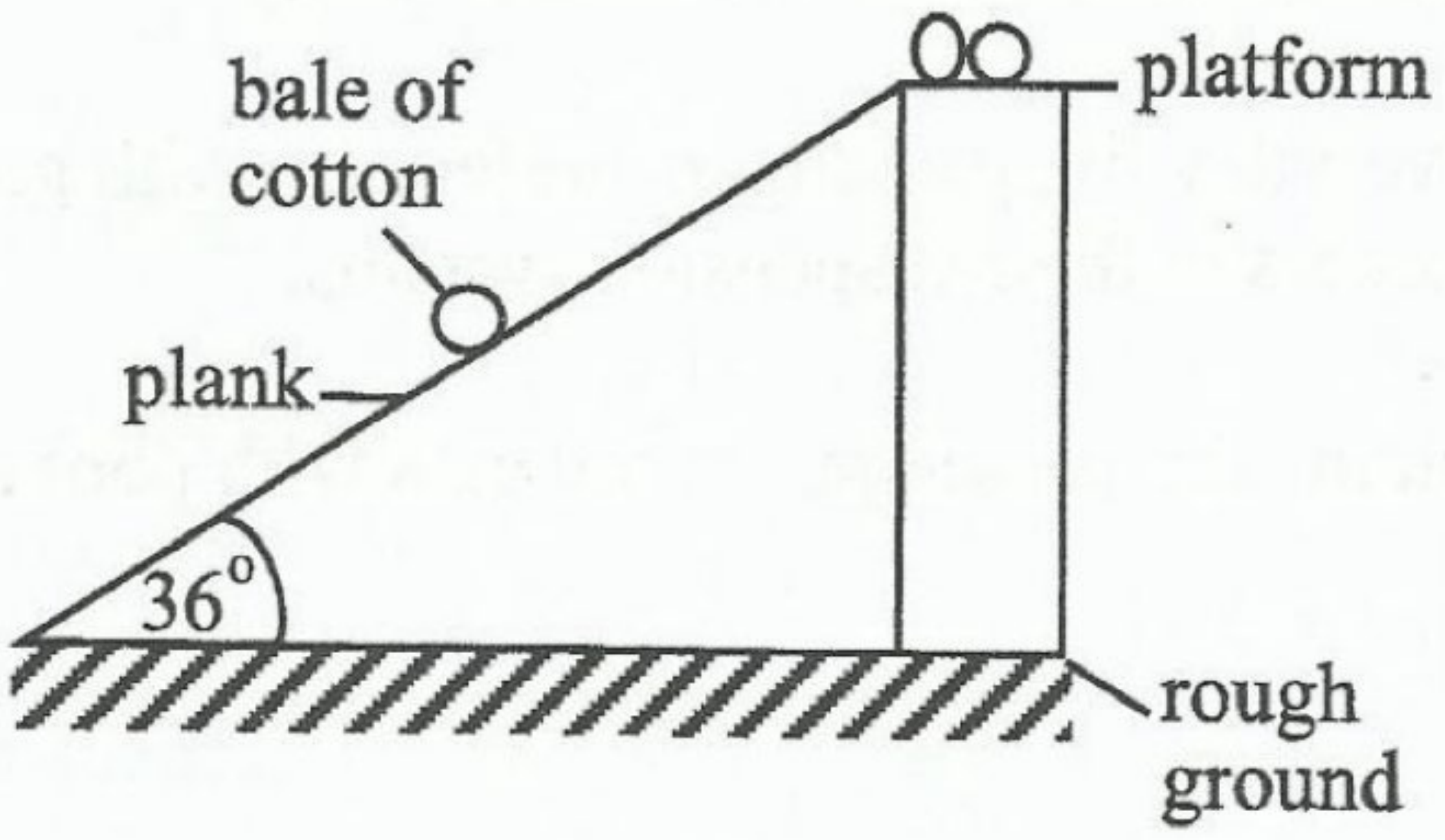

Fig. 2.1

(i) Draw a free-body diagram to show all the forces acting on the plank.

(ii) Calculate the reaction, *R*, due to the platform on the plank.

[6]

(c) Explain why a worker in construction industry prefers a long crow bar to a short one in moving a large stone from the construction site. [2]

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3 **(a)** State the principle of conservation of momentum. [1]

(b) In an elastic head-on collision, a ball of mass 500 g moving at 4.0 m/s collides with a stationery ball of mass 1.0 kg.

(i) Calculate the velocities of the two balls after the collision.

(ii) If the balls had stuck and moved off together as one body after colliding, explain how their **total** energy would be affected. [7]

(c) State and explain any **one** application of the law of conservation of momentum. [2]

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4 (a) State the **two** laws of reflection of light. [2]

(b) **Fig. 4.1** shows a ray of monochromatic light reaching a glass prism of refraction index 1.55.

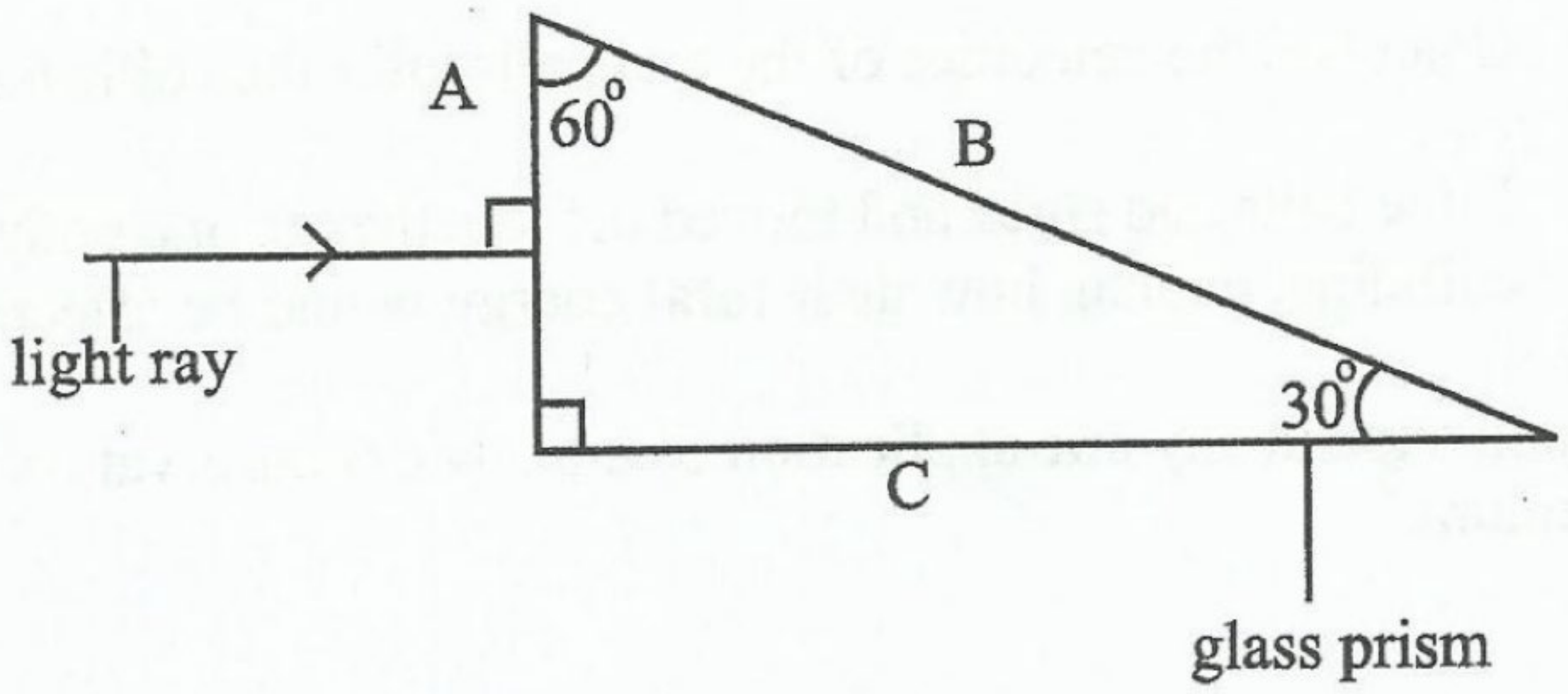


Fig. 4.1

(i) Calculate the critical angle for this glass and air.

(ii) Copy **Fig. 4.1** and complete the path of the ray as it enters face A, moves to face B, then to face C, and after face C.

Give a brief explanation for the path you have drawn.

(iii) Draw a diagram to show how total internal reflection occurs in fibre optics transmission. [6]

(c) In Zimbabwe copper cables are being replaced by fibre optic cables along the major high ways.

Explain why this is good for the country. [2]

JUNE 2014 9188/03

1 (a) (i) Systematic error

- Error caused by the faulty measuring instrument or ambient conditions which cause all the measured values to be incorrect by the same amount in the same direction. B1 B1
- can be eliminated
- Error which can be eliminated. B1

[Max 1]

Random error

- Error caused by the experimenter Bl. Error which causes measured values to be fluctuating scatter about the mean value. B1
- Error that causes measured values to have equal chances to be greater ~~and~~ or smaller than the true value. B1

[Max 1]

(ii) Systematic error can be reduced by:
replacing the instrument (with a better one) B1

- recalibrating the scale. B1
- plotting a graph B1
- conducting experiment in draught free environment/ AW B1
- Subtracting/adding zero-error

[Max 1]

Random error can be reduced by:

- taking several readings and calculating the average B1
- plotting the graph B1
- use of a mirror on analogue scales B1
- taking readings with line of sight at right angles to the scale at the points of reading B1

[Max 1]

(iii)
$$\frac{\Delta E}{E} = \pm\left(\frac{\Delta F}{F} + \frac{\Delta L}{L} + 2\frac{\Delta d}{d} + \frac{\Delta e}{e}\right) \checkmark$$

$$\frac{0.1}{26.5} + \frac{0.005}{3.255} + \frac{2 \times 0.02}{0.63} + \frac{0.05}{1.40}$$ C1

Ⓐ 10.5%

= ±0.105 / ±0.1 to 1s.f. A1

Ignore ±

Ignore units

(b) (i) Rate of change of momentum is directly proportional to applied force (and it takes place in the direction of the force.) B1

(ii) IN = 1 kg.ms $^{-2}$ OR A1

Force acting on a mass of 1 kg causing an acceleration of 1 ms $^{-2}$ A1

(iii) - Exhaust gases are forced /Pushed out of rocket by the combustion of fuel. Max 1. B1

- As gases shoot backwards out of the rocket, they react and force /Push the rocket forward. B1

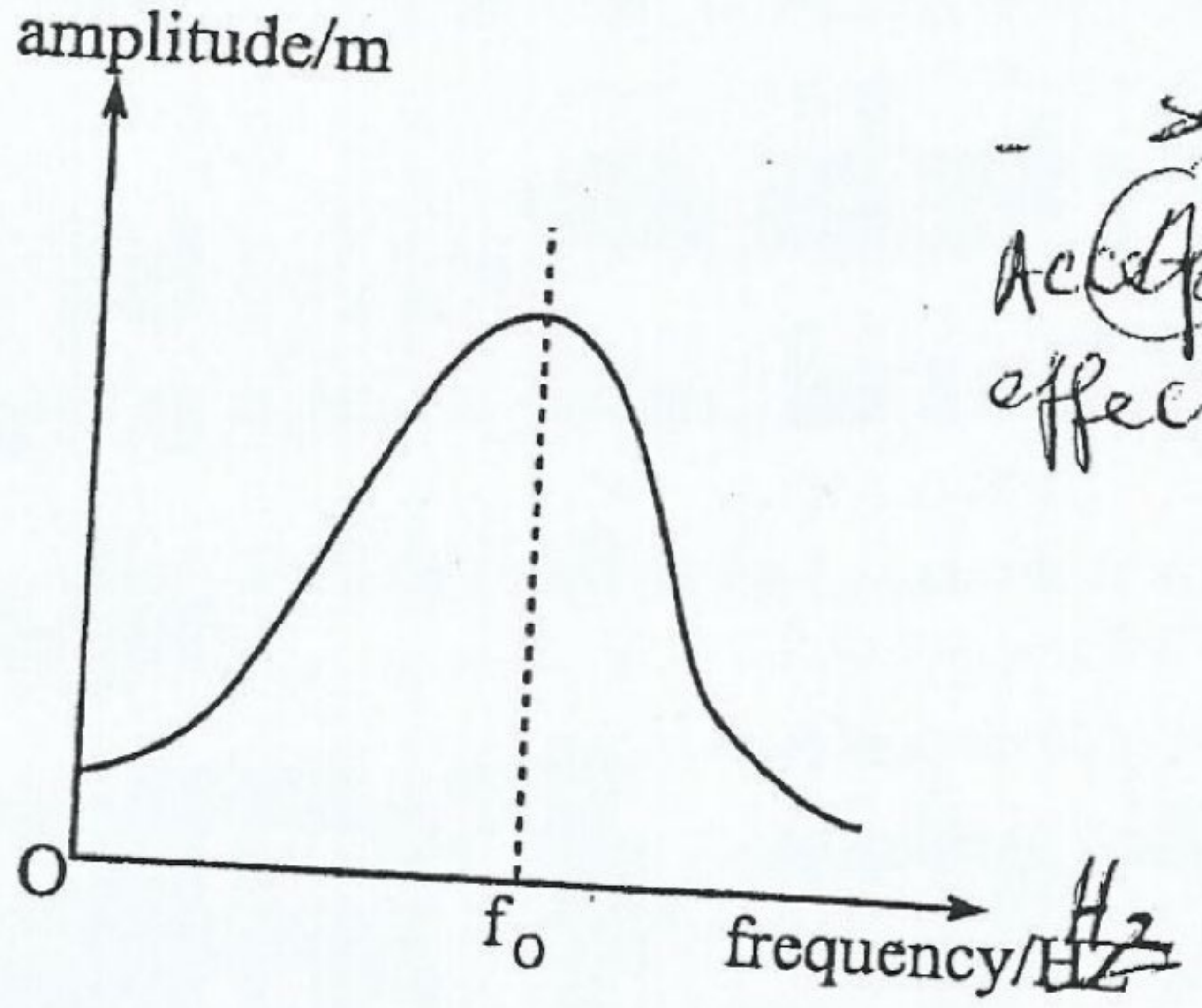
- Thus the gases accelerate backwards and the rocket accelerates forward. B1

- Momentum acquired by the rocket forward is equal in magnitude to momentum acquired by the gases backwards. B1
T. P. before = T.P after.

(c) (i) - Resonance is a situation where the natural frequency of oscillation is equal to forcing driving frequency. B1
coincide with

- (At resonance, amplitude is a maximum.) ~~B1~~

(ii)



- shape
Accept graphs showing effects [illegible]

B1

f_o: = natural frequency of bridge
= resonance frequency

(iii) The bridge might collapse at resonance /AW
Sensible reason Ad

(d) (i) Damps/opposes motion of pendulum | idea of amplitude decreasing. M1 B1

(ii) Kinetic energy is converted to internal energy of the surrounding air B1
- Kinetic energy is lost/reduced (by damping) B1
Maximum 1 mark

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(iii) - Poor working shork absorbers cause the car to oscillate, throwing passengers up and down. B1

- Riding is therefore uncomfortable B1

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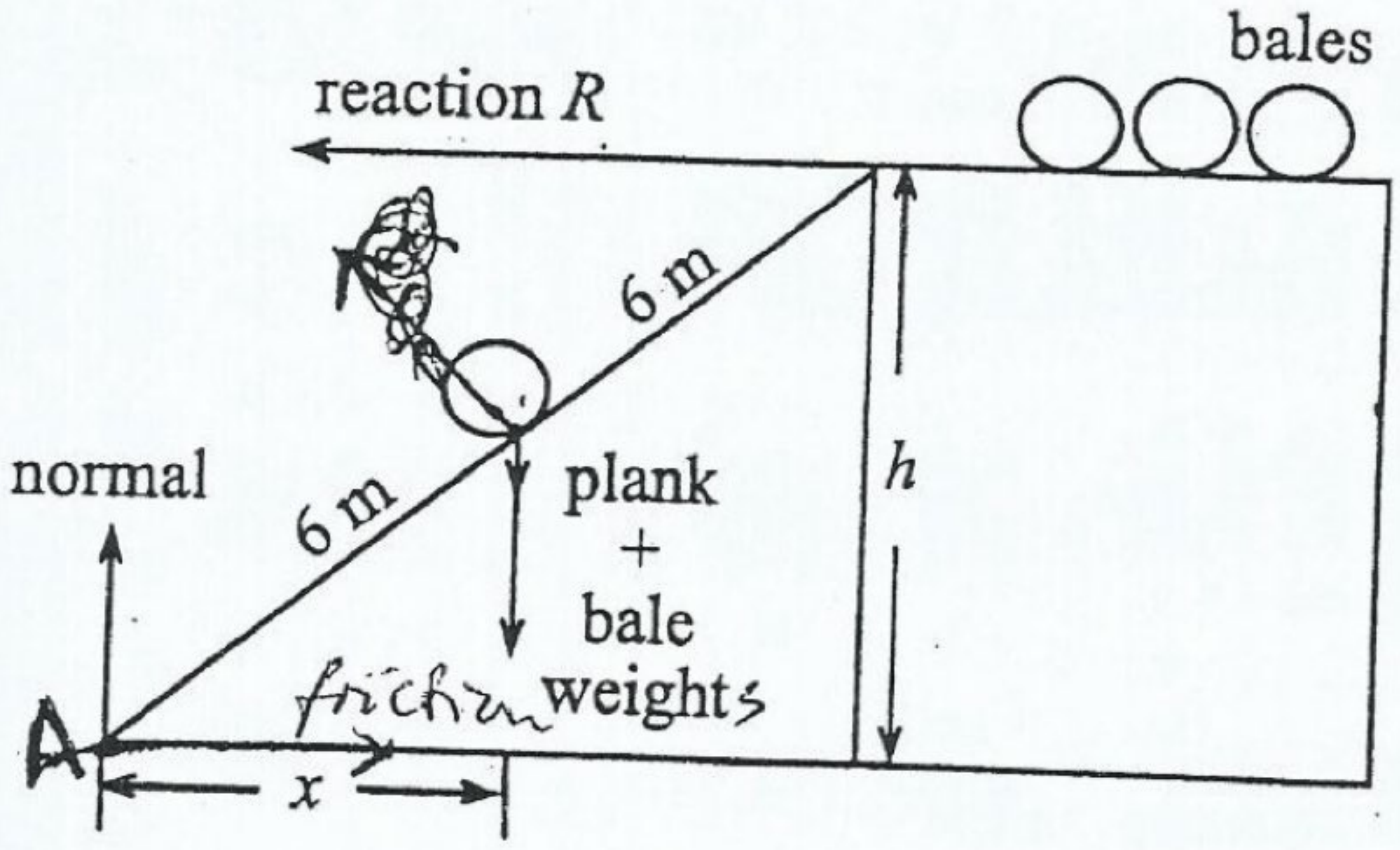
2 (a) Work - Product of force and displacement in the direction of the force. Ⓐ Eqns with terms defined B1

Moment - Product of force and perpendicular distance from pivot to line of action of the force. B1

(b) (i)



All correct
Normal reactions B1
Weights (Both) [illegible]
Same point of application of bale & plank, B1 B3 B1
- friction B1

(ii) Taking moments about point A: $R \times h = W \times x$

$h = 12\sin 36$; $x = 6\cos 36$ C1

$R \times 12\sin 36 = 3\ 000 \times 6\cos 36$ C1

$R = 2\ 064{,}57$ N A1

(c) A long crow bar enables the worker to apply a small effort to produce the same moment as that would be produced by a short bar using a large effort. B1 B1

- Plausible comparison

3 (a) In a closed/an isolated system, total momentum is conserved/AW B1

(b) (i) conservation of momentum:

$0.5 \times 4 = 0.5\,V_1 + V_2$

$2 = 0.5V_1 + V_2 \ldots$ (1) C1

Relative velocities $V_1 - V_2 = -(u_1 - u_2)$

$V_1 - V_2 = -(4 - 0)$

$4 = V_2 - V_1 \ldots$ (2) C1

(2) – (1) $2 = -1.5\,V_1$ C1

$V_1 = -1.33\text{ms}^{-1}$ A1

Take care $V_2 = (4 - 1.33)\text{ ms}^{-1}$ C1

$= 2.67\text{ms}^{-1}$ A1

OR

Conservation of kinetic energy

$$\frac{1}{2}m_1u_1 = \frac{1}{2}m_1v_1^{\,2} + \frac{1}{2}m_2v_2^2$$

$8 = 0.5\,V_1^2 + V_2^2$ (1) C1

Relative velocities $V_1 - V_2 = -(u_1 - u_2)$

$4 = V_2 - V_1$ (2) C1

substituting (2) into (1) simplifying

$3V_1^2 + 16V_1 + 16 = 0$ C1

By quadratic equation $V_1 = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$$= \frac{-16 \pm \sqrt{16^2 - 4(3)16}}{2 \times 3}$$

$V_1 = -1,33\text{ms}^{-1}$ or -4ms^{-1}

$\therefore$ [illegible] = [illegible] [illegible]

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~~$= 1{,}33ms^{-1}$ or $-4ms^{-1}$~~

$V_2 = 4 + \left(\frac{-16 \pm 8}{6}\right) = 4 - 1.33$ or $4 - 4$ C1

$= 2.67ms^{-1}$ or 0

If $V_1 = -1.33ms^{-1}$ then $V_2 = 2.67ms^{-1}$ A1

$V_1 = -4ms^{-1}$ then $V_0 = 0$ A1

(ii) Total energy remains the same (although some of the kinetic energy is changed to other forms of energy) Total energy is conserved. B1

(c) - In launching a rocket total final momentum is zero ~~A~~B1

- When rocket is fired change of momentum of rocket forward equals in magnitude to change of momentum of hot gas emitted from combustion of fuel backwards. ~~M~~B1

ACCEPT ANY PLAUSIBLE APPLICATION

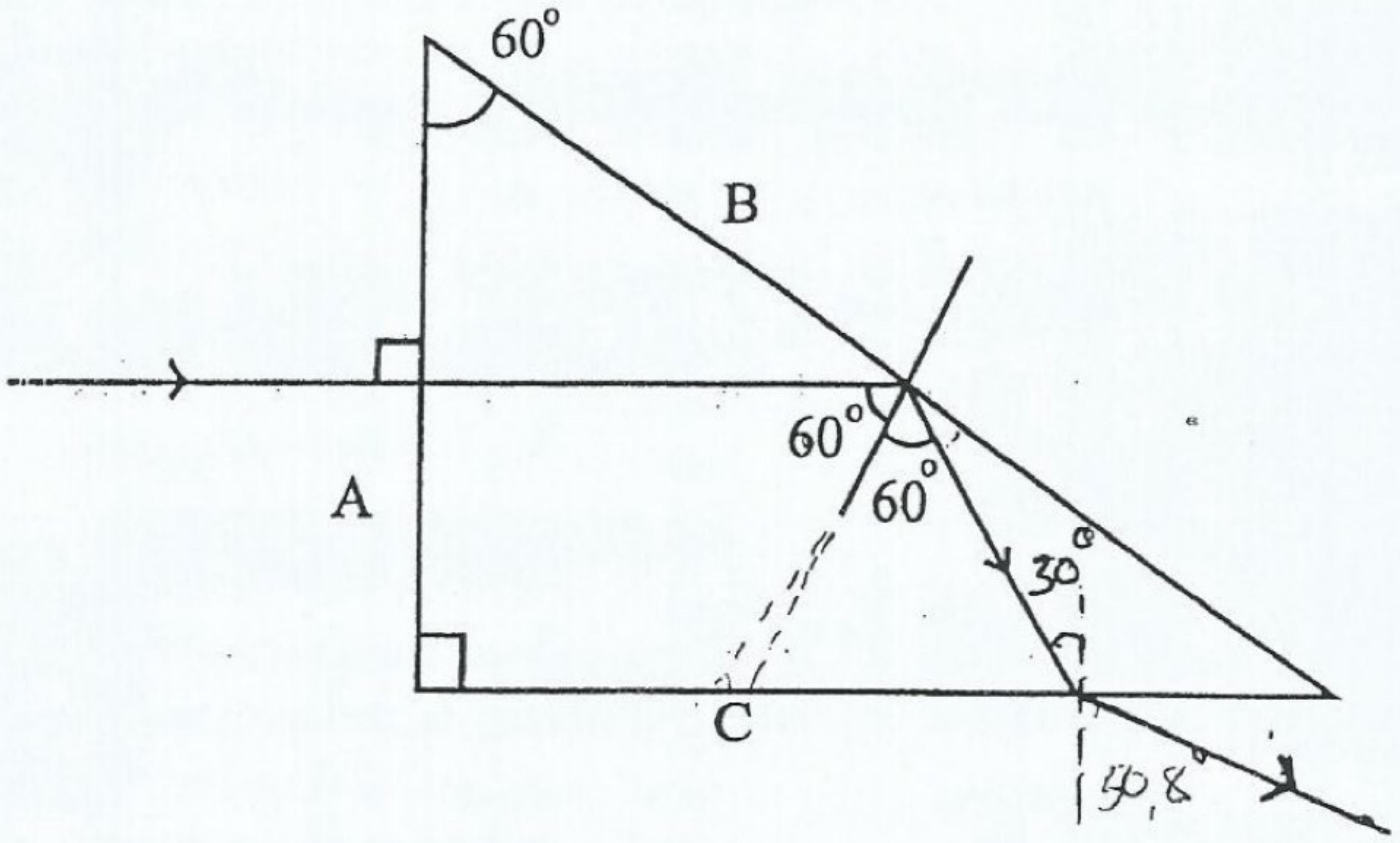
4 (a) Incident ray, reflected ray and the normal all lie in the same plane at the point of incidence. B1

Angle of incidence = Angle of reflection (i = r) terms defined. B1

(b) (i) $\sin C = \frac{1}{n} \Big/ C = \sin^{-1}\left(\frac{1}{1.55}\right)$ C1

$= 40.2°$ A1

(ii)



Correct path of rays
* Angles be shown
correct direction
* direction of rays
B2

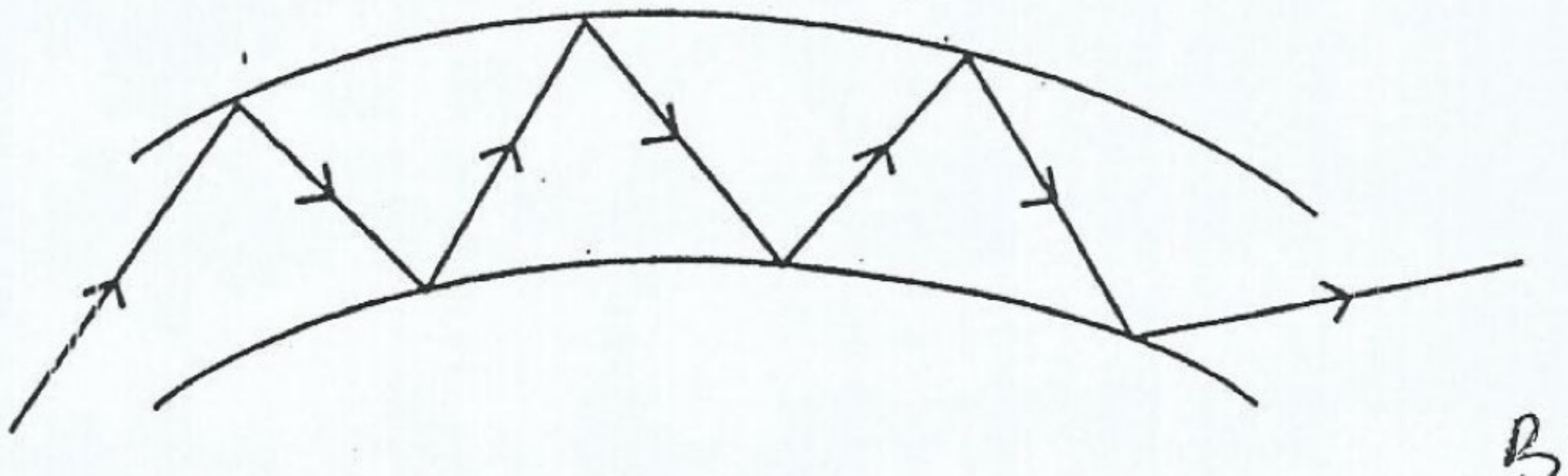
Since angle of incidence on face A = $\overset{0}{9}$0°, no refraction occurs ~~B1~~ B1

Since $\overset{i}{I}$ > C (60° > 40.2°), total internal reflection occurs at face B. B1

At C, refracted away from normal out of prism, glass more optically dense than air B1

Max 2

(iii)



- [illegible]
-

B1 ~~Max 4~~

(c) - Wide frequency band width: more information is carried down a single optical fibre.
- Less attenuation: less installation costs since few regenerators amplifiers/boosters are required.
- It is free from noise due to electrical interference. Regenerates/reshapes each pulse.

- It offers greater security to the user i.e. not stolen for other uses
- Cross talk between adjacent channels is negligible i.e. no interference

Advantage & Explanation
~~Explanation~~

B1
~~B1~~

Max 1

Max of 1 advantage
Max of 1 explanation

Low weight: smaller and easier to handle than a copper cable ®.

*Answer **question 1** and **any other 2** from the remaining questions.*

1 (a) (i) Express the farad in base units.

(ii) The braking force of a vehicle is given by the equation.

$$F = x^2 A + \frac{P}{V}$$

where

x is the distance moved after applying the brakes
A is a constant
P is the power
V is the speed when brakes are applied

1. Determine the base units for A.
2. Suggest the identity of physical quantity A. [5]

(b) (i) Define *displacement*.

(ii) **Fig. 1.1** shows a velocity time graph for a car.

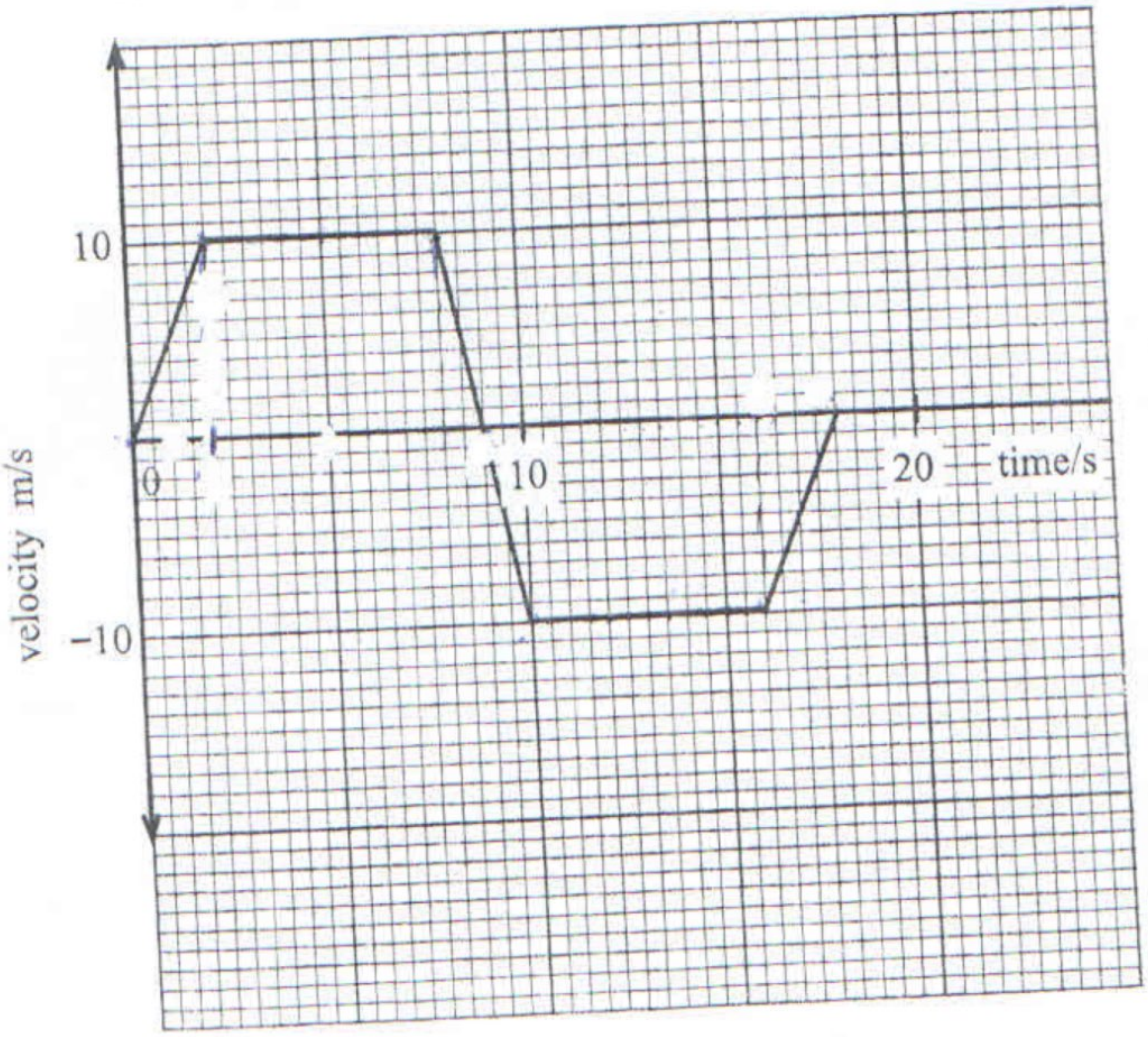


Fig. 1.1

1. Describe qualitatively the motion of the car during the first 10 seconds.
2. Calculate total distance travelled in 18 seconds.
3. Deduce the work done for the whole journey. [8]

(c) (i) Describe the term *coherence in waves*.

(ii) Explain why interference effects are not observable in light from two close stars.

[3]

(d) In a Young's double slit experiment using a laser of wavelength 638 nm, the screen is placed 2.5 m from the double slit.

(i) If the slit separation is 0.50 mm, calculate the distance between fringes.

(ii) State **two** ways of increasing the distance between fringes.

[4]

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2 (a) (i) State **two** conditions necessary for coplanar forces acting on a body to be in equilibrium.

(ii) **Fig. 2.1** shows a 65.0 kg man standing close to the edge of a balcony. The balcony has a weight of 3 450 N acting at a point 2.10 m from the wall. A supporting cable, S, keeps the system horizontal.

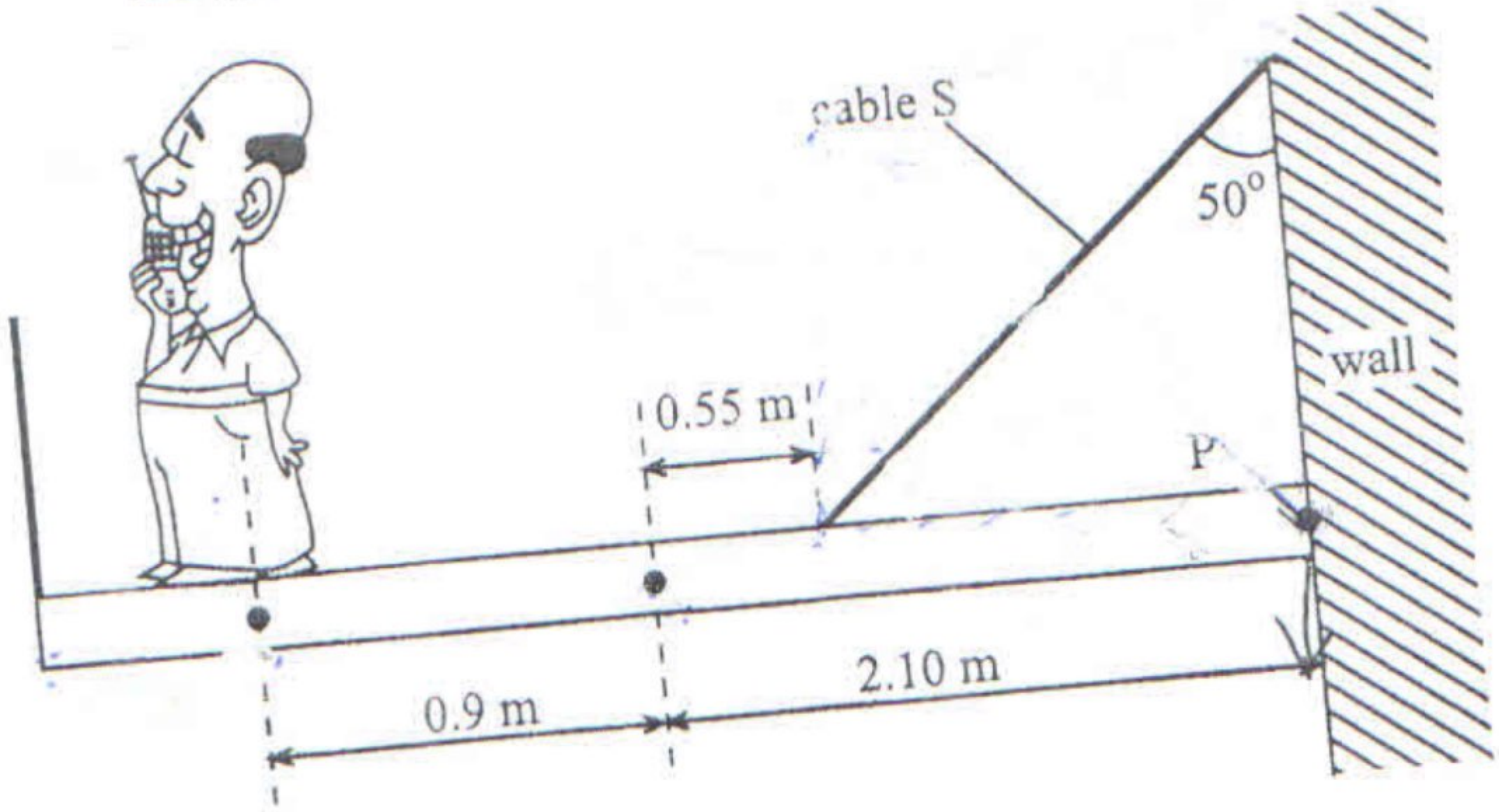

Fig. 2.1

Calculate the

1. tension in S,
2. reaction force at P.

[6]

$\tan\theta = \frac{opp}{x}$

$x = \frac{opp}{\tan\theta}$

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(b) (i) State Stoke's law.

(ii) **Fig. 2.2** shows a moving small steel ball just below the surface of a viscous liquid.

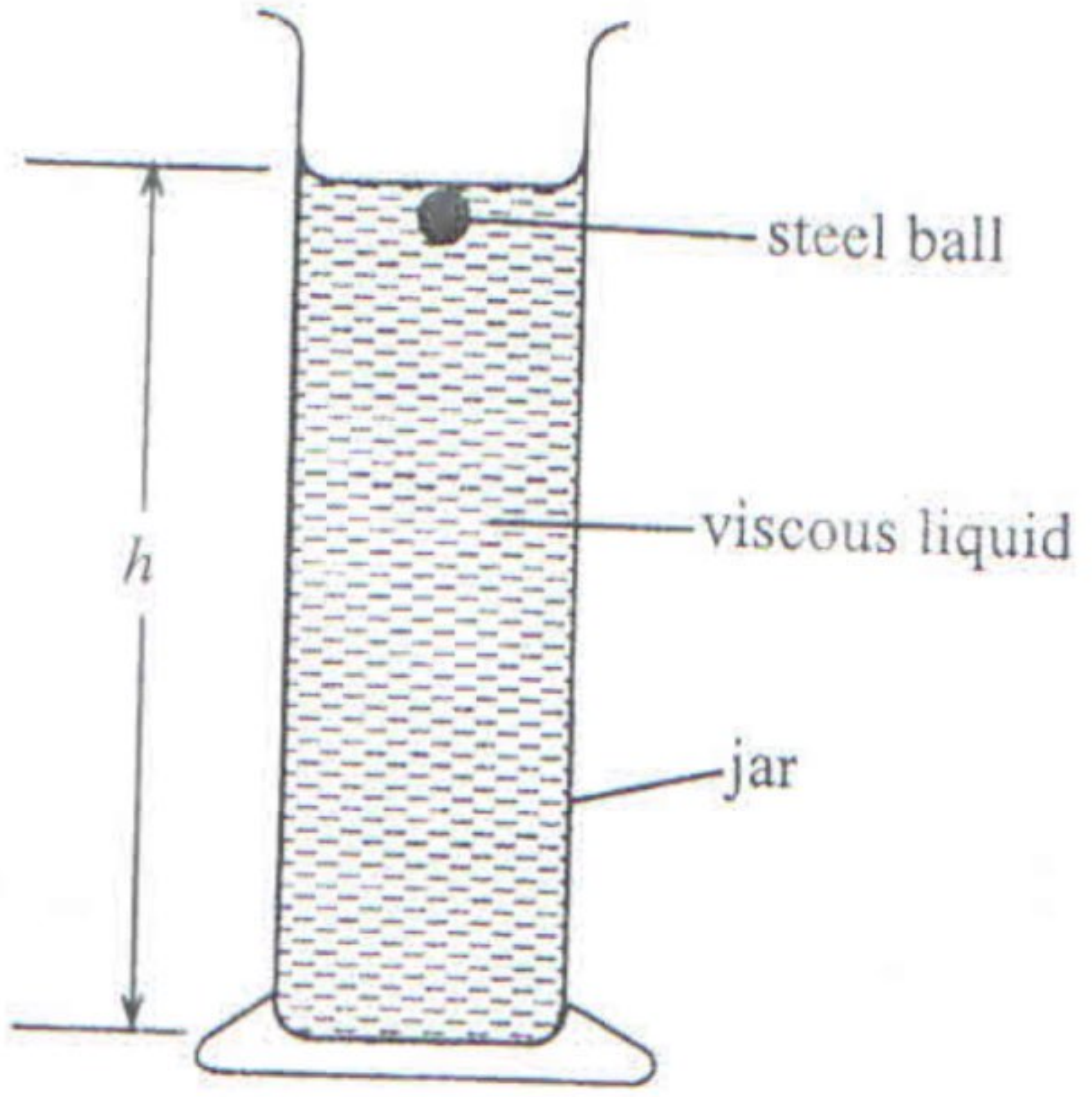

Fig. 2.2

1. Give all the forces acting on the steel ball.

2. The ball falls through the liquid to the bottom. Sketch a graph to show how the height, *h*, of the ball varies with time given that it attains terminal velocity.

[4]

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3 (a) (i) Define *linear momentum.*

(ii) Distinguish between *elastic* and *inelastic* collisions.

[3]

(b) A stone thrown horizontally from the top of a cliff with a velocity of 15 ms $^{-1}$ is observed to strike the ground at a distance 45 m from the base of the cliff.

Determine

(i) the height of the cliff,

(ii) the velocity of the stone at the moment of impact.

[6]

(c) Explain why the path of the stone in **(b)** is **not** a straight line. [1]

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2 (a) (i) State **two** conditions necessary for coplanar forces acting on a body to be in equilibrium.

(ii) **Fig. 2.1** shows a 65.0 kg man standing close to the edge of a balcony. The balcony has a weight of 3 450 N acting at a point 2.10 m from the wall. A supporting cable, S, keeps the system horizontal.

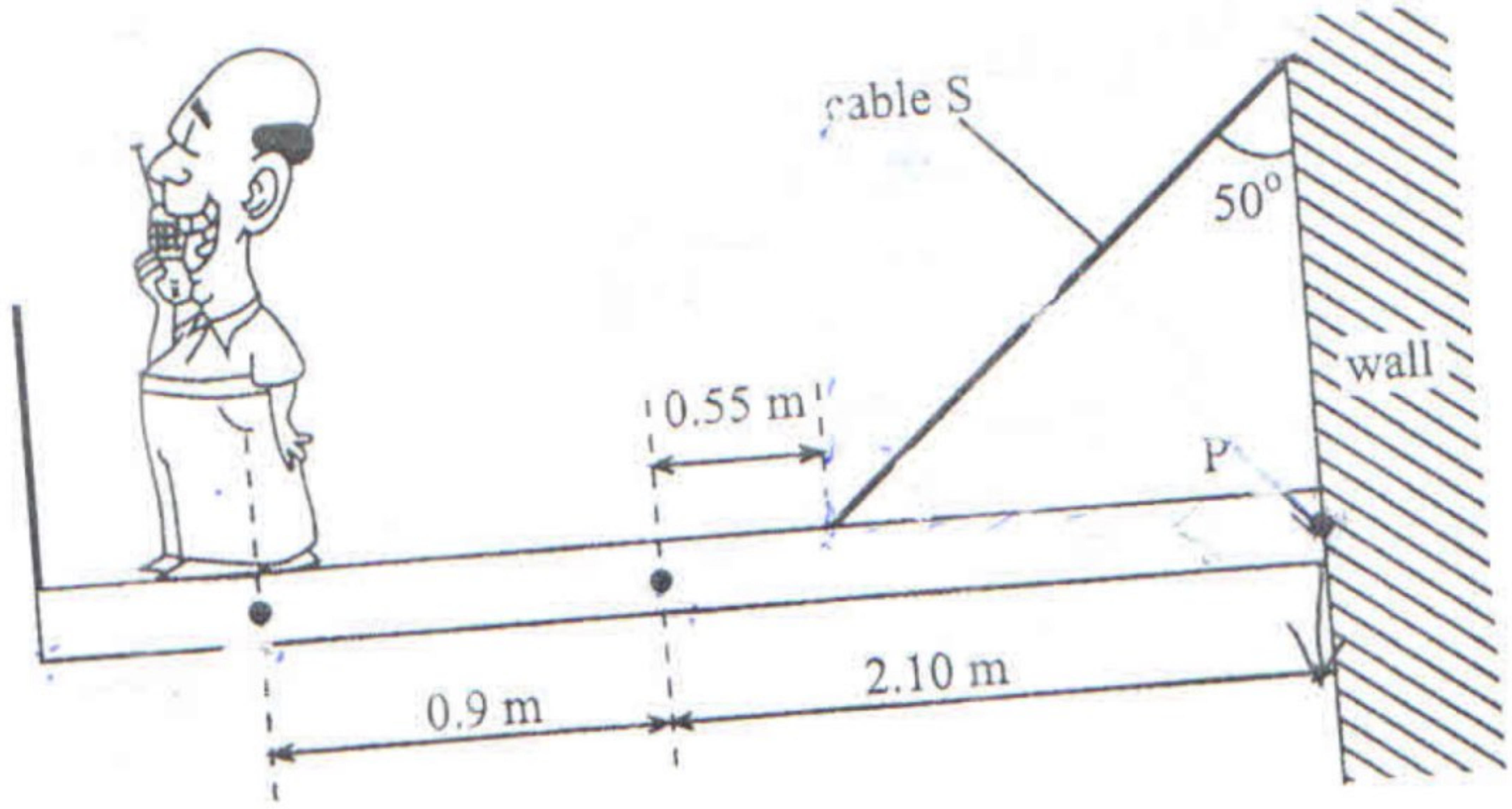

Fig. 2.1

Calculate the

1. tension in S,
2. reaction force at P. [6]

$\tan\theta = \frac{opp}{x}$

$x = \frac{opp}{\tan\theta}$

ZIMSEC

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

RUSITU SEC. SCHOOL
UNITED BAPTIST
P. BAG 2
CHIMANIMANI

PHYSICS

PAPER 3 Theory

9188/3

JUNE 2015 SESSION

50 minutes

Additional materials:
  Answer paper
  Scientific Calculator and / or Mathematical tables
  Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1**.

This question paper consists of 7 printed pages and 1 blank page.

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[Turn over

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Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Answer ***question 1*** *and* ***any other 2*** *from the remaining questions.*

1 (a) (i) A force-extension graph for a spring which obeys Hooke's law was drawn and it was observed that :

1. the plotted points did not follow a straight line
2. the intercept was **not** zero

State the error associated with each observation.

(ii) Explain whether or not a systematic error can be eliminated by averaging repeated readings.

[5]

(b) (i) State Newton's third law of motion.

(ii) A stone falls towards the earth but the earth does not move up towards the stone.

State, with reasons, whether Newton's third law is obeyed in this case.

[5]

(c) (i) State the **three** properties of an image formed by a plane mirror.

(ii) A ray of light enters glass from air. The angle of incidence is 40° and that of refraction is 26°.

Calculate the critical angle of glass.

[6]

(d) (i) 1. Define the term *gravitational field strength*.

2. Give an expression for the gravitational field strength, g, at a height, h, above the surface of the earth and explain all the symbols used.

(ii) An object is dropped from the top of a tall building.

Explain why

1. the gravitational field strength at the top of the building is the same as on the ground,
2. the acceleration of the object at the top of the building may not be the same as the acceleration near the ground.

[4]

2 (a) (i) State the relationship between *power* and *energy*.

(ii) Deduce the base units of power.

[3]

(b) At a school science exhibition, a student designed a model of a hydroelectric power station shown in **Fig. 2.1** (not to scale).

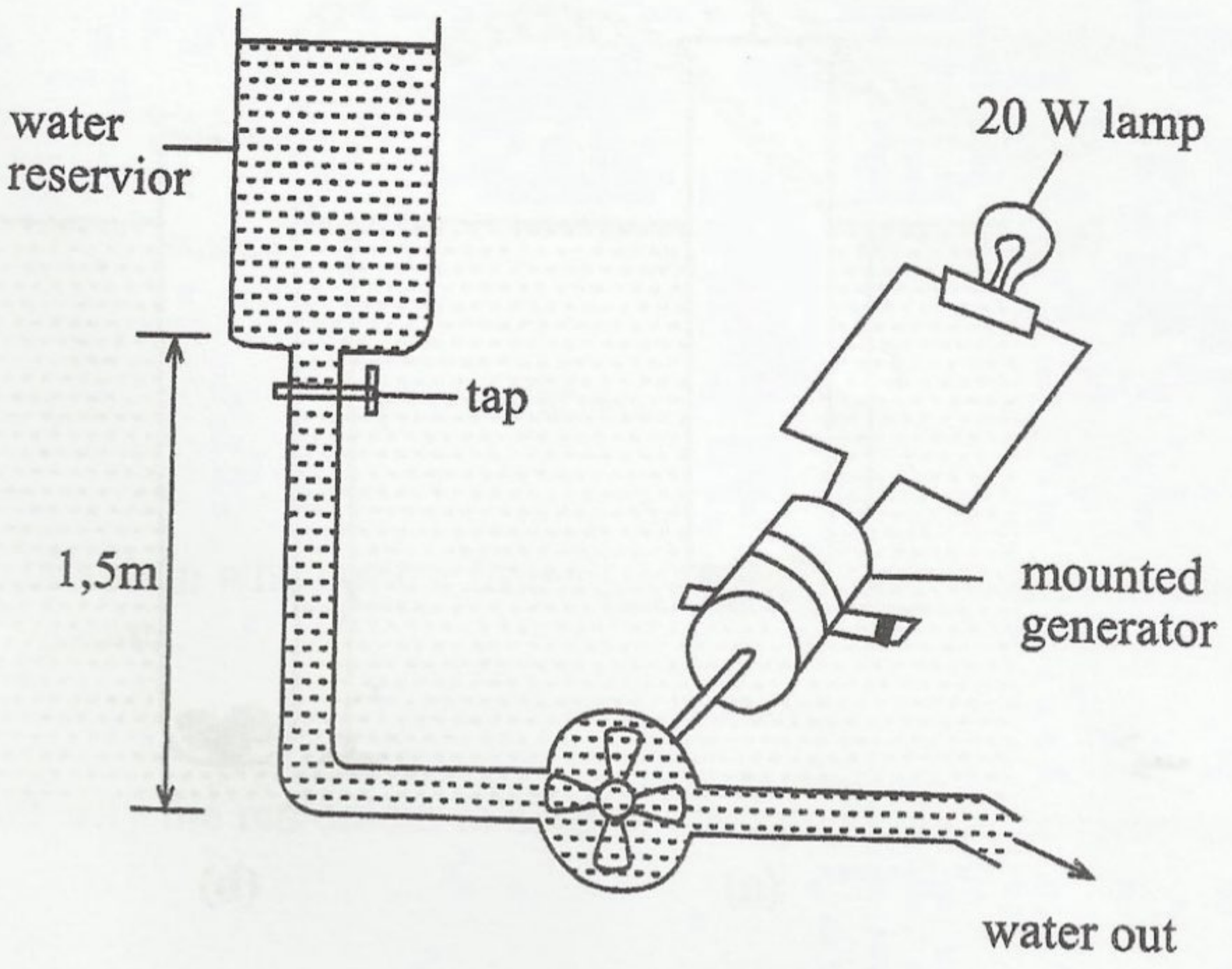

Fig.2.1

(i) Describe the main energy changes which take place when the tap is opened.

(ii) The 20 W lamp operates normally when the tap is opened and water flows out at 3 kgs^{-1}.

Calculate the

1. potential energy lost by the water per unit time,
2. efficiency of the model.

[5]

(c) Explain why a hydroelectric power station would be preferable to a thermal power station.

[2]

[Turn over

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3 **(a)** State the equation for simple harmonic motion, explaining the significance of the signs and symbols in the equation. [3]

(b) A loaded closed test-tube of mass, m, and cross-sectional area, A, floats in equilibrium with length, l, under the surface of a liquid of density, ρ. The test-tube is pressed down in the liquid a distance, x, as in **Fig.3.1** and released.

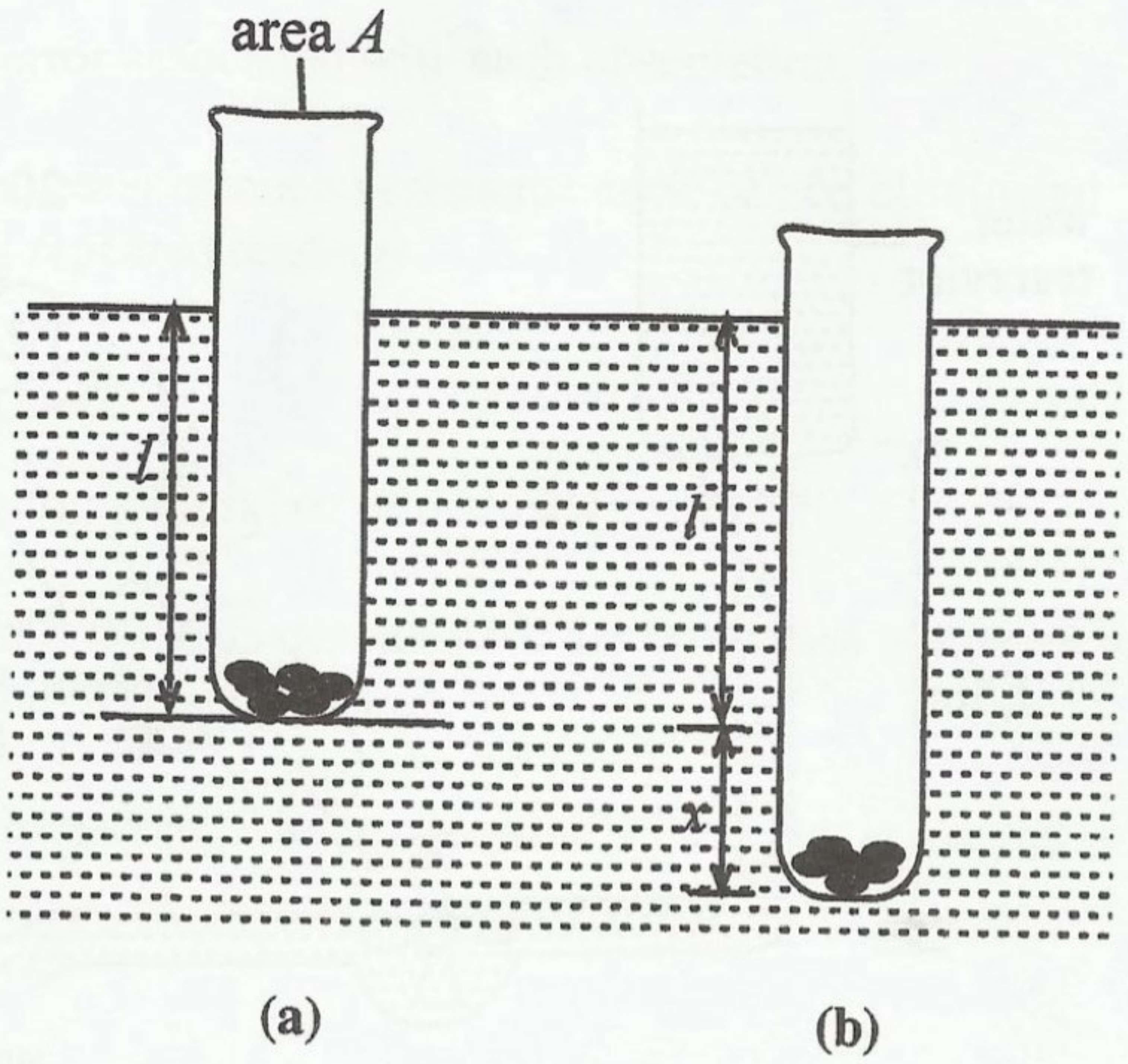

Fig.3.1

(i) The test-tube oscillates with simple harmonic motion.

Show that acceleration, a, is given by

$$a = \frac{-\rho A g}{m}$$

where g is the acceleration of free fall.

(ii) Determine an expression for the period of the test-tube.

[5]

(c) In practice the test-tube fails to execute true simple harmonic motion.

Explain. [2]

4 (a) Define *total internal reflection*. [2]

(b) (i) With the aid of a diagram, describe how light travels through an optical fibre shown in **Fig.4.1.**

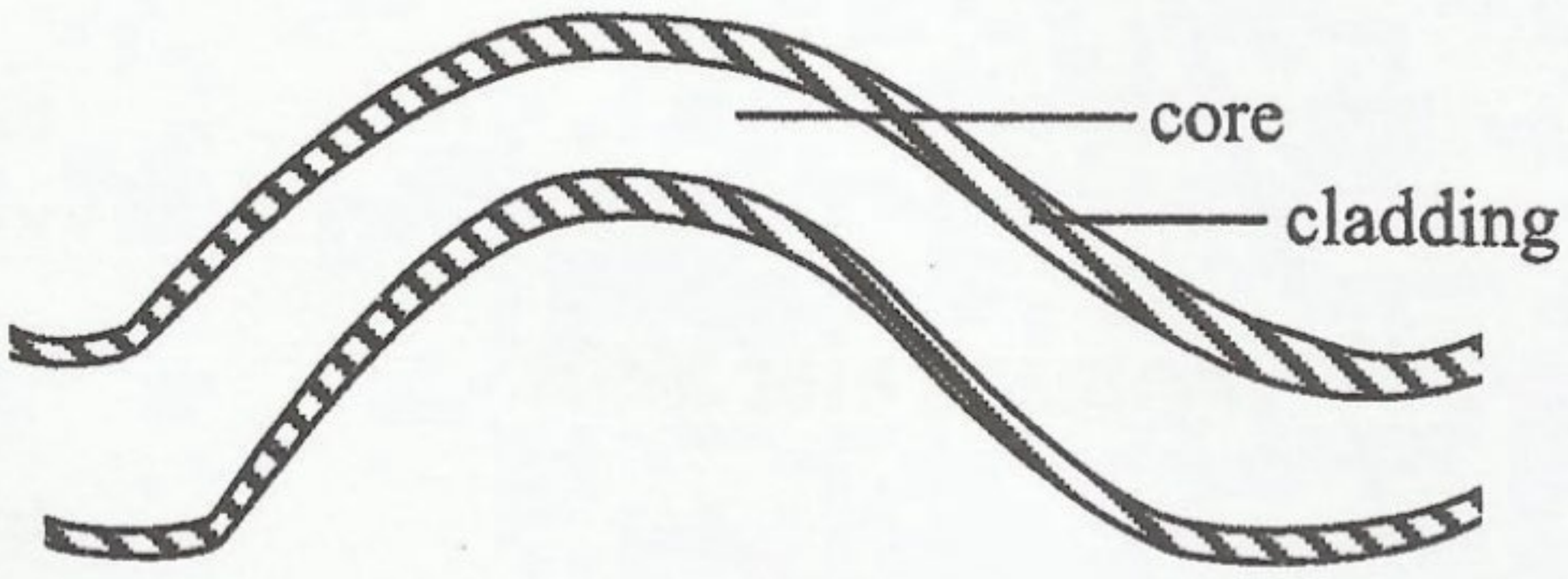

Fig.4.1

(ii) Explain why optical fibres are more preferred than electrical cables.

[6]

(c) Explain why the red colour is used in breakdown triangle reflectors. [2]

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

9188/3

PAPER 3

NOVEMBER 2015 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

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acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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Answer question 1 and any other 2 from the remaining questions.

1 (a) (i) State the base unit of temperature.

(ii) Boltzmann's constant, k, and Planck's constant, h, are related to Stefan's constant, δ, by the expression

$$\delta = \frac{ak^4}{h^3c^2},$$

where a is a dimensionless constant and c is the speed of light.

Determine the base units of δ.

(iii) State the limitation of using base units in the equation in **(ii)**. [5]

(b) (i) Define the terms *accuracy* and *precision*.

(ii) State and explain the error associated with precision.

(iii) The following results in Nkg^{-1} were obtained in an experiment to determine the earth's gravitational field strength, g:

8.6; 8.7; 8.8; 8.5; 8.2; 8.9

Discuss whether the results were precise and/or accurate. [6]

(c) **Fig.1.1** shows part of a car moving at 15 ms^{-1} on a level road. The wheel is of radius 0.30 m and has an angular velocity, ω, of 50 rad s^{-1}.

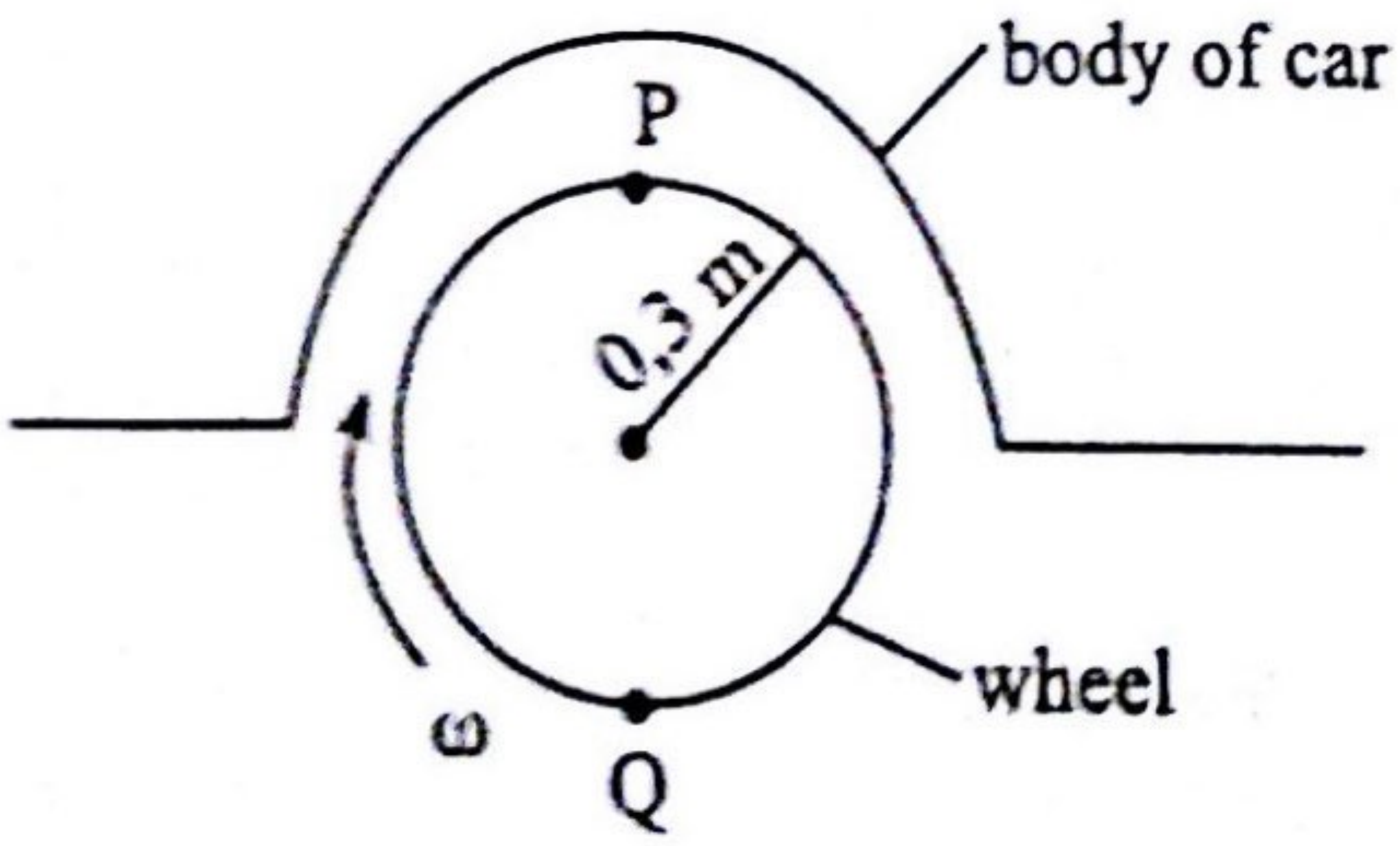

Fig.1.1

(i) Determine the minimum co-efficient of friction to avoid skidding given that the car is going round a curve of radius 200 m at 15 ms^{-1}.

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(ii) Point P is observed as moving at twice the velocity of the centre of the wheel while point Q is observed as momentarily at rest.

Explain these observations.

[5]

(d) The system shown in **Fig.1.2** is in equilibrium.

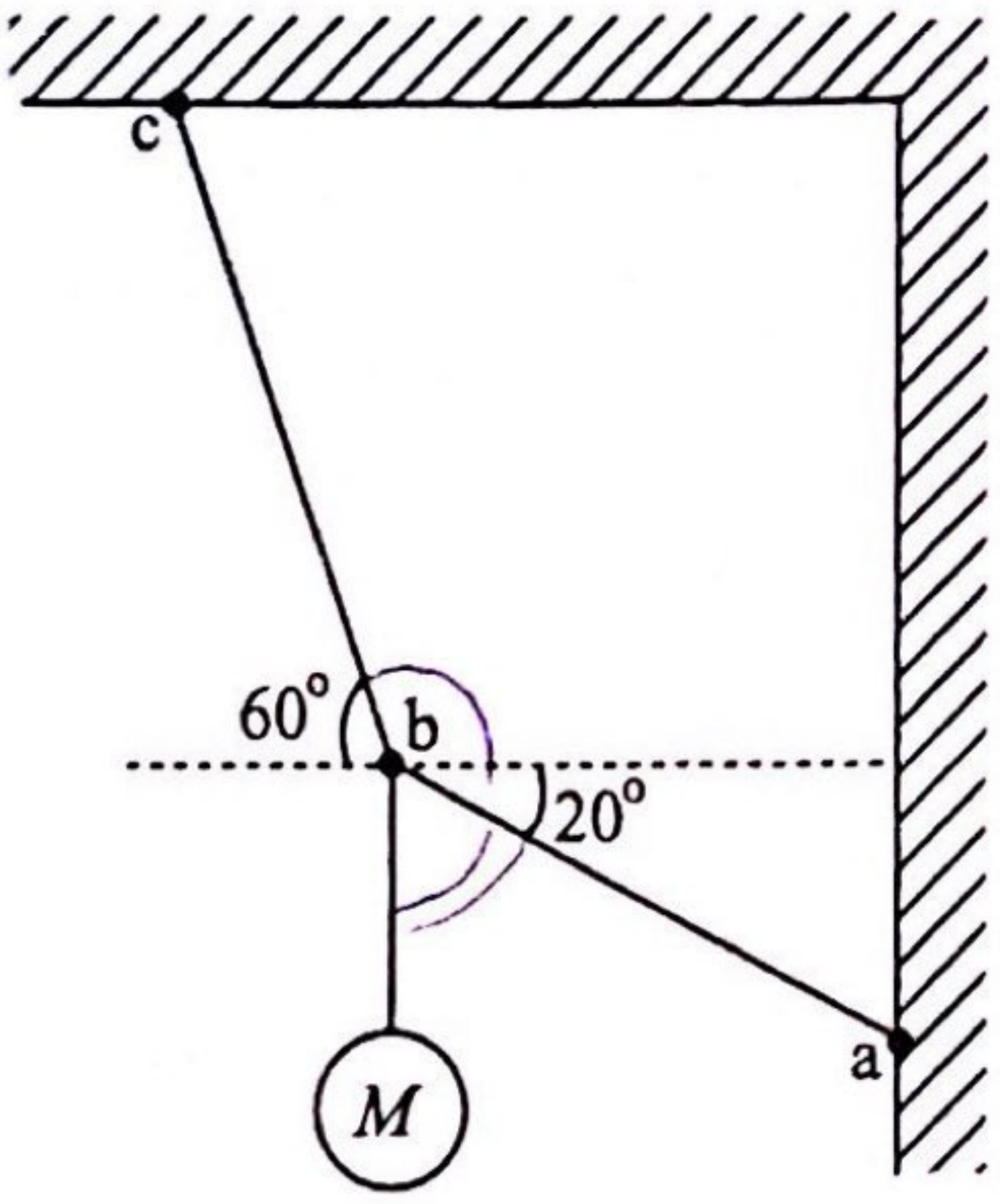

Fig.1.2

If $M = 2.0$ kg, find the magnitude of the tension in

(i) string ab,

(ii) string bc.

[4]

2 (a) Distinguish between a vector quantity and a scalar quantity. [2]

(b) A car travelling at 20 ms^{-1} due East turns and continues at 15 ms^{-1} due South.

(i) Draw a vector diagram to illustrate the

1. initial and the final velocity,

2. change in velocity.

(ii) Calculate the change in the

1. speed of the car,

2. velocity of the car.

[6]

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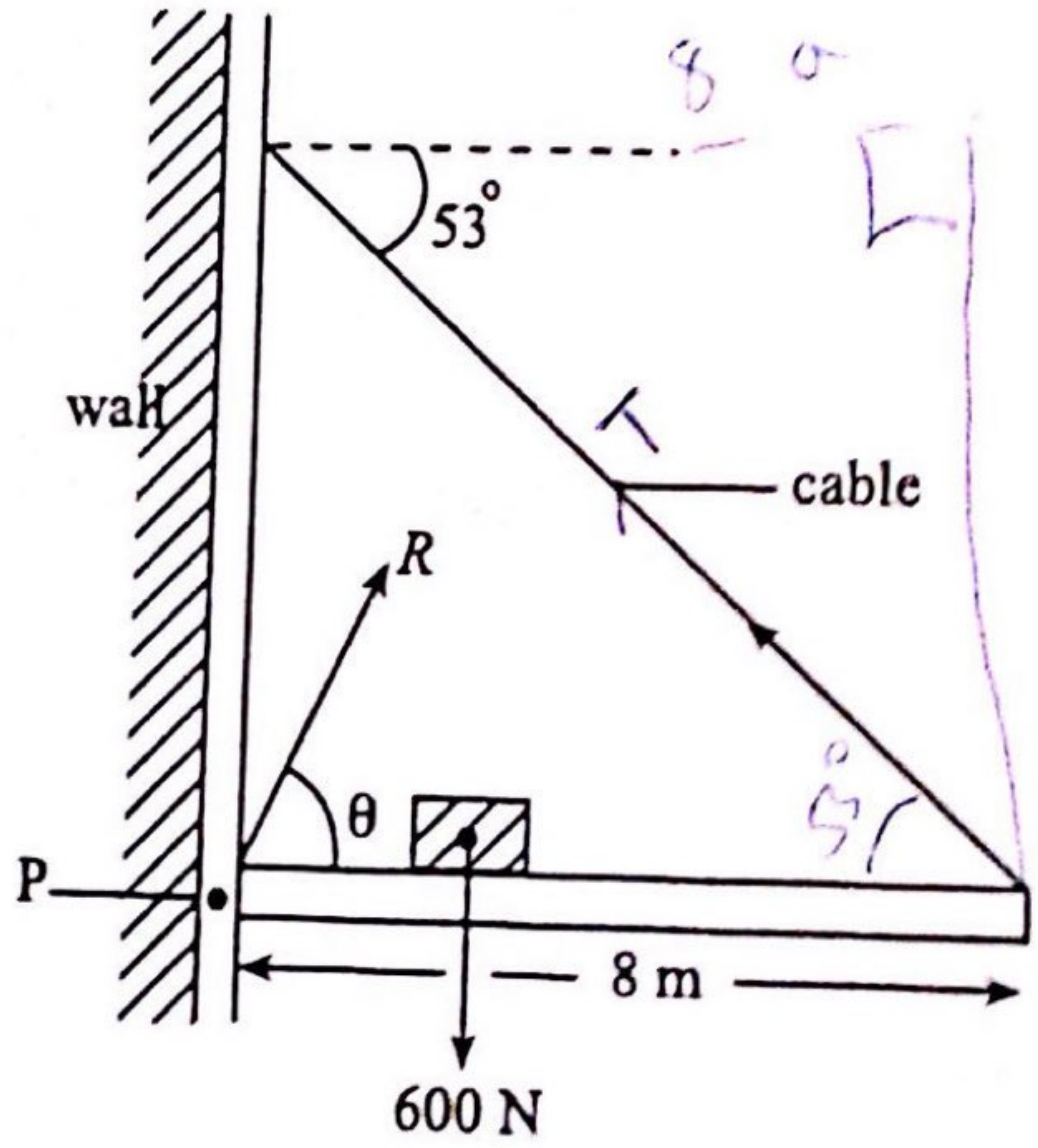
(c) Explain why the acceleration of an object may not be in the same direction as the velocity of the object. [2]

3 (a) (i) Define *a couple*.

(ii) State **two** conditions for a body to be in equilibrium.

[3]

(b) **Fig.3.1** shows a horizontal uniform beam of length 8 m and weight 200 N. The beam is pivoted at a wall with one of its ends connected to a metal cable of an angle of depression of 53°. A mass weighing 600 N is placed 2 m from the wall. A reaction force, R, acts at the pivot, P, at an angle, θ, to the horizontal.



cos

Fig.3.1

Calculate the

(i) tension in the cable,

(ii) reaction force, R,

(iii) angle θ.

[6]

(c) Give one example of everyday application of forces in equilibrium. [1]

4 (a) Define *gravitational field strength*. [1]

(b) A satellite is in a circular orbit of radius, r, about the earth of mass, M_E.

(i) Deduce an expression for the period of the satellite.

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(ii) A satellite of mass 500 kg is in circular orbit at a height of 2 000 km above the earth's surface. The radius of the earth is 6 400 km.

Calculate the

1. gravitational field strength at the height of 2 000 km,
2. orbital speed of the satellite. [7]

(c) Suggest why a geostationary satellite has a short lifespan. [2]

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C. B. MUTERO

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Ordinary Level

MARKING SCHEME

NOVEMBER 2015

PHYSICS **9188/3**

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1 (a) (i) kelvin (K) (Reject Wrong physics) B1

(ii) $[\delta] = \frac{J^4K^{-4}}{(J^3s^3)(m^2s^{-2})}$ ← ~~Reje~~ W.P. C1

$= Js^{-1}K^{-4}m^{-2}$ C1

Base units of $\delta = kg\,K^{-4}s^{-3}$ A1 Award answer mark if W-P is followed by correct answer ~~A1~~

(iii) ~~It~~ fails to check the presence of the constant a. Reject any other response not dealing with constant (a) B1

(b) (i) accuracy - degree by which the mean value is away from the true value AW B1

Accept idea of measure/closeness of mean value to t.V.

precision - degree of scatter of readings about their mean value AW B1

Accept definition with reference to instrument

(ii) random error Accept ~~de~~ idea of closeness/ spread/Scatter, B1

cause readings to be scattered about their mean. B1

(iii) Results were not accurate since their mean value of 8,63 Nkg^{-1} A1

is far from the true value of 9.81 N kg^{-1} ~~and~~ ~~not~~ precise. A1

Scatter of measured values is small

(c) (i) For no skidding ~~tan θ = μ.~~ (coefficient of friction). friction = centripetal force

$\mu mg = \frac{mv^2}{r}$

$~~\tan\theta~~ = \frac{v^2}{rg} = \frac{15^2}{(200)(9.81)}$ ~~B1~~ C1

$= 0.1147$

Accept $\mu = \frac{25}{218}$

$\therefore \mu_{min} = 0.1147$ Accept 1 s.f. A1

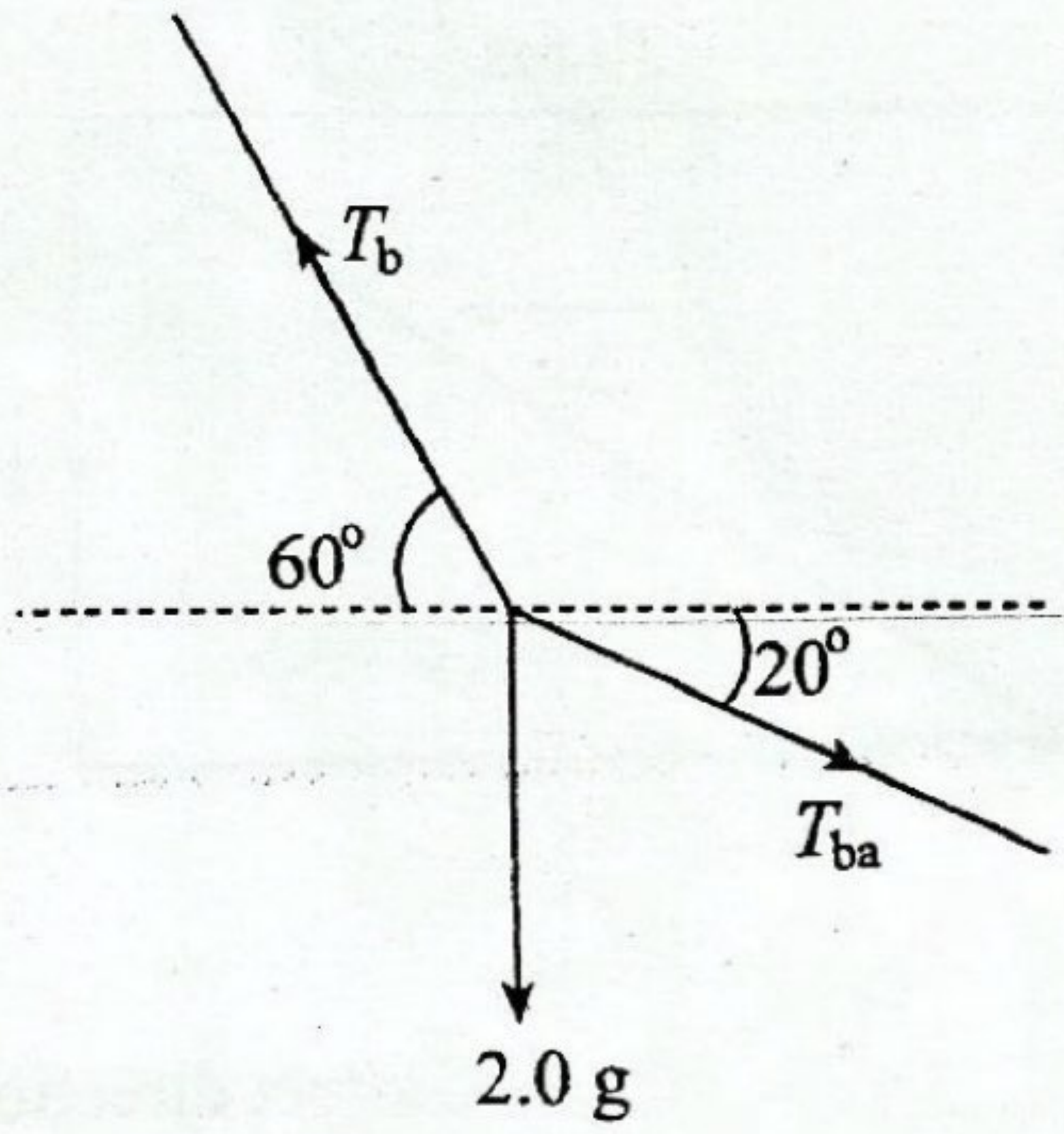
(ii) Wheel is rotating with forward velocity v, = 15 ms^{-1} and rotational velocity given by v = $r\omega$. B1

At P, centre velocity and rotational velocity or speed are in the same direction . B1

Resultant velocity = 30 ms^{-1} ~~B1~~

At Q, centre velocity and rotational velocity or speed are directly opposite. Resultant velocity = 0. B1

(d) (i)



By resolution

C1

$T_{bc}\cos 60 \quad = \quad T_{ba}\cos 20$

$T_{bc} \quad = \quad 1.88\ T_{ba}$ ~~C1~~

$2.0 \times 9.81 \quad = \quad T_{bc}\ \text{Sin}\ 60 - T_{ba}\ \text{Sin}\ 20$ C1

$= \quad 1.29T_{ba}$

$\therefore T_{ba} \quad = \quad \dfrac{2.0 \times 9.81}{1.29} = 15.3\ \text{N}$ Accept 15.2 or 2 s.f. A1

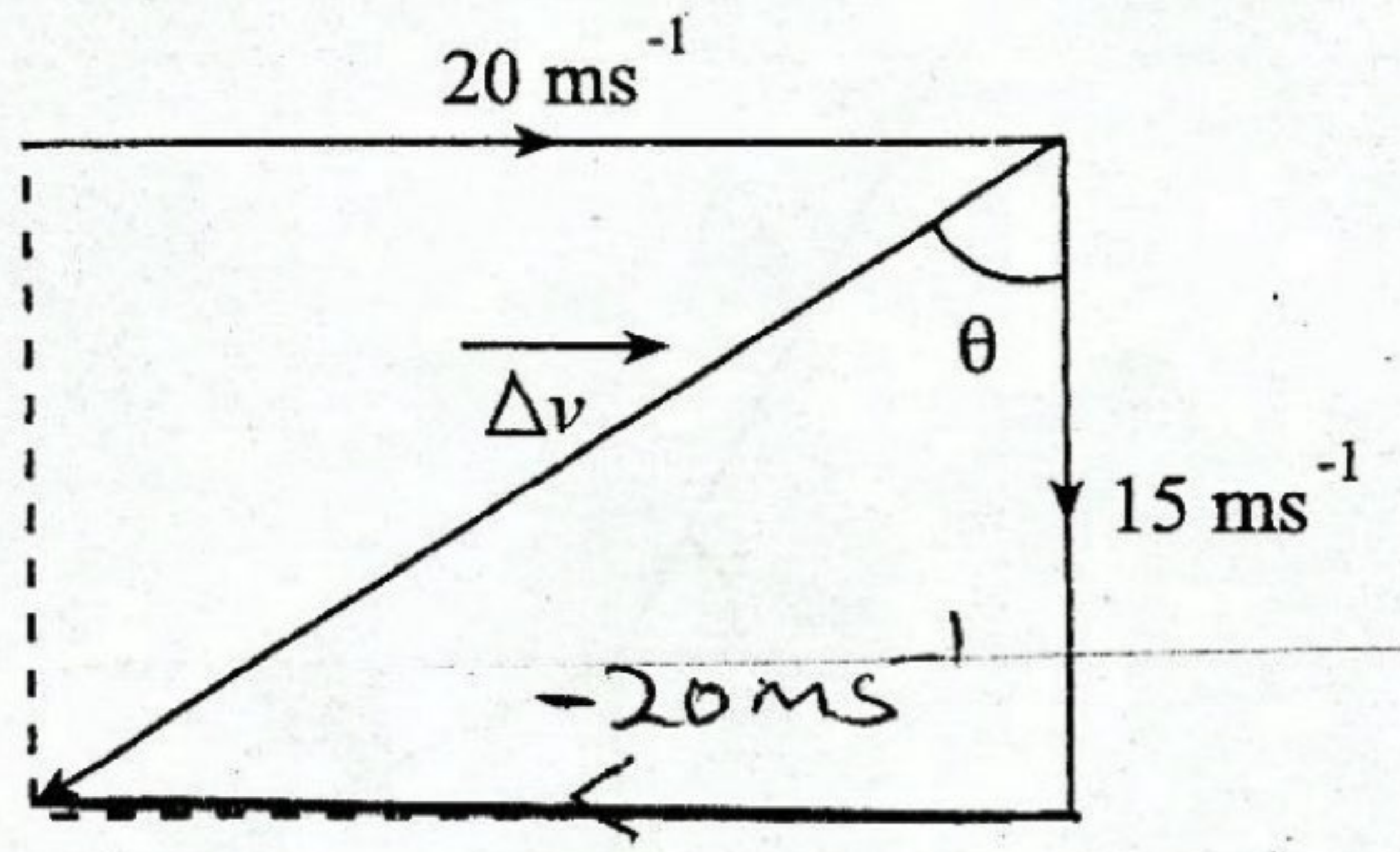
(ii) $T_{bc} \quad = \quad 1.88 \times 15.3$ Accept 28.6N or 29N to 2s.f.

$= \quad 28.7\ \text{N}$ A1

2. (a) Vector has a direction AW B1

Scalar has no direction AW B1

(b) (i)



1. Correct directions of the 20 ms^{-1} & 15ms^{-1} on diagram B1

2. ΔV on diagram pointing south-Westal direction. B1

(ii)

1. change in speed = 15 – 20

= (–)5ms^{-1} A1

Ignore minus sign

2. change in velocity $\overline{\Delta V}$ = $\sqrt{20^2 + 15^2}$ C1

= 25 ms^{-1} A1

at angle θ = $\tan^{-1}\left(\frac{20}{15}\right)$ or $\tan^{-1}\left(\frac{15}{20}\right)$

= 53.1° (to the vertical) or 36.9° to the horizontal A1

(c) Acceleration is change in velocity per unit time. B1

∴ Acceleration has the same direction as the change in velocity/AW Accept examples with explanation. B1

3 (a) (i) a pair of forces equal in size but opposite in direction B1
which act on a single body to cause rotation B1

(ii) Resultant force is zero / AW B1

Resultant torque is zero / AW B1

(b) (i) 8 T sin 53° = (600 x 2) + (200 x 4) C1

$T = \frac{2\,000}{8 \sin 53^\circ}$

$= 313$ N A1

(ii) Horizontal component $R_h = 313 \cos 53^\circ$ C1

$= 188$ N ~~C1~~

Vertical component $R_v = 600 + 200 - 313 \sin 53^\circ$ C1

$= 550$ N ~~A1~~

Reaction force R $= \sqrt{550^2 + 188^2}$

$= 581$ N A1

(iii) $\theta = \tan^{-1}\left(\frac{550}{188}\right)$

$= 71.1^\circ$ A1

(c) Use of a beam balance Accept definition in symbols defined A1

4 (a) Force per unit mass B1

(b) (i) $\frac{mv^2}{r} = \frac{GM_E m}{r^2}$

$\frac{v^2}{r} = \frac{GM_E}{r^2}$ ~~C1~~ B1

$v^2 = \frac{GM_E}{r}$

Also $v = \frac{2\pi r}{T}$ / $W = \frac{2\pi}{T}$ ~~C1~~ B1

$\therefore T = 2\pi\sqrt{\frac{r^3}{GM_E}}$ A1

(ii) 1. $g_1 = \frac{R_E^2}{(R_E+h)^2} \times g$

$= \left(\frac{6\ 400}{8\ 400}\right)^2 \times 9.81$ C1.

Follow their candidate's working

$= 5.69\ Nkg^{-1}$ Accept 5.67 Nkg^{-1}

Reject answer in ms^{-2} ~~with the units of m~~

2. $v^2 = g_1 r$

$= 5.69 \times 8\ 400 \times 10^3$ C1

mind ecf

$v = 6.92 \times 10^3\ ms^{-1}$ A1

(c) Satellite needs fuel to keep it in orbit and has to be replaced when fuel runs out/AW/other plausible reason. B1 B1

Accept:- Satellite lifespan is shortened by friction, loss of energy, technical, ~~faults~~ mechanical & physcal faults, effects of the sun (eclipse) B1

- The satellite has to be replaced when these effects occur B1

T2

Satellites

The life span of satellites depends largely on their size, or to be precise, it depends on how much liquid fuel they carry aboard. The liquid fuel is used to operate small rocket engines on the satellites. The rocket engines are very important for the satellite because there are three types of forces acting on the satellite in space causing the satellite to deviate from its course.

- before the satellite runs out of fuel , the ground station performs one last manoeuvre to send the satellite to a place called (the satellite graveyard) , it's an orbit around the earth used to retire old useless satellites & they become junk on space , a growing problem , this is when in it come to satellites using the geostationary orbit , for satellites using lower orbits they may be put on re-entry course so they burn before they reach the earth.

- Satellites are big money and made to last but it all depends on the type and use. A satellite's life can end by having it's orbit decayed (or moved by small on board rockets into the atmosphere) and then burned up or it can be simply left in place (becoming space junk a growing problem).

- Life span depends on the spacecraft, besides fuel also on technical failure of electrical components assembled in the satellites and equipment in Earth base stations. If the satellite runs out of fuel and when mechanical and electrical failures occur then it can not station keep and is basically debris.

Another likely scenario that will result in super-syncing a satellite would be loss of mission capability. Again, depending on the severity of the anomaly, the satellite would either continue on with mission, be placed in storage at super-sync or be decommissioned after being super-synced. There is a slight chance that with the loss of mission capability, the customer will choose to keep the satellite in storage at the super-sync orbit to perform longevity studies on the satellite or further testing that can provide insight to other satellites in the constellation or for future builds. The most likely scenario would be to decommission the satellite since the purpose of any satellite is to perform the mission it was designed for. Loss of mission capability includes loss of the payload or payloads, loss of power to the payload, loss of the ability to transmit mission data, loss of the ability to maintain mission attitude.

Once in super-sync and in storage mode, the extended life of the satellite can last for years, even lasting as long as the original design life. This is due to minimal use of fuel and most equipment in an off-state or a safe-state. At this stage of a geo-satellite, the decision to decommission is based on the ability to maintain the satellite in storage and its capability to perform mission when needed. Fuel maintenance has become less significant, since the satellite has already been taken out of the mission orbit. The ability to maintain power levels and attitude become more significant. A geo-satellite will have to be able to maintain power levels while in sunlight and through eclipse. A geo-satellite will experience 2 seasons of eclipse a year that can last anywhere from 30 minutes to 1 hour daily.

Because of this non-daily eclipse throughout the year, the battery will deteriorate more quickly than a low earth orbiting satellite and require more maintenance as the satellite ages. Either the loss of the batteries ability to maintain charge or the excess maintenance of the batteries is both reasons to decommission.

Since the attitude control systems is so complex, various anomalies can result in difficulties in maintaining attitude or maintaining momentum. So losing either capability will affect performing mission and thus can result in decommissioning a satellite.

Minor factors include the ability to maintain communication and maintain operable temperatures. For communication, most satellite design will have enough communication back up in both command plink and telemetry downlink. So communication is usually not a major factor, but if enough anomalies compile on top of each other, then the difficulty of communicating to the satellite might be cause to decommission a satellite. And losing the ability to transmit mission data is obviously a life limiting factor, as mentioned earlier. As for temperatures, as the satellite ages, thermal properties diminish, resulting in higher than ideal temperatures. Higher temperature can affect mission by changing the

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(a) (i) kelvin (K) (Reject Wrong physics) B1

(ii) $[\delta] = \frac{J^4K^{-4}}{(J^3s^3)(m^2s^{-2})}$ ~~Reje~~ W.P. C1

$= Js^{-1}K^{-4}m^{-2}$ C1

Base units of $\delta = kg\,K^{-4}\,s^{-3}$ A1 Award answer mark if W.P is followed by correct answer ~~A1~~

(iii) ~~It~~ fails to check the presence of the constant a. Reject any other response not dealing with constant (a) B1

(b) (i) accuracy - degree by which the mean value is away from the true value AW B1

Accept idea of measure/closeness of ~~mean~~ value to ~~t~~ T.V.

precision - degree of scatter of readings about their mean value AW B1

Accept definition with reference to instrument

(ii) random error Accept ~~the~~ idea of closeness/ spread/Scatter, B1

cause readings to be scattered about their mean. B1

(iii) Results were not accurate since their mean value of 8,63 Nkg^{-1} A1

is far from the true value of 9.81 N kg^{-1} and ~~not~~ precise. ~~B~~A1

Scatter of measured values is small

(c) (i) For no skidding ~~$\tan\theta = \mu$~~ (coefficient of friction). friction = centripetal force

$\mu mg = \frac{mv^2}{r}$

$$\cancel{\tan\theta} = \frac{v^2}{rg} = \frac{15^2}{(200)(9.81)}$$ ~~B~~ C1

$= 0.1147$

Accept $\mu = \frac{25}{218}$

$\therefore \mu_{min} = 0.1147$ Accept 1 s.f. A1

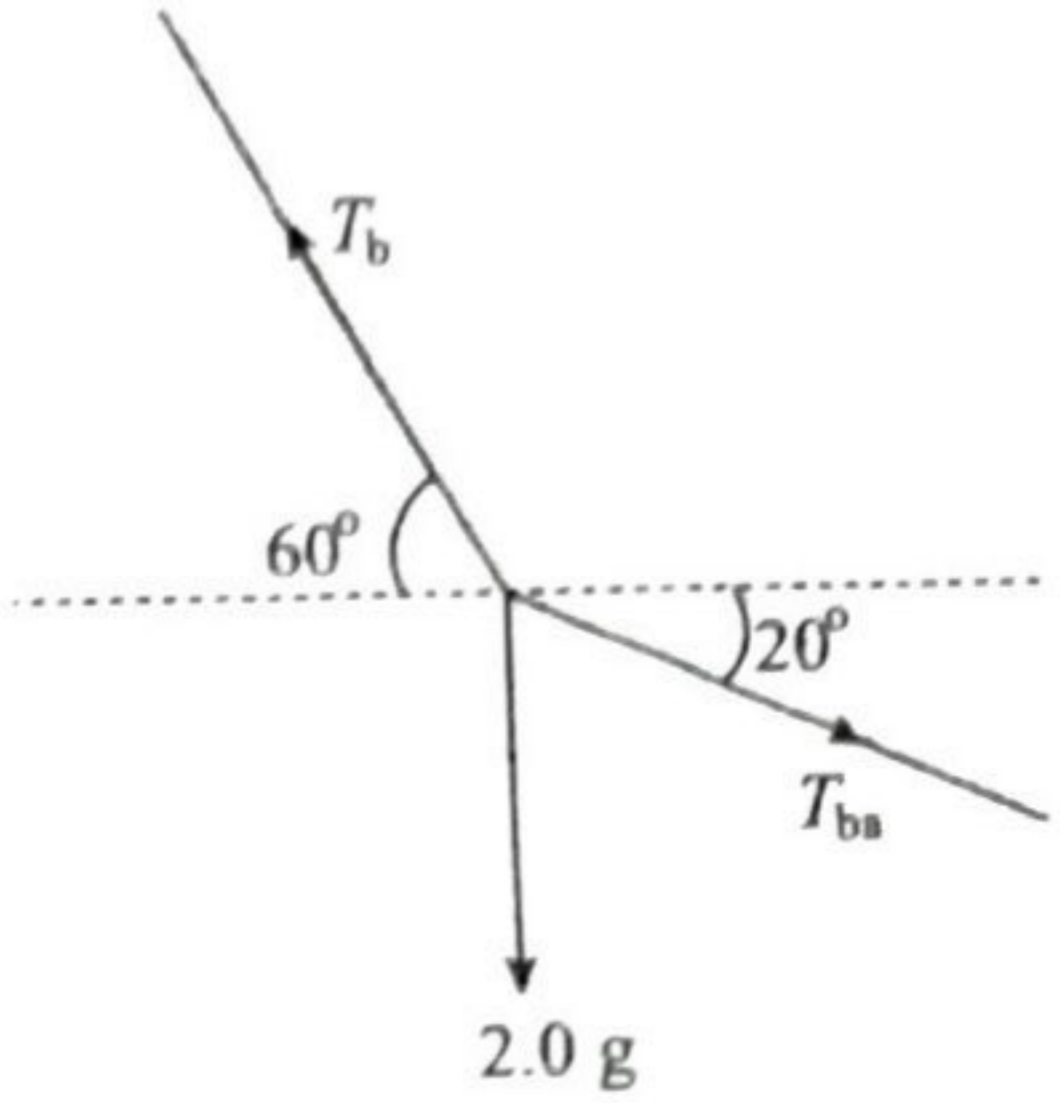
(ii) Wheel is rotating with forward velocity v, = 15 ms^{-1} and rotational velocity given by v = $r\omega$. B1

At P, centre velocity and rotational velocity or speed are in the same direction . B1

Resultant velocity = 30 ms^{-1} ~~B1~~

At Q, centre velocity and rotational velocity or speed are directly opposite. Resultant velocity = 0. B1

(d) (i)



By resolution

C1

$T_{bc}\cos 60 = T_{ba}\cos 20$

$T_{bc} = 1.88\ T_{ba}$ ~~C1~~

$2.0 \times 9.81 = T_{bc}\ \text{Sin}\ 60 - T_{ba}\ \text{Sin}\ 20$ C1

$= 1.29T_{ba}$

$\therefore T_{ba} = \dfrac{2.0\times 9.81}{1.29} = 15.3\ \text{N}$ Accept 15.2 or 2 s.f. A1

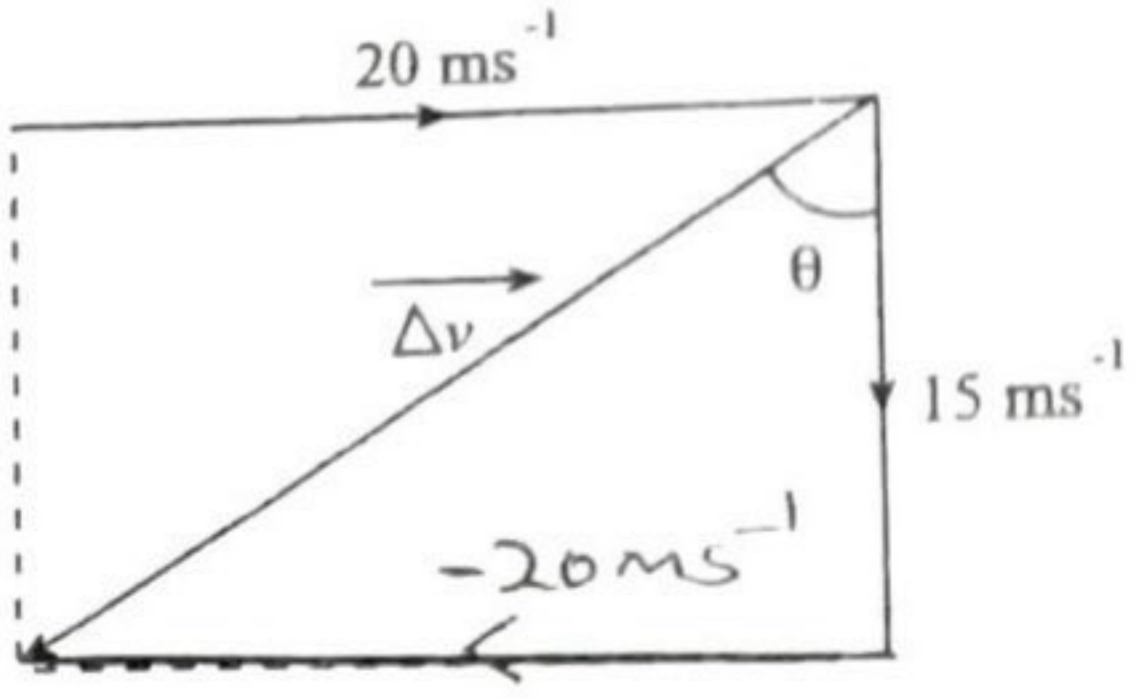
(ii) $T_{bc} = 1.88 \times 15.3$ Accept 28.6N or 29N w 2sf

$= 28.7\ \text{N}$ A1

2 (a) Vector has a direction AW B1

Scalar has no direction AW B1

(b) (i)



1. Correct directions of the $20\,ms^{-1}$ & $15\,ms^{-1}$ on diagram B1

2. ΔV on diagram pointing south-Westal direction. B1

(ii)

1. change in speed $= 15 - 20$

$= (-)5\,ms^{-1}$ A1

Ignore minus sign

2. change in velocity $\overline{\Delta V} = \sqrt{20^2 + 15^2}$ C1

$= 25\,ms^{-1}$ A1

at angle $\theta = \tan^{-1}\left(\frac{20}{15}\right)$ or $\tan^{-1}\left(\frac{15}{20}\right)$

$= 53.1°$ (to the vertical) or 36.9° to the horizontal A1

(c) Acceleration is change in velocity per unit time. B1

∴ Acceleration has the same direction as the change in velocity/AW Accept examples with explanation B1

3 (a) (i) a pair of forces equal in size but opposite in direction B1
which act on a single body to cause rotation B1

(ii) Resultant force is zero / AW B1

Resultant torque is zero / AW B1

(b) (i) 8 T sin 53° = (600 x 2) + (200 x 4) C1

$$T = \frac{2\,000}{8\sin 53^\circ}$$

$$= 313 \text{ N}$$ A1

(ii) Horizontal component R_h = 313 cos 53° C1

= 188 N ~~C1~~

Vertical component R_v = 600 + 200 – 313 sin 53° C1

= 550 N ~~A1~~

Reaction force R = $\sqrt{550^2 + 188^2}$

= 581 N A1

(iii) $\theta = \tan-1\left(\frac{550}{188}\right)$

$= 71.1^\circ$ A1

(c) Use of a beam balance A1

Accept definition in symbols defined

4 (a) Force per unit mass B1

(b) (i) $\frac{mv^2}{r} = \frac{GM_E m}{r^2}$

$\frac{v^2}{r} = \frac{GM_E}{r^2}$ ~~C1~~ B1

$v^2 = \frac{GM_E}{r}$

Also $v = \frac{2\pi r}{T}$ / $W = \frac{2\pi}{T}$ ~~C1~~ B1

$\therefore T = 2\pi\sqrt{\frac{r^3}{GM_E}}$ A1

(ii) 1. $g_1 = \frac{R_E^2}{(R_E+h)^2} \times g$ Follow thru candidate's working

$= \left(\frac{6\ 400}{8\ 400}\right)^2 \times 9.81$ C1

$= 5.69\ \text{N kg}^{-1}$ Accept 5.67 N kg^{-1}

Reject answer in ms^{-2} ~~with units of m~~

2. $v^2 = g_1 r$ mind ecf

$= 5.69 \times 8\ 400 \times 10^3$ C1

$v = 6.92 \times 10^3\ \text{ms}^{-1}$ A1

(c) **Satellite needs fuel to keep it in orbit and has to be replaced when fuel runs out/AW/other plausible reason.** B1 B1

Accept :- Satellite lifespan is shortened by friction, loss of energy, technical, ~~faults~~, mechanical & physcal faults, effects of the sun (eclipse) B1

- The satellite has to be replaced when these effects occur B1

+35

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

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PHYSICS **9188/3**

PAPER 3

JUNE 2016 SESSION 50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1.**

This question paper consists of 7 printed pages and 1 blank page.

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Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

gravitational potential, $\phi = -\frac{Gm}{r}$

refractive index, $n = \frac{1}{\sin C}$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

electric potential, $V = \frac{Q}{4\pi\epsilon_0 r}$

capacitors in series, $1/C = 1/C_1 + 1/C_2 + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

energy of charged capacitor, $W = \frac{1}{2}QV$

alternating current/voltage, $x = x_0 \sin \omega t$

hydrostatic pressure, $p = \rho gh$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2\rangle$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

critical density of matter in the Universe, $\rho_0 = \frac{3H_0^2}{8\pi G}$

equation of continuity, $Av = \text{constant}$

Bernoulli equation (simplified), $p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$

Stokes' law, $F = Ar\eta v$

Reynolds' number, $R_e = \frac{\rho v r}{\eta}$

drag force in turbulent flow, $F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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*Answer **question 1** and any other 2 from the remaining questions.*

1 **(a)** **(i)** State the SI unit of length.

(ii) The SI unit of length is defined as the length corresponding to 1 650 763.73 wavelengths of the light emitted by krypton 86 (Kr-86) atoms. The SI unit of time is defined as the duration of 9 192 631 770 periods of a particular radiation associated with atoms of caesium 133 (Cs-133).

Calculate

1. the wavelength of light from Kr-86.
2. the period of the radiation from Cs-133.
3. the frequency of the radiation from Cs-133.

(iii) Suggest the

1. colour of the light from Kr 86 atoms,
2. region of the electromagnetic spectrum which includes the radiation from Cs-133.

[6]

(b) **(i)** Write down the decimal equivalent of the

1. pico,
2. deci.

(ii) The pressure, P, of an ideal gas is given by the equation

$$P = \frac{1}{3}\rho < c^2 >$$

where ρ is the density and $< c^2 >$ is the mean square speed of the gas.

Use base units to check homogeneity of the equation.

[5]

(c) **(i)** Explain the terms *accuracy* and *precision*.

(ii) Explain why precise readings are **not** necessarily accurate readings.

[4]

(d) **(i)** State the **three** properties of coherent wave sources that produce an observable interference pattern.

(ii) Explain the term *destructive interference*.

[5]

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2 **(a)** **(i)** Define *work.*

(ii) Show that

power = force × velocity.

[3]

(b) **Fig. 2.1** shows a mineral ore dropping onto a long conveyor belt moving at a speed of 5 ms^{-1}. The mass of the conveyor belt is 50 kg.

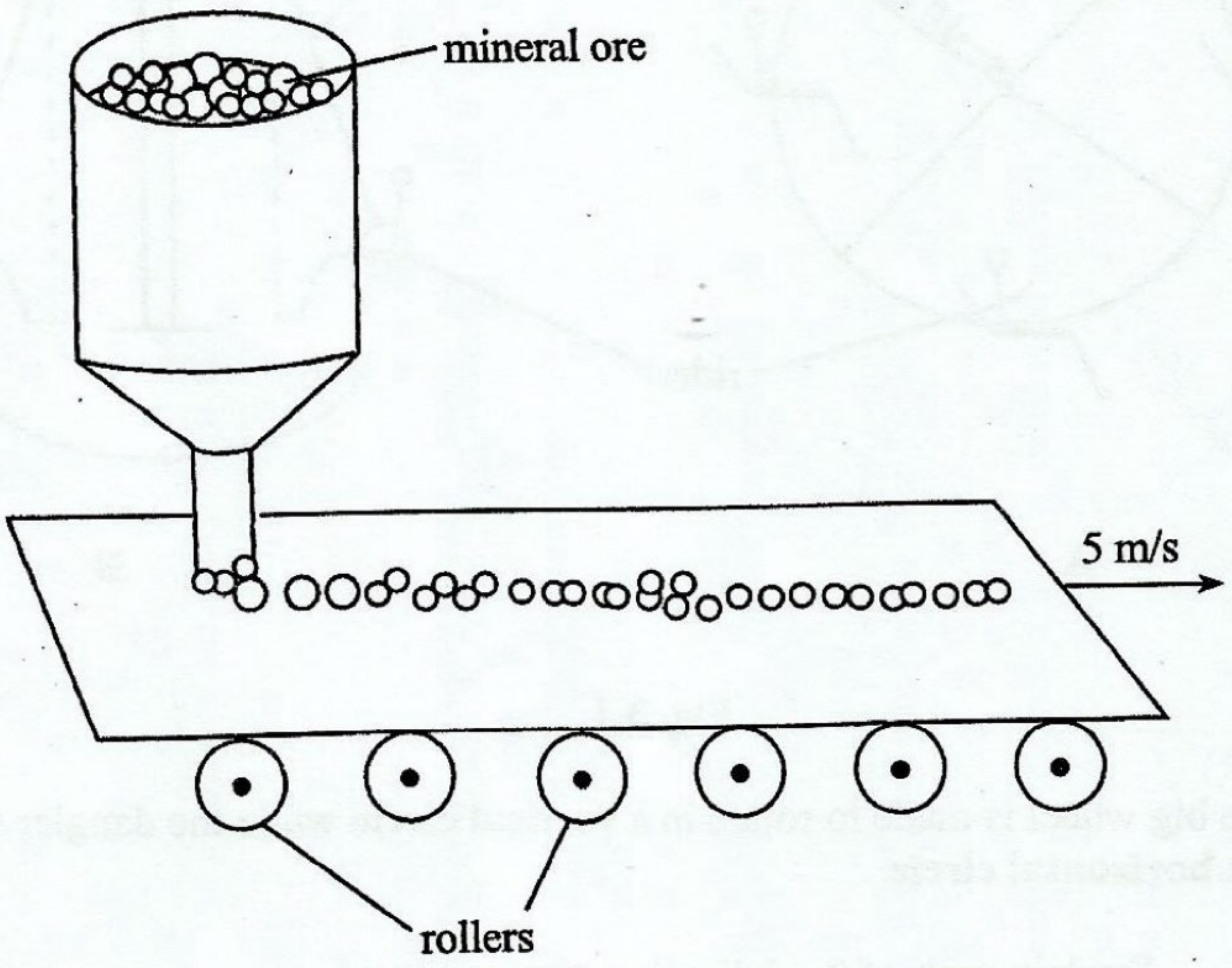

Fig. 2.1

The mineral ore is falling onto the belt at a rate of 750 kgs^{-1}.

(i) Calculate the

1. net force required to maintain the steady speed of the belt,
2. power used to move the belt.

(ii) Explain why in practical situations, the power needed to maintain steady speed is greater than the value calculated in **(b)** **(i)** 2.

[7]

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3 **(a)** Define *centripetal force*. [2]

(b) Two popular attractions at an amusement park are the big wheel and the dangler which are shown in **Fig. 3.1 A** and **B** respectively.

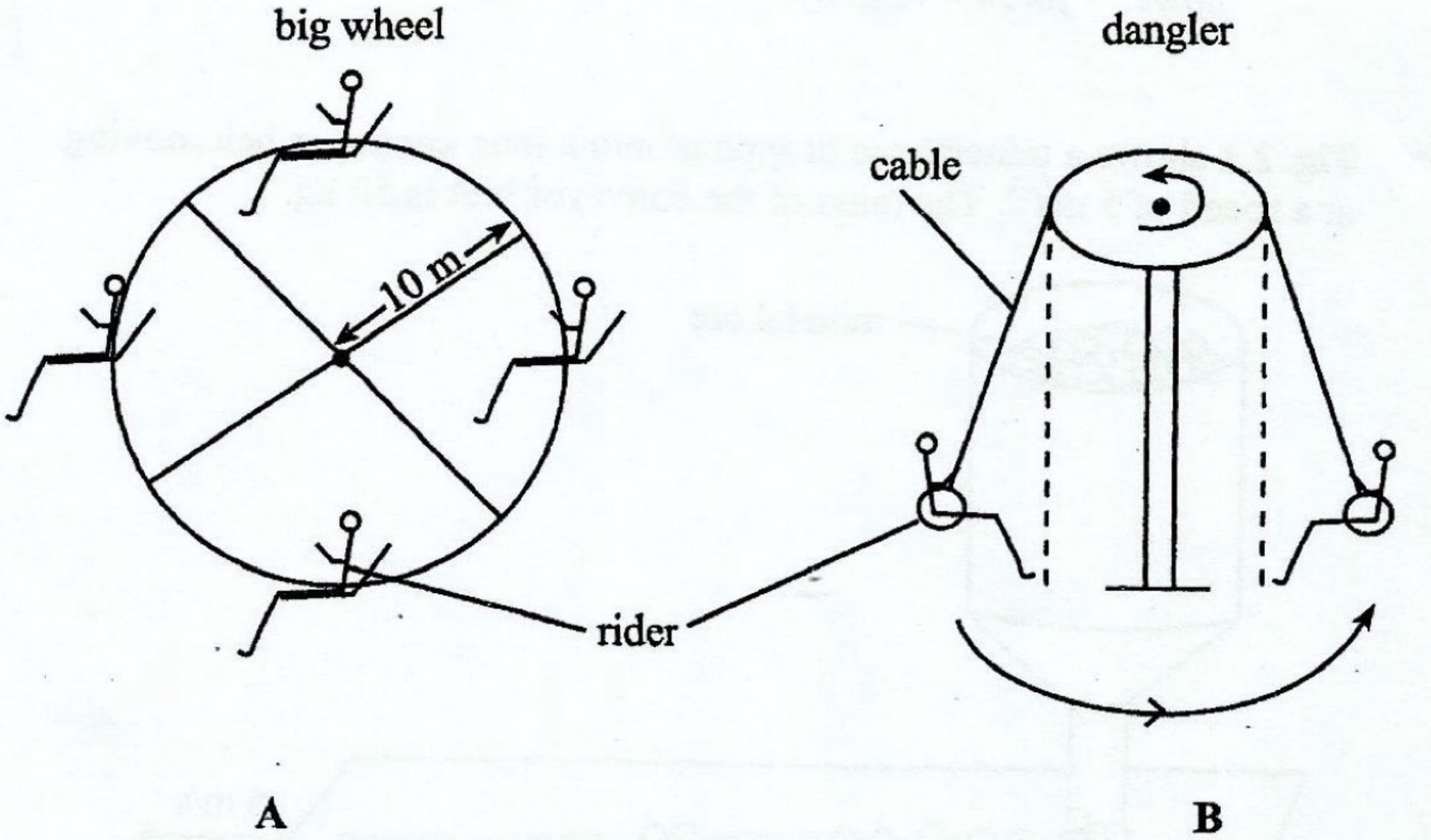

Fig. 3.1

The big wheel is made to rotate in a **vertical circle** while the dangler rotates in a **horizontal circle**.

(i) Explain each of the following observations:

1. when the dangler rotates the riders swing outwards and upwards

2. a rider on the big wheel feels heavier when at the bottom and lighter when at the top

(ii) Show that, for safety reasons, the rotational speed of the big wheel must not exceed 0.99 rads^{-1}.

[6]

(c) Describe and explain a possible danger of rotating the dangler at high speeds. [2]

4 **(a)** Distinguish between *interference* and *diffraction*. [2]

(b) **(i)** Describe how stationary waves are produced.

(ii) Two loudspeakers placed 50 m apart facing each other are connected to a signal generator that produces sound of frequency 160 Hz. A microphone is connected to a C.R.O and moved from one speaker to the other detecting nodes and antinodes. The speed of sound in air is 320 ms^{-1}.

Calculate the number of nodes and antinodes detected.

[6]

(c) Describe the effect of interference and the effect of diffraction in the action of a grating. [2]

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1 (a) (i) ([length] =) metre/m /AW

(ii) 1. $\lambda = \frac{1}{1\,650\,763{,}73}$

$= 6{,}06 \times 10^{-7}\text{m} = 606\text{ nm}$ Accept 2 s.f. A1

2. $T = \frac{1}{9\,192\,631\,770}$

$= 1{,}09 \times 10^{-10}\text{s} = 109\text{ps}$ A1

3. $f \neq \frac{1}{1} \times 9.19 \times 10^{9}\text{Hz}$ $\frac{1}{1.09 \times 10^{-10}}$ Accept 2 [illegible]

$= 9.19\text{ GHz}$ A [illegible] A1

(iii) 1. Red/orange B1

2. Microwave / Infrared B1

(b) (i) 1. 10^{-12} or 0.000 000 000 001 A1

2. 10^{-1} or 0.1 A1

(ii) LHS $[P] = (\text{Kgms}^{-2})(\text{m}^{-2})$

$= \text{kgm}^{-1}\text{s}^{-2}$ C1

RHS $[\rho < c^2 >] = (\text{kgm}^{-3})(\text{m}^2\text{s}^{-2})$

$= \text{kgm}^{-1}\text{s}^{-2}$ C1

Both sides have the same units A1

(c) (i) accuracy – describes how well the results of an experiment agree with the standard value / AW idea of degree B1

Precision – exactness of a measurement/closeness of measurements to the mean (AW) idea of degree B1

(ii)
- readings can be obtained irrespective of the wrongly or correctly calibrated instrument AW B1
- readings can be close to each other but far from the true value due to systematic error B1

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(d) (i) Coherent sources - sources with constant phase difference between them B1

- emit waves with same frequency/ wavelength B1

- to be close to each other B1

- emit waves of the same amplitude B1

Max 3.

(ii) Destructive interference - path difference between 2 coherent waves $n + \frac{\lambda}{2}$, where n = 0; 1; 2;... /AW. B1

- trough + crest; B1

- waves reach the same point, out of phase by $\overline{\pi}$ radians and cancel each other to give minimum amplitude /AW. B1

Max - 2

(a) (i) Product of force and distance moved in the direction of the force B1

(ii) Power = Work ÷ time

$$\text{Force} \times \frac{\text{distance}}{\text{time}}$$ C1

$$\text{But } \frac{\text{distance}}{\text{time}} = \text{velocity}$$ C1

Hence Power = force × velocity A0

(b) (i) 1. Force = rate of change of momentum [redacted]

$$= \frac{dp}{dt}$$ A =

$$= v\frac{dm}{dt}$$ C1

= 5x750 C1

= 3750N A1

2 P = Fv

= 3 750 × 5 C1

= 18 750 W A1

(d) Velocity of belt drops due to inertia of the mineral ore dropping onto it that tends to retard the belt/AW

energy is used to accelerate it again/work is done B

some energy is used to rotate the rollers and to overcome friction B

Max 2

(a) Resultant force acting on an object causing it to move in a circular path; /AW B1

towards the centre of the circle/AW; centripetal force = $\frac{mv^2}{r}$ B1

(b) (i) 1. So that the horizontal component of the tension provides centripetal force / and vertical component of tension to balance weight(mg) B1

2. At B: Reaction = weight + centripetal force (A) Diagram B1

At T: Reaction = Weight – centripetal force B1

(ii) Reaction ≥ 0 B

$mg - mrw^2 \geq 0$ $mg - \frac{mv^2}{r} \geq 0$ C

$g \geq rw^2$ | $g \geq \frac{v^2}{r}$ or $v^2 \geq gr$

$w \leq \sqrt{}$

$w \leq \sqrt{\frac{9.81}{10}}$ C

$w \leq 0.99\ rads^{-1}$

(c) Cable may break

due to high tension needed to provide centripetal force, B

If definitions are used; proper definition for difference must be clear.

4 (a) Interference involves superposition of waves on two different wavefronts; while diffraction involves superposition of waves from different parts of the same wavefront; / AW or Plausible answer. B1 B1

(b) (i) Stationary waves are produced by the superposition of two waves; B1
with the same amplitude, frequency and velocity; B1
moving in opposite directions; B1

(ii) $V = f\lambda$

$$\lambda = \frac{320}{160} = 2\text{m}$$ C1

Number of nodes = 50 A1

Number of antinodes = 51 A1

(c)
- interference produces interference pattern, B1
- diffraction produces diffraction envelope in which interference fringes are located B1

interference fringes are reduced to line fringes by diffraction grating. B1

Max 12

M.M

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Back credit - BC

B.C for numerical values

1 (a) (i) zero-error = 0.05 cm — Ignore absolute error in the readings. C1

reading = (4.48 ± ~~0.01~~) cm ~~Both correct~~ B1

(ii) 1. diameter = (4.48 – 0.05) ± 0.01) cm

= <u>(4.43 ± 0.01)</u> cm A1

2. Volume = $\pi r^2 l = \dfrac{\pi d^2 l}{4}$

— Accept 3.s.f. = $\frac{\pi}{4}(4.43^2)(25.0)$ ~~cm²~~ C1

= 385.33 cm³ Ignore units C1

~~error in~~ reject ± 0,005 in rulers if using r = 2,215 out of range error DONE

$\Delta V = \left(\dfrac{2\Delta d}{d} + \dfrac{\Delta l}{l}\right)(\text{Volume})$ Accept e.c.f in the error of the diameter. — No e.c.f if within the same part

$= \left(\dfrac{2 \times 0.01}{4.43} + \dfrac{1}{250}\right)(385.33)\ \text{cm}^2$ C1

= 3.281 cm³

∴ V = (385 ± 3) cm³ A1

W precision – values compared to their mean / Accuracy – mean values compared to True Value

(b) (i) precision is degree of closeness of value(s) to mean value while accuracy is closeness of mean value to true value. B1 B1

® precision is when readings are close to the mean & accuracy is when mean is close to true value

association of precision to random error – accuracy to systematic.

(ii) Set A: precise but not accurate A/W B1

Set B: accurate but not precise B1

(c) (i) (States that whenever) two waves are travelling meet/interact/overlap in the same region the total displacement at (any point) is equal to the vector sum of their individual displacements at that time B1 B1

accept sum of Amplitudes

resultant displacement is vector/algebraic sum

(ii) $V = f\lambda$

$\therefore\ \lambda = \dfrac{330}{1320}$

= 0.25 m — Ignore units C1

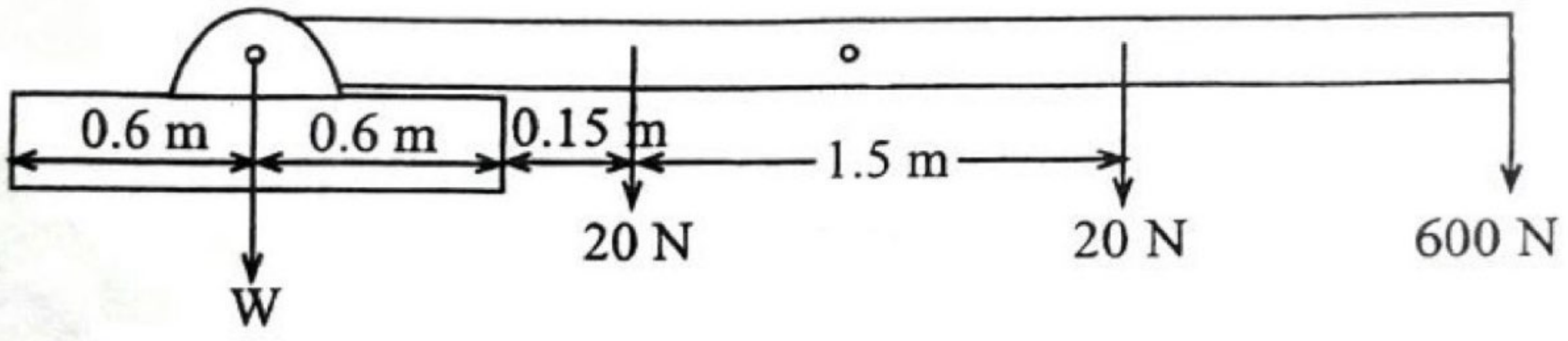
i.e distance between A and Z = $\dfrac{\lambda D}{a}$

$$= \frac{0.25 \times 7}{1.5}$$ C1

$= 1.17$ m Accept 1 sf A1

(d) (i) Product of the force and its perpendicular distance from pivot to its line of action) / accept turning effect of a force
accept expression with terms defined B1

(ii)



Clockwise moments = anticlockwise moments ~~B1~~ C1

$W \times 0.6 = (20)(0.15) + (20)(1.65) + (2.4)(600)$ C1

W = 2 460 N Accept 2500 N A1

2 (a) (i) $Y_2 = 2.00 \times 10^{-3} \sin\left[(600)t + (20.0)x\right]$ B1

(ii) - the waves in opposite directions [illegible] B1

- they have the same amplitude / frequency and speed B1

(iii) Resultant displacement $Y_R = Y_1 + Y_2$ accept both formula

Y_r = 2a Sin(ωt) Cos kx

$= \quad 2.00 \text{ mm } \times 10^{-3}\left(\sin\left[(600)t - (20.0)x\right] + \sin\left[(600)t + (20.0)x\right]\right.$ C1

$= \quad 4.00 \times 10^{-3} \cos\left[(20.0)x\right]\sin\left[(600)t\right]$ A1

(b) (i) $\dfrac{-2\pi x}{\lambda} = -(20.0)x$ C1

$\therefore \; \lambda = \dfrac{\pi}{10}\text{m}$ accept $\lambda = 0{,}314$ A1

$V = \dfrac{dy}{dt}$ accept $V = wr$

$= \quad (2.00 \times 10^{-3})(600)\cos\left[(600)t - (20.0)x\right]$ C1

$\therefore \; V_{\max} = 2.00 \times 10^{-3} \times 600 = 1200 \times 10^{-3} ms^{-1}$ A1

(c) **To replenish lost energy due to damping.** / maintain Amplitude constant B1

A/W

5

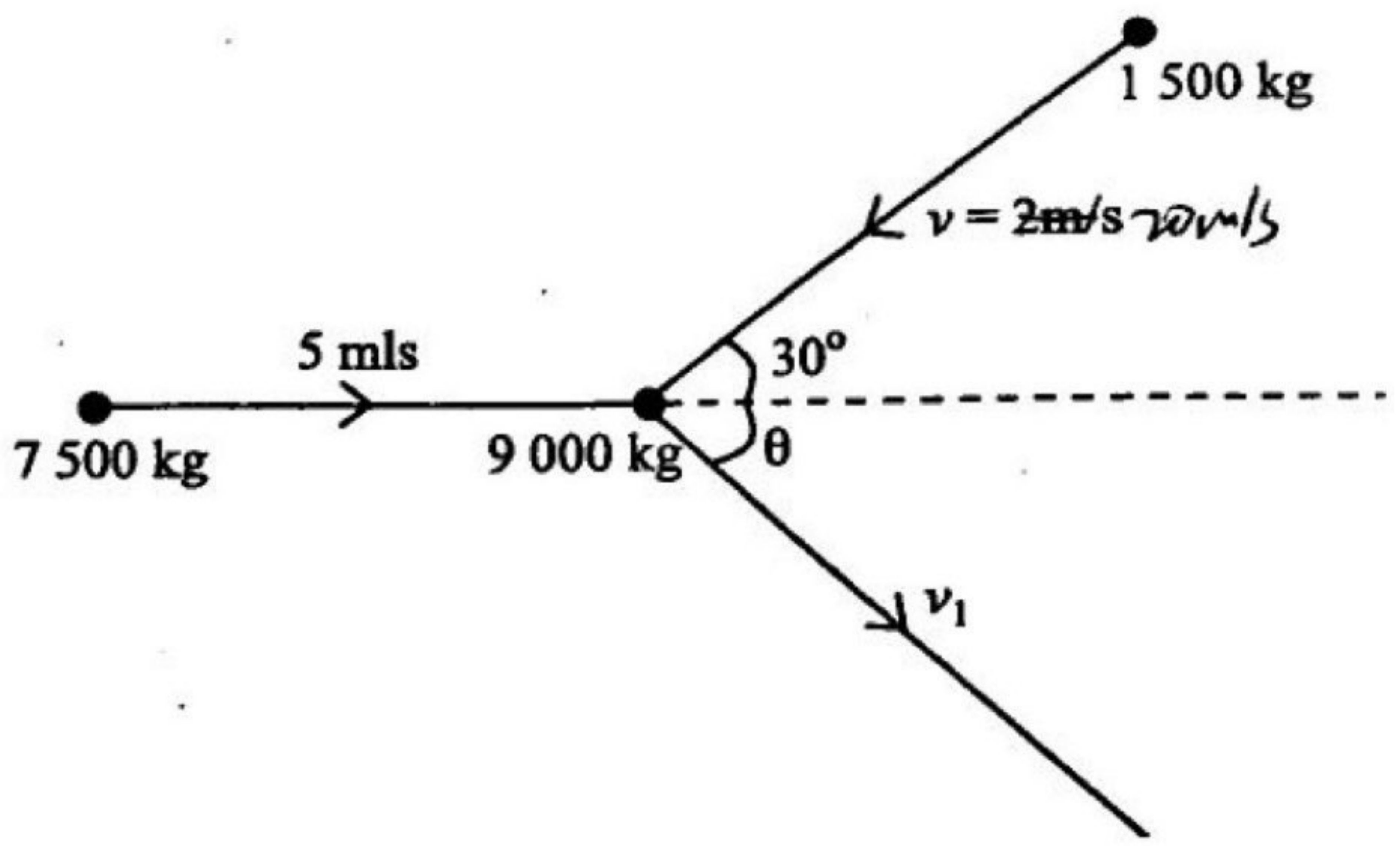
equation, terms defined.

(a) - change of momentum use of product Ft

(A) unit = ~~NS~~ Ns B1

® unit is kgms $^{-1}$ B1

(b) (i)



Consider vertical component

$$0 = 1500 \times 20 \sin 30 - 9000V \sin\theta$$ C1

$$\Rightarrow V_1 \sin\theta = 1.667 \quad \text{---------} \quad (1)$$

horizontal component

$$7500 \times 5 = 1500 \times 20 \times \cos 30 + 9000V_1 \cos\theta$$ C1

$$\Rightarrow \quad V_1 \cos\theta = 1.2799 \quad \text{--------} \quad (2)$$

divide (1) by (2)

$$\frac{V \sin\theta}{V \cos\theta} = \frac{1.667}{1.2799}$$ C1

$$\theta = \tan^{-1}\left(\frac{1.667}{1.2799}\right)$$

$$= \quad 52.5°$$ A1

$$\therefore \quad V = \frac{1.667}{\sin 52.5}$$ C1

$$= \quad 2.10 \text{ ms/}$$ A1

28

11

3

[redacted]

Idea of inertia on the head

(c) - head tends to stay at the same place while body moves forward B1

- hence head restraint pushes the head forward so that the whole body moves forward as one B1

4 (a) (i) work done per unit mass in bringing it from infinity to that point in a gravitational field Accept (on a unit mass) accept definition in symbols defined B1

$g = F/m$

m - point mass

r - distance from centre of Planet to point

(ii) force per unit mass B1

(b) (i) 1. By convention, at infinity potential is zero, hence negative values are less than zero B1

A/W - gravitational force is attractive B1

All attractive forces are associated with negative potential

2. its field is negligible A/W B1

so that it does not distort the field under investigation B1

(ii) $E_K = \frac{1}{2}Mv^2$

$\frac{1}{2}\left(\frac{MV^2}{R}\right) = \frac{1}{2}\left(\frac{GM_EM}{R^2}\right)$

$$\frac{MV^2}{R} = \frac{GM_EM}{R^2}$$ C1

$$V^2 = \frac{GM_E}{R}$$ C1

$$\therefore\ E_K = \frac{GM_EM}{2R}$$ A0

loss in PE > Gain in KE

(c) - satellite has both KE and PE B1

- the loss in potential energy is twice the gain of KE in orbit, hence all in all there is loss of energy A/W B1

- energy is lost as heat

- energy is lost as other forms instead of it being converted to K.E

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

9188/3

PAPER 3 Theory

NOVEMBER 2016 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

Candidates are advised to spend 25 minutes on **question 1.**

This question paper consists of 8 printed pages.

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[Turn over

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*Answer **question 1** and **any other 2** from the remaining questions.*

1 (a) **Fig. 1.1** shows a vernier callipers before and after making measurements of the internal diameter of a cylindrical tube. The tube has a length of 25.0 cm as measured by a ruler with an accuracy of 1 mm.

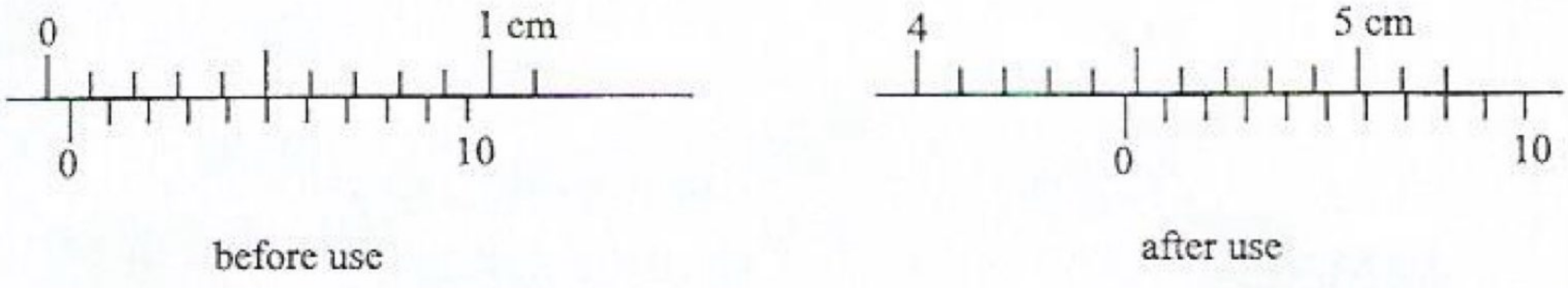

Fig. 1.1

(i) Write the readings shown in **Fig. 1.1**.

(ii) Calculate, with its uncertainty, the internal

1. diameter of the tube,

2. volume of the tube.

[6]

(b) (i) Distinguish between *precision* and *accuracy*.

(ii) Two sets of readings, **A** and **B**, were obtained by two students in experiments to determine the acceleration due to gravity.

[All readings are in ms^{-2}**.]**

Set **A**: 7.88; 7.87; 7.86
Set **B**: 8.75; 10.23; 10.45

State whether or **not** the sets of values are precise and accurate.

[5]

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(c) (i) State *the principle of superposition.*

(ii) **Fig. 1.2** shows a pair of loudspeakers 1.5 m apart and 7 m away from the line **AYZ**. The loudspeakers are emitting sound of frequency 1 320 Hz, and speed of 330 m/s. A listener moving from **A** to **Z** hears a minimum sound at **A** and **Z**, and a maximum sound at **Y**.

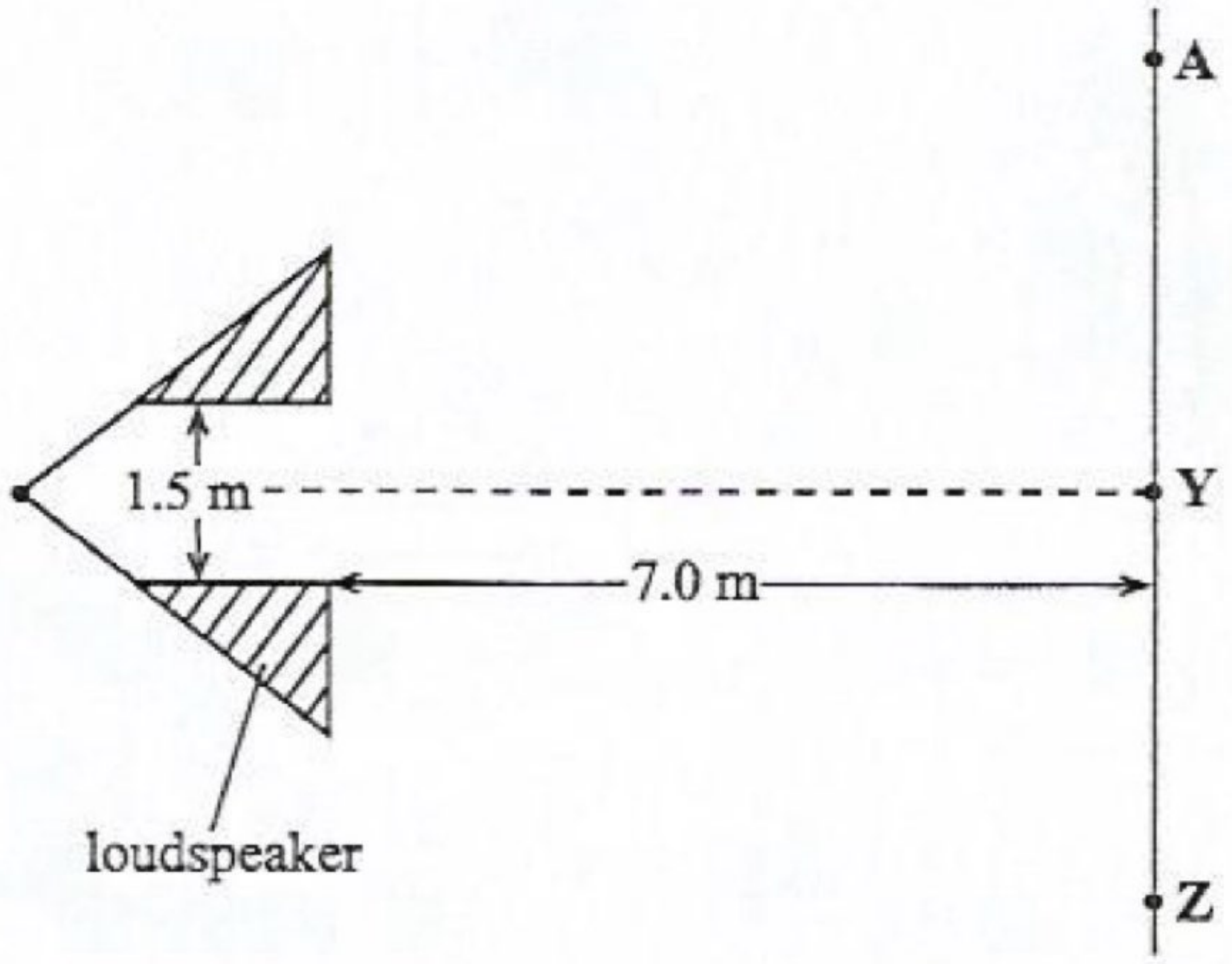

Fig. 1.2

Calculate the distance between **A** and **Z**.

[5]

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(d) **Fig. 1.3** shows a model of a front-end loader with a square base of side 1.2 m used to demonstrate the moment of a force. A uniform lever, with first and second arms each of length 1.5 m and weight 20 N, is pinned at the mid-point of the base.

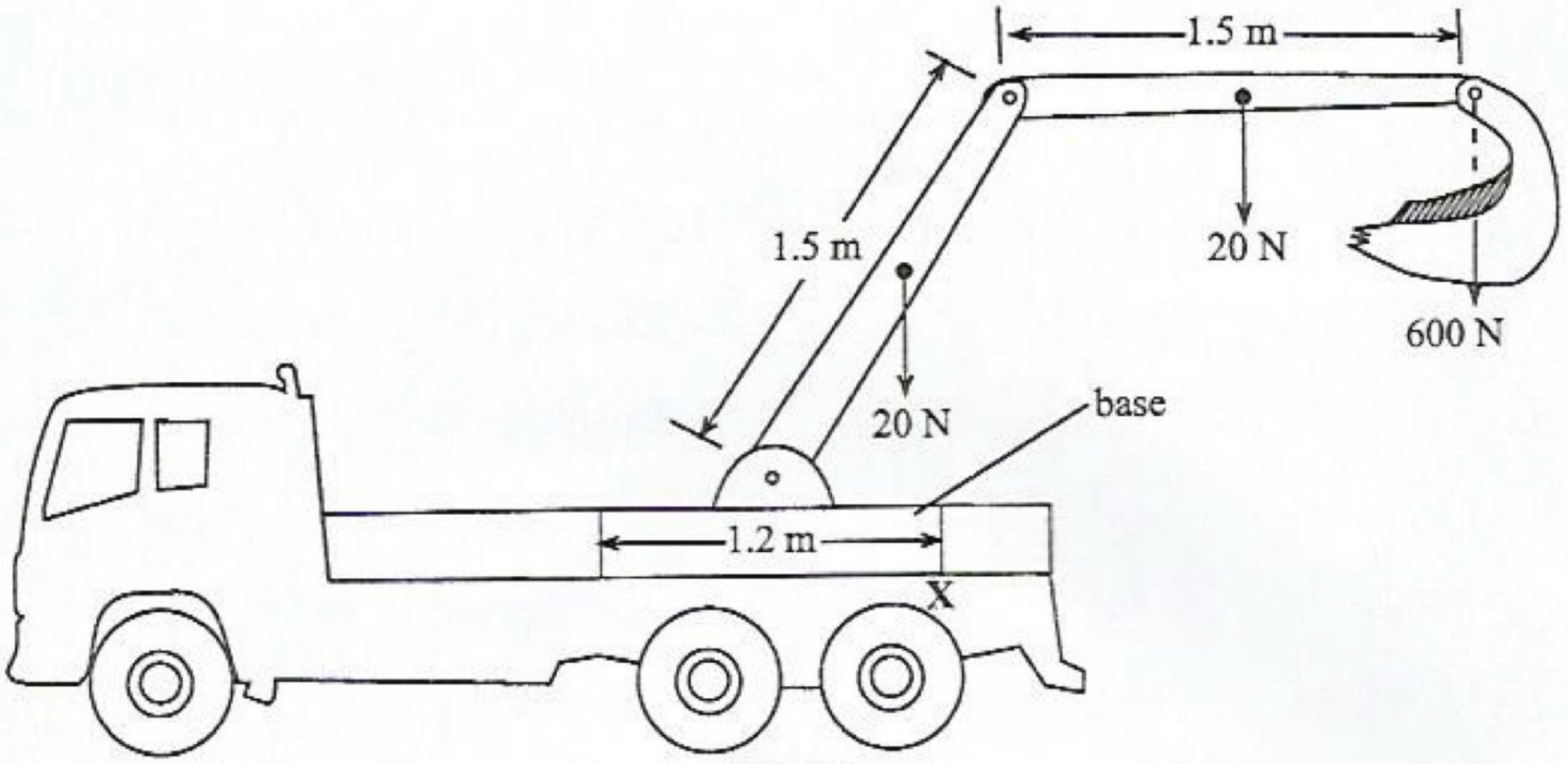

Fig. 1.3

The base is designed such that there is no toppling over at **X** when the arm is fully extended.

(i) Explain the term *moment of a force*.

(ii) Find the minimum weight of the base that just prevents toppling over at point **X** when the arm is fully extended.

[4]

2 (a) An equation for a progressive wave in a string is given by the expression:

$$Y = 2\times10^{-3}\sin[600t - 20X]$$

A series of such waves are transmitted along a stretched string fixed at one end. The waves reflected at the fixed end without loss of energy and superposition occurs in the string.

(i) Write an equation for the reflected wave.

(ii) Describe how these waves satisfy conditions for the production of a stationary wave.

(iii) Derive an equation for the resultant wave using the principle of superposition.

[5]

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(b) A damping material is placed at the fixed end of the string in **2(a)** so that the incident progressive waves are absorbed.

Find the

(i) wavelength of the progressive wave in **a(i)**,

(ii) maximum speed of a particle in the string. [4]

(c) Explain why an external agent is always required to maintain a stationary wave in a stretched string. [1]

3 **(a)** (i) Define *impulse*.

(ii) State the SI unit of impulse. [2]

(b) A 7 500 kg lorry travelling at 5 m/s due east collides with a 1 500 kg car moving at 20 m/s in the direction South 60° West. The two vehicles coalesce.

Determine the

(i) direction and

(ii) speed

of the wreckage. [6]

(c) **Fig. 3.1** shows some of the safety features in a car which include safety belt and head restraint. Explain how the head restraint prevents the driver from injury if the car is hit from behind. [2]

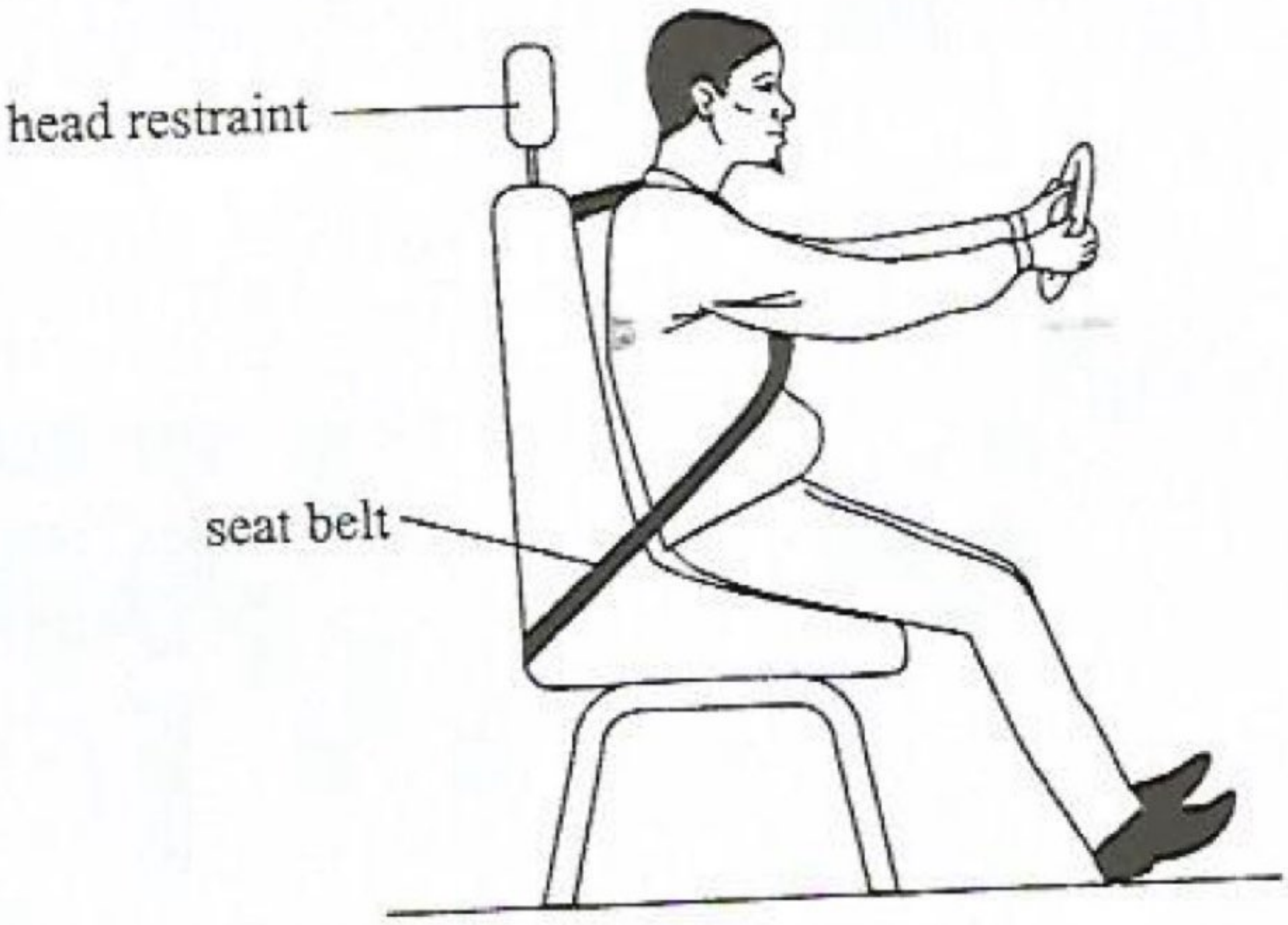

Fig. 3.1

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4 **(a)** Define the

(i) *gravitational potential* and

(ii) *gravitational field strength.*

at a point in a gravitational field. [2]

(b) **(i)** State the significance of

1. the negative sign in the equation for gravitational potential,
2. a test mass in the study of the gravitational field.

(ii) Show that the kinetic energy, E_k, of a satellite of mass, M, orbiting the Earth of mass, M_E, at a radius R, is given by $E_K = \frac{GM_EM}{2R}$.

[6]

(c) The satellite in **(b)(ii)** speeds up when it falls to a lower orbit, hence its kinetic energy increases.

Explain why the satellite loses energy. [2]

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M.M

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

NOVEMBER 2016

PHYSICS **9188/3**

5014 | 4017

Back credit - B1

B.C for numerical values

- Ignore absolute error in the readings.

1 (a) (i) zero-error = 0.05 cm C1

reading = $(4.48 \pm \cancel{0.01})$ cm ~~Both correct~~ B1

(ii) 1. diameter = $((4.48 - 0.05) \pm 0.01)$ cm

= $\underline{(4.43 \pm 0.01)}$ cm A1

2. Volume = $\pi r^2 l = \dfrac{\pi d^2 l}{4}$

— Accept 3.s.f. = $\dfrac{\pi}{4}(4.43^2)(25.0)\,\cancel{\text{cm}}^{2}$ C1

Ignore units

= 385.33 cm³ A1

~~error in~~ reject ± 0.005 in radius if using r = 2.215 out of max error DONE

$$\Delta V = \left(\frac{2\Delta d}{d} + \frac{\Delta l}{l}\right)(\text{Volume})$$

Accept e.c.f in the error of the diameter.

- No e.c.f within the same part

$$= \left(\frac{2 \times 0.01}{4.43} + \frac{1}{250}\right)(385.33)\ \text{cm}^2$$ C1

= 3.281 cm³

∴ V = (385 ± 3) cm³ A1

W precision - values compared to their mean / Accuracy - mean values compared to True value

(b) (i) precision is closeness of values to mean value while accuracy is closeness of mean value to true value. B1 B1

Degree of closeness

® precision is when readings are close to the mean & accuracy is when mean is close to true value

association of precision to random error - accuracy to systematic.

(ii) Set A: precise but not accurate A/W B1

Set B: accurate but not precise B1

(c) (i) (States that whenever) two waves are travelling in the same region the total displacement at (any point) is equal to the vector sum of their individual displacements at that time B1 B1

meet/interact/overlap

Men of wave

accept Sum of Amplitudes

resultant displacement is vector/algebraic sum

(ii) $V = f\lambda$

$$\therefore \ \lambda = \frac{330}{1320}$$

= 0.25 m — Ignore units A1

i.e distance between A and Z = $\dfrac{\lambda D}{a}$

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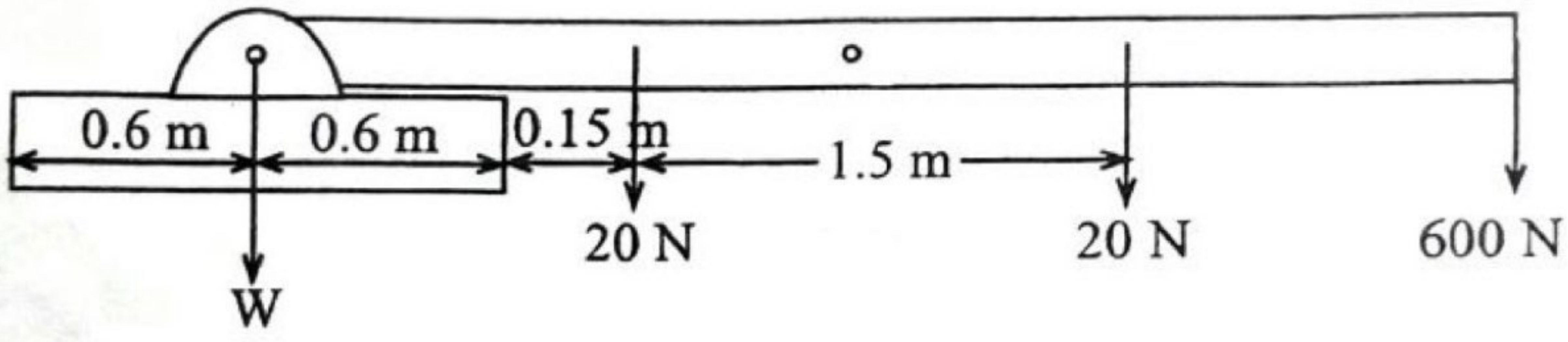
$$= \frac{0.25 \times 7}{1.5}$$ C1

$$= 1.17 \text{ m}$$ Accept 1 sf A1

(d) (i) Product of the force and its perpendicular distance from pivot to its line of action) / accept turning effect of a force
accept expression with terms defined B1

(ii)



Clockwise moments = anticlockwise moments ~~B1~~ C1

W × 0.6 = (20)(0.15) + (20)(1.65) + (2.4)(600) C1

W = 2 460 N Accept 2500 N A1

2 (a) (i) $Y_2 = 2.00 \times 10^{-3} \sin\left[(600)t + (20.0)x\right]$ B1

(ii)
- the waves in opposite directions [illegible] B1
- they have the same amplitude/frequency and speed B1

(iii) Resultant displacement $Y_R = Y_1 + Y_2$ accept bound formula

$y_r = 2a \sin(\omega t) \cos kx$

$= 2.00 \text{ mm } \times 10^{-3} \left(\sin\left[(600)t - (20.0)x\right] + \sin\left[(600)t + (20.0)x\right]\right.$ C1

$= 4.00 \times 10^{-3} \cos\left[(20.0)x\right] \sin\left[(600)t\right]$ A1

(b) (i) $\dfrac{-2\pi x}{\lambda} = -(20.0)x$ C1

$\therefore \lambda = \dfrac{\pi}{10} \text{m}$ accept $\lambda = 0.314$ A1

$V = \dfrac{dy}{dt}$ accept $V = \omega r$

$= (2.00 \times 10^{-3})(600) \cos\left[(600)t - (20.0)x\right]$ C1

$\therefore V_{\max} = 2.00 \times 10^{-3} \times 600 = 1200 \times 10^{-3} ms^{-1}$ A1

(c) To replenish lost energy due to damping./ maintain Amplitude constant B1

A/W

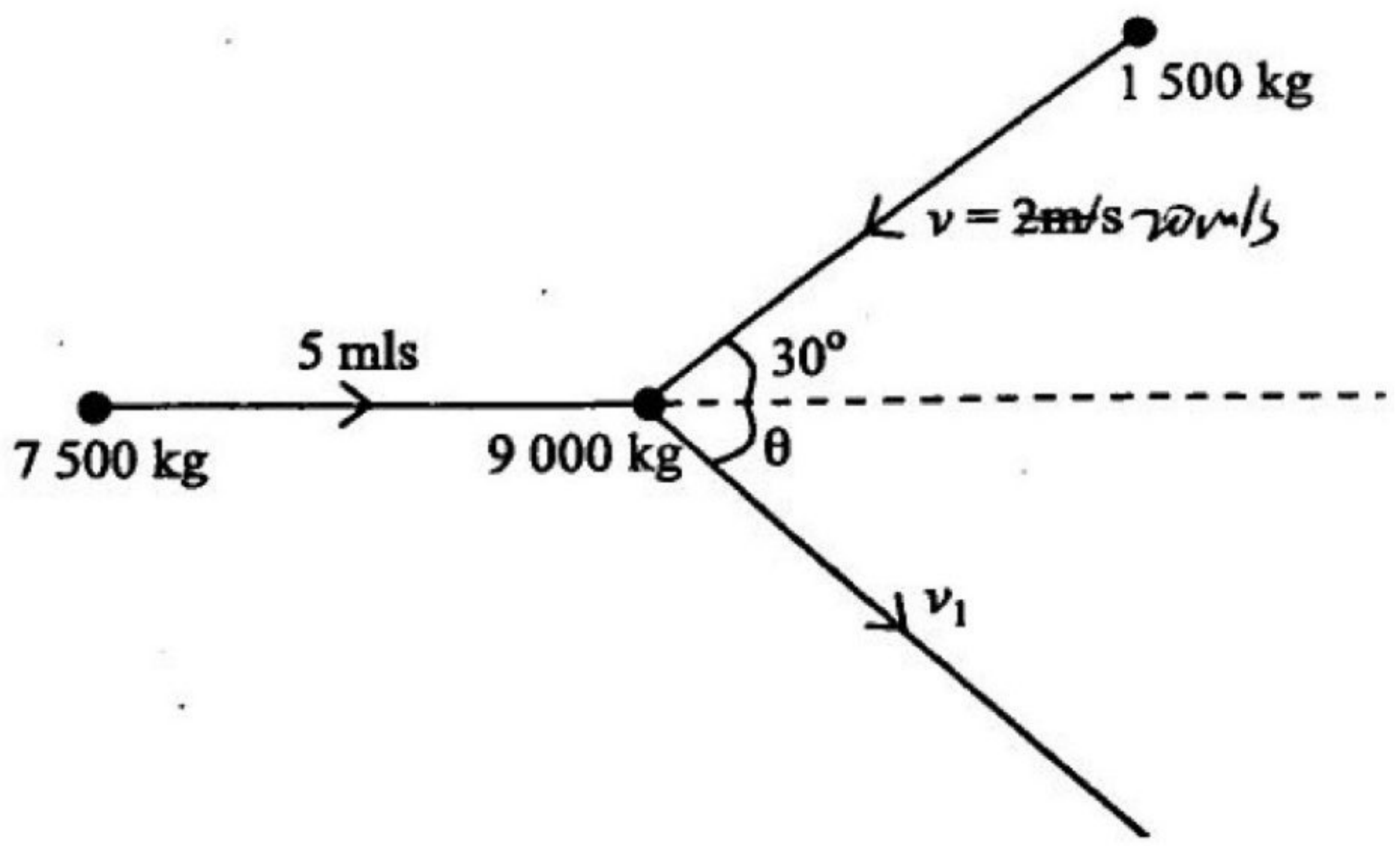
equation, terms defined.

(a) - change of momentum usual product Ft

(A) unit = ~~NS~~ Ns B1

® unit is kgms $^{-1}$ B1

(b) (i)



Consider vertical component

$0 = 1500 \times 20 \sin 30 - 9000V \sin\theta$ C1

$\Rightarrow V_1 \sin\theta = 1.667$ --------- (1)

horizontal component

$7500 \times 5 = 1500 \times 20 \times \cos 30 + 9000V_1 \cos\theta$ C1

$\Rightarrow V_1 \cos\theta = 1.2799$ -------- (2)

divide (1) by (2)

$\frac{V \sin\theta}{V \cos\theta} = \frac{1.667}{1.2799}$ C1

$\theta = \tan^{-1}\left(\frac{1.667}{1.2799}\right)$

$= 52.5°$ A1

$\therefore V = \frac{1.667}{\sin 52.5}$ C1

$=$ 2.10 ms/ A1

28

11

3

[redacted]

Idea of inertia on the head

(c) - head tends to stay at the same place while body moves forward B1

- hence head restraint pushes the head forward so that the whole body moves forward as one B1

4 (a) (i) work done per unit mass in bringing it from infinity to that point in a gravitational field Accept (on a unit mass) accept definition in symbols defined B1

$j = F/m$

m - point mass

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$\frac{MV^2}{R} = \frac{GM_EM}{R^2}$ C1

$V^2 = \frac{GM_E}{R}$ C1

$\therefore\ E_K = \frac{GM_EM}{2R}$ A0

loss in PE > Gain in KE

(c) - satellite has both KE and PE B1

- the loss in potential energy is twice the gain of KE in orbit, hence all in all there is loss of energy B1

A/W

- energy is lost as heat
- energy is lost as other forms instead of it being converted to K.E

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

9188/3

PAPER 3

JUNE 2017 SESSION

50 minutes

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

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INFORMATION FOR CANDIDATES

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This question paper consists of 7 printed pages and 1 blank page.

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Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^8\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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Answer ***question 1*** *and* ***any other*** *2 from the remaining questions.*

1 **(a)** **(i)** Define *the mole.*

(ii) Estimate

1. the mass and

2. the diameter

of a water molecule if the molecular mass for water is 18 g. [4]
(take density of water to be 1 000 kg/m^3)

(b) **(i)** Distinguish between *elastic* and *inelastic* collisions.

(ii) Two bodies, with masses m_1 and m_2 and corresponding initial velocities U_1 and U_2 undergo a perfectly elastic collision when moving in the same direction.

Fig. 1.1 shows the positions of the bodies before and after collision.

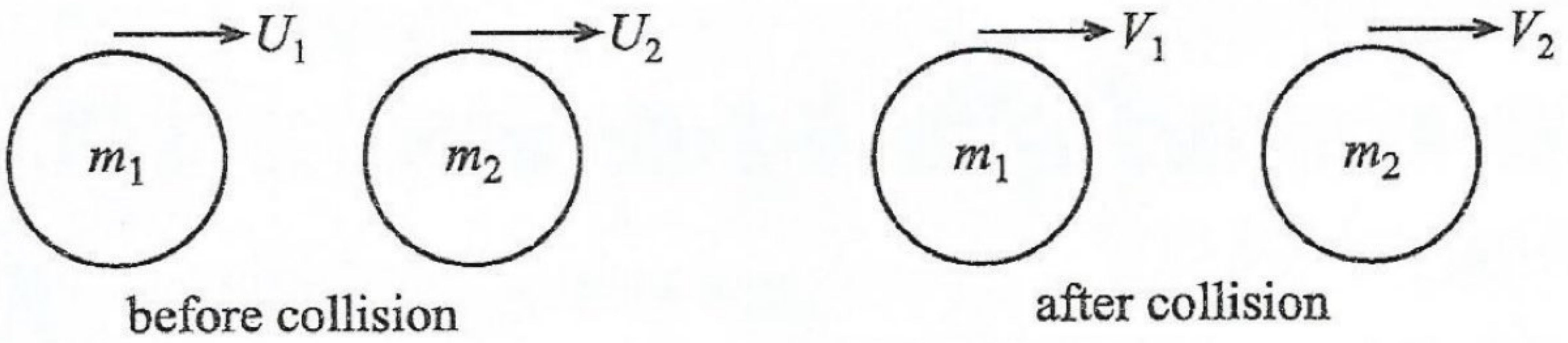

Fig. 1.1

Applying principles of conservation of momentum and kinetic energy, show that

$$U_1 - U_2 = -(V_1 - V_2)$$ [6]

(c) **(i)** State the *principle of superposition.*

(ii) Two identical progressive waves are travelling in opposite directions.

Describe what happens when they meet. [4]

(d) **(i)** Define *angular velocity.*

(ii) Derive the formula $v = r\omega$, where symbols have their usual meaning.

(iii) Explain why a particle moving with constant speed along a circular path has an acceleration.

[6]

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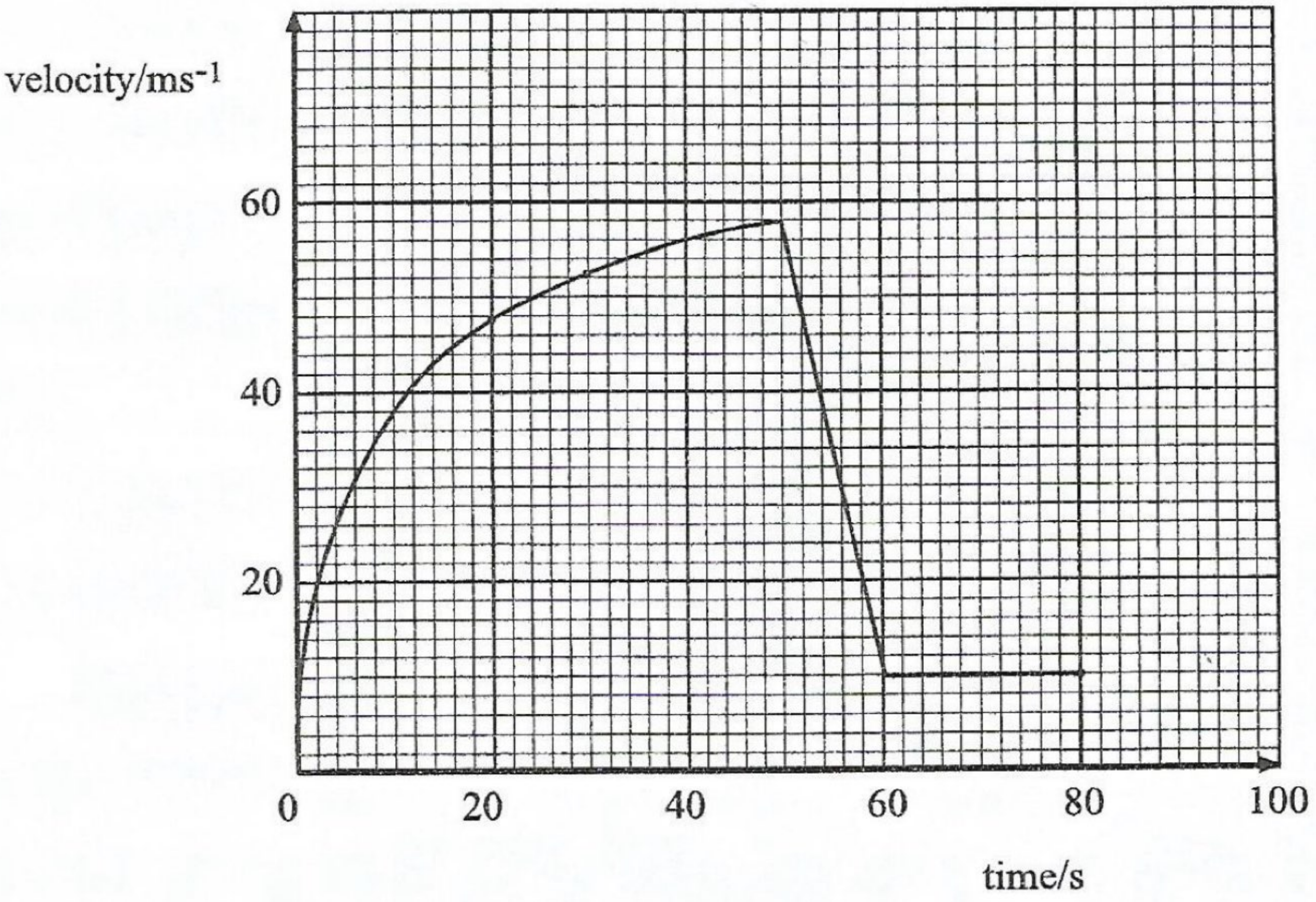
2 **(a)** Define *acceleration*. [1]

(b) **Fig. 2.1** shows a velocity-time graph for a parachutist after jumping from an aircraft.



(i) State what is happening to the acceleration of the parachutist during the first 35 seconds.

(ii) Explain your description in **(i)**.

(iii) Calculate the distance travelled between 60 seconds to 80 seconds.

[6]

(c) The distance from Harare to Beitbridge is 5.80×10^5 m by road.

It takes 8 hours for a vehicle to travel this distance.

(i) Define *distance*.

(ii) Calculate the average speed of the vehicle.

(iii) State **one** reason why practically it is impossible to maintain a constant velocity throughout the journey.

[3]

[Turn over

3 **(a)** Define *work*. [1]

(b) **(i)** State **one** advantage of hydro power generation over thermal power generation.

(ii) In a hydro-electric power station, water falls at a rate of 2.5×10^5 kg s^{-1} to drive turbines 220 m below.

Calculate the loss in gravitational potential energy per second for the water as it reaches the turbines.

(iii) The water leaves the turbines at a speed of 9.0 m/s.

Calculate the maximum input power to the turbines, assuming that all the potential energy lost is transferred to the kinetic energy of the water.

[7]

(c) State and explain any **one** disadvantage of using hydro-electric power to produce electricity. [2]

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4 **(a)** State the condition for two sources to be coherent. [1]

(b) Two sources of red light, S_1 and S_2 were set up as in **Fig. 4.1**.

y =

Fig. 4.1

(i) N is a point where $S_1N = S_2N$. State what is observed at N.

(ii) The wavelength of red light is 6.8×10^{-7}m.

Find the frequency for S_1 and S_2.

(iii) At point P_1, $S_1P = 5.0 \times 10^{-6}$m and $S_2P = 3.3 \times 10^{-6}$m.

1. Calculate the number of wavelengths in the path difference between S_1P and S_2P.
2. Using the answer to **(b)(iii)**1**,** determine what is observed at P.

[7]

(c) Explain why light from two head lamps of a car does not give a distinct interference pattern. [2]

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1 (a) (i) A mole is the number of particles as they are found in $\overset{12g}{\frac{1}{\cancel{12}}}$th mass of C – 12 atom **B1**

(ii) 1. Mass of a water molecule $= \dfrac{18 \times 10^{-3}}{6.0 \times 10^{23}}$ **A1**

$= 3.0 \times 10^{-26}\,\text{kg}$ Correct order $\times 10^{-23}$

2. Volume of a water molecule $= \dfrac{4\pi r^3}{3} = \dfrac{\pi d^3}{6}$ **C1**

Volume $= \dfrac{\text{mass}}{\text{density}}$

$\therefore$ diameter (d) $= \sqrt{\dfrac{6 \times 3 \times 10^{-26}}{1000\pi}}$

$= 3.9 \times 10^{-10}\,\text{m}$ order 10^{-10} m **A1**

(b) (i)

- Kinetic energy is conserved in an elastic collusion while it is not in an inelastic collision **B1**
- Relative $\overset{\text{speed/}}{\text{velocity}}$ of approach is equal to relative $\overset{\text{speed/}}{\text{velocity}}$ of separation in an elastic collision which is not in an inelastic collision. **B1**

(ii) conservation of momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$m_1(u_1 - v_1) = m_2(v_2 - u_2) \ldots \quad (1)$$ **C1**

Conservation of energy

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$$m_1\left(u_1^2 - v_1^2\right) = m_2\left(v_2^2 - u_2^2\right) \ldots \quad (2)$$ **C1**

$$(2) \div (1) \quad \frac{m_1(u_1 - v_1)(v_1 + u_1)}{m_1(u_1 - v_1)} = \frac{m_2(v_2 - u_2)(v_2 + u_2)}{m_2(v_2 - u_2)}$$ **C1**

$u_1 + v_1 = v_2 + u_2$ C1

$u_1 - u_2 = v_2 - v_1$

$u_1 - u_2 = -(v_1 - v_2)$ A0

(c) (i) when two or more waves meet (interact / superpose / overlap) at a point B1
the resultant displacement is a vector sum of the individual displacements B1

(ii) They produce a stationary wave B1
The waves reinforce at some regions to form antinodes; and cancel at other regions to produce nodes AW B1

(d) (i) Angular velocity is rate of change of angular displacement / Aw B1
Accept eqn with terms defined.

(ii) Arc length $s = r\theta$ B1

$w = \frac{\theta}{t}$ B1

$V = \frac{s}{t} = \frac{r\theta}{t}$ B1

$V = rw$ A0

(iii) Since velocity is a vector quantity change in direction changes velocity. B1
Accept definition of acceleration.

The acceleration is due to change of direction of velocity while its magnitude is constant. A/W B1

B1

2 (a) Rate of change of velocity/ AW B1

(b) (i) The acceleration is decreasing
idea of decrease must be clear B1

(ii) As the parachutist speeds up resistive force increases
idea of opposing forces to weight of parachutist B1

Resultant force on him decreases

(iii) Distance travelled = area under graph

C1

$= 10ms^{-1} \times 20s$

A1

= 200 m

B1

(c) (i) Actual length covered by moving object/ AW

(ii) Average velocity $= \frac{5.80 \times 10^5}{8\text{[illegible]} \times 60 \times 60} ms^{-1}$ C1

$= 20.14ms^{-1}$ | 72 km/h. A1

(iii) It is practically impossible to maintain a constant velocity throughout the journey because

1. there are road-blocks B1
2. the road has curves where cars slow down B1
3. of stops for fuel refilling/toll gates B1

Accept any plausible reason Max B1

3 (a) Work = Force × distance moved in the direction of force B1

(b) (i) Water is a renewable resource whilst biofuels are non-renewable resource Accept any plausable advantage. B1

(ii) $\Delta E_p = mg\Delta h = 2.5 \times 10^5 \times 9.81 \times 2.20$ C1

$= 5.40 \times 10^8$ J/s A1

(iii) Input power $= \Delta E_p - \Delta E_k$ C1

$= E_{k_1} - E_{k_2}$

$\Delta E_k = \frac{1}{2} \times 2.5 \times 10^5 \times 9^2$ C1

$= 1{,}0125 \times 10^7$J

$\therefore$ Input power $= (5.40 \times 10^8 - 1{,}0125 \times 10^7)\,\text{J}s^{-1}$ C1

$= 5{,}30 \times 10^8$ W A1

(c) Ecosystem is disrupted/ A/w B1

Land, plants and animals are destroyed during the construction of hydroelectric power stations. B1

Accept any plausable disadvantage

B1

4 (a) If the phase difference between the two sources is constant. B1

(b) (i) Bright(red)spot is observed at N. / AW

(ii) $C = f\lambda \therefore f = \dfrac{3.0 \times 10^{8}}{6.8 \times 10^{-7}}$ C1

$= 4.41 \times 10^{14}$ Hz min of 2 sf A1

(iii) 1. Path difference $= S_1P - S_2P$

$= 5{,}0 \times 10^{-6} - 3{,}3 \times 10^{-6}$ C1

$= 1{,}7 \times 10^{-6}$m

No of wavelengths $= \dfrac{1.7 \times 10^{-6}}{6.8 \times 10^{-7}} = 2.5$ A1

2. Since path difference is not an integral multiple of the wavelength destructive interference occur. / AW B1

A dark spot is at P. B1

(c) The head lamps are not coherent sources of light. B1

For coherence, they must come from a single source. B1

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Advanced Level

9188/3

PHYSICS
PAPER 3

50 minutes

NOVEMBER 2017 SESSION

Additional materials:
Answer paper
Electronic Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

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Answer question 1 and any other 2 from the remaining questions.

1 (a) In nuclear reactions the energy, E, and mass m, are related by the equation $E = mc^2$, where c is the speed of light.

(i) Check the homogeneity of the equation.

(ii) The period, T, of a simple pendulum of length l, is given by $T = 2\pi\sqrt{\frac{l}{g}}$, where g is the acceleration of free fall.

Calculate the percentage change in T if l increases by 0.5%.

[4]

(b) A projectile of mass 250 kg is projected horizontally with a velocity of 1.5 ms^{-1} from a height of 5.0 m above the ground.

(i) Define work.

(ii) Calculate the

1. speed of the projectile just before striking the ground,
2. energy of the projectile just before striking the ground.
(Assume air resistance is negligible)

(iii) State whether or not the body was in accelerated motion.

Explain your answer.

[6]

(c) **Fig. 1.1** shows an object of mass m, tied at the end of an inextensible string rotated in a vertical circle of radius r, at a constant speed v and angular velocity ω. A and B are positions of the particle at velocities v_A and v_B respectively.

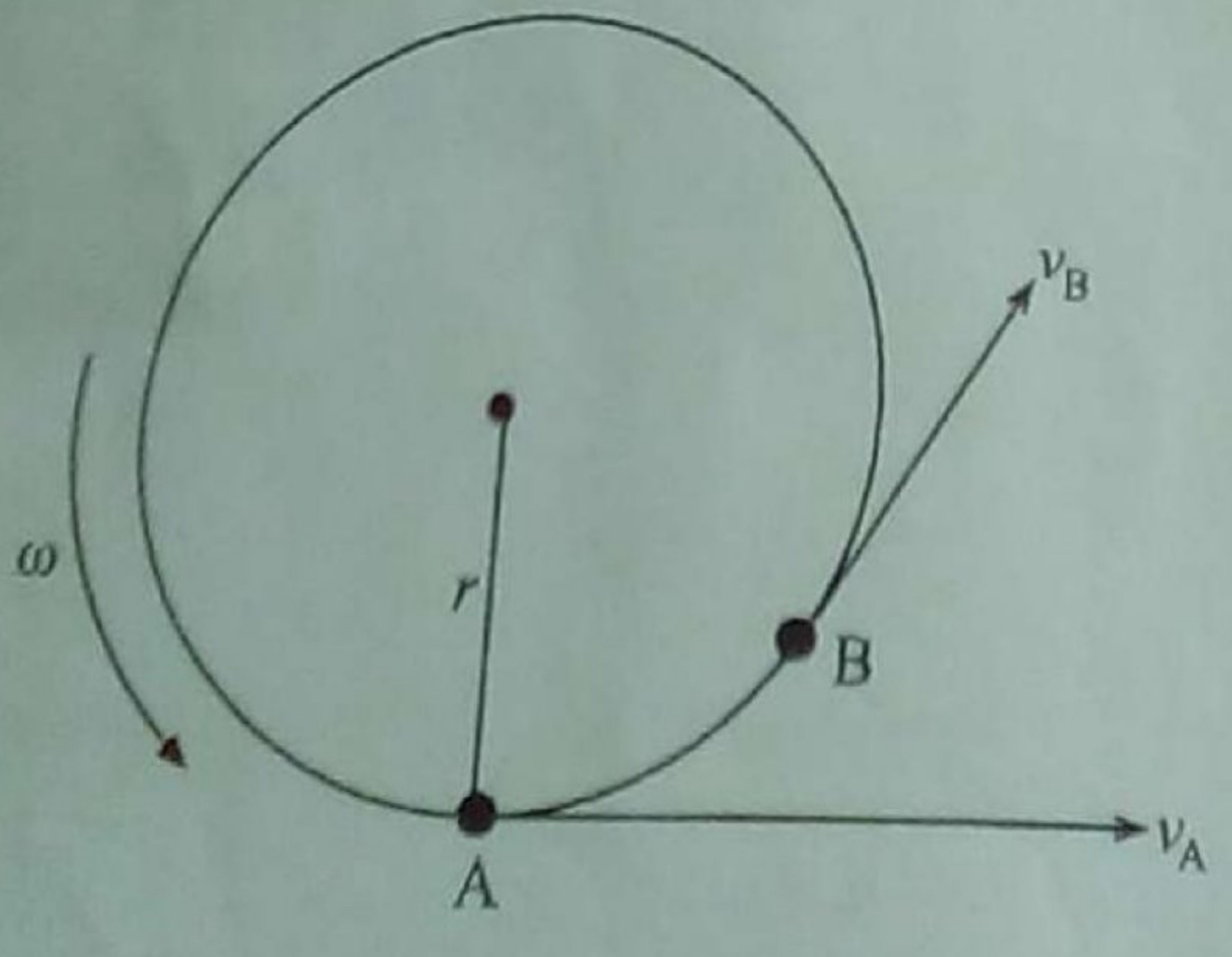

Fig. 1.1

The velocity changes from v_A to v_B and the resultant velocity Δv is given by the expression $\Delta v = v_B - v_A$.

(i) Draw a vector triangle of the velocity.

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(ii) Explain why the object is in an accelerated motion when the speed v is constant.

[4]

(d) (i) State **one** similarity and **one** difference between interference and diffraction patterns.

(ii) Visible light, of wavelength 500 nm, is made to fall on a grating. The maximum number of observable bright fringes from the central bright fringe is 3.

Calculate the number of lines per metre on the grating.

[6]

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2 (a) State the conditions for equilibrium. [2]

(b) **Fig. 2.1** shows a tree of length 15 m and mass 300 kg which has fallen over an electrical cable. The tree is suspended 9 m from point A inclined at 60° to the horizontal and its centre of mass is 6 m from point A.

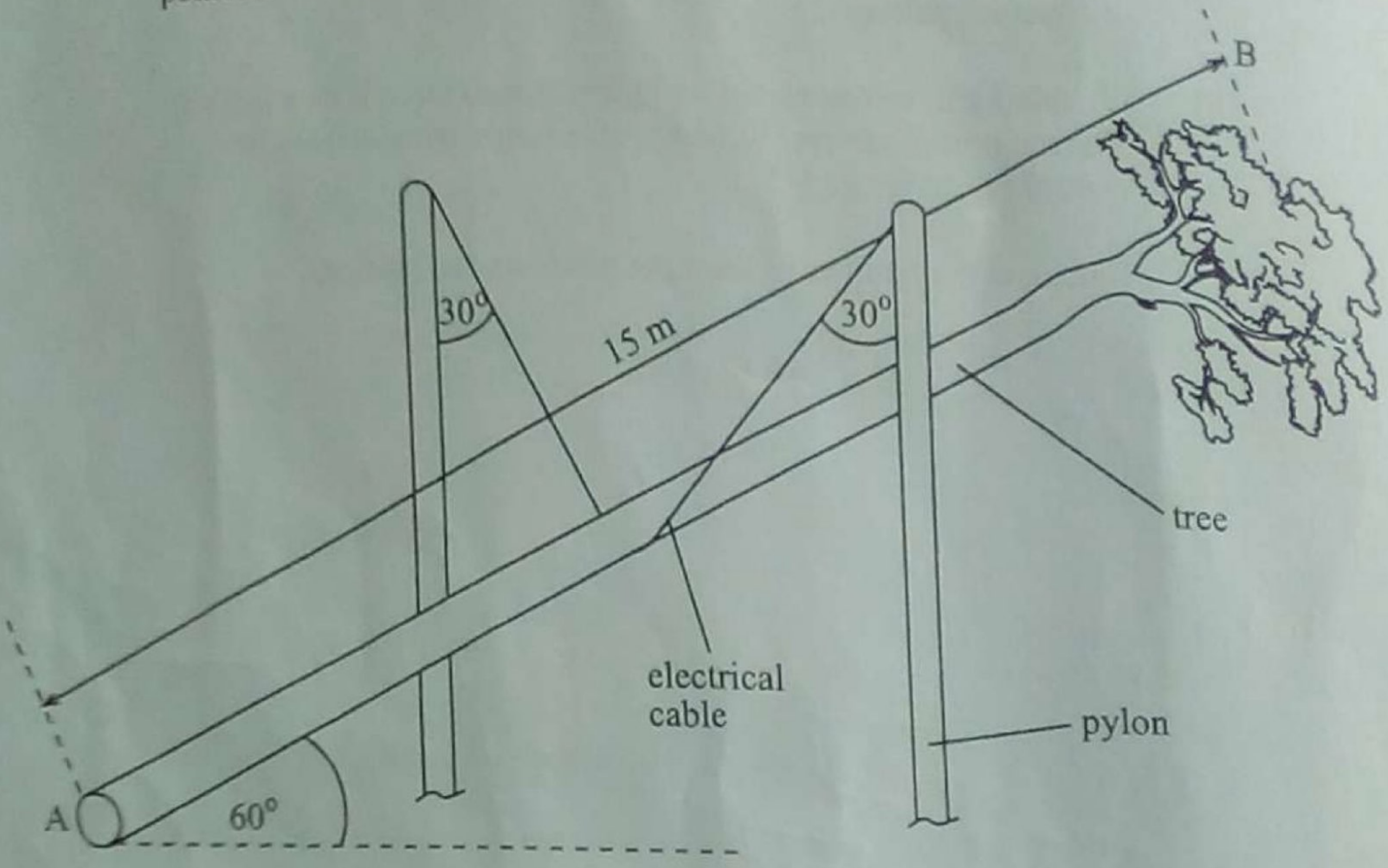

Fig. 2.1

Assuming the pylons remain vertical,

(i) draw a free body diagram to show all the forces acting in the system,

(ii) calculate the tension in the cable.

(iii) Suggest what would happen to the tree if the centre of mass was at the 9 m mark from point A.

(iv) Given that the cable would support a maximum force of 2 000 N, state with a reason whether or not the cable would break.

[8]

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3 **(a)** State *the principle of conservation of momentum.* [2]

(b) A boat of mass 3 000 kg moving at 5 m/s due north strikes a floating wooden log of mass 1 000 kg drifting due east with a velocity of 0.5 m/s. The boat and the wooden log remain locked together after collision.

Find their

(i) direction of movement after collision,

(ii) velocity after collision.

[6]

(c) State and explain whether the momentum of the boat is conserved after collision. [2]

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4 (a) Define *gravitational field strength*.

[1]

(b) Fig. 4.1 shows a tunnel dug along the diameter of the earth from North to South poles through the centre of the Earth, O.

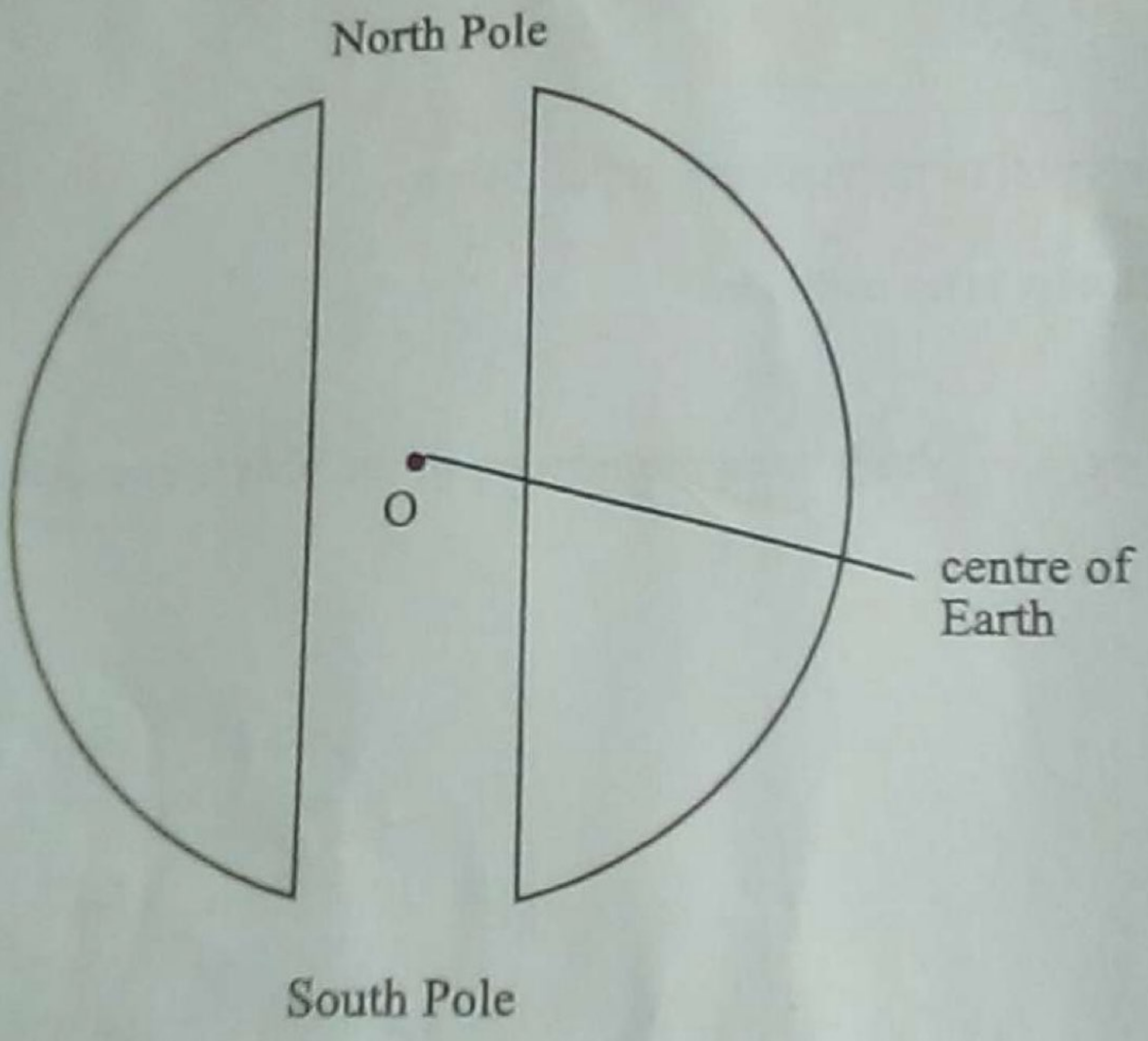

Fig. 4.1

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(i) Using **Fig. 4.2** sketch a graph to show how the field strength g, varies through the tunnel.

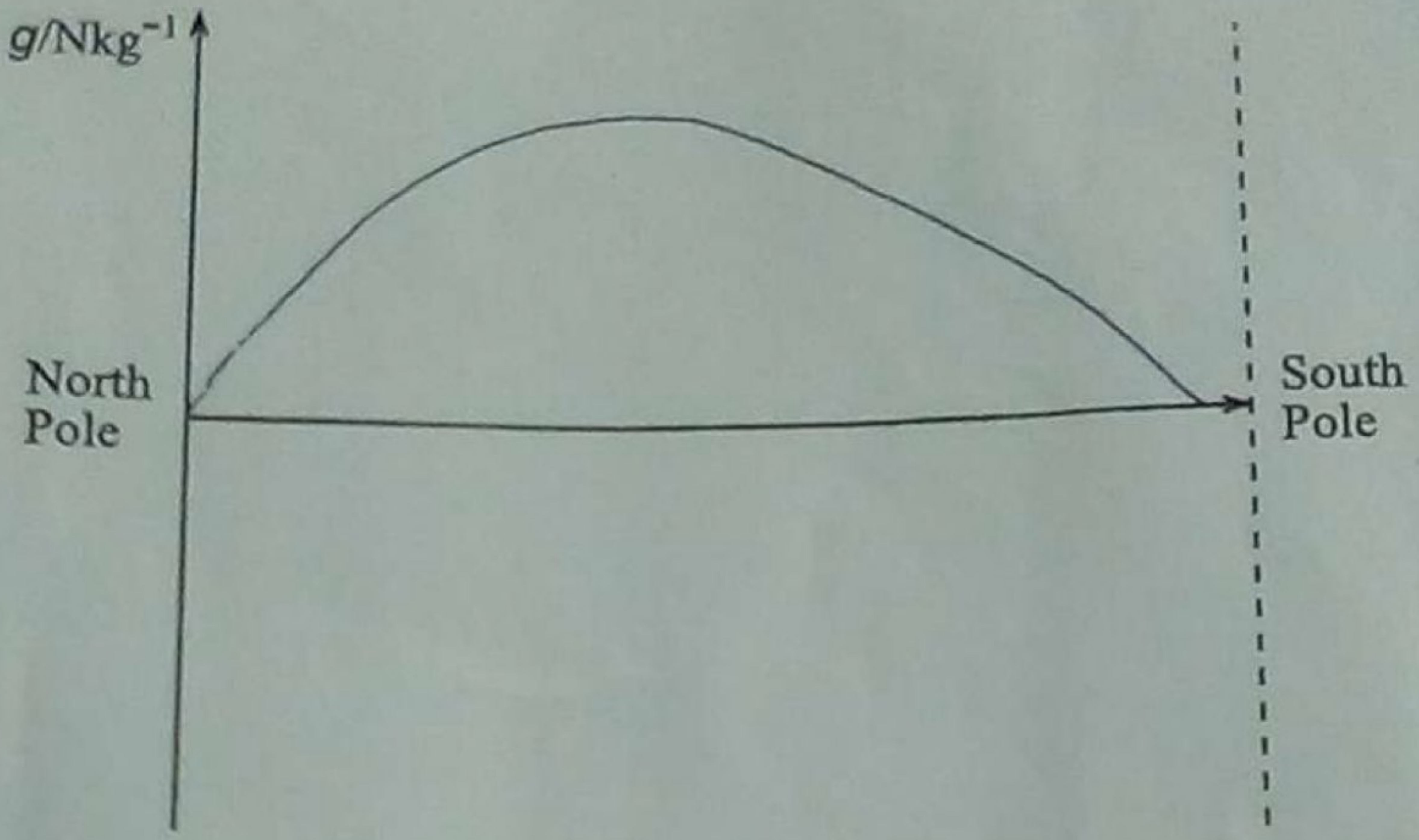

Fig. 4.2

(ii) Show that the acceleration a, of a test mass dropped into the tunnel at the North pole is given by $a = -\frac{gx}{R}$ where R is the radius of the Earth and x is any distance from the centre of the Earth.

(iii) The diameter of the Earth from the North pole to the South pole is 1.28×10^7 m and the field strength on the Earth's surface is 9.81 Nkg^{-1}.

Calculate the time for the test mass to travel from the North pole to South pole through the tunnel.

[7]

(c) Suggest any **two** reasons why a geostationary satellite in orbit has a limited life span. [2]

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

NOVEMBER 2017

HYSICS

9188/3

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1 (a) (i) $[E] = kgm^2s^{-2}$ WP not allowed B1

$[mc^2] = kgm^2s^{-2}$ / J B1

∴ the equation is homogeneous AO

(ii) $\frac{\Delta T}{T} \times 100\% = \frac{\frac{1}{2}\Delta L}{L} \times 100\%$

$= 0,5 \times 0,5\%$ C1

$= 0,25\%$ / $\frac{1}{4}$ % reject $\frac{25}{100}$ % A1

(b) (i) product of force and ~~displacement~~ distance in the direction of the force. / $F \times d\cos\theta$ B1

(ii) 1. $Vh = 1,5$ mls

$V_v^2 = 2 \times 9.81 \times 5$

$= 98.1\ m^2/s^2$ C1

time is mark if used to eq. = $v = u + at$ / $v^2 = u^2 + 2$

$V_v = 9.90ms^{-1}$ no penalize on unite of V_v

$V_r = \sqrt{1.5^2 + 98.1}$

$= 10.02$ m/s A1

acct 2 sigf ~~min~~ follow through cand's working.

2. $E = \frac{1}{2} \times 250 \times 10.02^2$

12 kJ / 13 kJ

$= 12,55$ kJ ecf. A1

accf 2 sigf.

(iii) accelerated motion reject yes $V_{v\,final} > V_{v\,ini}$ A1

accept acceleration due to gravity / free fall M1

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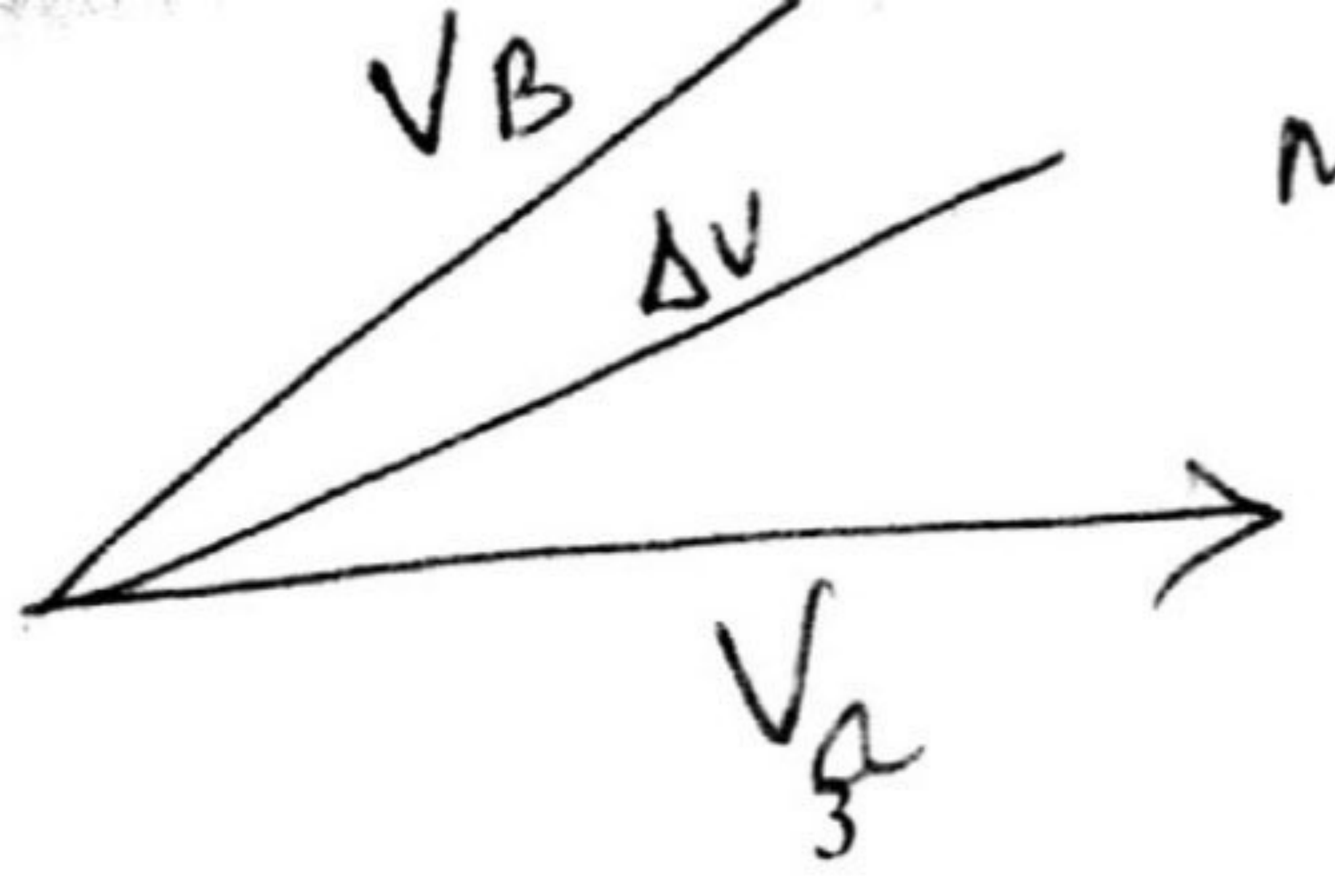
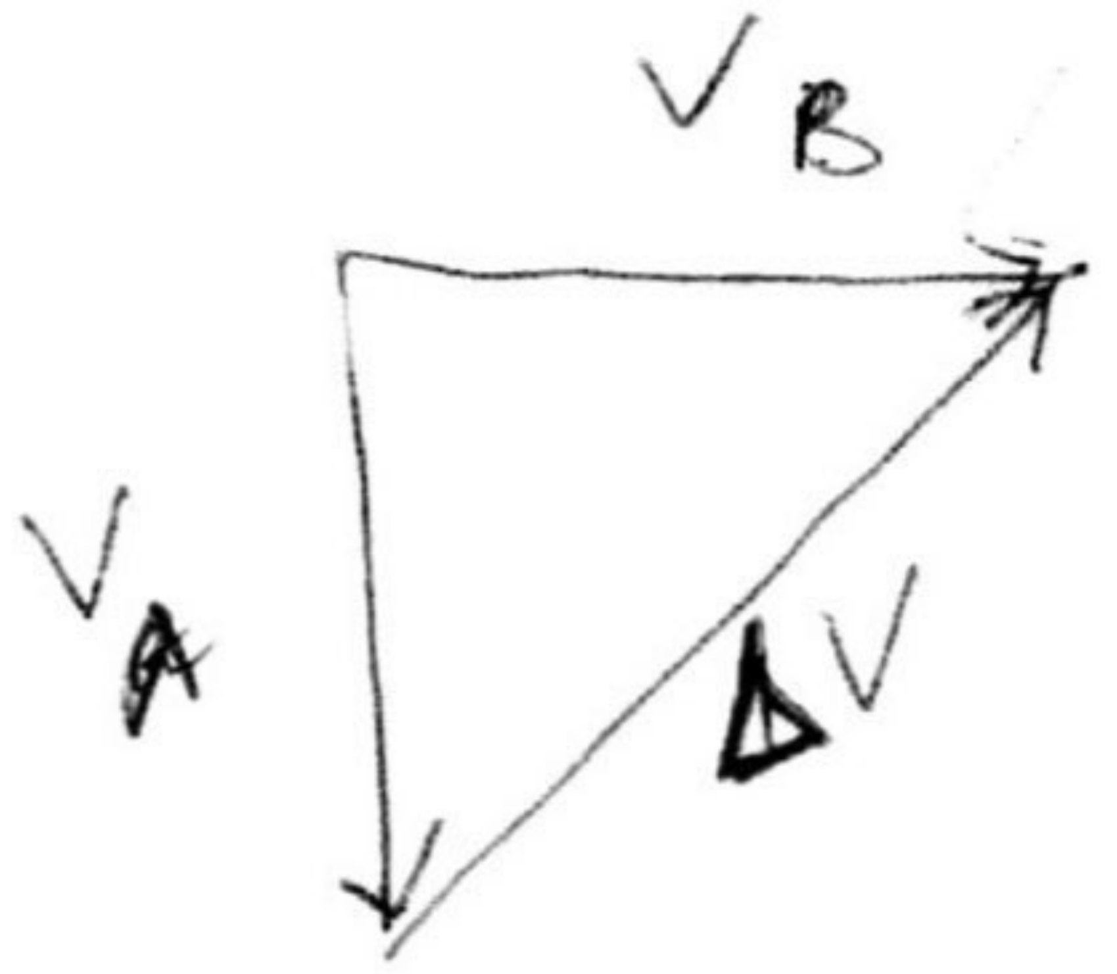
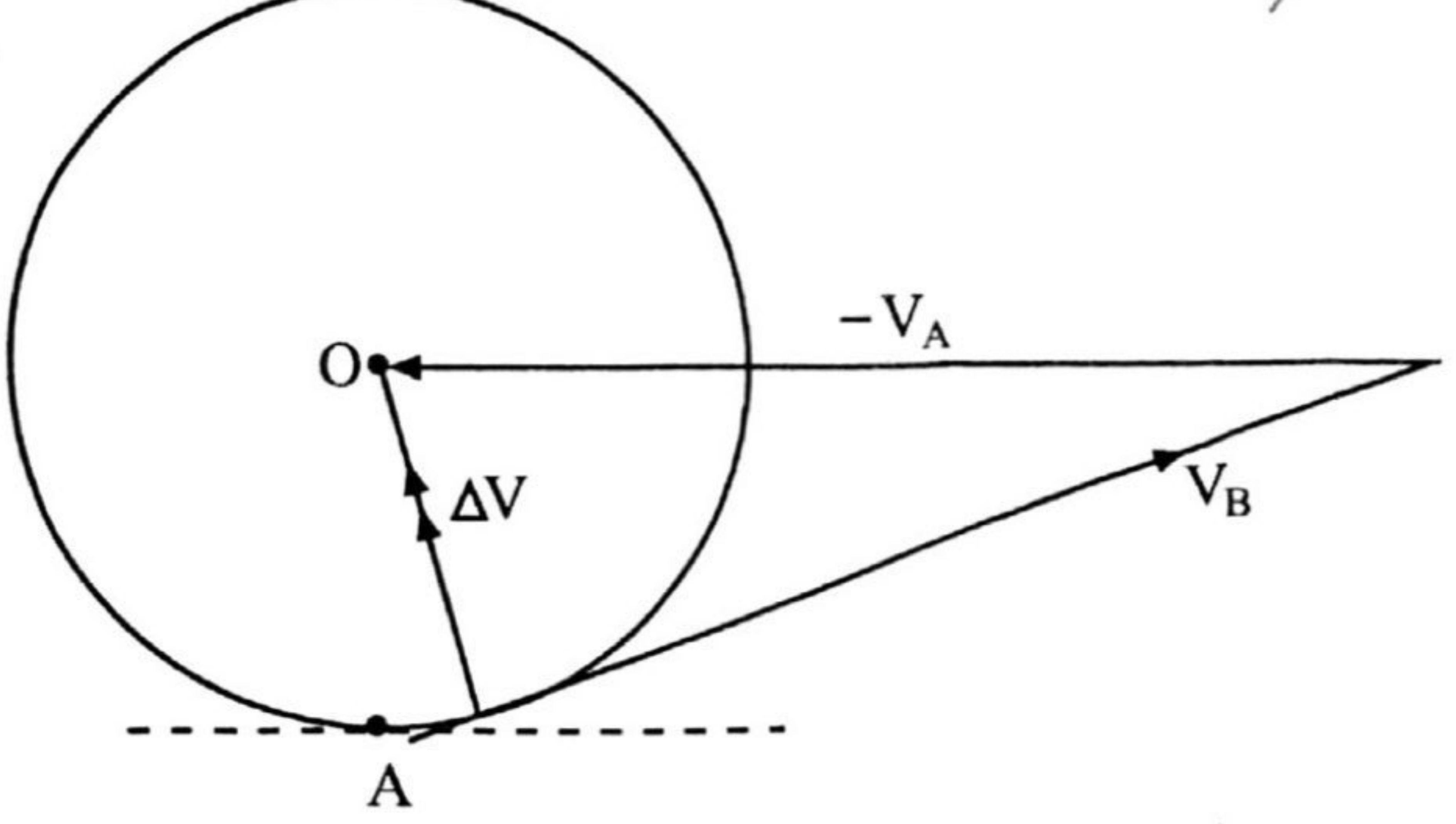
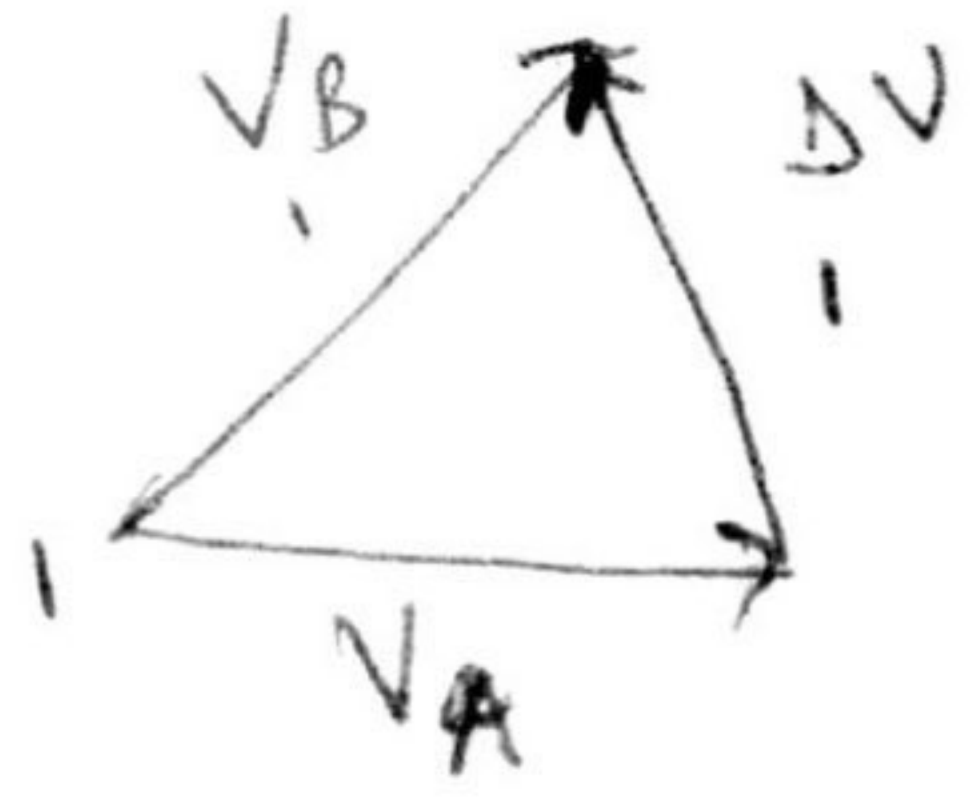


Max 2marks



(c) (i)





B3

~~Not~~ velocity is changing - no mark.

(ii) speed is constant but direction is always changing ~~B0~~
or
there is centripetal force B1

(d) (i) similarity both result from superposition B1
+ any possible similarity

differences

diffraction is concerned with wavelets from same wave~~length~~ fronts/waves while B1
interference is concerned with wavefronts (waves) from separate coherent sources B1
max 2
any possible difference

(ii) $d\sin\theta = n\lambda$ ~~$d\sin\theta = n\lambda \quad \frac{1}{d} = N$~~ or ~~C1~~

$$\frac{1}{N}\sin\theta = n\lambda \quad N = \frac{\sin\theta}{n\lambda}$$ C1

For more number of ~~triangles~~ lines $\sin\theta = 1$ | $\theta = 90^0$ C1

$$\therefore N = \frac{1}{n\lambda} = \frac{1}{3 \times 500 \times 10^{-9}}$$ C1

$= \quad 6.7 \times 10^5$ (lines/metre) A1

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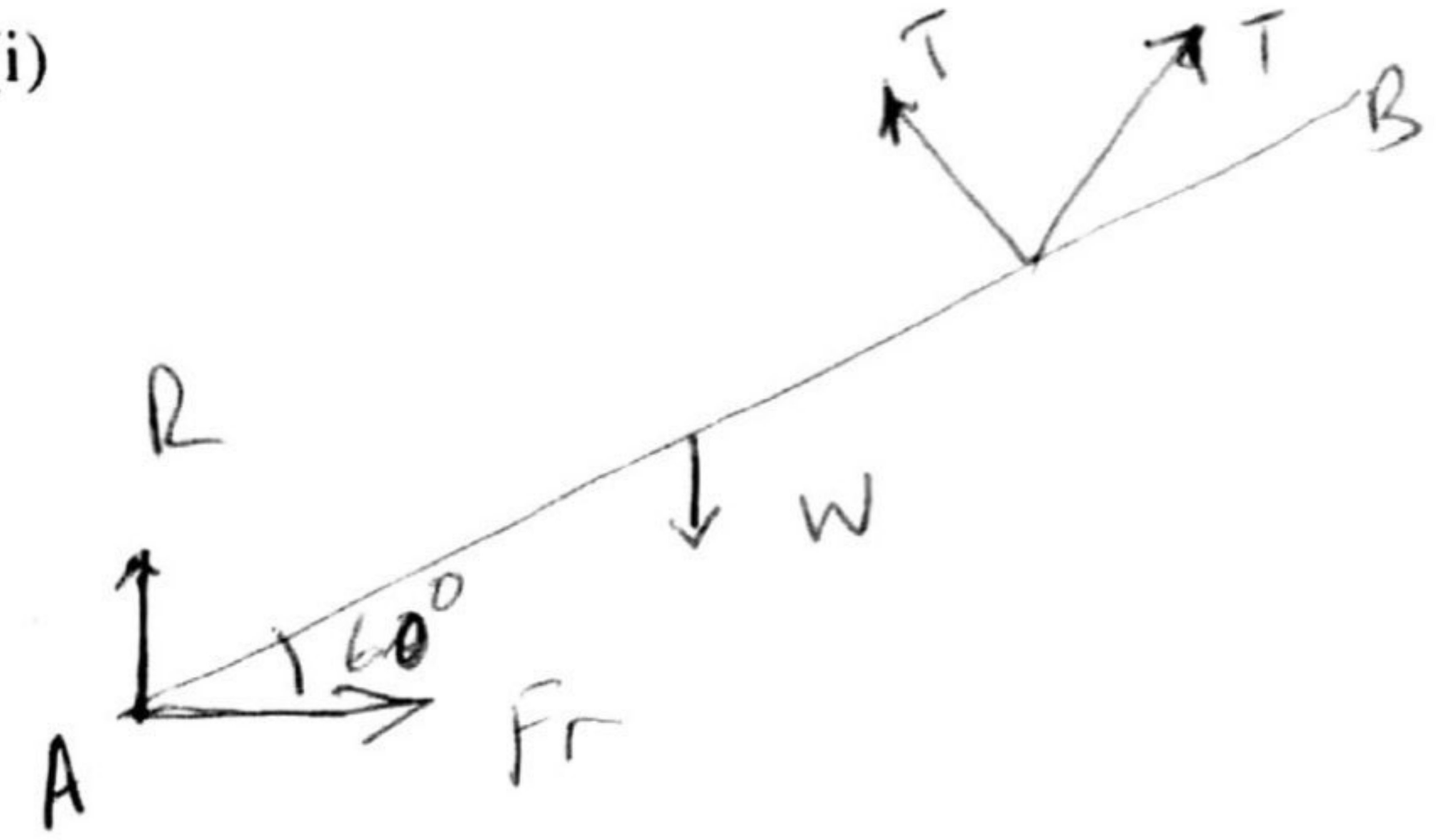
2 (a) $\sum F = 0$ [terms explained] A.W | reject clockwise M = anticlockwise M B1

$\sum T = 0$ A.W. reject clockwise M = Anticlockwise M. B1

(b) (i)



T = tension
W = weight 3 corre
R = normal 3m
Fr - friction.

At least 3 forces shown and labelled B3

(ii) taking moments about A

300 × 9.81 × 6cos60 = 2Tcos30 × 9 cos 60 C1

8829 = 7,79 T

T = 1133 N Accept 1 s.f. A1

1132,7 N, 8 N.

(iii) the tree would balance horizontally B1

Any possible - tree balance

(iv) it would break B1

Reason - all the weight of the tree (3 000 N) need to be supported by cable: 3 000 N > 2 000 N B1

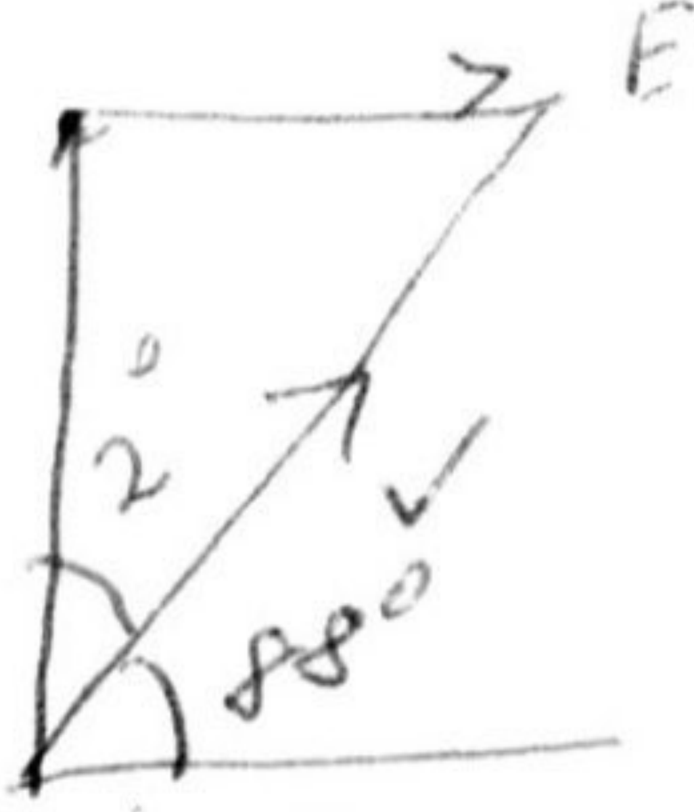
2943N

2943 > 2000 N

3 (a) In a ~~closed~~ isolated system, of colliding bodies total momentum is ~~conserved~~ constant B2

(b) (i) $3\,000 \times 5 = 4\,000 \times V\sin\theta$ C1

$1\,000 \times 0.5 = 4\,000 \times V\cos\theta$ C1



$\tan\theta = \dfrac{3\,000 \times 5}{1\,000 \times 0,5}$ C1

$\theta = 88°$ to the Fast horizontal Diagram with θ = A1

(ii) $V = \dfrac{3\,000 \times 5}{4\,000 \times \sin 88}$ ecf. A1

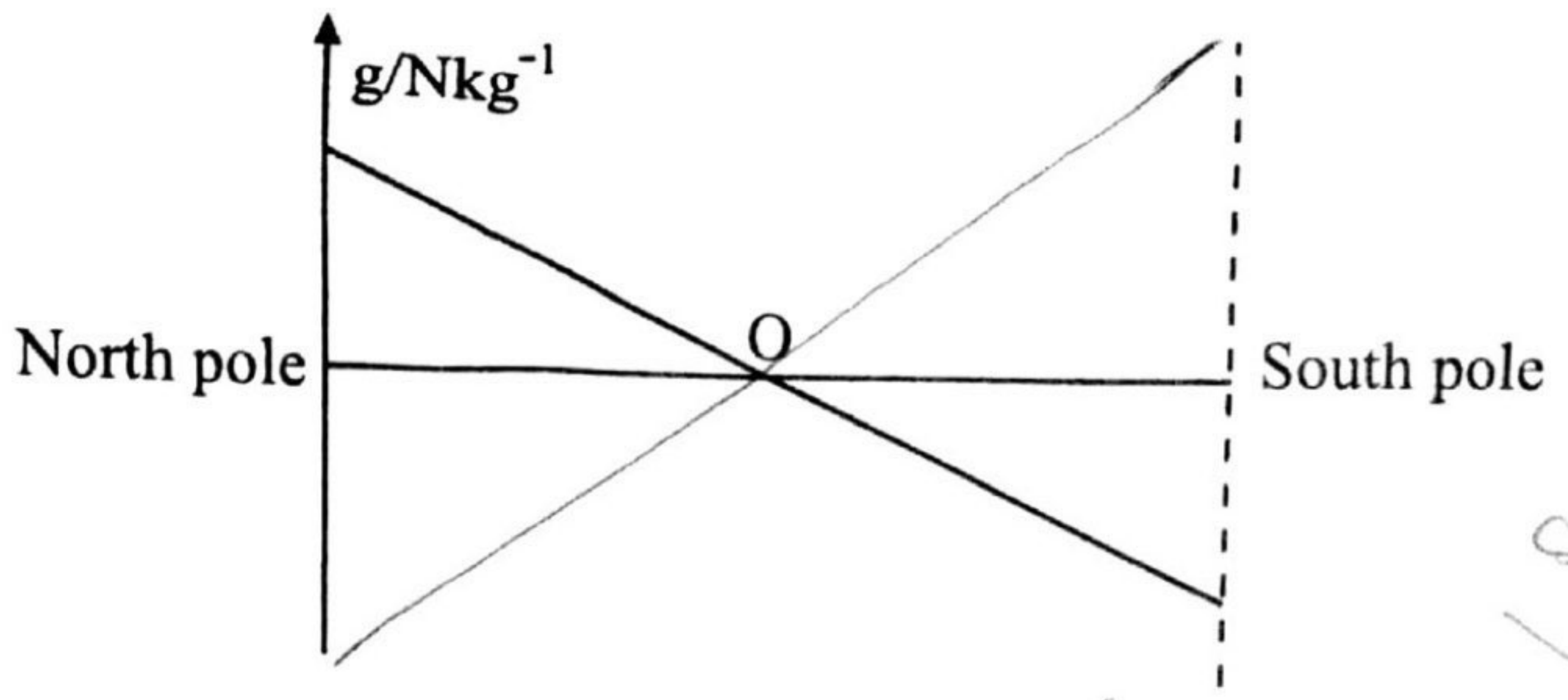
$V = 3,75$ m/s 1 sig f. accept. A1

(c) - not conserved | conserved bec boat is part of system A1

- Momentumafter < momentum before M1

4 (a) Force per unit ~~area~~ mass   terms deffined correctly   B1

(b) (i)



shape   B1

(ii) $\left[F = \frac{GMm}{x^2} \right]$ $\frac{M}{ME} = \frac{x^3}{R^3}$ ✓marking

F = ma and $-a = g$ $\left[g = \frac{GM_E}{R^2} \right]$ idea of negative in path of equation   B1

$\therefore ma = \frac{-gxm}{R}$ B1

$a = -\frac{gx}{R}$ ~~equilibrium~~ equation for shm   ~~A0~~

(iii) $w^2 = \frac{g}{R}$ / $w = \frac{2\pi}{T}$ C1

Time from North pole to South pole = $\frac{1}{2}$T

$t = \frac{1}{2}T = \pi\sqrt{\frac{6.4 \times 10^6}{9.81}}$ C1

= 2 537.5 s   accept 3 sgfs   A1

Or 42 min

= 0,7 hrs

Award 2 for T = 5074 s only

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(c) - friction between satellite and air molecules B1

- solid state materials used to make functional parts have short lives B1
- corrosion of parts of satellite causes deterioration of satellite B1
- collisions with either terrestrial bodies cause damage of satellite B1
- system failure causes satellite to be short live/AW B1

max2.

- constant exposure to sunlight
- fuel get used up.

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

9188/3

PAPER 3 Theory

JUNE 2018 SESSION

50 minutes

Additional materials:
Answer paper
Scientific Calculator and / or Mathematical tables
Ruler (mm)

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **three** questions.

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INFORMATION FOR CANDIDATES

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You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 8 printed pages.

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Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho vr}{\eta}$
drag force in turbulent flow,	$F = Br^2\rho v^2$

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Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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*Answer **question 1** and **any other 2** from the remaining questions.*

1 (a) (i) Define the term *homogenous equation.*

(ii) Explain why a homogenous equation is not always correct.

(iii) The volume, V, of a liquid that flows through a pipe in time, t, is given by

$$\frac{V}{t} = \frac{\pi P r^6}{8\,Cl}$$

where P, is pressure difference between the ends of the pipe of radius, r, and length, l. C is a constant.

1. Determine the base units of C.

2. Hence suggest what the quantity C represents. [6]

(b) (i) Define *impulse.*

(ii) An object of mass 4 kg moving at 12 m/s due east is subjected to an impulse of 30 Ns.

Calculate the final momentum of the object if the direction of the impulse is

1. due east,

2. due north. [5]

(c) (i) State what provides the centripetal force for an aeroplane turning in flight.

(ii) **Fig.1.1** shows a 50 g metal ball secured to a ceiling by a weightless string of length 1.5 m. The ball is raised through a height of 50 cm and then released.

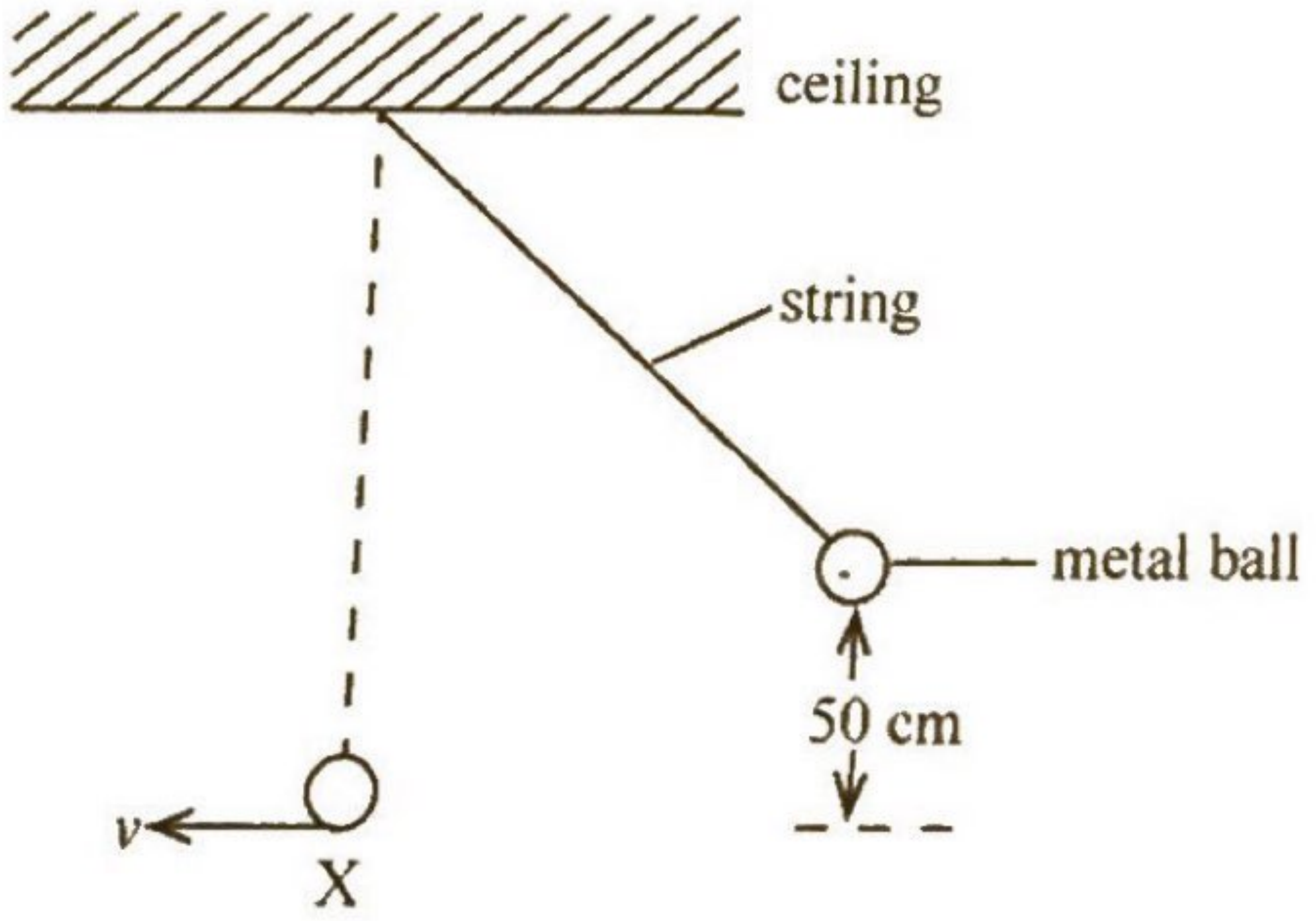

Fig.1.1

1. Calculate the speed, v, as the ball passes through point X, the equilibrium position.

   (ignore air resistance)

2. State and explain whether or not the tension in the string is equal to the weight of the ball at point X. [5]

(d) **(i)** Define *critical angle*.

(ii) Explain why the critical angle is never reached when light moves from an optically less dense medium to an optically denser medium.

(iii) Suggest why optical cables are made up of very thin fibres but not one solid thick rod. [4]

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2 Fig.2.1 shows how the velocity of an object dropped from a hovering helicopter at high altitude varies with time.

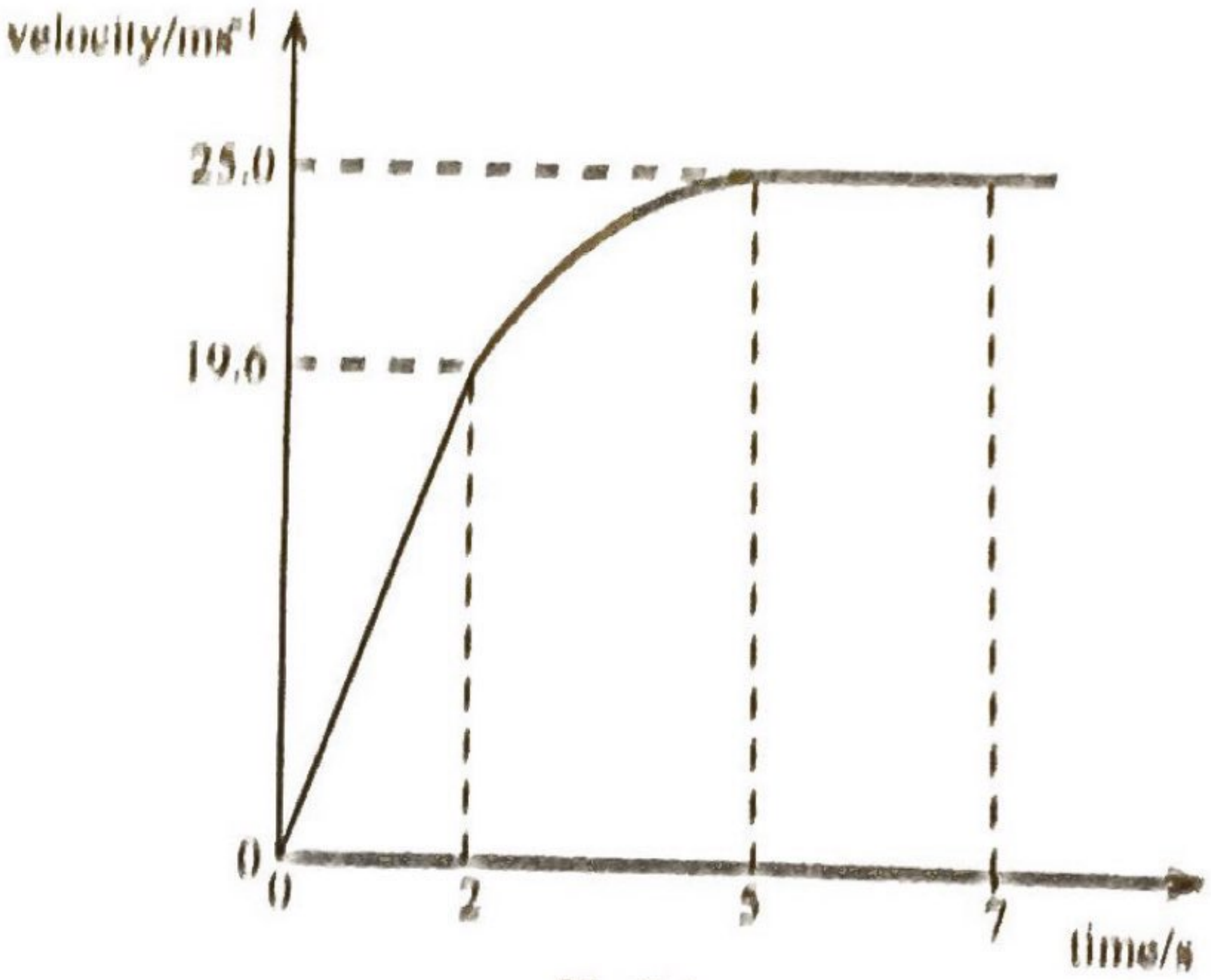

Fig.2.1

(a) State how distance moved can be obtained from a velocity-time graph. [1]

(b) (i) Calculate the

1. change in height,

2. acceleration in the first 2 seconds.

(ii) Explain the motion of the object from

1. 0s to 2s,

2. 2s to 5s,

3. 5s to 7s.

[6]

(c) Explain how a parachute would ensure a safer landing of the object. [3]

3 (a) Define

(i) *simple harmonic motion,*

(ii) *phase difference*

[2]

(b) Fig.3.1 shows how the displacement of an oscillating particle varies with time.

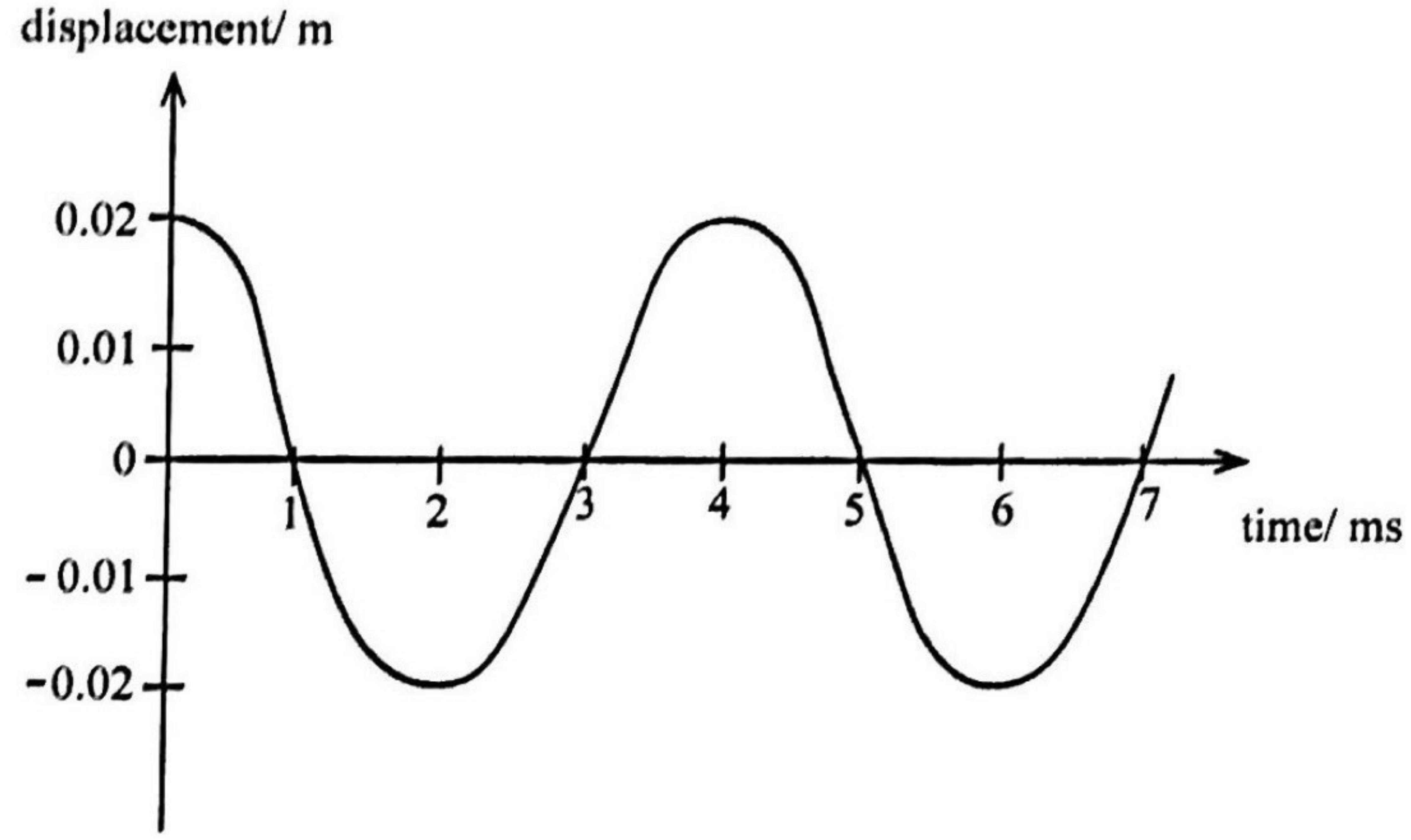

Fig.3.1

(i) Determine the

1. frequency of the particle,
2. phase difference between time $t = 0$ ms and time $t = 5$ ms,
3. maximum acceleration.

(ii) Sketch a labelled graph to show the variation of acceleration with displacement. [8]

4 (a) State how coherence is achieved in order to observe interference of

(i) water waves in a ripple tank,

(ii) light waves in a double slit experiment. [2]

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(b) **Fig.4.1** illustrates the positions of dust particles disturbed by a sound wave.

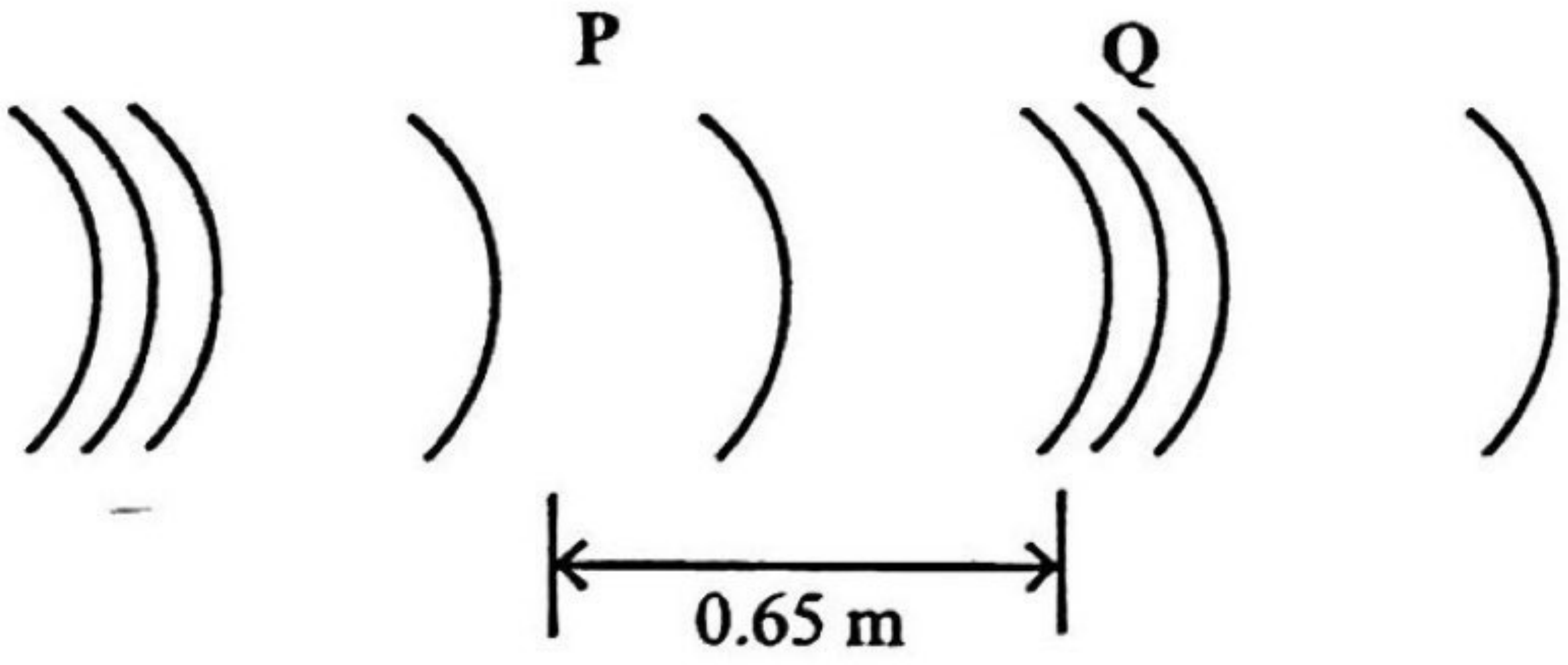

Fig.4.1

(i) Name the regions **P** and **Q.**

(ii) Determine the wavelength of the sound wave. [3]

(c) **Fig.4.2** shows monochromatic yellow light falling normally on a diffraction grating with 500 lines per millimetre and yellow spots are observed on a rule 2.00 m away.

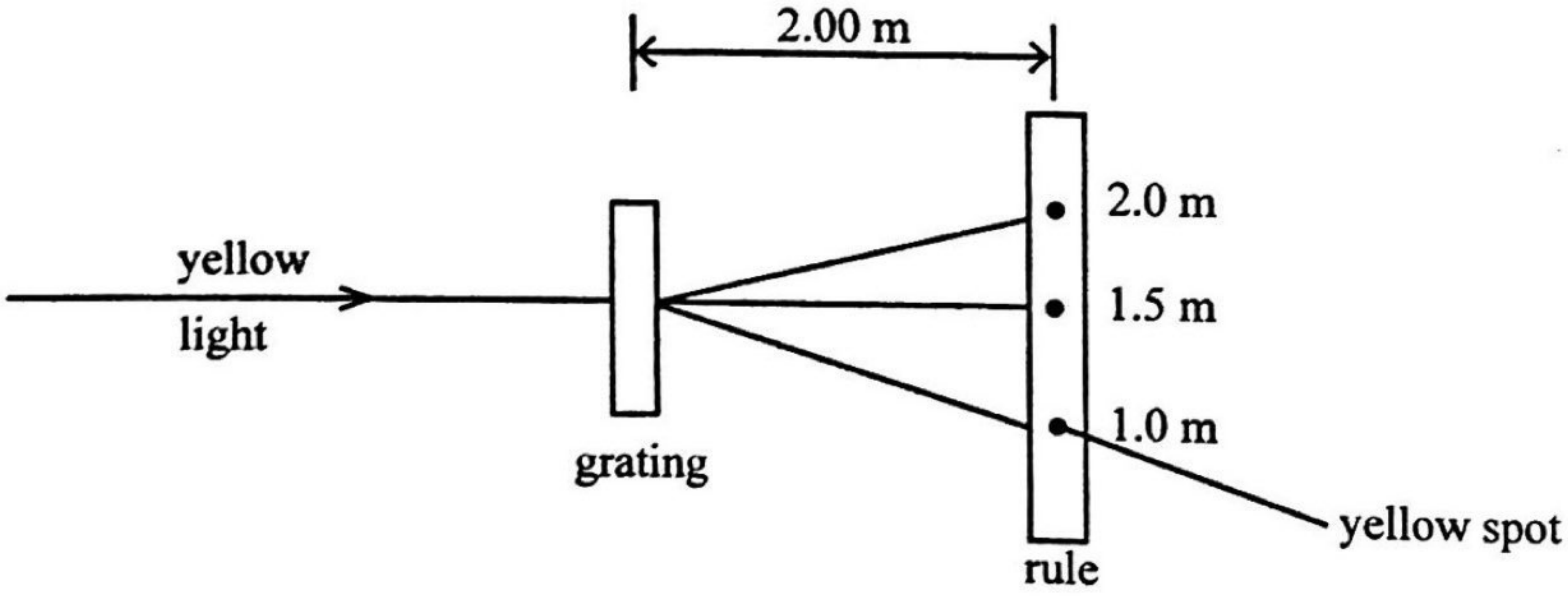

Fig.4.2

Calculate the wavelength of the light. [3]

(d) State and explain **one** use of lasers in Clinical therapy. [2]

H

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Ordinary Level

MARKING SCHEME

JUNE 2018

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1 (a) (i) Homogenous equation – when the (base) units on the right hand side equals base units on the left hand side B1

(ii) Homogenous equation does not consider constants B1

(iii) 1. $C = \frac{\pi P r^6 t}{8 V l}$ C1

Units of C $= \frac{\text{kg ms}^{-2}.\text{m}^{-2}.\text{m}^{6}.\text{s}}{\text{m}^{3}.\text{m}}$ no mark for wrong physics C1

$= \text{kgms}^{-1}$ A1

2. C is momentum, [illegible] / A. B1

(b) (i) change in momentum / product of Force & time B1

(ii) 1. Final momentum = 12 x 4 +30 C1

= 78 Ns east A1

2. final momentum = $\sqrt{48^2 + 30^2}$

at $\tan^{-1}\left(\frac{30}{48}\right)$ C1

= 56.6N E32° N A1

(c) (i) horizontal component of the lift force B1

(ii) 1. $V = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 0.5}$ C1

= 3.10 m/s A1

2. not equal A1

centripetal force depends on tension and weight M1

(d) (i) Angle of incidence for which the angle of refraction is 90 . B1

for light moving from optically denser medium to an optically less dense medium B1

(ii) Refracted ray always bends toward the normal B1

(iii) when thin they can easily be bend B1

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2 (a) Area under the graph

(b) (i) 1 $\Delta h = \frac{1}{2}\times 19.6\times 2 = 19.6$ m (A1

2 a = 19.6/2 = 9.8 ms^{-2} A1

(ii) 1 Constant acceleration – since air resistance is negligible at low speeds B1

2 Decreasing acceleration B1
since air resistance increases with speed B1

3 Constant velocity (since air resistance is equal to weight) B1

(c) large canopy ~~B1~~ C1
increases air resistance B1
hence reduces terminal velocity B1

3 (a) S. h. m $a \propto x$ ~~B1~~
a opposite x B1
phase difference : $\frac{2\pi\Delta t}{T}$ / $\frac{2\pi x}{\lambda}$ terms explained B1
~~Max B2~~

(b) 1 $f = \frac{1}{4\times10^{-3}}$ C1

250 Hz A1

2. $\phi = \frac{5}{4}\times 2\pi = 2\frac{1}{2}\pi$ / A1

3 $a = -\omega^2 r$ C1

$= 4.93\times10^4$ m/s^2 A1

(ii) Graph to show:

a straight line of negative gradient through the origin B1

critical values shown (a_{max}, $-x_{max}$) and
($-a_{max}$, x_{max}) B1

4 (a) (i) One motor drives both dippers B1

(ii) One light source illuminates both slits B1

(b) (i) P rarefaction Q compression B1

(ii) 2 x 0.65 C1

[illegible] A1

(c) $y = 2.0 - 1.5 = 1.5 - 1.0 = 0,5\text{ m}$ C1

$y = p\lambda D$

$= 500\times10^3\times\lambda\times2,00$ C1

$\lambda = 5\times10^{-7}\text{m}$ A1

(d) Scalpel –(intense and focused hence it)cuts with precision B2

[illegible]

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General Certificate of Education Advanced Level

MARKING SCHEME

JUNE 2018

PHYSICS **9188/5**

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B1

2. straight line of large constant gradient because resistance is small. B1

(ii) 1. In cold water, temperature is low so the resistance of the thermistor is high B1

so the lamp lights brightly B1

2. In hot water, temperature is high so thermistor resistance is low B1

so the lamp lights dimly. B1

(b) (i) The magnitude of the induced emf. is directly proportional to the rate of change of magnetic flux linkage B1

(ii) Emf $= \frac{N\,d\,\Phi}{dt}$

$= \text{BAN}\, d\,\frac{(Sin\omega t)}{dt}$

$= \text{BAN}\omega \cos \omega t$

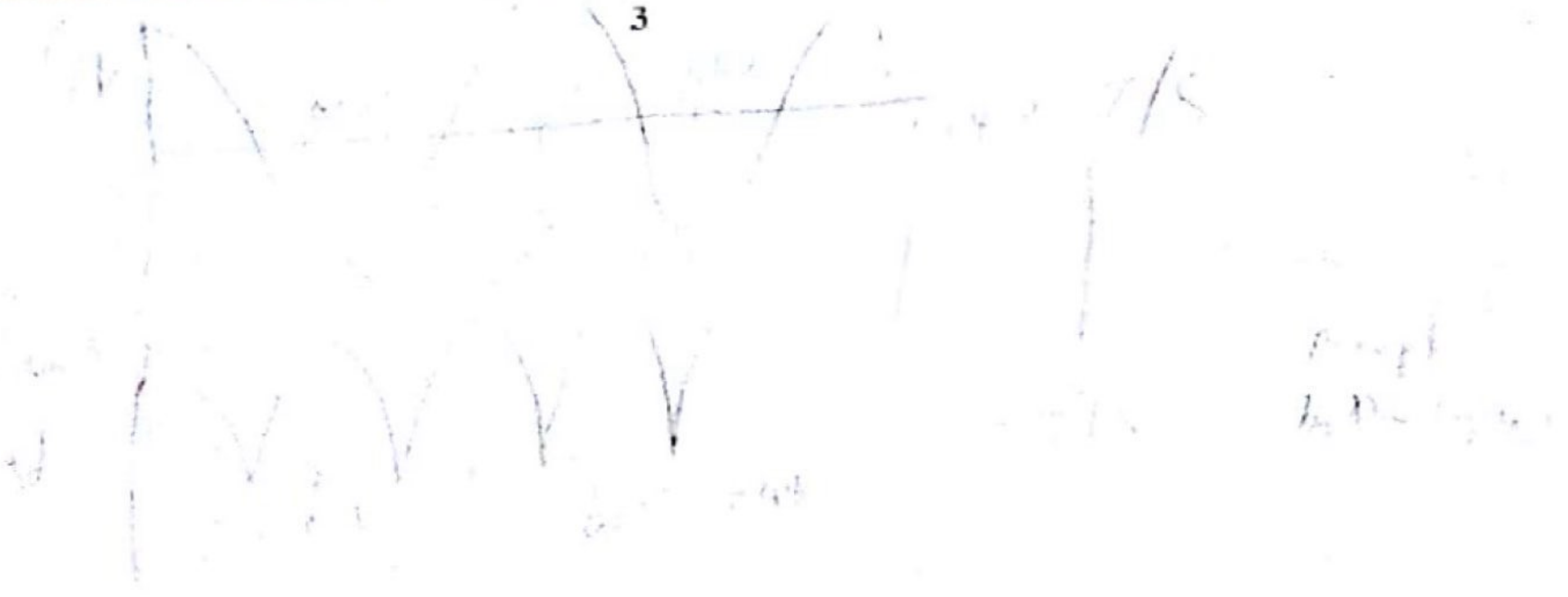
at max emf $\cos \omega t = 1$ C1

Max emf $= \text{BAN}\,\omega$

$= 5 \times 10$ [illegible] $\times 10 \times 10$ [illegible] $\times 5\,000 \times 100\pi$ C1

$=$ [illegible]

A1



Correct numerical labels on axes B1

Correct shape B1

Number of cycles (2) B1

(c) (i) 1. $\frac{hc}{\lambda} = E_{\infty} - E_0$

$$\lambda = \frac{h\ c}{E_{\infty} - E_0} \qquad \text{C1}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{-10.4 \times 1.6 \times 10^{-19}}$$

$$= 1.2 \times 10^{-7}\text{m} \qquad \text{A1}$$

2. Using $\lambda = \frac{h}{p}$

$$\Rightarrow p = \frac{h}{\lambda}$$

$$= \frac{6.63 \times 10^{-34}}{1.2 \times 10^{-7}} \qquad \text{C1}$$

$$p = 5.5 \times 10^{-27}\text{kgms}^{-1} \qquad \text{A1}$$

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(ii) ultra-violet B1

(d) (i) Probability of disintegration per unit time B1

(ii) Activity A $= \lambda N$

$N = \frac{m}{M} \times Na$

$= \frac{131 \times 10^{-3}}{131} \times 6.02 \times 10^{23}$ C1

$= 6.02 \times 10^{20}$

$A = 6,02 \times 10^{20} \times 1.003 \times 10^{-6}$ C1

$= 6,04 \times 10^{14} s^{-1}$ A1

(iii) Thyroid gland naturally absorbs iodine from the blood stream B1

iodine -131 has a short half life B1

iodine -131 is a gamma ray emitter. B1

[Max 2]

2 (a) conductors have delocalised (free) electrons B1

insulators have localised electrons B1

(b) (i) total number of electrons lost by one material equals total number of electrons gained by the other material B1

so total charge on both materials remains unchanged

(ii) 1. the Perspex rod is brought near the sphere B1

with the rod still in place, the far side of the sphere is earthed briefly B1

the rod is then removed B1

OR clearly labelled diagrams

2 the charged sphere is brought near the cap of a negatively charged gold leaf electroscope B1

the gold leaf diverges more, confirming the negative charge on the sphere B2

OR alternative method

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(c) (i) high concentration of charge at the sharp; points makes it highly likely for the discharge of the cloud to occur through the lightning conductor. B1 B1

(ii) the paint coating on the object is uniform or other advantage B1

3 (a) In compressible B1

non viscous B1

(b) (i) $A_1v_1 = A_2v_2$ C1

$v_2 = \frac{A_1v_1}{A_2}$

$v_2 = 4v_1$ B1

(ii) $P_1 + \frac{1}{2}P_w v_1^2 = P_2 + \frac{1}{2}P_w(4v_1)^2$

$16v_1^2 - v_1^2 = 2\frac{(P_1-P_2)}{P_w}$ C1

$P_1 - P_2 = e_{Hg}gh$ C1

$15v_1^2 = \frac{2(P_1-P_2)}{Pw}$

$v_1^2 = \frac{2P_{H}gh}{15P_w}$ C1

$v_1 = \sqrt{\frac{2 \times 13{,}600 \times 9.81 \times 2{,}5 \times 10^{-2}}{15 \times 1\,000}}$ C1

$= 0{,}67\ ms^{-1}$ A1

$v_2 = 4v_1 = 2{,}68\ ms^{-1}$ A1

(c) if $A_d < A_w$ the window will produce air current with high pressure B1

the door at high velocity and low pressure B1

pressure difference causes the door to bang B1

4 (a) capacitance is the ratio of charge to voltage B1

A farad is a capacitance when a charge of 1 coulomb is stored when the p.d. across the capacitor is 1 volt B1 or

1F = C V^{-1} B1

(b) (i) $V = V_1 + V_2 + V_3$ C1

$V_2 = \frac{Q}{G}$ and $V_2 = \frac{Q}{C_2}$, $V_3 = \frac{Q}{C_3}$

$\frac{Q}{C_{total}} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$ C1

$\therefore \frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ AO

(ii) 1. **Total capacitance**

$C_{total} = \frac{2 \times 10}{12}$ C1

$= \frac{20}{12} = 1.67\ \mu F$ A1

$\therefore$ charge through 2 μF is 10 μ C charge through 5 μF is $\frac{10}{2} = 5\ \mu C$ A1

A1

2. $E = \frac{1}{2} CV^2$

$= \frac{1}{2} \times 5 \times 1$ C1

$= 2.5\ \mu$ J A1

(c) Some of the energy is lost in the connecting wires as heat B1

B1

5 (a) 1 Light dependent Resistor LDR B1

2 OR gate B1

3 Buzzer (audio) or LED (visual) B1

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(b) (i) opamp has infinitely large slew rate, i.e. there is no time delay between change in input and output **B1**

(ii) Ideal opamp has ~~very low~~ output impedance i.e. delivers large currents **B1**

(c) (i) inverting mode **B1**

(ii) Gain A $= \dfrac{vout}{vin} = -\dfrac{R_f}{R_{in}}$ **C1**

$$= -\frac{50\ k\Omega}{5\ k\Omega}$$

$$= -10$$ **A1**

(iii) Vout $= -A(\text{Vin})$ but Vin $= \sqrt{2}.$ Vims

$= -10\ (0.71)$ $= \sqrt{2} \times 0.5$

$= -7.1\text{V}$ $= 0.71$

Graph to show
Peak values
Correct shape
Vout inverted
Correct period

B4

(b) (i) opamp has infinitely large slew rate, i.e. there is no time delay between change in input and output B1

(ii) Ideal opamp has ~~very low~~ output impedance i.e. delivers large currents. B1

(c) (i) inverting mode B1

(ii) Gain A $= \frac{vout}{vin} = -\frac{R_f}{R_{in}}$ C1

$= -\frac{50\ k\Omega}{5\ k\Omega}$

$= -10$ A1

(iii) Vout $= -A(\text{Vin})$ but Vin $= \sqrt{2}.\ \text{Vims}$

$= -10\ (0.71)$ $= \sqrt{2} \times 0.5$

$= -7.1\text{V}$ $= 0.71$

Graph to show
Peak values
Correct shape
Vout inverted
Correct period

B4

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

6032/3

NOVEMBER 2018 SESSION 2 hour 30 minutes

Additional materials:
Answer paper
Electronic calculator

TIME 2 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question 1 is compulsory.

Answer any other **three** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 10 printed pages and 2 blank pages.

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[Turn over

DATA

speed of light in free space	$c = 3.00 \times 10^8 \ ms^{-1}$
permeability of free space	$\mu_o = 4\pi \times 10^{-7} \ Hm^{-1}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \ Fm^{-1}$ ($1/4\pi \ \varepsilon_0 = 8.99 \times 10^9 \ mF^{-1}$)
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ Js
unified atomic mass unit	$1 \ u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31 \ JK^{-1} \ mol^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \ mol^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \ JK^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \ Nm^2 \ kg^{-2}$
acceleration of free fall	$g = 9.81 \ ms^{-2}$

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FORMULAE

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\,\Delta V$
gravitational potential	$\varnothing = - Gm/r$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$
	$v = \pm\omega\sqrt{(x_o^2 - x^2)}$
Attenuation of x-rays	$I = I_o e^{-\mu x}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi \varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_o \sin\omega t$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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Answer question 1 and any other 3 from the remaining questions.

1 **(a)** **(i)** Express the *volt* in base units.

(ii) Identify vectors and scalars from the following list of quantities:

electric field strength
tensile stress
momentum

[4]

(b) The resistive force, F, acting on a sphere depends on its radius, r, speed, v, and density, ρ, of medium.

(i) State the base units of F, ρ, and v.

(ii) Hence derive an equation for F in terms of ρ, v and r. [4]

(c) **(i)** Derive, using the definition of velocity and acceleration the equation:

$$v^2 = u^2 + 2as$$

(ii) A motorist travelling at 34 ms^{-1} spots a 30 ms^{-1} speed limit sign 50 m ahead. The reaction time for the driver is 0.2 s. On application of the brakes, the motorist decelerates uniformly at 5.0 ms^{-2}.

Deduce whether the motorist will attain the speed limit before reaching the sign.

[9]

(d) A grinding blade of diameter 40 m, rotates at 600 revolutions per minute when in use.

Calculate for a point on the edge of the blade, its

(i) linear speed,

(ii) acceleration.

[4]

(e) Satellites A and B, of the same mass are in orbit at heights of 6 370 km and 19 110 km respectively. Radius of the earth is 6 370 km.

Determine the ratio of

(i) potential energy of satellite B to potential energy of satellite A,

(ii) kinetic energy of satellite B to kinetic energy of satellite A. [4]

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$x = x_0$ Sinwt

SC —

2 (a) (i) Explain the concept of *damping*.

(ii) A car of mass 1.2 tonnes has four springs and oil dampers in its suspension system. At equilibrium each of the springs is shortened by 50 mm. To test if the springs and dampers are working the car is pressed vertically downwards 30 mm and released. The car executes simple harmonic motion when the dampers are not working and is critically damped when dampers are working.

SC~~ = x_0 Si

1. Determine the period of oscillation of the car when dampers are not working.

2. Sketch two graphs on the same axes to compare the oscillations of the car when dampers are not working and when they are working.

(iii) Describe energy changes that occur when oil dampers are working. [7]

(b) (i) State the *principle of superposition.*

(ii) Explain how progressive waves can be made to produce a stationary wave.

(iii) Explain why it is impossible to produce an observable interference pattern with two car headlights connected to the same battery. [6]

(c) (i) State any **one** property of X-ray radiation.

(ii) Estimate the wavelength of X-ray radiation.

(iii) With the aid of a well labelled diagram, describe how X-rays are produced in the tube.

(iv) Describe the energy changes in the x-ray production. [8]

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(d) **(i)** Explain the difference between the fringes produced by a grating and those produced by a pair of slits for the same light.

(ii) Using a pair of slits of separation 0.50 mm and red light of wavelength 546 nm, ten clear fringes are observed on a screen that is 0.80 m away from the slits.

Calculate the width of the ten fringes.

[4]

3 **(a)** **(i)** Define the terms

1. *electric field strength,*
2. *electric potential.*

(ii) State how electric field strength is related to electric potential.

(iii) **Fig.3.1** shows a charged oil drop held stationary between two parallel horizontal plates.

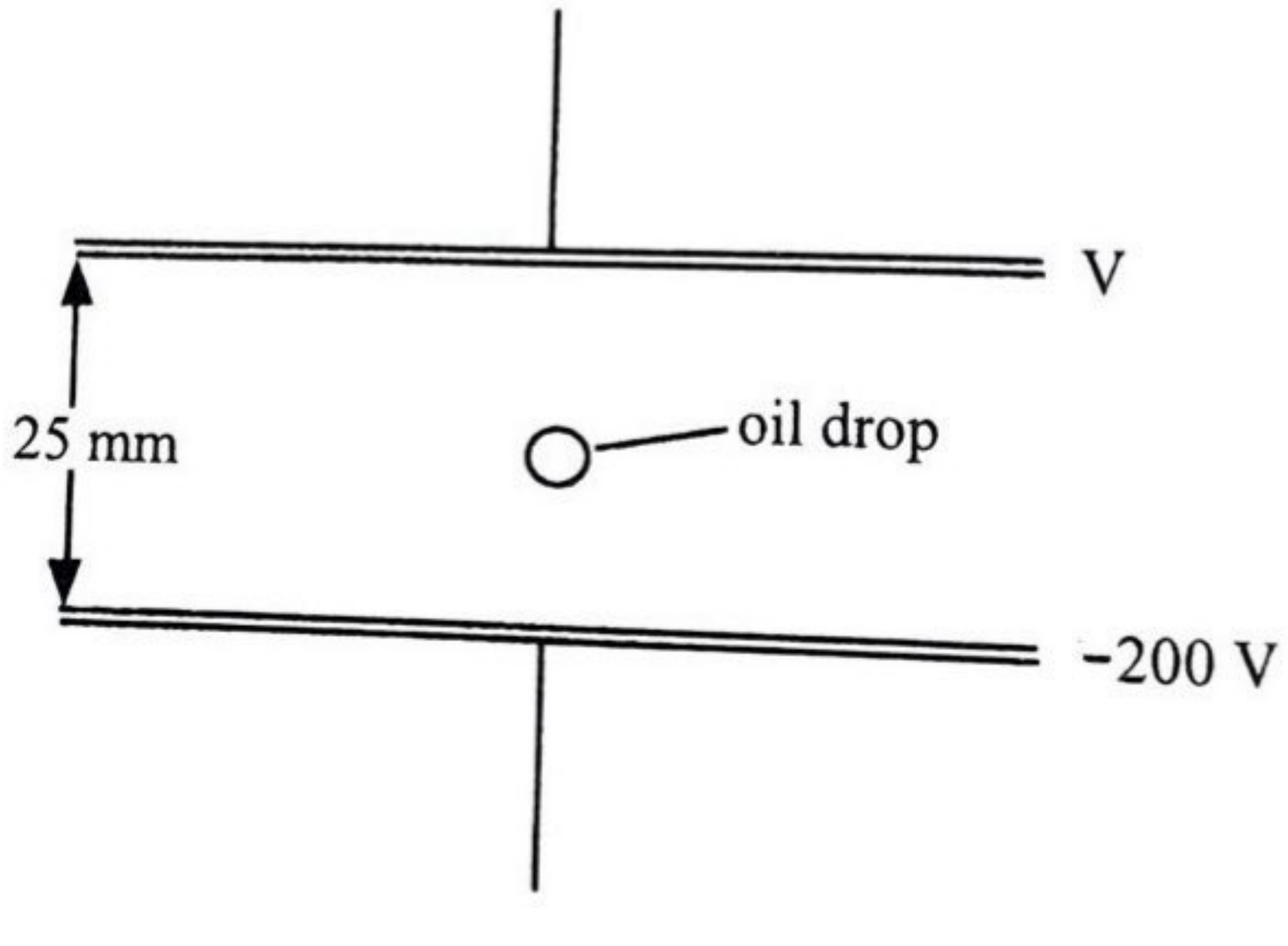

Fig.3.1

The oil drop has a mass of 5.0 mg and a charge of 64 μC.

Determine the value of the potential, V, on the top plate.

[7]

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3 **(b)** **(i)** State how negative feedback affects the bandwidth of an op-amp.

(ii) State any **one** characteristic of an ideal op-amp.

(iii) **Fig.3.2** shows an op-amp in use.

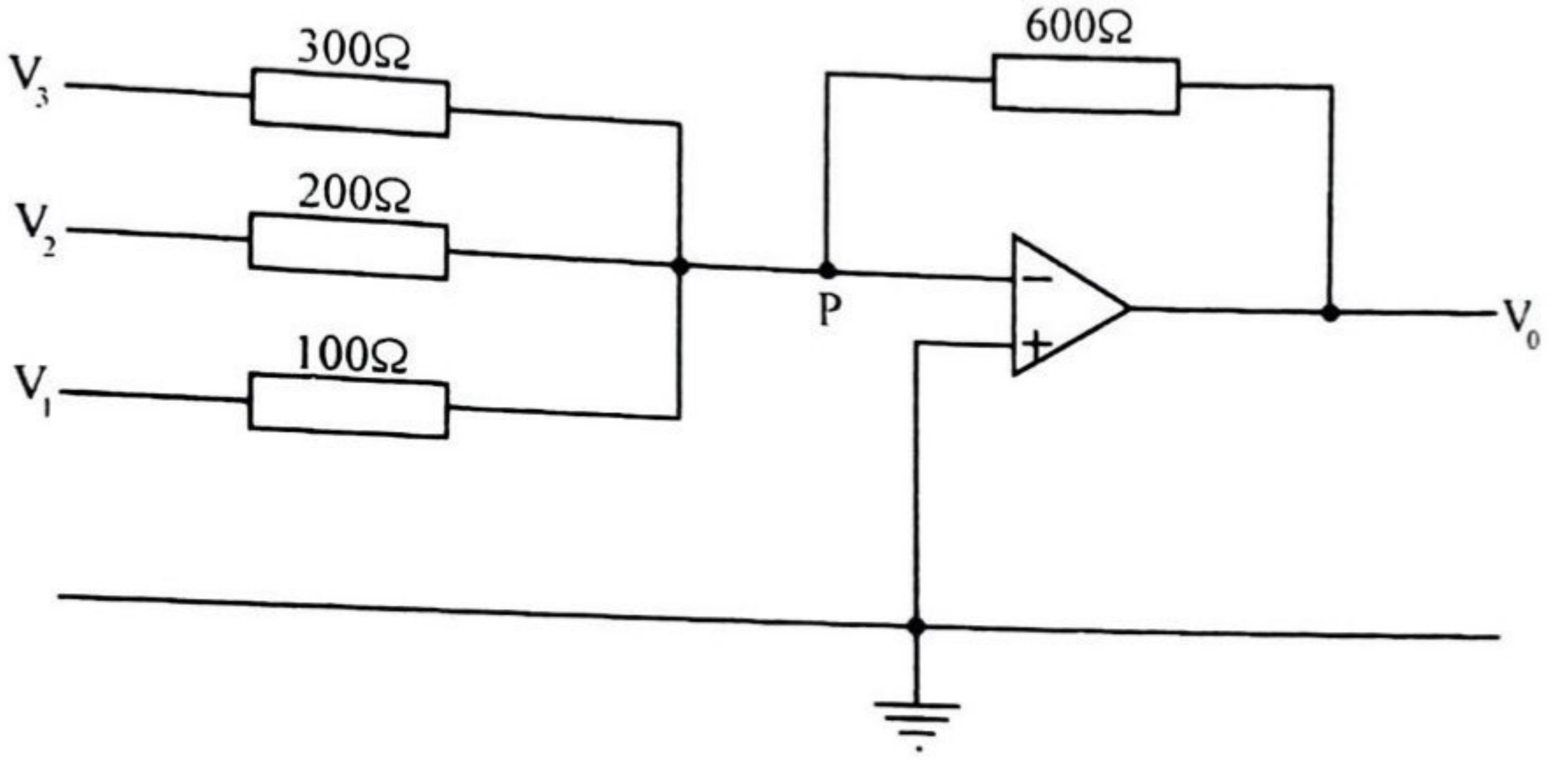

Fig. 3.2

1. For **Fig.3.2** show that $V_0 = -(6V_1 + 3V_2 + 2V_3)$.

2. State **one** practical situation where this circuit can be used.

3. Suggest **two** transducers commonly used as indicators to show the output of an op-amp. [7]

(c) **(i)** Define *magnetic flux linkage*.

(ii) Use Lenz's and Faraday's laws of electromagnetic induction to show that the input to a transformer and the output are out of phase. [3]

(d) **(i)** State any **two** reasons why oil is used in a transformer.

(ii) State and explain the economic advantage of using high voltages in the transmission of electricity.

$\Phi = BAN$

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(d) **(iii)** The value of alternating current generated by a source is given by

$$I = 15 \sin 6t.$$

The current flows through a 20 Ω resistor.

1. State the peak current value.

2. Calculate the period of the alternating current.

3. Determine the mean power dissipated by the 20 Ω resistor. [8]

4 **(a)** **(i)** State the *Zeroth Law* of thermodynamics.

(ii) State any two applications of the Zeroth Law. [4]

(b) **(i)** State the factors that affect the amount of heat, Q, needed to cause a certain temperature change, Δ T, of a substance.

(ii) A man of mass 80 kg had a body temperature of 39.0 °C instead of 37.0 °C.

Assuming that a human body is 65 % water, calculate the amount of heat required to cause this temperature rise, if specific heat capacity of water is 4 200 $Jkg^{-1}k^{-1}$. [6]

(c) **(i)** Compare any **four** properties of a constant volume gas thermometer with that of a thermocouple.

(ii) The cold junction of a thermocouple thermometer is maintained at 0.000 °C while the temperature of the hot junction is raised from 0.000 °C to 510.000 °C. The output voltage varied from 0.000 V to 28. 000 mV as the temperature was varied.

Determine the temperature of the hot junction when the output voltage is 10.200 mV. [7]

(d) **(i)** Explain what is meant by *mean square speed* of an ideal gas.

(ii) The density of a gas at 25 °C and pressure of 10^5 Pa is 1.29 kgm^{-3}.

Calculate the mean square speed, $< C^2 >$, of the gas.

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(iii) Determine the temperature of a gas if a gas molecule has a mean kinetic energy of 5.0×10^{-21}J. [6]

(e) Nitrogen has a melting point of 82 K and a boiling point of 96 K. Distinguish between nitrogen at 73 K and nitrogen at 273 K, in terms of

1. intermolecular spacing,
2. motion of molecules. [2]

5 **(a)** **(i)** Define a *carrier wave* and state the advantage of its use.

(ii) Distinguish between amplitude modulation and frequency modulation.

(iii) **Fig.5.1** shows a modulated wave.

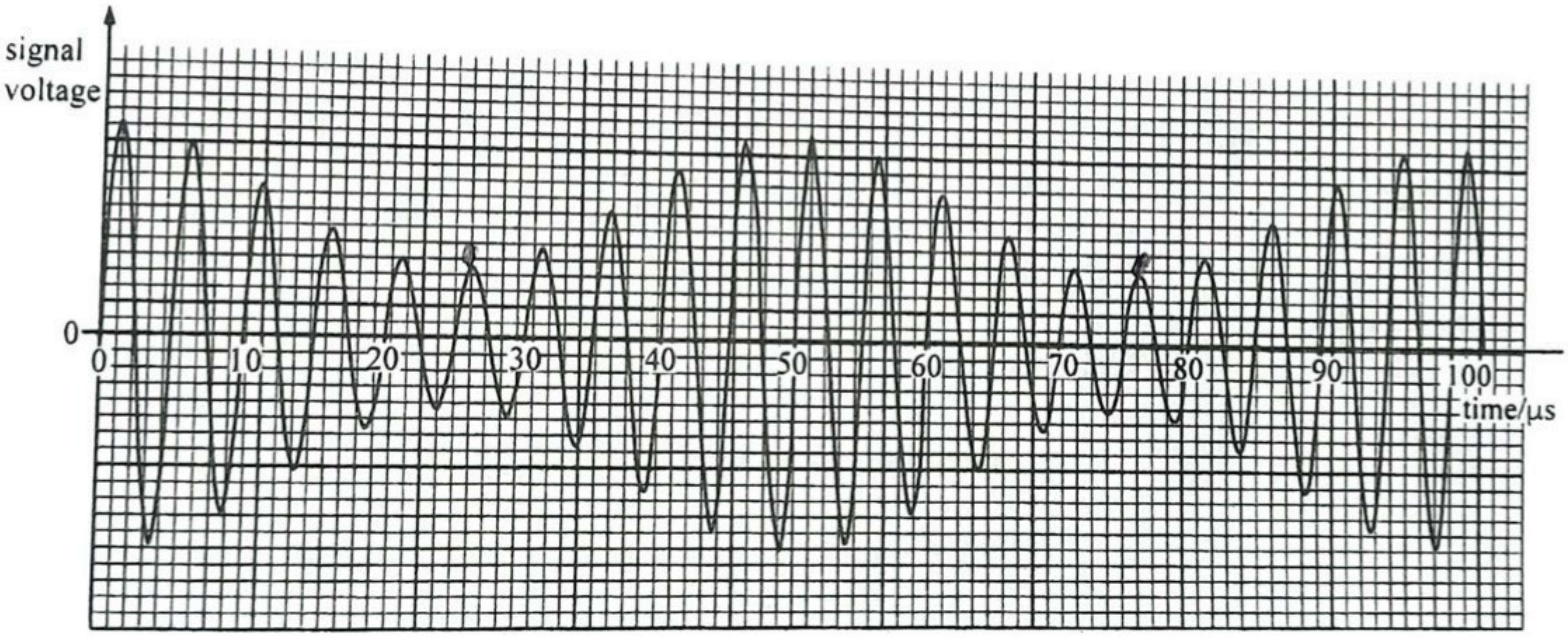

Fig.5.1

Using **Fig.5.1**

1. draw the frequency spectrum of the modulated wave,
2. determine the bandwidth. [8]

(b) **(i)** State what is meant by a *digital signal*.

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(ii) Explain how transmission of data in digital form is an advantage over the transmission of data in analogue form.

(iii) Describe how the accuracy of the reproduction of the original analogue signal can be improved in analogue to digital conversion. [5]

(c) **(i)** State any **two** advantages of using geostationary satellites.

(ii) In satellite communication

1. state how swamping is overcome,
2. why the satellites are used in conjunction with optical cables. [3]

(d) **(i)** Define *attenuation.*

(ii) State the advantage of using the decibel in comparisons.

(iii) The input power to a cable of length 40 km is 400 mW. The background noise is 3.0×10^{-13} W and the minimum signal to noise ratio permissible is 15 dB. The attenuation per unit length in the cable is 1.6 dB km^{-1}.

Calculate the

1. power output from the cable,
2. maximum interrupted length of cable along which the signal can be transmitted. [6]

(e) State the type of radio waves with frequency

1. between 3 MHz – 3 MHz,
2. greater than 30 MHz. [2]

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MARKING SCHEME

NOVEMBER 2018

PHYSICS **6032/3**

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1 (a) (i) $v = \frac{J}{c}$

$v = \frac{\text{kg ms}^{-2}\text{m}}{\text{A s}}$ C1

$v = \text{kg m}^2\text{s}^{-3}\text{A}^{-1}$ A1

(ii) Vectors - electric field strength B1

- Momentum ~~B1~~

Scalar - tensile stress B1

All 3 correct - 2 marks
2 correct - 1 mark
less than that - no mark

(b) (i) $[F] = \text{kgms}^{-2}$ $[\rho] = \text{kgm}^{-3}$ $[v] = \text{ms}^{-1}$ all correct B1

(ii) $F = K\rho^x r^y v^z$ C1

$\text{kgms}^{-2} = (\text{kgm}^{-3})^x . (\text{m})^y . (\text{ms}^{-1})^z$

$1 = x$

$1 = -3x + y + z$

$-2 = -z$

$\therefore x = 1, \quad y = 2, \quad z = 2$ C1

$F = K\rho r^2 v^2$ [ignore K] A1

(c) (i) velocity – rate of change of displacement B1

acceleration – rate of change of velocity $\left(\frac{v-u}{t}\right) = a$ symbols defined B1

distance = average speed x time C1

$s = \left(\frac{v+u}{2}\right)\left(\frac{v-u}{a}\right)$ 4 marks if terms defined. C1

$2as = (v+u)(v-u)$ C1

$2as = v^2 - u^2$

$v^2 = u^2 + 2as$ A0

(ii) thinking distance = 34 x 0.2

= 6.8 m C1

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distance covered during deceleration

$$\cancel{s} = \frac{34^2 - 30^2}{2 \times 5}$$

$$= 25,6\ \text{m}$$

Total distance = 25,6 + 6,8

= 32,4 m

A/Workings:

$v^2 = 34^2 + 2(-5)(50 - 6,8)$

$\underline{v = 26,9\ \text{m/s}}$ C1

Compare it with 30 m/s

$26,9 < 30$ C1

Total distance covered less than 50 m ∴ attain the speed limit before the speed limit sign / AW B1

(d) (i) $\overset{\omega}{\cancel{s}W} = \dfrac{600\ \overset{2\pi}{\cancel{rev}}}{60} \doteq 63\ \text{rads}^{-1}$ / 20π C1

$\therefore v = \omega r$

$= 63 \times \cancel{0}.20$ / 63×20 2/> (sf)

$= \cancel{12.6\ \text{ms}^{-1}}$ 1260 m/s, 1256,6 m/s, 1257 A1

(ii) $a = \dfrac{v^2}{r}$

$= \dfrac{(12,6)^2}{0,20}$ $\left\{\dfrac{(20\pi)^2 \times 20}{20}\right\}$ (e.c.f) C1

$= \cancel{800\ \text{ms}^{-1}}$ ~~7880 m/s~~ 78956,6 m/s A1

79380 m/s

(e) (i) P_E of A $= \dfrac{GMm}{12740}$ P_E of B $= \dfrac{GMm}{25480}$

$$\frac{P_B}{P_A} = \frac{-GMm}{25480} \times \frac{(12740)}{-GMm}$$ C1

$= \dfrac{1}{2}$ take note of order Ⓡ $\left(\dfrac{2}{1}\right)$ A1

Ⓐ 0,5

(ii) $\dfrac{KE\ \text{of}\ A}{KE\ \text{of}\ B} = \dfrac{1}{2}$, 0,5 - - - C1 A1

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2 (a) (i) Reduction in amplitude due to energy loss. /AW B1

Idea of energy loss ie friction

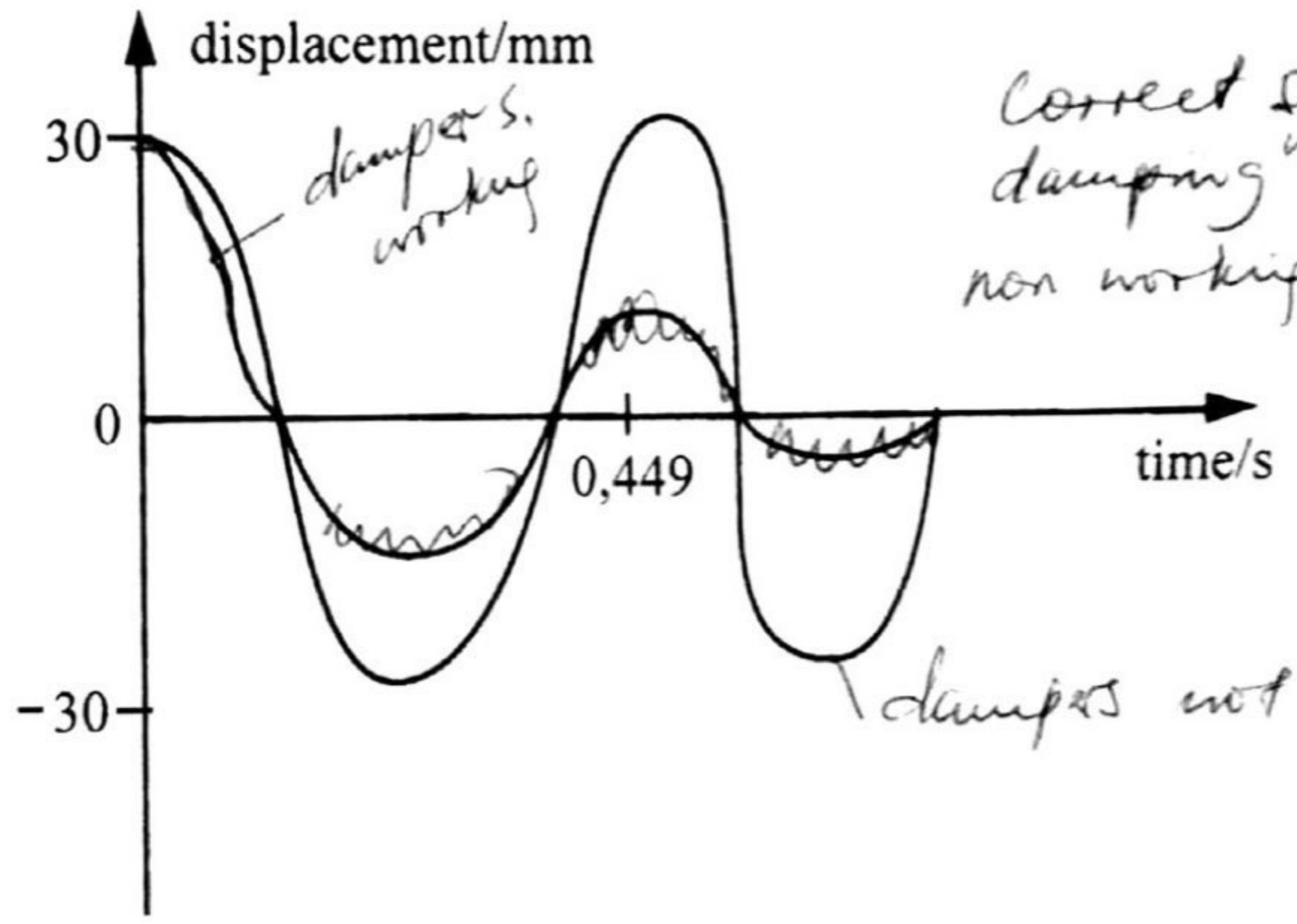
(ii) Using $a = \frac{kx}{m}$

$\omega^2 = \frac{k}{m}$ $\omega = \frac{2\pi}{T}$ C1

$T = \frac{mg}{\text{extension}}$ $K = \frac{1.2 \times 10^3 \times 9.81}{50 \times 10^{-3}}$ A1

$T = 0{,}449\ \text{s}$ A1

2.



Correct shape for damping working — B1
non working — B1

B2

Fig.2

heat energy (R) potential energy

(iii) Kinetic energy is converted into internal energy of the oil due to frictional forces. B1

(b) (i) Superposition is the meeting / overlapping/ interaction of waves to; B1
produce a combined effect /AW B1

(ii) - The progressive waves must be moving in opposite directions with the same frequency and amplitude. B1 B1 B1

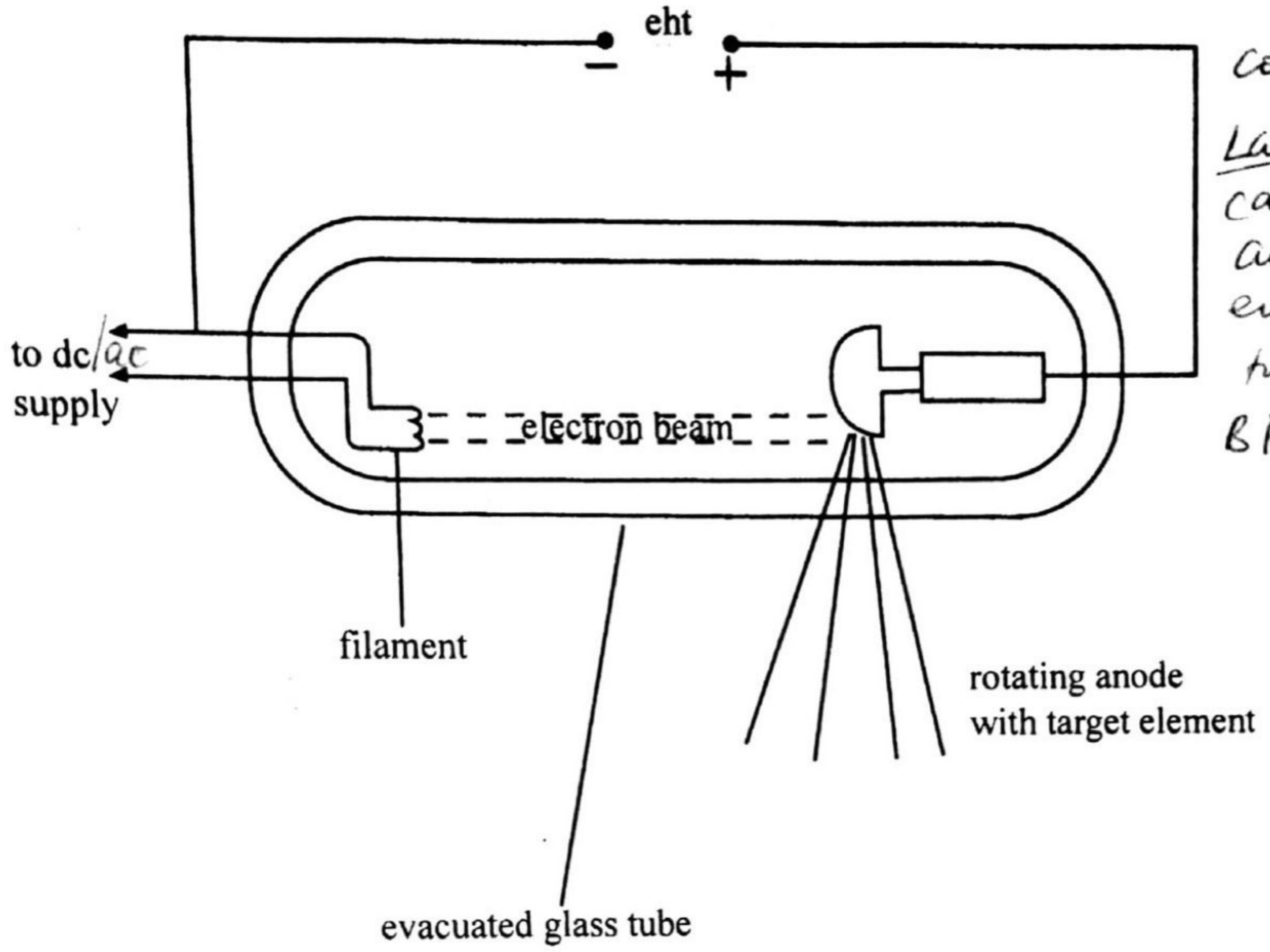
- They must interact in phase at some point in a medium to produce antinodes and at other points they must interact out of phase to produce nodes B1 B1 B1

(iii) ~~Loudspeakers are coherent sources while~~ car headlights are not coherent sources /AW – constant phase difference. B1

(c) (i) X-rays are short wavelength/ high frequency or high energy electromagnetic waves, travel with C in a vacuum B1
blackening of photographic plate,

(ii) 10^{-11}m to 10^{-9}m **B1**

(iii) 10^{-13}m. — 10^{-8} m



correct
Label
cathode
anode
evacuated tube } B1
B1 - diagram only.

B2

- electrons are emitted from the filament B1
- The electrons are accelerated by an accelerating tube voltage B1
- The fast moving electrons strike a target element on anode are stopped. / AW B1
- Their Kinetic energy is converted to (heat) and X-ray radiation B1

[max B3]

B1

(iv) Electrical energy (from supply) → Kinetic energy (of electrons) → Heat + x-ray radiation

(d) (i) Fringes from a grating are brighter and narrower than fringes from a pair of slits, equal **B1**

because a grating has several slits which allows more light than a pair of slits **B1**

(ii) Using $X_n = \frac{nD\lambda}{d}$

$$X = \frac{9 \times 0.80 \times 546 \times 10^{-9}}{0.50 \times 10^{-3}}$$ **C1**

$=$ ~~0.778 mm~~ / ~~0~~7,86 mm. (2 or > sf) **A1**

0,00786 m.

~~grating - not equal spaced~~
~~pair of slits - equal spaced~~

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3 **(a)** **(i)** 1. Force per unit positive charge $E = \frac{F}{Q}$ – unit positive charge - B1

2. Electric potential:- work done per unit (test) positive charge B1

in taking the charge from infinity to the point B1

(ii) E = $-\frac{dv}{dx}$ terms explained/ Omitt the differentials $E = -\frac{V}{x}$ with terms explained B1

– gradient of electric potential

(iii) $E = \frac{5.0 \times 10^{-3} \times 9.81}{6.4 \times 10^{-5}}$ C1

$= \frac{-200 - V}{25 \times 10^{-3}} = \frac{5.0 \times 10^{-3} \times 9.81}{6.4 \times 10^{-5}}$ C1

V = −220 V Ⓐ −219 V A1

lose A1 for omitting "−" sign

(b) (i) bandwidth is u~~nder at low gain~~ increased. B1

(ii)
- infinite input impedance B1
- zero output impedance B1
- infinite open loop gain Ⓡ high / large B1
- infinite slew rate B1
- infinite bandwidth B1

Max B1

(iii) 1. Op-amp does not draw any current / And $I_1 + I_2 + I_3 = I_F$ B1

- P point is virtual earth → $\frac{V_3 - 0}{300} + \frac{V_2 - 0}{200} + \frac{V_1 - 0}{100} = \frac{0 - V_0}{600}$ B1

$$\frac{V_3}{300} + \frac{V_2}{200} + \frac{V_1}{100} = \frac{-V_0}{600}$$ [illegible]

$$\therefore V_0 = -600\left(\frac{V_3}{300} + \frac{V_2}{200} + \frac{V_1}{100}\right)$$ C1

Ⓐ Any 1

$= -(6V_1 + 3V_2 + 2V_3)$ A0

2. music/ any plausible answer audio mixers / adding machines. B1

3. LED/ Buzzer/ Relay/ voltmeter B1, B1

(c) (i) - Magnetic flux linkage = NBA/ NΦ terms explained B1

(ii) - from Faraday's law there should be a change of flux for e.m.f to be induced B1

- from Lenz's Law, the induced e.m.f would be such as to oppose the effect causing it B1

hence input and output are out of phase. B0

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	(d)	(i)	- it does no react with wires or core	B1
			- it is used a coolant	B1
			- it is non-volatile	B1
			- It has a high heat capacity	B1
				[Max B2]
		(ii)	- high voltages imply low current in cables	B1
			- Low current imply that thinner cable are used which are **cheaper in terms of support and material** used	B1
		(iii)	1. Peak I = 15A	A1
			2. T = $\frac{2\pi}{6}$ = 1.05 s (2 or more s.f)	A1
			3. Pav = $\frac{1}{2}(15^2)(20)$	C1
			= 2 250 W	A1
4	(a)	(i)	Two systems that are each in thermal equilibrium with a third system are in thermal equilibrium with each other / AW	B1
			- ~~Bodies A and B are each in thermal contact so no thermal Interaction~~	~~B1~~
		(ii)	- calibration of thermometers	B1
			- measurement of temperature / comparing of thermometers readings of 2 bodies A/W	B1
	(b)	(i)	Factors are - mass substance	B1
			- specific heat capacity of substance / type of substance / material	B1
			- heat loss to surroundings	B1
		(ii)	Q = MCΔT	C1
			= 0.65 x 80 x 4 200 x 2.0	C1
			= 4.4 x 10^5J	A1

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4 (c) (i)

Thermocouple	Constant volume gas	
emf as thermometric property	Pressure of a fixed mass and volume of gas	B1
Can measure temperature at a point	Bulky, not suitable for measuring temperature at a point	B1
Measures rapidly changing temperatures	Not suitable for measuring rapidly changing temperatures	B1
Wide range	Wide range	B1
Sensitive	Sensitive	B1

Max B4

(ii) $\theta = \frac{E_\theta - E_0}{E_{100} - E_0} \times 100\ °C$ / $\theta = \frac{E_\theta - E_0}{E_{510} - E_0} \times 510°C$ C1

3. d. p on temperature. $= \frac{10,200 \times 10^{-3} - 0,000}{(28,000 - 0,000) \times 10^{-3}} \times 100°C$ $= \frac{10,2 - 0}{28 - 0} \times 510°C$ C1

C1

$=$ ~~36,4 °C~~ / 36,429°C. $= 185,786°C$ A1

or can calculate E_{100} as $\frac{100}{510} \times 28 = 5,490\ mV$ / Ans

(d) (i) Average of the square of the speeds of gas molecules B1

(ii) $P = \frac{Nm < c^2 >}{3V}$ $\frac{Nm}{V} =$ density ρ C1

$\therefore < c^2 > = \frac{3P}{\rho} = \frac{3 \times 10^5}{1.29}$ C1

$= 232\ 600\ m^2 s^{-2}$ A1

$232\ 558,14\ m^2 s^{-2}$

(iii) $\frac{1}{2} mv^2 = \frac{3}{2} KT$

$5.0 \times 10^{-21} = \frac{3}{2} \times 1.38 \times 10^{-23} T$ C1

$\therefore T = 241.5\ k$ A1

(e)

	Nitrogen at 73 K 73K	Nitrogen at 273 K	
spacing	very small spaces	very large spaces	B1
motion	vibration about fixed position	rapid and free ~~formulation~~ translation/movement	B1

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5 (a) (i) carrier wave - a (high frequency) wave used to transmit information high energy B1

advantage - allows different stations in the same locality to **transmit simultaneously without interference** B1

- reduces interference B1 [max B1]

(ii) a.m. - amplitude of carrier wave

f.m - frequency of carrier wave B1

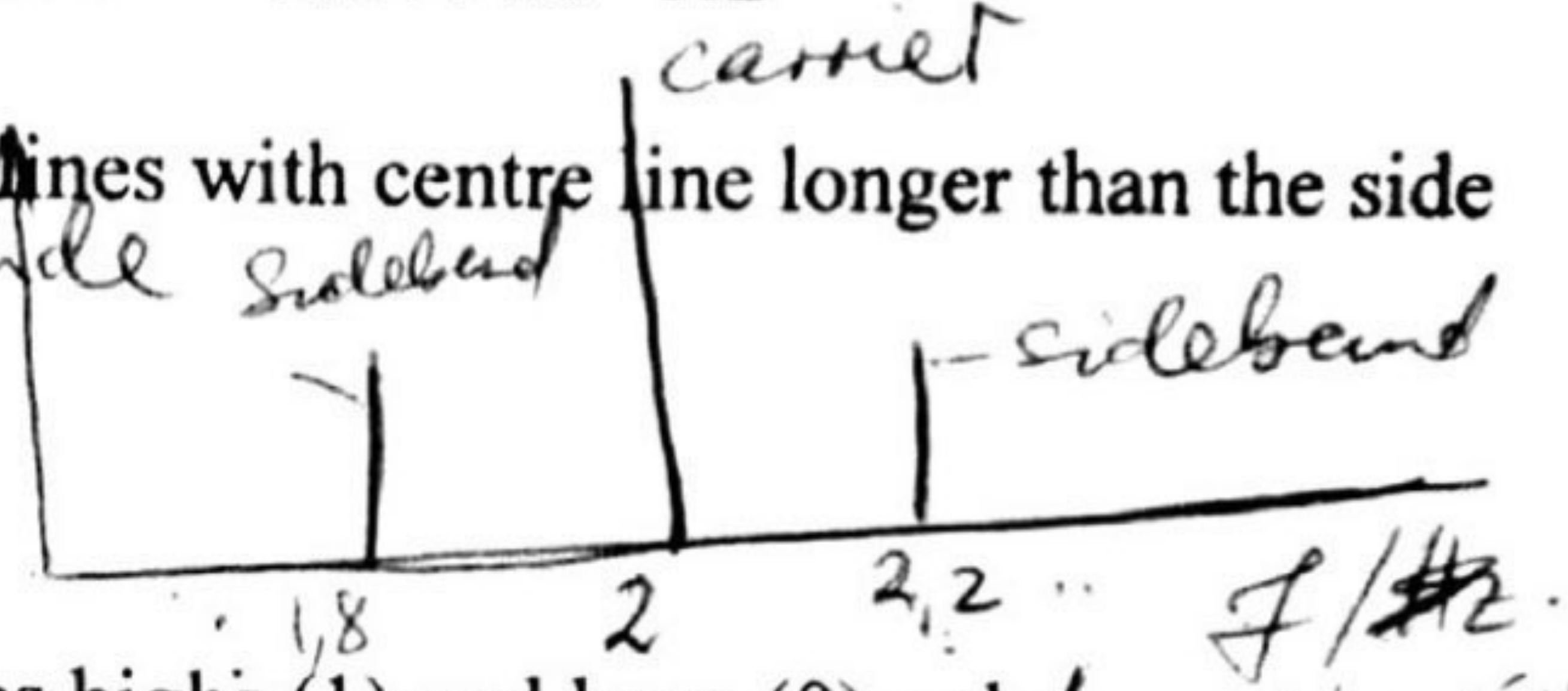
- Is made to vary in synchrony with displacement of information signal B1

(iii) 1. - Frequency of carrier wave = 2.0×10^5 Hz B1

- Frequency of signal wave = 2.0×10^4 Hz B1

ϕ. On graph: 3 vertical parallel lines with centre line longer than the side lines B1

2. Bandwidth: 4.0×10^4 Hz B1



(b) (i) - signal which comprises highs (1) and lows (0) only/ discrete values (0 and 1) B1

(ii) - regenerators enables filtering of noise in digital/ B1

- digital is more secure as codes can be added to the signal to protect it B1
- In analogue, the amplifiers amplify both noise and the signal ~~equality~~ equally. B1
- Faster transmission with digital B1
- less noise B1
- Signals from large number of diff sources can be made the same path B1 [Max B2]

(iii) - increase the sampling frequency / reduce sampling time B1.

- Increase the number of bits B1
- use filters to make waveform smooth B1

[Max B2]

(c) (i) Advantage :-

- allows for continuous communication B1
- have a longer life span B1
- no need for transoceanic cables B1

[Max B2]

(ii) 1. - the uplink frequency is greater than the downlink frequency / downlink freq is diff from uplink freq. B1

2. - to reduce time delays in conversations B1

(d) (i) loss in signal power/ energy during transmission B1

(ii) convenient since some of the figures can be too small or large B1

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(iii) 1. Total loss = 40 x 1.6 C1

$$64 = 10\log\left(\frac{400 \times 10^{-3}}{\text{Pout}}\right)$$

$\therefore$ Pout = 1.59×10^{-7} W A1

2. $$15 = 10\log\left(\frac{\text{Pmin}}{3 \times 10^{-13}}\right)$$

C1

Pmin = 9.49×10^{-12}W

$$\text{Maximum loss} = 10\log\left(\frac{400 \times 10^{-3}}{9.49 \times 10^{-12}}\right)$$ C1

= 106dB

$$\text{Maximum distance} = \frac{106}{1.6}$$

= 66 km A1

(c) sky waves
space waves / radio waves / microwaves ~~B1~~2

B1

For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS 6032/3

PAPER 3 THEORY

SPECIMEN PAPER 2 hour 30 minutes

Additional materials:
Answer paper
Electronic calculator and/or Mathematical tables
Ruler (mm)

TIME 2 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question1 is compulsory.
Answer any other **three** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 12 printed pages.

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[Turn over

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DATA

speed of light in free space	$c = 3.00 \text{ x } 10^8 \text{ms}^{-1}$
permeability of free space	$\mu_o = 4\pi \text{ x } 10^{-7}$ Hm^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \text{ x } 10^{-12}$ Fm^{-1} ($1/4\pi\varepsilon_0 = 8.99 \text{ x } 10^9$ mF^{-1})
elementary charge	$e = 1.60 \text{ x } 10^{-19}$ C
the Planck constant	$h = 6.63 \text{ x } 10^{-34}$ Js
unified atomic mass unit	$1 \text{ u} = 1.66 \text{ x } 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \text{ x } 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \text{ x } 10^{-27}$ kg
molar gas constant	$R = 8.31$ $\text{JK}^{-1}\text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \text{ x } 10^{23} \text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \text{ x } 10^{-23}$ JK^{-1}
gravitational constant	$G = 6.67 \text{ x } 10^{-11} \text{Nm}^2\text{kg}^{-2}$
acceleration of free fall	$g = 9.81$ ms^{-2}

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FORMULAE

uniformly accelerated motion	$s = ut + ½at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\ \Delta V$
gravitational potential	$\emptyset = -\mathrm{Gm/r}$
hydrostatic pressure	$p = \rho \mathrm{gh}$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_o \cos \omega \mathrm{t}$
	$v = \pm\omega\sqrt{(x_o^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
Attenuation of x-rays	$\mathrm{I} = \mathrm{I_o e}^{-\mu x}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{\mathrm{ntq}}$
alternating current/voltage	$x = x_o \sin\omega t$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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Answer question 1 and any other 3 from the remaining questions.

1 **(a)** **(i)** Define *systematic error*.

(ii) List any **two** possible causes of random error.

(iii) **Fig. 1.1(a)** and **Fig. 1.1(b)** shows the distribution of measurements taken by two students.

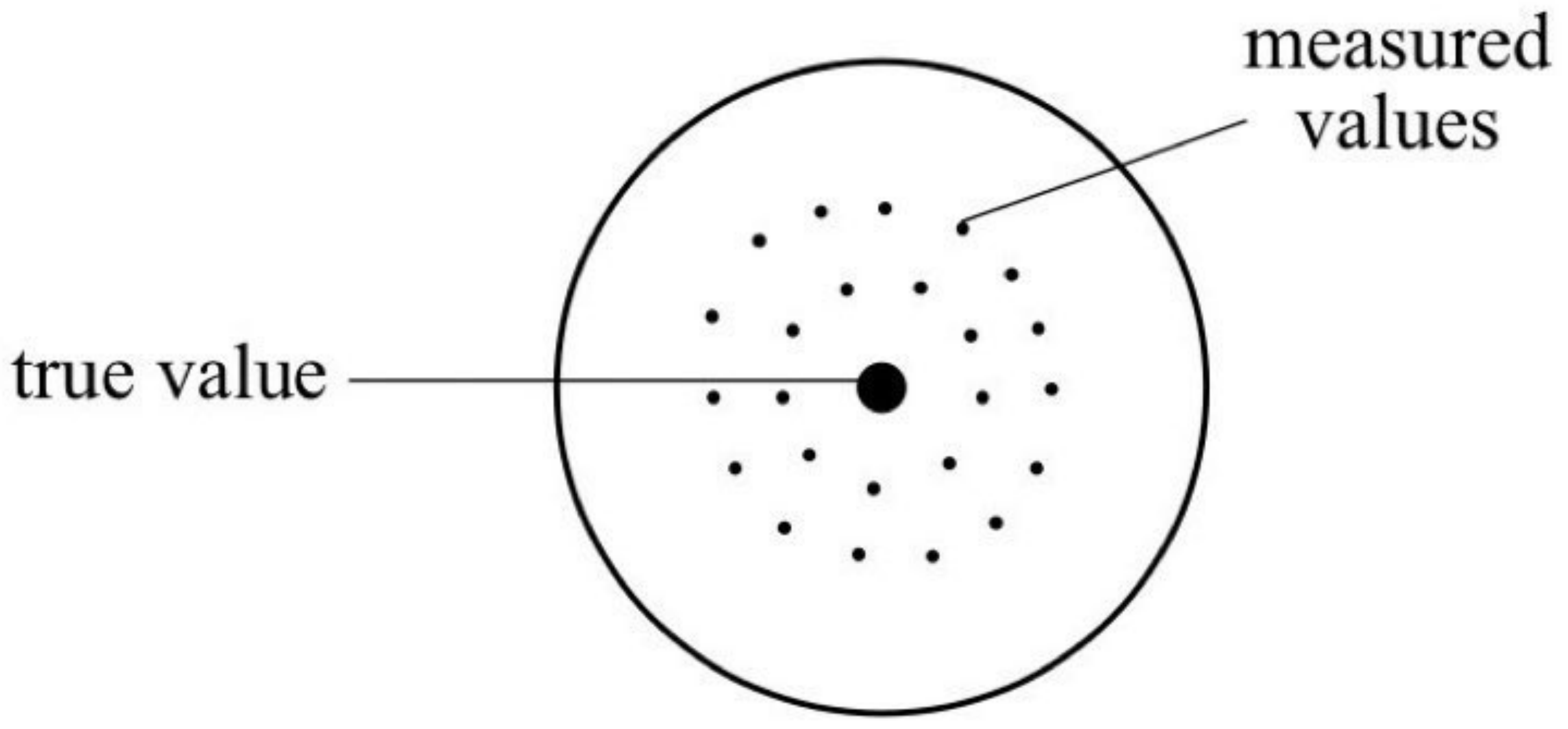

Fig. 1.1(a)

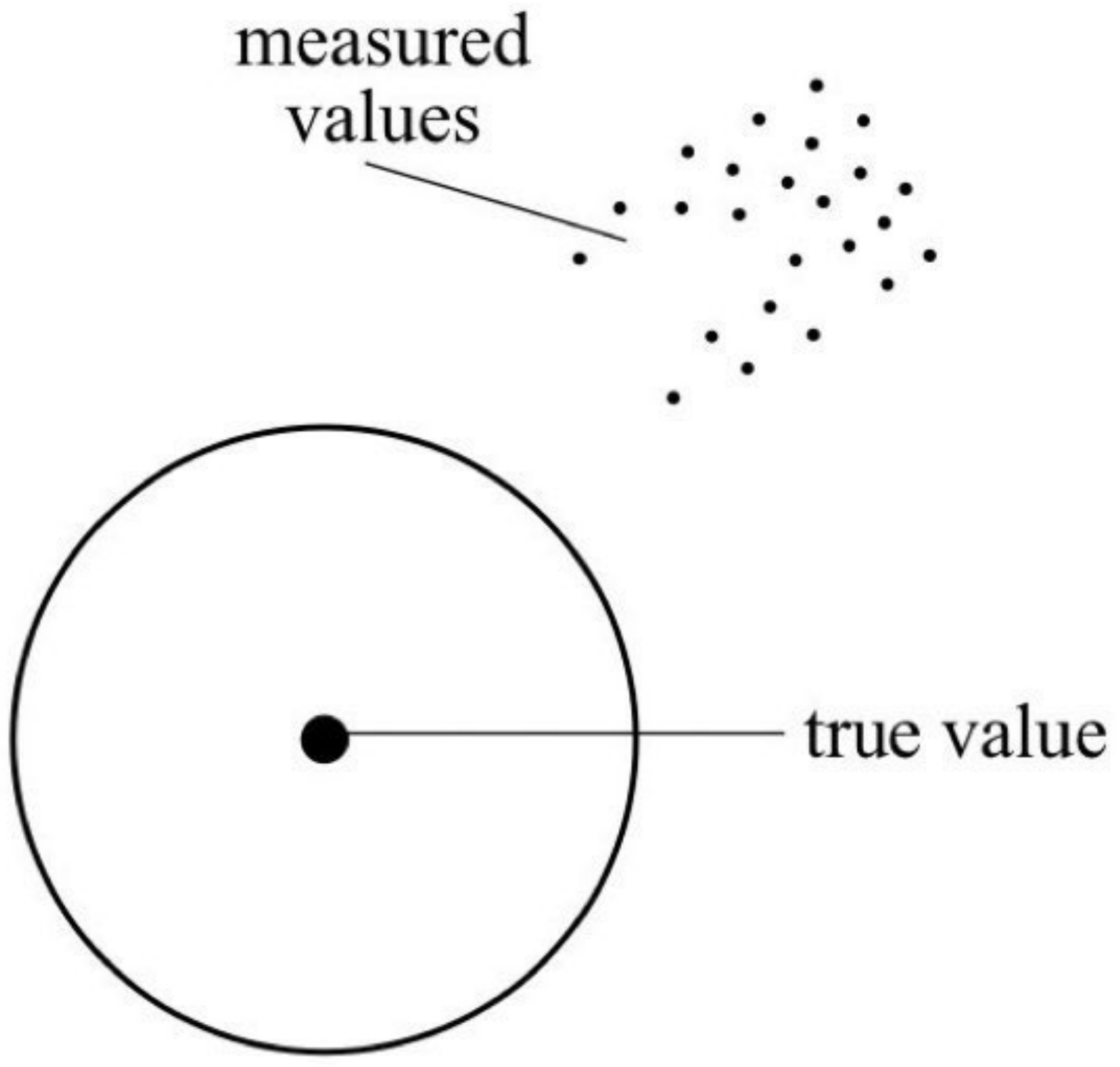

Fig. 1.1(b)

Comment on the precision and accuracy of the measurements.

[5]

(b) **Fig. 1.2** shows the paths of a ball thrown against a vertical wall.

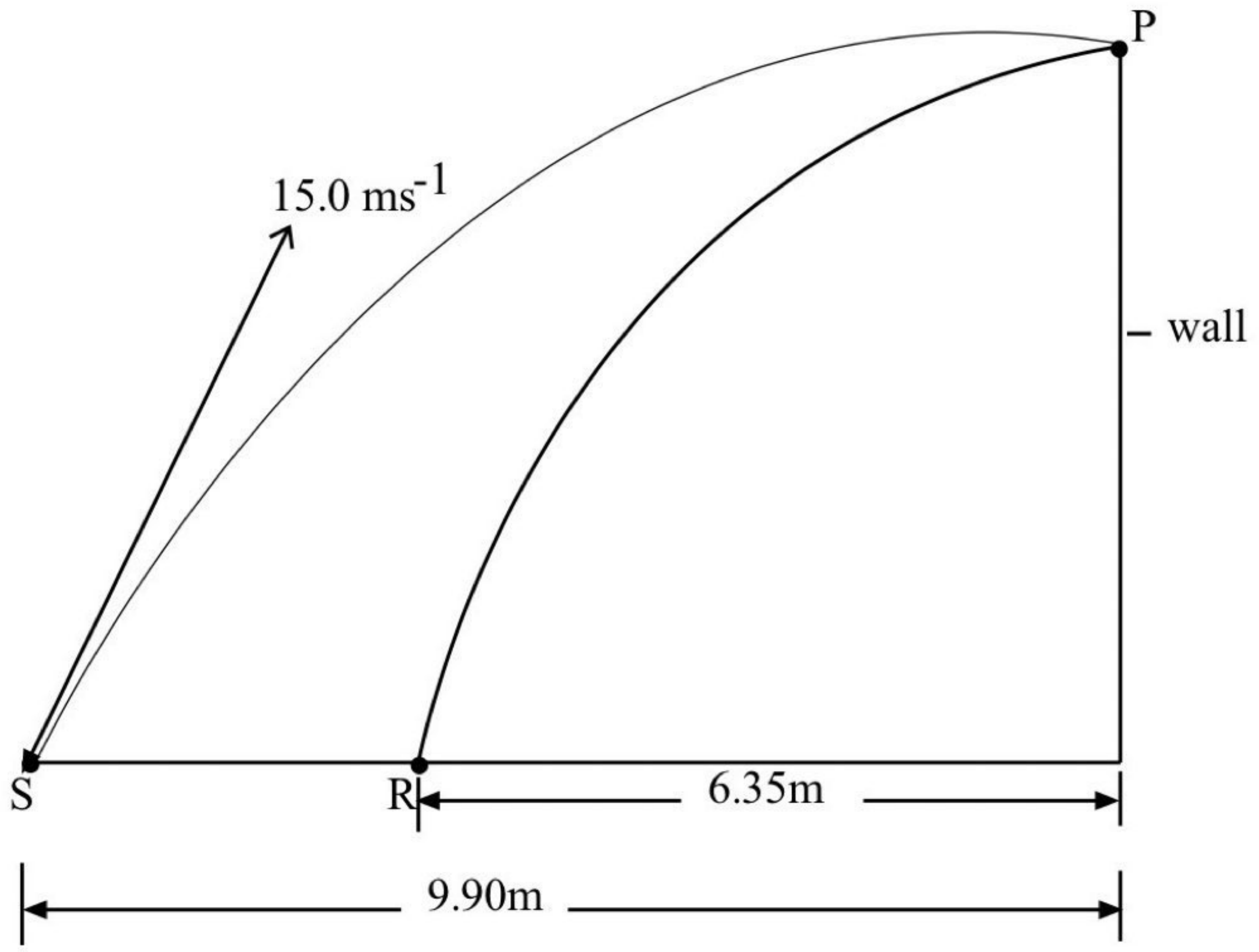

Fig. 1.2

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The ball is thrown from S with an initial velocity of 15.0 ms^{-1} at 60° to the horizontal. The horizontal distance from S to the wall is 9.90 m. The ball hits the wall at P with a velocity at right angles to the wall and rebounds to point R.

Assume no air resistance.

(i) Determine the vertical height gained by the ball as it travels from S to P.

(ii) Calculate the time taken by the ball to travel from **S** to **P**.

(iii) Show that the velocity of the ball immediately after rebounding from the wall is about 4.80 ms^{-1}.

(iv) The mass of the ball is 60×10^{-3}kg. Calculate the change in momentum as it rebounds from the wall.

[6]

(c) **Fig. 1.3** shows a box of mass 3.0 kg projected up a rough incline at 30° to the horizontal with an initial velocity of 10 ms^{-1}. The velocity decreases to 4.0 ms^{-1} at B. The length of the plane is 4.0 m.

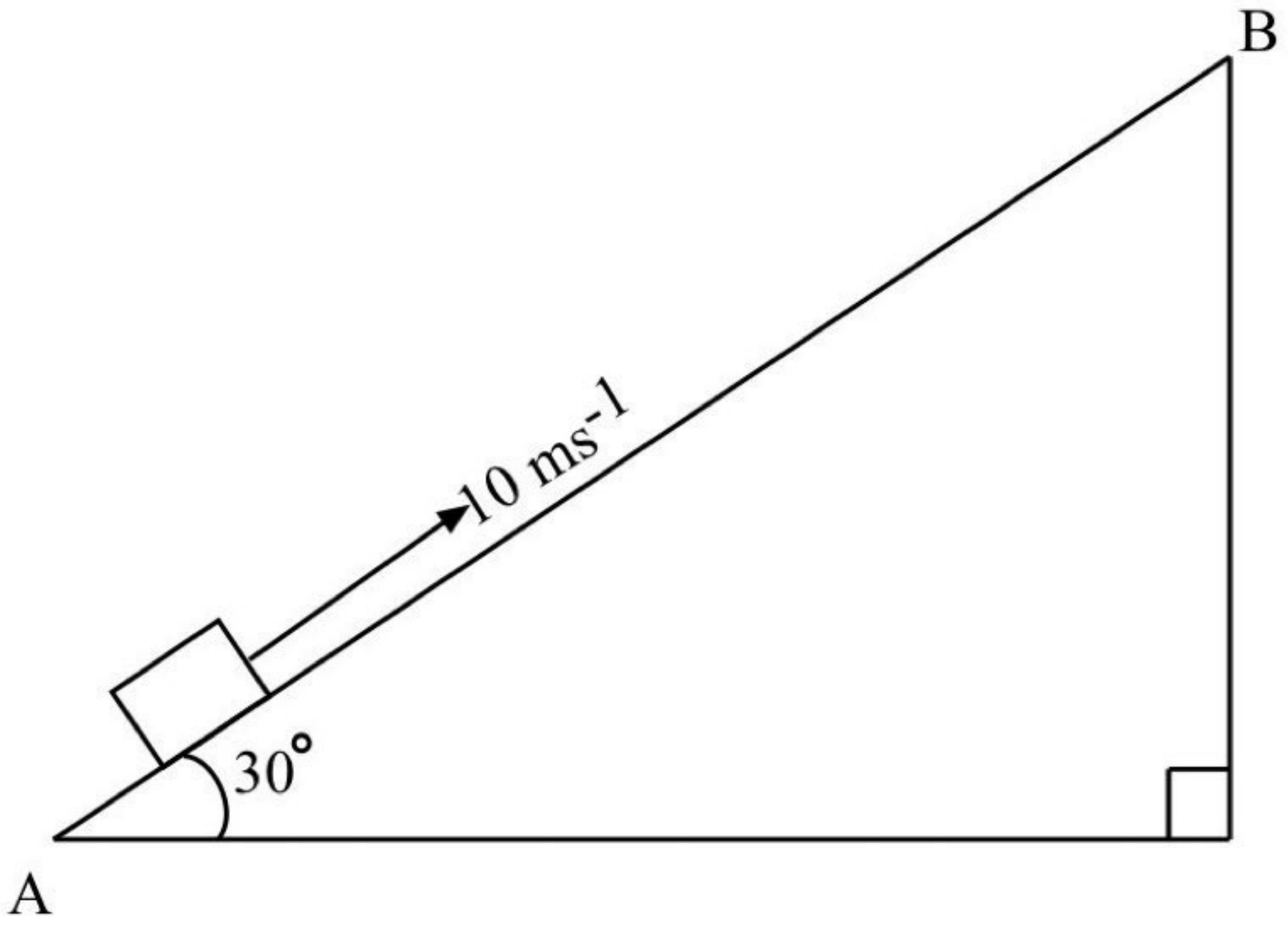

Fig. 1.3

(i) Draw a free body diagram showing all forces acting on the box.

(ii) Calculate the gain in gravitational potential energy.

(iii) Determine the work done against friction.

[7]

[Turn over

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(d) A satellite of mass m, travels at an angular speed ω, in a circular orbit at a height h, above the surface of planet of mass M and radius R.

(i) State in words Newton's law of universal gravitation.

(ii) Show that the period T, of the satellite is given by

$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$$

(iii) Suggest with a reason, what happens to the speed of the satellite if it moves to an orbit closer to the surface of the planet.

[7]

2 **(a)** **(i)** Define *simple harmonic motion*.

(ii) One end of a spring of spring constant k, is attached to a rigid support. A mass m, hanging from the lower end of the spring is displaced downwards from equilibrium and released.

Show that the mass execute simple harmonic motion.

[5]

(b) **(i)** **1.** Draw a labelled diagram showing apparatus required to determine the wavelength of red light using a pair of slits.

2. Give estimates for slit separation and slit to screen distance from the diagram in (i)1.

(ii) Explain the part played by diffraction in the production of fringes.

(iii) Use the estimate values in **(b)(i)** to calculate fringe separation for light of wavelength 590 nm.

[8]

(c) An X-ray beam of intensity $8.00 \times 10^5 \mathrm{Wm}^{-2}$ passes through an aluminium filter and linear attenuation coefficient μ of 250 m^{-1}. The filter allows 10% of the X-ray radiation to pass through it to a patient whose bone under examination has a thickness of 4.0 cm and attenuation coefficient of 1.05 m^{-1}.

(i) Calculate the

1. thickness of aluminium,
2. intensity of the X-ray radiation transmitted by the bone.

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(ii) Suggest the advantages of passing the X-rays through the filter before passing it through the patient.

(iii) Explain how an anti-scatter grid improves the X-ray image produced.

[8]

(d) **(i)** Outline how X-rays are used to build up the images produced in a CT scan.

(ii) Explain why CT scanning requires a powerful computer. [4]

3 **(a)** **(i)** Explain what is meant by *magnetic field*.

(ii) Sketch four lines to show the magnetic field around a long straight current carrying conductor.

(iii) **Fig. 3.1** shows two parallel sides of a rectangular frame carrying a current. The frame is in a magnetic field.

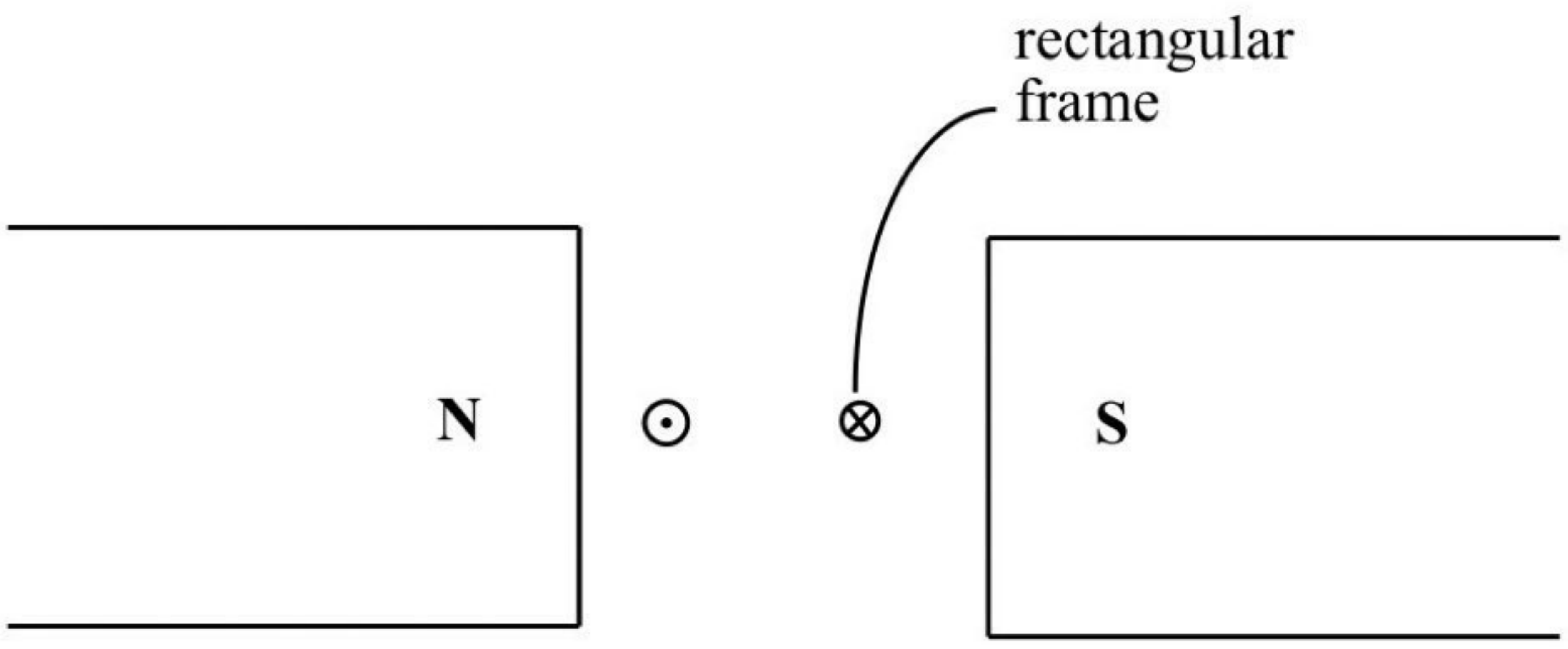

Fig. 3.1

1. Copy Fig. 3.1 and show the direction of the magnetic forces acting on the frame.
2. State and explain the effect of the forces on the frame.

[8]

[Turn over

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(b) **(i)** **Fig. 3.2** shows a magnet plunging into a solenoid.

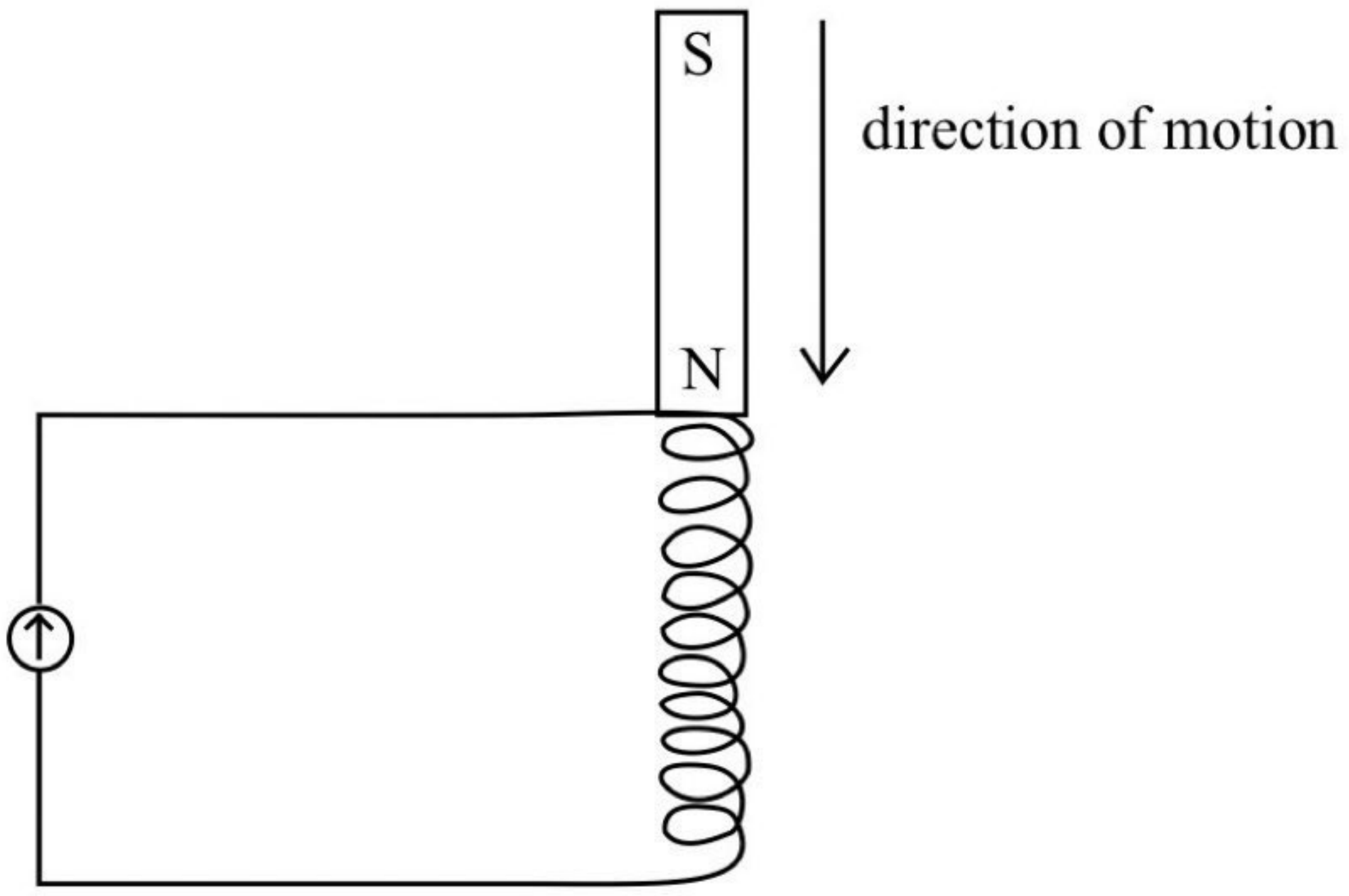

Fig. 3.2

With reference to **Fig. 3.2** explain how Lenz's law is an example of the principle of conservation of energy.

(ii) **Fig. 3.3** shows the variation of the magnetic flux linking a coil of 200 turns.

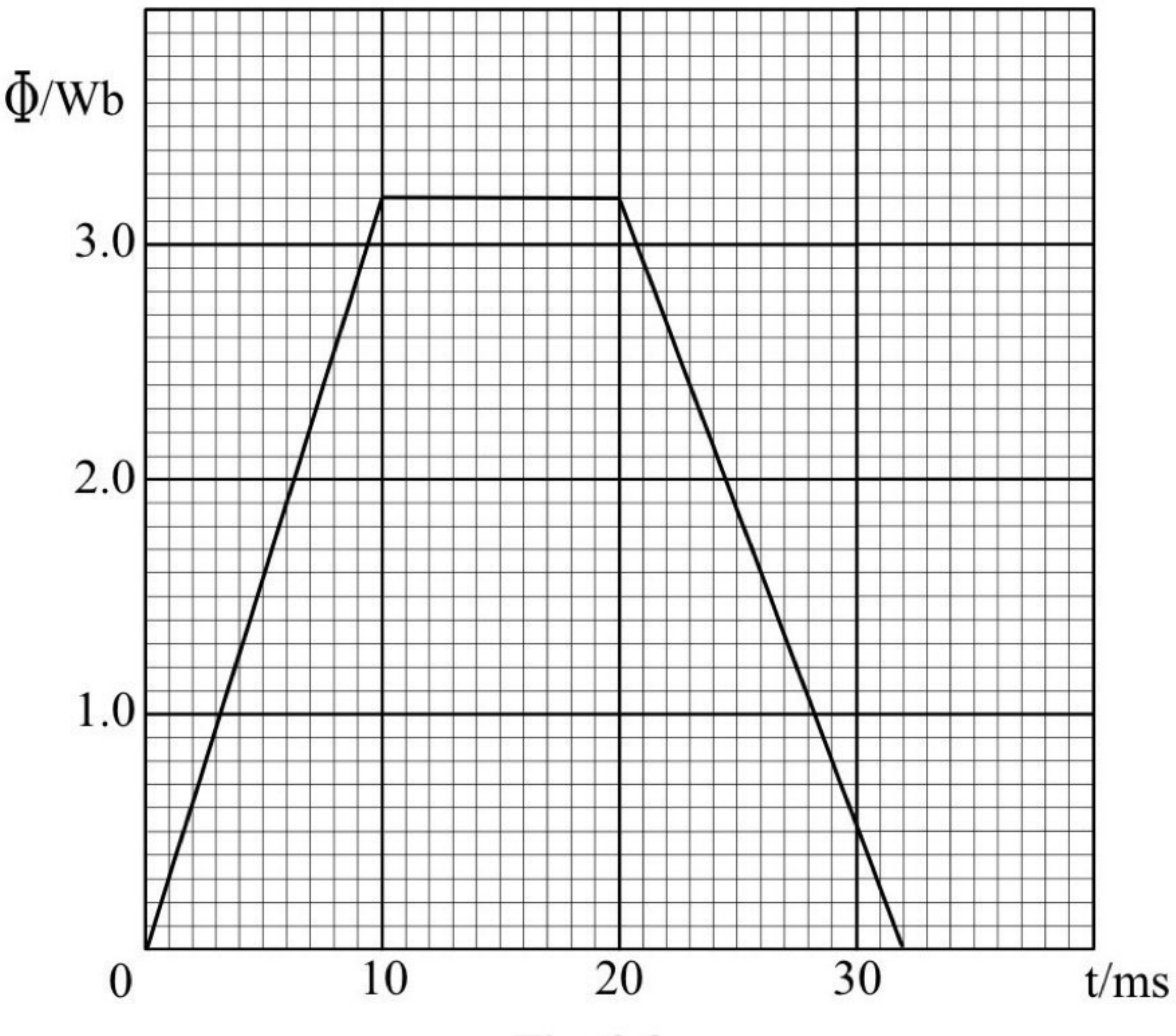

Fig. 3.3

(ii) **1.** Sketch a graph to show how the induced e.m.f. varies with time.

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2. Suggest **two** ways by which the magnitude of the induced e.m.f. can be increased.

[8]

(c) **(i)** State the function of a transformer.

(ii) A transformer has 600 turns in its primary coil and a sinusoidal input voltage of r.m.s. value 230 V. The output has a peak to peak voltage of 120 V.

1. Calculate the number of turns in the secondary coil.

2. Explain why r.m.s. values are considered and not mean values in a.c. circuits.

(iii) In a transformer, there is thermal energy produced. Describe and explain the sources of the thermal energy.

[9]

4 **(a)** Define

(i) laminar flow,

(ii) incompressible flow.

[2]

(b) Ethanol of density $\rho = 791\ \text{kg m}^{-3}$ flows smoothly through a horizontal pipe that tapers in cross-sectional area from A_1 to $A_2 = \frac{1}{2}A_1$. The pressure difference between the narrow and wider sections of the pipe is Δp. If R is the volume flow rate,

(i) Express in terms of R and A_1

1. v_1,

2. v_2.

(ii) Show that the pressure difference,

$$\Delta p = \frac{3\rho R^2}{2A_1^2}$$

(iii) Calculate R if ΔP is 4 120 Pa and A_1 is $1.20 \times 10^{-3}\ \text{m}^2$.

[6]

[Turn over

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(c) **(i)** Outline how molecular movement causes pressure exerted by a gas.

(ii) A car's tyre contains a gas at a pressure of 3.00×10^5 Pa. After a long drive the tyre becomes hot and expand. The volume of the gas increases by 1% while its temperature increases by 5%.

Calculate the final pressure, assuming the gas behaves ideally.

[4]

(d) **Fig. 4.1** shows a mass hanging from free end of a copper wire which is passed over a pulley.

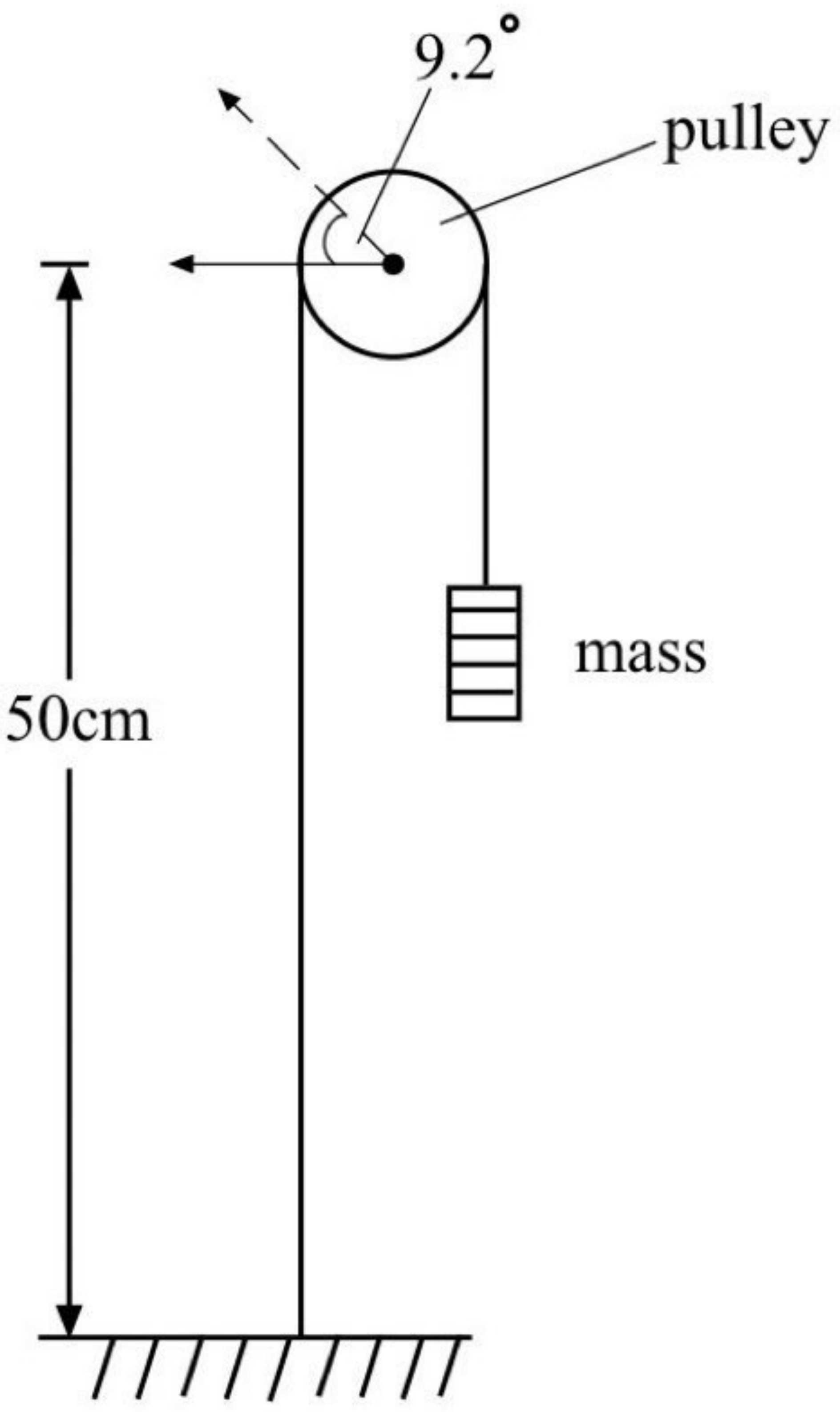

Fig. 4.1

When the mass is increased by 2.04 kg, a pointer attached to the pulley of diameter 3.0 cm rotates through an angle of 9.2°.

(i) For the increase in mass,

1. show that the wire extends by 2.4×10^{-3} m,

2. calculate the increase in strain in the wire.

(ii) Calculate the increase in the strain energy produced by the increase in the load if the initial load was 2.00 kg.

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(iii) The specific heat capacity of copper is 420 J/kg/k and the mass of the wire is 6.2 g.

1. Calculate the change in temperature of the wire as it extends.
2. State the assumption you have made in your calculation.

[8]

(c) **(i)** Explain what is meant by thermometric property.

(ii) Suggest with a reason, the suitable type of thermometer for measuring temperature of

1. boiling liquid oxygen,
2. molten iron in a blast furnace.

[5]

5 **(a)** **Fig. 5.1** shows a coaxial cable.

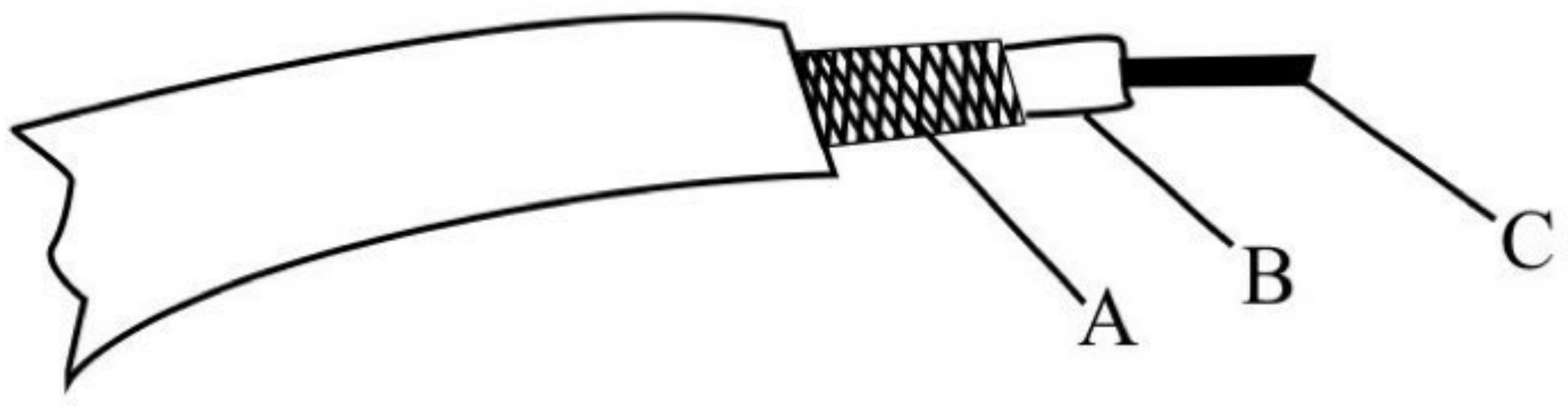

Fig. 5.1

(i) State the

1. names of the components labeled A, B and C,
2. functions of component A.

(ii) List **three** advantages of coaxial cables over wire pairs.

[8]

(b) **(i)** Define the term *modulation*.

(ii) Explain why

1. the reception of amplitude modulated signals is poorer than the frequency modulated signals,
2. frequency modulated transmissions are more expensive than amplitude modulated transmissions.

[6]

[Turn over

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(c) **Fig. 5.**2 shows an original analogue signal before transmission.

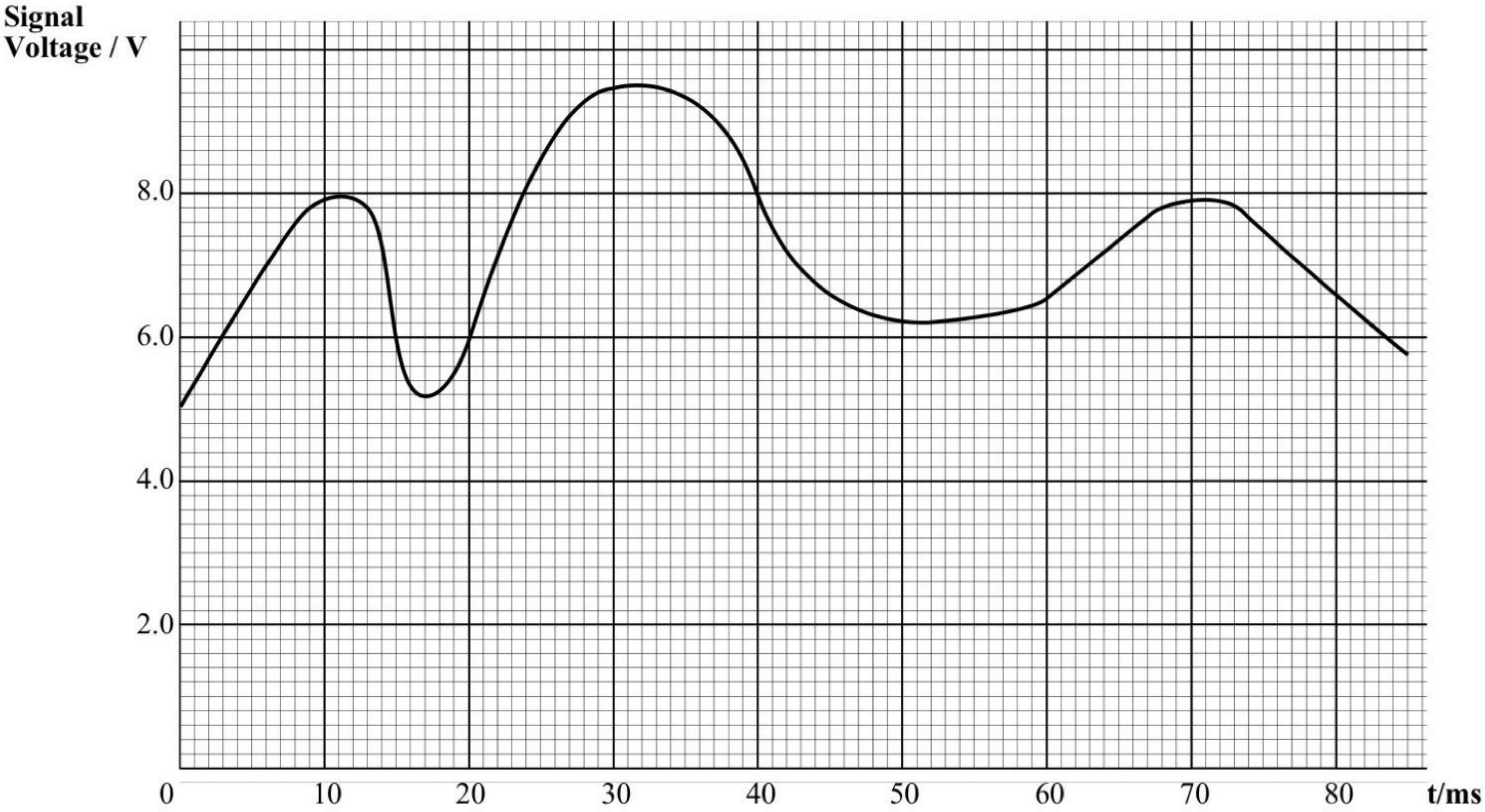

Fig. 5.2

(i) Copy **Table 5.1** and complete it using **Fig. 5.2**.

Table 5.1

Time/μs	0	40	70
Voltage/V	5.0		
Digital code	0101		

(ii) Using a sampling frequency of 100 kHz,

1. reconstruct **Fig. 5.2** to produce the **"recovered"** analogue signal after transmission and sketch it.
2. Explain how the reconstruction can be improved to have a more accurate representation of the original signal.

[11]

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS **6032/3**
PAPER 3

SPECIMEN PAPER **2018**

MARKING SCHEME

SPECIMEN6032/3

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1(a)(i) Error that causes shift of measurements from true value by a constant magnitude in a specific direction. B1

(ii) observer unable to take readings and unable to conduct experiment B1

Environmental conditions that cause fluctuations of readings about a mean value B1

(iii) Fig 1.1(a) is accurate and precise. Mean value is close to true value and measurements are close to each other B1

Fig 1.1(b) is not accurate but it is precise. Measurements are close to each other but the mean value is far from true value. B1

(b)(i) Vertical height $= \frac{V^2 sin^2\theta}{2g}$

$= \frac{15^2 sin^2 60^o}{2x9.81}$ C1

$=$ 8.60m A1

(ii) time from S to P $= \frac{Vsin\theta}{g}$

$= \frac{15sin60^o}{9.81}$ C1

$=$ 1.32s A1

(iii) 6.35 $=$ vtcosθ θ = 0 so 6.35 = vt

-8.60 $= -\frac{1}{2}x9.81t^2$ t $= \surd(\frac{2x8.60}{9.81}$ C1

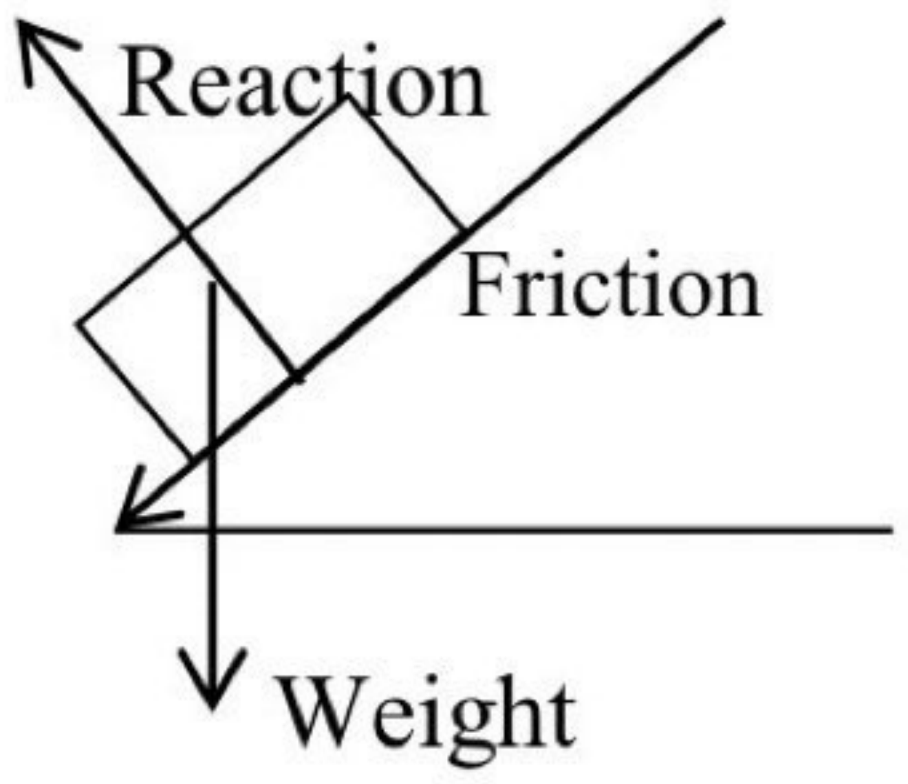
v $= \frac{6.35}{t} = \surd(\frac{9.81}{2x8.60})$x6.35

$=$ 4.80ms^{-1} A0

(iv) Change in momentum $=$ 60x10^{-3}(-4.80-15cos60^o)

$=$ -0.738Ns A1

1(c)(i)



B3

(No mark for Wrong physics)

(ii) Loss in k.e = gain p.e + work done against friction + final k.e

Gain in p.e $= \frac{1}{2} \text{ x } 3 \text{ x } 10^2 - 3 \text{ x } 9.81\sin 30^o \text{ x } 4 - \frac{1}{2} \text{ x } 3 \text{ x } 4^2$ C1

$= 67.14J$ A1

(iii) Work done against friction $= 3 \text{ x } 9.81\sin 30^o \text{ x } 4$ C1

$= 58.9J$ A1

(d)(i) Force between two point masses m_2 is directly proportional to the product of the masses B1
and inversely proportional to the square of their separation B1
(Do not accept equation with symbols).

(ii) $\frac{GMm}{r^2} = \frac{mv^2}{r}$ C1

$r = R+h$ C1

$v^2 = \frac{GM}{r} = \frac{GM}{R+h}$ $v = r\omega = \frac{2\pi}{T}$ C1

$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$ A0

(iii) Speed increases A1

In orbit, speed $v \alpha \frac{1}{\sqrt{r}}$, so going to a lower orbit radius r decreases. M1

2(a)(i) Simple harmonic motion is motion in which acceleration is always directed towards a fixed point B1
and is proportional to its displacement from the fixed point. B1

(ii) At equilibrium, $T = -ke = mg$

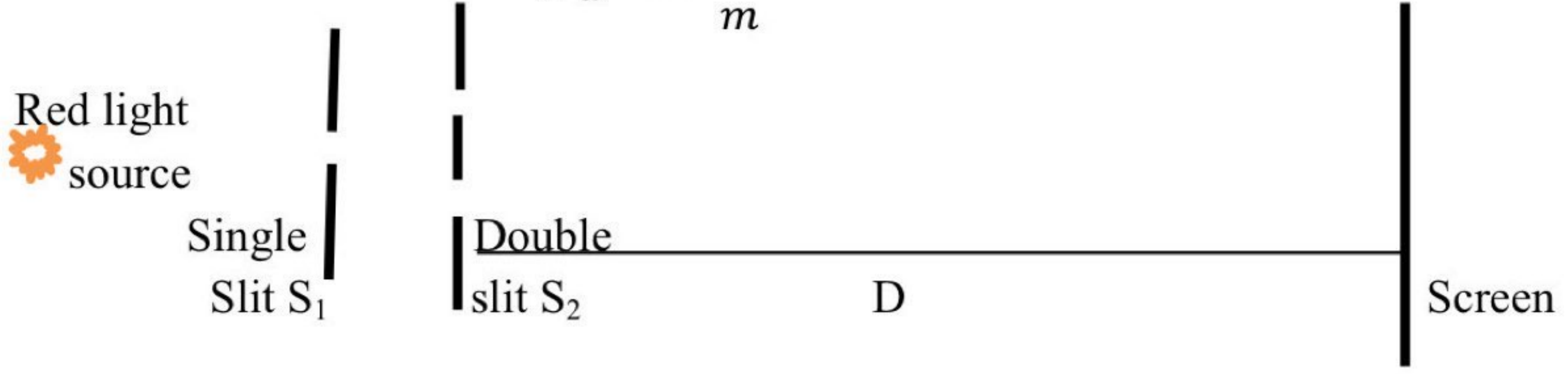
After displacement, $T_1 = -k(x + e)$ B1

When released $ma = T_1 - T = -k(x + e) - (-ke)$ B1

$= -kx$

$\therefore a = -\frac{kx}{m}$ A1

(b)(i)1



B2

(b)(i)2 slit separation = 10mm A1

D = 2m A1

(ii) Diffraction causes parallel wavefronts to spread out. B1

The diffracted wavefronts interfere to produce the observed fringes. B1

(iii) $x = \frac{D\lambda}{d}$

$= \frac{2 \, x \, 590 \, x10^{-9}}{10 \, x \, 10^{-3}}$ C1

$= 1.18 \text{ x } 10^{-4}$m A1

(c)(i) 1 $I = I_o e^{-\mu x}$

$\ln I = -\mu x$

$\ln(\frac{8 \, x10^4}{8 \, x10^5}) = -250m^{-1}x$ C1

$x = 9.21 \text{ x } 10^{-3}$m A1

2 $I = 8.00 \; 10^4 e^{-0.04x1.05}$ C1

$= 7.67 \text{ x } 10^4 Wm^{-2}$ A1

(ii) A filter removes low energy X-rays from an X-ray beam that may cause harm to patient if absorbed by the patient B1

Filters improve quality of X-ray radiation by removing unwanted radiation B1

(iii) An anti-scatter grid improves an x-ray image by removing all scattered x-rays from the beam transmitted by patient to film. B1

Scattered x-rays reduce sharpness and contrast of image. B1

(d)(i) A series of x-ray images for one section/slice are taken from different angles B1

The images are combined by a computer into a 2-D image of the section/slice B1

The process is repeated for many sections/slices

The 2-D images of all the slices are then combined into a 3-D image of an organ. B1

The 3-D image can rotate and viewed from different directions B0

(ii) Computer stores several complex data B1

Computer has complex statistical formulas to combine information from several slices B1

Computer produces 3-D images from 2-D images in the shortest possible time. B1

(Maximum 1mark)

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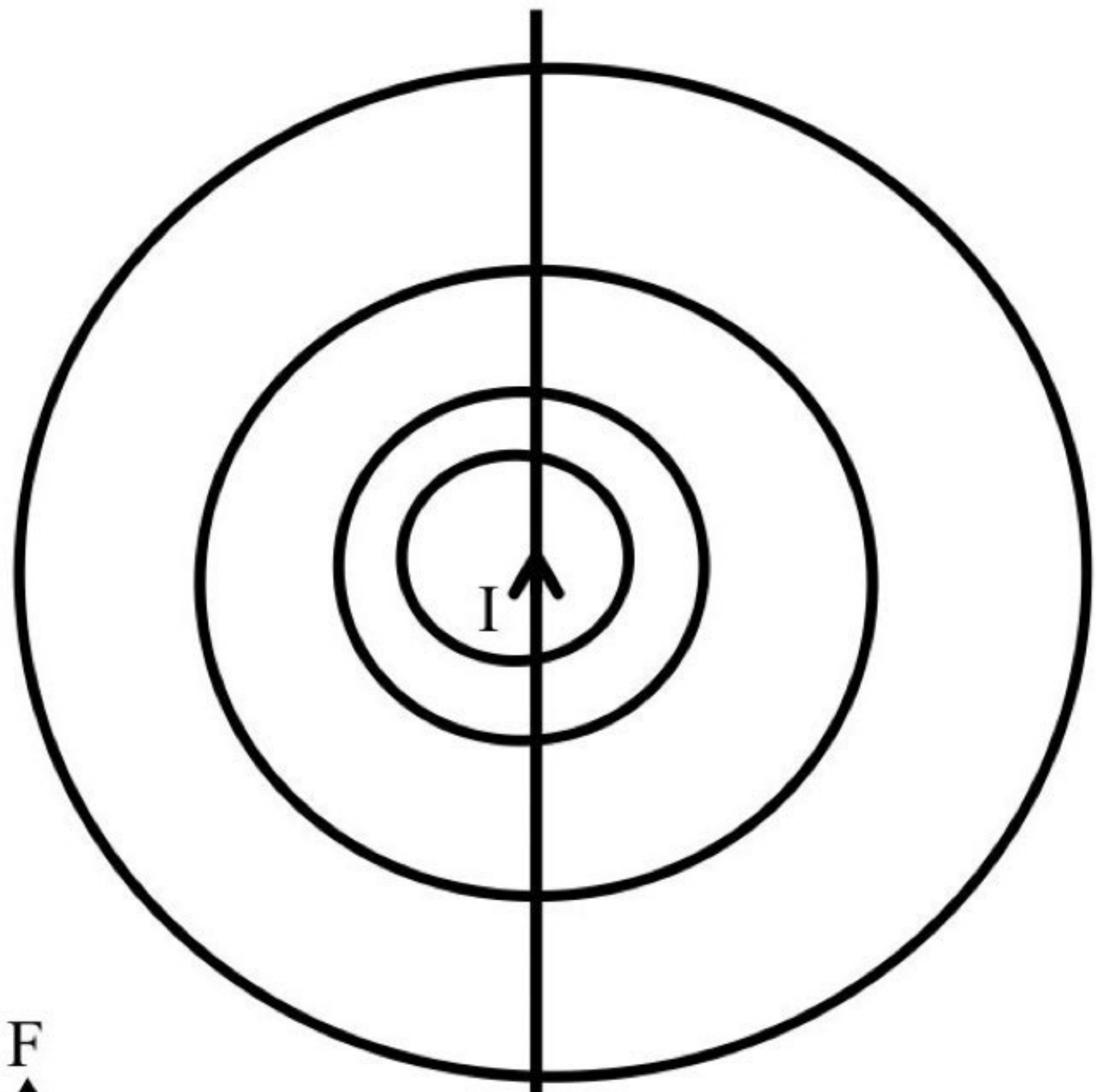
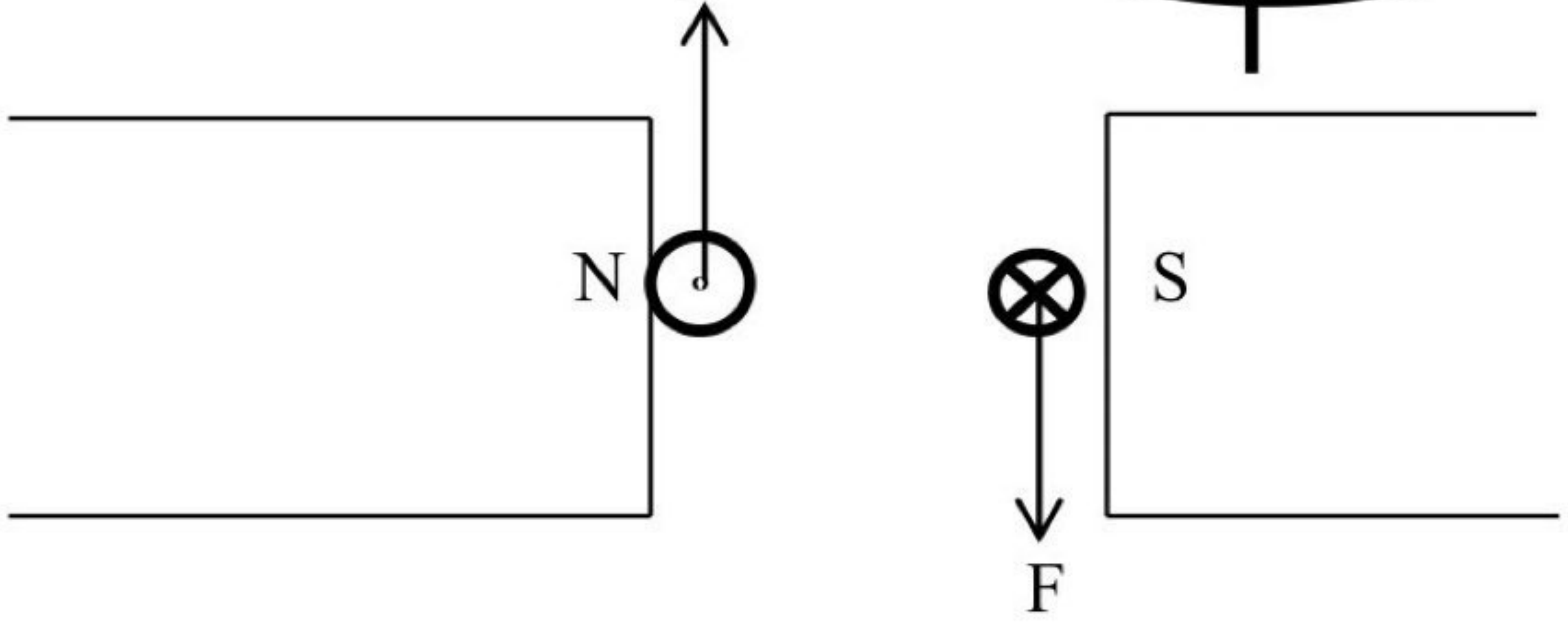
3(a)(i) Field of magnetic force B1

(ii)



B3

(iii) 1

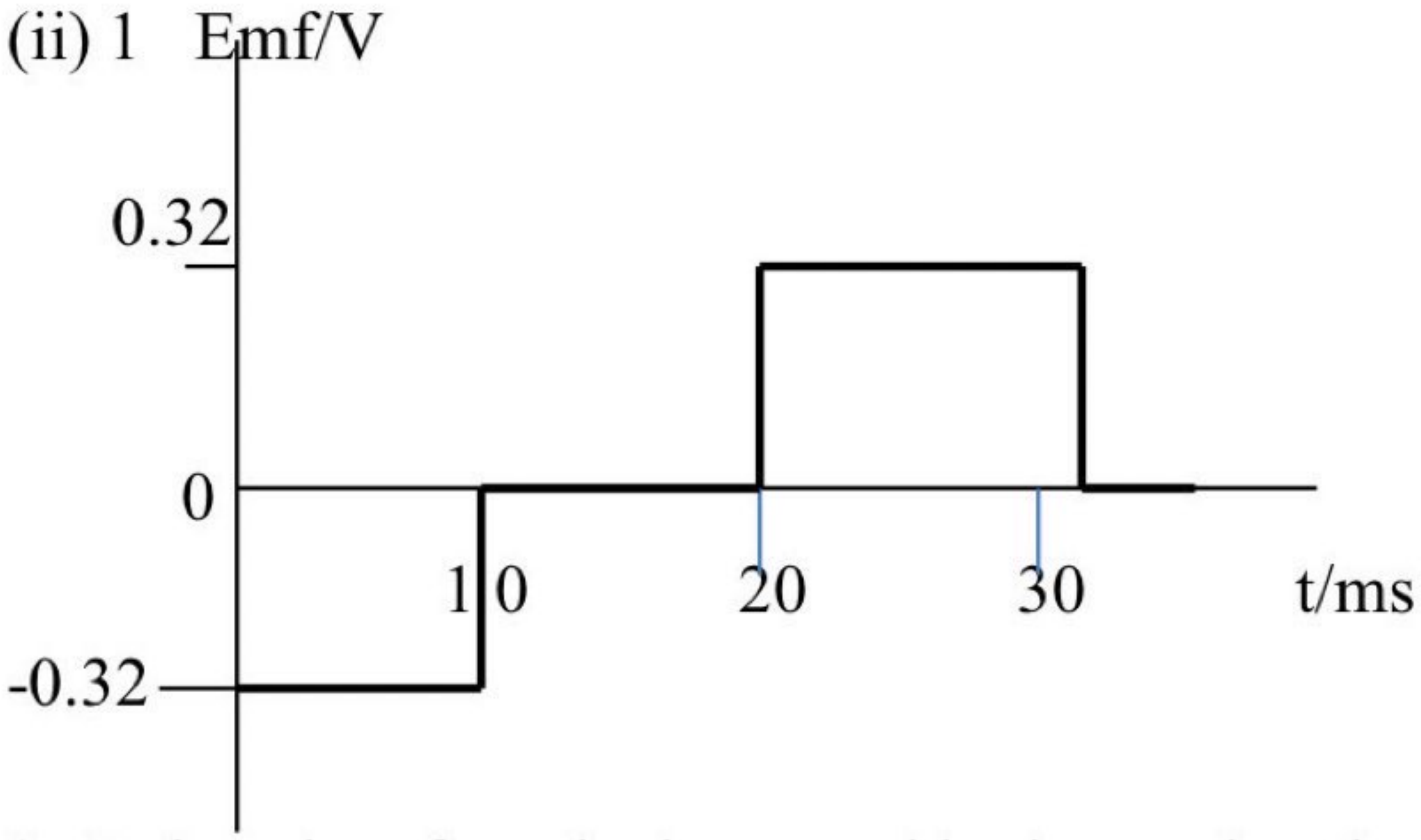


B2

2 The forces have a tendency to cause rotation B1
because the forces form a couple B1

(b)(i) Emf induced in the coil drives a current in the coil B1
The direction of the induced current is such to create a magnetic field which opposes the magnetic field due to the bar magnet B1

(ii) 1



B4

2 Induced emf can be increased by increasing the

- number of turns in coil B1
- speed of the bar magnet B1
- cross sectional area of the coil B1
- magnetic field strength or flux density B1

Maximum 2marks

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(c)(i) The transformer is to enhance magnetic flux in the secondary coil B1

The transformer changes the magnitude of ac voltage from one ac voltage to another high or low ac voltage B1

(ii) 1 $\frac{N_p}{N_s} = \frac{V_p}{V_s}$

2 $N_s = \frac{V_s N_p}{V_p}$ $V_{so} = 60V$ $V_{po} = 230V\sqrt{2}$ C1

$= \frac{60 \ x \ 600}{230\sqrt{2}}$ C1

= 111turns A1

(iii) Ac current into the primary coil creates an alternating magnetic flux B1

that links the soft iron core B1

The alternating magnetic flux induces eddy currents in the iron core B1

The eddy currents flowing in the iron core causes joule heating B1

Hence the thermal energy detected. A0

4(a)(i) Flow in which a fluid flows as a smooth layer/sheet of fluid B1

(ii) A flow in which density of fluid at any point is uniform B1

(b)(i) 1 $A_1v_1 = R \ \therefore v_1 = \frac{R}{A_1}$ A1

2 $A_{2V2} = R \quad \therefore v_2 = \frac{R}{A_2} = \frac{2R}{A_1}$ A1

(ii) $\Delta p = \frac{1}{2}\rho(v_2^2 - v_1^2)$

$= \frac{1}{2}\rho \left(\frac{4R^2}{{A_1}^2} - \frac{R^2}{{A_1}^2}\right)$ C1

$= \frac{3\rho R^2}{2{A_1}^2}$ A0

(iii) $4\,120 = \frac{3 \ x \ 791R^2}{2 \ x \ (1.2 \ x10^{-3})^2}$ C1

$R = 2.24 \text{ x } 10^{-3} \text{ m}^3\text{s}^{-1}$ A1

(c)(i) Gases exert pressure by bombarding the walls of their container. B1

Momentum of gas molecules change during each collision. B1

Rate of change of momentum of gas molecules is the force exerted by gas. B1

The force per unit area is the pressure exerted by the gas. B1

(Maximum 2 marks)

(ii) $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$

$p_2 = \frac{3 \ x \ 10^5 \ V_1 x \ 1.05T_1}{T_1 \ x \ 1.01V_1}$ C1

$= 311\,881.2\text{Pa} / 3.12 \text{ x } 10^5\text{Pa}/312\text{kPa}$ A1

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(d)(i) 1 extension x $= r\theta$

$= 1.5 \times 10^{-2} \times \frac{2\pi \times 9.2}{360}$ C1

$= 2.4 \times 10^{-3}$m A1

2 strain $= \frac{2.4 \times 10^{-4}}{3.50}$

$= 6.9 \times 10^{-4}$ A1

(ii) Work done $W = \frac{1}{2}kx^2$

Force F $= ke = mg = 2.00 \times 9.81$ C1

After increasing mass to 2.04, Force $F_1 = k(x + e)$

$2.04 \times 9.81 = kx + 2.00 \times 9.81$

$kx = 0.04 \times 9.81$

$\therefore W = \frac{1}{2}kx^2 = \frac{1}{2}(kx)x$

$= \frac{1}{2} \times 0.04 \times 9.81 \times 2.4 \times 10^{-4}$

$= 4.71 \times 10^{-4}$J A1

(iii) 1 $Q = mc\theta$

$\theta = \frac{4.71 \times 10^{-4}}{6.2 \times 10^{-3} \times 420}$

$= 1.81 \times 10^{-4}$K A1

4(d)(iii) 2 No heat energy is lost to the environment B1

All the work done is converted to heat which raise the temperature of the wire. B1

(e)(i) Property of a material which changes linearly and monotonically with temperature B1

(ii) 1 For boiling oxygen- a constant volume gas thermometer is used B1

It can measure temperature below -183°C and it has range of 3 to 1750K B1

2 For a molten iron in a blast furnace- a thermocouple thermometer is used B1

It has a wide range of temperature of 80 to 1400K and it can be connected to other circuit or computer, so it can be used remotely B1

5(a)(i) 1 A-copper braid (outer conductor) B1

B-insulation B1

C-copper wire (inner conductor) B1

2 Copper braid

- shields inner core from noise/interference/cross-talk B1
- acts as a return path for signals B1

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(ii) Coaxial cable

- has a larger bandwidth, so the cable is capable of carrying much more information than a wire-pair. B1
- has less signal attenuation, regeneration stations can be much farther apart B1
- a negligible radiation of energy, so very little cross-talk/link B1
- picks up less noise, so it is much clearer signal B1
- is virtually impossible to tap into, so is much secure B1

Any **three** advantages

(b)(i) Modulation is variation of amplitude or frequency of a carrier wave in line with the amplitude or frequency of modulating signal B1

(ii) 1

- AM signals have interference/noise/cross-talks while FM signals have negligible or no interference/noise/ cross-talks B1
- AM signals are prone to interference by electromagnetic radiation from other sources like lightning, unsuppressed internal combustion engines, switching a c on/off while FM signals are less prone to interference by electromagnetic radiation B1
- AM signals have a narrower frequency bandwidth than FM signals, so quality of sound is poorer for AM signals than FM signals B1

2

- FM uses expensive and more advanced technology while AM transmissions use cheaper and less advanced technology. B1
- Range of AM transmission is much wider than FM transmission, hence more transmitters are required than in AM transmission. B1.

(c)(i) B4

Time/µs	0	40	70
Voltage/V	5.0	8.0	7.9
Digital code	0101	1000	0111

(c)(ii) 1

Time/ms	0	10	20	30	40	50	60	70	80
Voltage level/V	5	7	6	9	8	6	7	7	7

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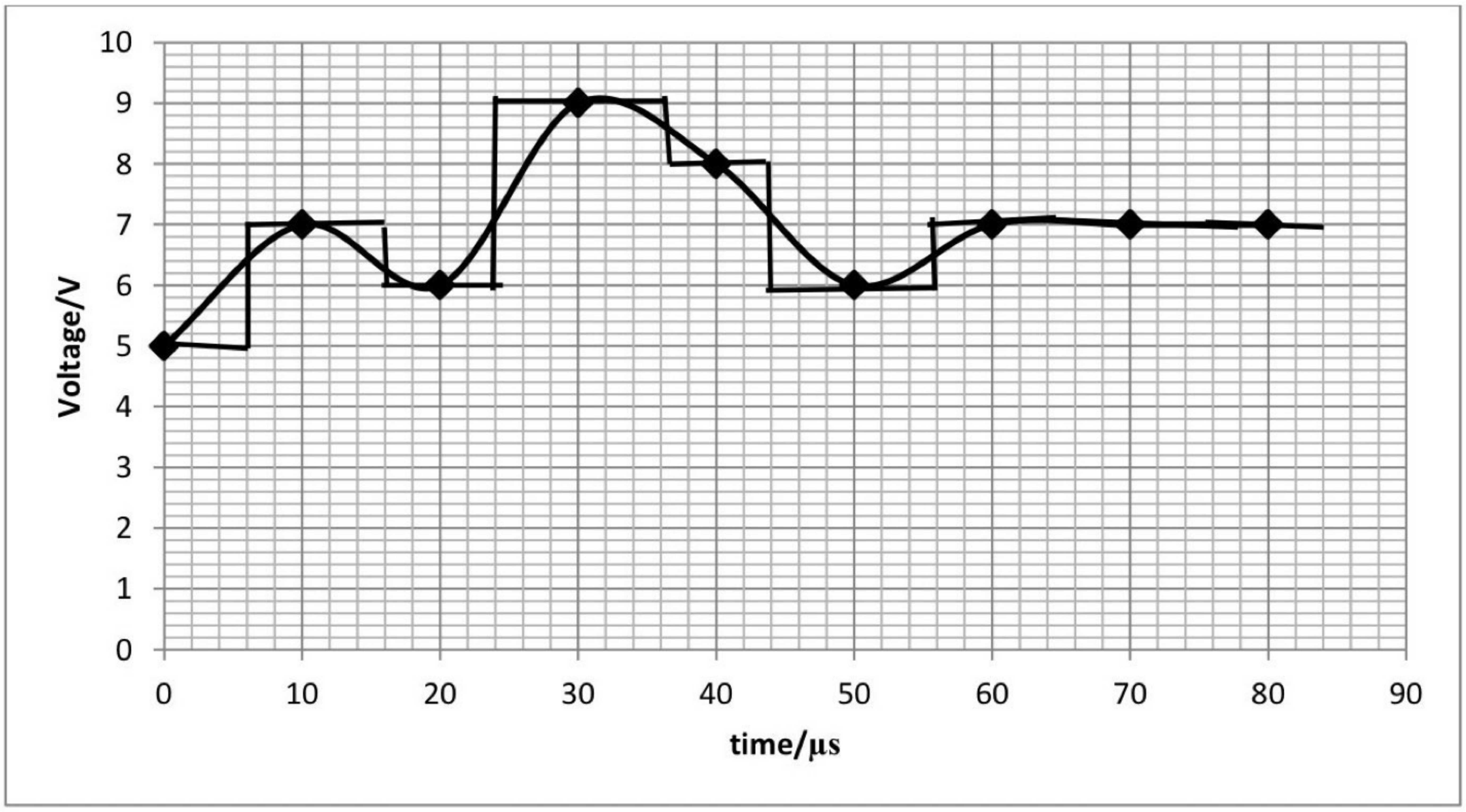

B3

2	By using ADC and DAC with larger number of bits/By increasing bit rate	B1
	This makes smaller step height	B1
	By increasing sampling frequency	B1
	This makes smaller step width	B1

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For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

6032/3

Paper 3 THEORY

JUNE 2019 SESSION

2 hours 30 minutes

Additional materials:
Answer paper
Scientific calculator

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question1 is compulsory.
Answer any other **three** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

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DATA

speed of light in free space	$c = 3.00 \times 10^8 ms^{-1}$
permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ Hm^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1} ($1/4\pi\varepsilon_0 = 8.99 \times 10^9$ mF^{-1})
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ Js
unified atomic mass unit	$1\ u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31$ JK^{-1}mol^{-1}
the Avogadro constant	$N_A = 6.02 \times 10^{23}$mol^{-1}
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ JK^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$Nm^{2}kg^{-2}
acceleration of free fall	$g = 9.81$ ms^{-2}

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FORMULAE

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\,\Delta V$
gravitational potential	$\emptyset = - Gm/r$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$
	$v = \pm\omega\sqrt{(x_o^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
Attenuation of x-rays	$I = I_o e^{-\mu x}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_o \sin\omega t$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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Answer question 1 and any other three from the remaining questions.

1 **(a)** **(i)** State the numerical equivalence of

1. deci,
2. giga.

(ii) The gravitational potential, V, at a distance from the centre of the earth is given by $V = \frac{-GM}{r}$, where symbols have their usual meanings.

Show that the equation is homogeneous. [4]

(b) The velocity, v, of a wave on a string depends on tension, T, in the string, length, l and its mass, m.

Derive using base units, the equation connecting v in terms of T, l and m. [4]

(c) An object is sliding on a horizontal line XYZ where XY = 24 m and XZ = 30 m. The object experiences a constant resistive force of 0.3 N. The speed of the object at X is 20 ms^{-1} and at Y is 16 ms^{-1}.

Calculate the

(i) acceleration of the object,

(ii) speed of the object at Z,

(iii) weight of the object.

[4]

(d) **(i)** Define *centripetal force.*

(ii) A 0.8 kg object, attached to a string 0.5 m long, is whirled in a vertical circle at a constant speed. The minimum tension in the string is 30 N.

Calculate the

1. angular frequency,
2. linear speed,
3. maximum tension in the string.

[6]

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(e) **Fig. 1.1** shows a 10 N uniform rod which is 1.2 m long. The rod is held horizontally by a cable attached at point Y and point Z. The cable makes an angle of 40° with the vertical and a 30 N load is hung at point Y.

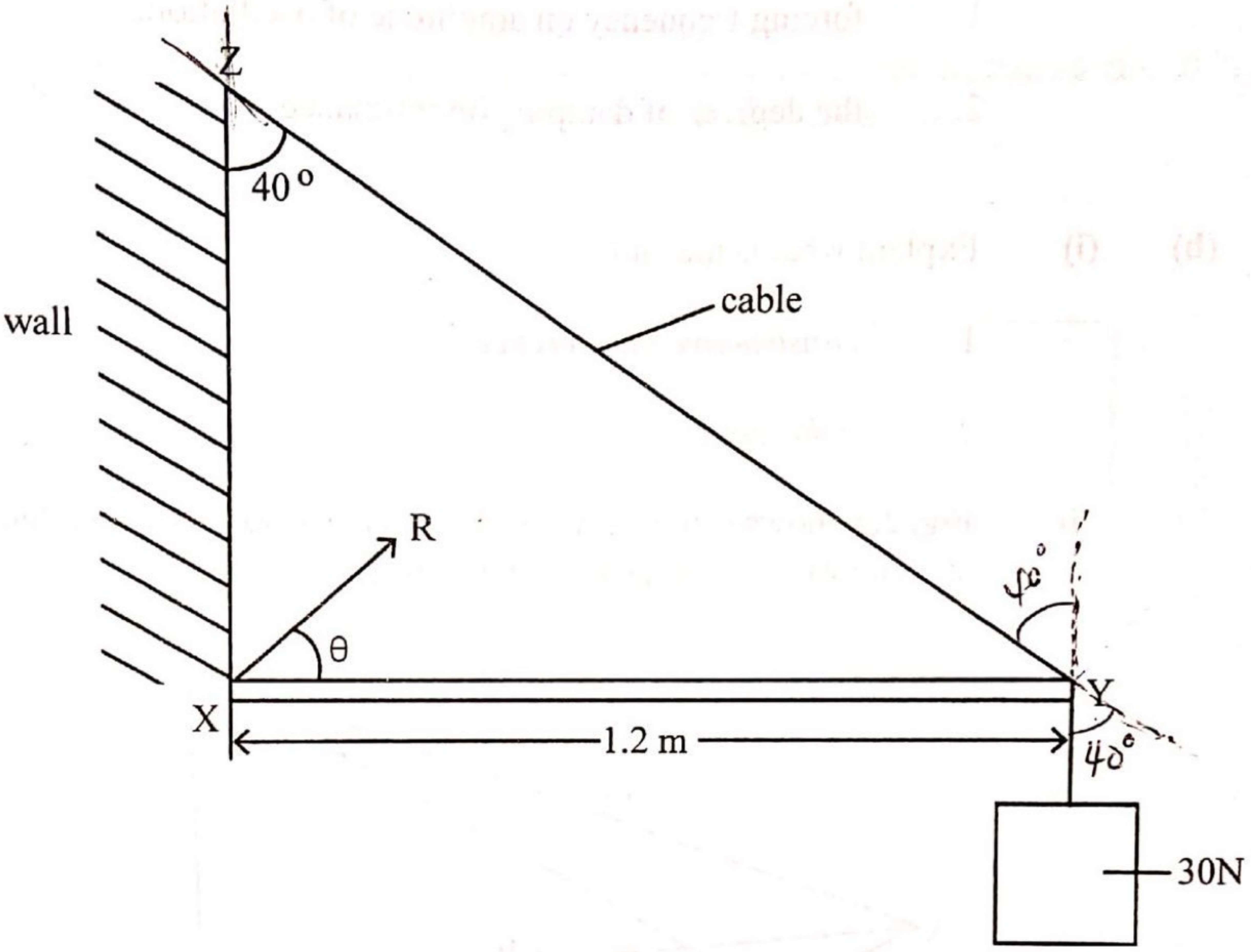

Fig. 1.1

Calculate the

(i) tension in the cable,

(ii) angle, θ,

(iii) reaction force, R.

[7]

[Turn over

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2 (a) (i) Explain what is meant by *resonance*.

(ii) Describe the effects of

1. forcing frequency on amplitude of oscillation,

2. the degrees of damping on resonance.

[8]

(b) (i) Explain what is meant by

1. *constructive interference*,

2. *coherence*.

(ii) **Fig. 2.1** shows sources, A and B, producing waves of wavelength, λ. The waves superpose at O, P and Q on the screen.

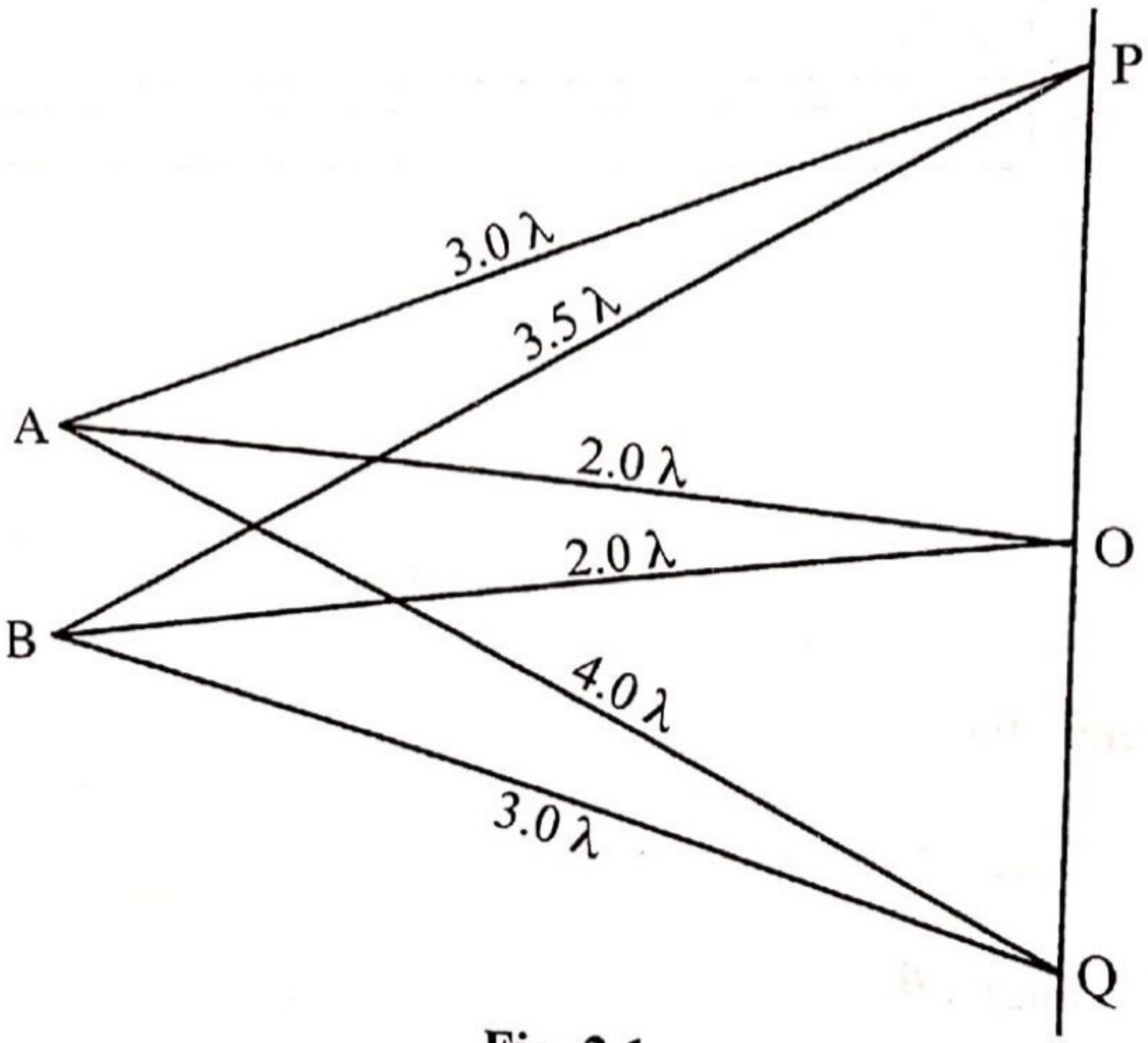

Fig. 2.1

State and explain the effects produced at O, P and Q.

[9]

(c) (i) Describe the main principles of CT scanning.

(ii) State the advantages of CT scanning over X-ray imaging.

[8]

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3 **(a)** **(i)** Define *potential difference.*

(ii) State and explain the effect of internal resistance of a power source on its terminal potential difference.

(iii) **Fig. 3.1** shows a current of 1.5 A being driven through a circuit by a battery of emf 9.0 V and internal resistance 2.0 Ω.

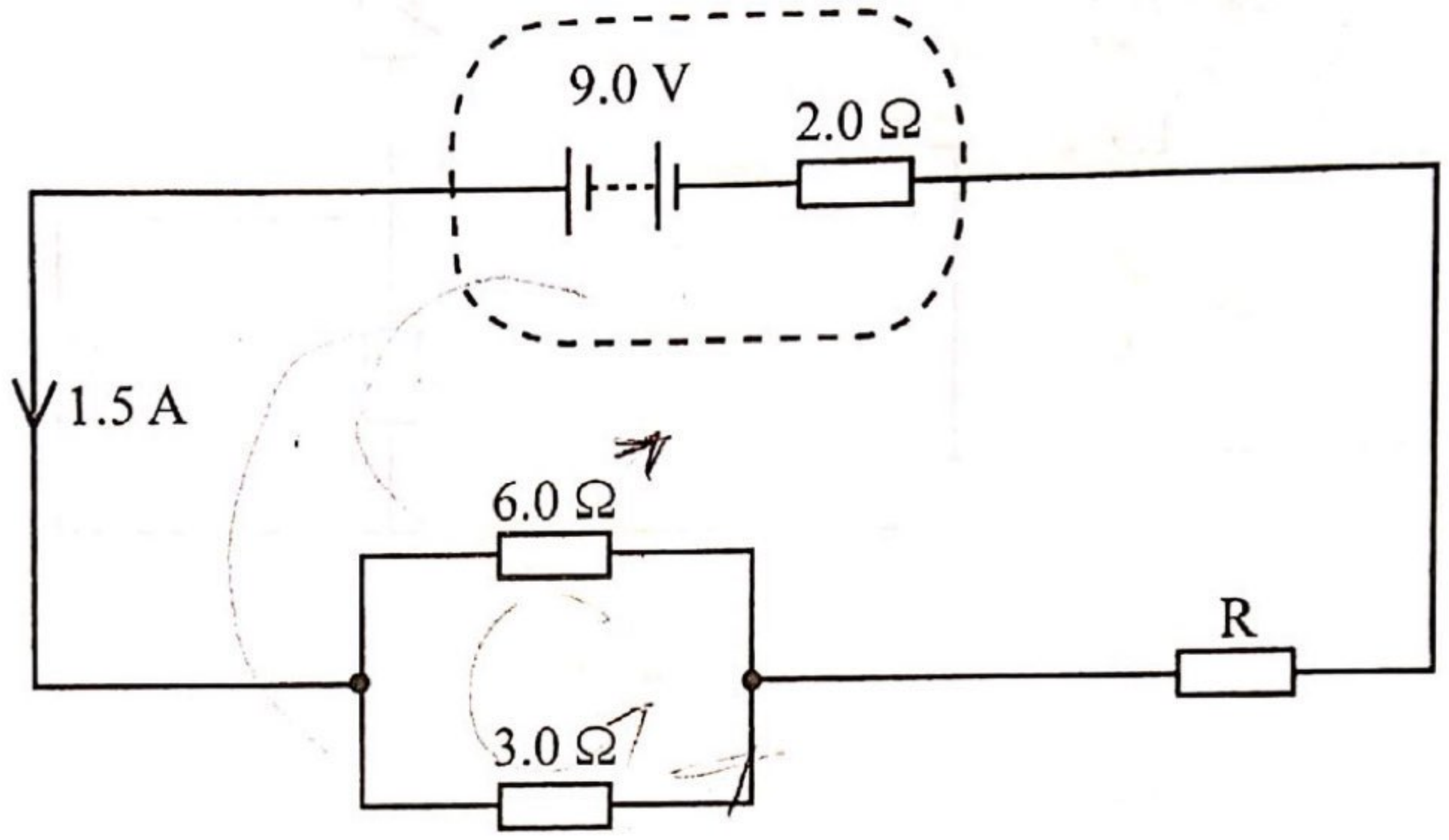

Fig. 3.1

Determine the

1. current flowing through the 6.0 Ω resistor,

2. amount of charge that passes through the 6.0 Ω resistor in 5.0 minutes,

3. value of the resistor, R.

[8]

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(b) **Fig. 3.2** shows a potential divider circuit with a cell of emf 1.5 V and negligible internal resistance. The voltmeter has an infinite resistance. At 0 ºC the thermistor has a resistance of 3.9 kΩ and the voltmeter reads 1.0 V.

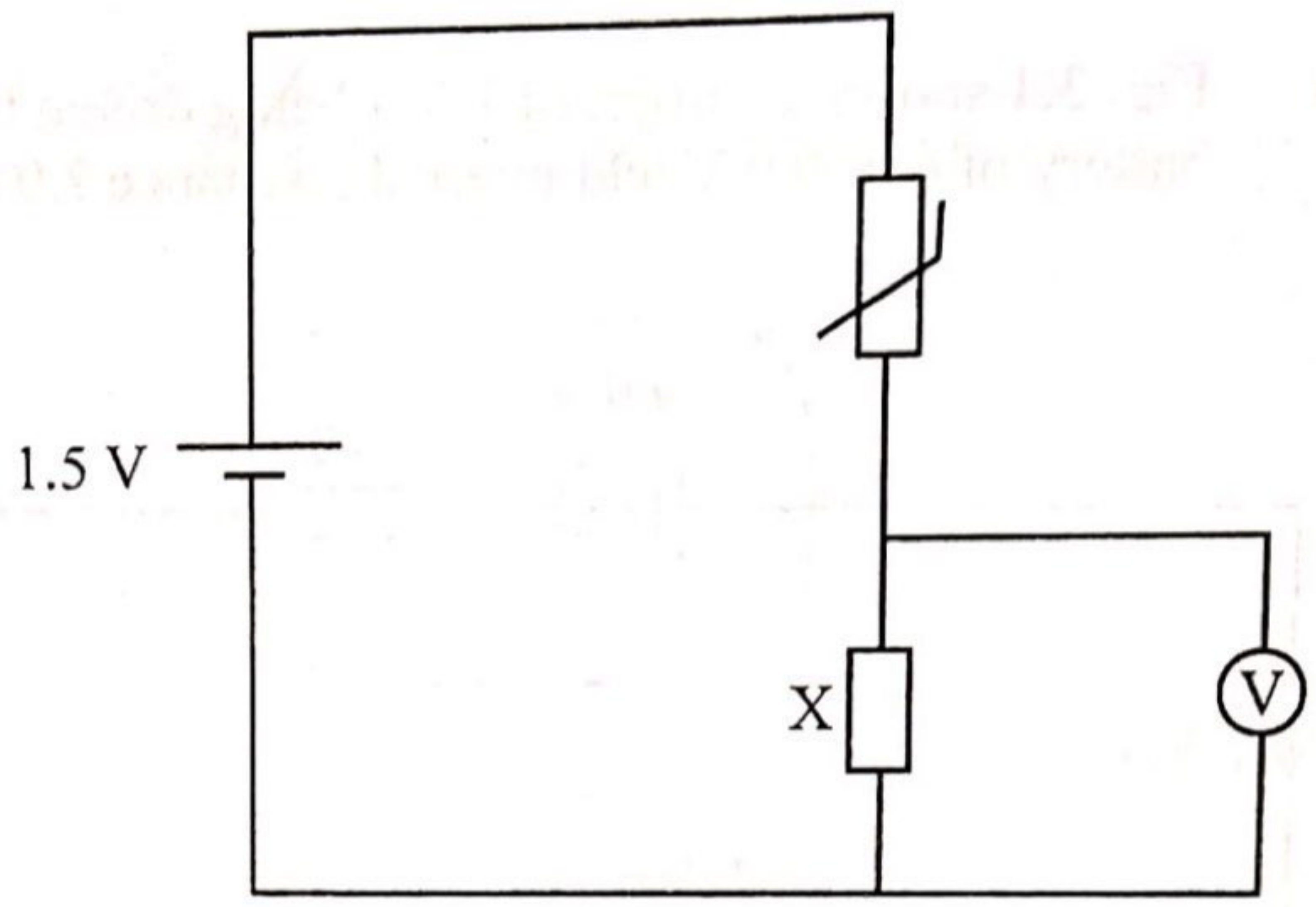

Fig. 3.2

(i) Determine the

1. resistance of the fixed resistor X,

2. voltmeter reading at 30° C when the thermistor has a resistance of 1.3 kΩ.

(ii) Suggest a practical use of this circuit.

[5]

(c) **(i)** State the significance of the following properties of an ideal amplifier.

1. *infinite bandwidth.*

2. *infinite slew rate.*

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(ii) **Fig. 3.3** shows an amplifier circuit.

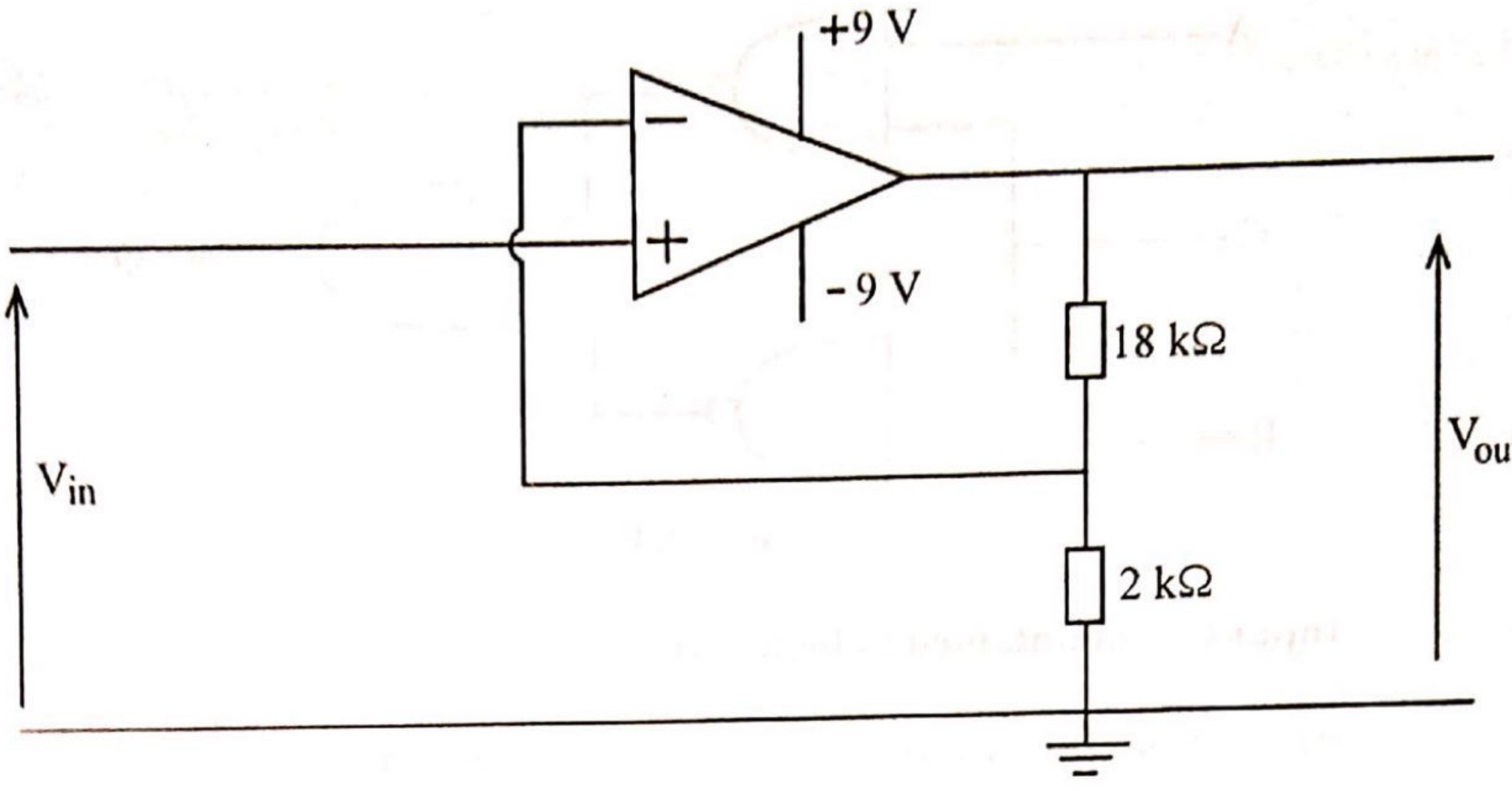

Fig. 3.3

1. State the mode of operation of the amplifier circuit.

2. Calculate the gain of the amplifier.

3. The input voltage is given by $V_{in} = 0.6 \sin \omega t$.

   Sketch on the same axes graphs showing the variation of the input and output voltages.

[8]

[Turn over

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(d) **Fig. 3.4** shows a combination of logic gates.

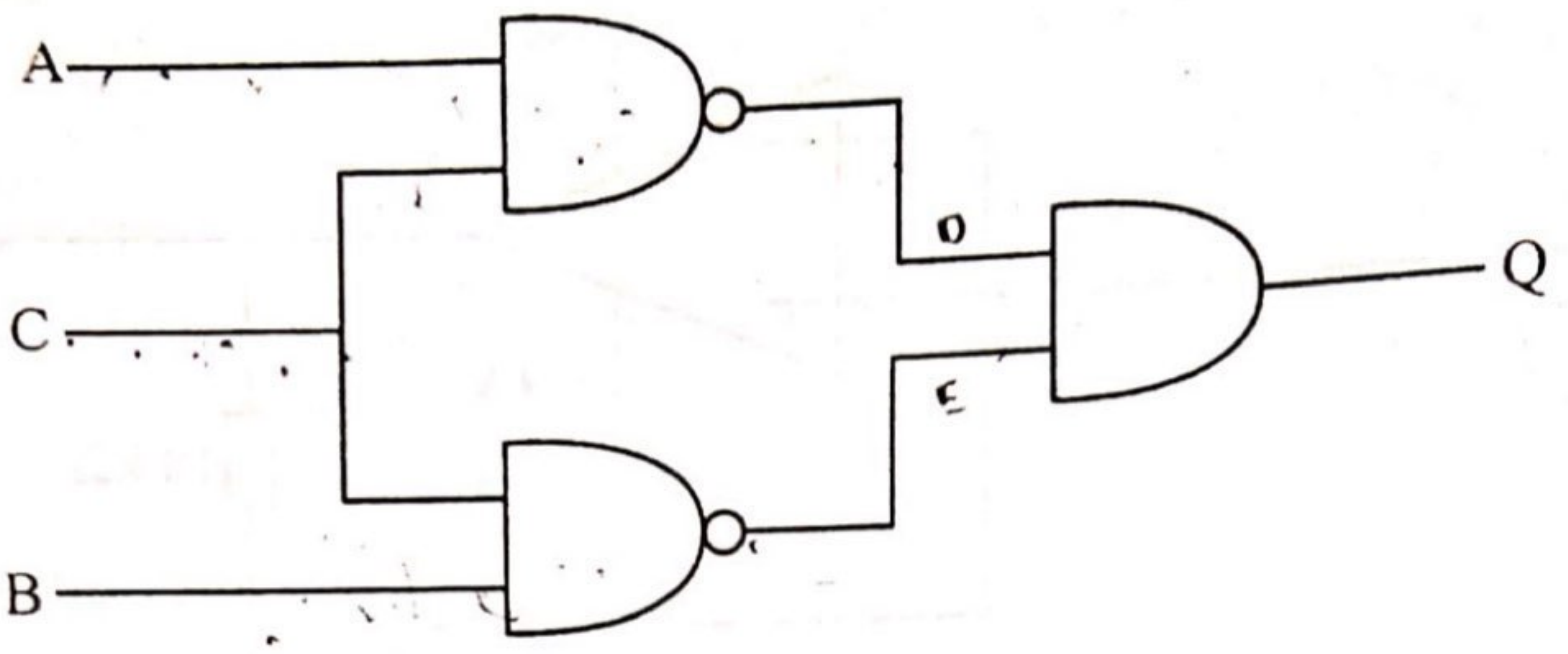

Fig. 3.4

Input C is maintained at logic level 1.

(i) Construct the truth table for the combination.

(ii) Hence deduce the single logic gate that is equivalent to the combination.

[4]

4 **(a)** **(i)** Define *tensile stress* and *tensile strain*.

(ii) A mass of 0.20 kg is supported by a vertical aluminium wire of length 2.0 m and diameter 0.80 mm. The wire extends by 110 μm.

Determine the

1. tensile stress,
2. tensile strain,
3. Young Modulus for aluminium.

[8]

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(b) **Fig. 4.1** shows graphs of tensile stress against tensile strain for samples of materials X and Y up to their ultimate tensile stress (**UTS**).

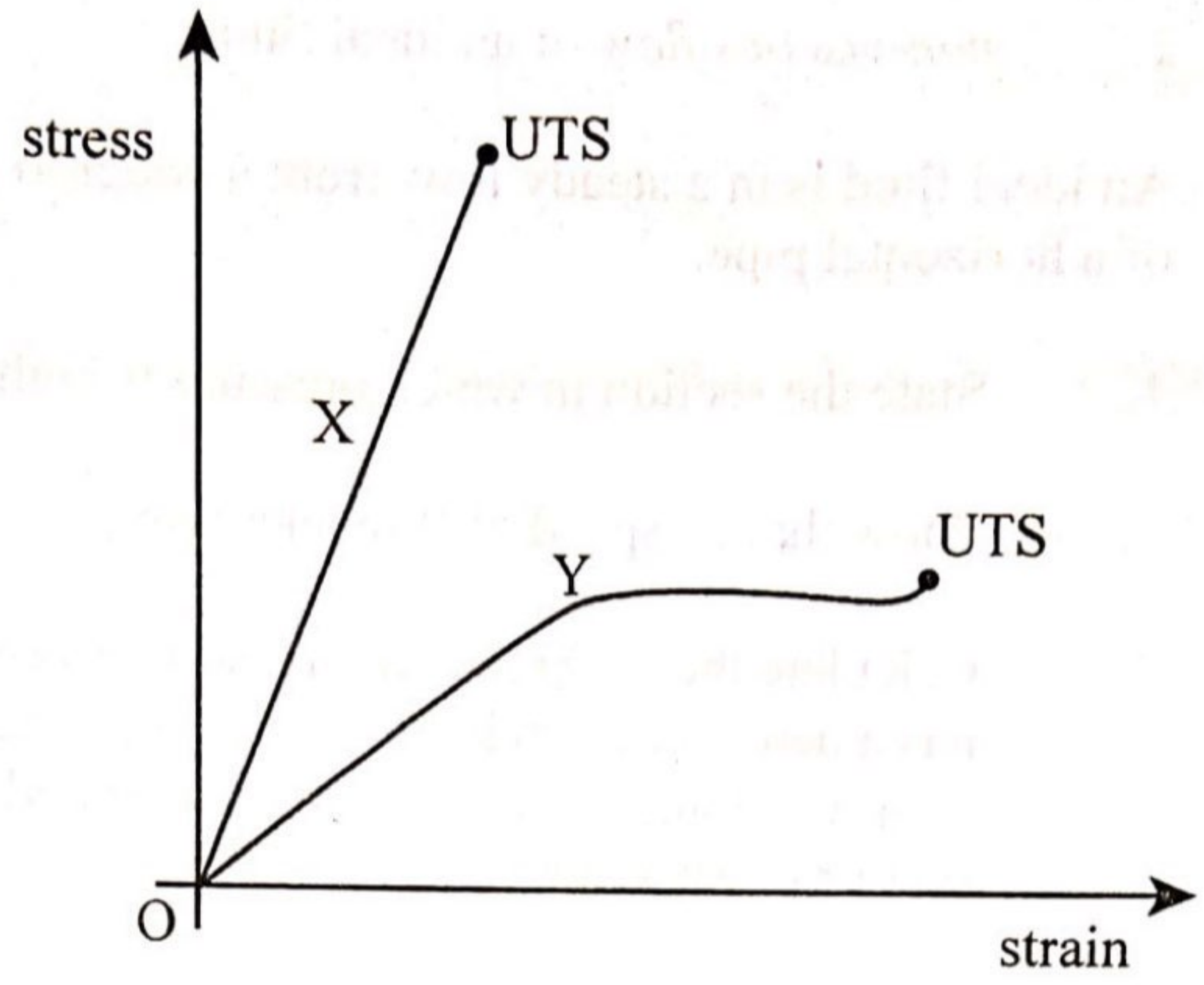

Fig. 4.1

(i) Deduce from **Fig. 4.1**, giving a reason, which material is

1. stronger,
2. stiffer,
3. ductile.

(ii) One of the materials is a ceramic used for making rotor blades of jet engines.

1. State, with a reason, which material is ceramic in **Fig. 4.1**.
2. Suggest **two** other properties, not depicted in **Fig. 4.1** which make the ceramic suitable for this use.

[10]

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(c) **(i)** Explain what is meant by

1. *Incompressible flow*,

2. *non-viscous flow* of an ideal fluid.

(ii) An ideal fluid is in a steady flow from a wider to a narrower section of a horizontal pipe.

1. State the section in which pressure is higher.

2. Show that its speed of flow increases.

3. Calculate the difference in pressure, given that the fluid has a density of 800 kgm^{-3} and is flowing with velocities 0.74 ms^{-1} and 3.5 ms^{-1} in the wider and narrower sections respectively.

[7]

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5 **(a)** **(i)** Define the term *photoelectric effect*.

(ii) The wavelength, λ, of an electromagnetic radiation incident on a metal surface was varied and the corresponding maximum kinetic energy, E_{max}, of the photoelectrons was measured.

Fig. 5.1 shows the corresponding graph of E_{max} against $\frac{1}{\lambda}$.

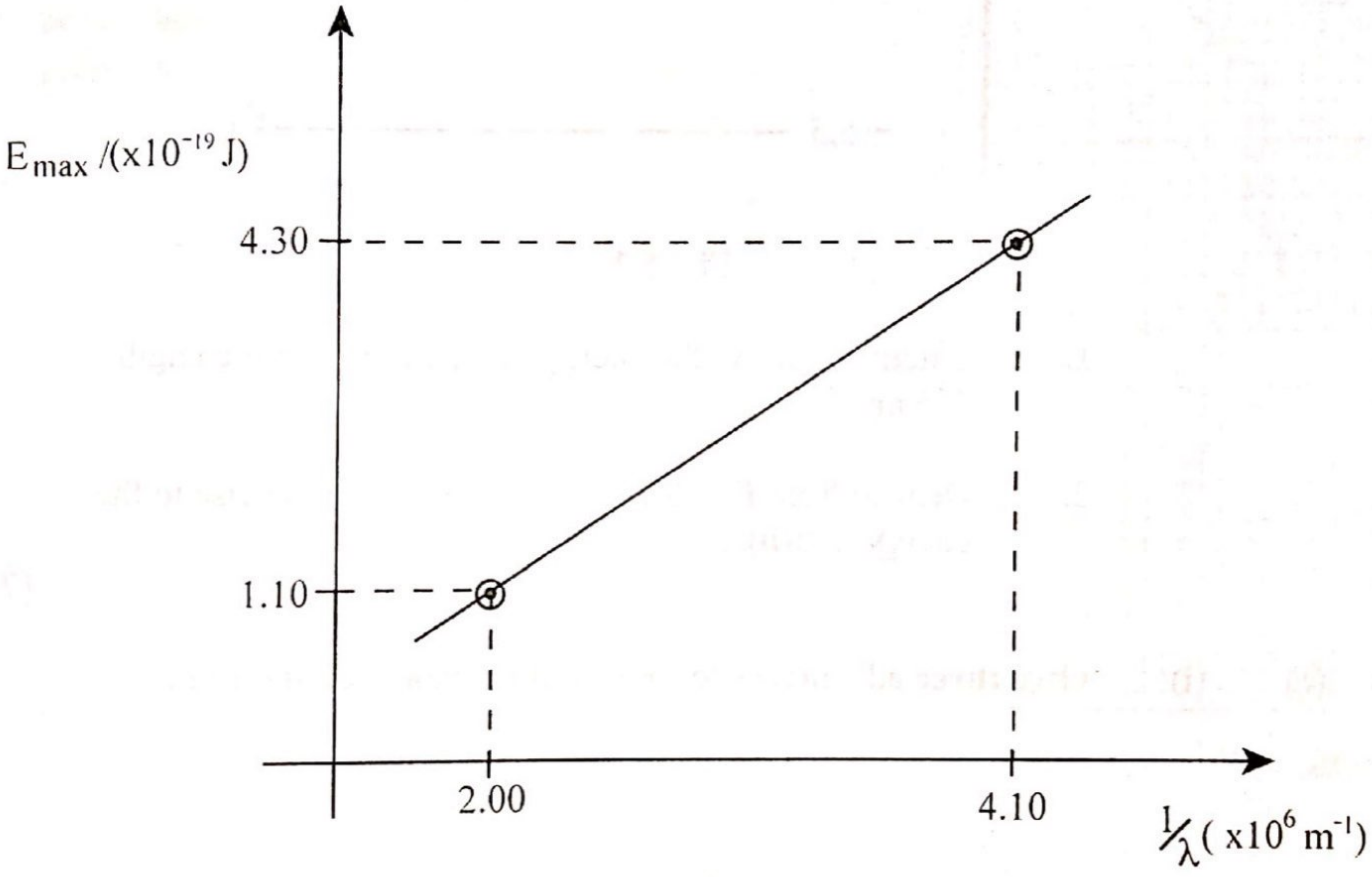

Fig. 5.1

Determine the

1. gradient of the graph,

2. work function of the metal.

$v = f\lambda$

$f = v/\lambda$

[6]

(b) White light is incident on a transparent vessel enclosing cool mercury vapour. The spectrum of the emergent light consists of a number of dark lines.

(i) Account for the dark lines.

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(ii) **Fig. 5.2** shows some energy levels in an atom of mercury vapour.

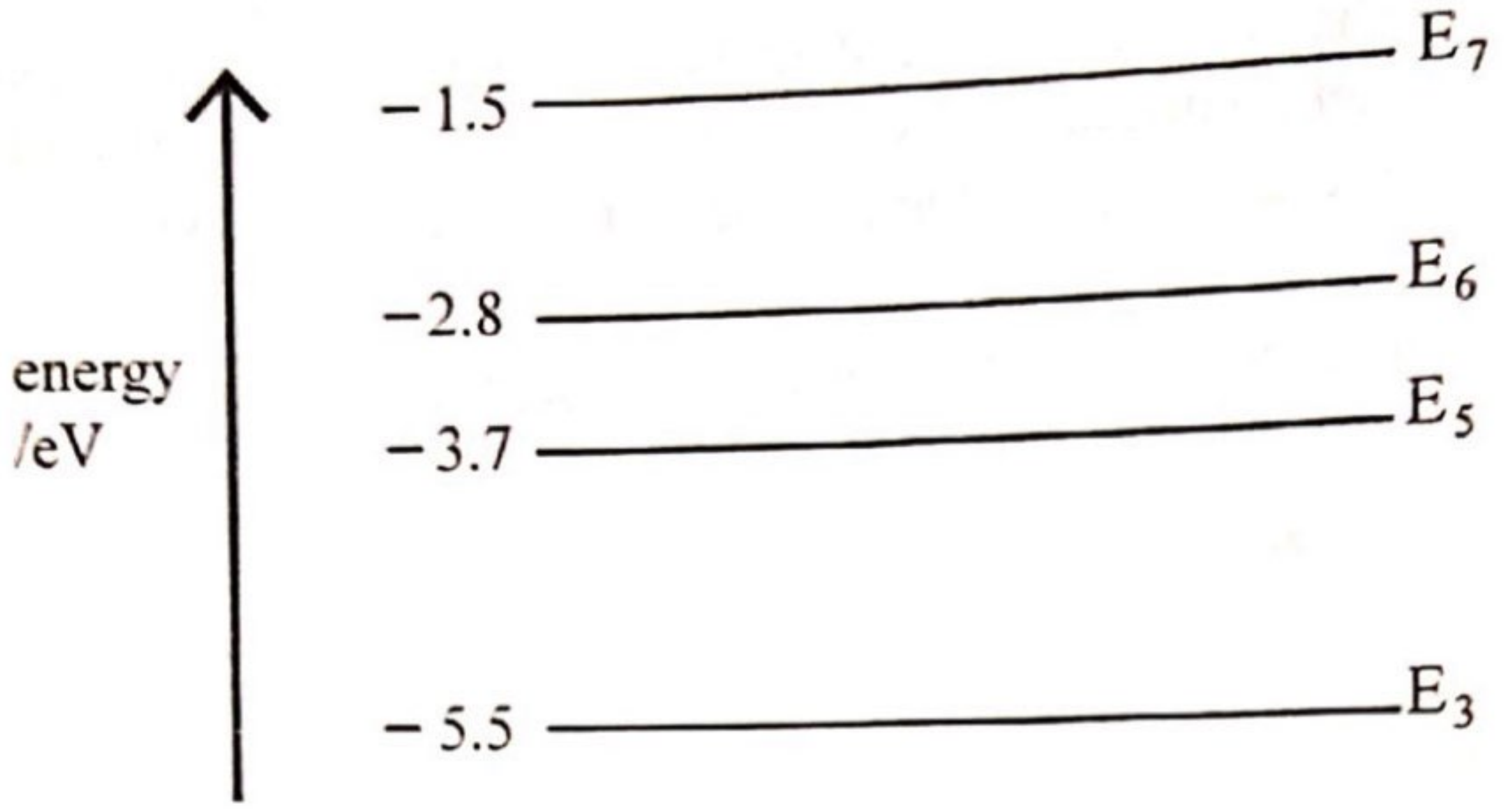

Fig. 5.2

1. Calculate, in eV, the energy of a photon of wavelength 565 nm.

2. Deduce from **Fig. 5.2** the transition that gives rise to the energy in **b(ii)** 1.

[7]

(c) **(i)** Give **three** advantages for transmitting data in digital form.

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(ii) **Fig. 5.3** shows an analogue output of a microphone.

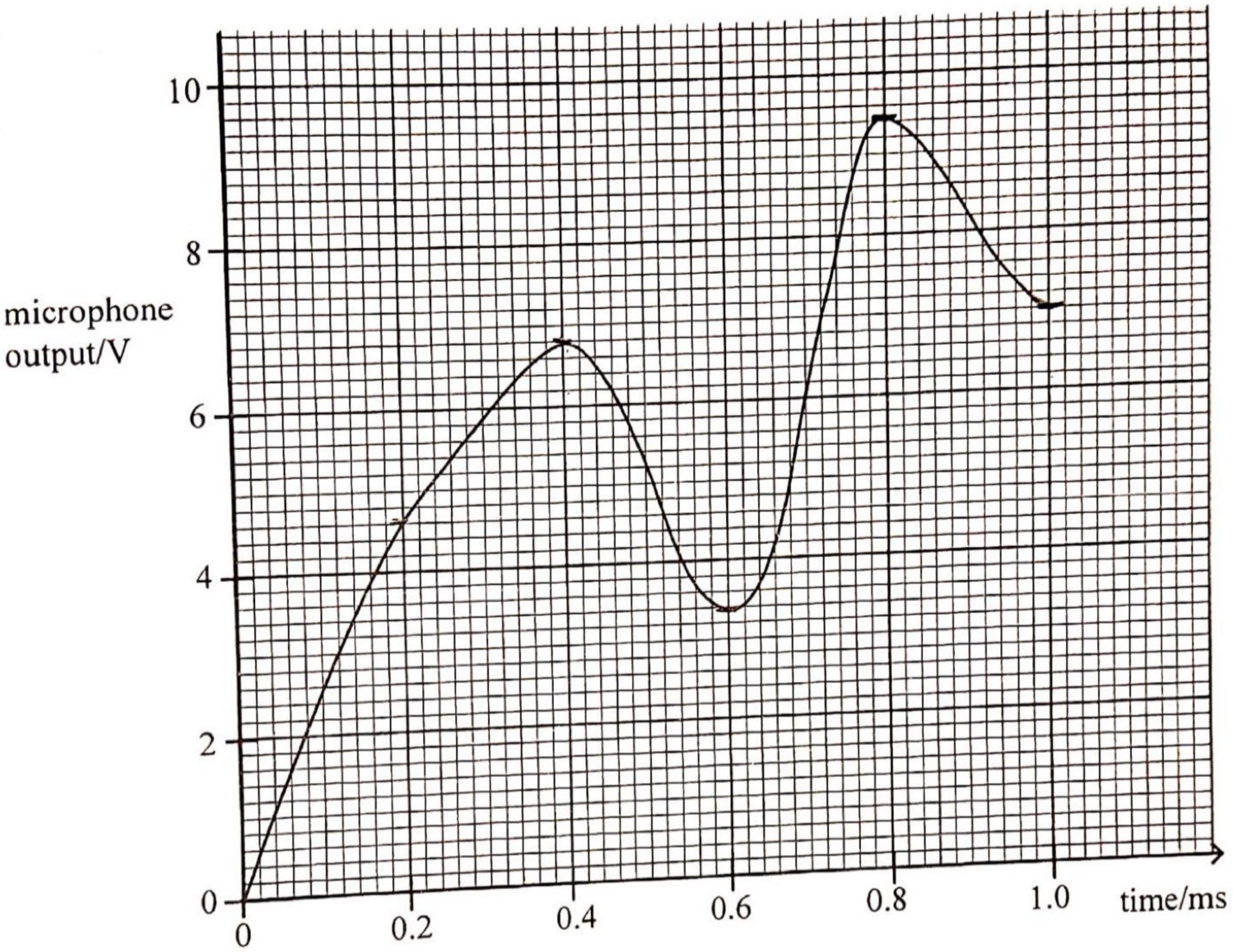

Fig. 5.3

The output is sampled at 0.2 ms intervals.

1. Determine the sampling rate.
2. Use the four-bit system to represent the output of the microphone in digital form at each interval.
3. Suggest **two** ways of improving the matching between the microphone output and its digital form. [12]

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For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

6032/3

PAPER 3

NOVEMBER 2019 SESSION 2 hours 30 minutes

Additional materials:
Answer paper
Electronic calculator

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question 1 is compulsory.

Answer any other **three** from the remaining questions.

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INFORMATION FOR CANDIDATES

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This question paper consists of 16 printed pages.

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[Turn over

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DATA

speed of light in free space	c = 3.00 x 10^{8} ms^{-1}
permeability of free space	μ_o = 4π x 10^{-7} Hm^{-1}
permittivity of free space	ε_0 = 8.85 x 10^{-12} Fm^{-1} ($1/4\pi\, \varepsilon_0$ = 8.99 x 10^{9} mF^{-1})
elementary charge	e = 1.60 x 10^{-19} C
the Planck constant	h = 6.63 x 10^{-34} Js
unified atomic mass unit	1 u = 1.66 x 10^{-27} kg
rest mass of electron	m_e = 9.11 x 10^{-31} kg
rest mass of proton	m_p = 1.67 x 10^{-27} kg
molar gas constant	R = 8.31 JK^{-1} mol^{-1}
the Avogadro constant	N_A = 6.02 x 10^{23} mol^{-1}
the Boltzmann constant	k = 1.38 x 10^{-23} JK^{-1}
gravitational constant	G = 6.67 x 10^{-11} Nm^{2} kg^{-2}
acceleration of free fall	g = 9.81 ms^{-2}

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FORMULAE

uniformly accelerated motion	$s = ut + ½at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\,\Delta V$
gravitational potential	$\emptyset = -\mathrm{Gm/r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$
	$v = \pm\omega\sqrt{(x_o^2 - x^2)}$
Attenuation of x-rays	$\mathrm{I} = \mathrm{I}_o e^{-\mu x}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\,\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{\mathrm{ntq}}$
alternating current/voltage	$x = x_o \sin\omega t$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

[Turn over

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Answer question 1 and any other 3 from the remaining questions.

1 **(a)** **Fig. 1.1** shows a longitudinal cross-section of an optical fibre strand. The diameter of the core, d, is (2.51 ± 0.01) μm and the thickness, t, of the cladding is (0.18 ± 0.01) μm.

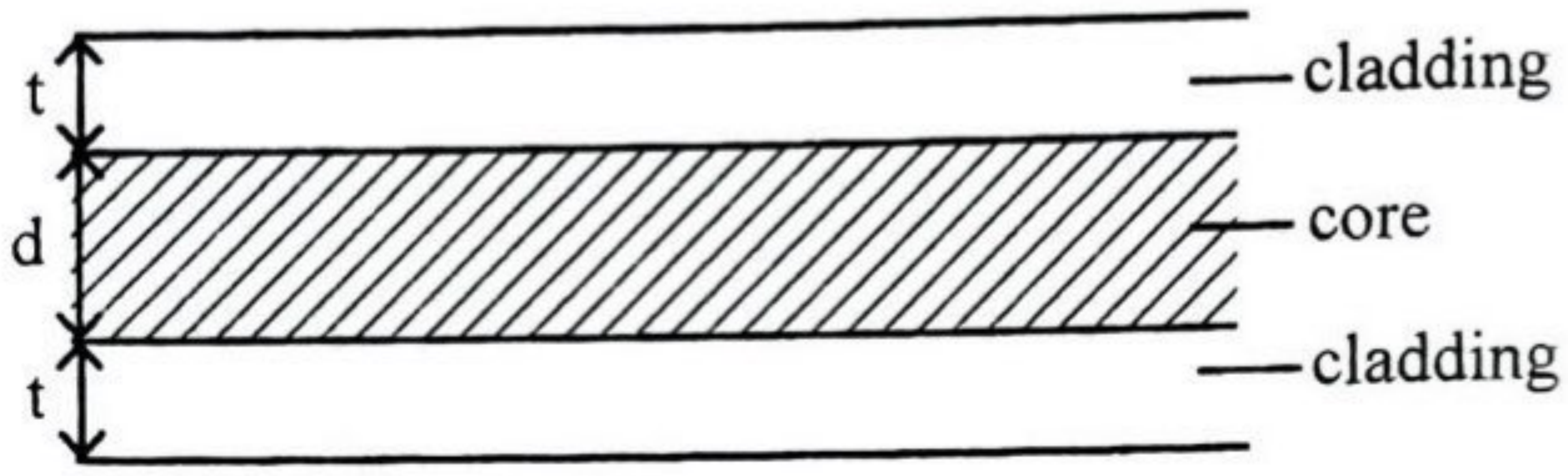

Fig. 1.1

Calculate the

1. diameter of the optical fibre strand and its uncertainty,
2. fractional error of the volume of the optical fibre strand of length (1.00 ± 0.01) μm.

[4]

(b) **Fig. 1.2** shows an object that is projected at an angle θ to the vertical. The object follows a trajectory that has a maximum height of 2.20 m and a range of 18.06 m. The speed of projection is 15 ms^{-1}.

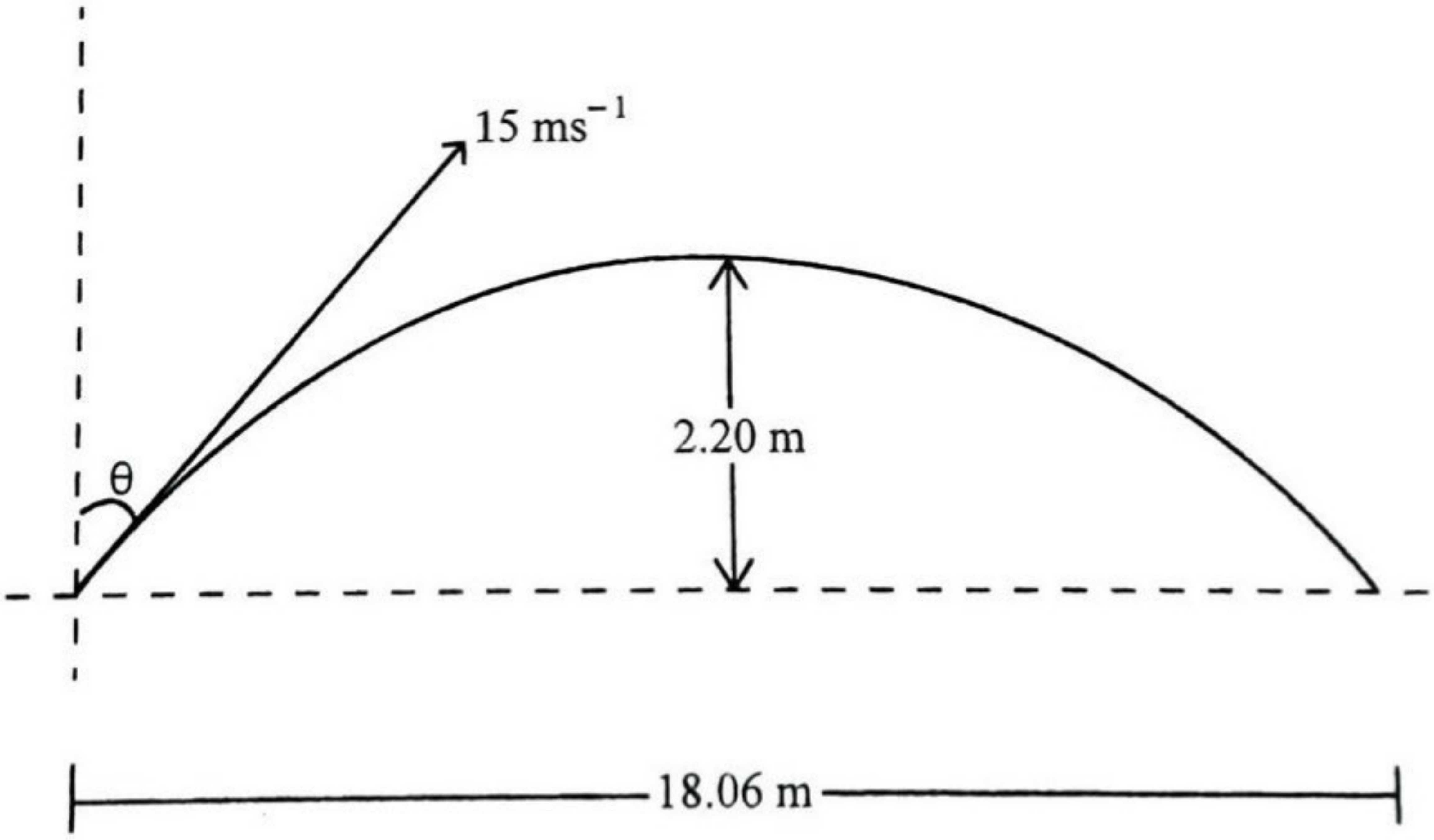

Fig. 1.2

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Calculate the

(i) angle θ,

(ii) time of flight,

(iii) initial horizontal velocity,

(iv) final vertical velocity,

(v) direction of the final resultant velocity. [8]

(c) **Fig. 1.3** shows a pressure-time graph of gas molecules colliding with walls of a container. The total surface area of the container is 20 cm^2.

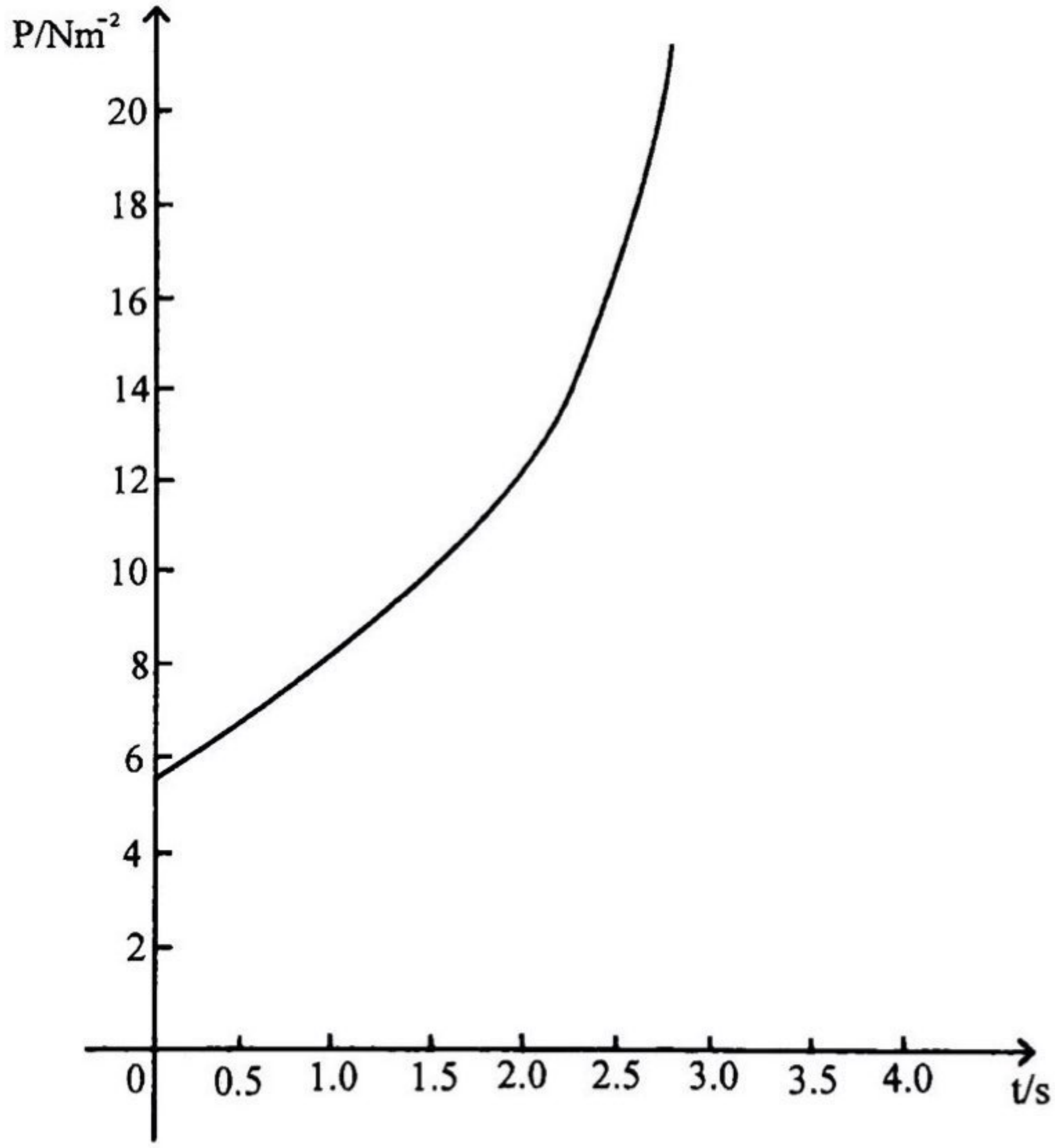

Fig. 1.3

(i) Estimate, for the period 1.5 s to 2.0 s the

1. average force that the gas molecules exert on the walls,

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2. impulse of the gas molecules as they collide with the walls of the container.

(ii) Deduce how the impulse varies if the change in pressure increases for the same time interval. [4]

(d) The kinetic energy of a body is given by

$$E_k = \frac{1}{2}\mathrm{m}(\Delta v)^2.$$

Show that the change in momentum, Δp, of the body can be expressed as

$$\Delta p = \frac{2Pt}{\Delta v}$$

where t is time, P is power and Δv is velocity change. [3]

(e) **Fig. 1.4** shows a metal arm of a fairground ride that propels a toy rocket of mass 140 kg in a horizontal circle of radius 5 m with a constant speed of 8 ms^{-1}.

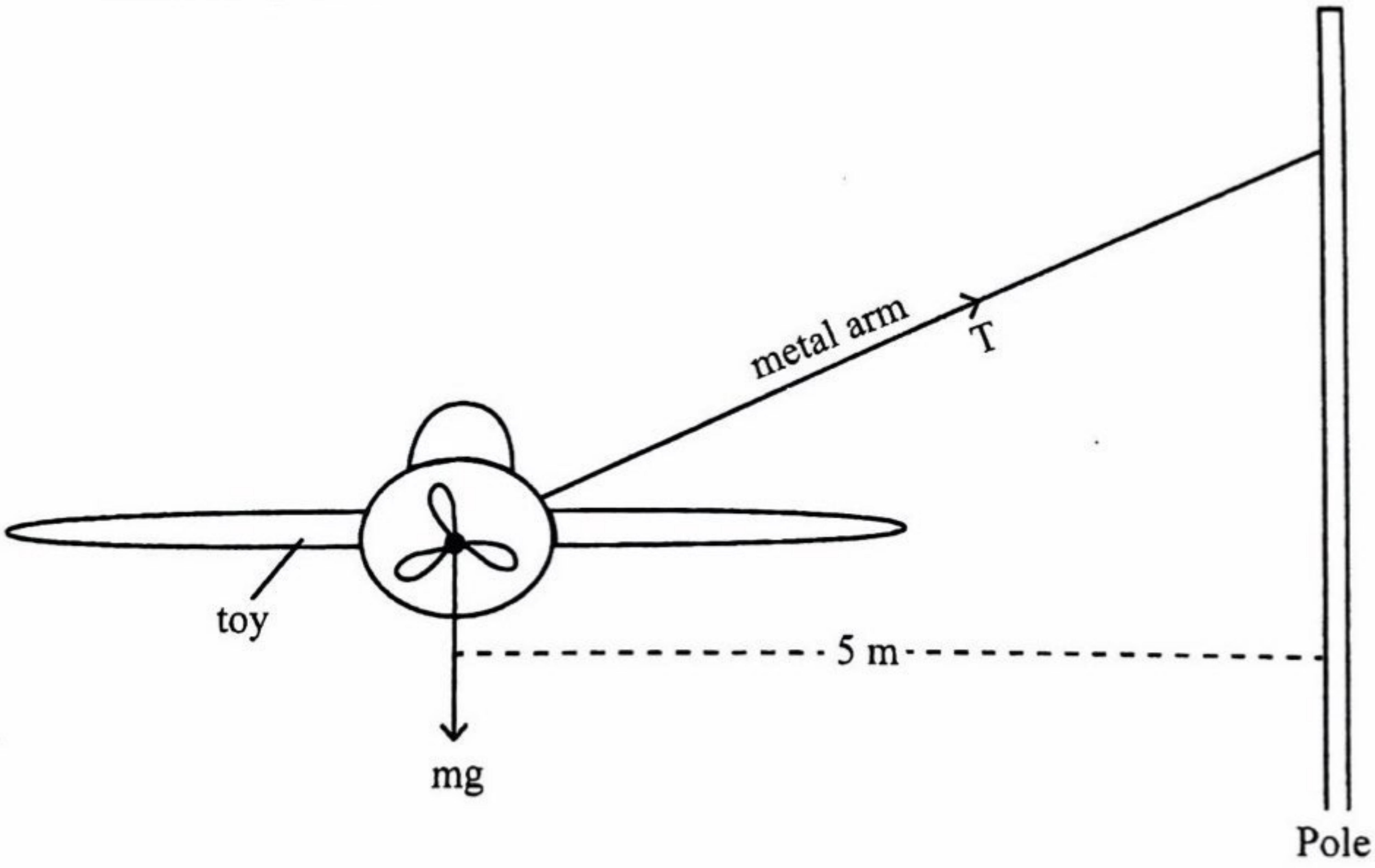

Fig. 1.4

If the metal arm is slightly inclined to the horizontal, find the tension, T, in the metal arm. [3]

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(f) **Fig. 1.5** shows a star 4.6×10^{20} m from the centre of a galaxy of mass, M. The star orbits with a speed of $v = 3 \times 10^5\ \mathrm{ms^{-1}}$.

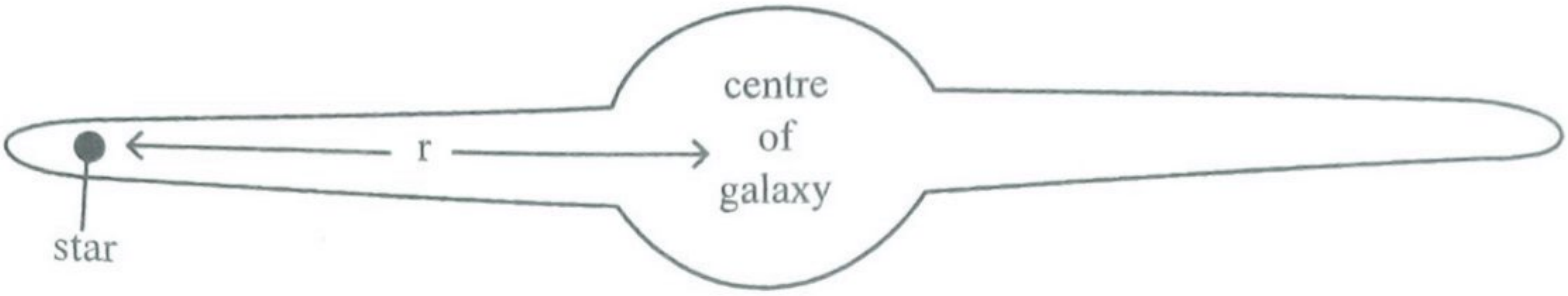

Fig. 1.5

Determine the mass, M, of the galaxy. [3]

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2 (a) **Fig. 2.1** shows a 0.814 kg mass suspended at a lower end of a helical spring of spring constant 0.5 Nmm^{-1}. The mass oscillates vertically between the points A and B at which the extensions of the spring are 13.0 mm and 22.0 mm respectively.

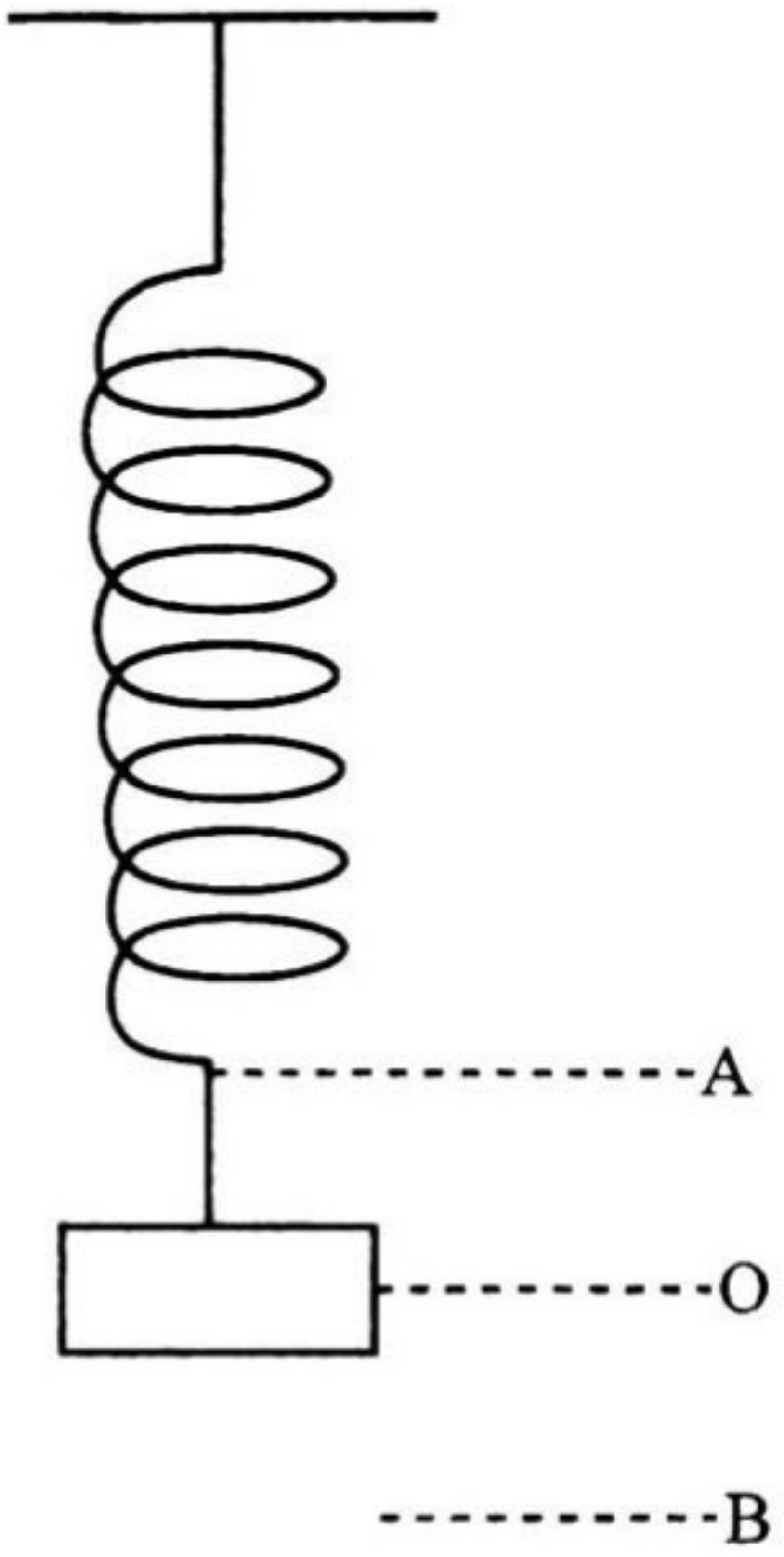

Fig. 2.1

(i) Calculate the

1. period of oscillation,
2. kinetic energy of the mass when it passes through the equilibrium position O.

(ii) State and explain the effect of using a

1. spring of higher spring constant on the amplitude of the oscillation,
2. greater mass on the period of oscillation.

(iii) Sketch a graph of the variation of amplitude of the oscillation with time if the mass is made to oscillate in oil.

[11]

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(b) **(i)** Describe the use of X-rays in the identification of minerals.

(ii) A material of thickness 2.10 mm reduces the intensity of an X-ray beam to 68 % of the incident intensity.

Calculate the

1. attenuation coefficient of the material,
2. fraction of intensity that reaches a depth of 3.72 mm in the same material.

(iii) State any **one** disadvantage of CT scanning over X-rays.

[9]

(c) A parallel beam of light of wavelength 673 nm is incident normally at a single slit of size 0.095 mm. A screen is placed 1.75 m away from the single slit as shown in **Fig. 2.2**.

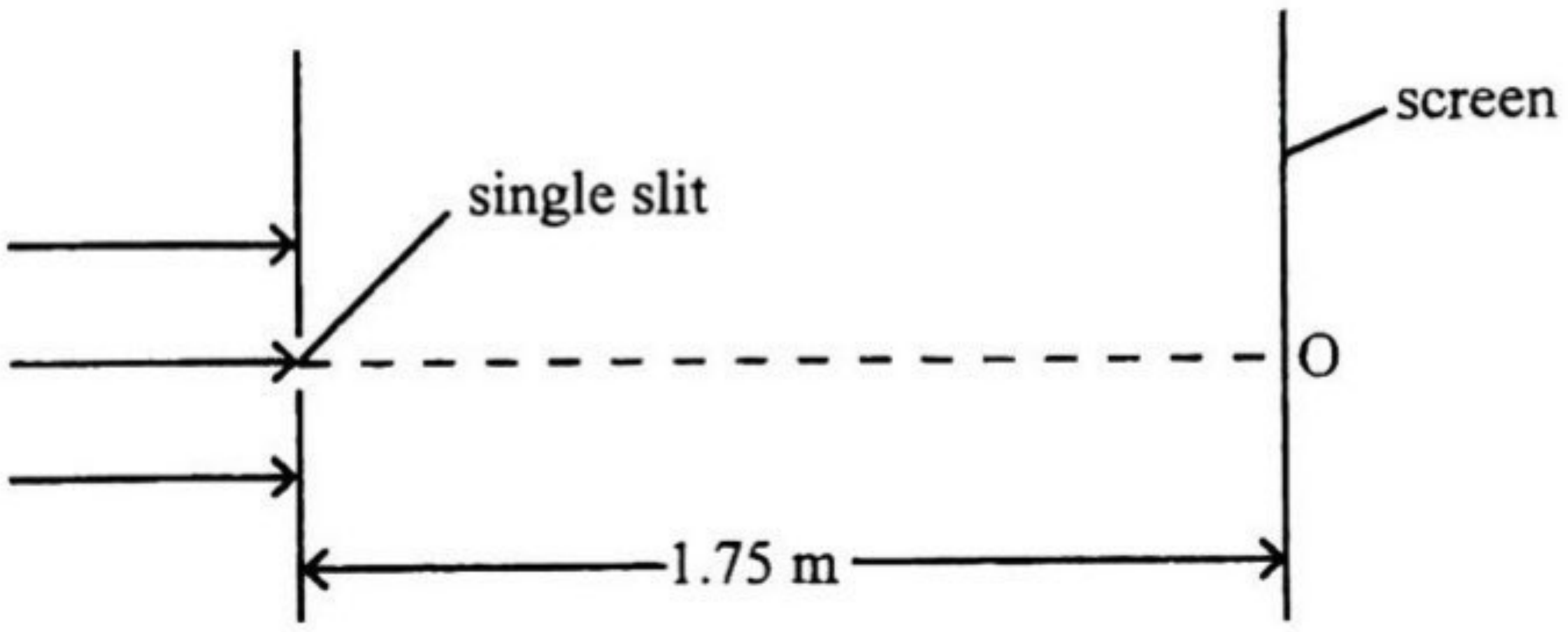

Fig. 2.2

(i) Calculate the position of the first minima on the screen.

(ii) State and explain the variation of intensity of the central bright maxima with increase in slit width.

[5]

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3 **(a)** **Fig. 3.1** shows an a.c circuit consisting of a 240 V source connected in series with a resistor.

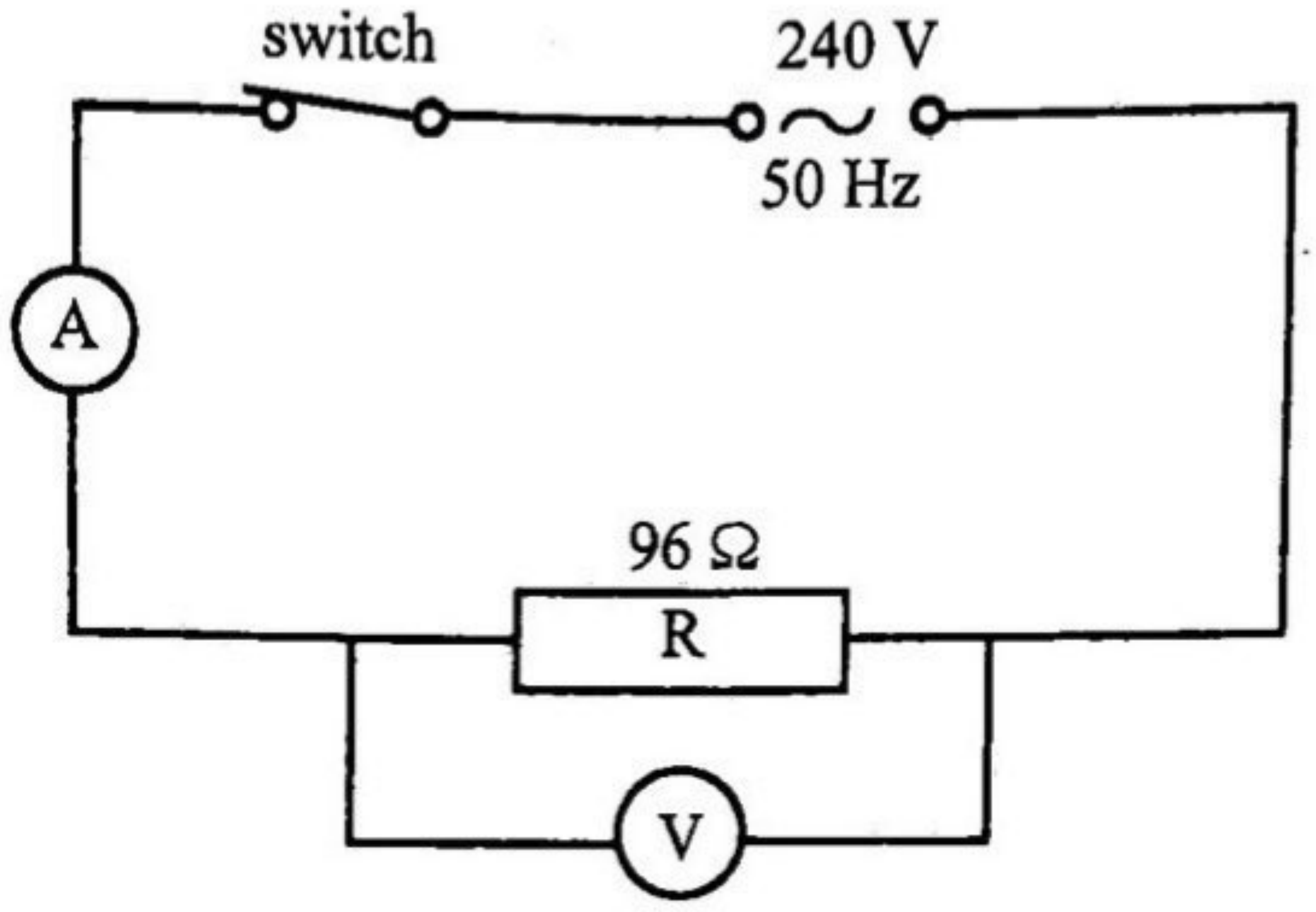

Fig. 3.1

(i) Determine the reading on the

1. voltmeter,

2. ammeter.

(ii) Show that for a sinusoidal supply, the mean power, P_m, dissipated in a resistor is equal to half the maximum power, P_{max}.

$$\left[P_m = \frac{1}{2}P_{max}\right].$$

[7]

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(b) **Fig. 3.2** shows a four-diode rectifier circuit connected between a 15 V a.c supply and a d.c load R_L.

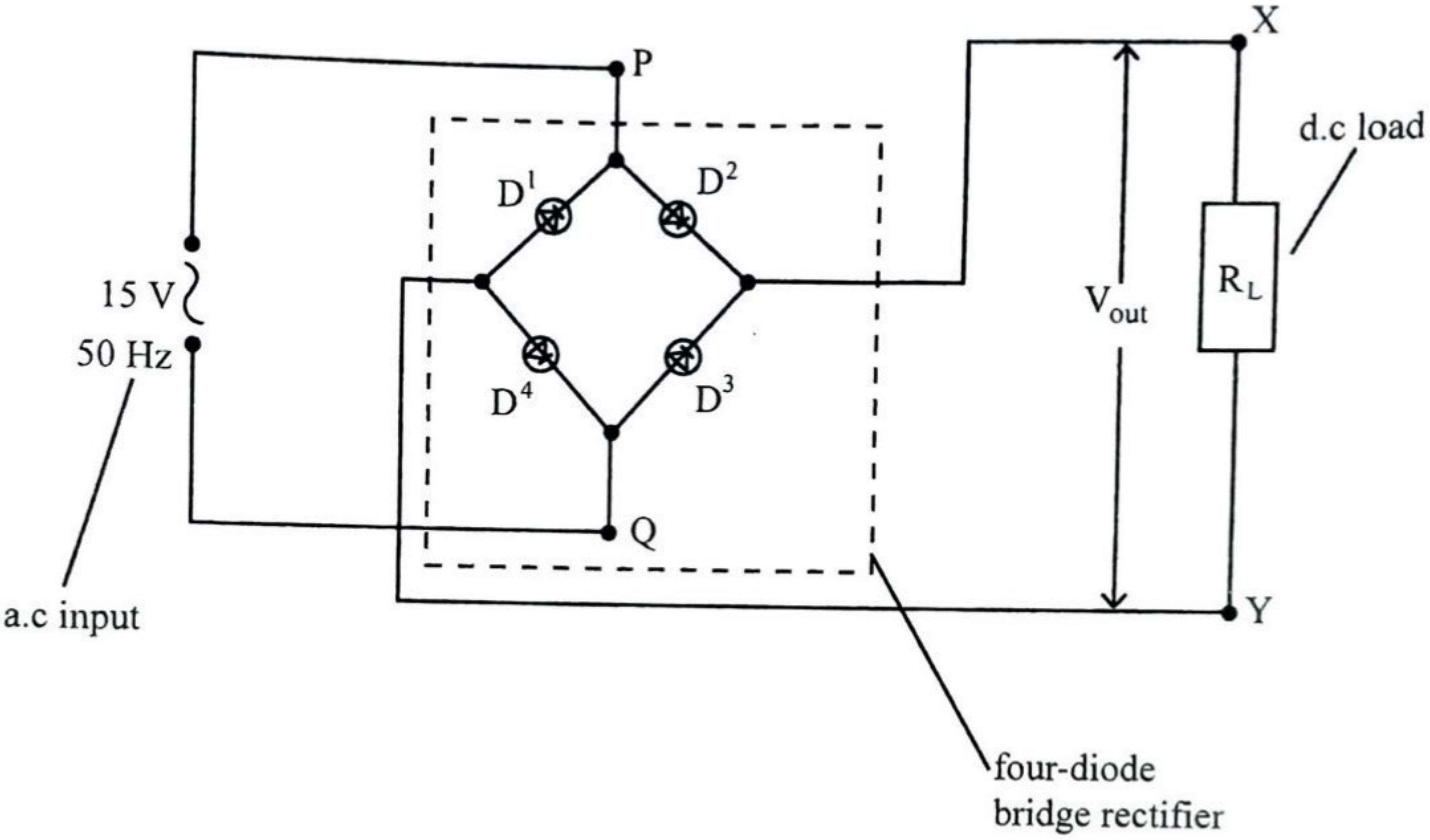

Fig. 3.2

(i) Sketch the variation of the output voltage, V_{out}, with time.

(ii) Explain

1. the operation of the bridge rectifier when point P is positive with respect to point Q.

2. why the four-diode bridge rectifier is more widely used in electronic systems than the single diode rectifier.

(iii) 1. State the effect of connecting a single "smoothing capacitor" across the dc load R_L.

2. Explain how increasing the value of the capacitance of smoothing capacitor affect variations in the output voltage, V_{out} when the dc load R_L has a fixed resistance.

[10]

(c) State **two** scientific and **two** economic advantages of producing electrical energy in the form of a.c and **not** d.c. [4]

[Turn over

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(d) A student uses the circuit in **Fig. 3.3 (a)** to investigate the variation of the terminal p.d, V, of a d.c source with current I.
Fig. 3.3 (b) shows a sketch graph of the results obtained from the experiment.

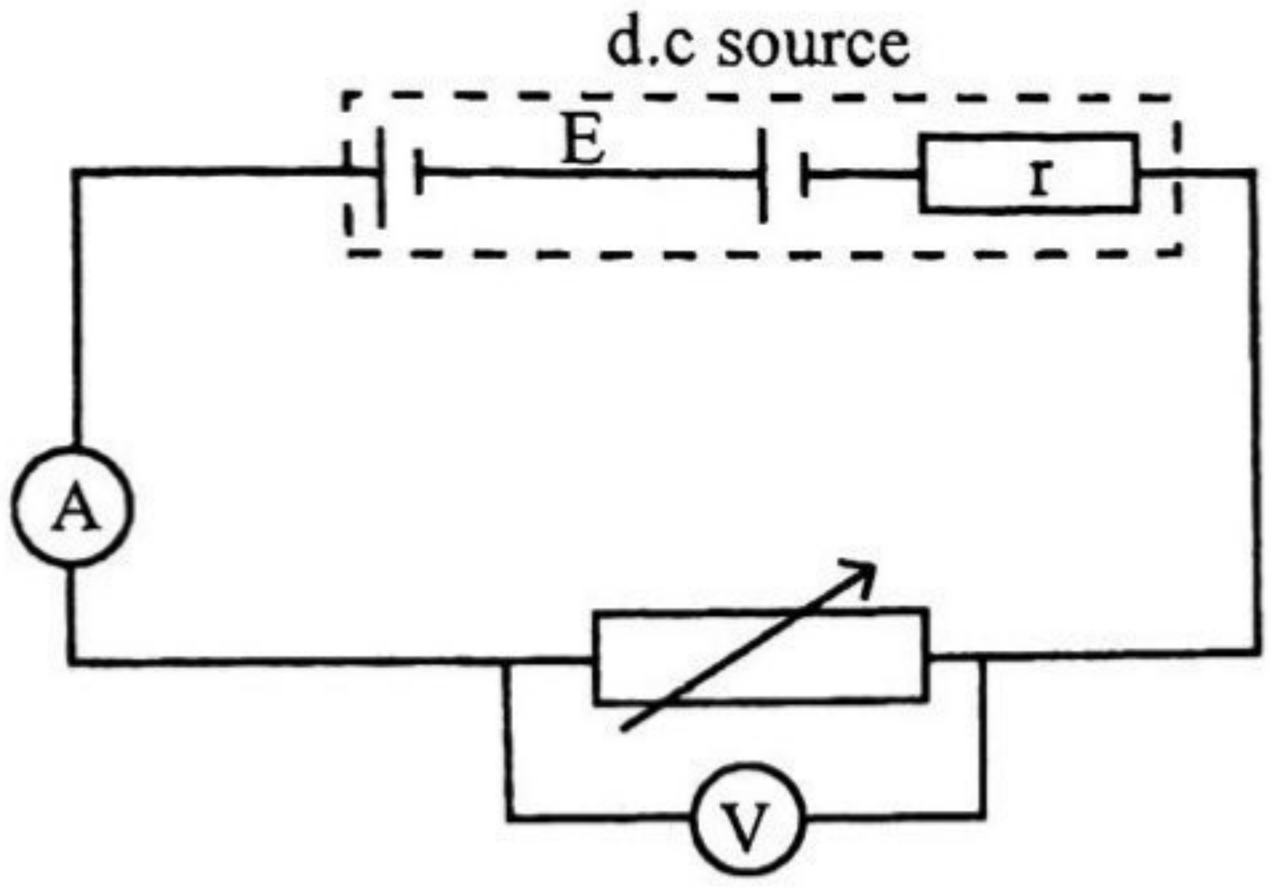

Fig. 3.3 (a)

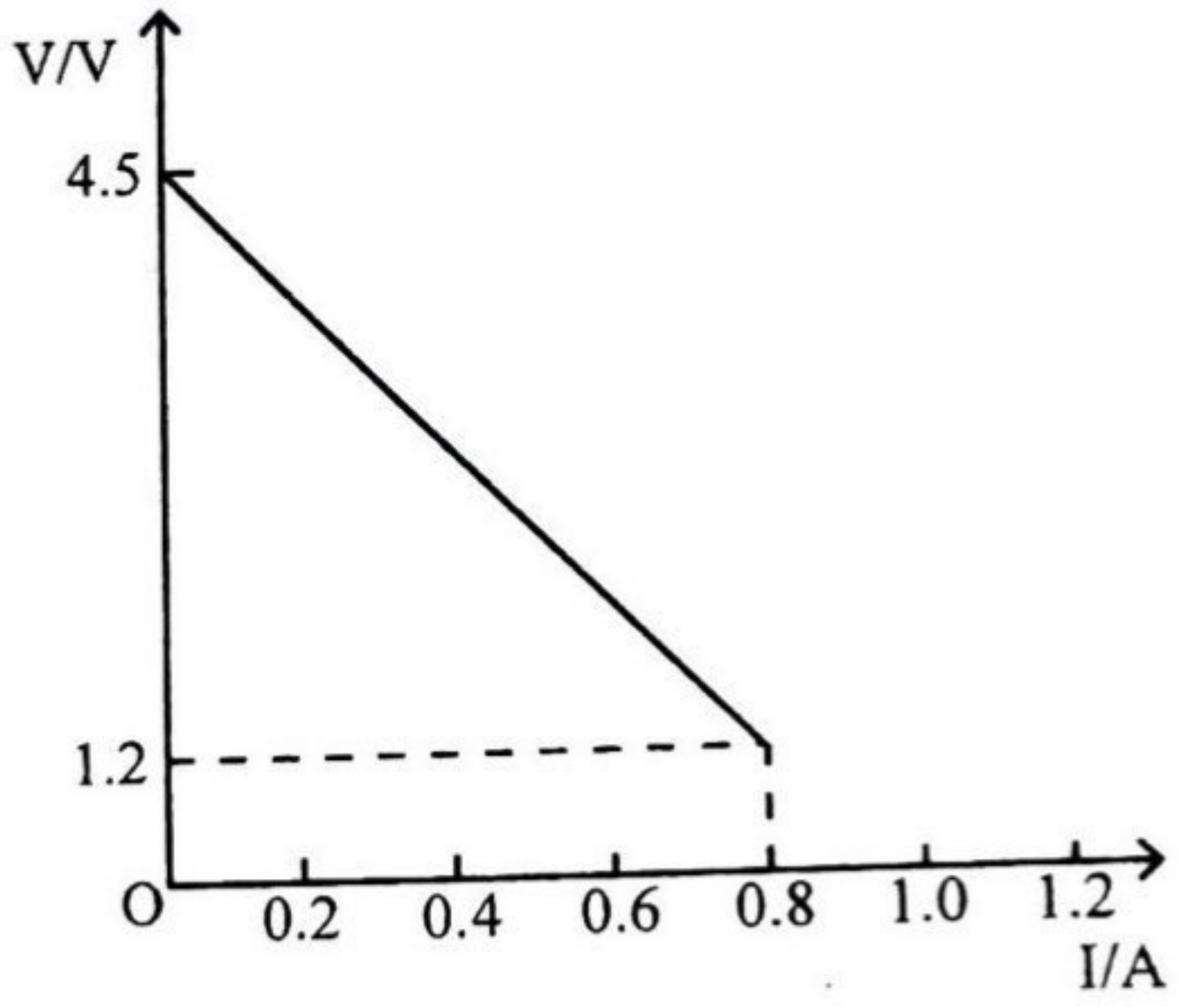

Fig. 3.3 (b)

(i) Use **Fig. 3.3 (b)** to determine, the

1. e.m.f of the d.c source,

2. internal resistance of the source.

(ii) Describe the effect of internal resistance on the output power delivered by the source.

[4]

4 **(a)** **(i)** State any **two** assumptions of the kinetic theory of gases.

(ii) The kinetic theory of gases leads to the equation

$$P = \frac{1}{3}\rho < c^2 >.$$

State the meaning of the symbol $< c^2 >$.

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(iii) An ideal gas at a temperature of 320 K and pressure of 1.013×10^5 Pa is in a cubic container of volume $0.15\ m^3$.

Determine the

1. number of moles of the gas present,
2. mass of the gas present given that its relative molecular mass is 360 g/mol,
3. density of the gas,
4. r.m.s speed of the gas molecules.

(iv) The size of the molecules of the gas in (iii) can be considered to be large.

Explain the effect of the large molecule size on ideality. [12]

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(b) **(i)** Define *thermometric property*.

(ii) **Fig. 4.1** shows the principal features of a platinum resistance thermometer.

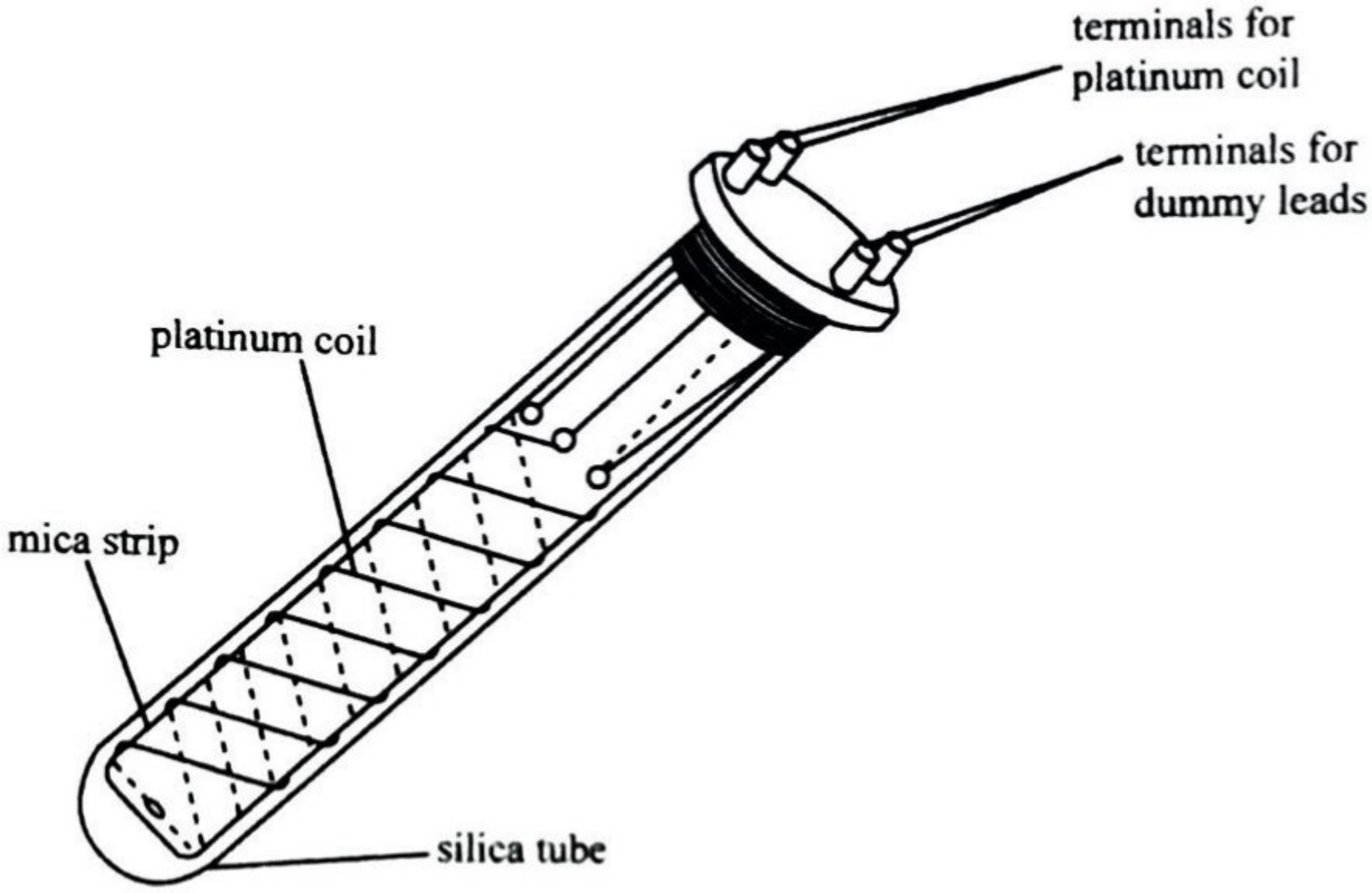

Fig. 4.1

Explain the function of the

1. silica tube,
2. dummy leads,
3. mica.

(iii) State any **three** disadvantages of a liquid-in-glass thermometer for the measurement of temperature.

[7]

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(c) **(i)** Define the term *creep*.

(ii) **Fig. 4.2** shows part of a crane that ferries waste material in a noisy heavy industry from the production site to the dumping site where the waste is constantly burnt.

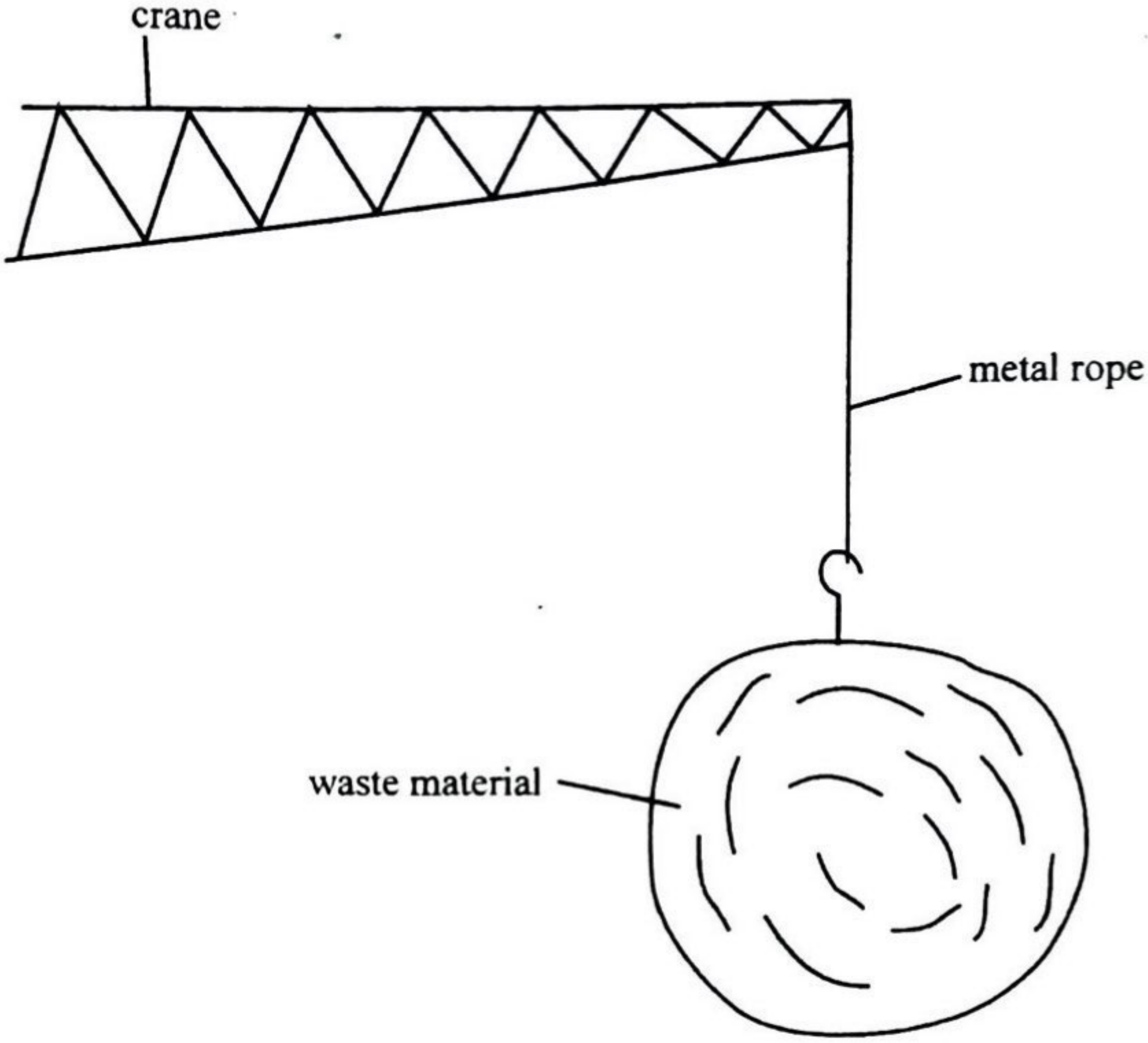

Fig. 4.2

The metal rope on the crane suddenly breaks whilst it was carrying a load of waste below the ultimate tensile stress of the rope.

Explain any **two** possible causes of this failure.

(iii) From a health and safety perspective, suggest any measure to be taken to reduce the risk of failure of the metal rope in **(c)** **(ii)**.

[6]

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5 **(a)** In a velocity selector, crossed electric and magnetic fields are used to separate charged particles moving at different velocities. The electric field strength is 2.8×10^4 Vm^{-1}. The magnetic field is perpendicular to the electric field and is of magnetic flux density 0.20 mT.

(i) Calculate the velocity of a beam of electrons that passes through the crossed field undeviated.

(ii) The electrons in **(a) (i)** pass through a magnetic field of flux density 0.20 mT and follow a circular path of radius, $r = 0.514$ m.

Calculate the value of $\frac{e}{M_e}$.

[4]

(b) **(i)** Describe *electron diffraction*.

(ii) Explain the evidence provided by electron diffraction on the nature of particles. [5]

(c) **(i)** Sketch the graph that shows the variation of binding energy per nucleon with nucleon number.

(ii) Explain why light nuclei with a low binding energy per nucleon tend to undergo nuclear fusion as opposed to nuclear fission.

[5]

(d) A mixture of two radioisotopes, A and B undergoes radioactive decay. Isotope A of mass 35 mg has a decay constant of 4.81×10^{-6} Bq. Isotope B of mass 105 mg has a decay constant of 1.20×10^{-5} Bq.

(i) Calculate the time at which the mixture will have equal masses of each isotope.

(ii) Determine the mass of isotope A in **(i)**.

(ii) Explain steps that can be taken to overcome problems due to background radiation when measuring activity of the mixture.

[6]

(e) Contrast the merits of using geostationary and polar orbiting satellites in communication. [5]

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MARKING SCHEME

NOVEMBER 2019

PHYSICS 6032/3

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1 (a) (1) $D = 2.51 + 0.18 + 0.18$ C1

$= 2.87\,\mu m$ Ⓐ 2.87×10^{-6} m

$\Delta D = \pm(0.01 + 0.01 + 0.01)$

$= (\pm) 0.03\,\mu m$ Ⓐ 0.03×10^{-6} m. C1

$D = (2.87 \pm 0.03)\,\mu m$ A1

(2) $\frac{\Delta V}{V} = \pm\left[\frac{2\Delta d}{\partial} + \frac{\Delta L}{L}\right]$ C1

$= \pm\left[\frac{2 \times 0.03 \times 10^{-6}}{2.87 \times 10^{-6}} + \frac{0.01}{1}\right]$ C1

$= 0.0209 + 0.01$

$= 0.03$ Ⓐ 1 or 2 s.f. A1

(b) (i) $h_{max} = \frac{U^2 Cos^2\theta}{2g}$ C1

$2.20 = \frac{15^2 Cos^2\theta}{2 \times 9.81}$ Follow candidate's working C1

$Cos\,\theta = \sqrt{0.19184}$

$\theta = Cos^{-1}(\sqrt{0.19184})$

$\theta = 64.0°$ A1

(ii) $t = \frac{2U Cos\theta}{g}$ C1

$= \frac{2 \times 15\, Cos64}{9.81}$ (Check for ecf for θ)

$= 1.345$ A1

(iii) $V_H = USin\theta$ C1

$= 15 \times Sin64$ (ecf)

$= 13.5\,ms^{-1}$ 2 or more s.f. A1

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~~(iv) $V_v = U\cos\theta - gt$~~

~~$= -0.57 \text{ m s}^{-1}$~~ ~~A1~~

~~(v) $\theta = \tan^{-1}\left(\frac{V_v}{V_h}\right)$~~

~~$= \tan^{-1}\left(\frac{-0.57}{13}\right)$~~

~~$= 25.0°$ below horizontal~~ ~~A1~~

$= -26°$

(c) (i) 1. $f =$ Area× Average pressure ~~$\left(\frac{12+10}{2}\right)$~~ C1

$= \frac{(12+10)}{2} \times 0.002$ A1

$= 0.022$ N (Allow ±0.005) i.e. 0.015N to 0.027N

2. $I = ft$

$=$ ~~$\Delta P \times A \times t$~~ (e c f). B1

$= 0.022 \times 0.5$

$=$ ~~0.002 NS~~ 0.011 Ns A1

(ii) Increases A1

Increase in pressure causes increase average force / Impulses is directly proportional to pressure. M1 B1

(d) ~~$P = \frac{E}{t}$~~

~~$P = \frac{1}{2}M(\Delta v)^2 \times \frac{1}{t}$~~ ~~B1~~

~~$2Pt = M(\Delta v)^2$~~

~~$\frac{2Pt}{\Delta v} = M(\Delta v)$~~ ~~B1~~

~~$\Delta v = \frac{2Pt}{\Delta V}$~~

(e) $T\cos\theta = \frac{mv^2}{r}$
$T\sin\theta = \frac{mg^2}{r}$
up $\tan\theta$ } — C1

$T^2 = \left(\frac{mv^2}{r}\right)^2 + (mg)^2$ Ⓐ A/W ~~B1~~ C1

$T^2 = \left(\frac{140 \times 8^2}{5}\right)^2 + (140 \times 9.81)^2$ C1

$=$ 2 257.8N

$= 2.3 \times 10^3$ N A1

Calculation for θ C1

Calculation T = A1

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HYSICS
APER 3

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Question 1

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(?) $\frac{GMm}{r^2} = \frac{mv^2}{r}$

$m = \frac{rv^2}{G}$

Substitution

$M = \frac{4.6 \times 10^{20} \times (3 \times 10^5)^2}{6.67 \times 10^{-11}}$ C1

$M = 6.21 \times 10^{41}$ kg A1

(a) (i) 1. $T = 2\pi\sqrt{\frac{m}{k}}$ $T = 2\pi\sqrt{\frac{e}{g}}$ ($e = 0,016$ m) C1 for fi[illegible] of subs.

$= 2\pi\sqrt{\frac{0.814}{500}}$ C1

$= 0.25455$ 0,2535 A1

2. $E_K = \frac{1}{2}mw^2x_0^2 = \frac{1}{2}kx^2$ $\frac{1}{2}(0,814)\left(\frac{4\pi^2}{0,254^2}\right)(4,5\times10$ B1

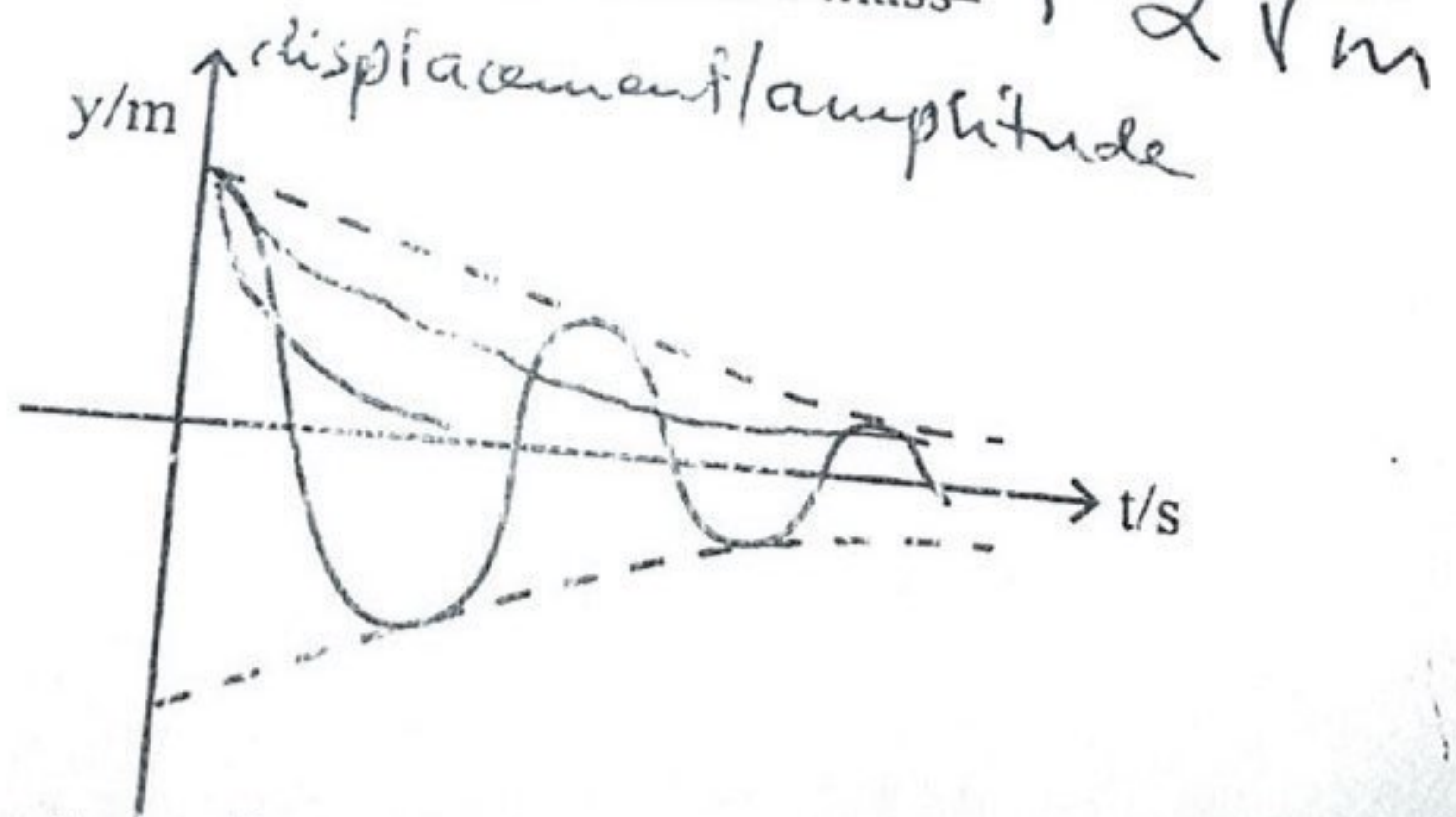
$= \frac{1}{2} \times 500 \times (4.5 \times 10^{-3})^2$ $= 0,00504$J, C1

$= 0.00506$J (A) 0,00504J A1

(ii) 1.
- reduces amplitude B1
- amplitude decreases with increases in spring constant B1

2.
- increases period B1
- ~~period increases with mass~~ $T \propto \sqrt{m}$ B1

(iii)



Labelled graph of displacement/amplit

- ~~oscillation for more than one period~~ B1
- decreasing amplitude B1

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Sample is coupled to pre-labelled diagram

(b) (i) beam of x-rays passes through a crystal B1

x-rays emerge at different angles B1

each crystal has a unique diffraction angle B1

the arrangement and spacing of atoms is worked out from the angle (AW). B1

(ii) 1. $I = I_0 e^{-\mu x}$

$$\mu_0 = \frac{-\ln\left(\frac{I}{I_0}\right)}{x}$$

$$= \frac{-\ln 0.68}{2.1 \times 10^{-3}}$$ C1 2 or more s.f.

$\mu_0 = 184\ \text{m}^{-1}$ ① 1,84 cm^{-1} or 0,184 mm^{-1} A1

2. $\frac{I}{I_0} = e^{-(184 \times 3.7 \times 10^{-3})}$ C1

$\frac{I}{I_0} = 0.5061$ A1

~~(iii)~~
- increase in exposure to harmful radiation B1
- more expensive B1
- requires a powerful computer to generate images B1
- (high cost of installation/maintenance) any 1

(c) (i) $n\lambda = d\sin\theta$

$$\sin\theta = \frac{673 \times 10^{-9}}{0.095 \times 10^{-3}}$$ C1 2 or more s.f.

$\theta = 0.41°$ or 0.0125 m A1

(ii)
- increases ~~decrease~~ in intensity B1
- no superposition occurring/more light passes through B1
- wavelength of light very small compared to slit size B1

~~(iii) mean power~~ $= \frac{V_0 I_0}{2}$

$= \frac{0.75 \times 2.5 \times 10^{-3}}{2}$ ~~C1~~

$= 9.38 \times 10^{-4}\ \text{W}$ ~~A1~~

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0 B1

3 (a) (i) 1 Voltmeter reading = 240 V (R.M.S) C1

2 Ameter reading: IRMS = $\frac{V_{RMS}}{R}$

$= \frac{240\,V}{96\,\Omega}$ A1

2.5 A (2. Significant figures) B1

(ii) $P_M = V_{RMS} \times I_{RMS}$ B1

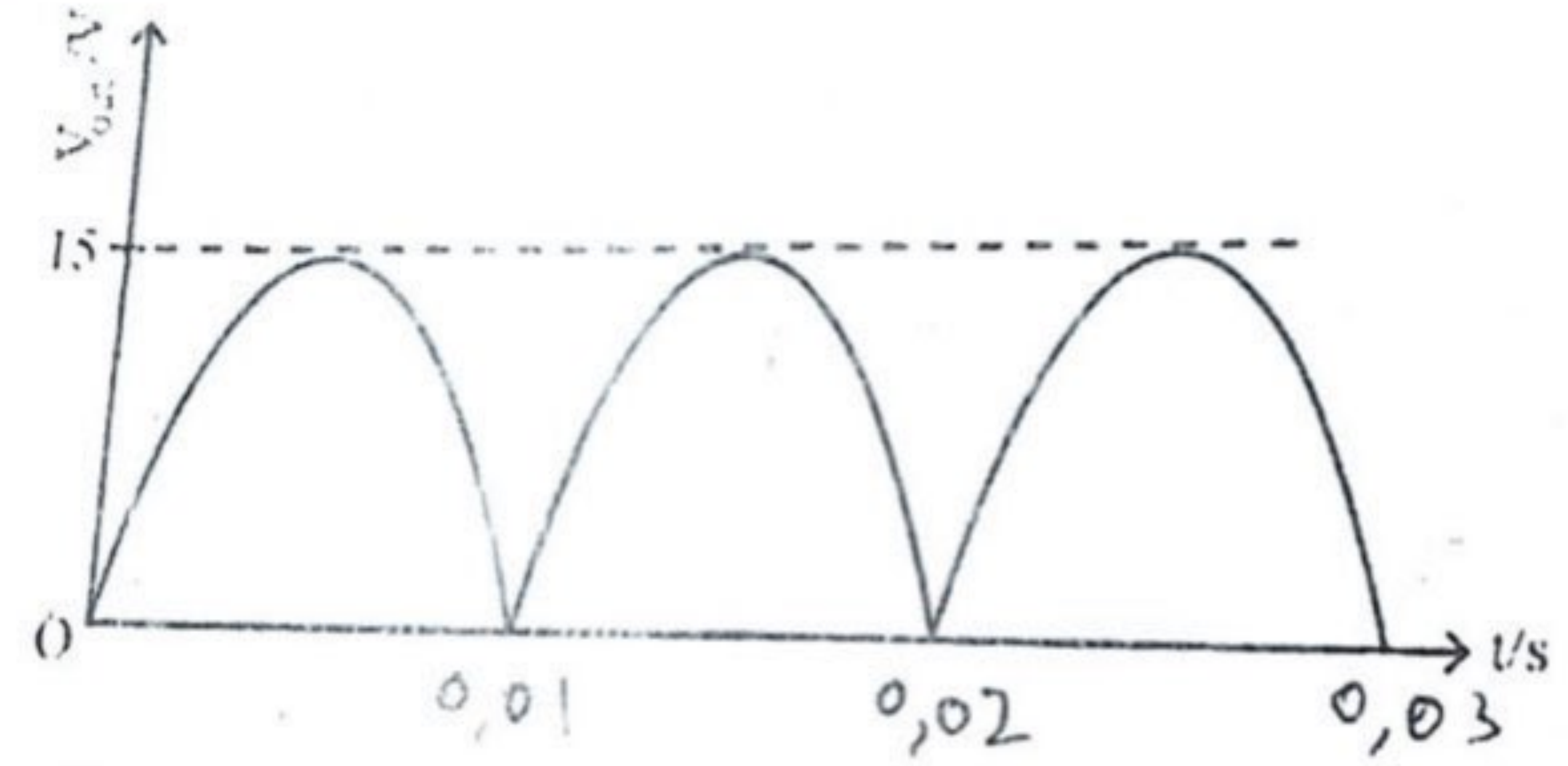
Alternative proving method.

$= \left(\frac{V_0}{\sqrt{2}}\right) \times \left(\frac{I_0}{\sqrt{2}}\right)$ B1

$= \frac{V_0 I_0}{2}$

$\therefore P_m = \frac{1}{2} P_{max}$ $P_{max} = V_0 I_0$ B1

(b) (i)



Shape

Peak value of Vout constant. B1

Values on axes. B1

(ii) 1. Current flows from source via point P – to D_1 – to – resistor R_L – to – D_4 – back to source via point Q B1

B1

- Explanation: D_2 and D_3 are reverse biased (offer very high resistance to current flow) / current flows through path least resistance B1

OR - current follows the path ~~of least resistance~~ via D_2 and D_4 which are forward biased

2. Provides full wave rectification Many 2

It allows electric current during both positive and negative half cycles of the input AC signal, ~~hence reduces heat losses.~~ (AW). B1

(iii) 1. ~~To smoothen the signal from the rectified circuit.~~ Reduces ripple voltage / Makes output voltage more steady. ~~B1~~ B1

2. A larger capacitor stores more energy and discharges ~~less~~ slowly Hence output becomes steadier. B2

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(c) Scientific advantages

- voltage can be changed using transformers B1
- easier to convert from A.C to D.C than from D.C to A.C ~~any correct~~ B1
- easier to switch. Any 2 of above correct B2 and off ac.

Economic advantages

- It is cheaper to generate than D.C
- It is cheaper to transmit any correct advantage B2

(d) (i) 1. E.m.f = 4.5 V B1

2. Internal resistance = (−) gradient of graph /using a point on graphline C1

$$(-)r = \frac{1.2-4.5}{0.8-0.0}$$

$$= 4.1\ \Omega$$ A1

(ii) – Output power maximum ~~the~~ R = r. B1 B1

- It reduces the output power delivered by the source/limits output power if R > r The B1 B1

e.g. It increases ~~the~~ output power if R<r. B1 B1

Max 2

4 (a) (i)

- gas consists of a large number of molecules
- gas molecules collide elastically (with one another and with the walls of the container) A
- there is no intermolecular forces except during collision
- volume of gas molecules is negligible compared to the volume of container /A W,
- duration of collision is ~~negligible~~ compared to time interval between collisions /A any two B2

random motion

(ii) $< c^2 >$ - mean square speed B1

(iii) 1. $n = \frac{pv}{RT}$ C1: either formula or substitution.

$$= \frac{1.013 \times 10^5 \times 0.15}{8.31 \times 320}$$ 2 or more s.f. C1

$= 5.71$ (moles) A1

2. $n = \frac{m}{Mr}$

$m = n \times Mr$ (take care of ecf)

$= 5.71 \times 360 = 2055.6g.$ C1

$= 2.06$ kg A1

(2 or more s.f)

3. $\rho = \frac{m}{V}$

$= \frac{2.06}{0.15}$ C1 (Take care of ecf)

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$= \quad 13.7\ \text{kgm}^{-3}$ A1

4. $< c^2 > = \frac{3P}{\rho}$

$\text{C.r.m.s} = \sqrt{\frac{3P}{\rho}}$ 2 or more s.f. C1

$= \sqrt{\frac{3 \times 1.013 \times 10^5}{13.7}}$

$= \quad 149\ \text{ms}^{-3}$ A1 A1

~~(iv)~~
- causes deviation from ideality/AW B1
- volume of gas no longer negligible compared to volume of container B1
- intermolecular forces no longer negligible (any one)

(b) (i) a physical property which varies with temperature (and maybe used for the measurement of temperature) B1

(ii) 1. - protects the resistance wire from corrosion B1

2. - compensate for the change in resistance of leads between wheatstone and the platinum wire (idea of c[illegible] B1

3. - hold wire in position
- ~~insulates to prevent induction~~ (any 1) B1

(iii)
- small range
- fragile
- non-uniform bore B1
- relatively large heat capacity: affect the temperature / poor, responsiveness B1
- not accurate B1
- ~~poor responsiveness~~

Can be used for remote readings. (any three)

(c) (i) failure due to (sustained) stress below that required for immediate failure combine with elevated temperatures/AW B1

(ii)
- creep - exposure to sustained stress high temperatures at the dumping site results in elongation of metal rope B1 B1
- fatigue - there is cyclic stressing/unstressing with loads below ultimate tensile strength; B1 B1

resonance due noise.

(iii)
- regularly change the metal rope
- using a heat resistant material for the metal rope / creep [illegible] ~~(any 1)~~ B1
- [illegible] [illegible] / [illegible]

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5 (a) (i) $V = \frac{E}{B}$

$= \frac{2.8 \times 10^4 \text{ Vm}^{-1}}{0.20 \times 10^{-3} \text{ T}}$ C1

$= 1.40 \times 10^8 \text{ ms}^{-1}$ 2 or more s-f A1

(ii) $\frac{e}{m_e} = \frac{V}{rB}$ R

$= \frac{1.40 \times 10^8}{0.514 \times 0.20 \times 10^{-3}}$ ecf for v (2 or more sf) C1

$= 1.36 \times 10^{12} \text{Ckg}^{-1}$ Ⓐ $1.76 \times 10^{11} \text{ Ckg}^{-1} = \frac{e}{m_e}$ from data value A1

(b) (i) - Electron (high energy) beam is incident (normally) on a metal foil/graphite film; B1

Diagram well labelled (B3).

lattice of foil acts as grating which spreads diffracts the electron beam; B1

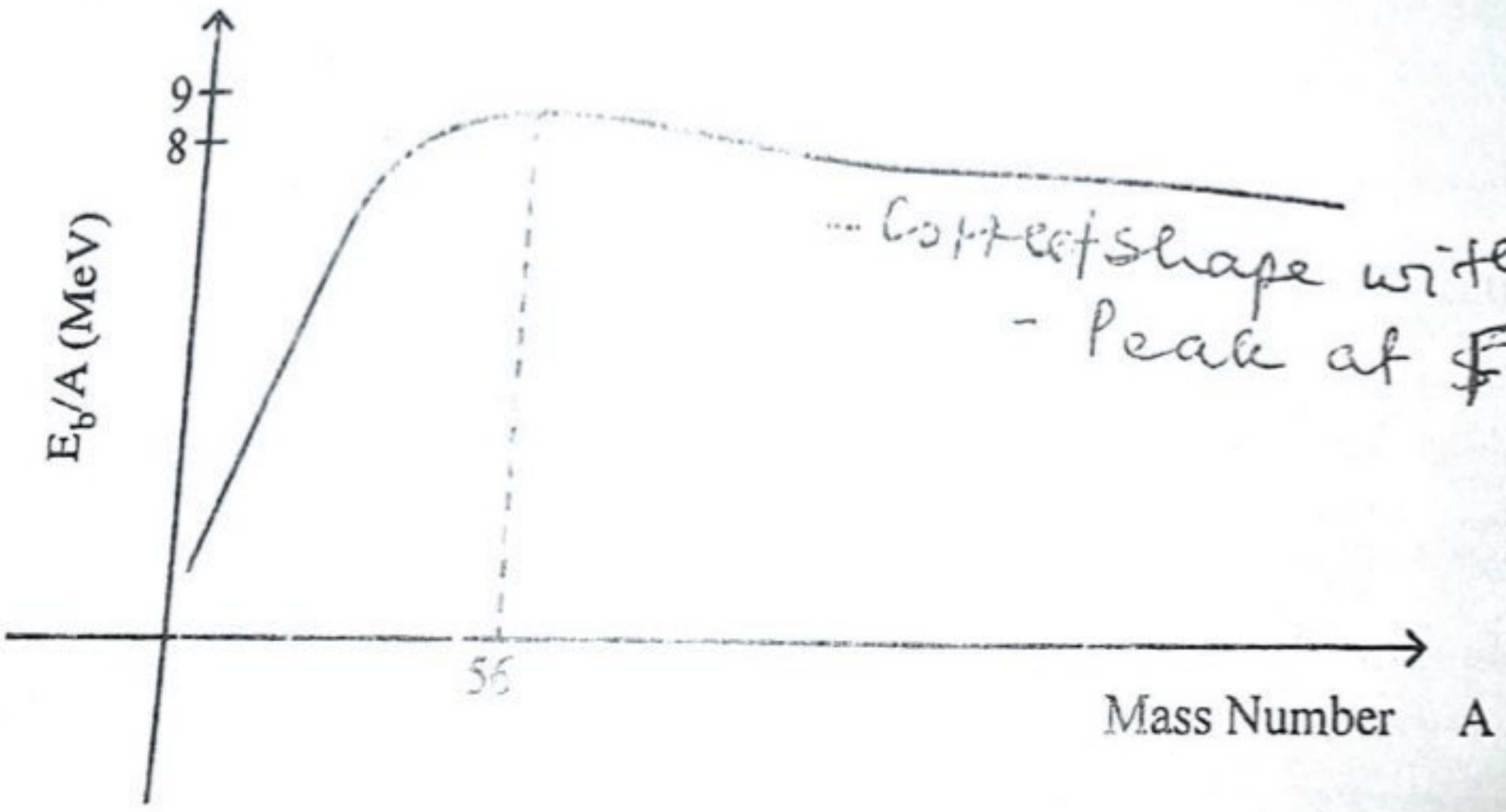
a diffraction pattern is produced B1

(ii) electrons are diffracted as ~~waves~~ B1

~~electrons have characteristics for both waves and particles~~ B1

diffraction is a property of waves.

(c) (i)



Correct shape with a peak
- Peak at Fe-56

(ii) - Less stability ~~nucleon number is below 56/low~~ B1

- nuclei combine/fuse to increase number/release energy /AW B1
- Eb/A increases/stability of nuclide increases /AW B1

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G1

(d) (i) $M_1 e^{-\lambda_1 t} = m_2 e^{-\lambda_2 t}$

$$\frac{M_1}{M_2} = e^{(\lambda_1 - \lambda_2)t}$$

$$t = \frac{ln\left(\frac{M1}{M2}\right)}{\lambda_1 - \lambda_2}$$ C1

$$= \frac{ln\left(\frac{35}{105}\right)}{4.81 \times 10^{-6} - 1.20 \times 10^{-5}}$$ A1

$$t = 1.53 \times 10^5 s$$

(ii) $M = M_0 e^{-\lambda t}$ C1

$$= 35\, e^{(-4.81 \times 10^{-6}\ 1.53 \times 10^5)}$$ (ecf for t) A1

$$= 16.8 \text{ mg}$$

(iii)
- measure background radiation several times and determine an average / AW B1
- measure activity including sample and subtract value for background radiation / AW B1

(e)

Polar satellite	Geostationary satellite	
- cannot be used for continuous communication	- suitable for continuous communication	B1
- covers polar regions	- cannot cover polar regions	B1
- small time delay	- larger time delay	B1
- re-orientation of receivers as satellite moves	- no need for re-orientation of receivers	B1
- difficult to track down satellite	- easy to track satellite	
- short life span	- long life span	B1

max 4

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

6032/3

PAPER 3 THEORY

JUNE 2020 SESSION 2 hours 30 minutes

Additional materials:
Answer paper
Electronic calculator

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question1 is compulsory.

Answer any other **three** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 16 printed pages.

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[Turn over

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3 **(a)** Define *capacitance* and the *Farad.* [2]

(b) When a 10 μF capacitor C_1 is connected across a 7.2 V dc source, 72 μC of charge is deposited on its plates.

The capacitor is now placed in a vacuum without loosing any charge as shown in Fig. 3.1.

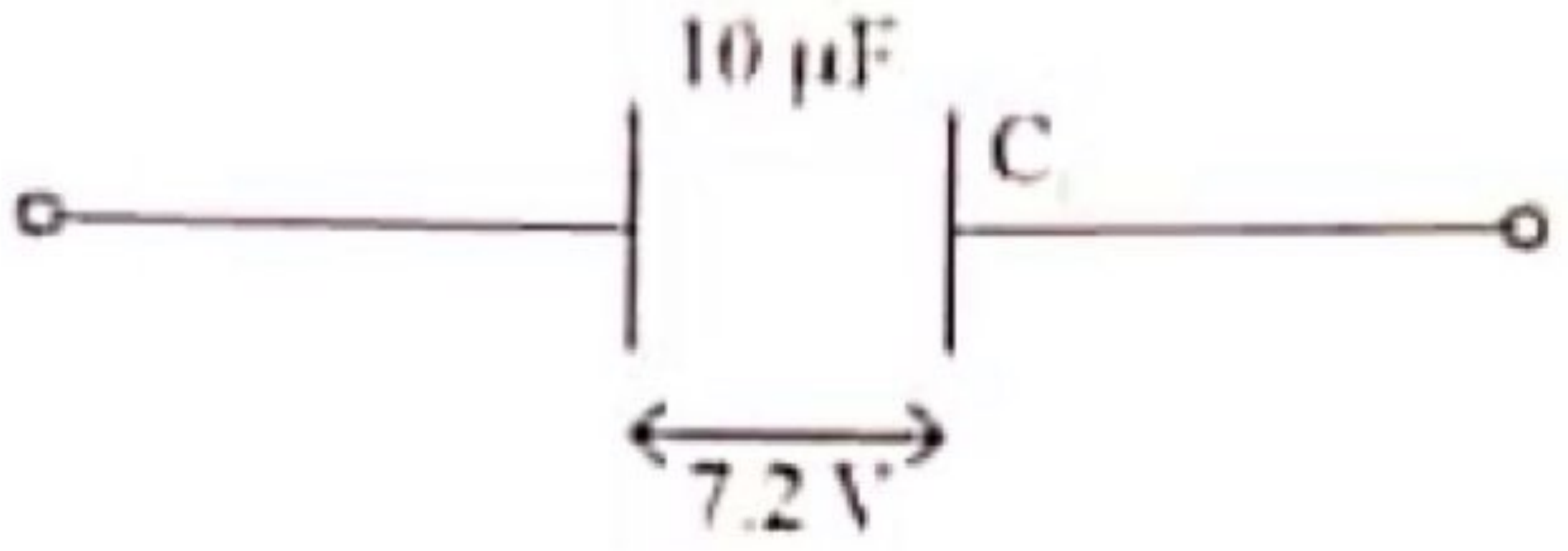

Fig. 3.1

(i) Calculate the energy stored on the capacitor C_1.

(ii) A second uncharged 12 μF capacitor C_2 is now connected across C_1 as shown in **Fig. 3.2**.

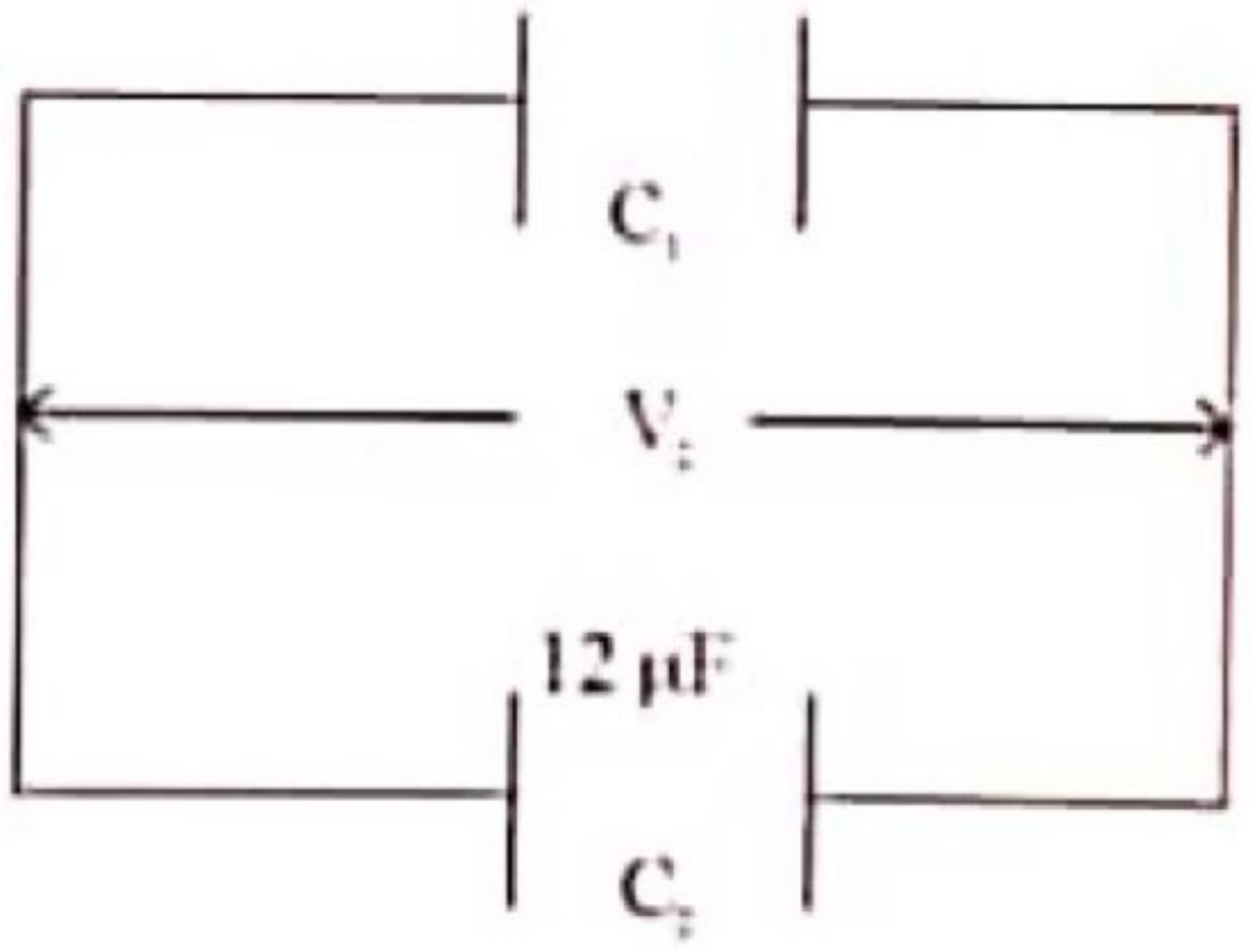

Fig. 3.2

Determine the

1. effective capacitance due to C_1 and C_2,
2. p.d. V_2 across the combination,
3. energy stored in the combination.

$\frac{1J}{Coul}$ [6]

$C = \underline{lv}$

c

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5 (a) Distinguish between emission spectra and absorption spectra. [2]

(b) (i) Explain the terms

1. *wave-particle duality,*

2. *de Broglie's wavelength.*

(ii) In an electron gun, electrons are accelerated from the cathode by a p.d. of 225 V.

1. Calculate the maximum speed of an electron towards the anode.

2. Determine the de Broglie wavelength associated with an electron travelling at the speed calculated in **(b)(ii) 1**.

$\lambda = \frac{h}{p} = \frac{h}{m}$

3. Identify the part of the electromagnetic spectrum to which the wavelength in **(b)(ii) 2** belongs.

[7]

(c) (i) Deuterium $\left({}_{1}^{2}\text{H}\right)$ and Tritium $\left({}_{1}^{3}\text{H}\right)$ are isotopes of hydrogen. They react to give a helium nucleus and a neutron.

Write a nuclear equation to show the reaction

(ii) Estimate the energy released during the nuclear reaction in **(c)(i)**.

$$\left[\begin{array}{l} m\left({}_{1}^{2}\text{H}\right) = 2.01410u, m\left({}_{1}^{3}\text{H}\right) = 3.0160u, m\left({}_{2}^{4}\text{He}\right) = 4.00260u \\ m\left({}_{0}^{1}n\right) = 1.00866u \end{array}\right]$$ [4]

(d) A milling company suspects that part of a batch of flour packs is contaminated with a radioisotope of strontium – 90 (Sr – 90). A test is to be carried out using a Geiger-Muller tube.

(i) Describe the procedure that must be taken to accurately measure the activity of a radioactive sample.

(ii) Calculate the time taken for the activity to fall to 30% of the initial value.

[Decay constant of Sr – 90 is $7.75 \times 10^{-10}\text{s}^{-1}$]

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(iii) Fig. 2.2 shows a monochromatic parallel beam of light directed towards point **A** on a vertical wall.

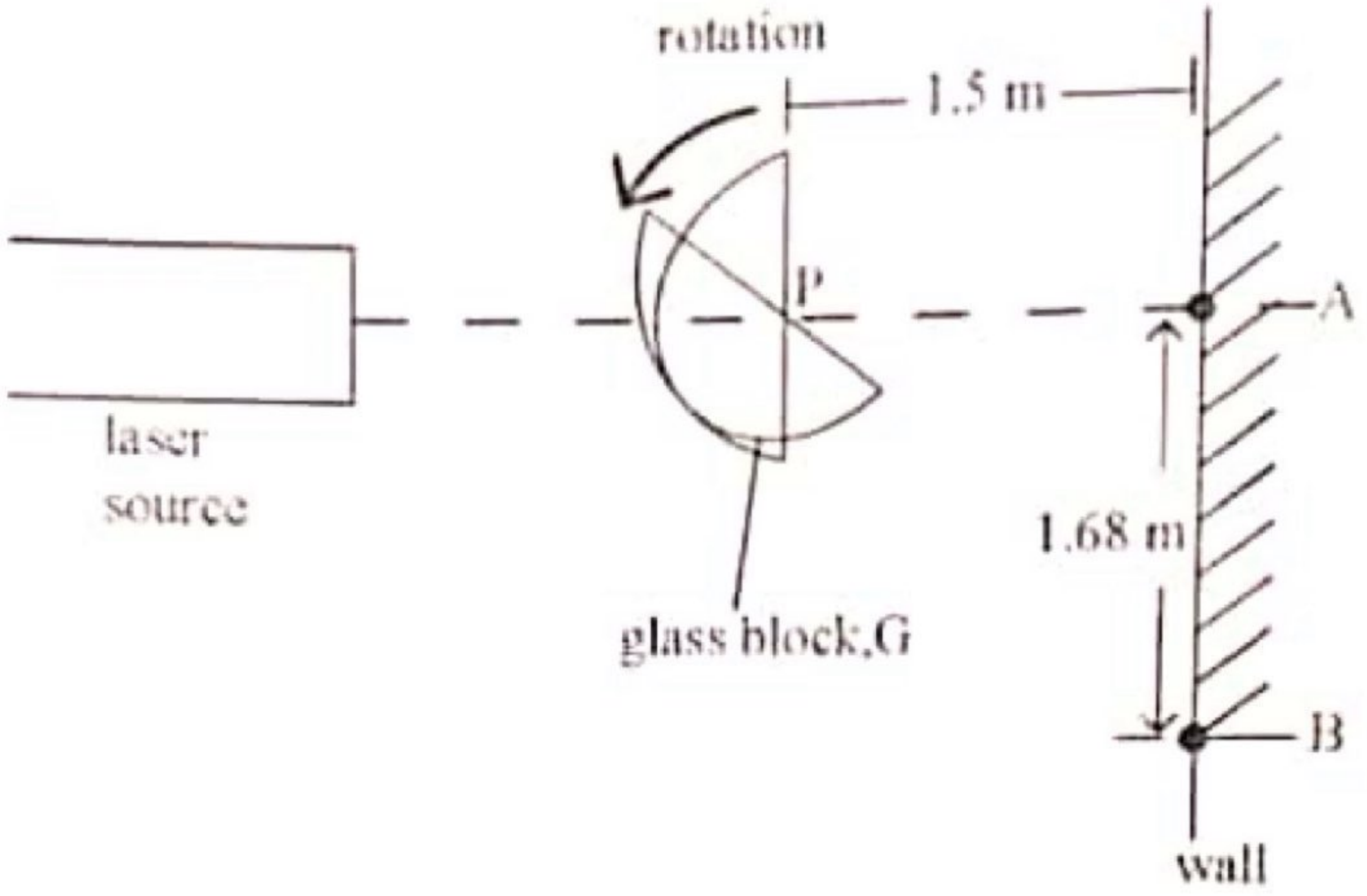

Fig. 2.2

A semi-circular glass block, **G**, is placed symmetrically across the path of light a distance 1.5 m from the wall producing a bright spot on point **A**. When the block, **G**, is rotated about point P, the bright spot moves from **A** to **B** and immediately disappears after point **B**.

Explain why

1. the bright spot moves from **A** to **B** as **G** is slowly rotated anticlockwise,

2. the light disappears as the block **G** is rotated further.

(iv) Determine the refractive index of the glass block **G**.

(v) Predict whether distance **AB** will be shorter or longer if glass of a higher refractive index is used.

[11]

(c) Oil has a linear attenuation (absorption) coefficient of 0.59 cm^{-1} for a particular incident X-ray beam.

Calculate the depth required to reduce the intensity of the X-ray beam to 0.0027 of its incident intensity. [3]

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(b) **(I)** Define *Young Modulus*.

(II) Fig. **4.2** shows a copper wire ABC of length 1.4 m and diameter 3.0 mm fixed between two supports.

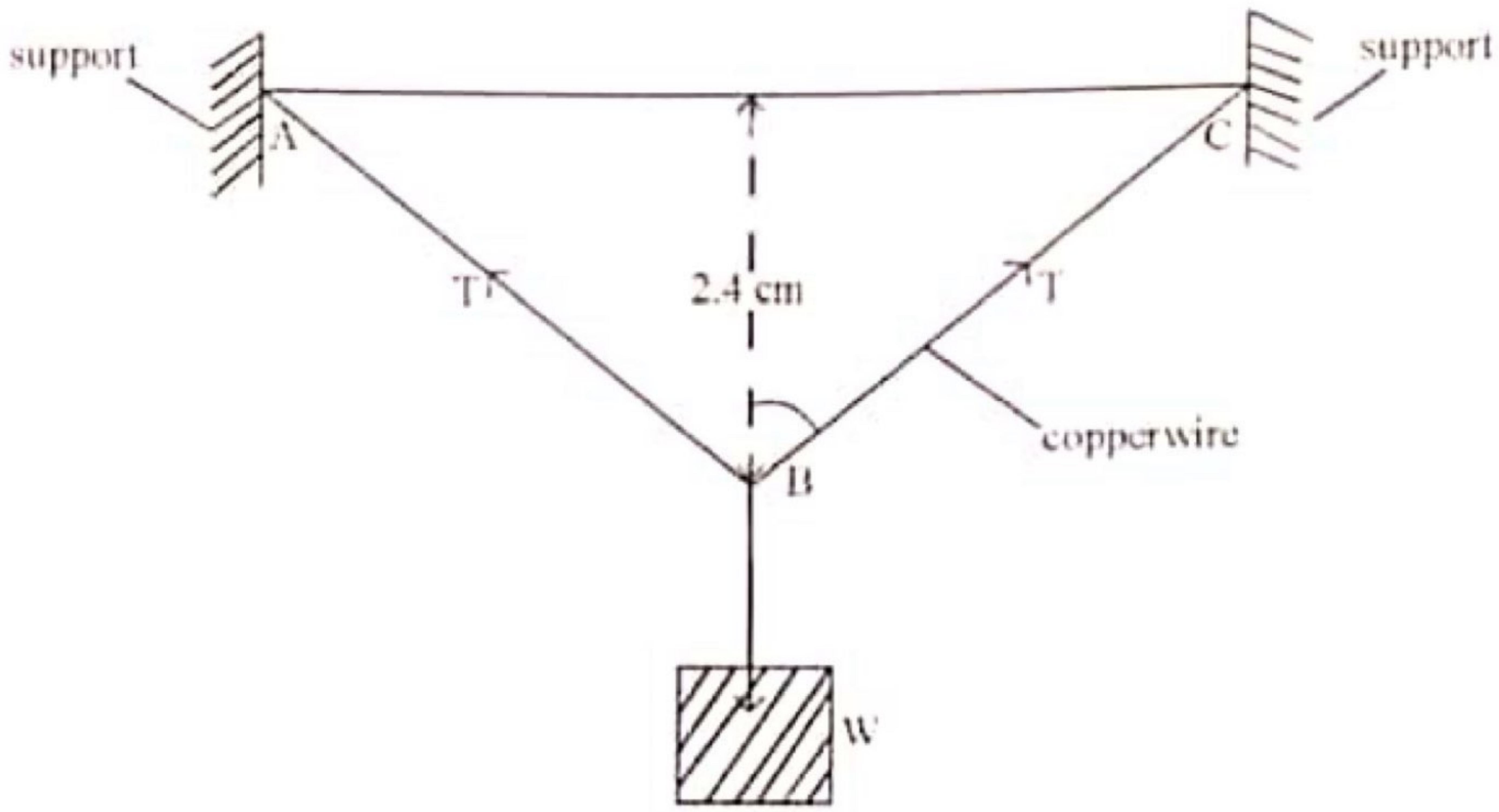

Fig. 4.2

A weight of 98 N is hung from the midpoint of the wire, B, such that the point sags 2.4 cm below the horizontal line.

Calculate for the wire, the

1. extension when the weight is hung.

2. tension.

3. Young Modulus.

(III) State any **two** assumptions made in **(b)(II)**.

[11]

(c) **(I)** State the *Zeroth Law of Thermodynamics*.

(II) Explain why

1. when a person is holding a piece of metal rod whilst the other end of the rod is in contact with ice, the end he is holding finally becomes cold as well.

2. a thermocouple records a higher value of e.m.f. when placed near a red hot metal than when placed near the human body.

[5]

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(d) A sample object consists of 4 voxels. The object is scanned from 4 different directions. The readings for each individual voxel are summed up and the result is shown in **Fig. 2.3**.

23	50
32	35

5 8

Fig. 2.3

The total background reading is 20.

Determine the initial pattern of the pixels in the voxels. [2]

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(iii) Suggest a way of disposing the contaminated floor packs safely.

[7]

(e) (i) Define *signal attenuation.*

(ii) **Fig. 5.1** shows a communication channel with two repeater units 100 km apart. The gain of the amplifier is 37.2 dB.

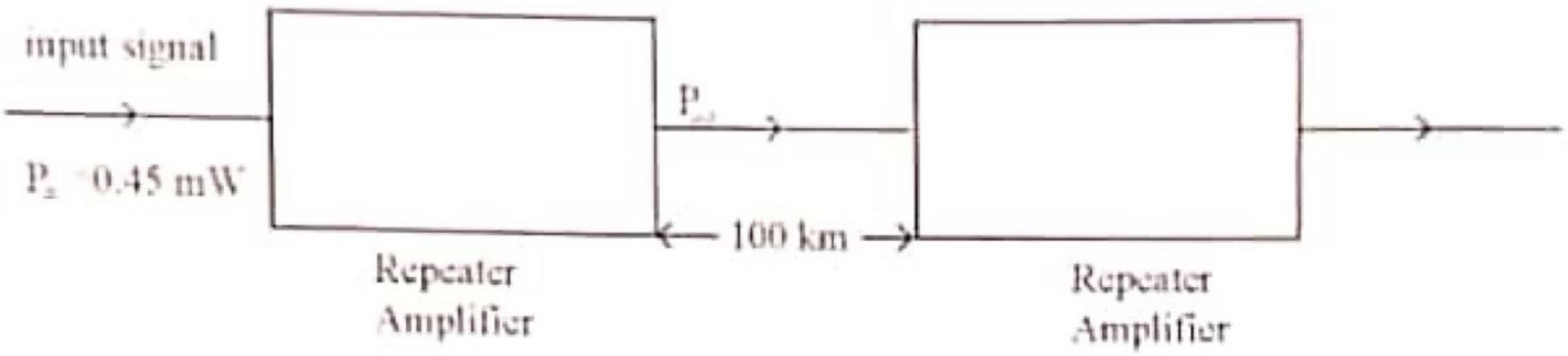

Fig. 5.1

Calculate the

1. power output of the amplifier,
2. attenuation per unit length of the cable.

[5]

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(c) **Fig. 3.3** shows a negatively charged solid metal sphere placed in a vacuum.

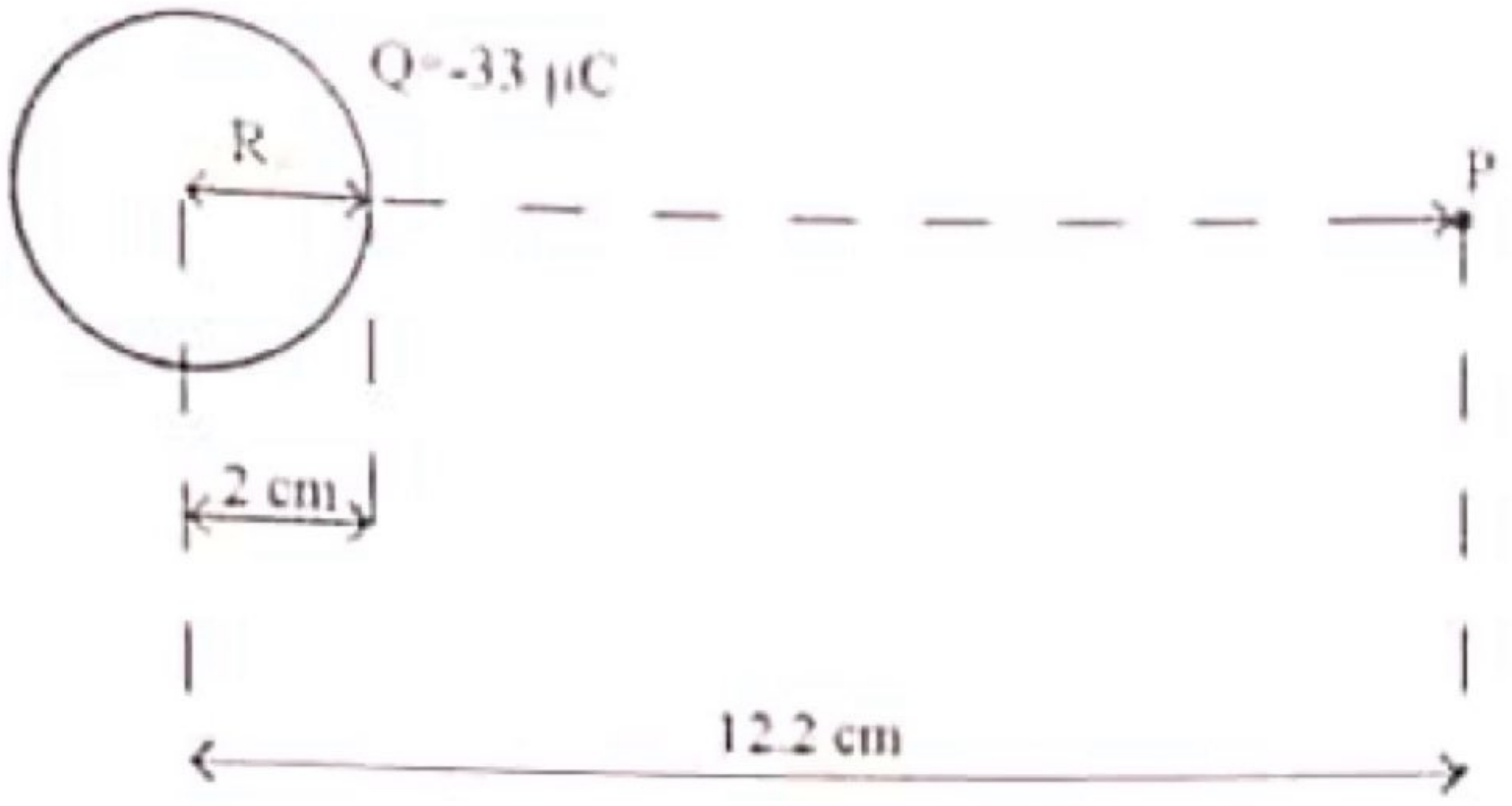

Fig. 3.3

(i) Calculate the magnitude of the electric field strength at point **P**.

(ii) Sketch the variation of electric potential **V** with distance *r* from the centre of the sphere to point **P**.

(iii) State any **two** differences in the general characteristics between the field of an isolated point charge and an isolated planet.

[6]

(d) **Fig. 3.4** shows a potential divider circuit.

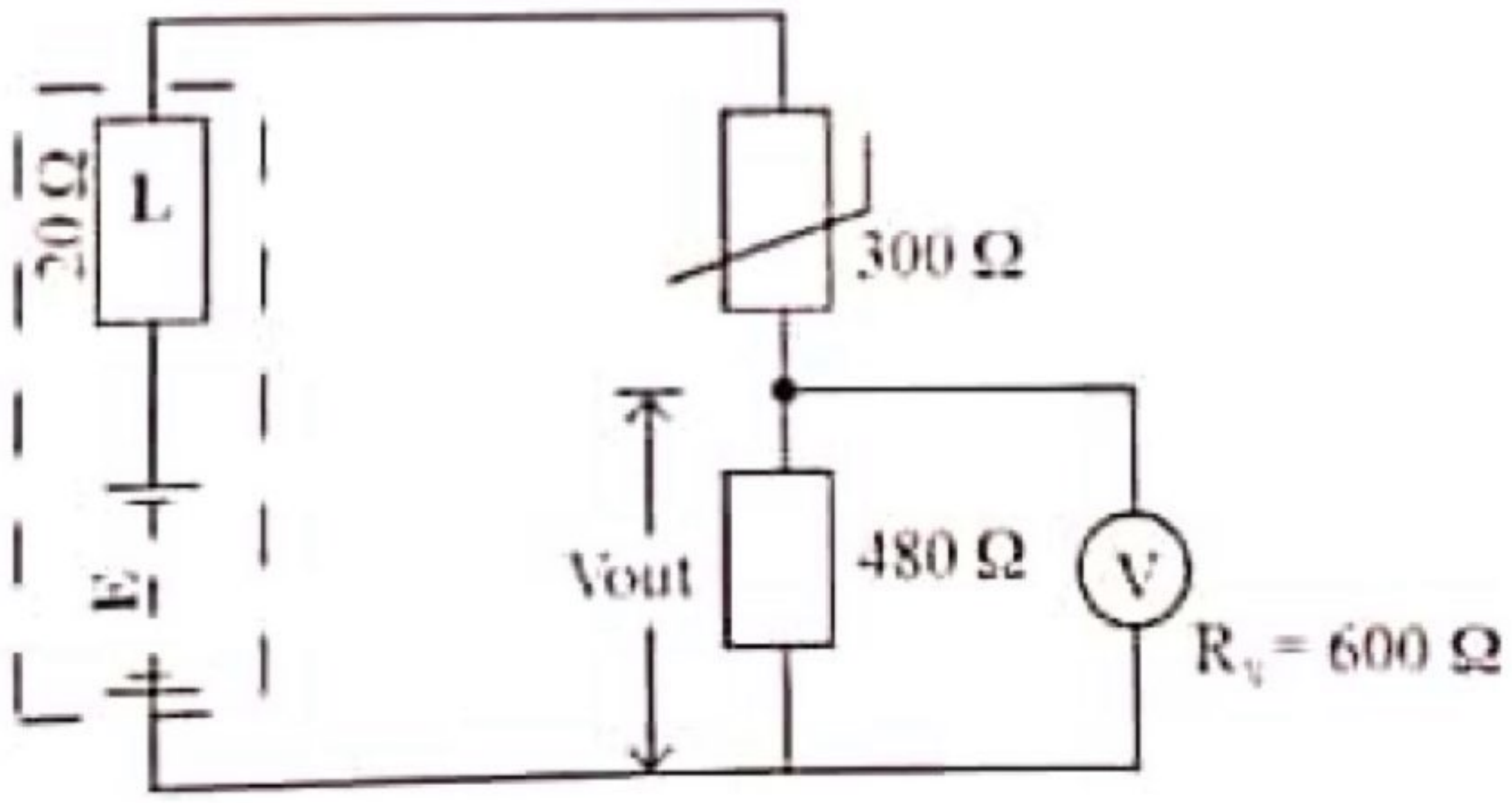

Fig. 3.4

Calculate the

(i) magnitude of V_{out} ignoring the value of R_V,

(ii) actual voltmeter reading.

[5]

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5 (a) Distinguish between emission spectra and absorption spectra. [2]

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1. *wave-particle duality.*

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(ii) In an electron gun, electrons are accelerated from the cathode by a p.d. of 225 V.

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$\lambda = \frac{h}{p} = \frac{h}{mv}$

3. Identify the part of the electromagnetic spectrum to which the wavelength in **(b)(ii) 2** belongs.

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[Decay constant of Sr – 90 is $7.75 \times 10^{-10}\mathrm{s}^{-1}$]

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2 (a) (i) Explain the term *phase difference*.

(ii) Fig. 2.1 shows a displacement-time graph of a body of mass 0.2 kg undergoing simple harmonic motion.

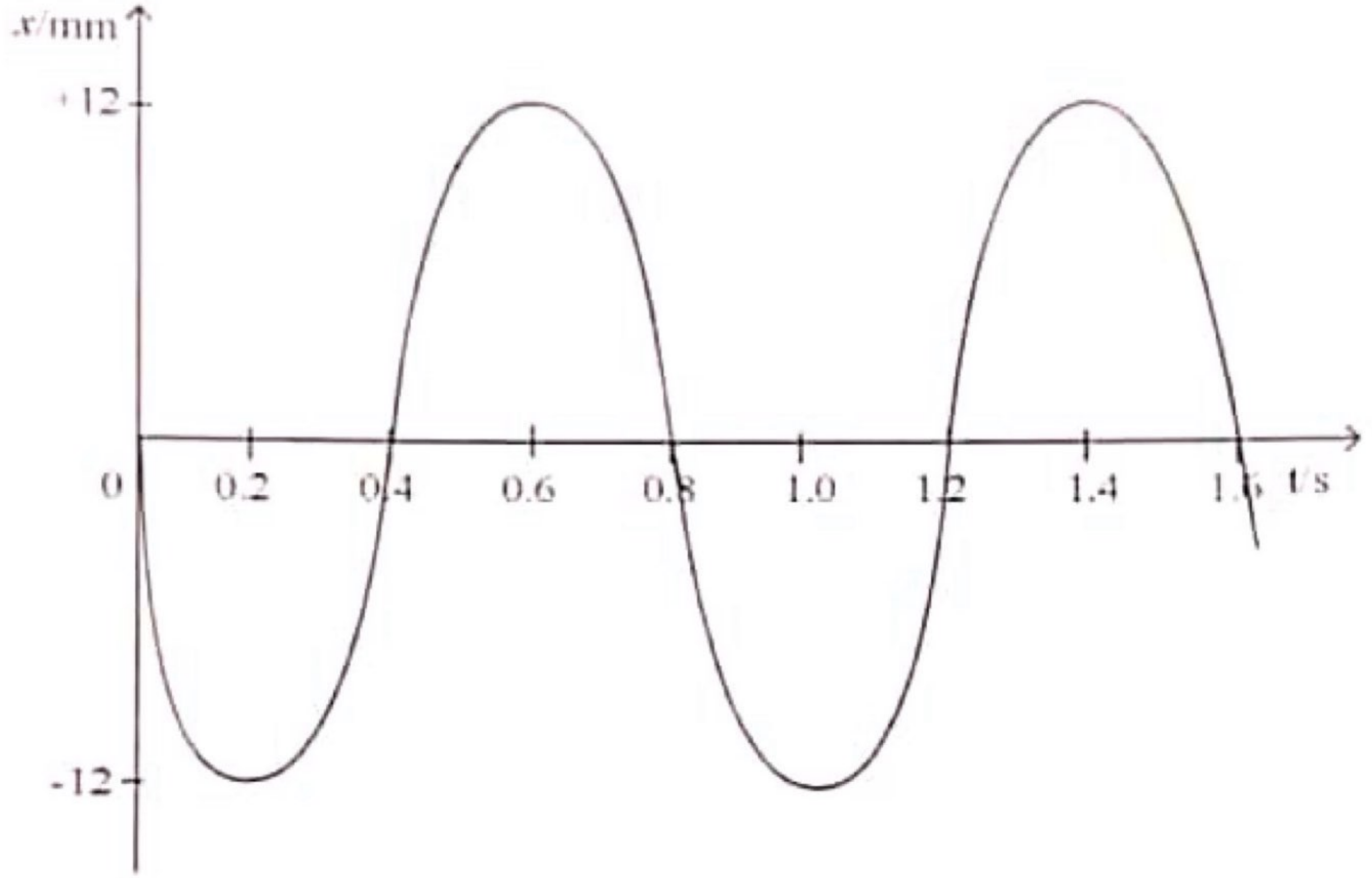

Fig. 2.1

1. Calculate the angular velocity of the oscillation.

2. Write the equation of the velocity of the oscillation in the form $x = x_0 sinwt$.

3. Sketch the velocity-displacement graph of the oscillation.

4. Hence or otherwise deduce the maximum energy of the oscillation.

[9]

(b) (i) Define *total internal reflection*.

(ii) Explain why the optical density of the core of an optical fibre must be greater than that of the cladding.

V =

[Turn over

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The body rolls down from rest and reaches the bottom of the plane.

(i) Calculate the

1. acceleration of the body as it moves down the plane,

2. velocity of the body on reaching the bottom of the plane.

The body hits the bottom and rolls up to point **B** with the same acceleration as in **(b)(i)**.

(ii) Calculate the velocity of the body at the bottom after rolling down **OB**.

(iii) Suggest forms in which energy is lost at point **O**.

[8]

(c) (i) Use Newton's first law to explain why a passenger in a lift feels lighter when the lift stops while ascending.

(ii) The system in **Fig. 1.2** is in equilibrium. The maximum force that the string can withstand is 100 N.

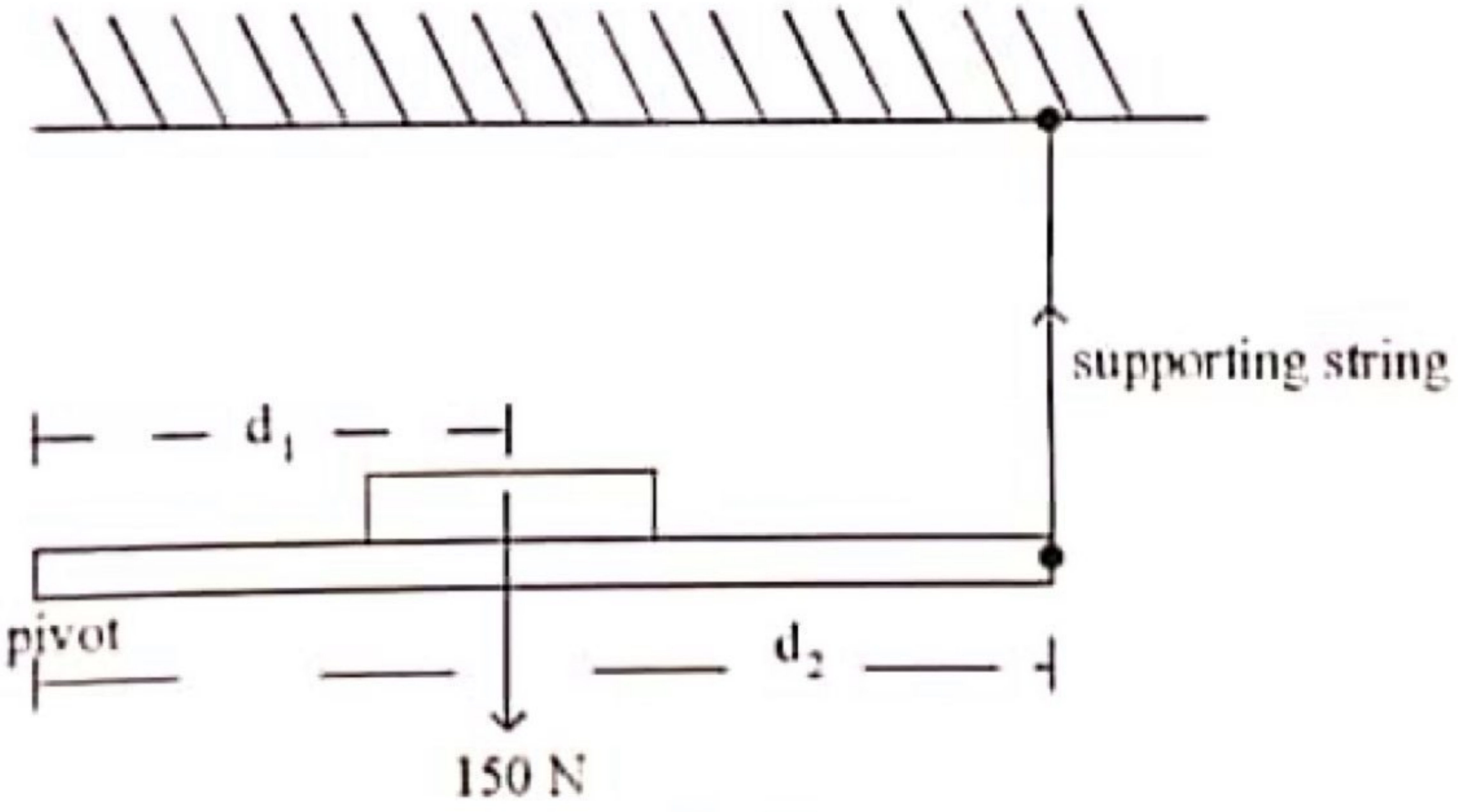

Fig. 1.2

Use the principle of moments to determine the maximum possible value of the ratio $\frac{d_2}{d_1}$.

[4]

[Turn over

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4 (a) (i) State two separate ways of increasing the internal energy of an ideal gas.

(ii) Fig. 4.1 shows a P – V graph for an ideal gas in a perfectly insulated cylinder.

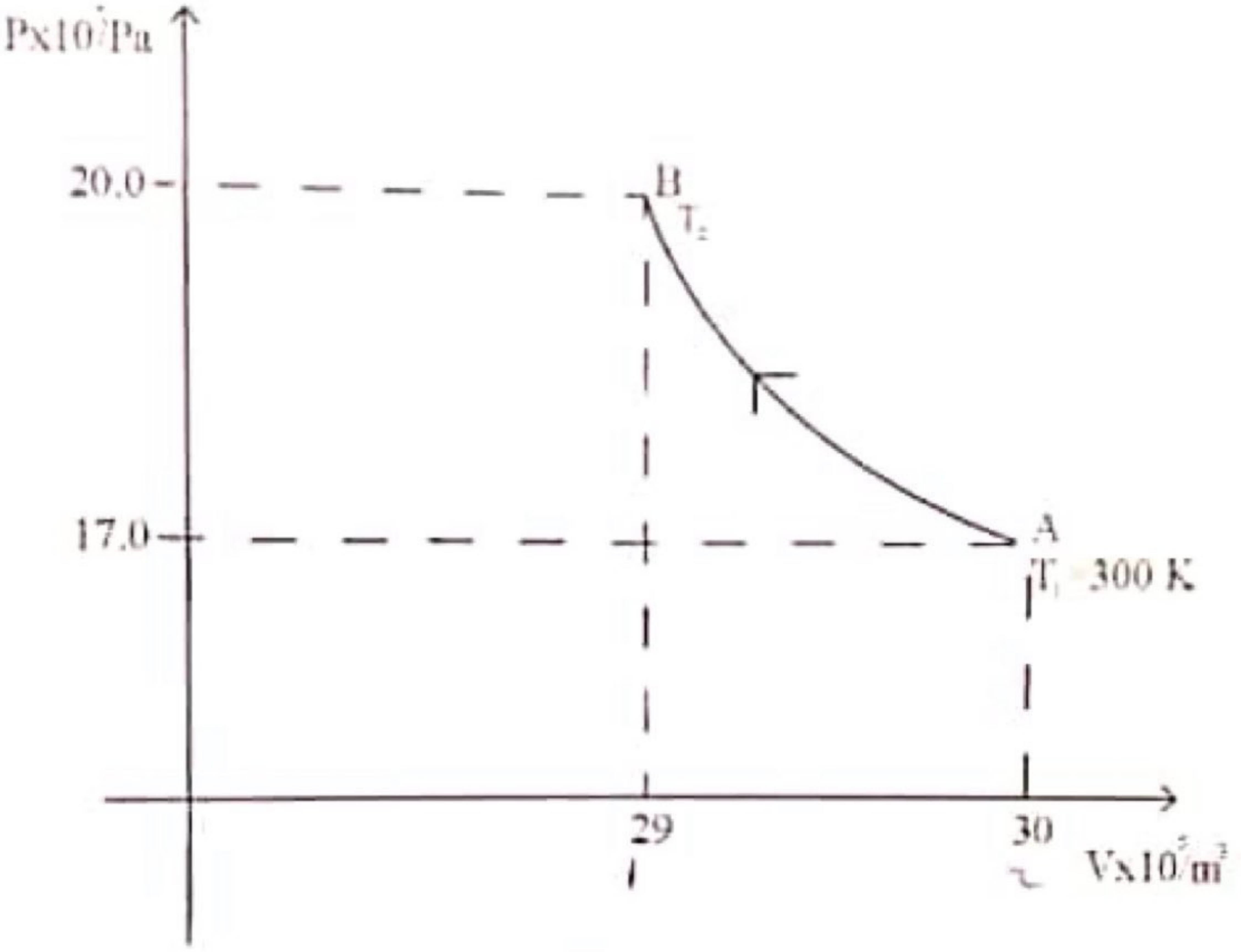

Fig. 4.1

Using **Fig. 4.1**

1. state a reason why, in Section A to B, work is said to be done on the system,

2. determine the temperature of the gas at point B,

3. determine the change in internal energy between A and B if the work done on the system is approximately 17.6 J.

(iii) Explain why in practical situations, the temperature at **B** is lower than the value calculated in **(ii)2**.

[9]

[Turn over

PV = nRT

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(e) Fig. 3.5 shows the circuit of a Schmitt trigger with positive feedback.

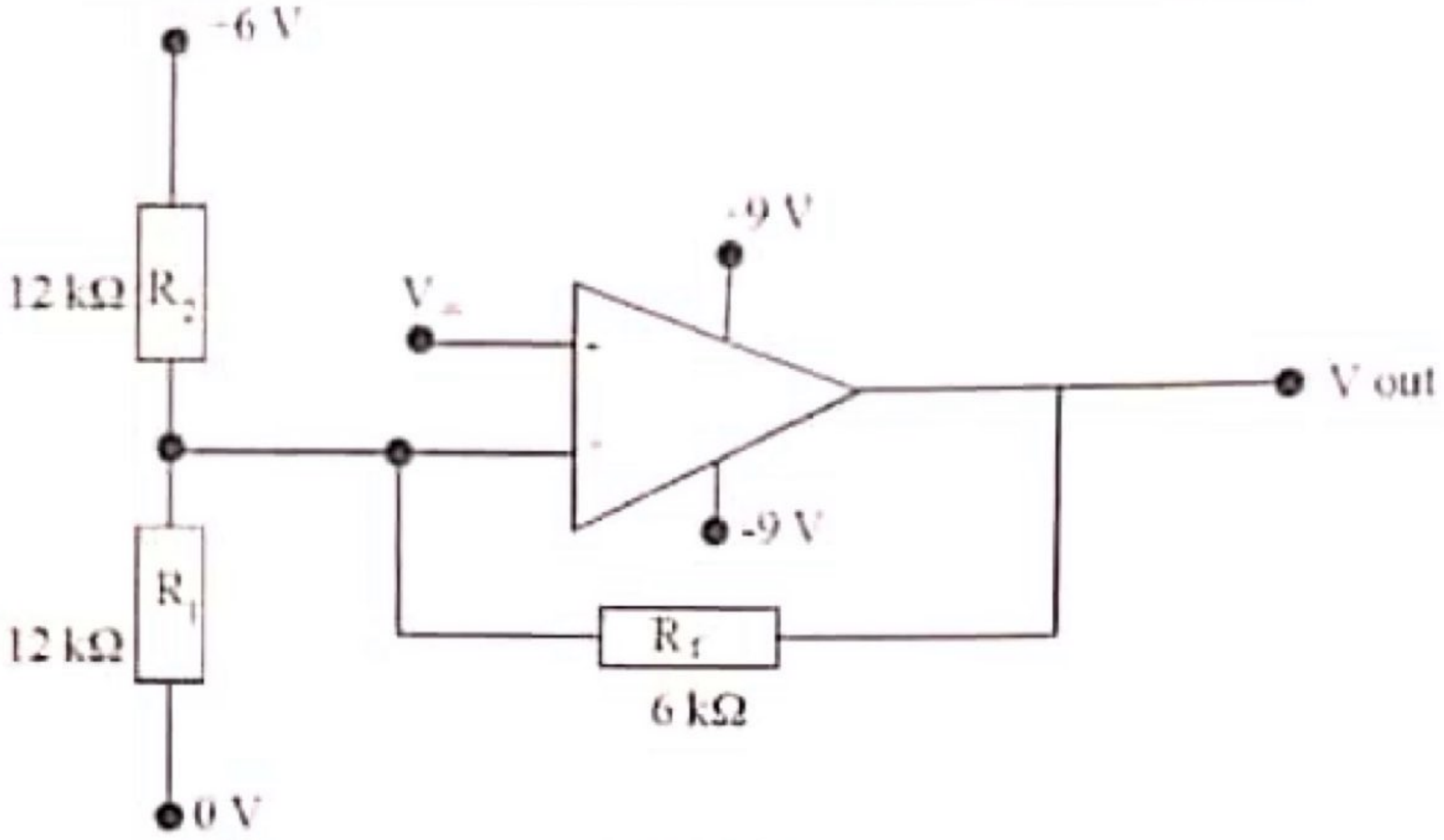

Fig. 3.5

(i) Describe the behavior of the output voltage V_{out} as V_{in} varies from 0 to +6 V then down to −6 V.

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(iii) Describe any **two** positive impacts of digital electronic systems on organisational security.

[6]

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(d) (i) Define *gravitational potential* at a point in a gravitational field.

(ii) **Fig. 1.3** shows a body of mass 1 000 kg being moved along the path shown in a uniform gravitational field.

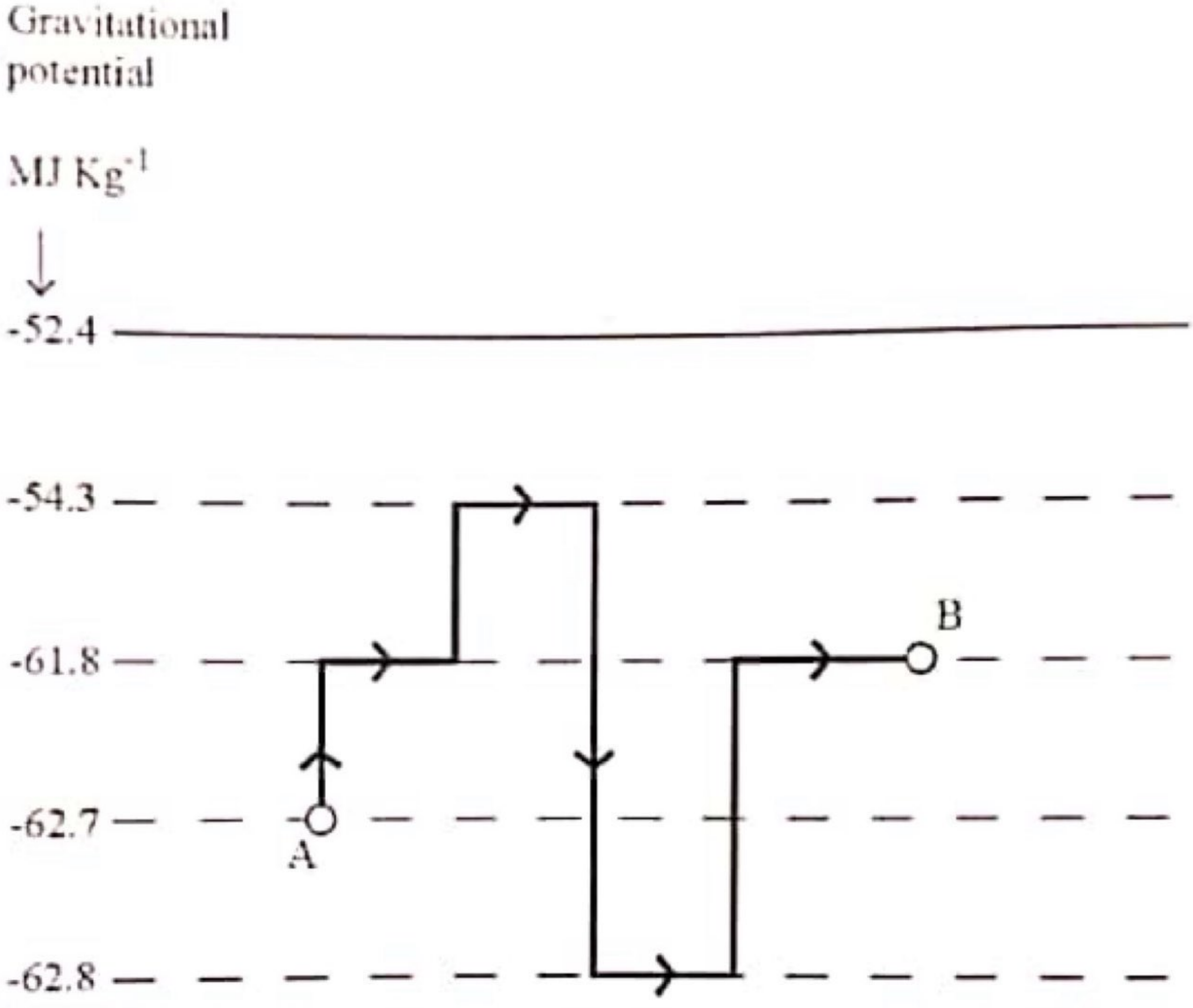

Fig. 1.3

Calculate the workdone in moving the body along the path shown.

(iii) The gravitational field strength, g, near the surface of the earth is given a value 9.81 Nkg^{-1}.

Suggest why in reality the value varies. [8]

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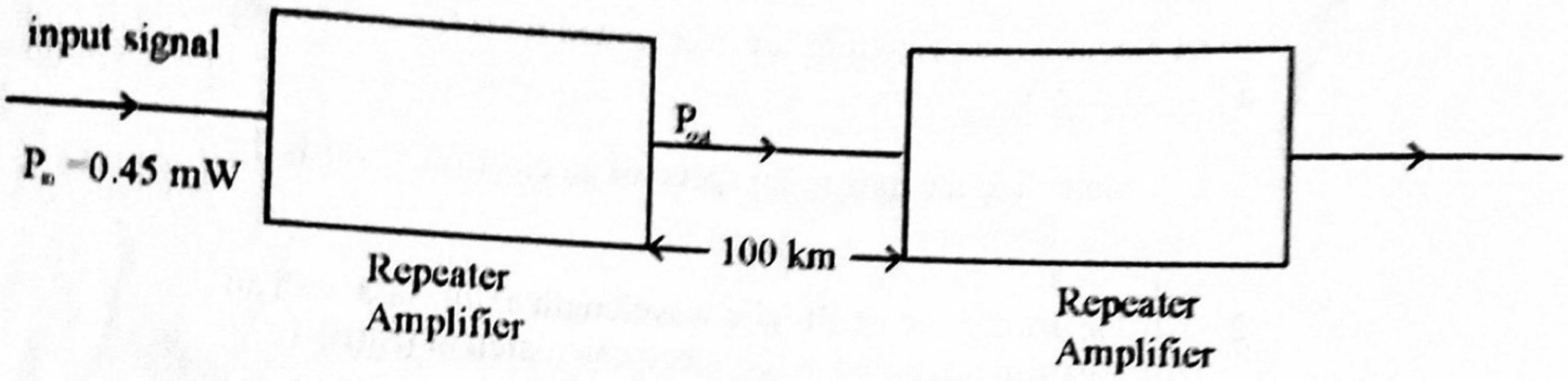

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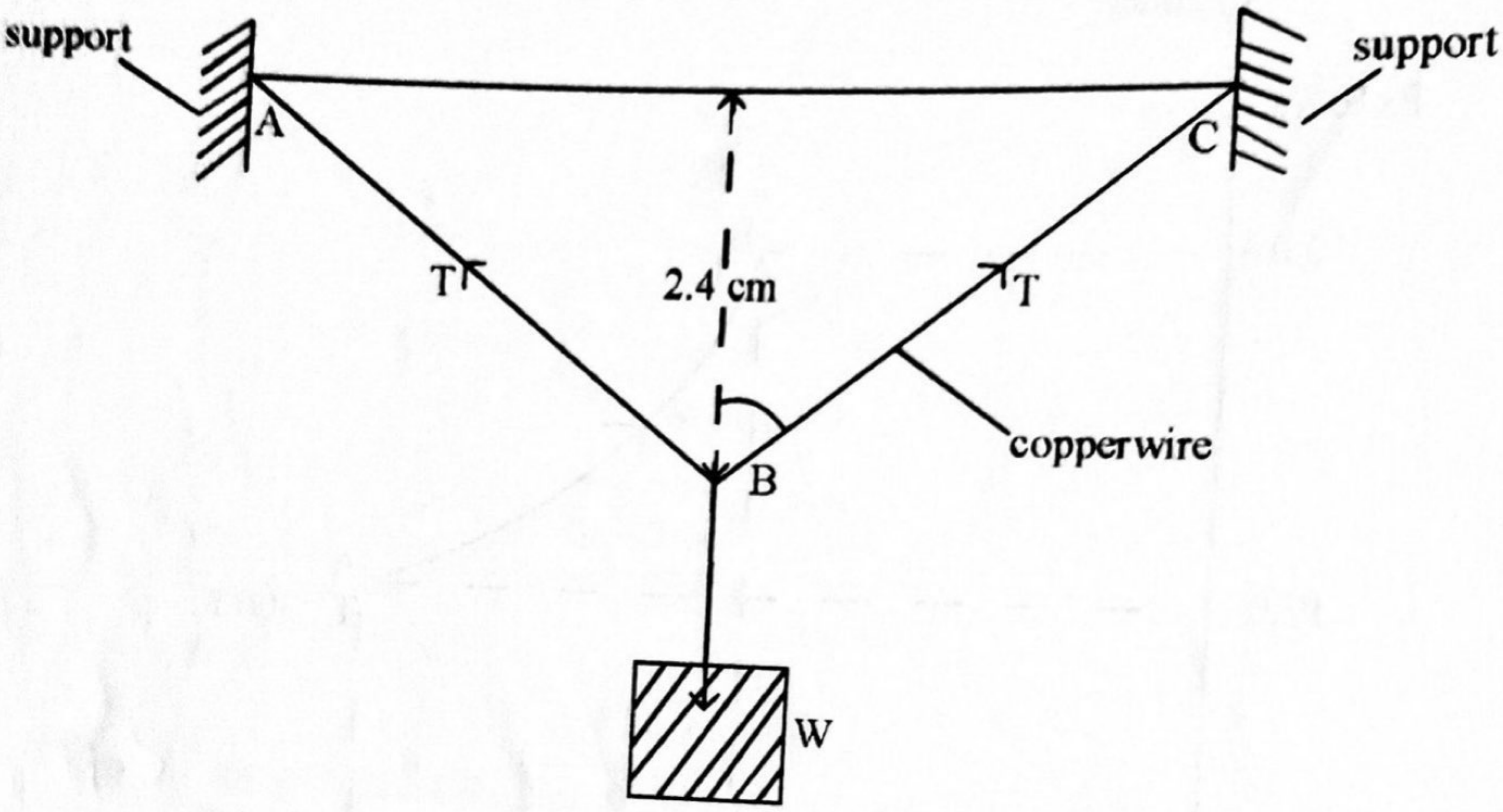

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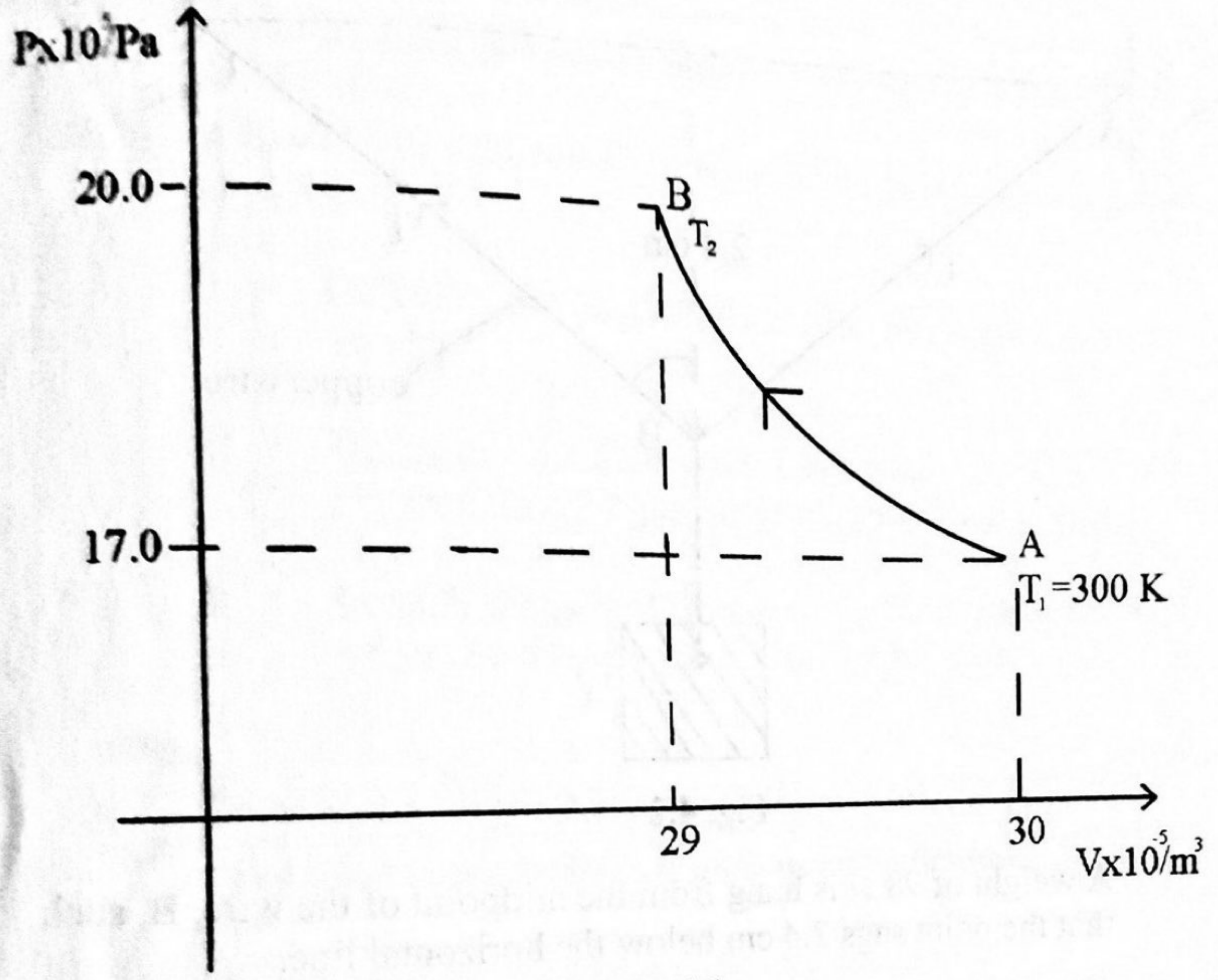

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(iii) **Explain why in practical situations, the temperature at B is lower than the value calculated in (ii)2.** **[9]**

[Turn over

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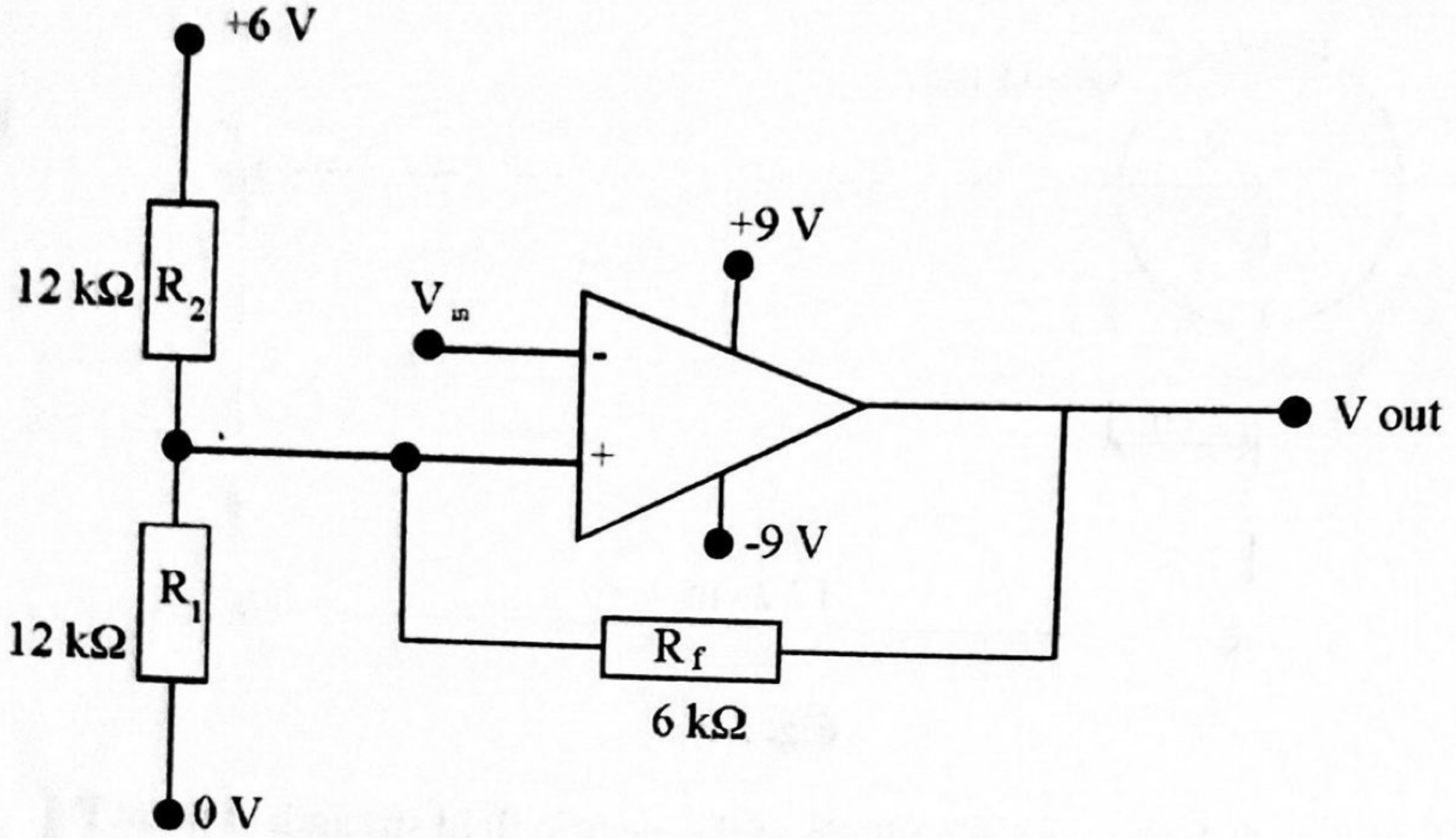

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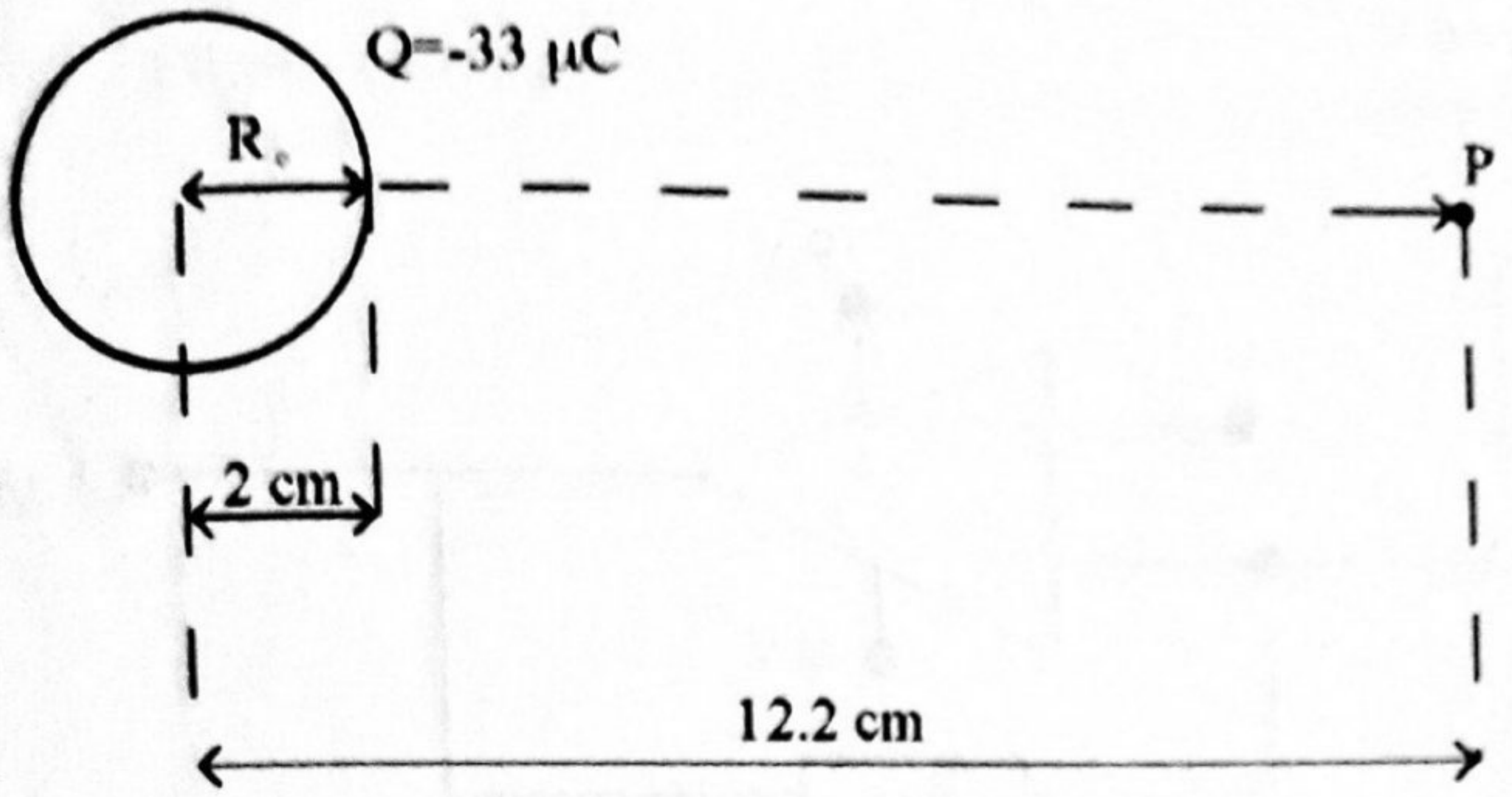

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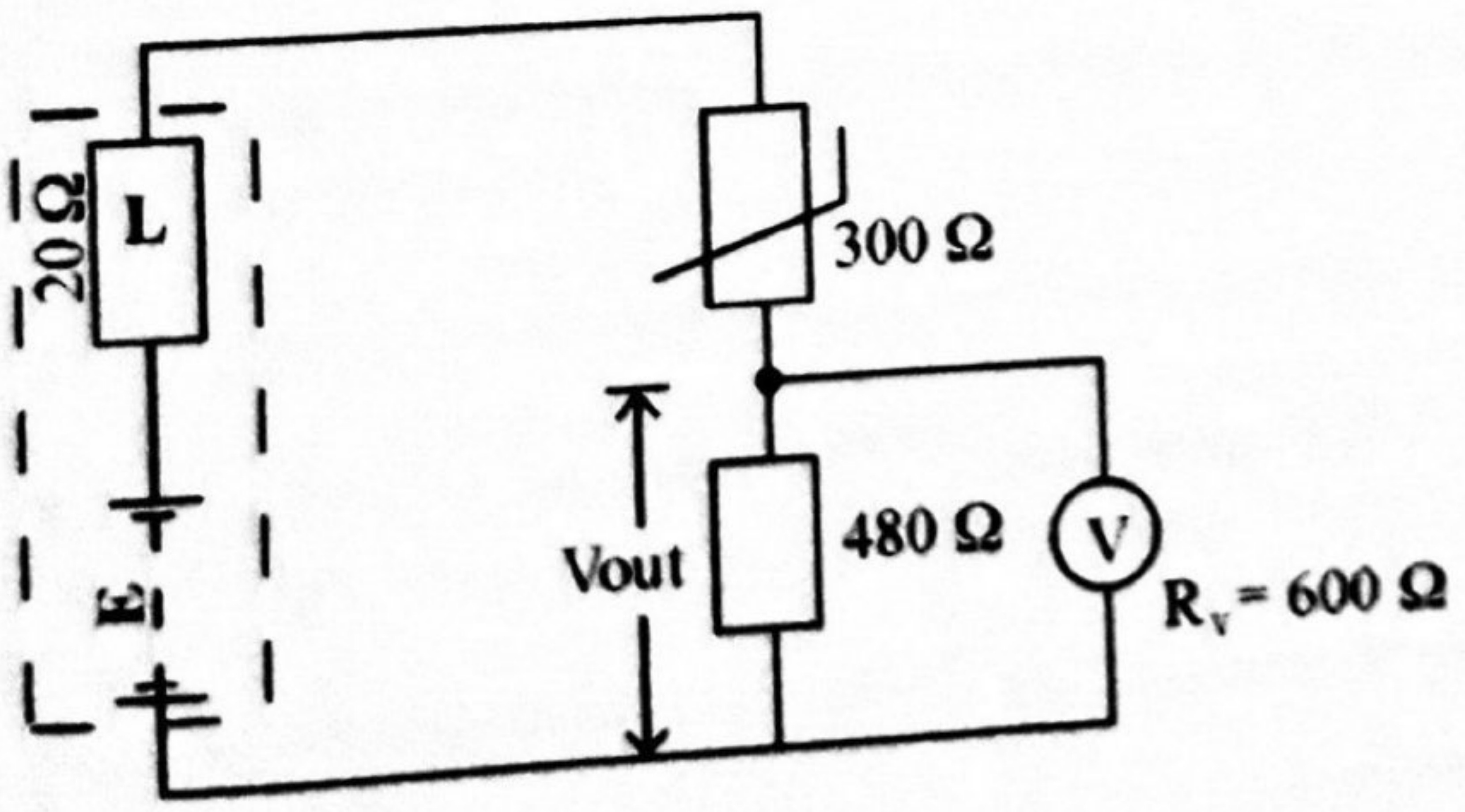

Fig. 3.4

Calculate the

(i) **magnitude of V_{out} ignoring the value of R_v.**

(ii) **actual voltmeter reading.**

[5]

[Turn over

[2]

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The capacitor is now placed in a vacuum without loosing any charge as shown in **Fig. 3.1**.

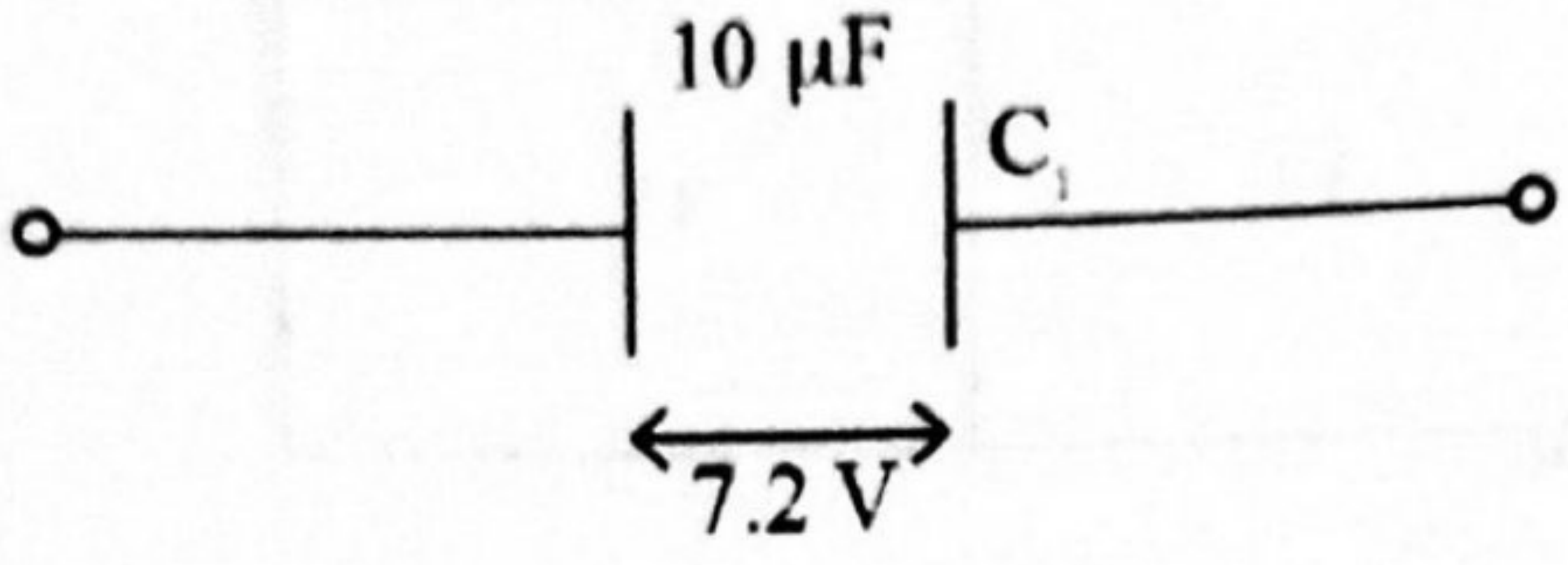

Fig. 3.1

(i) Calculate the energy stored on the capacitor C_1.

(ii) A second uncharged 12 μF capacitor C_2 is now connected across C_1 as shown in **Fig. 3.2**.

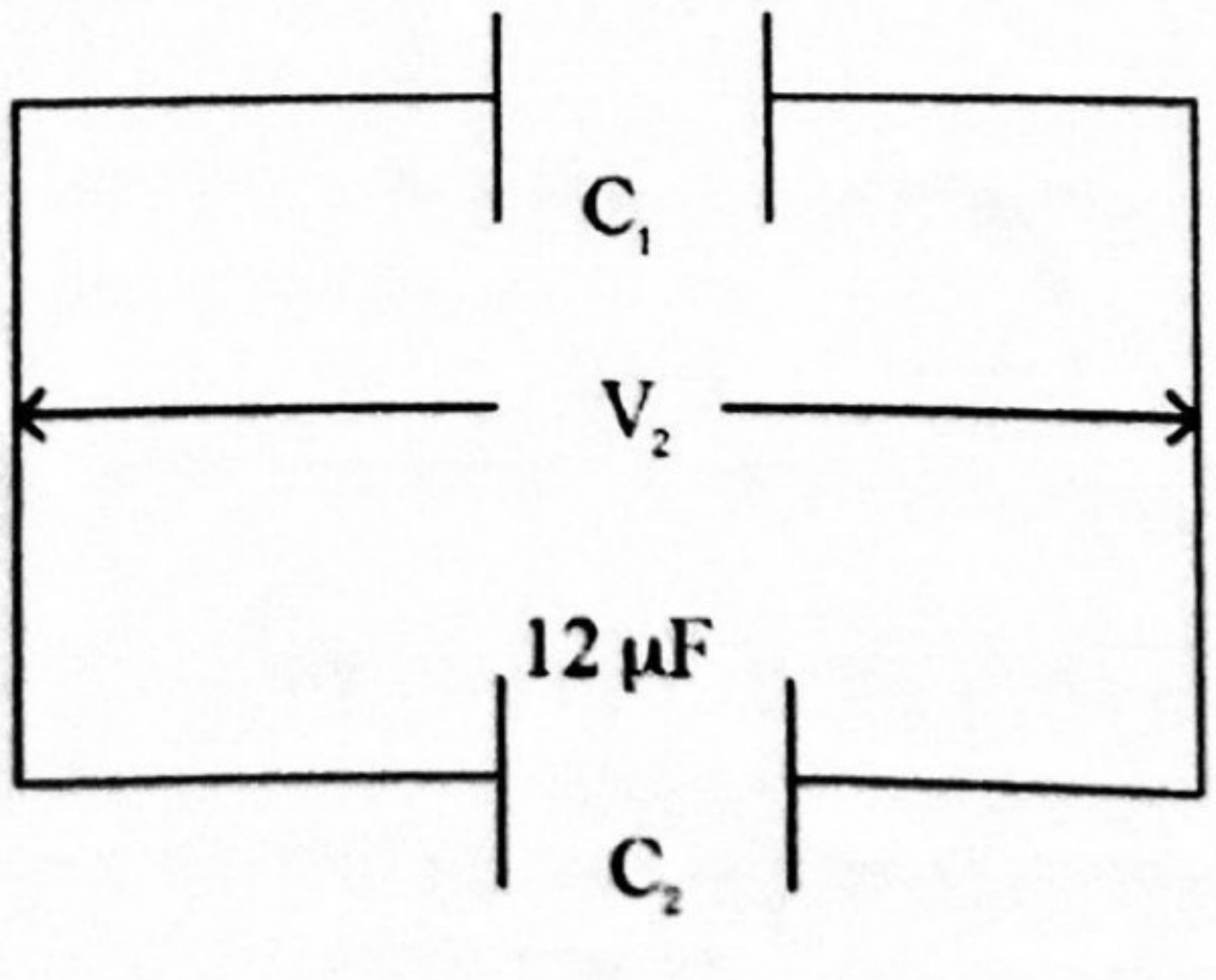

Fig. 3.2

Determine the

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2. p.d. V_2 across the combination,

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(d) A sample object consists of 4 voxels. The object is scanned from 4 different directions. The readings for each individual voxel are summed up and the result is shown in Fig. 2.3.

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The total background reading is 20.

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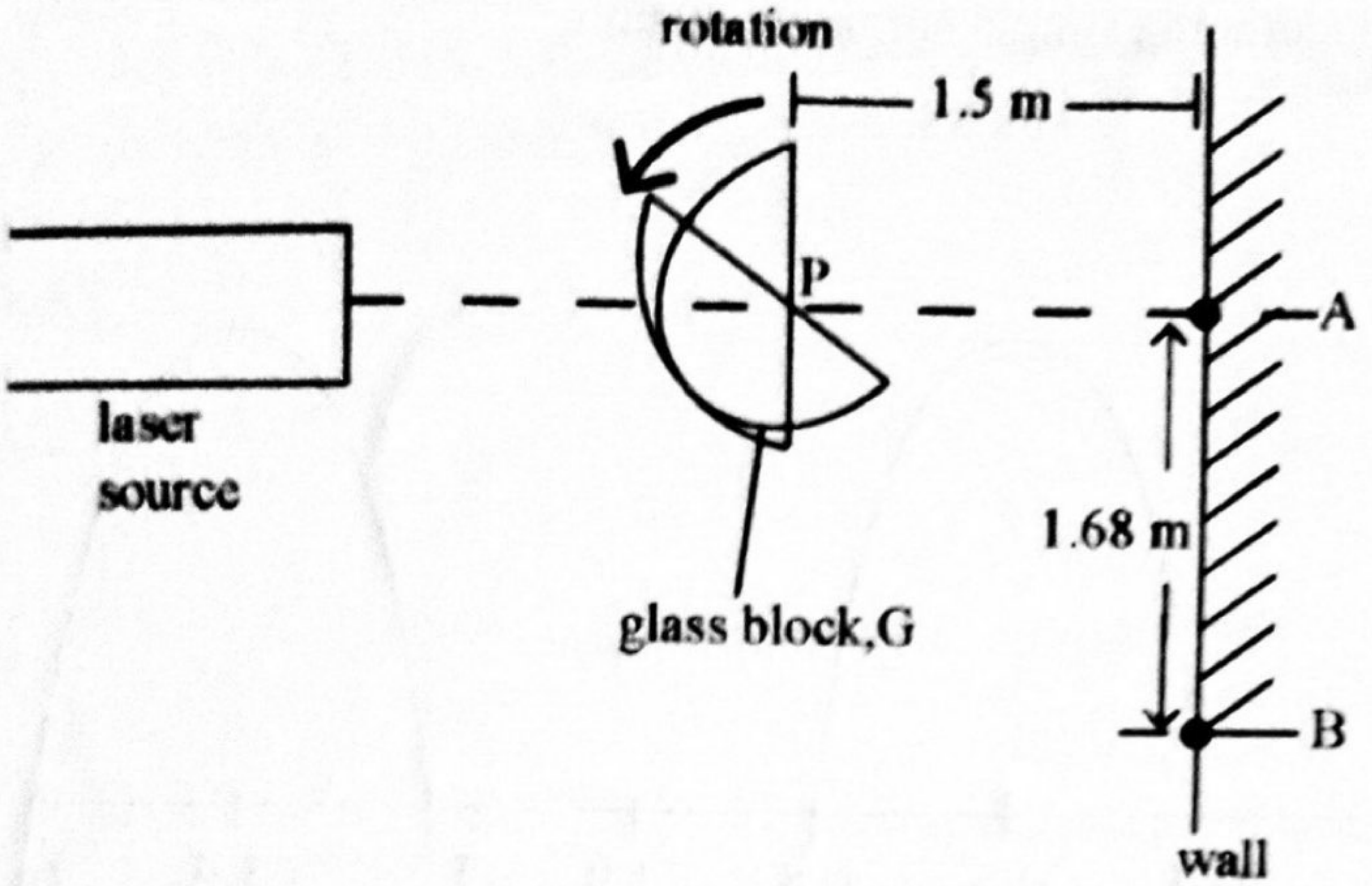

Fig. 2.2

A semi-circular glass block, **G**, is placed symmetrically across the path of light a distance 1.5 m from the wall producing a bright spot on point **A**. When the block, **G**, is rotated about point P, the bright spot moves from **A** to **B** and immediately disappears after point **B**.

Explain why

1. the bright spot moves from **A** to **B** as **G** is slowly rotated anticlockwise,

2. the light disappears as the block **G** is rotated further.

(iv) Determine the refractive index of the glass block **G**.

(v) Predict whether distance **AB** will be shorter or longer if glass of a higher refractive index is used.

[11]

(c) Oil has a linear attenuation (absorption) coefficient of 0.59 cm^{-1} for a particular incident X-ray beam.

Calculate the depth required to reduce the intensity of the X-ray beam to 0.0027 of its incident intensity. [3]

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2 **(a)** **(i)** **Explain the term *phase difference*.**

(ii) **Fig. 2.1 shows a displacement-time graph of a body of mass 0.2 kg undergoing simple harmonic motion.**

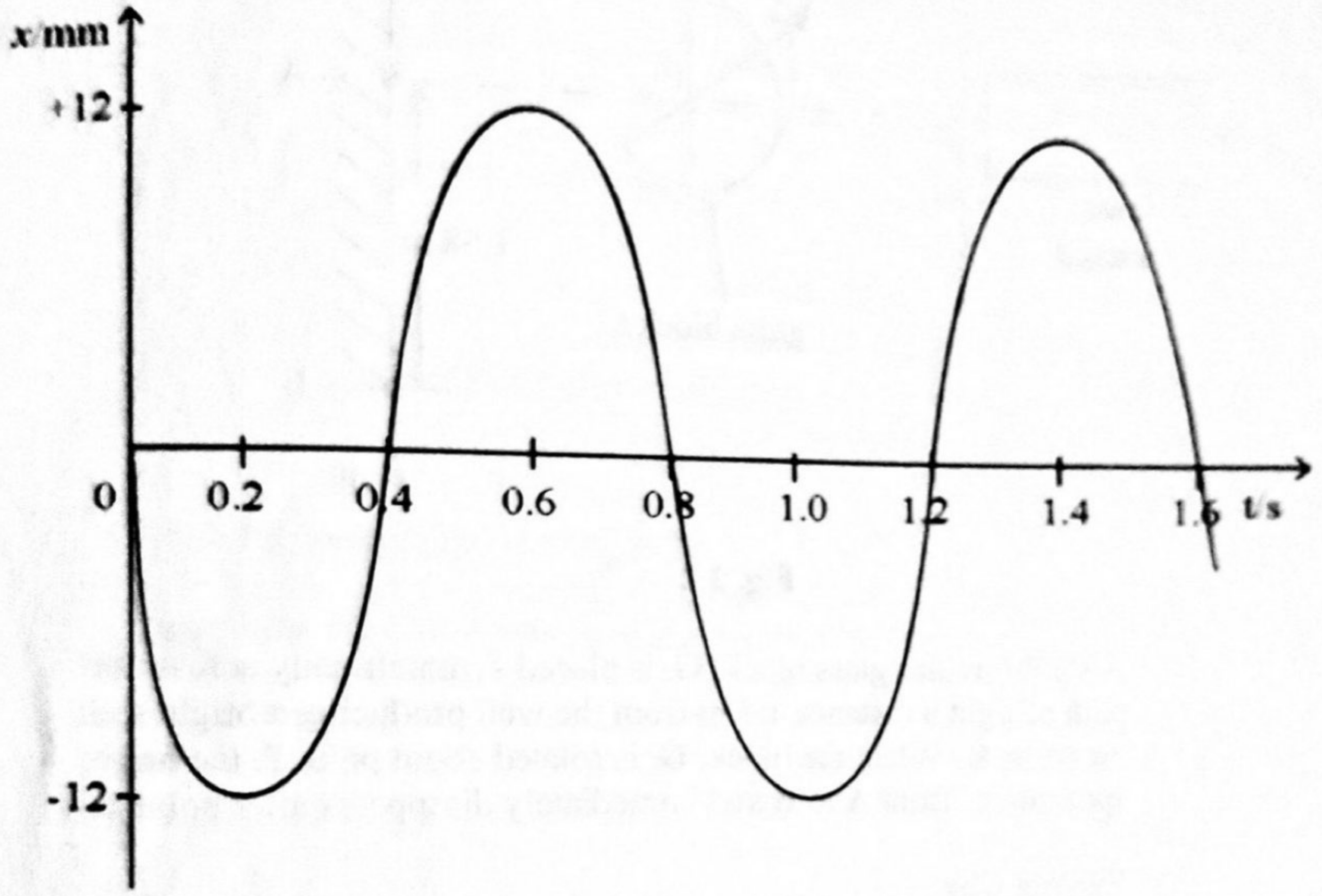

Fig. 2.1

1. Calculate the angular velocity of the oscillation.

2. Write the equation of the velocity of the oscillation in the form $x = x_0 sinwt$.

3. Sketch the velocity-displacement graph of the oscillation.

4. Hence or otherwise deduce the maximum energy of the oscillation. [9]

(b) **(i)** **Define *total internal reflection*.**

(ii) **Explain why the optical density of the core of an optical fibre must be greater than that of the cladding.**

[Turn over

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(d) **(i)** **Define *gravitational potential* at a point in a gravitational field.**

(ii) **Fig. 1.3 shows a body of mass 1 000 kg being moved along the path shown in a uniform gravitational field.**

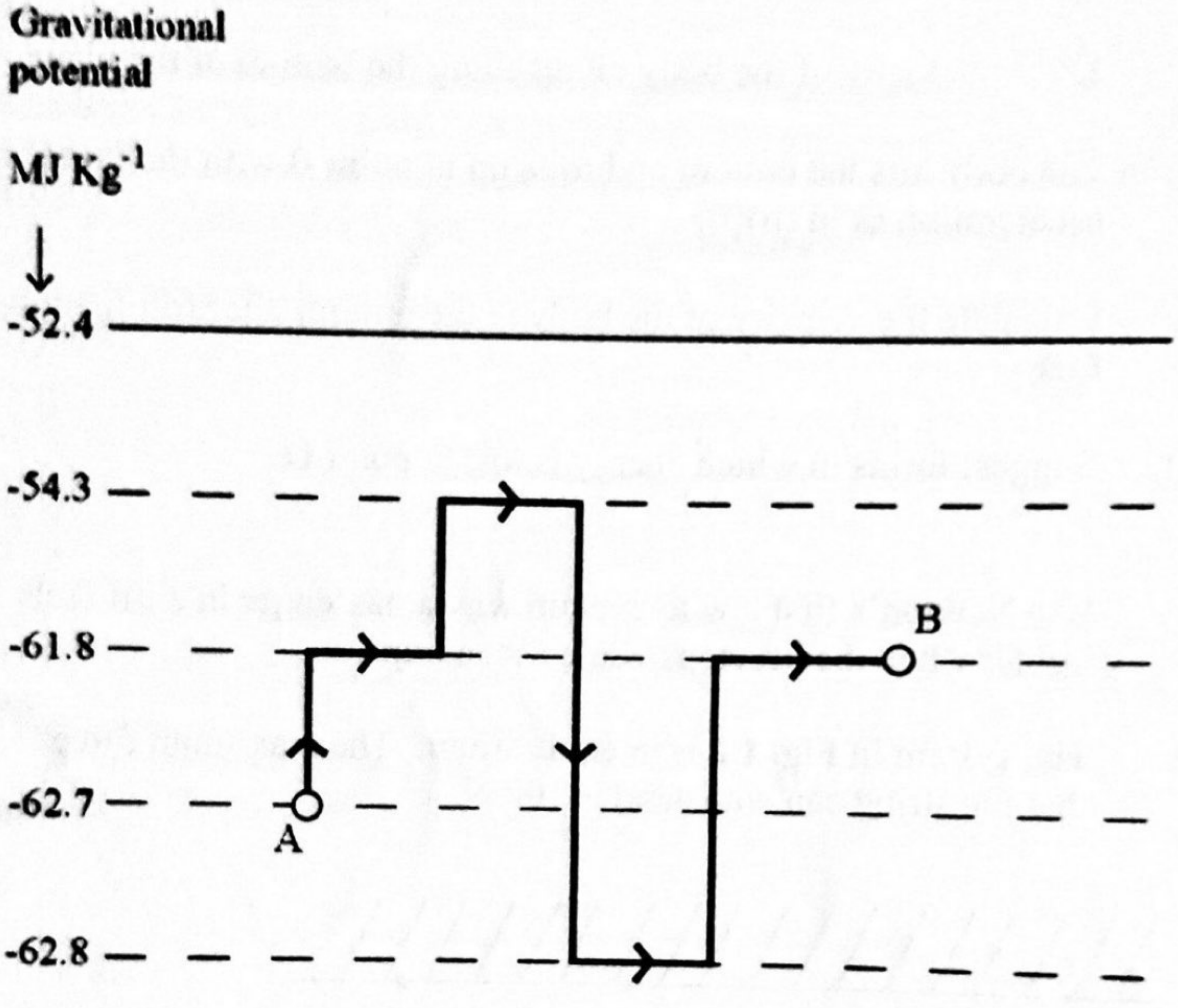

Fig. 1.3

Calculate the workdone in moving the body along the path shown.

(iii) The gravitational field strength, g, near the surface of the earth is given a value 9.81 Nkg^{-1}.

Suggest why in reality the value varies.

[8]

The body rolls down from rest and reaches the bottom of the plane.

(i) Calculate the

1. acceleration of the body as it moves down the plane,

2. velocity of the body on reaching the bottom of the plane.

The body hits the bottom and rolls up to point **B** with the same acceleration as in (b)(i).

(ii) Calculate the velocity of the body at the bottom after rolling down **OB**.

(iii) Suggest forms in which energy is lost at point **O**.

[8]

(c) **(i)** Use Newton's first law to explain why a passenger in a lift feels lighter when the lift stops while ascending.

(ii) The system in **Fig. 1.2** is in equilibrium. The maximum force that the string can withstand is 100 N.

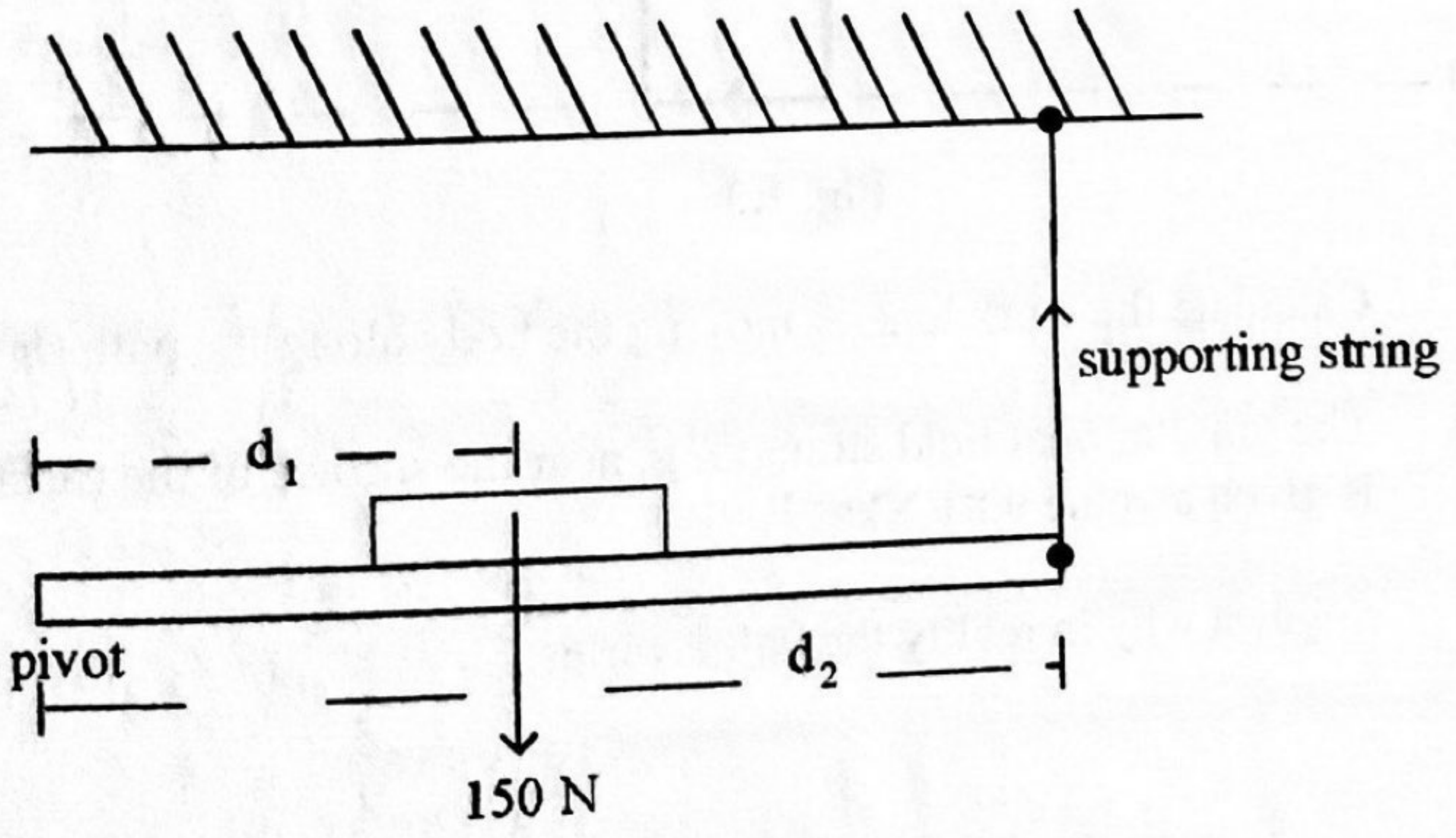

Fig. 1.2

Use the principle of moments to determine the maximum possible value of the ratio $\frac{d_2}{d_1}$.

[4]

Answer question 1 and any other 3 from the remaining questions.

1 (a) The vertical displacement, y, of an electron of mass, m_e passing through an electric field of strength, E, between two parallel plates is given by

$$y = \frac{1}{2}\frac{eEDt^2}{m_e},$$

where t is the time spent between the plates and e is the charge of the electron.

(i) Show that D is a dimensionless constant.

(ii) Calculate the percentage error in y given that

$E = (1.20 \times 10^2 \pm 0.03)\ NC^{-1}$,

$D = 0.992$,

$t = (1.62 \times 10^{-1} \pm 0.01)s$.

[5]

(b) **Fig. 1.1 shows a body of mass 0.5 kg at the top of a 1.0 m long smooth plane inclined at 50° to the horizontal.**

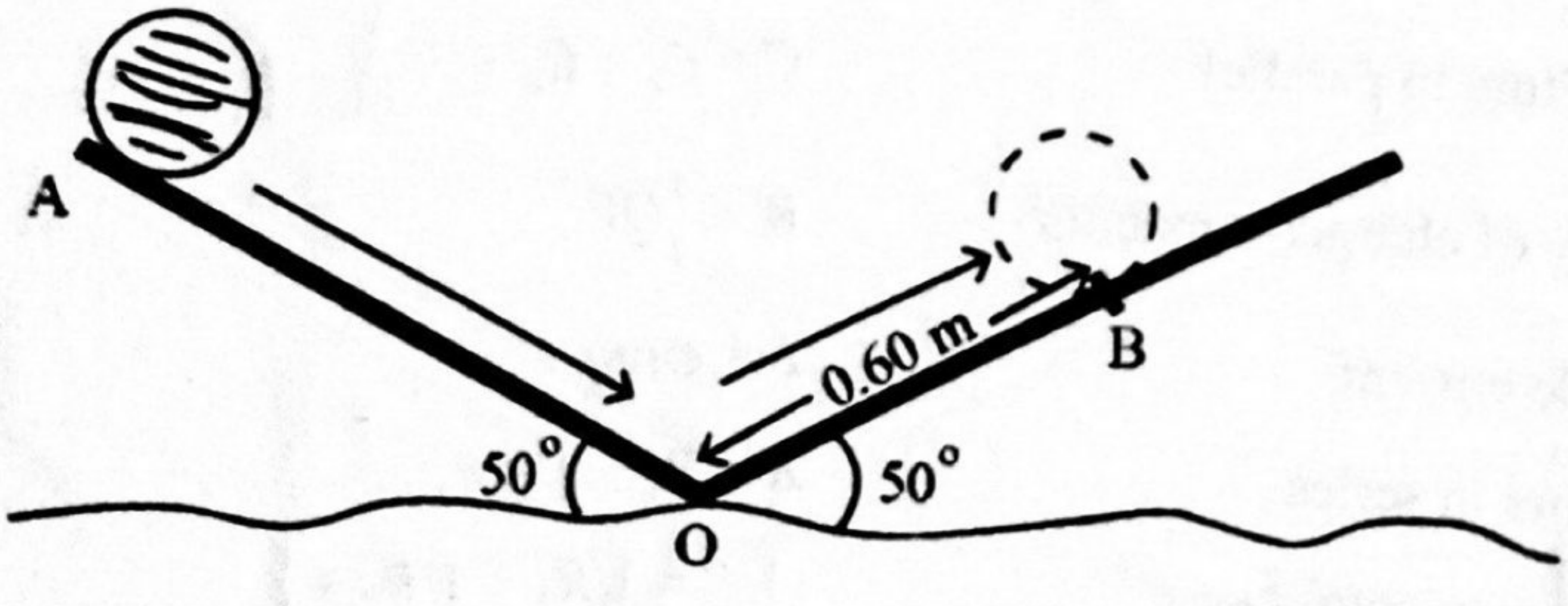

Fig. 1.1

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FORMULAE

uniformly accelerated motion	$s = ut + ½at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\,\Delta V$
gravitational potential	$\emptyset = -Gm/r$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$ $v = \pm\omega\sqrt{(x_o^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
Attenuation of x-rays	$I = I_o e^{-\mu x}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_o \sin\omega t$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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DATA

speed of light in free space	$c = 3.00 \times 10^8 ms^{-1}$
permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ Hm^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1} $(1/4\pi\varepsilon_0 = 8.99 \times 10^9$ $mF^{-1})$
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ Js
unified atomic mass unit	$1 u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31$ $JK^{-1}mol^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} mol^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ JK^{-1}
gravitational constant	$G = 6.67 \times 10^{-11} Nm^2kg^{-2}$
acceleration of free fall	$g = 9.81$ ms^{-2}

$mc^2 = h\cancel{c}/\lambda$

$\lambda = hc/mc^2$

$= h/$ $c = h\cancel{c}/mc$

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For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

6032/3

PAPER 3 THEORY

JUNE 2020 SESSION 2 hours 30 minutes

Additional materials:
Answer paper
Electronic calculator

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

Question1 is compulsory.

Answer any other **three** from the remaining questions.

Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 16 printed pages.

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For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

6032/3

PAPER 3

NOVEMBER 2022 SESSION **2 hours 30 minutes**

Additional materials:
Answer paper
Electronic calculator

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

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This question paper consists of 15 printed and 1 blank page.

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DATA

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acceleration of free fall	$g = 9.81\ \mathrm{ms^{-2}}$

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FORMULAE

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radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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Answer question 1 and any other 3 from the remaining questions.

1 (a) (i) State two conditions under which the following equations of motion are applicable:

$$v^2 = u^2 + 2as$$
$$s = ut + \frac{1}{2}at^2$$

(ii) Fig. 1.1 shows a ball of mass, 50 g, thrown horizontally with a speed of 5 m/s. The ball falls through a vertical height of 1.8 m before bouncing off the ground.

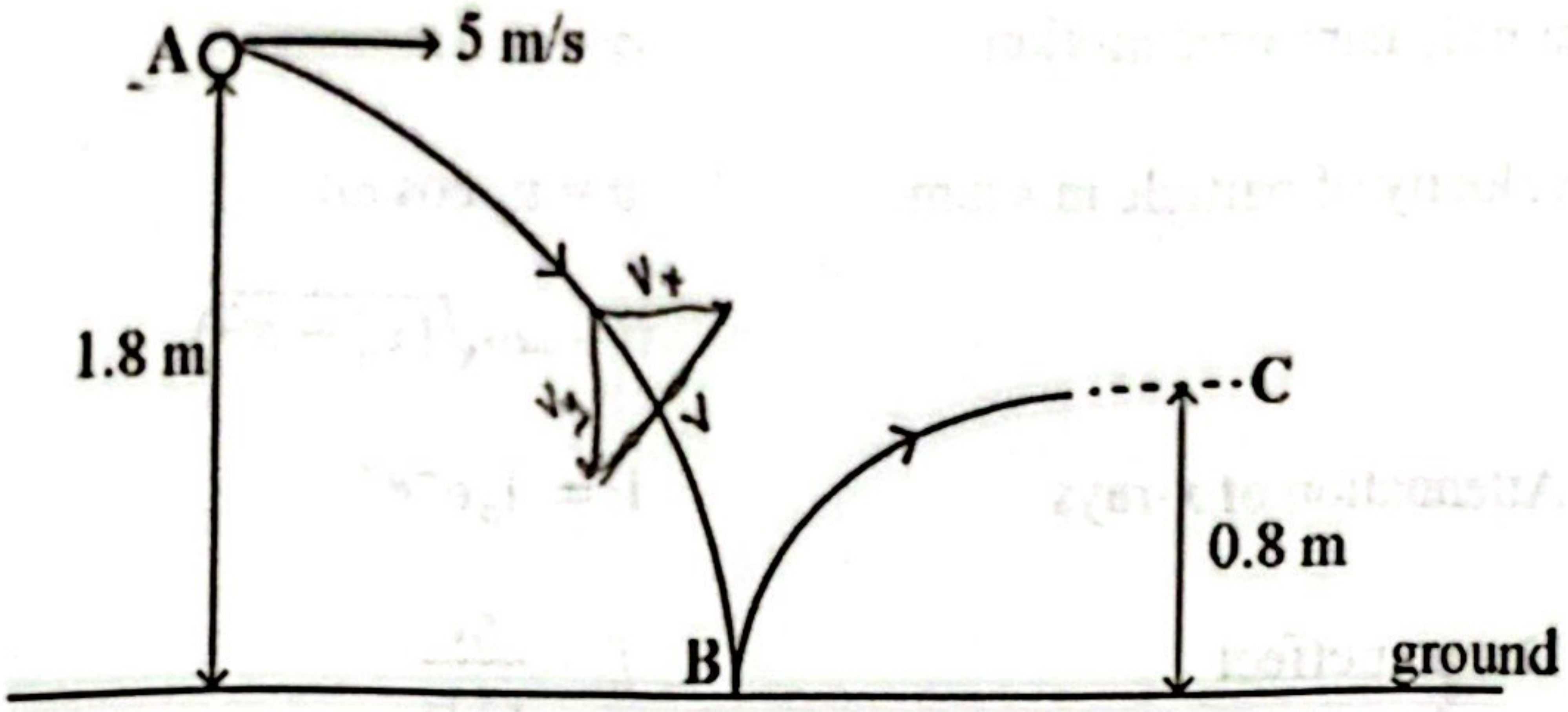

Fig. 1.1

Assume air resistance is negligible.

1. State the magnitude of the horizontal component of its velocity.

2. Show that the vertical component of the velocity at point B is 5.9 m/s.

3. Calculate the vertical component of the velocity of the ball as it leaves the ground at point B.

(iii) The ball is in contact with the ground for a time of 0.15 s.

Calculate the

1. change in momentum,

2. average force exerted by the ground on the ball due to this momentum change. [11]

(b) **(i)** **Explain what is meant by *moment of a force*.**

(ii) **Fig. 1.2 shows a 5 kg mass hung from the end B of a uniform bar AB of mass 2 kg. The bar is hinged to a wall at A and held horizontally by a wire BC.**

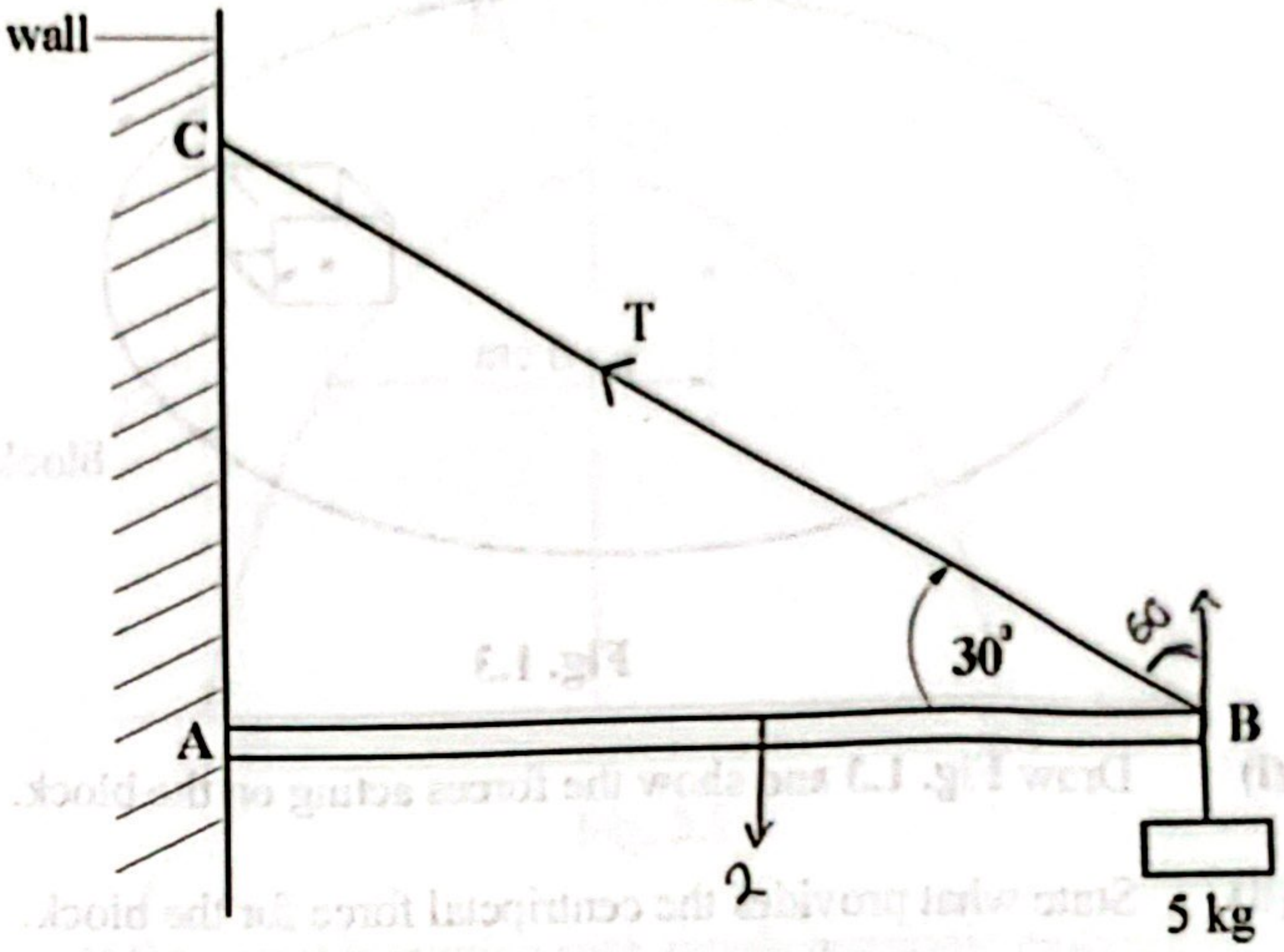

Fig. 1.2

1. **State two conditions for equilibrium.**
2. **Find the tension in the wire.**

[6]

(c) **(i)** **State *Newton's law of gravitation*.**

(ii) **Explain one everyday application of the gravitational force of attraction.**

[3]

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(d) **Fig. 1.3 shows a small block placed on the surface of a horizontal disc at a point 6 cm from the centre of the disc. The block is on the point of slipping when the disc rotates at $1\frac{1}{2}$ rev s^{-1}.**

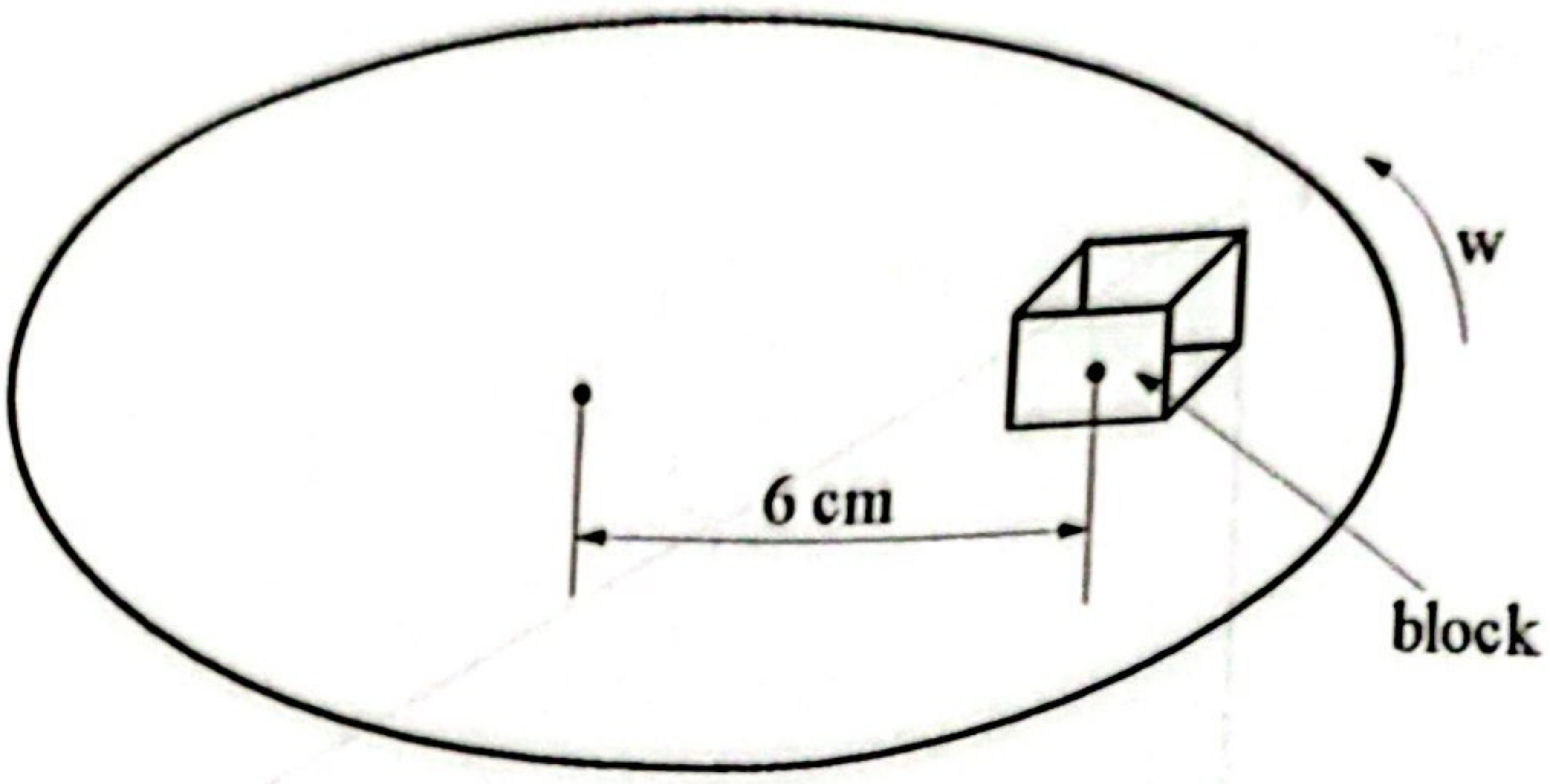

Fig. 1.3

(i) Draw **Fig. 1.3** and show the forces acting on the block.

(ii) State what provides the centripetal force for the block.

(iii) Find the coefficient of friction between the block and the surface of the disc. **[5]**

2 **(a)** **(i)** State **two** factors that affect the quality of an X-ray image.

(ii) Explain why it is difficult to produce a good quality X-ray image of the stomach. **[5]**

(b) **(i)** Define *critical angle.*

(ii) A ray of light moves from glass of refractive index, *n*, into a vacuum.
Show that $n = \frac{1}{SinC}$ where *n* is refractive index of glass and *C* is the critical angle.

(iii) Light passes from glass of refractive index 1.52 to water of refractive index 1.33.

Calculate the critical angle in glass. **[5]**

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(c) (i) Define *simple harmonic motion.*

(ii) **Fig. 2.1 shows a graph of the variation of kinetic energy of an object of mass 5 kg with position x from equilibrium position.**

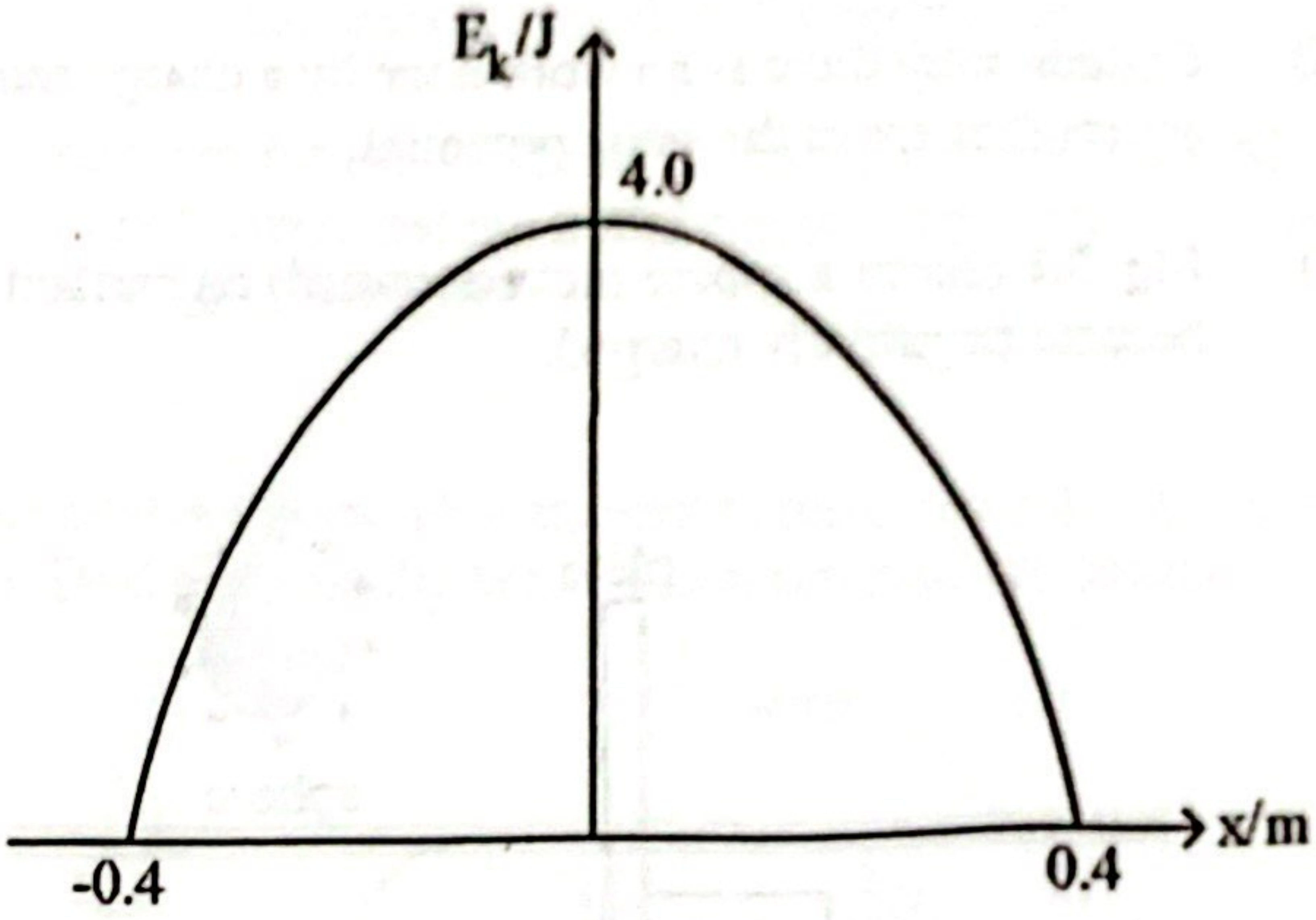

Fig. 2.1

If the object is moving with simple harmonic motion,

Calculate the

1. period of oscillation,
2. velocity of the object at a displacement of 0.25 m from the equilibrium position,
3. maximum acceleration of the object.

(iii) Sketch an acceleration (a) position (x) graph for the motion. [11]

(d) (i) Give a typical wavelength of ultraviolet.

(ii) Calculate the typical photon energy of ultraviolet using the answer in d(i).

(iii) Give any characteristic of electromagnetic waves.

[4]

[Turn over

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3 (a) (i) Sketch the electric field pattern around an isolated positively charged sphere.

(ii) Show on the sketch points that are at the same potential.

(iii) Explain why there is no work done by a charge moving between points that are at the same potential.

(iv) Fig. 3.1 shows a sphere moved towards an earthed metal plate and the pla became negatively charged.

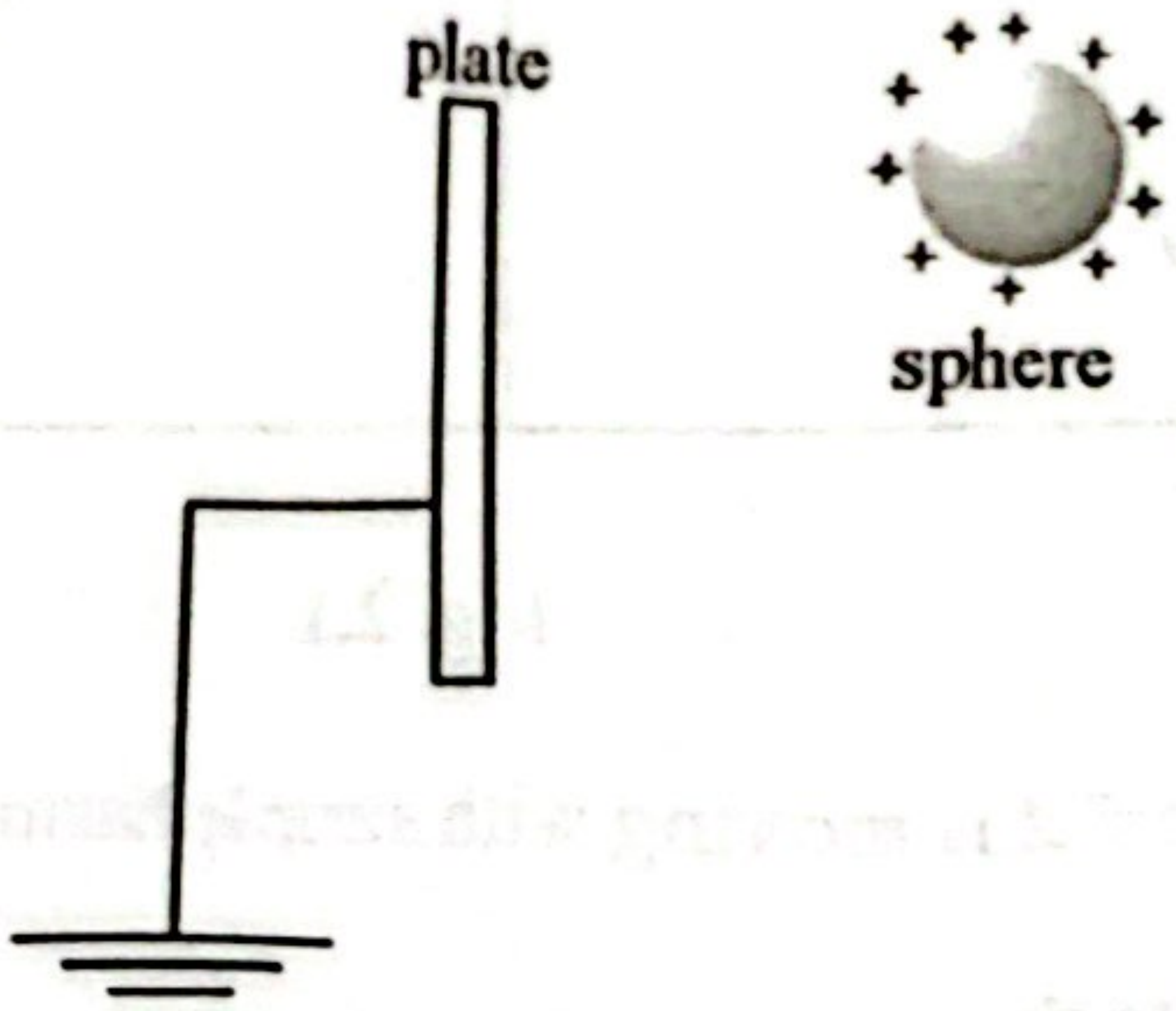

Fig. 3.1

Suggest how the negative charge on the plate arises. [5]

(b) *Fig. 3.2* shows a circuit where switch **A** is initially closed and switch **B** is open.

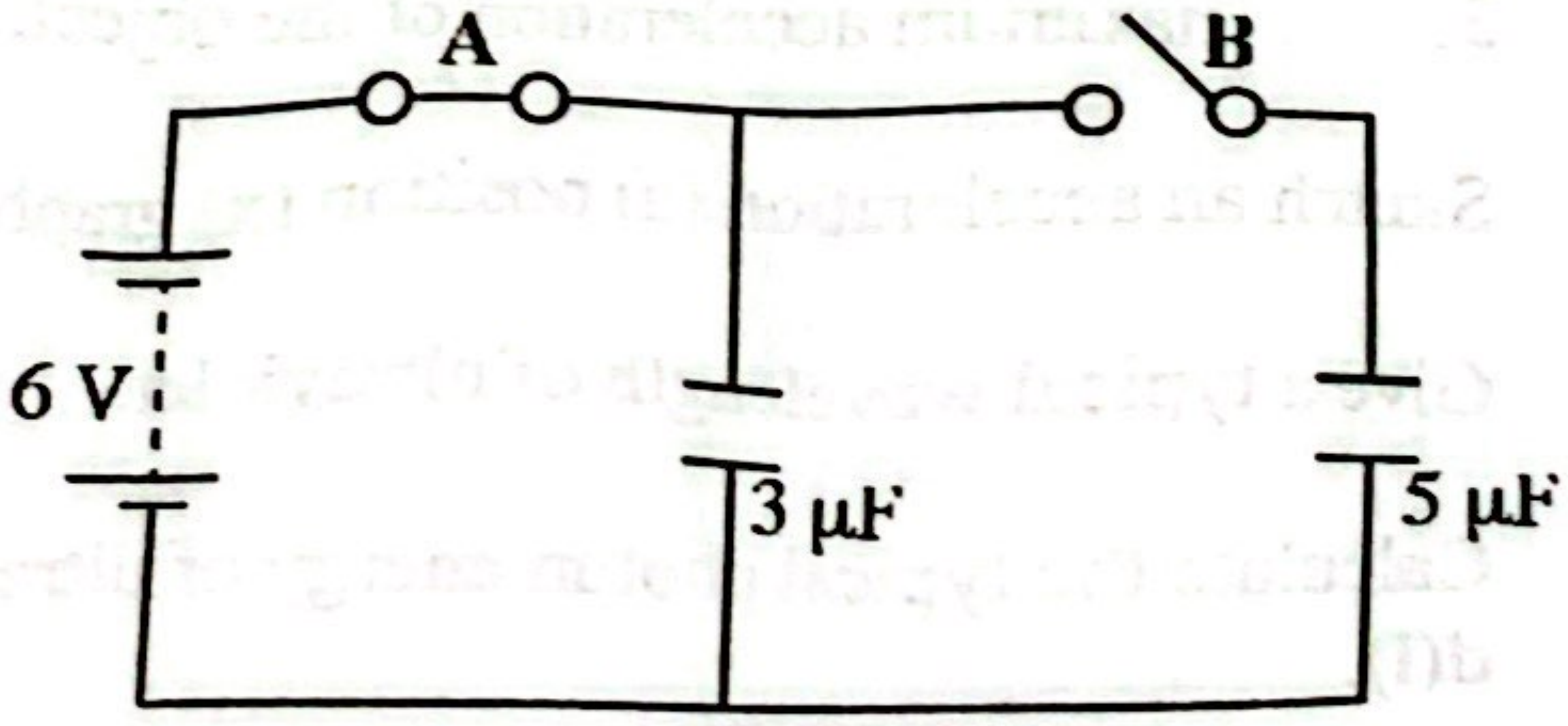

Fig. 3.2

When the 3 μF capacitor is fully charged, switch **A** is opened and switch **B** is closed.

(I) Calculate the

1. final potential difference across the combination when switch **B** is closed,

2. final energy stored by the capacitors.

(II) Account for the difference in the initial and final values of the energy stored, given that the initial energy stored by the 3 μF capacitor when fully charged is 5.4×10^{-5} J.

[7]

(c) Fig. 3.3 shows a horse shoe magnet placed on a top pan balance. A 3.2 cm wire is fixed horizontally between the poles of the magnet.

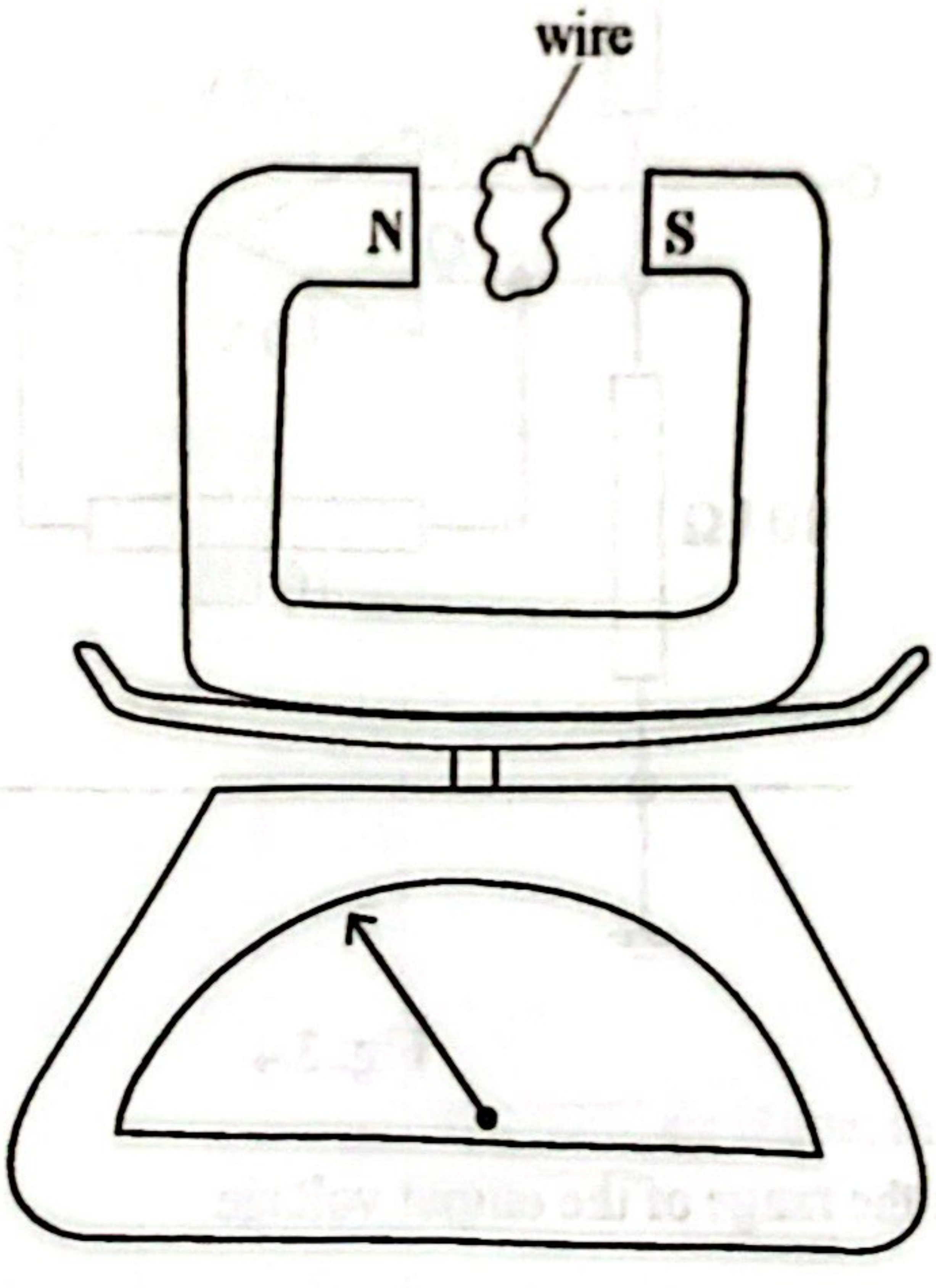

Fig. 3.3

When there is no current flowing, the balance reads 119.46 g and when a 2 A current flows, the balance reads 119.72 g.

(i) Explain why the readings on the balance differ.

(ii) Determine the direction of the current.

(iii) Calculate the magnetic field strength between the magnet's poles.

(iii) Describe what happens to the wire when a direct current is applied to the wire and the wire is not fixed.

(iv) Suggest how periodic force can be produced onto the pan-balance.

[7]

(d) Fig. 3.4 shows a Schmitt trigger.

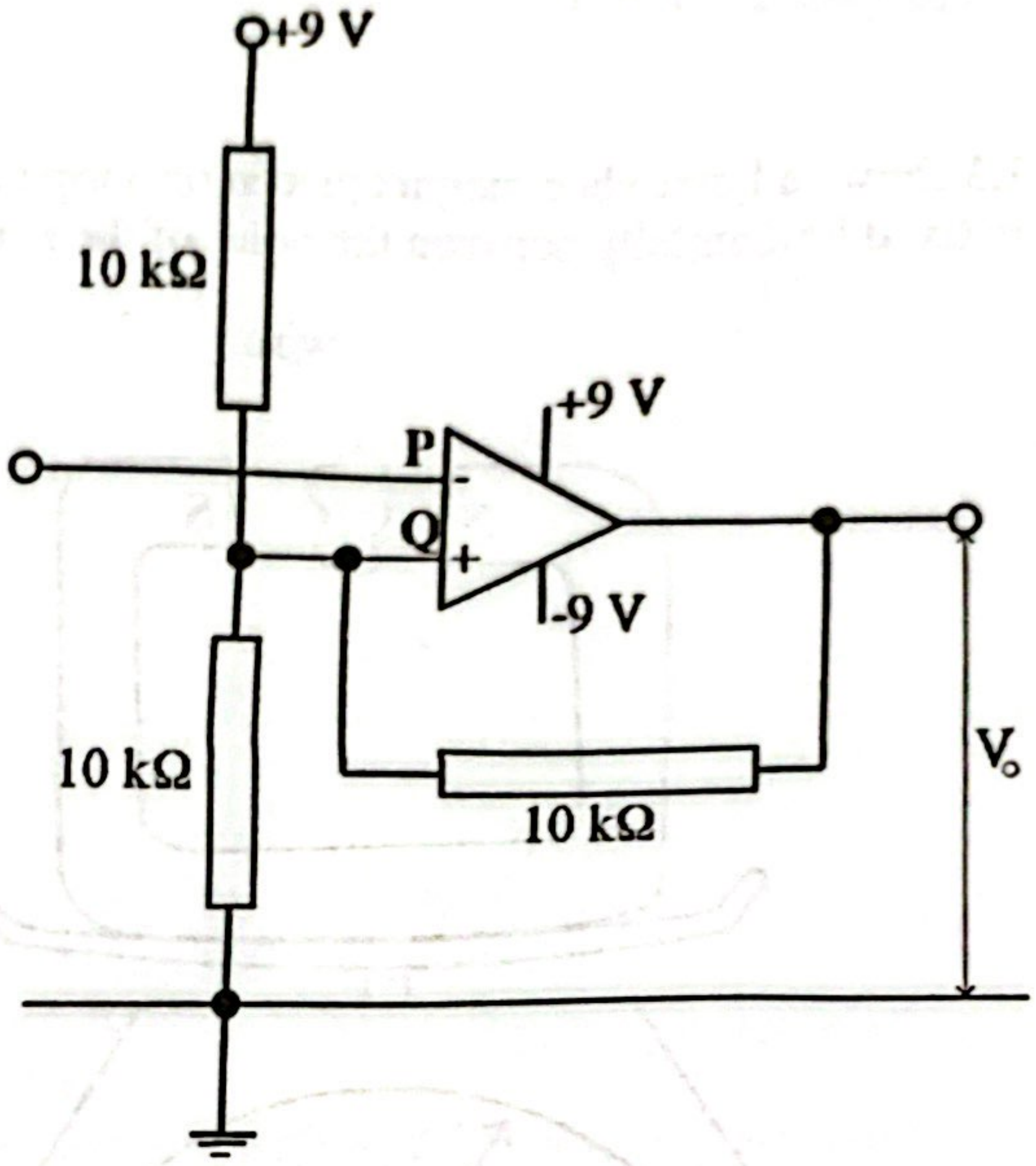

Fig. 3.4

(i) State the range of the output voltage.

(iii) Calculate the output voltage, V_0, when the potential at Q = 6 V.

(iv) Explain why the Schmitt trigger is useful as an electronic switch.

[6]

4 (a) An empirical Celsius scale is defined by an equation $\theta = \left(\frac{X_\theta - X_0}{X_{100} - X_0}\right) \times 100$ °C.

(i) Explain the symbols

1. X_0,

2. X_{100},

3. X_θ.

(ii) Re-write the equation in (a) for a thermocouple.

(iii) State three advantages of mercury-in-glass over a platinum resistance thermometer.

[7]

(b) (i) Explain the term *non viscous fluid flow.*

(ii) Fig. 4.1 shows a filter pump set-up.

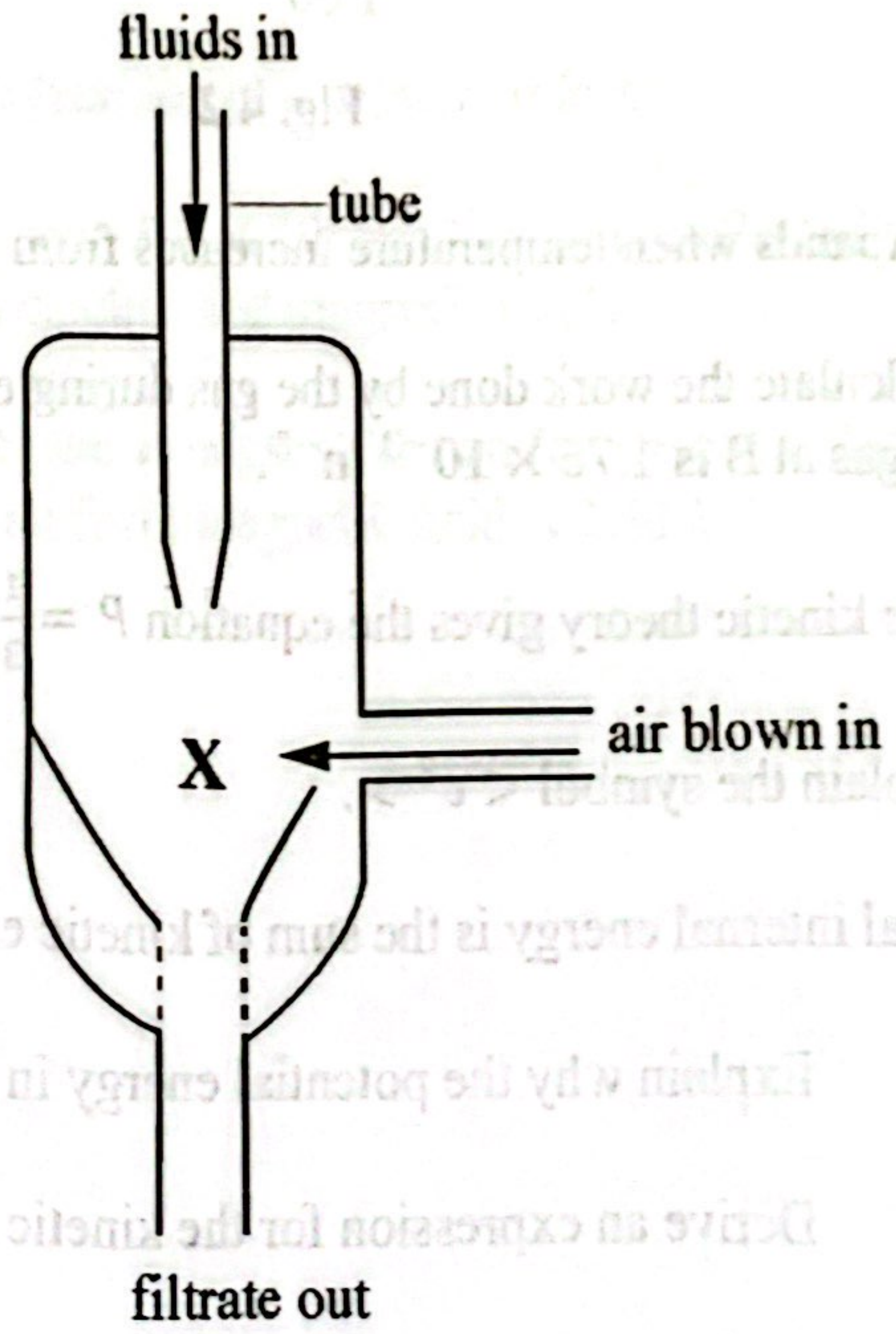

Fig. 4.1

Explain why the

1. tube becomes narrow towards X,

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2. air is blown towards X.

(iii) **Explain one advantage of using the filter pump in industry.**

[4]

(c) **Fig. 4.2 shows P – V graphs for an ideal gas at 300 K and 500 K respectively.**

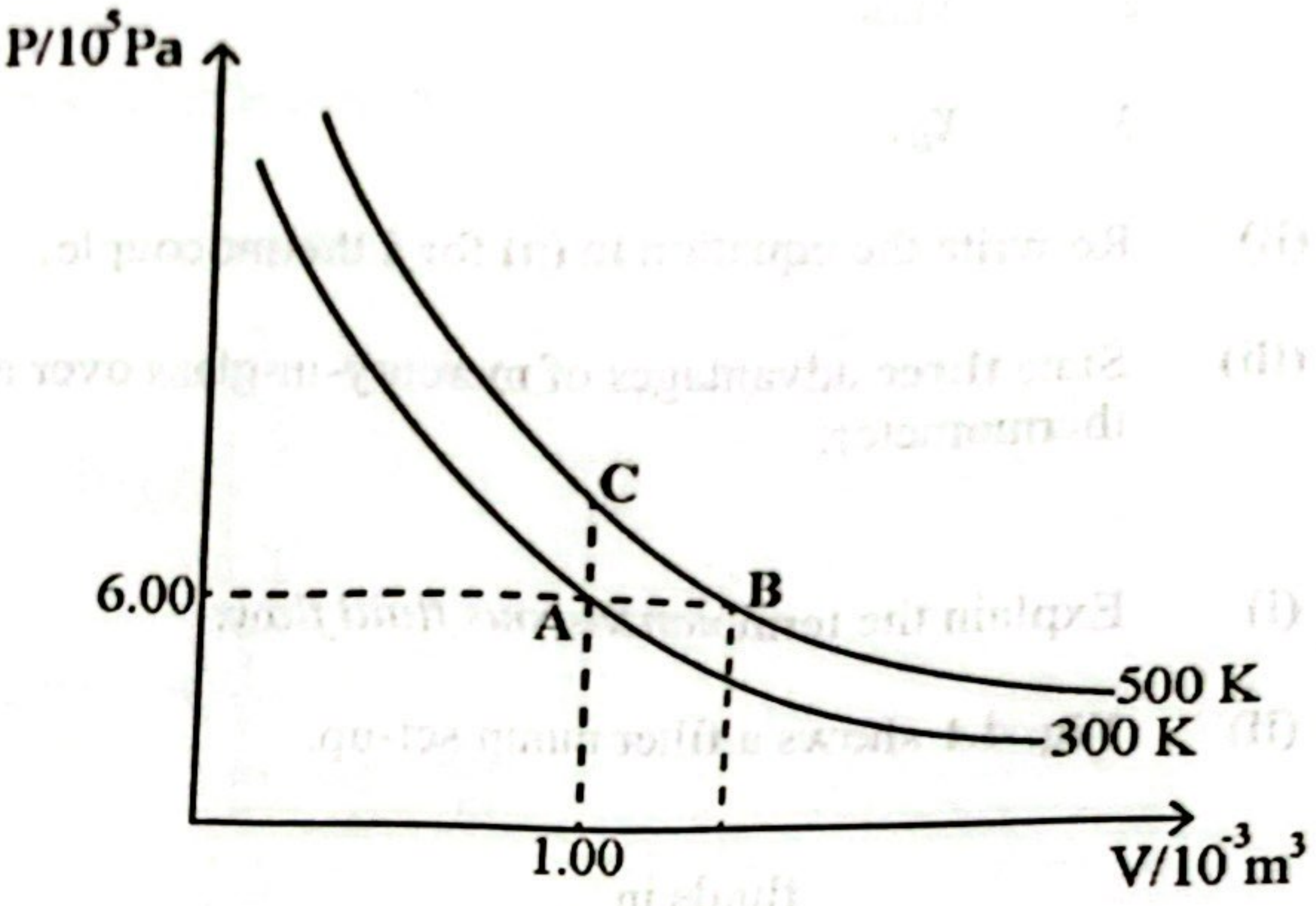

Fig. 4.2

The gas expands when temperature increases from 300 K to 500 K.

(i) Calculate the work done by the gas during expansion given that the volume of gas at B is 1.75×10^{-3} m^{-3}.

(ii) The kinetic theory gives the equation $P = \frac{1}{3}\rho < c^2 >$.

Explain the symbol $< c^2 >$.

(iii) Total internal energy is the sum of kinetic energy and potential energy.

1. Explain why the potential energy in an ideal gas system is zero.
2. Derive an expression for the kinetic energy of molecules.
3. Calculate the total internal energy when the temperature is 300 K.

(iv) Estimate the total internal energy at 500 K.

[14]

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5 **(a)** Fig. 5.1 shows the deflection of alpha and beta-particles in uniform electric and magnetic fields.

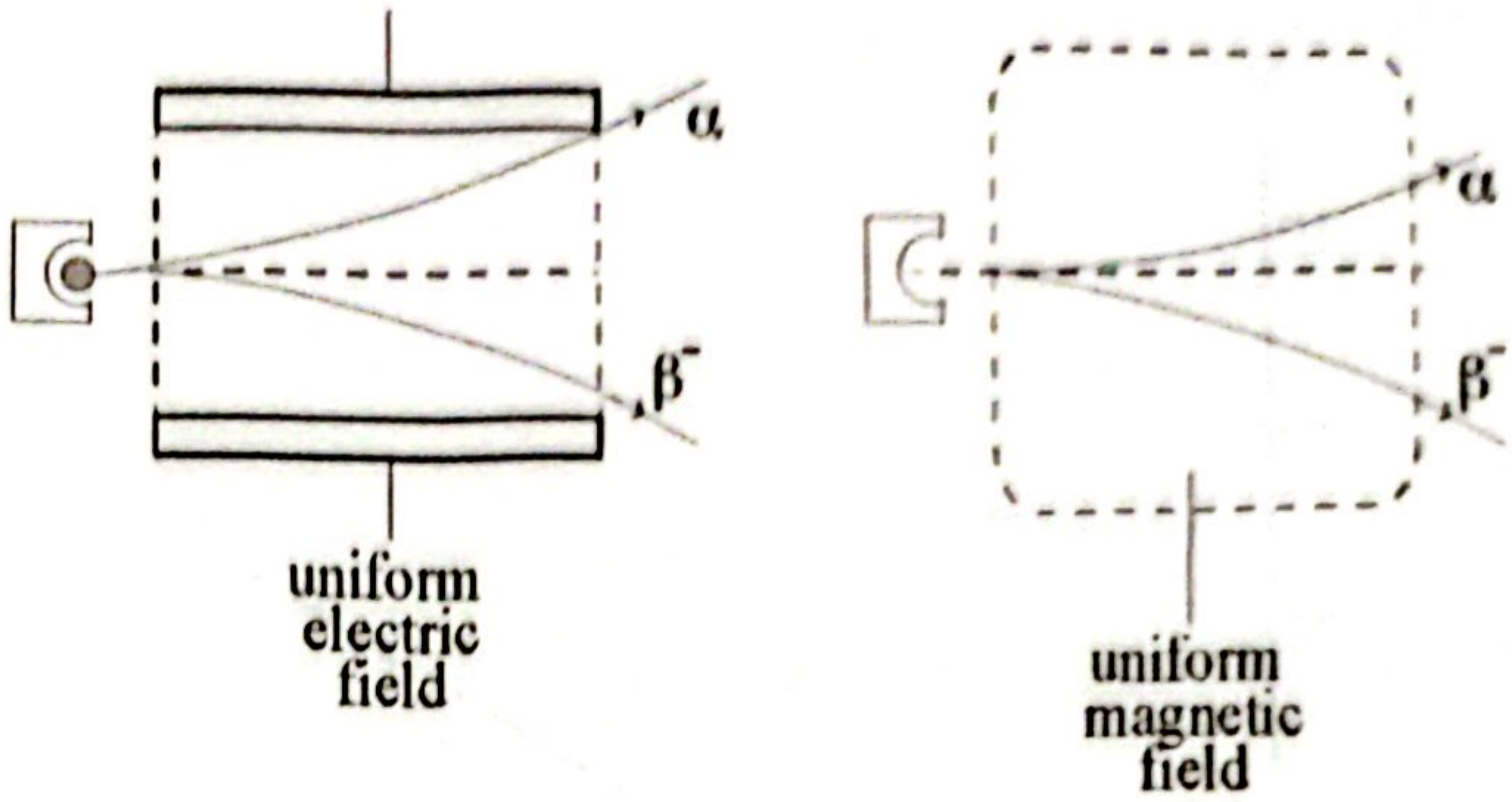

Fig. 5.1

(i) State the direction of the uniform magnetic field.

(ii) Explain why alpha-particles are strongly deflected in electric fields but weakly deflected in uniform magnetic fields.

(iii) State the function of a velocity selector.

(iv) Ions of speed 5.0×10^6 ms^{-1} pass undeflected in a region of crossed uniform electric and magnetic fields.

Calculate the strength of the uniform electric field when strength of the applied uniform magnetic field is 0.30 T.

[5]

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(b) **Fig. 5.2 is a graph showing the variation of maximum kinetic energy of photoelectrons with incident radiation frequency on a particular metal.**

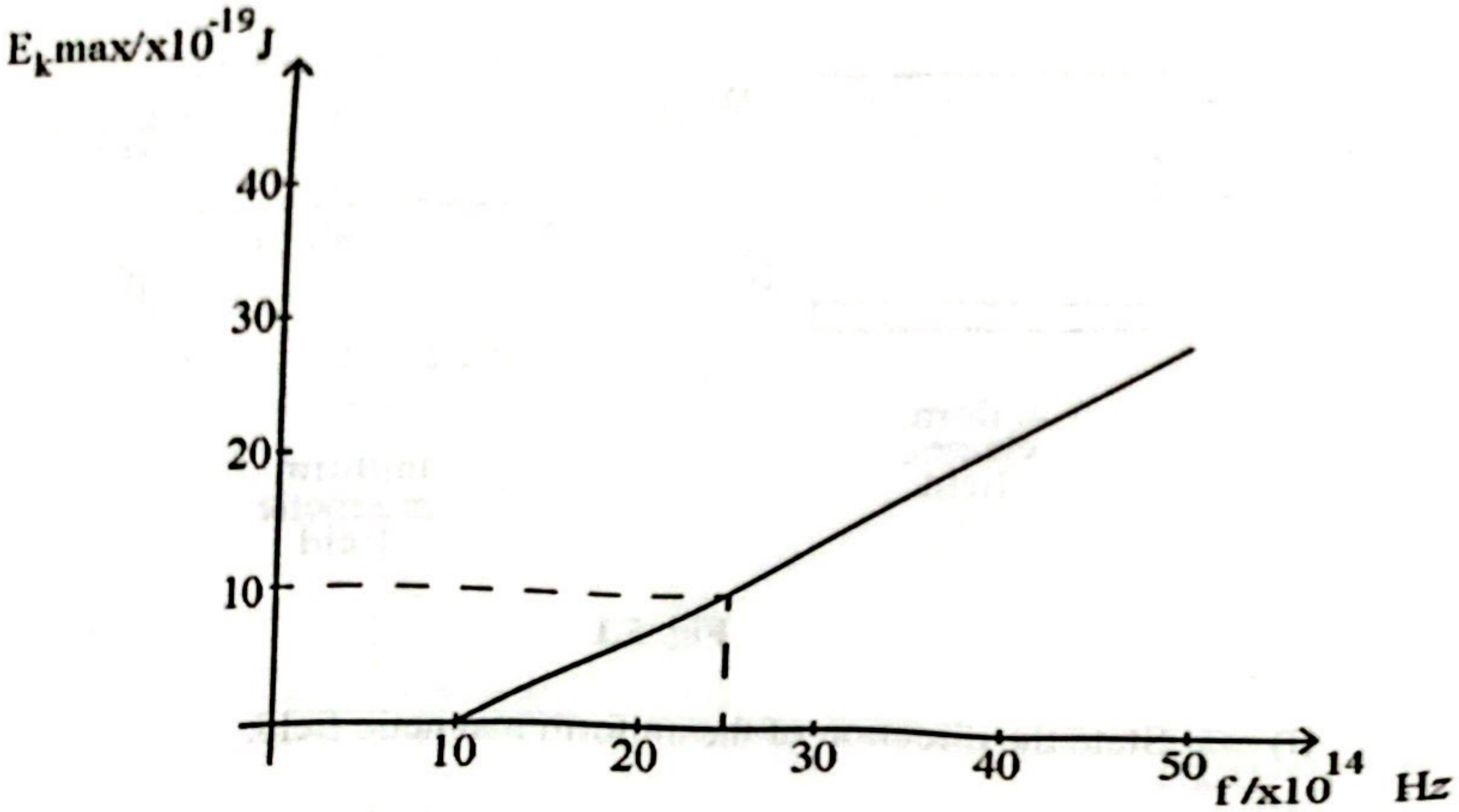

Fig. 5.2

(i) Determine

1. the threshold frequency for the metal,

2. work function of the metal.

(ii) Explain why the

1. maximum velocity of photoelectrons depend on radiation frequency and not intensity,

2. number of photoelectrons is proportional to radiation intensity.

[5]

(c) The nuclide notation of Uranium-235 is $^{235}_{92}U$.

mass of U-235 = 234.992 U
mass of proton = 1.00 U
mass of neutron = 1.009 U

(i) Calculate the

1. mass excess of the U-235 nucleus.

2. binding energy per nucleon of U-235.

(ii) Explain why U-235 tends to undergo nuclear fission reaction. [5]

(d) A physics student measured count-rate using a GM-tube. The readings obtained during a 3 minute interval were:

$292\ s^{-1}$, $256\ s^{-1}$ and $274\ s^{-1}$.

(i) State the count-rate obtained.

(ii) Give a reason for the variation in the raw readings.

(iii) The student was surprised to note a reading of $285\ s^{-1}$ in the absence of a radioactive source.

Explain the student's observation.

(iii) Thorium has a half-life of 432 hours.

Calculate the activity of a Thorium sample containing 3.8×10^{12} nuclei. [5]

(e) (i) State **two** key stages in analogue to digital conversion.

(ii) Define *signal attenuation*.

(iii) The input power into a communication system is 0.24 mW and the output is 0.03 mW.

Calculate the gain of the system in dB. [5]

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ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

-952

MARKING SCHEME

Penalize one per question for omitting units.

NOVEMBER 2022 SESSION

PHYSICS 6032/3

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(i) - motion is in a straight line B1

constant acceleration / AW

- no air resistance B1

any two

(ii) 1. 5 m/s A1

2. $v^2 = u^2 + 2gs$ C1

$v = \sqrt{o^2 + 2 \times 9.8 \times 1.8}$ C1

$v = 5.9$ m/s A0

3. $\frac{1}{2}mv^2 = mgh$

$v = \sqrt{2gh}$ C1

$v = \sqrt{2 \times 9.81 \times 0.8}$

= 3.96 m/s A1

(iii) 1. $\Delta P = mv - mu$

$= 50 \times 10^{-3} \times 4 - 50 \times 10^{-3} \times (-5.9)$ ecf. C1

= 0.493 kgm/s / 0.495 Ns A1

2. $F = \frac{\Delta P}{\Delta t}$

$= \frac{0.5}{0.15}$ C1

= 3.29 N / 3.3N A1

(i) Product of force and the perpendicular distance of force from the axis B1

turning effect of force

(ii) 1. - No resultant torque / AW B1

- No resultant force / AW B1

$\Sigma F = 0$ $\Sigma T = 0$ (Translational, rotational)

2. Taking moments about A C1

$2g \times L + 5g \times 2L = T\sin 30 \times AB$

$120\,L = 0.5\,T \times 2\,L$ C1

T = 117.72 N / 120 N (Accept 118 N to 120 N) A1

(c) (i) The force of attraction between two point masses is directly proportional to the product of the masses and inversely proportional to the square of the distance between them / AW Ⓐ Eqn with symbols defined B1 B1

(ii) - Use of satellites – provides centripetal force to keep then in orbit B1

- to trace earth's water and tide

- maintain balance of objects – all objects on earth fall back B1

(d) (i)

mg – vertically downwards

Reaction – vertically upwards

mg = - R B1

friction – towards centre.

friction ~~centripetal force~~ B1

(Reject wrong physics).

(ii) Friction B1

(iii) $R = mg$

$Fmax = \mu R = mrw^2$

$\mu = \frac{rw^2}{g}$ C1

$u = \left(\frac{6}{100}\right) \times \left(\frac{10\pi}{3}\right)^2 \times \left(\frac{1}{9.81}\right)$ C1

0.67 0,54 A1

(a) (i)
- contrast / hardness / tissue density / coefficient B1
- sharpness / collimation / target area / size of window. B1

(ii)
- organs have approximately same density / attenuation coefficients B1
- edges of organs difficult to determine / AW B1
- degree of darkening approximately the same / AW B1

(b) (i)
- angle of incidence giving rise to an angle of refraction of 90°; (ray moves from a denser to a less dense medium;) / AW B1

(ii) $n_1 sin i_1 = n_2 \sin i_2$ B1

i_2 = critical angle C

i_1 = 90° B1

n_1 = 1

n_2 = n

$n = \frac{1}{SinC}$

(iii) $n_g Sin\, i_g = N_w Sin i_w$

$Sin i_g = \frac{Nw}{Ng} Sin\, i_w$ $i_w = 90°$ C1

$= \frac{1.33}{1.52} \times Sin\, 90$

$i_g = 61°$ 2 or more s.f. A1

) (i)
- acceleration of object is directly proportional to displacement B1
- acceleration is always opposite to displacement / Aw B1

— $a = -\omega^2 x$ (terms defined) minus defined correctly

(ii) 1. $K.E = \frac{1}{2} mw^2 x_o^2$ C1

$\omega = \sqrt{\frac{2 \times K.E}{m x_o^2}}$

$= \sqrt{\frac{2 \times 4}{5 \times 0.4^2}}$ C1

$= 3.16\ rads^{-1}$ C1

$T = \frac{2\pi}{3.16}$

$T = 1.99$ s A1

2. $V = \pm\omega\sqrt{x_o^2 - x^2}$

$= \pm 3.16\sqrt{0.4^2 - 0.25^2}$ ecf C1

$= \pm 0.99$ m/s A1

3. $a = -(3.16)^2 \times 0.4$ ecf. C1

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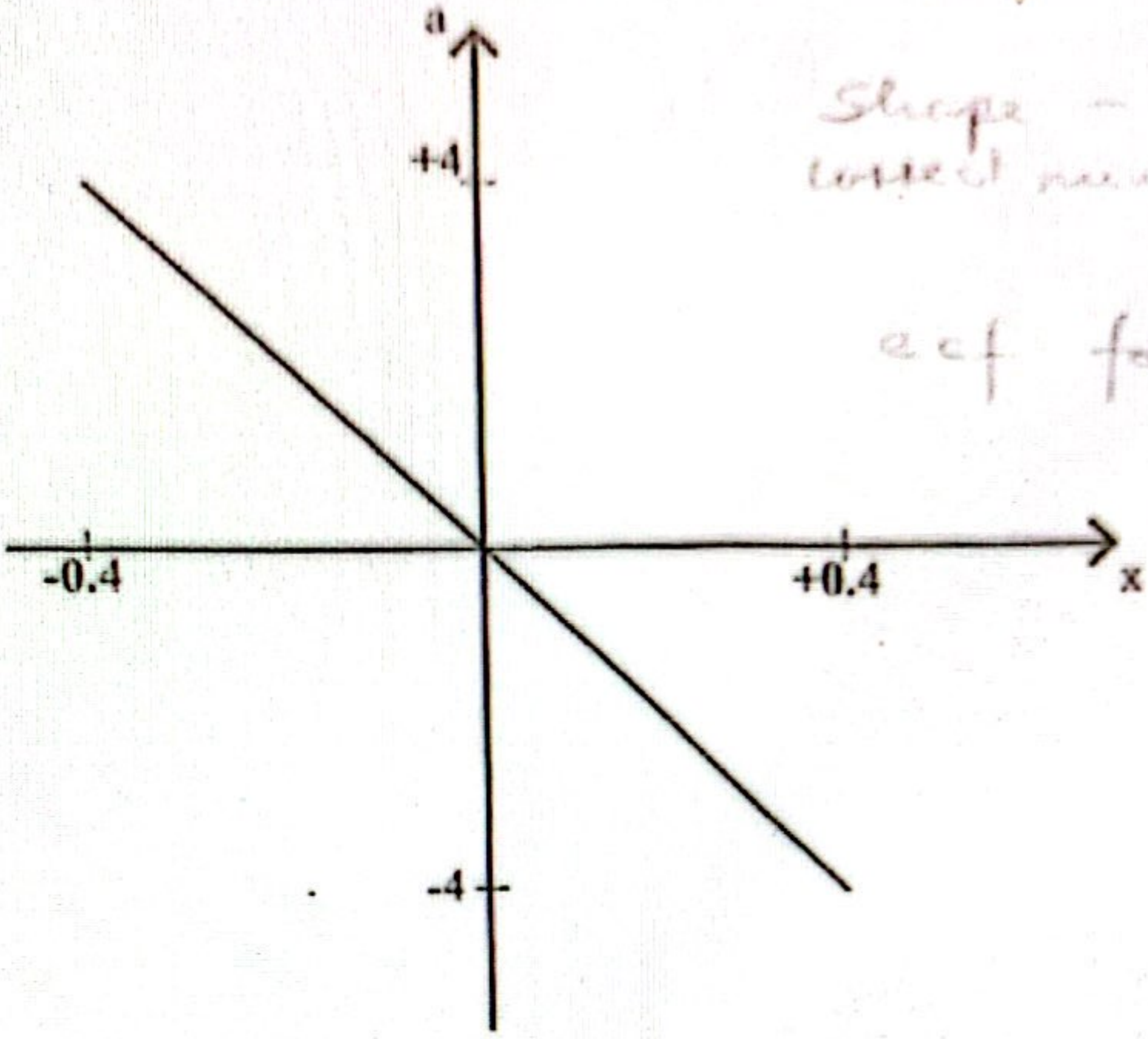
$a = -3.99\ m/s^2$ A1

(iii)



Shape – B1
correct numerical values – B1

ecf for acceleration a

(d) (i) $10^{-8}m$ 10^{-7} to 10^{-10} m (100nm to 0,1 nm) B1
Reject range in candidate's answer

(ii) $E = h\frac{c}{\lambda}$

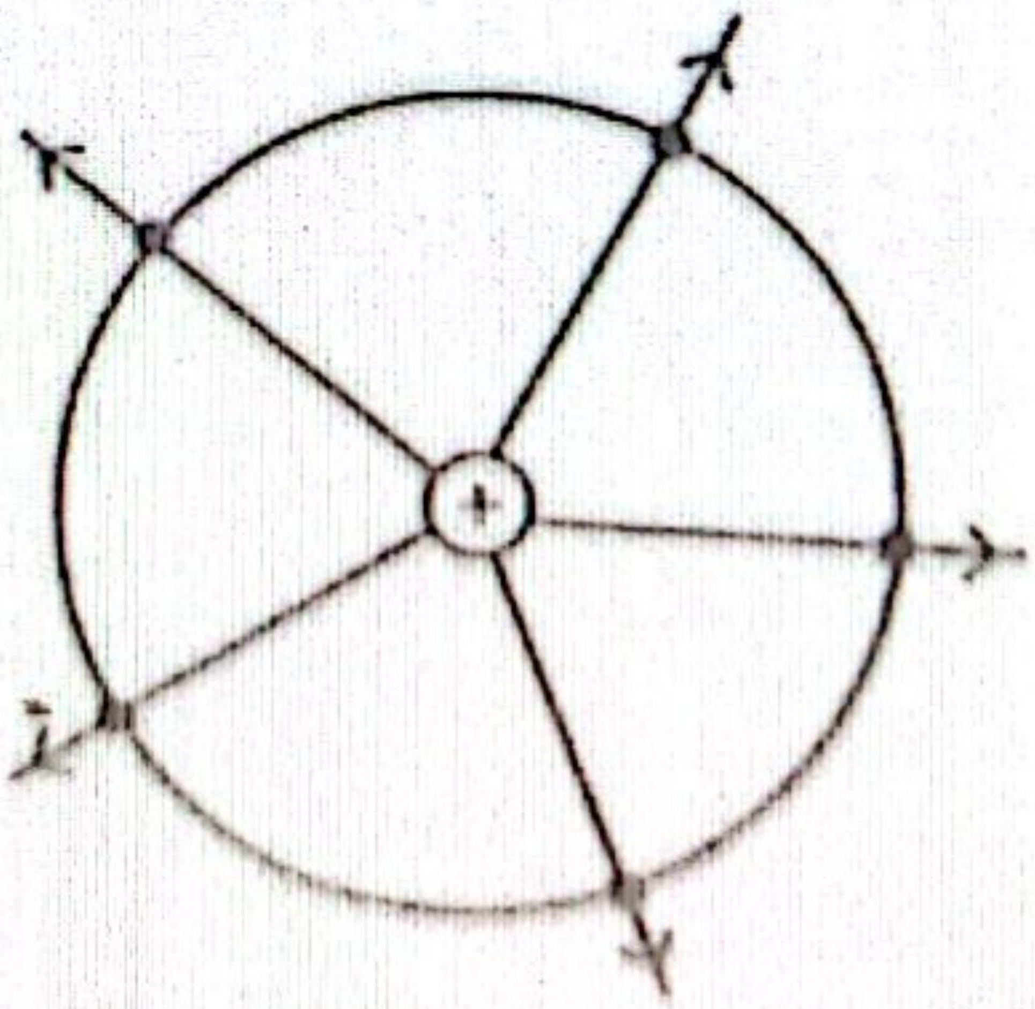
$= 6.63 \times 10^{-34} \times \frac{3 \times 10^{8}}{10^{-8}}$ e.c.f [illegible] B.C C1

$= 1.99 \times 10^{-17}J$ Accept 1.99×10^{-15} J to 1.99×10^{-18} J A1

(iii)
- travel at a speed of 3×10^{8} m/s in a vacuum B1
- can travel in a vacuum B1
- transverse in nature B1
- consists of alternating electric and magnetic fields B1

Plausible characteristic of e.m.w max 1

3 (a) (i) B1



radial lines B1
Arrows on lines B1

(ii) correct points / correct equipotential surface B1

(iii) Electric field force is at right angles to the displacement of the charge
$\therefore f_s \cos 90 = 0$ / From $W = qV$ $V = 0$ B1

(iv) - negative charges are drawn from the earth B1
- due to the attraction with positively charged sphere B1

(i) 1. Total Q = CV ~~C1~~

$= 3 \times 10^{-\overset{5}{6}} \times 6$

$= 1.8 \times 10^{-\overset{5}{6}} C$ C1

then $V = \frac{Q}{C_1 + C_2} = \frac{1.8 \times 10^{-5}}{3 \times 10^{-6} + 5 \times 10^{-6}}$ C1

$= \frac{1.8 \times 10^{-5}}{8 \times 10^{-6}}$

$=$ 2.25 V A1

2. $E = \frac{1}{2}Q_1V + \frac{1}{2}Q_2V$ / $E = \frac{1}{2}C_T V^2$ C1

$E_1 = 7.59 \times 10^{-6}$ $E_2 = 1{,}27 \times 10^{-5}$ J $= \frac{1}{2}(8 \times 10^{-6} \times 2{,}25^2)$

$= \frac{1}{2} \times V \times (Q_1 + Q_2)$ $= 2{,}02 \times 10^{-5}$ J. C1

$= \frac{1}{2} \times 2.25 \times 18 \times 10^{-\overset{5}{6}}$

$=$ ~~9×10^{-6} J~~ $1{,}03 \times 10^{-5}$ J A1

(ii) - lost as heat when charge flows in wires or circuit / AW B1

(i) magnetic field force adds onto the weight when current is switched on / AW B1
Reaction on wire

(ii) (Left hand rule) into paper out of paper / upwards. B1

(iii) $\left[\frac{119.72 - 119.46}{1000}\right] \times 9.81 = BIL$ M1

$\frac{2.55 \times 10^{-3}}{2 \times 3.2 \times 10^{-2}} = B$

$B = 3.986 \times 10^{-2}$ T A1

(iv) wire is forced ~~down~~ up / AW. B1

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(v) use of AC alternating current / Switch on and off d.c. B1

(d) (i) 0V to + 9 V B1

(ii) $V_o = \left(1 + \frac{Rf}{Ri}\right) vi$ C1

$V_o = \left(1 + \frac{10}{20}\right) \times 6$ A1

$V_o = +9\,V$ A1

(iii) - Unaffected by fluctuation in input voltage /AW C1

- which would affect an ordinary comparator switch C1

(a) (i) 1. X_0 = thermometric value at 0 °C /AW B1

2. X_{100} = thermometric value at 100 °C / AW B1

3. X_θ = thermometric value at θ °C B1

(ii) $\theta = \frac{emf_\theta - emf_0}{emf_{100} - emf_0} \times 100\ °C$ / other symbols when defined. B1

(iii) - Gives direct temperature values B1

- portable B1

- cheap/suitable for everyday use B1

- Any plausible advantage(s)

(b) (i) Movement of fluid in which there are no mechanisms that reduce kinetic energy / AW B1

(ii) 1. so that fluid velocity increases / Pressure decreases B1

2. to reduce pressure at X by increasing velocity of motion of fluid B1

(iii) Filtration process is faster/more filtrate can be collected/process is profitable / AW B1

(c) (i) $W = p\Delta V$ C1

$= 6 \times 10^5\,(1.75 - 1) \times 10^{-3}$ C1

$= 450\,J$ A1

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(ii) $< c^2 >$ = average of the sum of velocities squared / Mean Square speed

= $\frac{c_1^2 + c_2^2 + c_3^2 + \dots + c_N^2}{N}$ B1

(intermolecular attractive)

(iii) 1. (Pe = 0), because there are no forces in an ideal system / Ans B1

2. From $P = \frac{1}{3}\rho < c^2 >$ but $\rho = \frac{Nm}{V}$ ~~C1~~

$P = \frac{1}{3}\frac{Nm}{V} < c^2 >$ $pV = \frac{Nm<c^2>}{3}$

$pV = \frac{2}{3}N\left(\frac{1}{2}m < c^2 >\right)$ but $pV = nRT$ C1

$nRT = \frac{2}{3}N(Ke)$ $nRT = \frac{Nm<c^2>}{3}$

$\frac{3}{2}\frac{nRT}{N} = Ke$ but $n = \frac{N}{NA}$ $\frac{3}{2}\frac{NRT}{N_A} = \frac{Nm<c^2>}{2}$ C1

$\frac{3}{2}\frac{NRT}{NN_A} = Ke$ but $\frac{R}{N_A} = K$ $\therefore \frac{R}{N_A} = k$ C1

$\frac{3}{2}\overset{N}{\wedge}KT = Ke$ where K = Boltzmann's constant $\therefore E_k = \frac{3}{2}NkT$ A1

3. $U = \frac{3}{2}\overset{N}{\wedge}KT$ $pV = NkT$

= $\frac{3}{2} \times 1.38 \times 10^{-23} \times 300$ $6\times10^5 \times 1\times10^{-3} = \frac{N\times8.31\times300}{6.02\times10^{23}}$ C1

$N = 1.45\times10^{23}$ C1

= 6.21×10^{-21} J $U = \frac{3}{2} \times 1.45\times10^{23} \times 1.38\times10^{-23} \times 300$ ~~A1~~

= 900 J A1

(iv) $E \propto T$

$\frac{500}{300} \times E_K = \frac{500}{300} \times 900$ J C1

= ~~1.035×10^{-20} J~~ 1 500 J A1

5 (a) (i) Into paper/plane / down words B1

Accept a cross X

(ii) They have a large charge to mass ratio B1

– idea of charge in E-field and Mass in B-field

~~(iii) Selects charged particles of different masses with a common velocity B1~~

(iv) $v = \frac{E}{B}$ C1

E = Bv

= $0.30 \times 5 \times 10^6$ 2 or more s.f.

= 1.50×10^6 V m^{-1} Accept NC^{-1} as unit. A1

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~~= 1.5 × 10^5 Vm^{-1}~~ [illegible] ~~A1~~

(b) (i) 1. $10 \times 10^{+14} H_z$ Accept 1.0×10^{15} Hz A1

2. $\emptyset = hf_o$

$= 6.63 \times 10^{-34} \times 10 \times 10^{14}$ Accept working from graph C1

$= 6.63 \times 10^{-19}$ J / 4.14 eV, $\phi = 6.58 \times 10^{-19}$ J A1

Range $(5.57 - 6.63) \times 10^{-19}$ J

(ii) 1. $hf = \emptyset + \frac{1}{2}mv_{max}^2$ $E_K \propto f$ – B1 Max 1

$f \propto v^2$ Intensity – B1

since $\emptyset$ = constant AW
m = constant
h = constant

or

from graph $\frac{1}{2}mv^2$ against f is linear B1

2. One photon ejects one electron B1

$= (1.00 \times 92 + 1.009 \times 143 - 234.992)u$

(c) (i) 1. $\Delta m =$ ~~[1.007 + 1.009] − [234.992] U~~ C1

$=$ ~~−233.976 U~~ 1.295u / 2.1497×10^{-27} kg. A1

1.295 × 931 MeV

2. $\frac{\Delta E}{A} =$ ~~−333.976 × MeV~~ ÷ 235 C1

= 5.13 MeV/nucleon / 8.2329×10^{-13} J/nucleon

$\frac{\Delta E}{A} = -923$~~MeV~~/nucleon Accept 5.15 MeV/nucleon A1

(ii) - The binding energy per nucleon of U – 235 is smaller (than that of the most stable nucleus Fe-56) or is unstable B1 ~~B1~~

- U-235 is a heavy element B1

(d) (i) Count rate $= \frac{292+256+274}{3}$

Accept any one of the given counts.

$= 274\ s^{-1}$ A1

(ii) The random nature of radioactive decay / AW B1

(iii) The reading is due to the background radiation / AW B1

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(iv) $\lambda = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{432 \times 3\,600}$

$\lambda = 4.46 \times 10^{-7}\, s^{-1}$ Accept $1.60 \times 10^{-3}\, hr^{-1}$

$A = \lambda N$

$= (4.46 \times 10^{-7})(3.8 \times 10^{12})$ C1

$A = 1.69 \times 10^{6}$ Bq / s^{-1} Accept $6.1 \times 10^{9}\, hr^{-1}$ A1

(i)
- sampling B1
- conversion from decimal to binary / digitization B1

(ii) Loss of signal power / AW B1

(iii) $G = 10_{log}\left(\frac{P_{out}}{P_{in}}\right)$ C1

$= 10_{log}\left(\frac{0.03}{0.24}\right)$

$G = -9.03$ dB

Attenuation = 9.03dB. A1

(−ve means attenuation)

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