2021 MOCK EXAMINATION

PHYSICS PAPER 1

8.30 am – 11.00 am (2 hours 30 minutes)

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.

2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book **B**.

3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book B. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**

4. The diagrams in this paper are **NOT** necessarily drawn to scale.

5. The last pages of this question paper contain a list of data, formulae and relationships which you may find useful.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.

2. When told to open this book, you should check that all the questions are there. Look for the words **'END OF SECTION A'** after the last question.

3. All questions carry equal marks.

4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on Answer Sheet, so that wrong marks can be completely erased with a certain rubber. You must mark the answers clearly, otherwise you will lose marks if the answers cannot be captured.

5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

6. No marks will be deducted for wrong answers.

Section A

There are 33 questions.

1. A cup contains 400 g of tea at 90 °C. The heat capacity of the cup is 250 J °C^{-1}. If 100 g of milk at 25 °C is added, what is the final temperature of the mixture ? Assume that the cup and the tea are always at the same temperature.

Given : specific heat capacity of milk = 3800 J kg^{-1} °C^{-1}
specific heat capacity of tea = 4200 J kg^{-1} °C^{-1}

A. 76.4 °C
B. 79.3 °C
C. 80.5 °C
D. 82.6 °C

2. A vessel of fixed volume 500 cm^3 contains a certain amount of an ideal gas at a pressure of 200 kPa and a temperature of 25 °C. If there is a small hole at the vessel so that the gas leaks out continuously from the vessel, calculate the amount of gas leaking out the vessel when the pressure inside the vessel drops to 120 kPa. Assume that the temperature of the gas remains unchanged during the leakage.

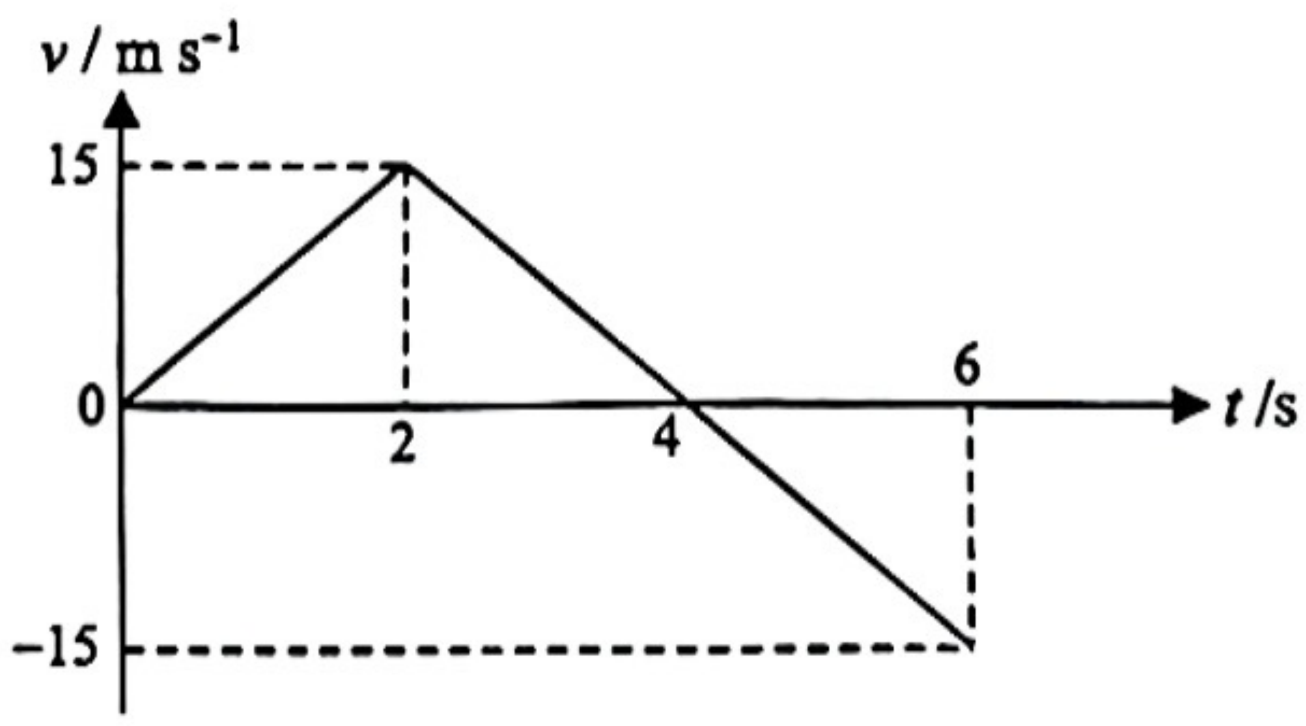
A. 12×10^{-3} mol
B. 14×10^{-3} mol
C. 16×10^{-3} mol
D. 18×10^{-3} mol

3. A fixed mass of an ideal gas is contained in a vessel with a movable piston. If the gas is cooled under constant pressure, which of the following statements are correct ?

(1) The average separation of the gas molecules will decrease.
(2) The change of momentum of gas molecules in hitting the walls of the container will decrease.
(3) The number of collisions of the gas molecules with the walls of the container in one second will decrease.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

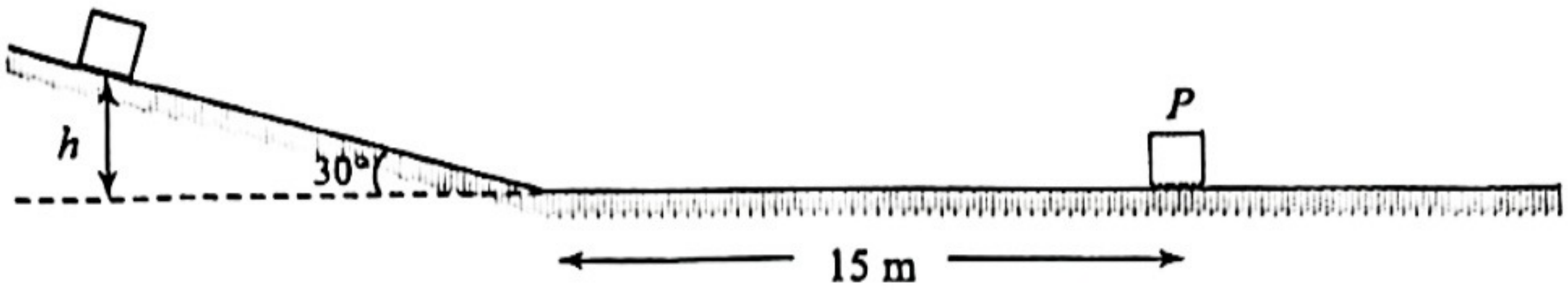
4.



A car moves along a straight line. Its variation of the velocity with time during a time interval of 6 s is shown in the figure. Take forward direction as positive. What is the average velocity of the car within this 6 s ?

A. 0.5 m s^{-1}
B. 2.5 m s^{-1}
C. 5.0 m s^{-1}
D. 7.5 m s^{-1}

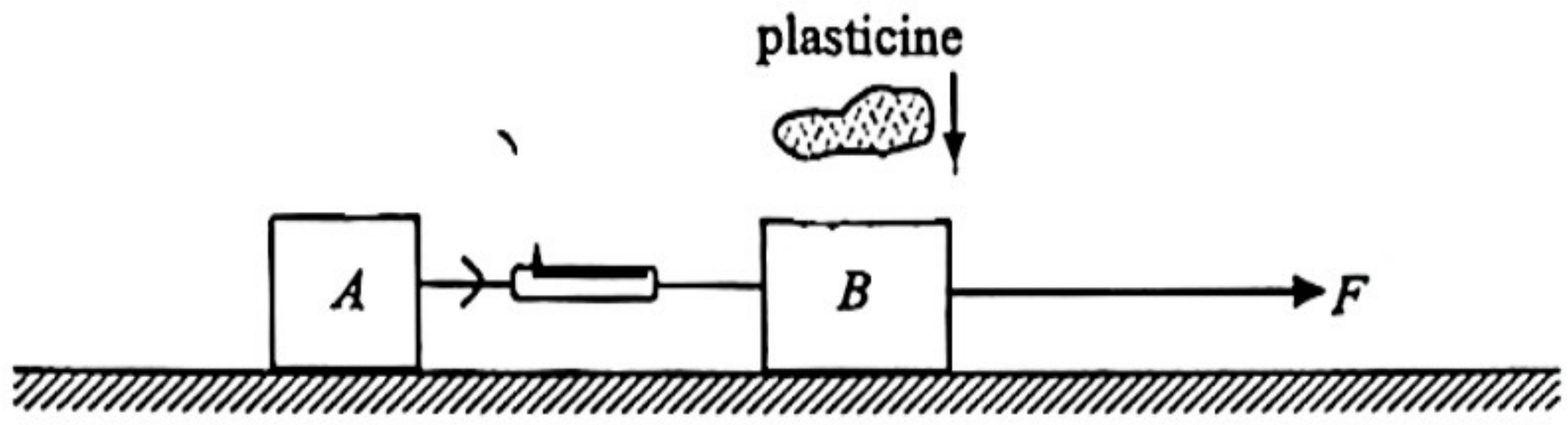
5.



A block of mass 1.2 kg is released at a height h above the horizontal ground on a smooth inclined plane of angle 30°. It finally stops at position P after travelling a distance of 15 m on the horizontal ground as shown in the above figure. If the friction between the block and the horizontal ground is 2.5 N, find the height h.

A. 3.2 m
B. 3.8 m
C. 4.6 m
D. 5.4 m

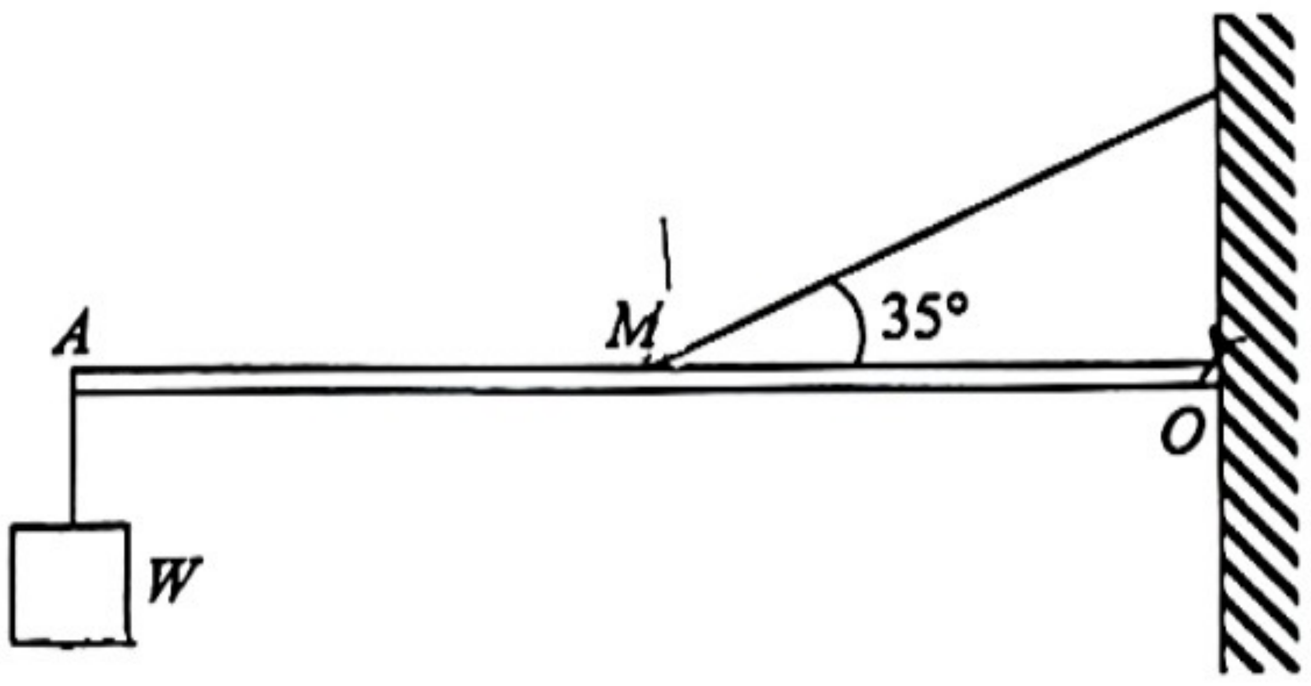
6.



Blocks A and B of mass 1.2 kg and 1.8 kg respectively are connected by a light spring balance and placed on a smooth horizontal surface as shown. When a constant horizontal force F acts on block B and the system accelerates to the right, the reading of the spring balance is found to be 3 N. Suppose a lump of plasticine of mass 1 kg is dropped onto B and moves together with B. What is the reading of the spring balance if the same force F is applied to the system ?

A. 1.25 N
B. 1.75 N
C. 2.25 N
D. 2.75 N

7.



A uniform metre rule AO of mass 0.04 kg is hinged to a vertical wall at one end O. A string is attached to the mid-point M of the metre rule making an angle of 35° with it. A weight W of 0.8 N is attached at the other end of the metre rule as shown. Find the tension of the string.

A. 3.47 N
B. 3.84 N
C. 4.25 N
D. 4.68 N

8. A car of mass 1500 kg starts from rest and accelerates along an upward inclined road with inclination angle of 10°. After a time of 20 s, it travels 200 m on the road and attains a speed of 25 m s^{-1}. Neglect the resistance force acting on the car, what is the average power developed by the car engine during this period ?

A. 38 kW
B. 49 kW
C. 98 kW
D. 171 kW

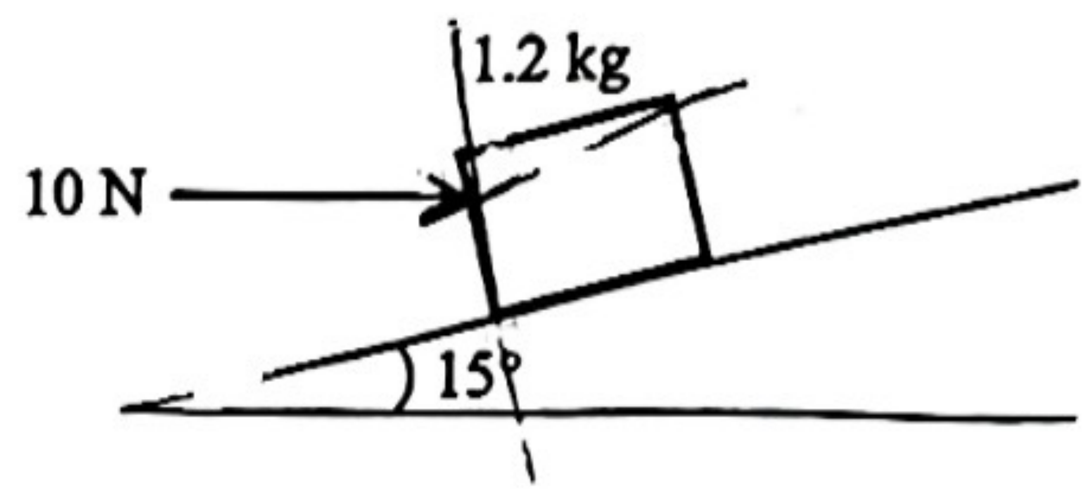
9.

On a smooth horizontal surface, particle A moving with speed u collides head-on with another particle B, which is at rest. After collision, both particles move in the same direction. The collision is perfectly elastic. Which of the following statements about this collision are correct ?

(1) After collision, the speed of B must be greater than that of A.
(2) After collision, the loss of kinetic energy of A must be equal to the gain of kinetic energy of B.
(3) After collision, the magnitude of the momentum change of A must equal the magnitude of momentum change of B.

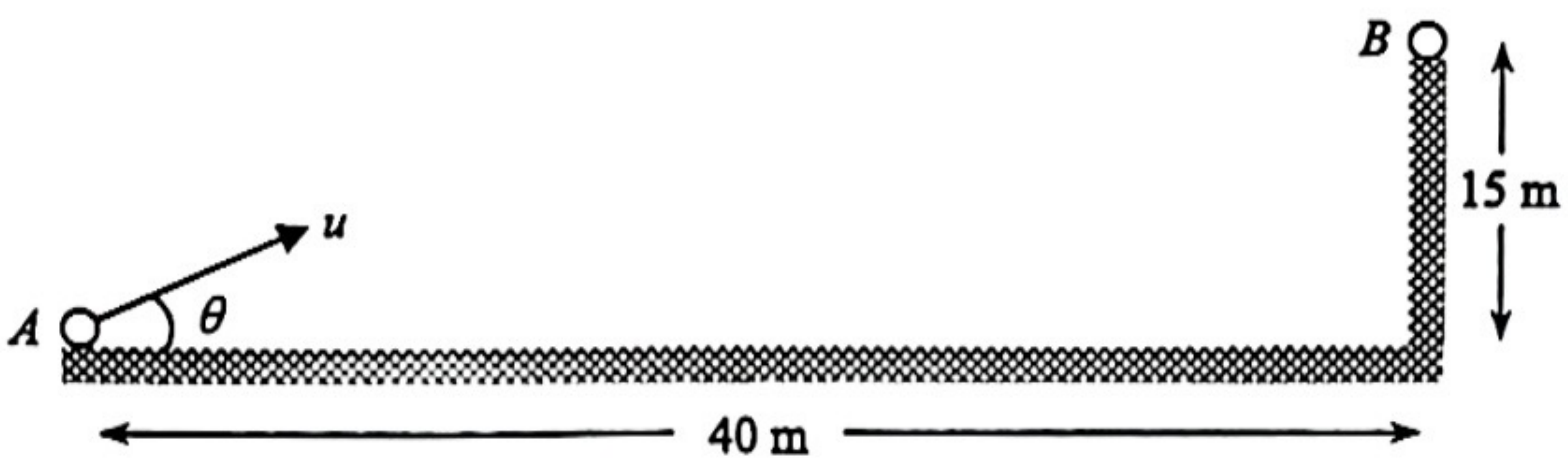
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

10. A horizontal force 10 N is applied to a block of mass 1.2 kg placed on a smooth incline making an angle 15° with the horizontal as shown. Find the acceleration of the block.



A. 5.5 m s^{-2}
B. 5.8 m s^{-2}
C. 6.5 m s^{-2}
D. 6.8 m s^{-2}

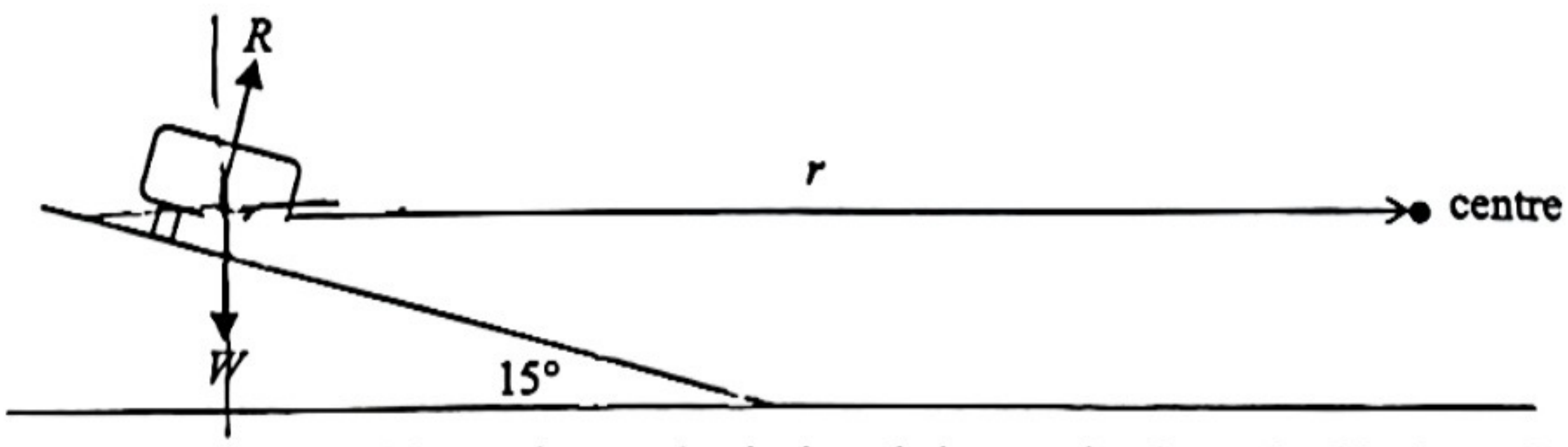
11.



As shown in the above figure, ball A is projected from the ground with an initial speed u and elevation angle θ to hit another ball B placed at the top of a tower, which is at a height of 15 m above the ground and the tower is at a distance of 40 m away. If the two balls collide after 2.5 s, what is the projection speed u of ball A ? Take g to be 10 m s^{-2}.

A. 18.6 m s^{-1}
B. 22.8 m s^{-1}
C. 24.5 m s^{-1}
D. cannot be determined since angle θ is not given

12.



A car of mass 1800 kg is moving with speed v on a banked road along a circular path of horizontal radius r. The angle of inclination of the road is 15°. If the only forces acting on the car are the weight W and the normal reaction R, what is the magnitude of the centripetal force acting on the car ?

A. 4570 N
B. 4730 N
C. 17100 N
D. insufficient information

13. An artificial satellite revolves in a circular orbit at a height h above the Earth's surface. If the satellite takes 12 hours to revolve one cycle at its orbit, determine the height h. Given that the radius of the Earth is 6400 km.

A. 18750 km
B. 20280 km
C. 23560 km
D. 26680 km

14.

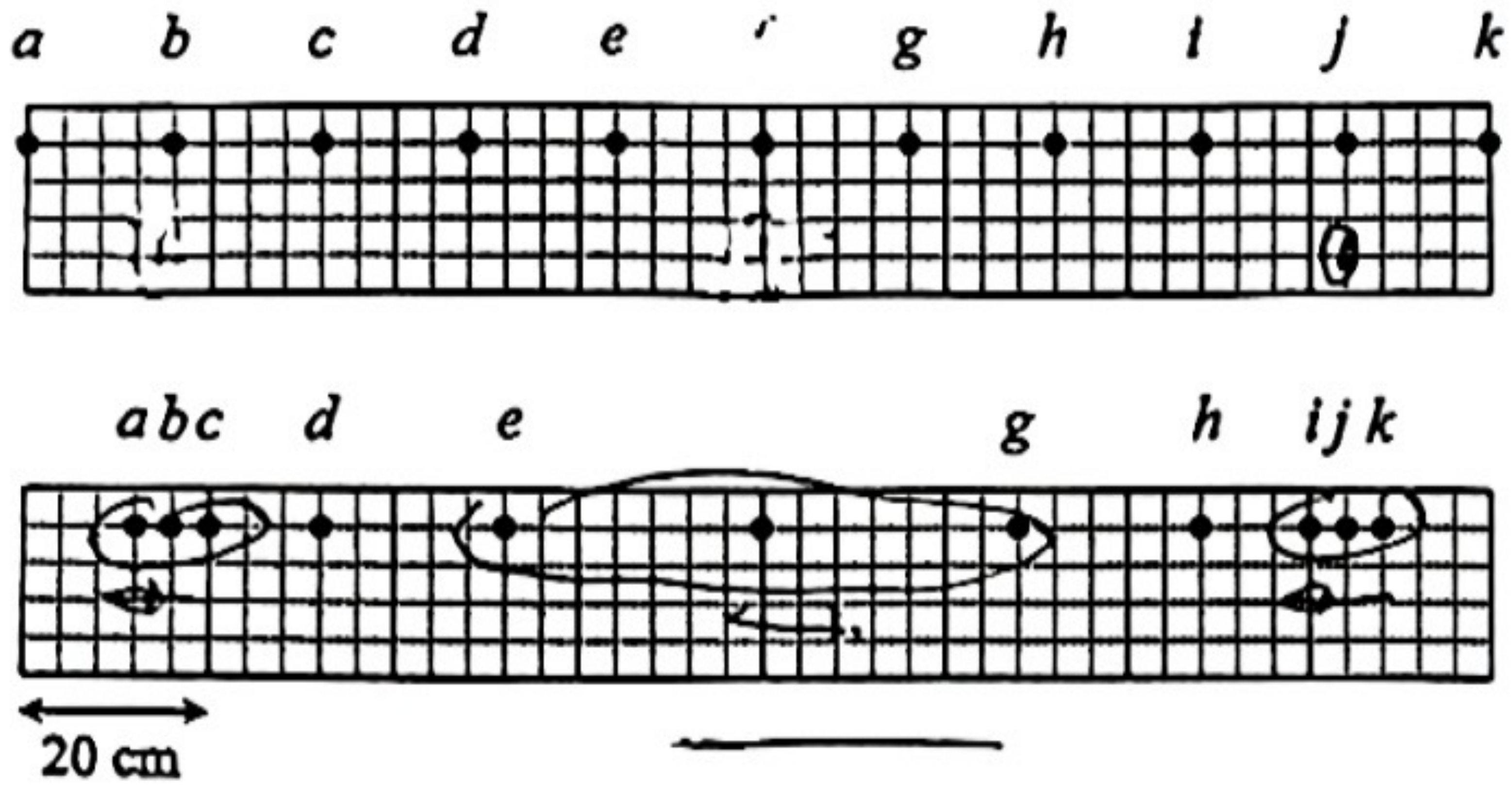


Figure (a)

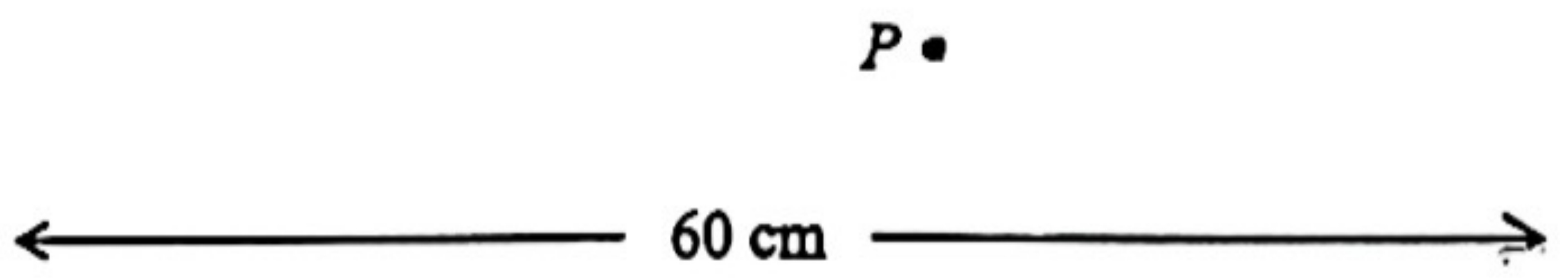
Figure (b)

Figure (a) shows a series of particles (a – k) at their equilibrium positions. Figure (b) shows the positions of the particles at a certain instant t when a longitudinal wave travelling from right to left passes through the particles. Which of the following statements are correct ? (Note : displacement to the right is taken to be positive.)

(1) The amplitude of the wave is 16 cm.
(2) The wavelength of the longitudinal wave is 128 cm
(3) Both particles c and e are moving towards the right at the instant t.

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D. (1), (2) and (3)

15.



The figure shows the waveform of a transverse wave at a certain instant. Particle P is at the equilibrium point. The wave is travelling towards the left. If it takes a time of 1.2 s for the particle P to move to the crest, what is the speed of the wave ?

A. 10 cm s^{-1}
B 15 cm s^{-1}
C. 20 cm s^{-1}
D. 25 cm s^{-1}

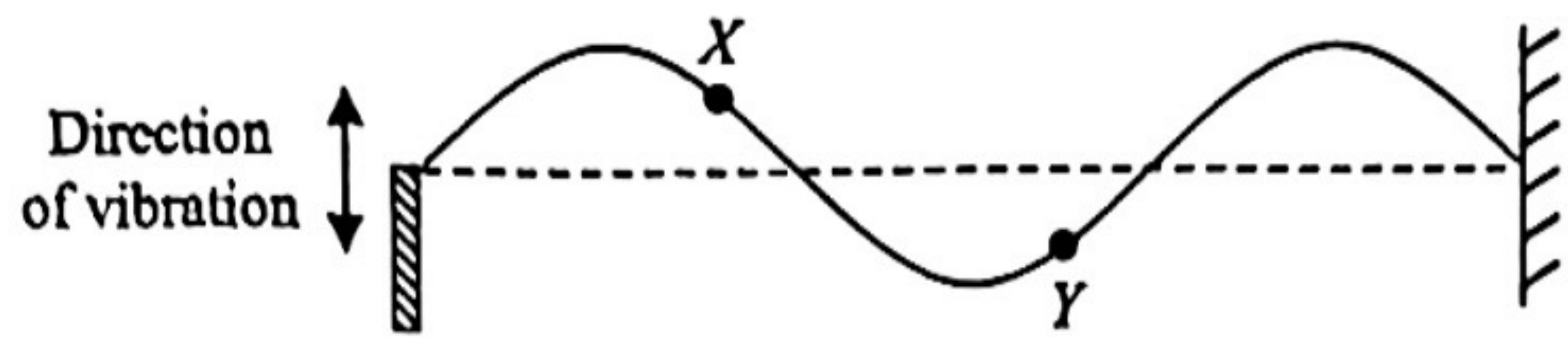
16. A convex lens has a focal length of 60 cm. What should be the object distance so that an object of height 3 cm can give an erect image of height 9 cm ?

A. 20 cm
B 30 cm
C 40 cm
D. 50 cm

17. Which of the following statements concerning ultrasound is correct ?

A. Ultrasound travels with a greater speed than audible sound.
B. Total internal reflection may occur when ultrasound travels from air to water.
C Since the wavelength of ultrasound is short, it does not have diffraction.
D. Ultrasound can be used to sterilize drinking water.

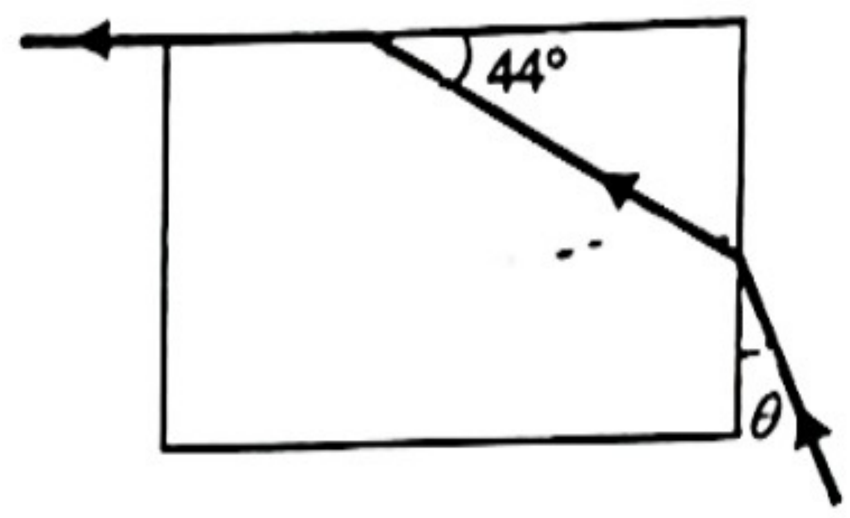
18.



A vibrator generates a stationary transverse wave on a string. The above figure shows the string at a certain instant. Which of the following statements is NOT correct ?

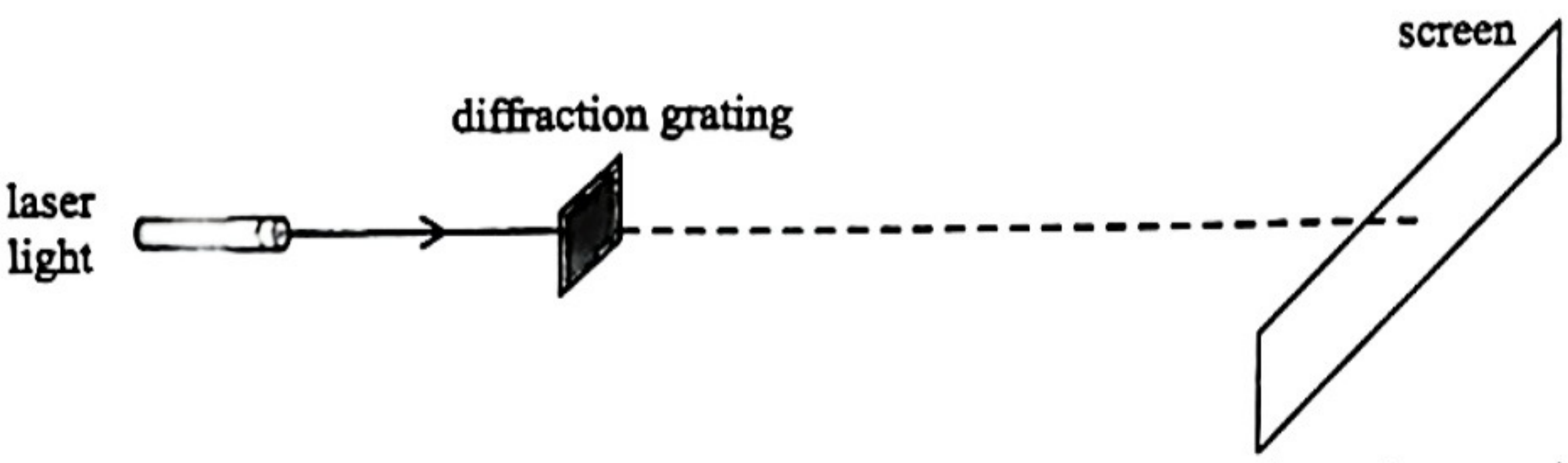
A. X and Y vibrate with the same frequency
B. X and Y must always move in opposite directions.
C. When X is at rest, Y must also be at rest.
D. If the frequency of vibration is doubled, X and Y would still move in antiphase.

19. A ray of light enters a rectangular plastic block and travels along the path as shown in the figure. Find the angle θ.

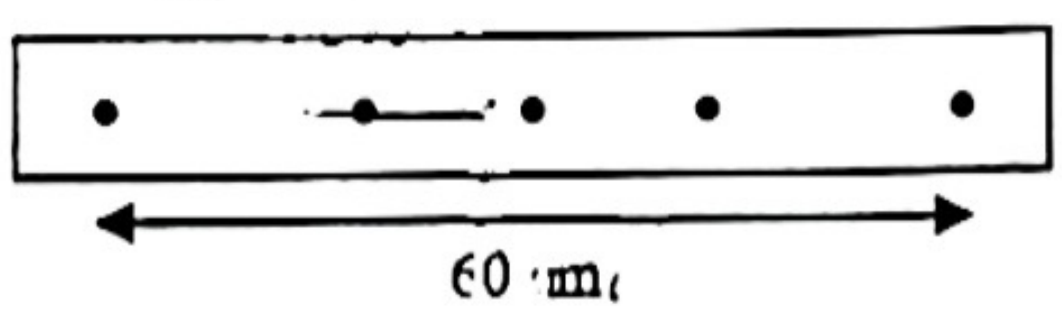


A. 15°
B. 18°
C. 21°
D. 24°

20.



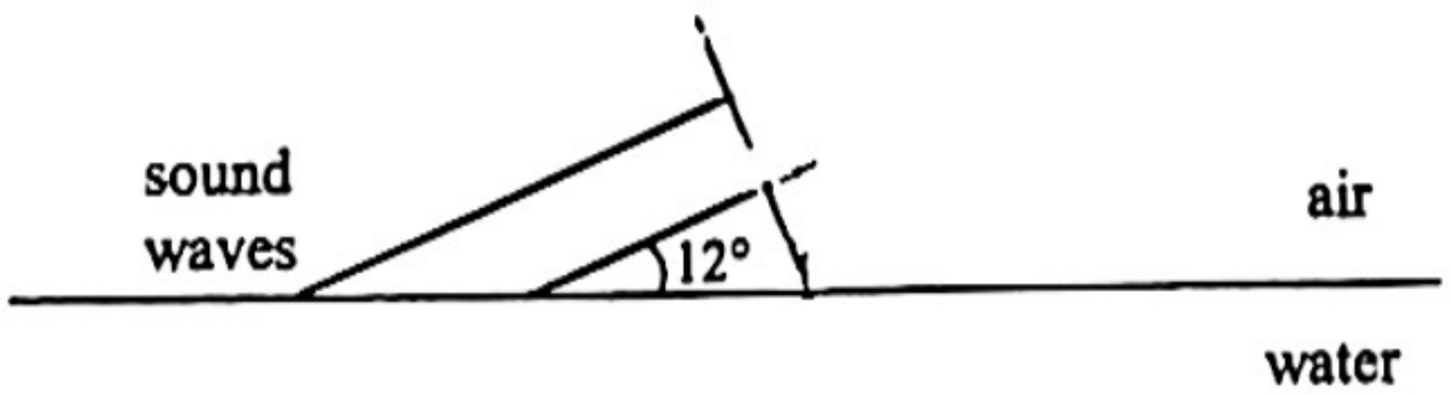
A laser light emitting a monochromatic light is directed on a diffraction grating. A screen is placed at a distance of 0.8 m from the grating. There are 5 bright dots appearing on the screen as shown below.



If the grating has 300 lines per mm, determine the wavelength of light emitted by the laser light.

A. 4.65×10^{-7} m
B 5.35×10^{-7} m
C. 5.85×10^{-7} m
D. 6.45×10^{-7} m

21.



An ultrasound of frequency 30 000 Hz travels from air to water as shown. The incident wavefront makes an angle of 12° with the interface. If the speed of sound in air and that in water are 330 m s^{-1} and 1500 m s^{-1} respectively, what is the angle of refraction in water ?

A. 65°
B 71°
C 73°
D. 79°

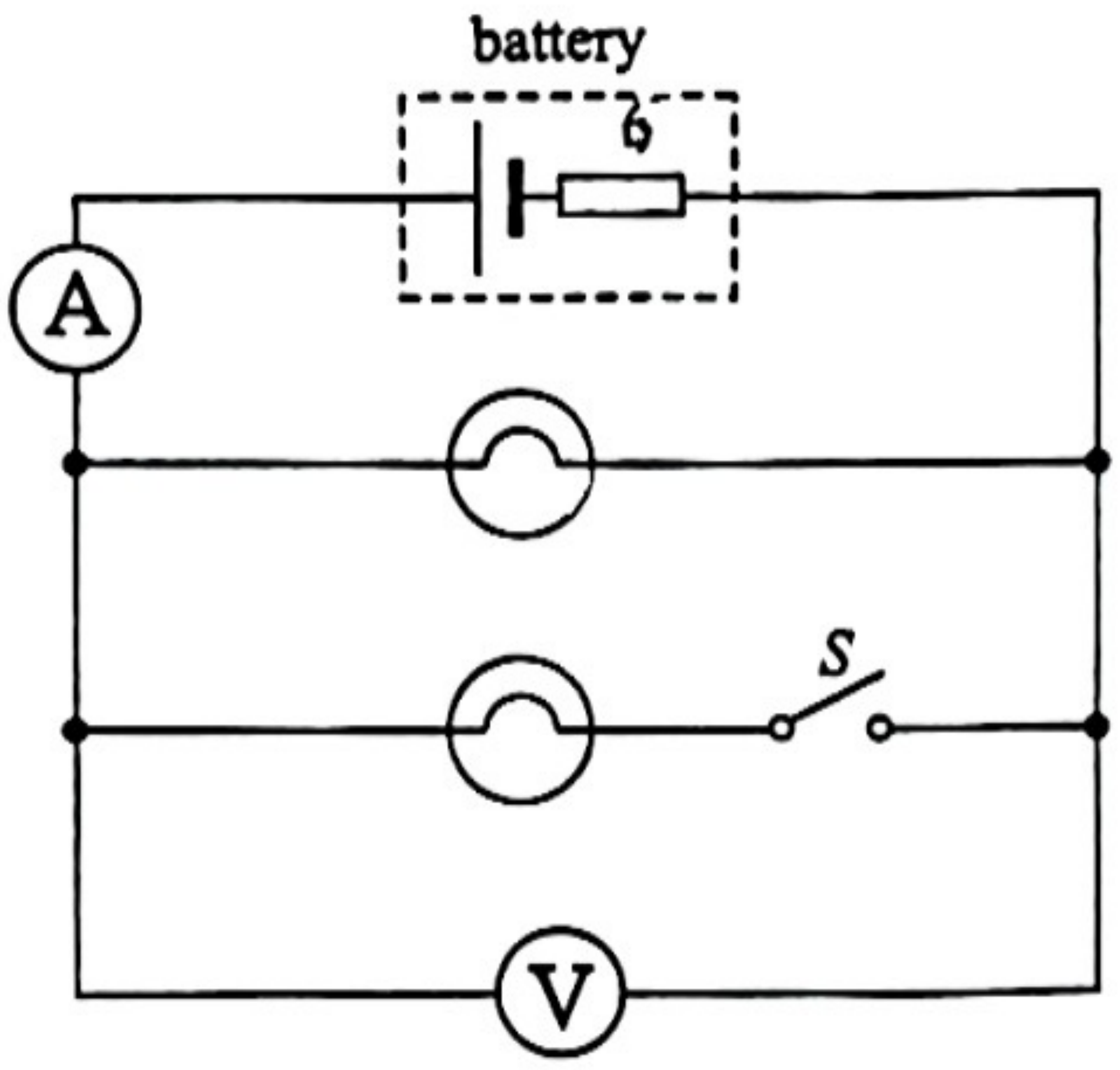
22.

The above figure is drawn to scale. Two point charges $-Q$ and $-2Q$ are situated at the positions shown. Which of the following descriptions about the electric field at different points is/are correct ?

(1) The direction of electric field at a is opposite to that at b.
(2) The magnitude of electric field at b is greater than that at a.
(3) The magnitude of electric field at a is greater than that at d.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

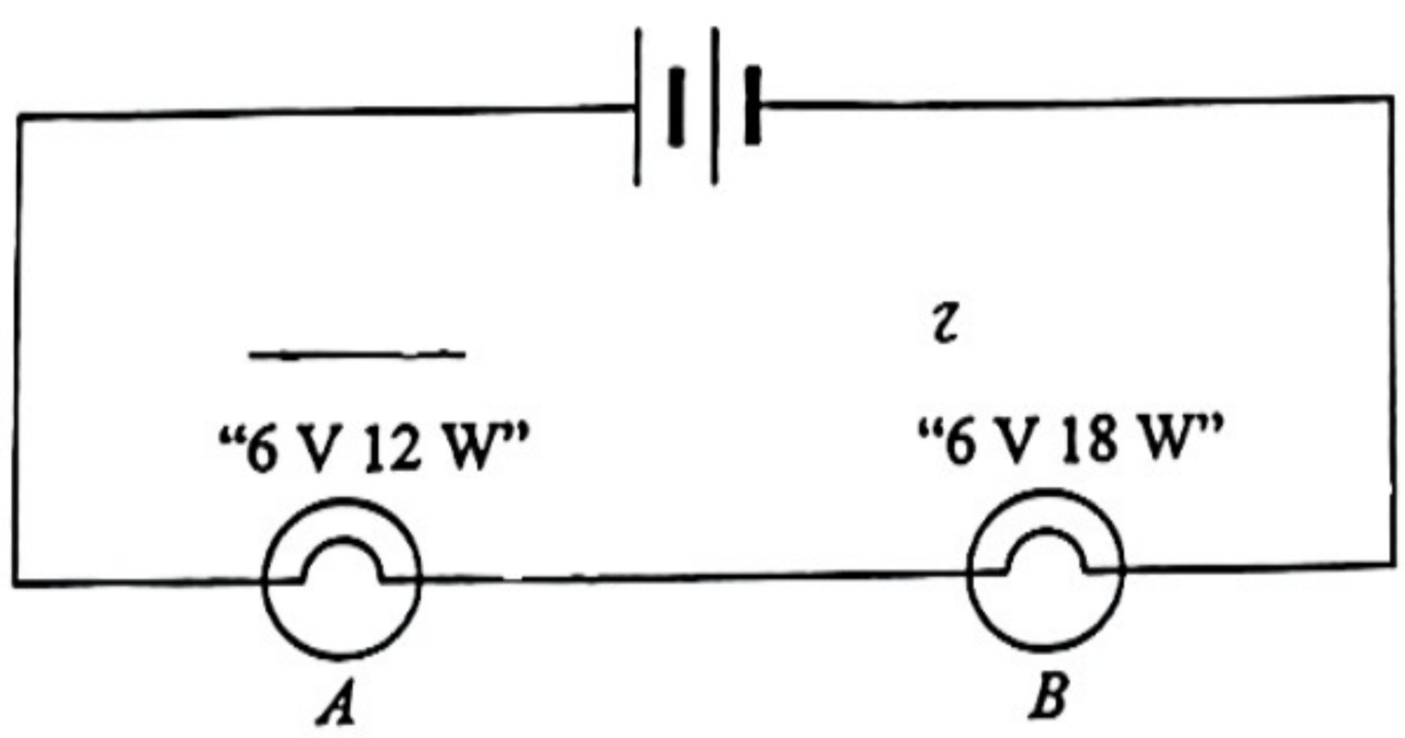
23.



A battery of e.m.f. 12 V and with non-zero internal resistance is connected to two identical light bulbs as shown. Before the switch S is closed, the reading of the ammeter and the voltmeter is 0.48 A and 9.6 V respectively. Assume that the ammeter and voltmeter are ideal. What is the reading of the ammeter if the switch S is closed ?

A. 0.60 A
B. 0.72 A
C. 0.80 A
D. 0.96 A

24.



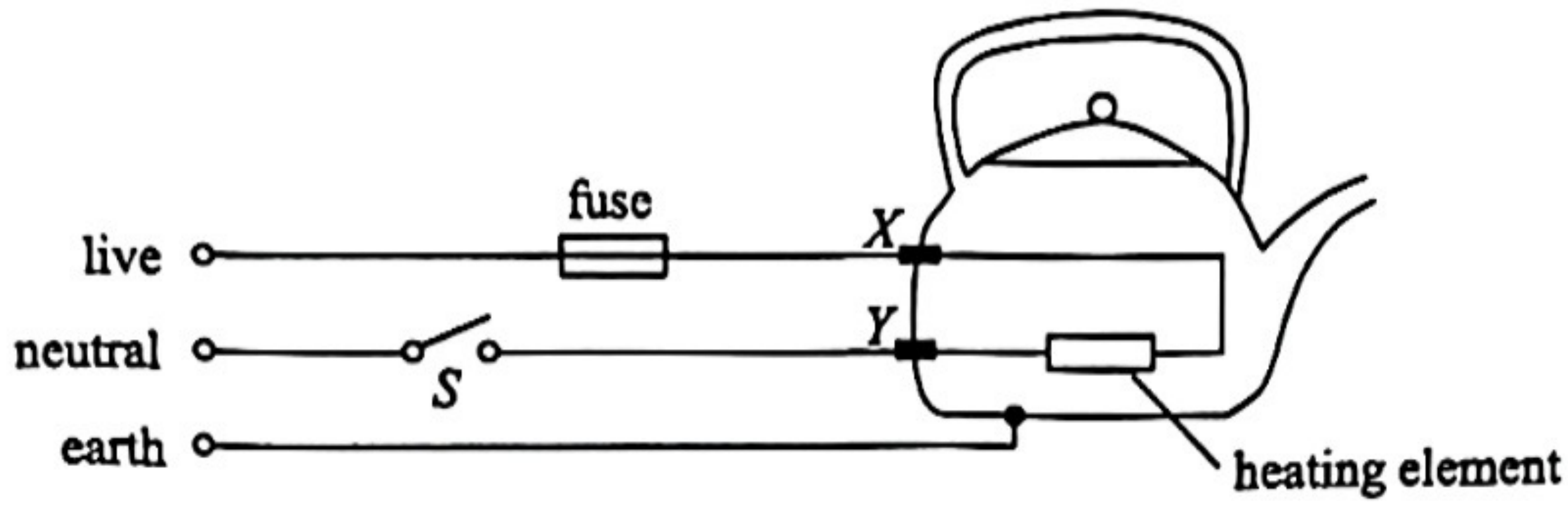
Two light bulbs A, B with rating values of "6 V 12 W", "6 V 18 W" respectively are connected in series to a battery. If the light bulb A works normally, what is the voltage of the battery ?

A. 10 V
B. 12 V
C. 15 V
D. 16 V

25. A battery has a capacity of 4300 mA h. It is used in an electrical device that operates normally at 2.5 V. If the average power output of the device is 375 mW, how long can the battery operate ?

A. 14.4 hours
B. 21.6 hours
C. 28.7 hours
D. 43.2 hours

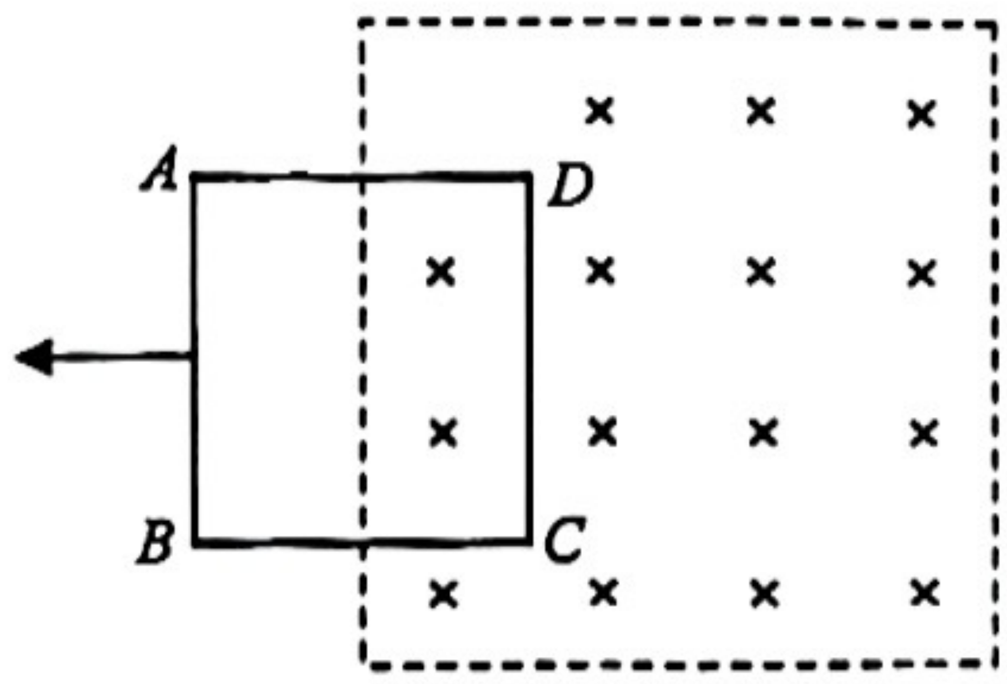
26.



The figure above shows the main parts of an electric kettle. The switch S is wrongly connected on the neutral wire. Which of the following statements is correct ?

A. A current will flow through the live wire even when S is open.
B. The fuse will blow when S is closed.
C. The fuse will blow if the insulation at X is worn out even when S is open.
D. The fuse will blow if the insulation at Y is worn out even when S is open.

27.



A square loop of each side 15 cm is placed inside a uniform magnetic field of 1.2 T pointing into the paper. The loop is pulled to the left with a uniform velocity of 2.5 m s^{-1}. The total resistance of the loop is 0.5 Ω. Which of the following statements is **NOT** correct at the instant shown ?

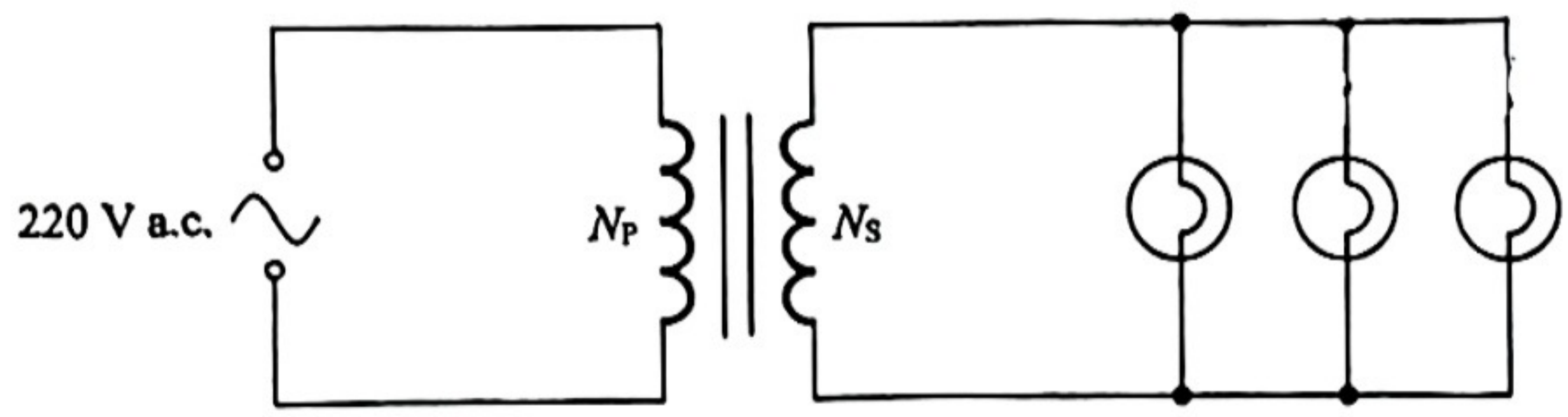
A. There is an induced current flowing in clockwise direction in the loop.
B. The induced current in the loop has a magnitude of 0.9 A.
C. There is a magnetic force acting on side CD towards the right.
D. The magnitude of magnetic force acting on the loop is 0.324 N.

28.

A particle, having a mass of 4.8×10^{-26} kg and a charge of -1.6×10^{-19} C, enters a uniform magnetic field of flux density 0.24 T at a speed of 2×10^{5} m s^{-1}, as shown. It will

A. be deflected upward in a circular arc of radius 0.25 m.
B. be deflected upward in a circular arc of radius 0.50 m.
C. be deflected downward in a circular arc of radius 0.25 m.
D. be deflected downward in a circular arc of radius 0.50 m.

29.



In the circuit, the turns ratio of the transformer ($N_P : N_S$) is 550 : 40. The three light bulbs are identical, each has a resistance of 12 Ω. If the transformer has an efficiency of 80%, what is the primary current flowing in the transformer ?

A. 0.242 A
B. 0.364 A
C. 0.514 A
D. 0.728 A

30. An electrical power of 500 kW is transmitted at 20 kV through cables of total resistance of 40 Ω. What is the efficiency of this power transmission ?

A. 90 %
B. 95 %
C. 97 %
D. 99 %

31. The activity of a sample of radioactive source decreases to 60% of its initial value in 30 s. How much more time is needed for the activity to decrease to 30% of its initial value ?

A. 41 s
B. 60 s
C. 71 s
D. 80 s

32. The radioactive isotope of uranium, $^{235}_{92}U$, decays to $^{207}_{82}Pb$ finally after a series of decay processes. Which of the following statements concerning the decay series are correct ?

(1) There are 7 alpha particles emitted in the series.
(2) There are 4 beta particles emitted in the series.
(3) $^{225}_{88}Ra$ may be one of the daughter nuclide in the decay series.

A (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D (1), (2) and (3)

33. A star radiates energy at a constant rate of 4.0×10^{26} W by nuclear fusion. The mass of the star is 2.5×10^{30} kg initially. Estimate the lifetime of the star if 0.072% of its mass is converted into radiation energy during its lifetime.

A. 1.0×10^{10} years
B. 1.3×10^{10} years
C. 1.6×10^{10} years
D. 1.9×10^{10} years

END OF SECTION A

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31 \text{ J mol}^{-1}\text{ K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
acceleration due to gravity	$g = 9.81 \text{ m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
charge of electron	$e = 1.60 \times 10^{-19} \text{ C}$
electron rest mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
atomic mass unit	$u = 1.661 \times 10^{-27} \text{ kg}$ (1 u is equivalent to 931 MeV)
astronomical unit	$AU = 1.50 \times 10^{11} \text{ m}$
light year	$ly = 9.46 \times 10^{15} \text{ m}$
parsec	$pc = 3.09 \times 10^{16} \text{ m} = 3.26 \text{ ly} = 206265 \text{ AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$

Rectilinear motion

For uniformly accelerated motion :

$$v = u + at$$

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

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

Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radian)

Astronomy and Space Science

$U = -\dfrac{GMm}{r}$	gravitational potential energy
$P = \sigma A T^4$	Stefan's law
$\left\lvert\dfrac{\Delta f}{f_0}\right\rvert \approx \dfrac{v}{c} \approx \left\lvert\dfrac{\Delta\lambda}{\lambda_0}\right\rvert$	Doppler effect

Energy and Use of Energy

$E = \dfrac{\Phi}{A}$	illuminance
$\dfrac{Q}{t} = k\dfrac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \dfrac{k}{d}$	thermal transmittance U-value
$P = \dfrac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

$\dfrac{1}{2}m_e v_{max}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\dfrac{13.6}{n^2}\text{ eV}$	energy level equation for hydrogen atom
$\lambda = \dfrac{h}{p} = \dfrac{h}{mv}$	de Broglie formula
$\theta \approx \dfrac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta \approx \dfrac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
power $= \dfrac{1}{f}$	power of a lens
$L = 10\log\dfrac{I}{I_0}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \dfrac{I_r}{I_0} = \dfrac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_0 e^{-\mu x}$	transmitted intensity through a medium

A1.	$E = mc\,\Delta T$	energy transfer during heating and cooling
A2.	$E = l\,\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nmc^2$	kinetic theory equation
A5.	$E_k = \frac{3RT}{2N_A}$	molecular kinetic energy

B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment $= F \times d$	moment of a force
B3.	$E_p = m\,g\,h$	gravitational potential energy
B4.	$E_k = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv = \frac{W}{t}$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d\sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer

E1.	$N = N_0e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$E = mc^2$	mass-energy relationship

Hong Kong Diploma of Secondary Education Examination

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Candidate Number									

2021

Mock Examination

PHYSICS PAPER 1

SECTION B : Question-Answer Book B

This paper must be answered in English

Question No.	Marks
1	7
2	6
3	8
4	8
5	8
6	9
7	8
8	11
9	9
10	10

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write you Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) Answer ALL questions.

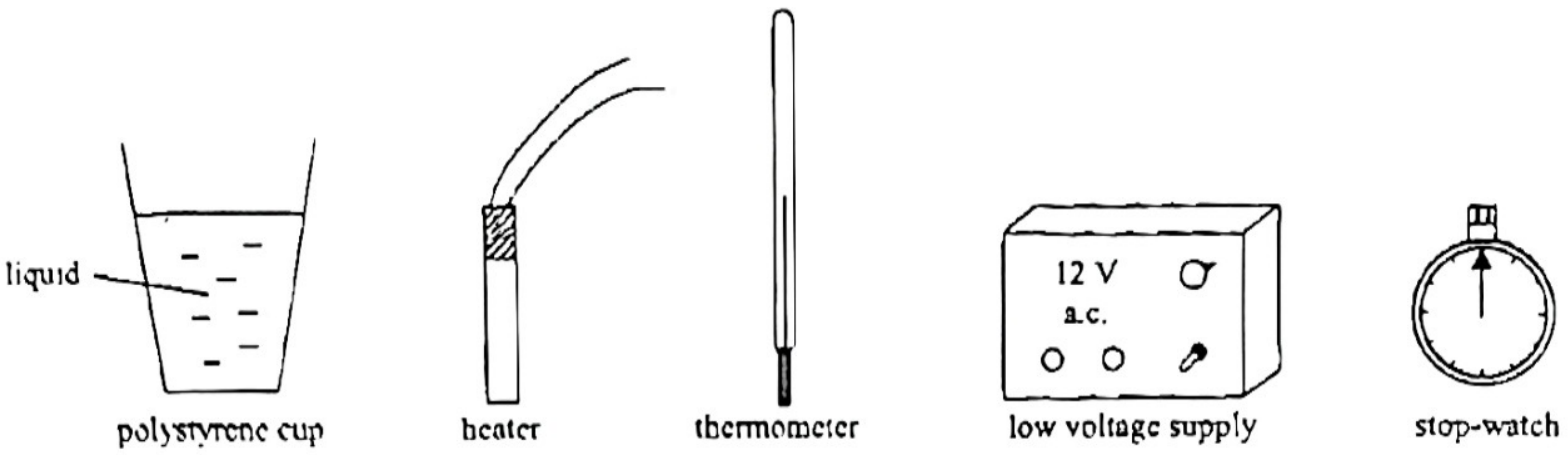
(4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) Graph paper and supplementary answer sheets will be provided on request. Write your candidate number, mark the questions box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(6) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Section B : Answer ALL questions. Write your answers in the spaces provided.

1. (a) The following apparatus shown below are given.



The liquid inside the polystyrene cup has been measured to be 350 g. The rating of the heater is "12 V 40 W". Describe how you would use the above apparatus only to find the specific heat capacity of the liquid. Specify all the measurements that have to be taken and write down an equation for calculating the value of the specific heat capacity c of the liquid. (4 marks)

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(b) Suggest with reason one more piece of apparatus to improve the accuracy of the experiment. (1 mark)

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(c) After the experiment, the liquid is heated up to a temperature of 48 °C. Find the mass of ice at 0 °C that should be added to the liquid in order to lower its temperature to 0 °C. (2 marks)

(Specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}; specific heat capacity of liquid = 4000 J kg^{-1}°C^{-1})

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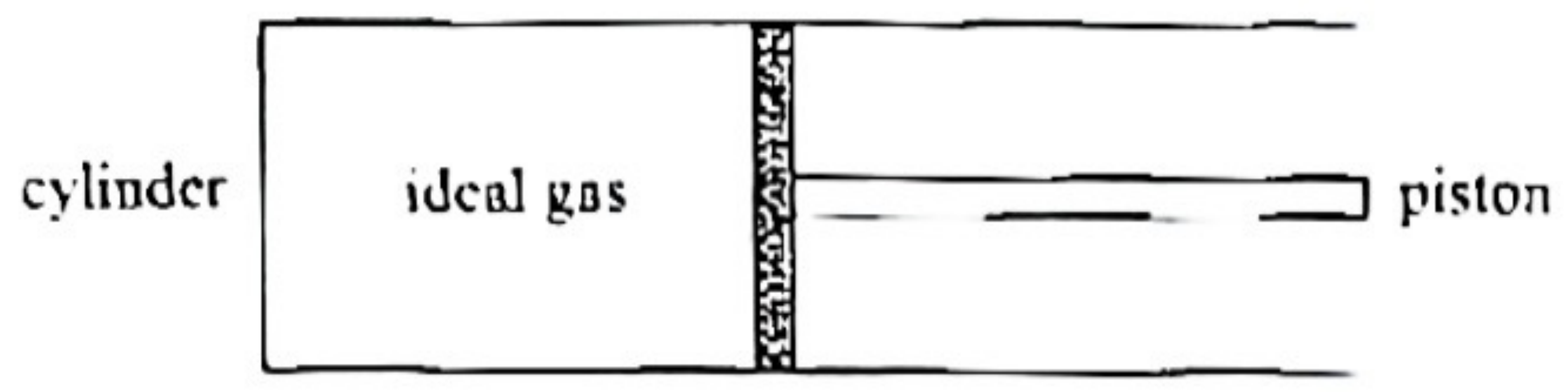
2. A cylinder fitted with a light piston contains an ideal gas of mass 0.72 g as shown below. The piston can move freely.

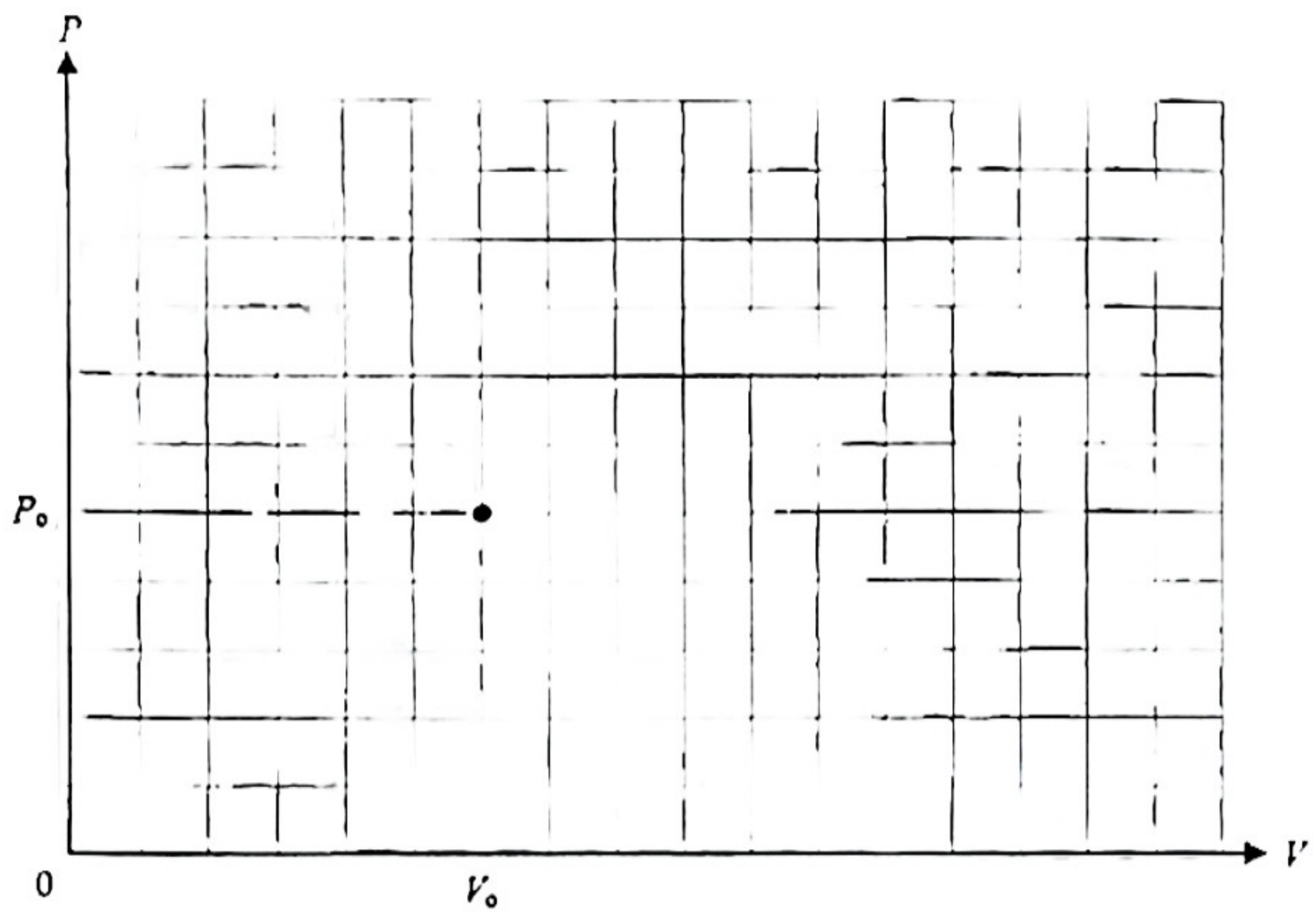


The ideal gas is initially at a volume of V_o and a pressure of P_o. It then undergoes the following two processes :

① the ideal gas is heated under constant volume until the gas pressure is increased to $2P_o$

② the piston is then pushed outwards slowly until the gas pressure is restored to P_o under constant temperature

(a) Sketch on the following graph to show the variation of the gas pressure P with the gas volume V for the above two processes. Label the processes as ① and ②. (2 marks)



(b) Use kinetic theory to explain why the pressure increases when the ideal gas is heated under constant volume. (2 marks)

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(c) Suppose finally the ideal gas inside the cylinder is at a pressure of 125 kPa and a volume of 350 cm^3. Calculate the root-mean-square speed of the gas molecules at the final state. (2 marks)

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Answers written in the margins will not be marked.

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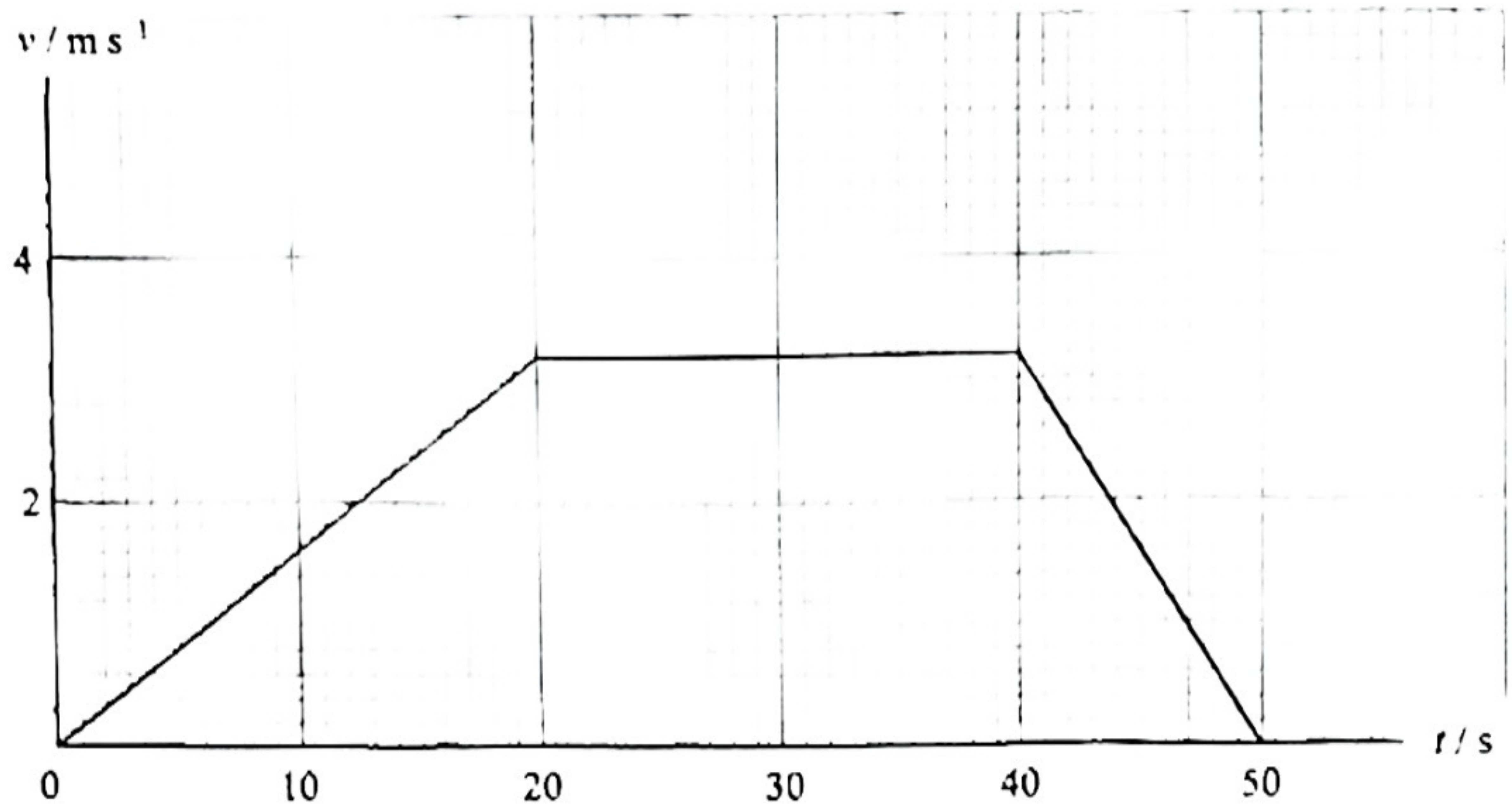
3. A lift system is pulled by a motor through a cable. There is a passenger of mass 60 kg standing on a pan balance inside the lift. The figure below shows the velocity-time graph of the lift during an ascending motion. Take g to be 10 m s^{-2}.



(a) Find the reading of the pan balance at the time instant of 45 s. (3 marks)

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(b) Determine the height that the lift moved in the upward motion. (2 marks)

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(c) Calculate the average power output of the lift to the passenger during the ascending motion of the lift. (2 marks)

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(d) State **ONE** safety measure of a lift system. (1 mark)

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Answers written in the margins will not be marked.

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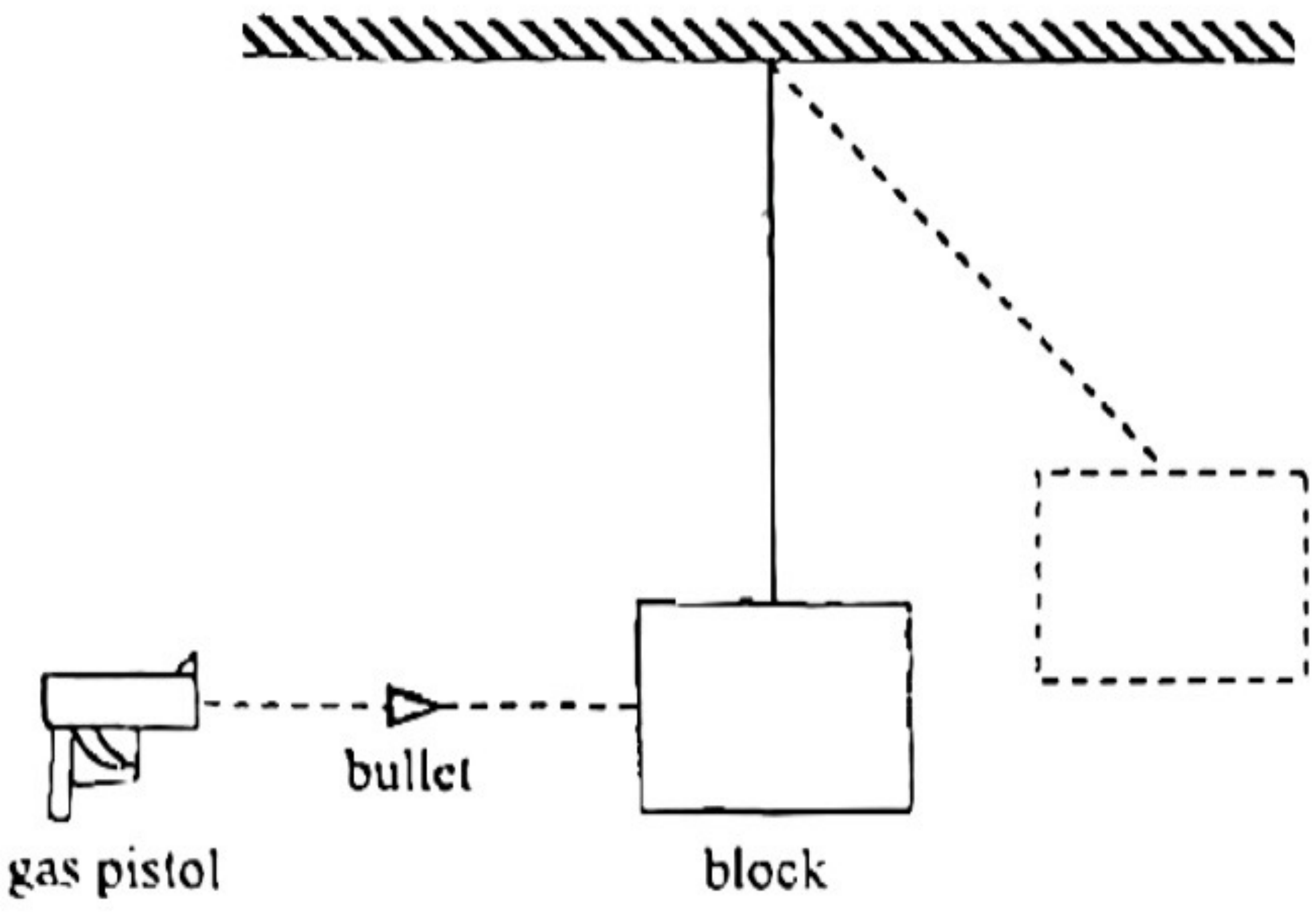

An experiment is conducted to find out the speed of a bullet fired from a gas pistol. The mass of the bullet is 1.2 g. After shooting out as shown in the above figure, the bullet hits a block of mass 53.8 g suspended by a light inextensible string. Upon collision, the bullet embeds into the block and they move together to rise up a vertical height of 12.6 cm.

(a) Calculate the speed v of the block after the bullet hits and embeds into the block. (2 marks)

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(b) Determine the speed of the bullet fired out from the gas pistol. (2 marks)

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(c) Explain whether kinetic energy is conserved during the collision between the bullet and the block. (1 mark)

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(d) If the bullet hits the block and rebounds backward, explain how this would affect the vertical height reached by the block after collision (3 marks)

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Answers written in the margins will not be marked.

5. Assume the Earth is a perfect sphere with radius 6380 km. The Earth has a self-rotation with a period of 24 hours.

(a) City A is exactly at the equator of the Earth. Calculate the linear speed of city A as the Earth rotates. (2 marks)

(b) There is a parking satellite directly above city A. Calculate the radius of the orbit of the parking satellite. (3 marks)

(c) What is the centripetal acceleration of this parking satellite ? (2 marks)

(d) Parking satellite is used for satellite communication. State **ONE** advantage of using parking satellite for communication. (1 mark)

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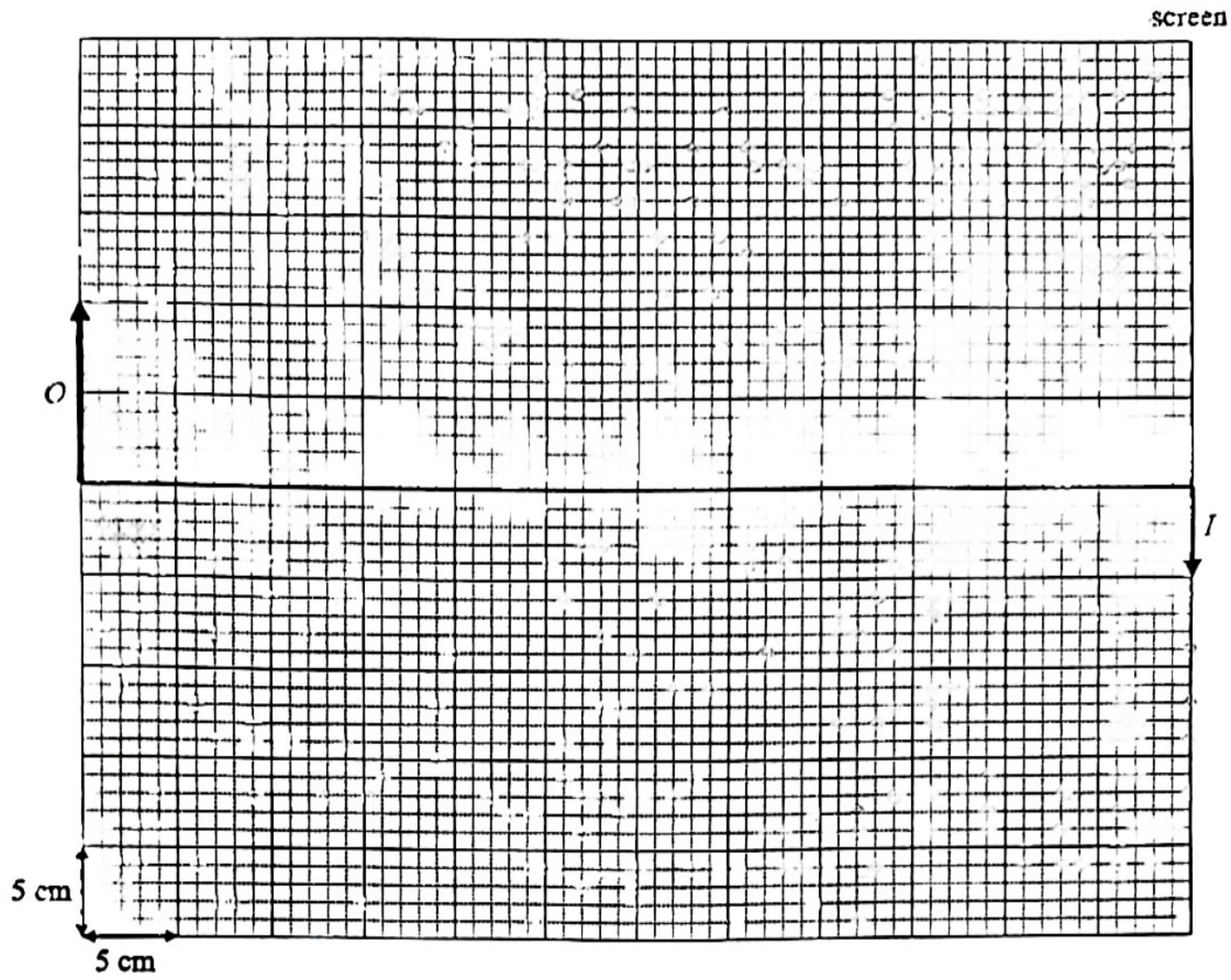
6. An object O of height 10 cm is placed in front of a convex lens such that an image I of height 5 cm is formed on a screen placed at a distance of 60 cm from the object. The figure below shows the object O and the image I on the screen.



(a) On the above figure, draw

(1) a suitable line to locate the position of the lens, label it as L ;

(2) a suitable light ray to locate the position of the principal focus, label it as F. (2 marks)

(b) Write down the focal length of the convex lens L. (1 mark)

Focal length = ______________ cm

(c) If now the object O is moved slightly towards the lens L and the position of the lens L remains fixed, state the change of the image distance and the image size. (2 marks)

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(d) Suppose now the object O is placed at 8 cm in front of the lens L.

(i) Calculate the image distance and the magnification of the image. (3 marks)

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(ii) State **ONE** application of the lens to produce this type of image. (1 mark)

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Answers written in the margins will not be marked.

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Figure (a)

In Figure (a), two identical loudspeakers P and Q are connected to a signal generator emitting sound wave of a certain frequency in phase. The separation between P and Q is equal to 1 m.

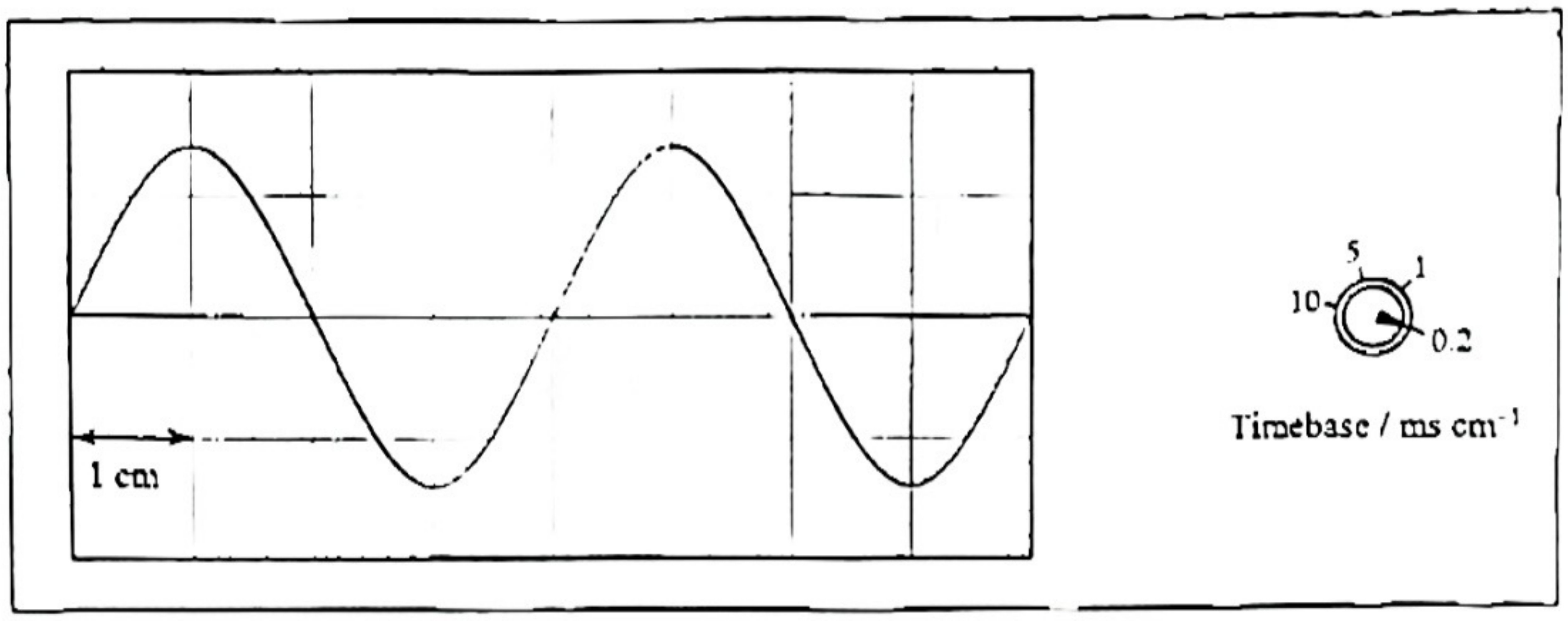

Figure (b)

A microphone M is connected to a CRO to display the sound. When the microphone is placed at position B, the trace appeared on the CRO is shown in Figure (b).

(a) Calculate the frequency of the sound. (2 marks)

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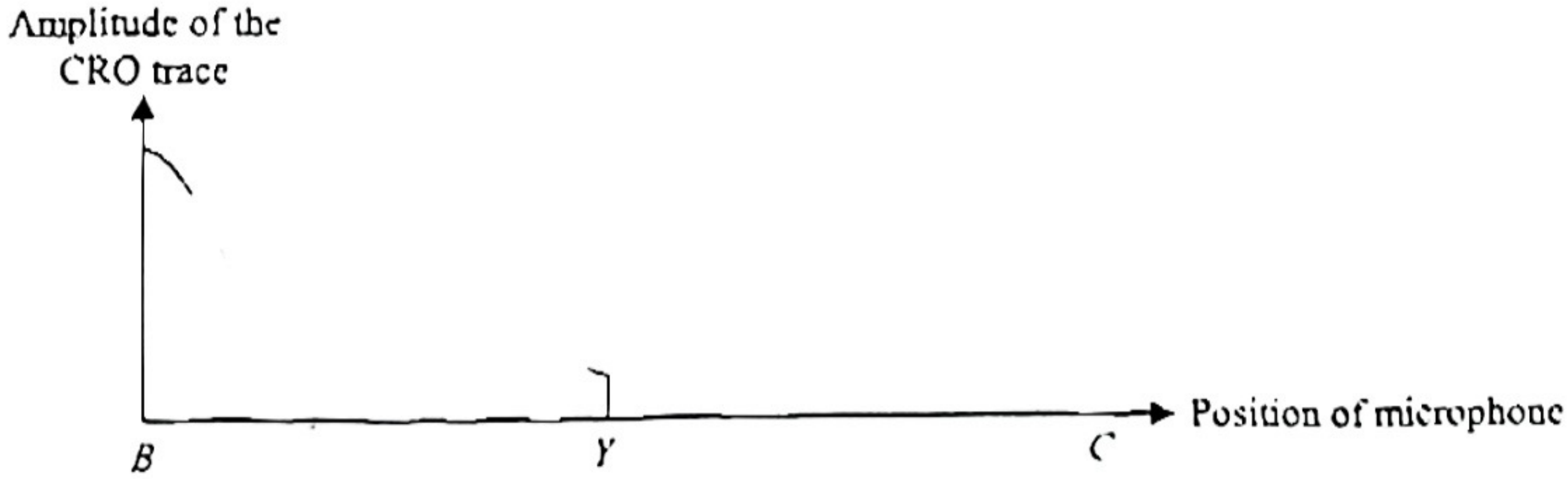

Figure (c)

The microphone is then moved from B to C to record the variation of the loudness of the sound. Figure (c) shows the variation of the amplitude of the CRO trace, where the amplitude indicates the loudness of the sound.

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(b) Suppose $PY = 2.15$ m and $QY = 2.54$ m.

(i) Determine the wavelength of the sound emitted by the signal generator. (2 marks)

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(ii) Hence, find the speed of sound wave in air. (2 marks)

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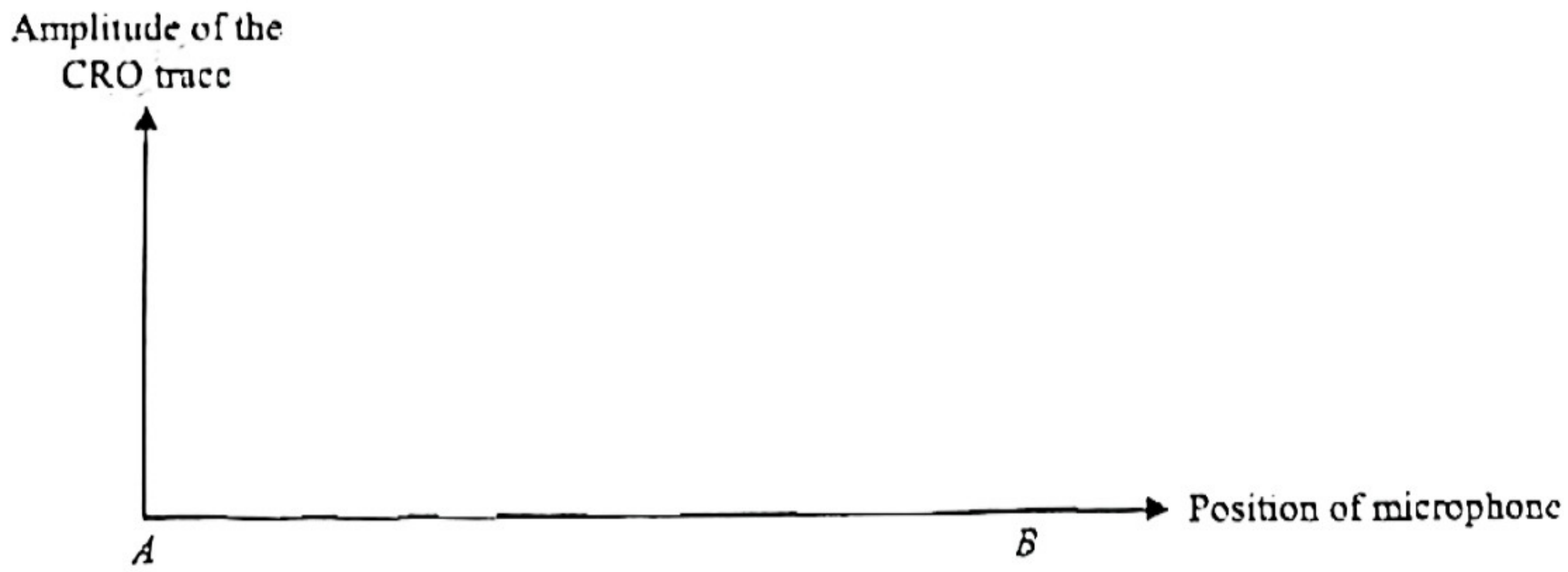
(c) If the microphone is moved gradually from position B to C and beyond, state how many points of minimum can be detected. (1 mark)

Number of points of minimum detected : ____________

(d) Sketch the graph to show the variation of the amplitude of the CRO trace along the central line AB. (1 mark)



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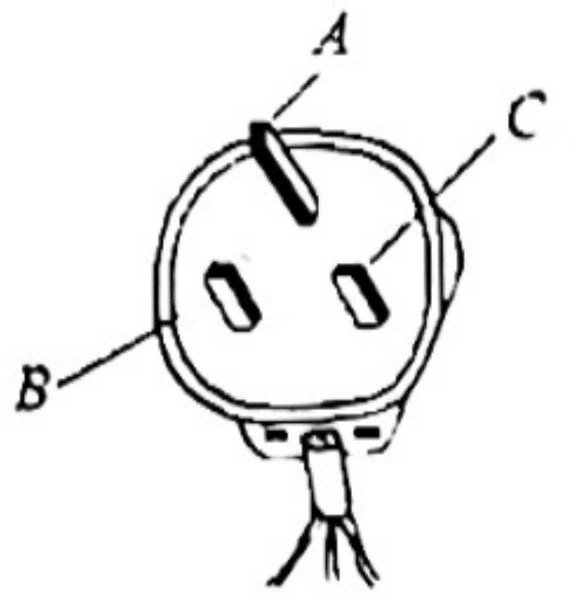

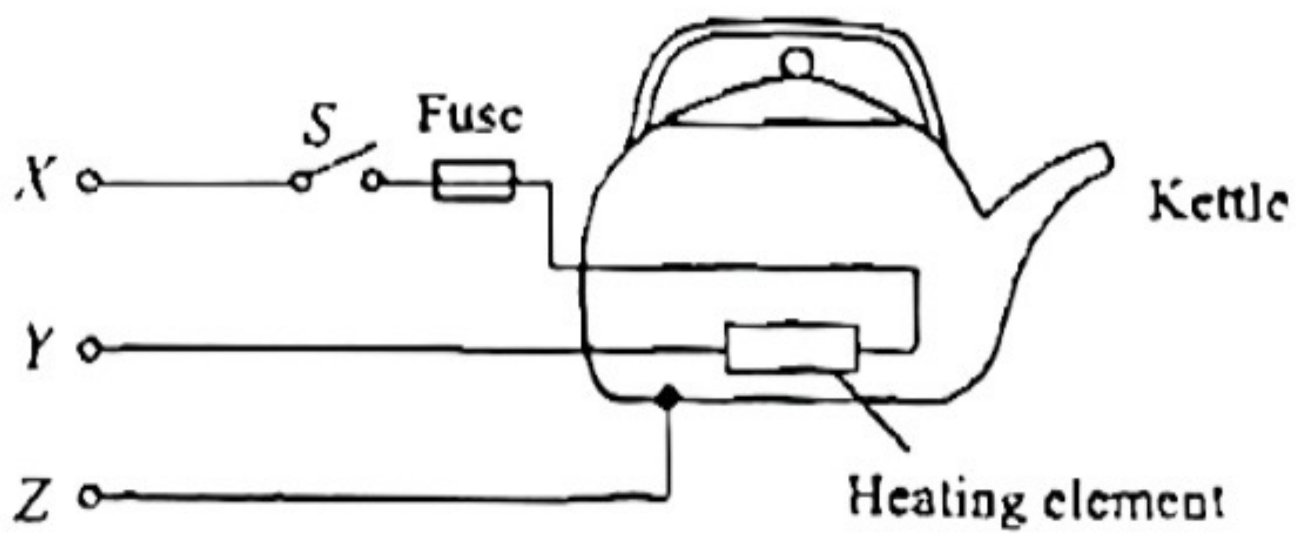

The above figure shows a 3-pin plug and a kettle with a metal case.

(a) State the proper connection of the pins to the wires of the kettle. (1 mark)

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(b) Explain the potential hazard if the wire Z has not been connected to the mains socket. (1 mark)

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(c) The rating of the kettle is '240 V, 2000 W'. It is connected to the mains supply of Hong Kong that has a mains voltage of 220 V.

(i) Calculate the actual power supplied to the kettle. (2 marks)

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(ii) Suppose now the kettle is filled up with water of mass 1.8 kg at an initial temperature of 25 °C. The heat capacity of the kettle is 800 J °C^{-1}. Find the time taken to heat up the water in the kettle to the boiling point, assume 20% of power supplied is lost to the surrounding air. Given that the specific heat capacity of water is 4200 J kg^{-1} °C^{-1}. (3 marks)

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(iii) Hence calculate the cost of electricity for this boiling process, given that electricity has a current cost of $1.2 per kW h. (2 marks)

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(d) A student comments that if the wire Y accidentally touches the metal case of the kettle, the fuse will blow and the kettle stops working. Explain whether his comment is correct. (2 marks)

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Answers written in the margins will not be marked

9. Read the following passage about the power transmission system in Hong Kong and answer the questions that follow.

Power Transmission System in Hong Kong

A system of underground cables and overhead lines forming a transmission network carries electricity over long distances from the power plants to the stations close to the populated areas. In the stations the voltage is stepped down. Through another system of cables forming the distribution network, the electricity is distributed over shorter distances to the users.

On Hong Kong Island, transmission of electricity is done at a maximum of 275 kV for HEC Power. The use of high voltage for transmission over long distances is energy efficient. Although the resistance per unit length of the thick transmission cables is very low, over long distances, the total resistance is significant. Transmission at high voltage reduces the power lost as heat along the cables.

When electricity is generated at the power plant, the output is always in the form of an alternating current of 50 Hz. The output voltage from the generator is about 22 kV. So the output voltage has to be stepped up to the transmission voltage through the use of transformers. The transformers in the electricity transmission and distribution systems are very large, close to the size of a house.

(a) In order to step up the voltage from 22 kV to 275 kV, a transformer is used. If the number of turns in the secondary coil is 5000, what should be the number of turns in the primary coil ? (1 mark)

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(b) Suppose an electrical power of 385 MW is transmitted at a voltage of 275 kV through an overhead cable from the power plant to a certain place with a distance of 15 km. The resistance of the transmission cable per km is 0.08 Ω.

(i) Calculate the current through the transmission cable. (2 marks)

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(ii) Hence calculate the power output to the target place through the transmission cable. (3 marks)

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(c) Assume the transformers used in the transmission system are ideal. State **TWO** ways to increase the power transmission through the cable. (2 marks)

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(d) Explain why a.c. is used in power transmission. (1 mark)

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10. A sample contains polonium-210 (Po-210) as the only radioisotope initially. Polonium has an atomic number of 84 and it decays by emitting an alpha particle. After 84 days, the mass of Po-210 in the sample drops to 65 % of the original.

(a) Write down the decay equation of Po-210. Use X to represent the daughter nuclide. (1 mark)

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(b) Given a GM counter, suggest a simple method to identify that the emitted radiation is alpha particles. (1 mark)

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(c) Calculate the half-life of Po-210. (2 marks)

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(d) Calculate the decay constant of Po-210, expression the answer in SI unit. (2 marks)

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(e) If the initial activity of the sample is 500 MBq, find the initial mass of the Po-210 in the sample, given that its molar mass is 210 g. (3 marks)

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(f) State ONE application of radioactivity making use of an alpha source. (1 mark)

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END OF PAPER

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Hong Kong Diploma of Secondary Education Examination

2021

Mock Examination

PHYSICS PAPER 2

Question-Answer Book

(1 hour)

This paper must be answered in English

Please stick the barcode label here.

Candidate Number									

INSTRUCTIONS

(1) After the announcement of the start of the examination, you should first write you Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided.

(2) This paper consists of **FOUR** sections, Section A, B, C and D. Each section contains eight multiple-choice questions and one structured question which carries 10 marks. Attempt **ALL** question in any **TWO** sections.

(3) Write your answers to the structured questions in the **ANSWER Book** provided. For multiple-choice questions, blacken the appropriate circle with an HB pencil. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

(4) Graph paper and supplementary answer sheets will be provided on request. Write your candidate number, mark the questions box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(5) The Question-Answer Book and Answer Book will be collected **SEPARATELY** at the end of the examination.

(6) The diagrams in this paper are **NOT** necessarily drawn to scale.

(7) The last two pages of this Question-Answer Book contain a list of data, formulae and relationship which you may find useful.

(8) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Section A : Astronomy and Space Science

Q.1 : Multiple-choice questions

1.1 Which of the following statements concerning the retrograde motion of Mars is/are correct ?

(1) During retrograde motion, Mars moves from West to East over a period of several weeks.
(2) During retrograde motion, Mars and Earth must be at the same side of the Sun.
(3) In Ptolemy's geocentric model, since Earth is at the centre of the Universe, it cannot explain the retrograde motion of Mars.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

A ○ B ◉ C ○ D ○

1.2 A planet is moving in an elliptical orbit around the Sun as shown. Which of the following statements is/are correct ?

(1) The kinetic energy of the planet is greatest when it is closest to the Sun.
(2) The potential energy of the planet is greatest when it is closest to the Sun.
(3) The gravitational force is always perpendicular to the motion of the planet.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

A ◉ B ○ C ○ D ○

1.3 A space capsule is launched from the surface of the Earth with an initial speed of u. When it is very far away from the Earth, the speed is found to be 5000 m s^{-1}. Given that the radius of the Earth is 6400 km, determine the initial speed u of the space capsule. Neglect air resistance.

A. 11200 m s^{-1}
B. 12300 m s^{-1}
C. 13900 m s^{-1}
D. 14800 m s^{-1}

A ○ B ◉ C ○ D ○

1.4 Triton is a satellite revolving around Neptune in an elliptical orbit. The length of the semi-major axis is 356 000 km. Triton takes a time of 70 hours to move from aphelion (point of farthest approach) to perihelion (point of closest approach). Calculate the mass of Neptune

A. 1.05×10^{26} kg
B. 2.25×10^{26} kg
C. 2.75×10^{26} kg
D. 3.65×10^{26} kg

A ◉ B ○ C ○ D ○

1.5 The following table shows the apparent magnitude m and absolute magnitude M of two stars X and Y.

	Apparent magnitude m	Absolute magnitude M
star X	3.6	2.4
star Y	1.8	3.2

Which of the following statements is/are correct ?

(1) When observing from the Earth, star X has greater brightness than Y.
(2) The luminosity of star X is greater than that of star Y.
(3) Star X is at a greater distance away from the Earth than star Y.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

A B C D

1.6 Star X has a luminosity 30 000 times that of the Sun and its radius is 25 times that of the Sun. If the surface temperature of the Sun is 5800 K, what is the surface temperature of star X ?

A. 2200 K
B. 15300 K
C. 34100 K
D. 40200 K

A B C D

1.7

A star is moving at a velocity of v making an angle of 24° to the line of sight from the Earth as shown. One of the spectral line emitted by the star is 624.35 nm. However, this spectral line observed on the Earth is 625.48 nm. What is the velocity of the star ?

A. 385 km s^{-1}
B. 496 km s^{-1}
C. 594 km s^{-1}
D. 667 km s^{-1}

A B C D

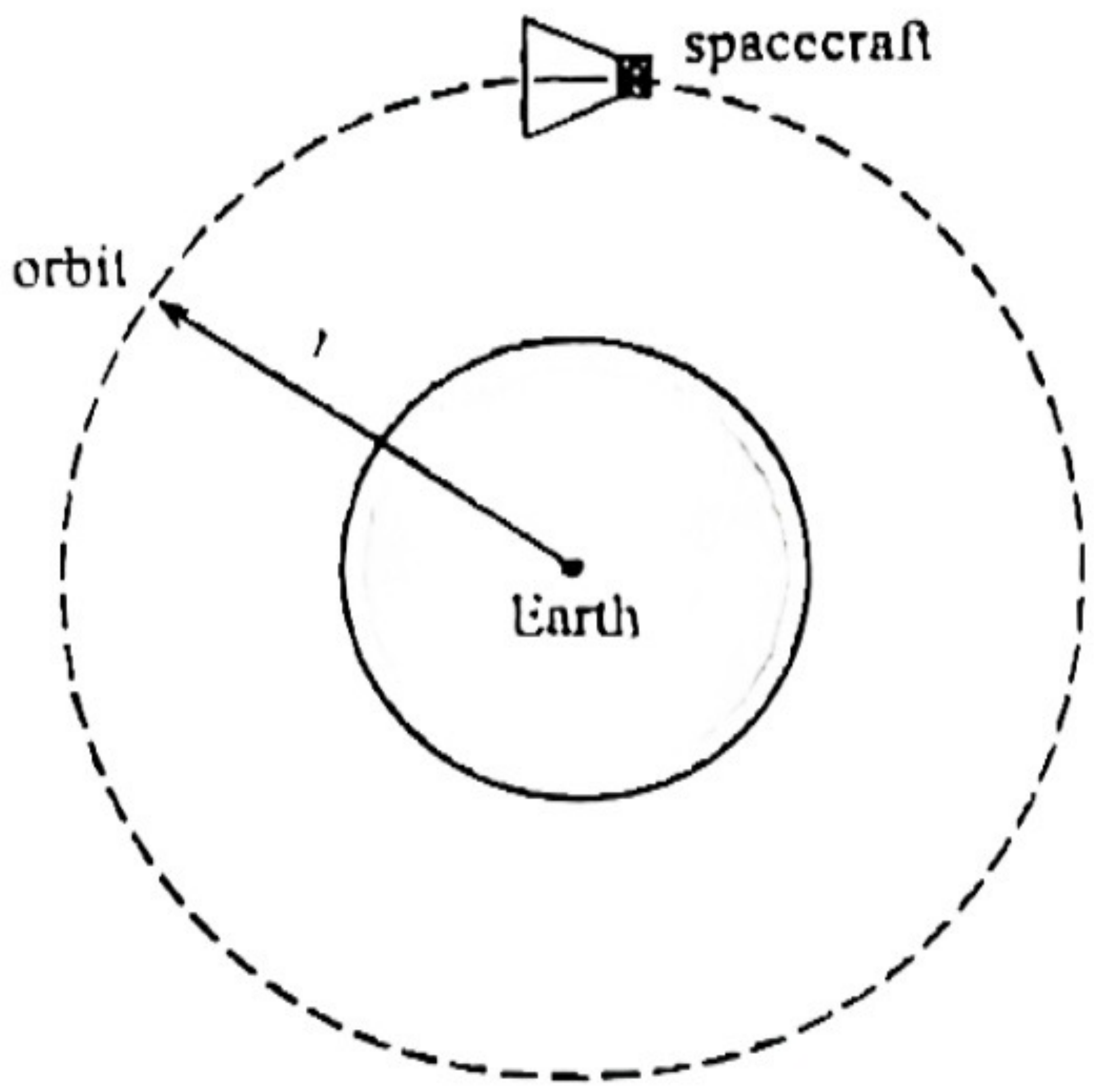
1.8 A star is observed to have a parallax of 0.125 arcsecond. Its brightness observed on the Earth is 3.6×10^{-7} W m^{-2}. What is the luminosity of this star ?

A. 5.52×10^{27} W
B. 8.48×10^{28} W
C. 2.76×10^{29} W
D. 5.84×10^{29} W

A B C D

Q.1 : Structured question

A spacecraft of mass m is moving round the Earth in a circular orbit of radius r with its engine turned off. The mass of the Earth is denoted by M. G is the universal gravitational constant.



(a) (i) Derive an expression for the kinetic energy K of the spacecraft in terms of G, M, m and r. (2 marks)

(ii) By considering the gravitational potential energy U, derive an expression for the total mechanical energy E of the spacecraft in terms of G, M, m and r, take the gravitational potential energy at infinity as zero. (2 marks)

(b) Suppose the mass of the Earth is 6.02×10^{24} kg and the mass of the spacecraft is 5000 kg. At a certain orbit, the kinetic energy of the spacecraft is 1.3×10^{11} J.

(i) Calculate the radius of the orbit of the spacecraft. (1 mark)

(ii) State the total mechanical energy E of the spacecraft. (1 mark)

(iii) If now the engine of the spacecraft is fired for a short duration so that an extra energy of 10^{11} J is given to the spacecraft, find the new orbital radius of the spacecraft. (2 marks)

(c) An astronaut inside the spacecraft is said to be 'weightless'. A student comments that the reason is that the weight of the astronaut becomes zero in the orbit. Explain whether you agree with the student. (2 marks)

Section B : Atomic World

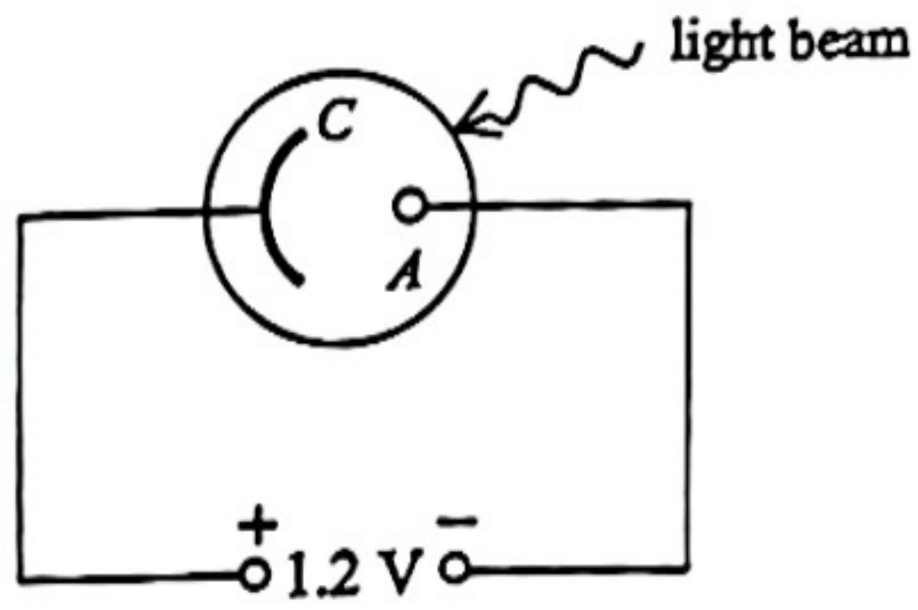
Q.2: Multiple-choice questions

2.1 In an experiment about the photoelectric effect, when a light beam of intensity I and wavelength λ is shone on the surface of the cathode, 2×10^{10} electrons are emitted from the surface per second. If another light beam of intensity $2I$ and wavelength 2λ is used, what is the number of electrons emitted from the cathode surface per second ?

A. 1×10^{10}
B. 2×10^{10}
C. 4×10^{10}
D. 8×10^{10}

A B C D

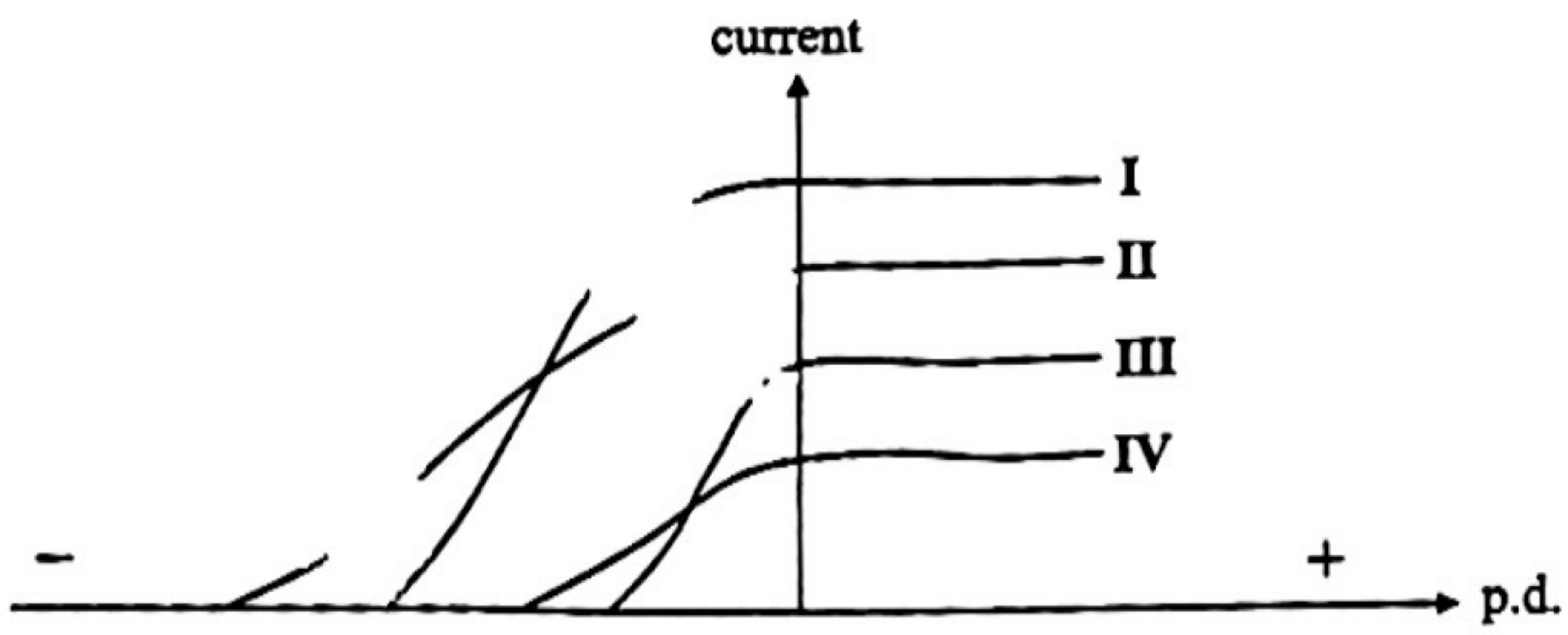
2.2 A photocell is connected to a 1.2 V d.c. source as shown. A monochromatic light beam is incident on cathode C of the photocell so that photoelectrons are emitted. If the work function of cathode C is 1.6 eV and the maximum kinetic energy of the photoelectrons reaching the anode A is 2.4 eV, what is the wavelength of the incident light ?



A. 2.39×10^{-7} m
B. 3.24×10^{-7} m
C. 3.68×10^{-7} m
D. 4.44×10^{-7} m

A B C D

2.3



The figure above shows the currents observed in a photocell circuit as a function of the potential of the anode relative to the cathode of the photocell when light beams I, II, III and IV were each directed in turn at the cathode. Which of the beams has the lowest frequency ?

A. I
B. II
C. III
D. IV

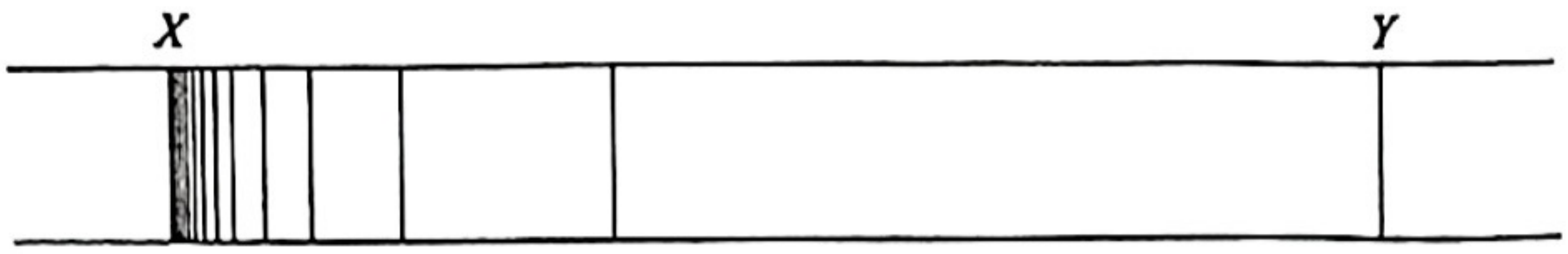
A B C D

2.4 Hydrogen gas in ground state is illuminated by an ultraviolet light beam. It is found that the wavelength of 97.5 nm ultraviolet light is absorbed by the hydrogen gas. When the excited hydrogen gas atoms return to the ground state, a few spectral lines are emitted. How many spectral lines are in the visible light region ?

A. 1
B. 2
C. 3
D. 4

A B C D

2.5



The above figure shows the series of emission lines of the hydrogen spectrum associated with electron transitions from excited energy levels to the first excited state ($n = 2$). Lines X and Y are at the two extreme ends of this series. Which of the following statements are correct ?

(1) Spectral line X has the shortest wavelength in this series.
(2) The wavelength of spectral line Y is about 660 nm.
(3) This series of spectral lines are all in the visible light region.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

A B C D

2.6 Under normal light, the diameter of the human pupil is about 4 mm. A man observes two small objects at a distance of 40 m away. What is the minimum separation between the two objects that the man can just resolve ? Assume the average wavelength of light emitted by the objects is 550 nm.

A. 3.05 mm
B. 4.45 mm
C. 5.25 mm
D. 6.71 mm

A B C D

2.7 Which of the following statements concerning a Lotus leaf are correct ?

(1) The surface of a Lotus leaf is hydrophobic.
(2) Water droplets can roll off easily on a Lotus leaf.
(3) The leaf surface contains nano-sized waxy bumps that can be observed by using an optical microscope.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

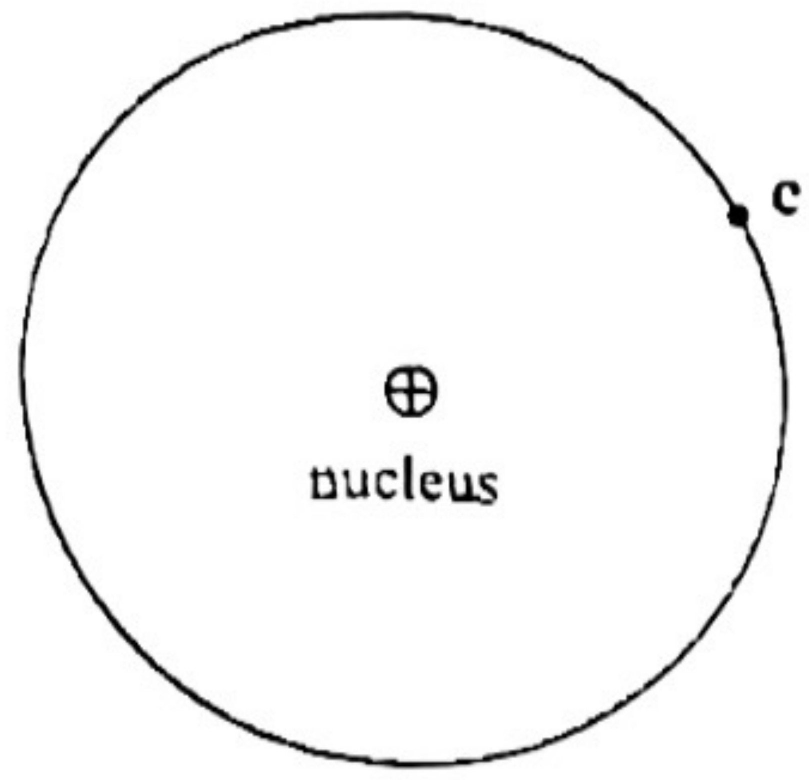
A B C D

2.8 Diamond and graphite consists of carbon atoms only. Which of the following statements comparing these two allotropes is **NOT** correct ?

A. The spatial arrangements of these two allotropes are different.
B. The melting point of these two allotropes are different.
C. The chemical properties of these two allotropes are different.
D. The electrical conductivity of these two allotropes are different.

A B C D

Q2 : Structured question



In Bohr's model of hydrogen atom, the nucleus consists of a positive charge $+e$ and an electron of charge $-e$ moves around the nucleus in uniform circular motion. Mass of an electron is m. The electron is assumed to move in orbit of radius r with a constant speed v.

(a) One of the postulates of the Bohr's atom is that the angular momentum of the electron is quantized. Write down an expression to show the quantization of the angular momentum of the electron. (1 mark)

(b) Another postulate of the Bohr's atom is that the electrostatic force between the nucleus and the electron provides the centripetal force of the electron.

(i) Find an expression for the radius r of the orbit. (2 marks)

(ii) Hence calculate the smallest possible radius of the electron's orbit. (1 mark)

(c) The energy of an electron in a hydrogen atom can be expressed as

$E_n = -\frac{E_o}{n^2}$ where E_o is the ionization energy of hydrogen atom and n is the quantum number

(i) Derive an expression for the wavelength λ of radiation emitted when the electron undergoes a transition from a higher energy level $n = a$ to a lower energy level $n = b$. (1 mark)

(ii) Given that the ionization energy of hydrogen atom is 13.6 eV. Calculate the wavelength of the photon emitted when the electron in the hydrogen atom transits from the third excited state to the ground state. Give your answer corrected to 4 significant figures. (2 marks)

(d) Electron is a particle. However, it also exhibits wave properties. Give one piece of evidence to show that electron can also behave like waves. (1 mark)

(e) Suppose the electron in a hydrogen atom is at the third excited state. By considering the radius in part (b) (ii), find the de Broglie wavelength of the electron in this excited state. (2 marks)

Section C : Energy and Use of Energy

Q.3 : Multiple-choice questions

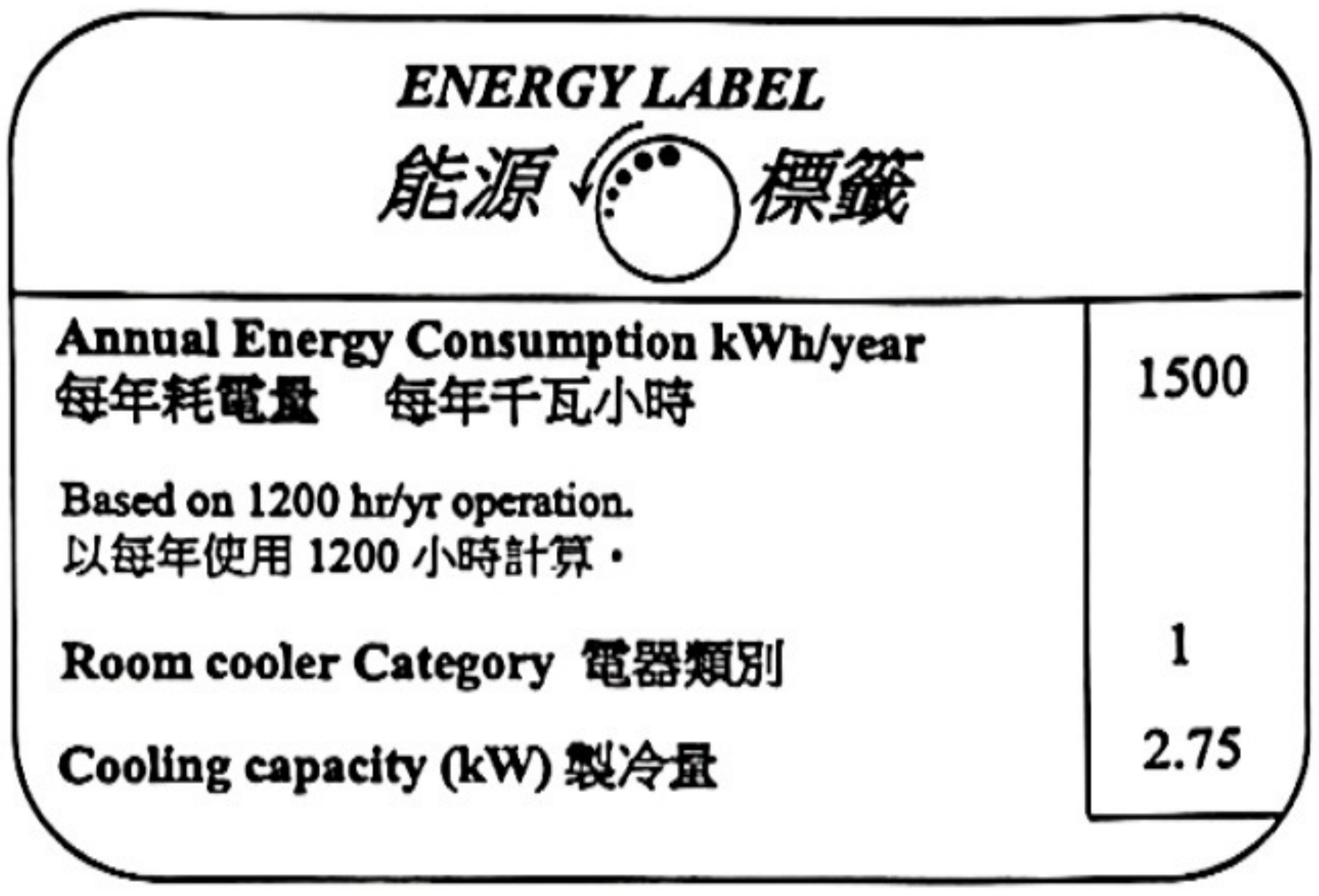
3.1 Which of the following statements concerning an induction cooker is/are correct ?

(1) An induction cooker consists of a coil producing varying magnetic field.
(2) Eddy current is induced in the induction cooker to generate heat.
(3) All cooking pot made of metal can be used for an induction cooker.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

A B C D

3.2

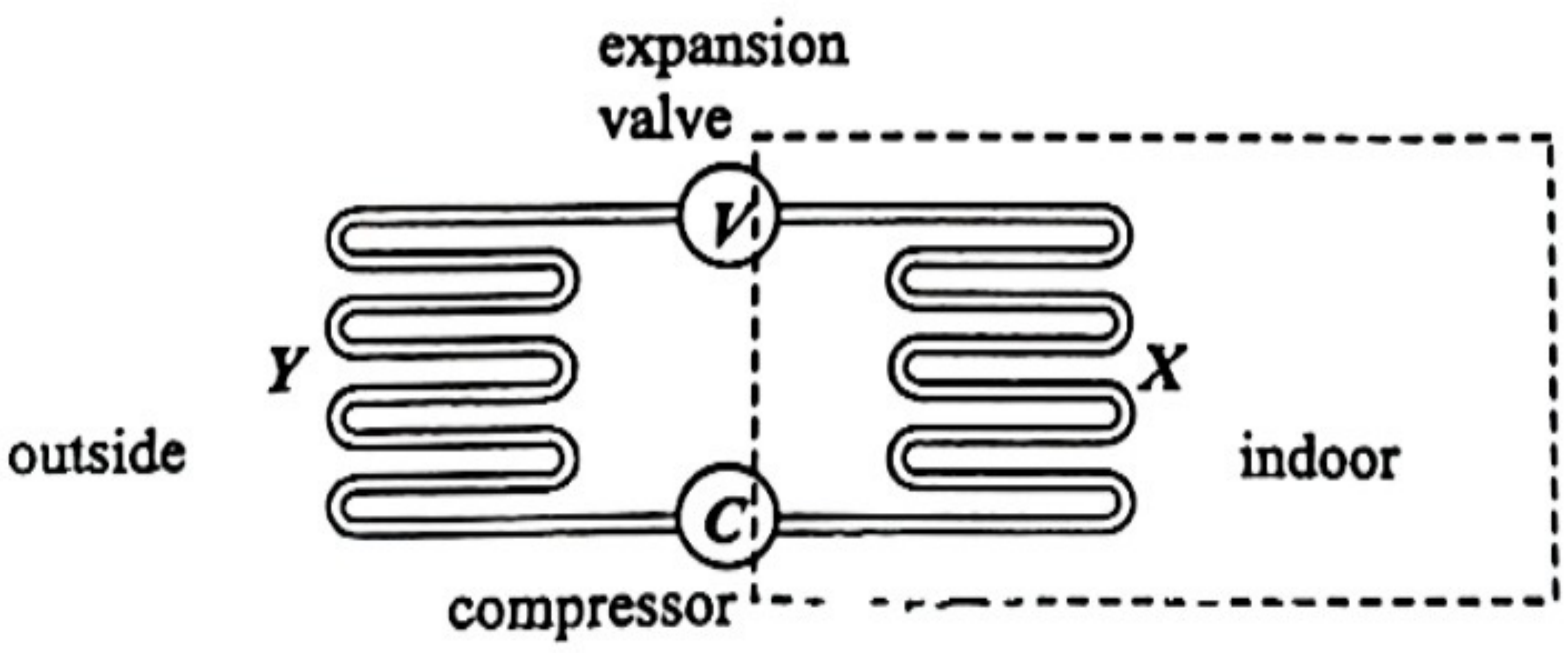


The above figure shows part of the energy label of an air-conditioner. Which of the following statements is **NOT** correct ?

A. The average power rating of the air-conditioner is 1250 W.
B. The amount of heat that can be removed from the room by the air-conditioner in 1 hour is 2.75 kWh.
C. During operation, the rate of heat released to the outdoor environment is 2750 W.
D. The coefficient of performance of the air-conditioner is 2.2.

A B C D

3.3



The above figure shows a simplified diagram of a 'reverse-cycle air conditioner' that can operate in cooling mode to give cool or warming mode to give warm air. If it is operated in warm air mode, which of the following statements is **NOT** correct ?

A. The coefficient of performance (COP) of the air-conditioner in cooling mode or warming mode are the same.
B. The direction of flow of the refrigerant is $C \rightarrow X \rightarrow V \rightarrow Y$.
C. The refrigerant flowing through the expansion valve V is in liquid state.
D. Latent heat of vaporization is absorbed by the refrigerant in component Y.

A B C D

3.4 Which of the following concerning an electric-petrol hybrid car is correct ?

A. The car needs to be charged regularly with the external charging plug in charging station.
B. Hybrid car has zero pipe emission.
C. The motor would become a generator during the regenerative braking of the car.
D. The battery in the hybrid car can only be charged by regenerative braking system.

A B C D

3.5 A typical fission reaction is as follows :

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{144}_{56}Ba + ^{90}_{36}Kr + 2^{1}_{0}n$$

Given : binding energy of $^{235}_{92}U$ nucleus = 7.587 MeV per nucleon

binding energy per nucleon of $^{144}_{56}Ba$ nucleus = 8.269 MeV per nucleon

binding energy per nucleon of $^{90}_{36}Kr$ nucleus = 8.591 MeV per nucleon

What is the mass defect in this fission reaction ?

A. 0.178 u
B. 0.184 u
C. 0.188 u
D. 0.194 u

A B C D

3.6 A hydroelectric storage system is designed to store the excess electrical energy in form of gravitational potential energy near a power plant. The power plant keeps running to give a steady electrical power output of 500 MW. In a day, there is about 8 hours of low demand period, that the average demand is only 180 MW. The excess power is then used to pump water from a lower reservoir to a higher reservoir at an average height of 250 m. If the conversion efficiency of energy is 75 %, what should be the capacity of the higher reservoir ? Given that the density of water is 1000 kg m^{-3}.

A. 2.82×10^{6} m^3
B. 3.73×10^{6} m^3
C. 5.64×10^{6} m^3
D. 6.25×10^{6} m^3

A B C D

3.7 A wind turbine can give out electrical power of 650 kW when the wind blows normally at the turbine with a constant velocity of 18 m s^{-1}. The turbine consists of 2 blades, each of length 15 m and the average density of air is 1.2 kg m^{-3}, what is the efficiency of the wind turbine ?

A. 23.5 %
B. 26.[illegible]
C. 28.8 %
D. 31.6 %

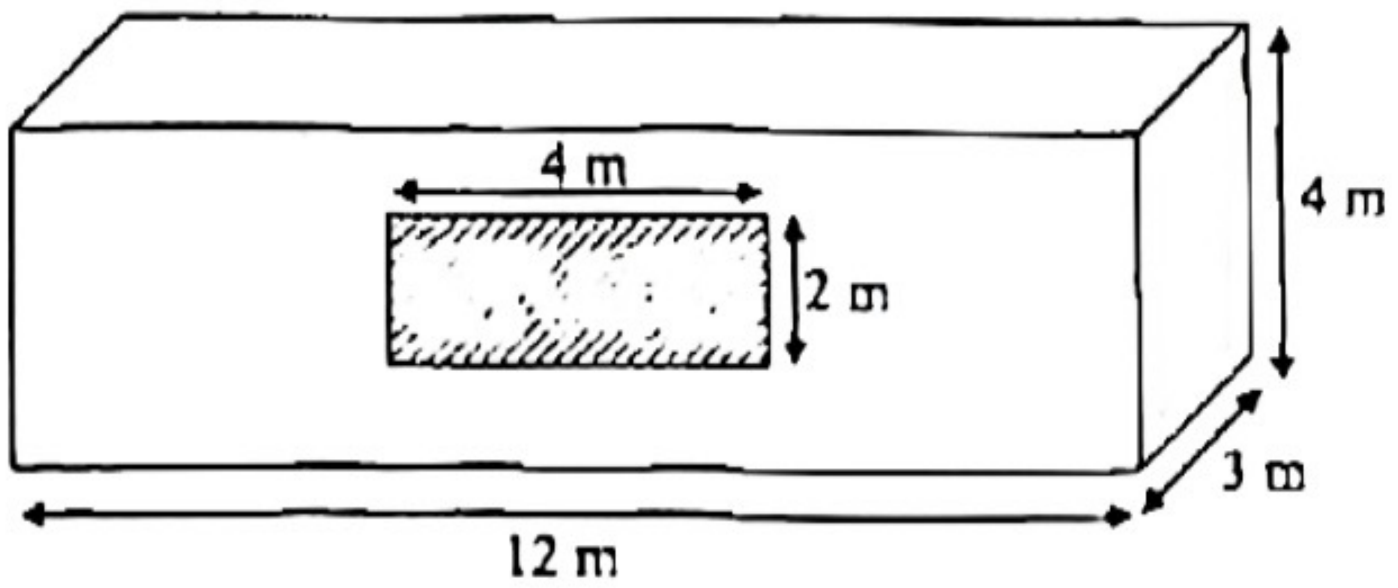
A B C D

3.8 Given that the solar constant is 1.38 kW m^{-2}. In a sunny day, the atmosphere absorbs an average of 42.5% of solar power. If a solar panel is designed to give an electrical power output of 4 kW, what should be the surface area ? Assume that the solar radiation shines at an incident angle of 25° with the normal of the panel and the efficiency of the solar panel is 15%.

A. 28 m
B. 37 m
C. 45 m
D. 53 m

A B C D

Q.3 : Structured question



A small house has a floor size of 12 m × 3 m with a height of 4 m. It has a window of 4 m × 2 m installed on the front side as shown in the above figure.

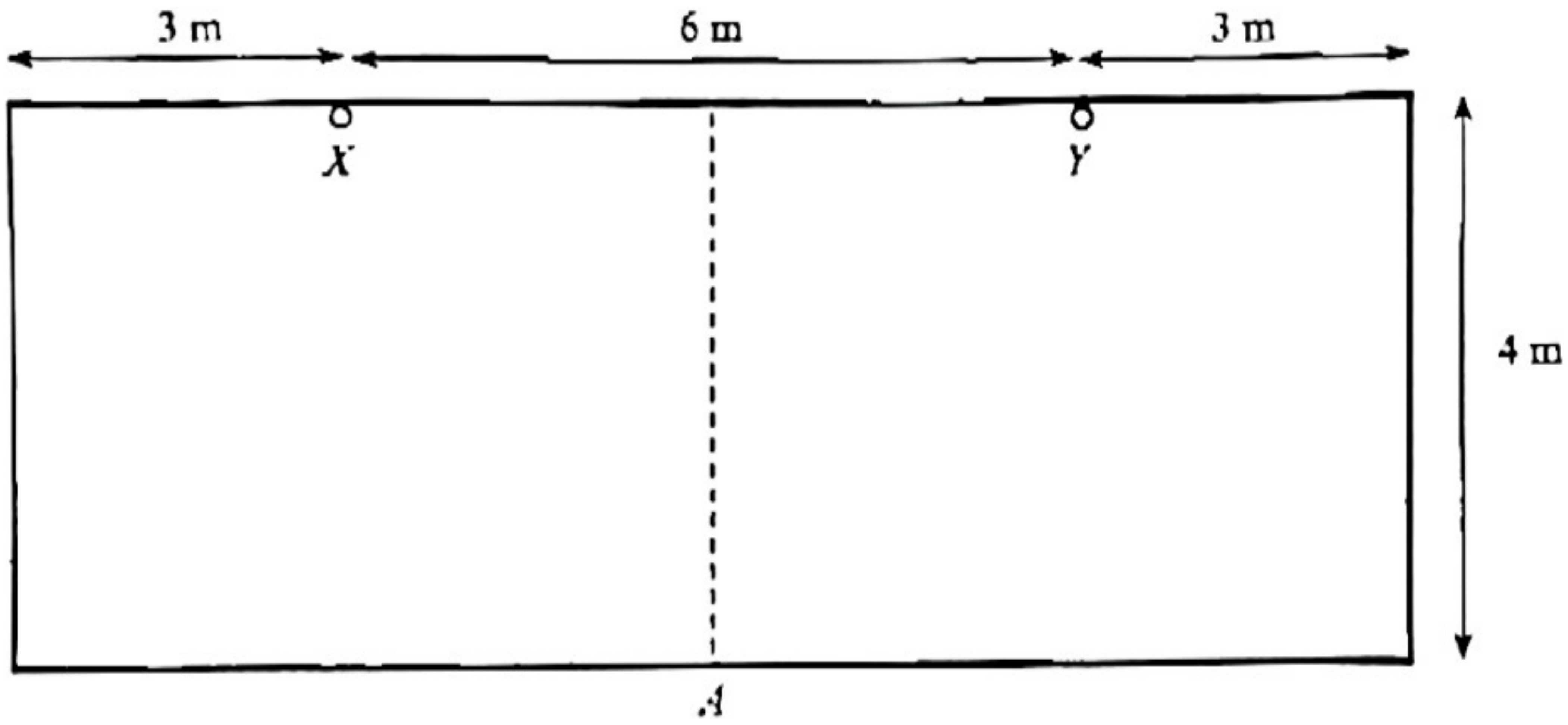
(a) The walls and ceiling of the house are made of concrete material. Given that the thermal transmittance of the concrete material is 1.5 W m^{-2} K^{-1} and that of the glass window is 2.8 m^{-2} K^{-1}. On average, the outdoor temperature is higher than the indoor by 10 °C. Apart from the bottom, heat can transfer into the house through all the five surfaces.

(i) Calculate the rate of heat transfer into the house by conduction through the walls and ceiling. (2 marks)

(ii) Estimate the Overall Thermal Transfer value (OTTV) of the house. (2 marks)

(iii) State **ONE** advantage and **ONE** disadvantage of increasing the size of the window. (2 marks)

(b)



Inside the house, there are two identical small lamps X and Y installed at the ceiling as shown. Each lamp has a power rating of 20 W. The efficacy of the lamp is 85 lumen W^{-1}.

(i) Calculate the luminous flux given out by each lamp. (1 mark)

(ii) Point A is at the middle of the floor. Find the illuminance at point A on the floor. Assume no other light sources other than these two lamps (2 marks)

(iii) Without changing the lamps, state **ONE** way to increase the illuminance at point A on the floor. (1 mark)

Section D : Medical Physics

Q.4 : Multiple-choice questions

4.1 When a man looks at a distant object, the power of his eye lens is 40 D. If he now changes to look at a near object placed at 25 cm away from him, what is the power of his eye lens ?

A. 40 D
B. 42 D
C. 44 D
D. 45 D

A B C D

○ ○ ○ ○

4.2 A boy observes two close objects in dim light. He finds that he can just resolve these two objects when he stands at 15 m away. However, under bright light condition, he finds that he has to walk a distance *d* towards the two objects in order to just resolve them. If the size of pupil of his eye changes from 3 mm in dim light to 2.5 mm in bright light, what is the distance *d* that he should move ?

A. 2.5 m
B. 7.5 m
C. 12.5 m
D. 14.5 m

A B C D

○ ○ ○ ○

4.3 A loudspeaker emits a sound. A man stands at 4 m away hears an intensity level of 50 dB. If now the man walks 1 m directly away from the loudspeaker, what would be the intensity level heard by him ?

A. 49 dB
B. 48 dB
C. 47 dB
D. 46 dB

A B C D

○ ○ ○ ○

4.4 When sound is transmitted from the eardrum via the ossicles to the oval window, pressure of the sound is amplified. If the ratio of the diameter of the eardrum to that of oval window is 4.5, and the gain of pressure by the lever action of the ossicles is 1.6, what is the total amplification of the pressure of the sound after passing the middle ear ? Assume the eardrum and the oval window are circular in shape.

A. 7.2
B. 12.7
C. 21.9
D. 32.4

A B C D

○ ○ ○ ○

4.5 Which of the following statements concerning an endoscope is/are correct ?

(1) Both the coherent and incoherent bundle can transmit images
(2) Light rays entering an optical fibre of the coherent bundle with incident angle greater than a certain value can be transmitted to the other end of the fibre.
(3) The refractive index of the cladding must be smaller than that of the core for light rays to undergo total internal reflection in an optical fibre.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

A	B	C	D
O	O	O	O

4.6 The intensity of a beam of X-ray drops to 60 % of the original after passing through 4.5 cm of a body tissue. What is the half-value thickness of this tissue ?

A. 2.7 cm
B. 4.5 cm
C. 5.2 cm
D. 6.1 cm

A	B	C	D
O	O	O	O

4.7 A radioactive isotope has a physical half-life of 12 hours. If 5 mg of this isotope is injected into the body of a patient, after 12 hours, only 1 mg is left in the body. What is the biological half-life of this isotope ?

A. 5.2 hours
B. 6.0 hours
C. 8.4 hours
D. 9.1 hours

A	B	C	D
O	O	O	O

4.8 Which of the following statements concerning radionuclide imaging (RNI) is correct ?

A. A scan that shows a hot spot confirms that a tumour exists.
B. Radionuclide imaging can provide the functional information about the organ.
C. The image resolution of a radionuclide image is much better than that of an X-ray radiographic image.
D. For the same purpose, radionuclide imaging gives smaller effective dose than X-ray radiographic imaging.

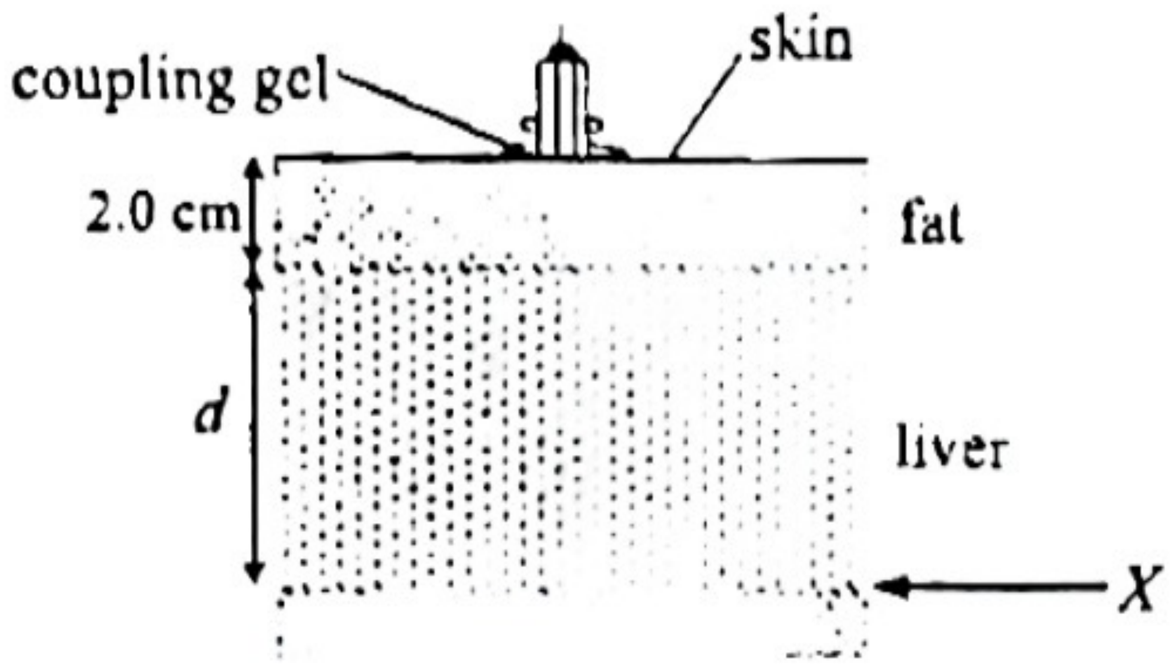
A	B	C	D
O	O	O	O

Q.4 : **Structured question**

The table shows information relating to the transmission of ultrasound through fat and liver.

Tissue	Speed of ultrasound / m s^{-1}	Acoustic impedance / kg m^{-2} s^{-1}
Fat	1450	1.37×10^6
Liver	1610	1.66×10^6

A transducer is pressed against a layer of coupling gel on the skin as shown. Pulses of ultrasound are produced by the transducer.



(a) Explain how a piezoelectric transducer can produce an ultrasound pulse. (2 marks)

(b) If a pulse of ultrasound of intensity 25 mW cm^{-2} is incident from fat to liver, what is the intensity of the ultrasound reflected from the interface ? (2 marks)

(c) If the echo time for the ultrasound pulse going to and reflect from the tissue interface X as shown in the figure is 145 μs, calculate the depth d of the liver. (2 marks)

(d) In medical ultrasound scanning, ultrasound of frequency in the range of 2 MHz to 15 MHz may be used. State **ONE** advantage and **ONE** disadvantage of using low frequency ultrasound for scanning purpose. (2 marks)

(e) There are two types of ultrasound scanning, the A-scan and the B-scan. State **TWO** differences of these two types of scan. (2 marks)

END OF PAPER

Section A

Answers

1.	B	6.	C	11.	C	16.	C	21.	B	26.	C	31.	A
2.	C	7.	A	12.	B	17.	B	22.	B	27.	D	32.	A
3.	A	8.	B	13.	B	18.	D	23.	C	28.	C	33.	B
4.	B	9.	D	14.	A	19.	A	24.	A	29.	B		
5.	A	10.	A	15.	B	20.	C	25.	C	30.	B		

Solution

1. B

Heat lost by the tea + heat lost by the cup = heat gained by the milk

$m_t c_t \Delta T_t + C_c \Delta T_c = m_m c_m \Delta T_m$

$(0.400)(4200)(90-\theta) + (250)(90-\theta) = (0.100)(3800)(\theta - 25)$

$\therefore \theta = 79.3\ °C$

2. C

By $PV = nRT$ $\therefore n = \dfrac{PV}{RT}$

$\Delta n = \dfrac{\Delta P \cdot V}{RT} = \dfrac{(200-120)\times 10^3 \times (500\times 10^{-6})}{(8.31)(25+273)} = 16\times 10^{-3}$ mol

3. A

✓ (1) As temperature drops, volume of the vessel decreases, thus average separation decreases.

✓ (2) As temperature decreases, the average speed of the molecules decreases, thus the change of momentum decreases in hitting the walls.

× (3) As the speed decreases, the gas molecules hit the walls less violently. However, to maintain constant pressure, the gas molecules must hit the walls more frequently.

4. B

Resultant displacement : s = net area under the graph $= \frac{1}{2}\times 4\times 15 - \frac{1}{2}\times 2\times 15 = 15$ m

Average velocity $= \dfrac{15}{6} = 2.5\ \text{m s}^{-1}$

5. A

Loss of potential energy = work done against friction

$mgh = fs$

$(1.2)(9.81)h = (2.5)(15)$ $\therefore h = 3.2$ m

6. C

Before the plasticine is dropped :

$(3) = (1.2)\,a \qquad \therefore\ a = 2.5\ \text{m s}^{-2}$

$F = (1.2 + 1.8)(2.5) = 7.5\ \text{N}$

After the plasticine is dropped :

$(7.5) = (1.2 + 1.8 + 1)\,a \qquad \therefore\ a = 1.875\ \text{m s}^{-2}$

$T = (1.2)(1.875) = 2.25\ \text{N}$

7. A

As the metre rule has a length of 1 m, the centre of gravity is at the mid-point M which is 0.5 m from O.

Take moment at O.

Moment of tension = moment of the weight W + moment of the weight of the metre rule

$(T \sin 35°)(0.5) = (0.8)(1) + (0.04 \times 9.81)(0.5)$

$\therefore\ T = 3.47\ \text{N}$

8. B

Work done by the engine = gain of KE + gain of PE

$W = \frac{1}{2} m v^2 + m g h = \frac{1}{2}(1500)(25)^2 + (1500)(9.81)(200 \sin 10°) = 979800\ \text{J}$

$P = \dfrac{W}{t} = \dfrac{(979800)}{(20)} = 49\,000\ \text{W} = 49\ \text{kW}$

9. D

(1) Since both particles move in the same direction after collision, they must both move to the right. The particle behind must move slower than the one in front, thus speed of B must be greater than A.

(2) Since the collision is elastic, kinetic energy is conserved. Thus, the loss of KE of A must be equal to the gain of KE of B.

(3) Since there is no external force acting on the system, the total momentum is conserved. Thus, the decrease of momentum of A must be equal to the increase of momentum of B.

10. A

The component of the applied force parallel to the incline is $F \cos \theta$.

$F \cos \theta - mg \sin \theta = m a$

$\therefore\ (10) \cos 15° - (1.2 \times 9.81) \sin 15° = (1.2)\,a$

$a = 5.5\ \text{m s}^{-2}$

11. C

Horizontal component : $s_x = u_x t \qquad \therefore\ (40) = u_x (2.5) \qquad \therefore\ u_x = 16\ \text{m s}^{-1}$

Vertical component : $s_y = u_y t + \frac{1}{2} a t^2 \qquad \therefore\ (15) = u_y (2.5) + \frac{1}{2}(-10)(2.5)^2 \qquad \therefore\ u_y = 18.5\ \text{m s}^{-1}$

$u = \sqrt{(16)^2 + (18.5)^2} = 24.5\ \text{m s}^{-1}$

12. B

For a banking road without friction, the horizontal component of the normal reaction provides the centripetal force F.

$F = R\sin\theta$

$mg = R\cos\theta$

$\dfrac{F}{mg} = \tan\theta \qquad \therefore\ F = mg\tan\theta = (1800)(9.81)\tan 15° = 4730\text{ N}$

13. B

By $g = \dfrac{GM}{R^2} \qquad \therefore\ GM = gR^2 = (9.81)(6400\times10^3)^2 = 4.018\times10^{14}$

By $\dfrac{GMm}{r^2} = mr\omega^2 \qquad \therefore\ \dfrac{GM}{r^3} = \left(\dfrac{2\pi}{T}\right)^2$

$\therefore\ \dfrac{(4.018\times10^{14})}{r^3} = \left(\dfrac{2\pi}{12\times3600}\right)^2 \qquad \therefore\ r = 26680\times10^3\text{ m} = 26680\text{ km}$

$\therefore\ h = 26680 - 6400 = 20280\text{ km}$

14. A

(1) Particle b is at the centre of the compression, while particle f is at the centre of rarefaction. Particle d at the middle between b and f is at the extreme point and is momentarily at rest. The displacement of particle d is the amplitude, which is 16 cm.

(2) The separation between 2 adjacent compressions is the wavelength. Thus, distance between b and j is one wavelength, which is 128 cm.

× (3) At that instant, a, b, c are moving towards the left and e, f, g are moving towards the right. Thus, c and e should move in opposite direction.

15. B

Since the wave is travelling towards the left, particle P is moving downwards.

For particle P to reach the crest, it performs $\frac{3}{4}$ cycle.

Period : $\dfrac{3}{4}T = 1.2 \qquad \therefore\ T = 1.6\text{ s}$

Wavelength : $\lambda = 60\text{ cm}\times\dfrac{2}{5} = 24\text{ cm}$

Speed : $v = \dfrac{\lambda}{T} = \dfrac{24}{1.6} = 15\text{ cm s}^{-1}$

16. C

$m = \dfrac{9}{3} = 3 \qquad \therefore\ \dfrac{v}{u} = 3 \qquad \therefore\ v = 3u$

Since the image is erect, it is virtual.

$\dfrac{1}{f} = \dfrac{1}{u} + \dfrac{1}{v} \qquad \dfrac{1}{(60)} = \dfrac{1}{u} + \dfrac{1}{(-3u)} \qquad \therefore\ u = 40\text{ cm}$

17. B

× A. Ultrasound travels with the same speed as audible sound, since speed does not depend on frequency.

✓ B. Ultrasound travels with greater speed in water than in air.
When a wave travels from a region of lower speed to a region of higher speed,
total internal reflection may occur, if the incident angle is large enough.

× C. Ultrasound is a wave, it possesses diffraction, although the diffraction is small.

× D. Ultrasound can be used to remove dirt, but it cannot be used to sterilize drinking water.
Ultraviolet radiation can be used to sterilize drinking water.

18. D

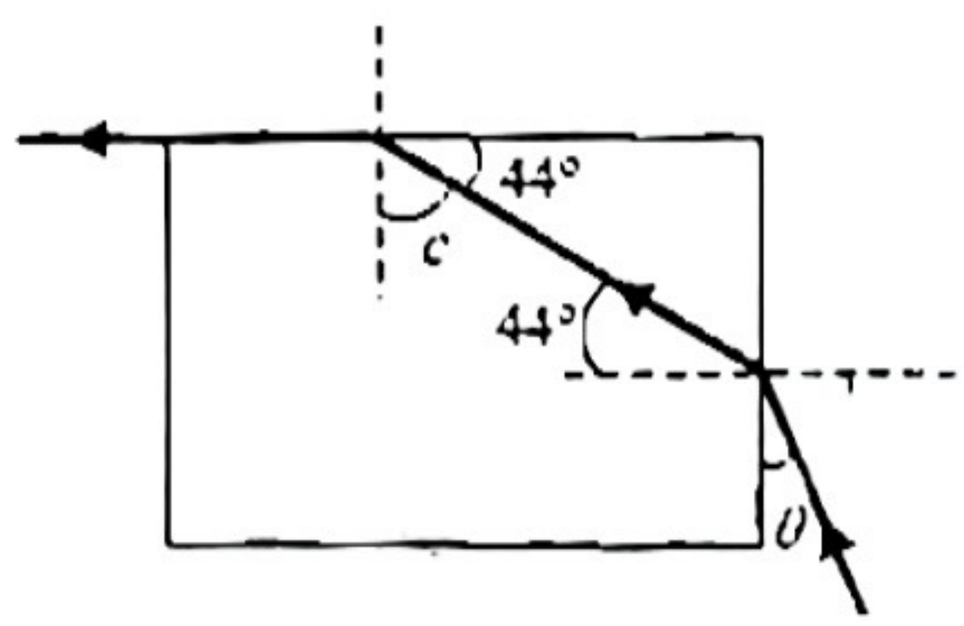
A. In a wave, all particles must vibrate with the same frequency, no matter travelling or stationary wave.

✓ B. Since X and Y are in opposite phase, they must always move in opposite directions.

✓ C. In a stationary wave, when a particle is at rest, all the particles must also be at rest.

× D. If the frequency is doubled, the wavelength is halved.
The number of loops of the stationary wave would increase from 3 loops to 6 loops.
X would then be in the second loop and Y in the fourth loop, counting from the vibrator.
Thus, X and Y would then be in phase.

19. A



From the figure, critical angle : $c = 90° - 44° = 46°$

By $n = \dfrac{1}{\sin c} = \dfrac{1}{\sin 46°} = 1.39$

When light ray enters the block from air,
incident angle is i and refracted angle is 44°.

By $n = \dfrac{\sin i}{\sin r}$ $\quad \therefore \ (1.39) = \dfrac{\sin i}{\sin 44°}$

$\therefore \ i = 74.95°$ $\quad \therefore \ \theta = 90° - 74.95° \approx 15°$

20. C

For the 5 dots, the middle one is the central bright dot.

The first and fifth dots are the second order bright dot at both sides.

The first dot is at 30 cm from the central dot. Since it is the second order, it makes angle θ_2 with the central line.

$\tan\theta_2 = \dfrac{0.30}{0.80}$ $\quad \therefore \ \theta_2 = 20.556°$

By $d\sin\theta = n\lambda$ $\quad \therefore \ (\dfrac{1\times10^{-3}}{300})\sin 20.556° = (2)\lambda$ $\quad \therefore \ \lambda = 5.85\times10^{-7}$ m

21. B

During refraction, $\sin\theta \propto v$

$\therefore \ \dfrac{\sin\theta_a}{\sin\theta_w} = \dfrac{v_a}{v_w}$ $\quad \therefore \ \dfrac{\sin 12°}{\sin\theta_w} = \dfrac{330}{1500}$ $\quad \theta_w = 71°$

22. B

The magnitude of electric field : $E \propto Q/r^2$

In the above figure, the arrows above the horizontal line represent the electric field by $-Q$ and the arrows below the horizontal represent the electric field by $-2Q$.

× (1) The resultant electric field at a is towards the right.
As the strength of electric field due to $-2Q$ is greater, the resultant electric field at b is towards the right.
Thus, they should be in the same direction.

× (2) The magnitude of electric field at b and c due to $-2Q$ are the same.
However, the electric field at b due to $-Q$ decreases the resultant but at c increases the resultant.
Thus, the magnitude of electric field at b should be smaller than that at c.

(3) The electric field due to $-Q$ at a is greater than that at d,
and the electric field due to $-2Q$ at a and d are the same,
thus the resultant electric field at a is greater than that at d.

23. C

Before the switch is closed, current through the light bulb is 0.48 A and voltage across it is 9.6 V.

Resistance of the light bulb : $R = \dfrac{9.6}{0.48} = 20\ \Omega$

Since two light bulbs are identical, the resistance of the other light bulb is also 20 Ω.

Voltage across the internal resistance $= 12 - 9.6 = 2.4$ V

Internal resistance of the battery : $r = \dfrac{2.4}{0.48} = 5\ \Omega$

After the switch is closed, equivalent resistance of the circuit $= 5 + \dfrac{20}{2} = 15\ \Omega$

Current given out by the battery : $I = \dfrac{12}{15} = 0.8$ A

24. A

Resistance of $A = \dfrac{(6)^2}{(12)} = 3\ \Omega$ Resistance of $B = \dfrac{(6)^2}{(18)} = 2\ \Omega$

For A to work normally, voltage across $A = 6$ V

Since A and B are in series, they have same current, thus, $V \propto R$

Voltage across $B = 4$ V

Voltage of the battery $= 6 + 4 = 10$ V

25. C

Energy stored in the battery : $E = QV = (4300 \times 10^{-3} \times 3600)(2.5) = 38700$ J

By $E = Pt$ $\therefore (38700) = (375 \times 10^{-3})\, t$ $\therefore t = 103200$ s $= 28.7$ hours

26. C

× A. When S is open, the circuit is not complete, thus current would not flow.

× B. When S is closed, current flows normally through the resistor, thus the fuse would not blow.

✓ C. If the insulation at X is worn out, current would flow through the fuse, via X to the earth. There is a short circuit between the live and the earth, and the current would become very large, thus the fuse would blow, even when S is open.

× D. If the insulation at Y is worn out, current would flow through the fuse, the resistor, via Y to the earth. As the current is limited by the resistor, the current is normal and the fuse will not blow.

27. D

A. By Right hand rule, the induced e.m.f. on the side DC is downwards, with point C at a higher potential. Thus, the induced current flowing in clockwise direction through the loop.

B. Induced e.m.f. $= BvL = (1.2)(2.5)(0.15) = 0.45$ V Induced current $= \frac{0.45}{0.5} = 0.9$ A

C. Whenever there is induced current, there is an opposing magnetic force. This magnetic force can also be determined by Left hand rule.

× D. Magnetic force $= BIL = (1.2)(0.9)(0.15) = 0.162$ N

28. C

By Left-hand rule, direction of magnetic force on the particle carrying negative charge is downward.

$$Bqv = \frac{mv^2}{r}$$

$\therefore (0.24)(1.6\times10^{-19}) = \frac{(4.8\times10^{-26})(2\times10^5)}{r}$ $\therefore r = 0.25$ m

29. B

By $\frac{N_P}{N_S} = \frac{V_P}{V_S}$ $\therefore \frac{550}{40} = \frac{220}{V_S}$ $\therefore V_S = 16$ V

Power output : $P_{out} = \frac{16^2}{12} \times 3 = 64$ W

By $\eta = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{V_{in} I_{in}}$

$\therefore 80\% = \frac{(64)}{(220) I_P}$ $I_P = 0.364$ A

30. B

By $P = VI$ $(500) = (20) I$ $\therefore I = 25$ A

By $P_{loss} = I^2 R$ $\therefore P_{loss} = (25)^2 (40) = 25\ 000$ W

Power output : $P_{out} = 500\ 000 - 25\ 000 = 475\ 000$ W

Efficiency $= \frac{P_{out}}{P_{in}} = \frac{(475000)}{(500000)} \times 100\% = 95\%$

31. A

When the activity drops to 60% of its initial value : $(0.6A_0) = A_0 \cdot e^{-k(30)}$ $\therefore$ $k = 0.0170\ \text{s}^{-1}$

When the activity drops to 30% of its initial value : $(0.3A_0) = A_0 \cdot e^{-(0.0170)t}$ $\therefore$ $t = 70.82\ \text{s} \approx 71\ \text{s}$

Time more to need $= 71 - 30 = 41$ s

32. A

$^{235}_{92}\text{U} \rightarrow {}^{207}_{82}\text{Pb} + x\ {}^{4}_{2}\text{He} + y\ {}^{0}_{-1}\text{e}$

✓ (1) Balancing the mass, $235 = 207 + 4x$ $\therefore$ $x = 7$

✓ (2) Balancing the charge, $92 = 82 + 2(7) + y(-1)$ $\therefore$ $y = 4$

✗ (3) Since the difference of the mass number between U-235 and Ra-225 is 10, which is not a multiple of 4, Ra-225 cannot be one of the daughter nuclide in the decay series.

33. B

$E = mc^2 = (2.5 \times 10^{30} \times 0.072\%) \times (3 \times 10^8)^2 = 1.62 \times 10^{44}$ J

$E = Pt$

$\therefore$ $(1.62 \times 10^{44}) = (4.0 \times 10^{26})\ t$

$\therefore$ $t = 4.05 \times 10^{17}$ s $= 1.3 \times 10^{10}$ years

Section B

1. (a) Put the thermometer into the liquid to measure its initial temperature T_1. [1]

Connect the heater to the low voltage supply and then put the heater into the liquid. [1]

Use the stopwatch to record the time of heating t. [1]

Measure the final temperature T_2 of the liquid.

The specific heat capacity of the liquid is found by : $c = \dfrac{40 \times t}{0.350 \times (T_2 - T_1)}$ [1]

(b) Add a stirrer and well stir the liquid to ensure uniform temperature of the liquid. [1]

OR

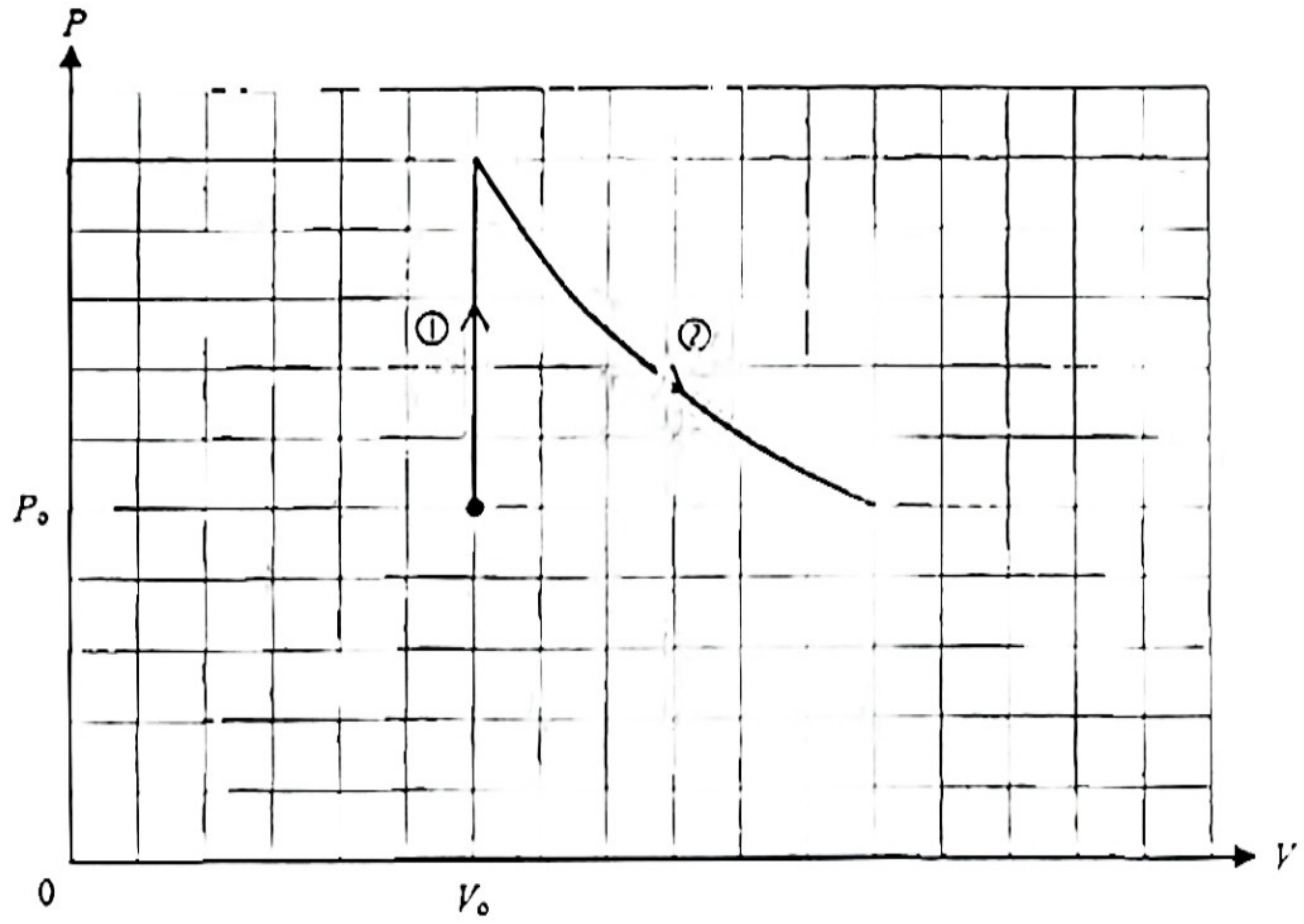
Add a lid so that the heat lost to the surrounding air can be reduced. [1]

(c) $m_i l_f = m_l c_l \Delta T_l$

$m_i (3.34 \times 10^5) = (0.350)(4000)(48 - 0)$ [1]

$m_i = 0.201$ kg [1]

2. (a)



< process ① : a vertical line from P_o to $2P_o$ > [1]

< process ② : a curve back to P_o with volume at $2V_o$ > [1]

(b) When the gas is heated, its kinetic energy increases and the molecules move faster. [1]

Therefore, the gas molecules hit the walls of the container more violently and more frequently. [1]

Thus, the pressure increases.

(c) $PV = \frac{1}{3} N m \overline{c^2} = \frac{1}{3} M \overline{c^2}$

$\therefore (125 \times 10^3)(350 \times 10^{-6}) = \frac{1}{3}(0.72 \times 10^{-3})\overline{c^2}$ [1]

$\therefore c = 427 \text{ m s}^{-1}$ < accept 425 to 430 m s^{-1} > [1]

3. (a) a = slope of the graph at 45 s $= -\frac{3.2}{10} = -0.32$ m s^{-2} [1]

Direction of a is downwards.

$\therefore$ $mg - R = ma$

$\therefore$ $(60)(10) - R = (60)(0.32)$ [1]

$\therefore$ $R = 580.8$ N < accept 581 N > [1]

Balance reading = 580.8 N

(b) Height that the lift moved = total area under the graph

$= \frac{1}{2}(20+50)(3.2)$ [1]

$= 112$ m [1]

(c) Average power output $= \frac{mgh}{t}$

$= \frac{(60)(10)(112)}{(50)}$ [1]

$= 1344$ W < accept 1340 W > [1]

(d) Any **ONE** of the following : [1]

* Install an emergency braking system.
* Attach strong springs under the lift.

4. (a) $\frac{1}{2}(m+M)v^2 = (m+M)gh$

$\therefore$ $\frac{1}{2}v^2 = (9.81)(0.126)$ [1]

$\therefore$ $v = 1.57$ m s^{-1} [1]

(b) $mu = (m+M)v$

$\therefore$ $(1.2)u = (1.2+53.8)(1.57)$ **OR** $(0.0012)u = (0.0012+0.0538)(1.57)$ [1]

$\therefore$ $u = 72.0$ m s^{-1} < accept 72 to 72.1 m s^{-1} > [1]

(c) Kinetic energy is not conserved since the collision is inelastic. [1]

(d) If the bullet rebounds backward, the change of momentum of the bullet would be greater. [1]

By the Law of conservation of momentum, the gain of momentum of the block is greater. [1]

Thus, the block would rise up to a higher vertical height. [1]

5. (a) $v = R\omega = R\cdot\frac{2\pi}{T}$

$\therefore$ $v = (6380\times10^3)\cdot\frac{2\pi}{(24\times3600)}$ [1]

$v = 464$ m s^{-1} [1]

5. (b) $g = \frac{GM}{R^2}$ $\therefore GM = gR^2 = (9.81)(6380\times10^3)^2 = 3.993\times10^{14}$ [1]

The period of parking satellite is 24 hours.

$\frac{GMm}{r^2} = mr\omega^2$ $\therefore \frac{GM}{r^3} = \omega^2 = (\frac{2\pi}{T})^2$ [1]

$\frac{(3.993\times10^{14})}{r^3} = (\frac{2\pi}{24\times3600})^2$ $\therefore r = 4.23\times10^7$ m [1]

(c) $a = r\omega^2 = (4.23\times10^7)(\frac{2\pi}{24\times3600})^2$ [1]

$\therefore a = 0.224$ m s^{-2} [1]

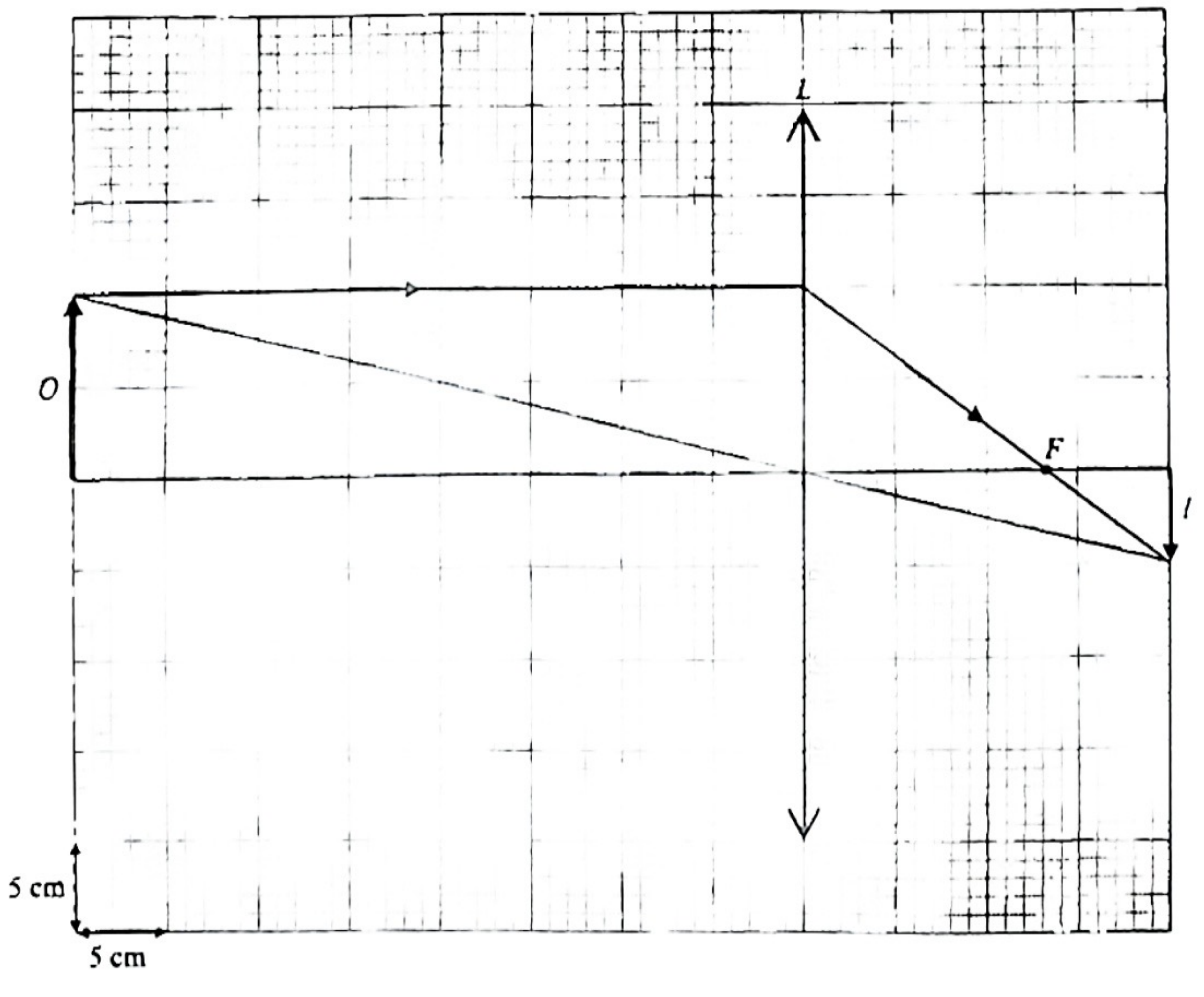
OR

$a = g = \frac{GM}{r^2} = \frac{(3.993\times10^{14})}{(4.23\times10^7)^2}$ **OR** $a = g = (9.81)\times\left(\frac{6380\times10^3}{4.23\times10^7}\right)^2$ [1]

$\therefore a = 0.223$ m s^{-2} [1]

(d) The ground station can transmit the radio signals to the satellite in a fixed direction without the need of tracking. [1]

6. (a)



< a line joining the arrow of object and the arrow of image properly drawn, with the lens L correctly drawn > [1]

< a horizontal ray drawn from the object to the image, with F properly marked > [1]

6. (b) Focal length = 13.2 cm < accept 13 to 14 cm > [1]

(c) The image distance increases. [1]

The image size increases. < Image becomes magnified NOT accepted > [1]

(d) (i) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\therefore \frac{1}{(13.2)} = \frac{1}{(8)} + \frac{1}{v}$ [1]

$\therefore v = -20.3$ cm

Image distance is 20.3 cm < accept 19.4 to 20.8 cm > [1]

Magnification $= \frac{v}{u} = \frac{20.3}{8} = 2.54$ < accept 2.4 to 2.6 > [1]

(ii) magnifying glass [1]

7. (a) Period $= 4 \times 0.2 = 0.8$ ms [1]

Frequency $= \frac{1}{0.8 \times 10^{-3}} = 1250$ Hz [1]

(b) (i) Path difference at Y = 2.54 − 2.15 = 0.39 m

Since Y is at the second minimum, path difference at Y is 1.5λ.

$\therefore 0.39 = 1.5\lambda$ [1]

$\therefore \lambda = 0.26$ m [1]

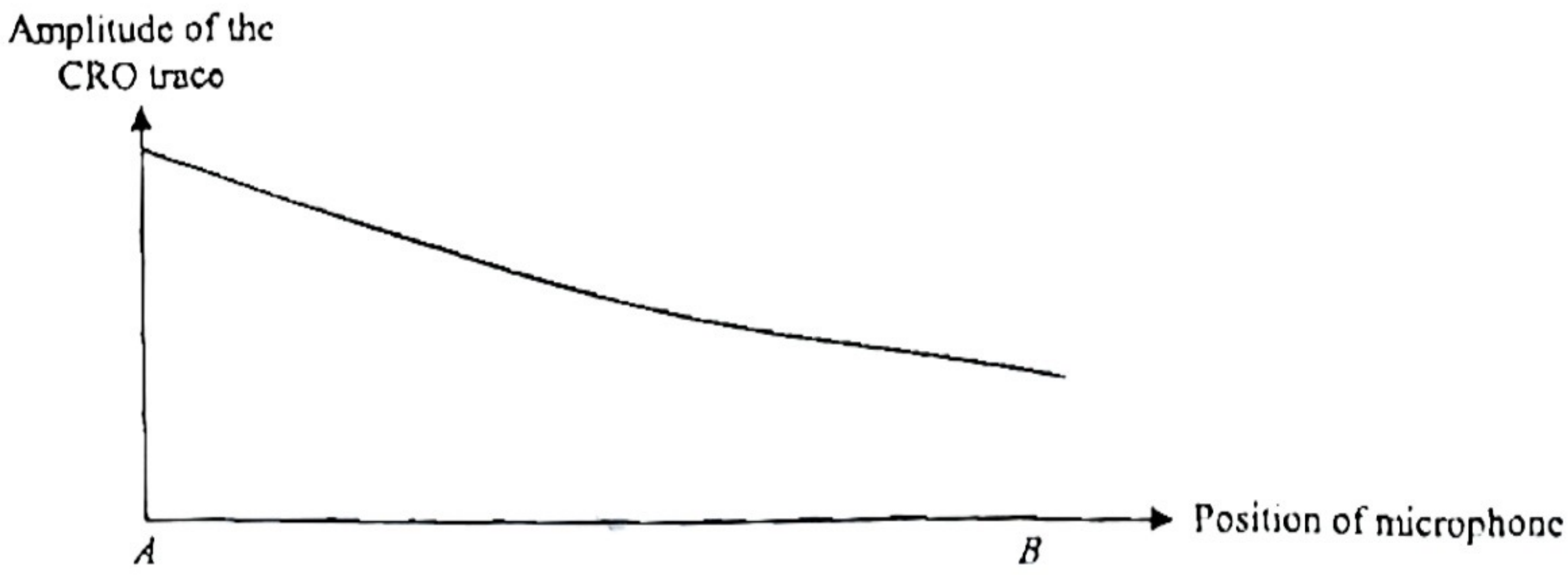
(ii) $v = f\lambda = (1250)(0.26)$ [1]

$\therefore v = 325$ m s^{-1} [1]

(c) Number of points of minimum detected : 4 [1]

[$a = 1 \text{ m} = \frac{1}{0.26}\lambda = 3.84\lambda$, thus path difference may be $\frac{1}{2}\lambda$, $1\frac{1}{2}\lambda$, $2\frac{1}{2}\lambda$, $3\frac{1}{2}\lambda$]

(d)



< a line (straight or curve) decreases gradually from A to B >

[1]

8. (a) Z to A ; X to B ; Y to C [1]

(b) If the earth wire is not connected, then when the live wire accidentally touches the metal case, someone touching the metal case will get an electric shock. [1]

(c) (i) Resistance of the kettle $= \dfrac{(240)^2}{(2000)} = 28.8\ \Omega$ [1]

Actual power $= \dfrac{V'^2}{R} = \dfrac{(220)^2}{(28.8)} = 1680$ W [1]

(ii) $Pt \times (1 - 20\%) = mc\Delta T + C\Delta T$ [1]

$(1680)\,t \times 80\% = (1.8)(4200)(100 - 25) + (800)(100 - 25)$ [1]

$\therefore\ t = 467$ s [1]

(iii) $E = Pt = (1680)(467) = 784\,560$ J $= 0.218$ kW h [1]

Cost $= 0.218 \times 1.2 = \$\,0.262$ [1]

OR

$E = Pt = \dfrac{1680}{1000}$ kW $\times \dfrac{467}{3600}$ h $= 0.218$ kW h [1]

Cost $= 0.218 \times 1.2 = \$\,0.262$ [1]

(d) His comment is not correct. [1]

Current still flows through the resistor and the kettle works normally. [1]

9. (a) $\dfrac{V_P}{V_S} = \dfrac{N_P}{N_S}$

$\therefore\ \dfrac{(22)}{(275)} = \dfrac{N_P}{(5000)}$

$\therefore\ N_P = 400$ [1]

(b) (i) $P = VI$

$\therefore\ (385 \times 10^6) = (275 \times 10^3)\,I$ [1]

$\therefore\ I = 1400$ A [1]

(ii) Resistance of the cable $= 0.08 \times 15 = 1.2\ \Omega$ [1]

Power loss $= I^2R = (1400)^2(1.2) = 2\,352\,000$ W $= 2.352$ MW [1]

Power output $= 385 - 2.352 = 382.648$ MW < accept 383 **OR** 382.6 **OR** 382.65 MW > [1]

(c) ① Transmit the power using a higher voltage. [1]

② Use thicker transmission cable to reduce the resistance. [1]

(d) A.c. can be stepped up by transformers efficiently to reduce the current through the transmission cables, thus reduce the power loss during transmission. [1]

10. (a) $^{210}_{84}\text{Ra} \longrightarrow {}^{206}_{82}X + {}^{4}_{2}\text{He}$ (**OR** $^{4}_{2}\alpha$) [1]

(b) Place the GM counter close to the sample to record the count rate.

Move the GM counter away to a distance greater than a few centimetres, the count rate drops suddenly. [1]

OR

Place the GM counter close to the sample to record the count rate.

Insert a paper between the sample the GM counter, count rate drops significantly. [1]

(c) $M = M_o\left(\frac{1}{2}\right)^{t/t_{1/2}}$

$\therefore\ 0.65M_o = M_o\left(\frac{1}{2}\right)^{(84)/t_{1/2}}$ [1]

$\therefore\ t_{1/2} = 135$ days [1]

(d) $k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{(135 \times 24 \times 3600)}$ [1]

$\therefore\ k = 5.94 \times 10^{-8}\ \text{s}^{-1}$ <accept $5.91 \times 10^{-8}\ \text{s}^{-1}$> [1]

OR

$M = M_o\,e^{-kt}$

$\therefore\ (0.65\,M_o) = M_o\,e^{-k(84 \times 24 \times 3600)}$ [1]

$\therefore\ k = 5.94 \times 10^{-8}\ \text{s}^{-1}$ [1]

(e) $A_o = k\,N_o$

$\therefore\ (500 \times 10^6) = (5.94 \times 10^{-8})\,N_o$ [1]

$\therefore\ N_o = 8.42 \times 10^{15}$ [1]

$M_o = \frac{(8.42 \times 10^{15})}{(6.02 \times 10^{23})} \times 0.210$

$= 2.94 \times 10^{-9}$ kg <accept 2.90 to 2.98×10^{-9} kg> <accept 2.94×10^{-6} g> [1]

(f) smoke detector [1]

Section A : Astronomy and Space Science

1.1 B

× (1) During prograde motion, Mars moves from West to East.
During retrograde motion, Mars should move from East to West.

✓ (2) When Mars and Earth are at the same side of the Sun, Earth overtakes Mars to give retrograde motion.

× (3) Ptolemy's geocentric model can still explain the retrograde motion by use of epicycle.

1.2 A

✓ (1) By Kepler's second law, the planet sweeps equal areas in equal times.
Thus, the speed and hence the kinetic energy are the greatest when the planet is closest to the Sun.

× (2) As the potential energy : $U = -GMm/r$,
the potential energy is greatest when it is farthest away from the Sun.

× (3) Since the motion is not circular, the gravitational force is not always perpendicular to the motion.

1.3 B

The gravitational field g at the surface is 9.81 N kg^{-1}.

$$g = \frac{GM}{R^2}$$

$$\therefore \frac{GM}{R} = gR = (9.81)(6400 \times 10^3) = 6.28 \times 10^7$$

By conservation of energy,

$KE + PE$ = constant (gravitational PE is zero at infinity)

$$\therefore \frac{1}{2}mu^2 + (-\frac{GMm}{R}) = \frac{1}{2}mv^2 + (0)$$

$$\frac{1}{2}u^2 + (-\frac{GM}{R}) = \frac{1}{2}v^2$$

$$\therefore \frac{1}{2}u^2 + (-6.28 \times 10^7) = \frac{1}{2}(5000)^2$$

$$u = 12300 \text{ m s}^{-1}$$

1.4 A

From aphelion to perihelion, it is half a cycle that takes half period.

$\therefore$ Period : $T = 70 \times 2 = 140$ hours

By $T^2 = \dfrac{4\pi^2 a^3}{GM}$

$$\therefore (140 \times 3600)^2 = \frac{4\pi^2 (356000 \times 10^3)^3}{(6.67 \times 10^{-11})M}$$

$$\therefore M = 1.05 \times 10^{26} \text{ kg}$$

1.5 D

× (1) Apparent magnitude m represents the brightness of the star observed on Earth.
The smaller the apparent magnitude m, the brighter the star is.
Since star Y has a smaller value of m than X, star Y is brighter than X.

(2) Absolute magnitude M compares the actual brightness if it is placed at the same distance of 10 pc.
Thus, M represents the luminosity, that is, the power of light energy given out.
Since star X has a smaller value of M, star X has greater luminosity.

(3) Distance of the star can be compared by considering the value of $(m - M)$.

For star X: $m - M = 3.6 - 2.4 = 1.2 > 0$ $\quad \therefore d > 10$ pc

For star Y: $m - M = 1.8 - 3.2 = -1.4 < 0$ $\quad \therefore d < 10$ pc

Thus, star X is farther away from the Earth than star Y.

1.6 B

By $L = 4\pi R^2 \sigma T^4$

$$\therefore \frac{L_X}{L_S} = \left(\frac{R_X}{R_S}\right)^2 \left(\frac{T_X}{T_S}\right)^4$$

$$\therefore (30000) = (25)^2 \left(\frac{T_X}{5800}\right)^4$$

$\therefore T_X = 15300$ K

1.7 C

Radial velocity : $v_r = v \cos \theta$

By Doppler effect,

$$\frac{v_r}{c} = \frac{\Delta\lambda}{\lambda_0} \qquad \therefore \frac{v \cos 24°}{3 \times 10^8} = \frac{(625.48 - 624.35)}{(624.35)} \qquad \therefore v = 594 \text{ km s}^{-1}$$

1.8 C

Distance of the star from the Earth :

$$d = \frac{1}{p} = \frac{1}{0.125} = 8 \text{ pc} = 8 \times 3.09 \times 10^{16} = 2.472 \times 10^{17} \text{ m}$$

Brightness of the star : $b = \dfrac{L}{4\pi d^2}$

$$\therefore (3.6 \times 10^{-7}) = \frac{L}{4\pi(2.472 \times 10^{17})^2} \qquad \therefore L = 2.76 \times 10^{29} \text{ W}$$

Q1. (a) (i) Gravitational force provides the centripetal force :

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$ [1]

$$\therefore K = \frac{1}{2}mv^2 = \frac{GMm}{2r}$$ [1]

(ii) $U = -\frac{GMm}{r}$ [1]

Total mechanical energy :

$$E = K + U$$

$$= (\frac{GMm}{2r}) + (-\frac{GMm}{r})$$

$$= -\frac{GMm}{2r}$$ [1]

(b) (i) $K = \frac{GMm}{2r}$

$$\therefore (1.3 \times 10^{11}) = \frac{(6.67\times10^{-11})(6.02\times10^{24})(5000)}{2r}$$

$\therefore r = 7.72 \times 10^6$ m < accept 7720 km > [1]

(ii) $E = -\frac{GMm}{2r} = -1.3 \times 10^{11}$ J [1]

(iii) $E = -\frac{GMm}{2r}$

$$\therefore (-1.3\times10^{11} + 10^{11}) = -\frac{(6.67\times10^{-11})(6.02\times10^{24})(5000)}{2r}$$ [1]

$\therefore r = 3.35 \times 10^7$ m < accept 33500 km > [1]

(c) The student is not correct since at orbit of radius r, the weight (OR gravitational force) is $\frac{GMm}{r^2} \neq 0$. [1]

The astronaut is 'weightless' because his weight is completely used for centripetal acceleration (OR force), [1]

thus there is no normal reaction acting on him by the floor.

Section B : Atomic World

2.1 D

① $P = IA$ ∴ $P \propto I$ ∴ $I \to 2I \Rightarrow P \to 2P$

② $P = \frac{N}{t} \cdot \frac{hc}{\lambda}$ ∴ $P \to 2P$ and $\lambda \to 2\lambda \Rightarrow \frac{N}{t} \to 4\frac{N}{t}$

③ $\frac{n}{t} \propto \frac{N}{t}$ ∴ $\frac{n}{t} \to 4\frac{n}{t}$ ∴ $\frac{n}{t} = 4 \times (2 \times 10^{10}) = 8 \times 10^{10}$

2.2 A

Since the anode is negative, photoelectrons decelerate in moving from cathode to anode with a decrease of KE.

∴ Maximum KE of photoelectrons emitted from cathode $C = 2.4 + 1.2 = 3.6$ eV

By Einstein's Photoelectric equation :

Energy of a photon of the incident light :

$E = \phi + K_{max} = (1.6) + (3.6) = 5.2$ eV

By $E = \frac{hc}{\lambda}$

∴ $(5.2 \times 1.6 \times 10^{-19}) = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{\lambda}$

∴ $\lambda = 2.39 \times 10^{-7}$ m

2.3 C

For the light having the lowest frequency, energy of photon is the lowest.

Thus, the emitted photoelectrons should have the lowest K_{max},

resulting in a smallest stopping potential V_S ($K_{max} = e V_S$)

Curve III has the smallest stopping potential V_S.

Thus, curve III has the lowest frequency.

[Note that since the intensity may not be the same, the saturation current does not need to be considered.]

2.4 B

Energy of the ultraviolet photon :

$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{(97.5 \times 10^{-9})} \times \frac{1}{1.6 \times 10^{-19}} = 12.75$ eV

Energy level of the ground state of hydrogen atom : $E_1 = -13.6$ eV

After absorbing the ultraviolet photon, the hydrogen atom is excited to a higher level.

Energy level at the excited state $= (-13.6) + 12.75 = -0.85$ eV

By $E = -\frac{13.6}{n^2} = -0.85$ ∴ $n = 4$

Hydrogen atom is excited to the quantum number of 4, which is the third excited state.

The transition from $n = 4$ to $n = 2$ and the transition from $n = 3$ to $n = 2$ give spectral lines in Balmer series.

Thus, number of lines in visible light region is 2.

2.5 A

(1) Line X corresponds to the transition of electron from E_∞ to E_2, that has the highest frequency and shortest wavelength.

(2) Line Y is the transition of electron from E_3 to E_2.

Energy level of hydrogen : $E_n = -\frac{E_o}{n^2}$ where $E_o = 13.6$ eV

$$\therefore \left(-\frac{E_o}{9}\right) - \left(-\frac{E_o}{4}\right) = \frac{hc}{\lambda}$$

$$\therefore (13.6)\times 1.6\times 10^{-19}\times\left(\frac{1}{4}-\frac{1}{9}\right) = \frac{(6.63\times 10^{-34})(3\times 10^8)}{\lambda}$$

$$\therefore \lambda = 6.58\times 10^{-7}\text{ m} \approx 660\text{ nm}$$

× (3) Only the rightmost 4 lines are in the visible light region. Others are in the ultra-violet region.

2.6 D

By Rayleigh criterion, resolving power :

$$\theta = 1.22\frac{\lambda}{d} = 1.22\times\frac{550\times 10^{-9}}{4\times 10^{-3}} = 1.6775\times 10^{-4}\text{ rad}$$

Angular separation between two objects :

$$\theta = \frac{a}{L} \quad \therefore (1.6775\times 10^{-4}) = \frac{a}{(40)}$$

$$\therefore a = 6.71\times 10^{-3}\text{ m} = 6.71\text{ mm}$$

2.7 A

(1) The surface of a Lotus leaf is highly water repelling, which is hydrophobic.

(2) Since the leaf surface is hydrophobic, water will not stick to the surface but roll off easily.

× (3) Nano-sized materials cannot be observed by optical microscope, but can only be observed by electron microscope.

2.8 C

A. Carbon atoms in diamond are arranged in tetrahedral structure but carbon atoms in graphite are arranged in hexagonal structure.

B. Since the two allotropes have different arrangement of atoms with different bonding forces, their melting points must be different.

C. Since the two allotropes consists of carbon atoms only, their chemical properties must be the same.

D Diamond does not have free electrons, thus diamond cannot conduct electrical. Graphite consists of free electrons, thus graphite conducts electricity well.

Q2. (a) $m v r = n \dfrac{h}{2\pi}$ [1]

(b) (i) $\dfrac{e^2}{4\pi\varepsilon_0 r^2} = \dfrac{m v^2}{r}$ $\therefore v^2 = \dfrac{e^2}{4\pi\varepsilon_0 m r}$ [1]

From the expression of angular momentum :

$$v = \frac{n h}{2\pi m r}$$

$$\frac{e^2}{4\pi\varepsilon_0 m r} = \left(\frac{n h}{2\pi m r}\right)^2$$

$$r = n^2 \frac{h^2 \varepsilon_0}{\pi m e^2}$$ [1]

(ii) $r_1 = (1)^2 \dfrac{(6.63\times10^{-34})^2 (8.85\times10^{-12})}{\pi(9.11\times10^{-31})(1.60\times10^{-19})^2} = 5.31\times10^{-11}$ m [1]

(c) (i) $\Delta E_{ba} = hf = \dfrac{hc}{\lambda}$

$$\therefore \left(\frac{-E_0}{a^2}\right) - \left(\frac{-E_0}{b^2}\right) = \frac{hc}{\lambda}$$

$\dfrac{1}{\lambda} = \dfrac{E_0}{hc}\left(\dfrac{1}{b^2} - \dfrac{1}{a^2}\right)$ **OR** $\lambda = \dfrac{hc}{E_0}\left(\dfrac{1}{b^2} - \dfrac{1}{a^2}\right)^{-1}$ [1]

(ii) $\dfrac{1}{\lambda} = \left[\dfrac{13.6 \times (1.6\times10^{-19})}{(6.63\times10^{-34})(3\times10^8)}\right]\left(\dfrac{1}{1^2} - \dfrac{1}{4^2}\right)$ [1]

$\therefore \lambda = 1.026 \times 10^{-7}$ m [1]

(d) Electron diffraction [1]

(e) At third excited state, $n = 4$.

Radius : $r_4 = 4^2 \times r_1 = 4^2 \times (5.31 \times 10^{-11}) = 8.496 \times 10^{-10}$ m [1]

Angular momentum : $mvr = n\dfrac{h}{2\pi}$ $\therefore mv \times (8.496 \times 10^{-10}) = (4) \times \dfrac{(6.63\times10^{-34})}{2\pi}$

Momentum : $p = mv = 4.968 \times 10^{-25}$

De Broglie wavelength : $\lambda = \dfrac{h}{p} = \dfrac{(6.63\times10^{-34})}{(4.968\times10^{-25})} = 1.33\times10^{-9}$ m [1]

OR

At third excited state, $n = 4$.

Radius : $r_4 = 4^2 \times r_1 = 4^2 \times (5.31 \times 10^{-11}) = 8.496 \times 10^{-10}$ m [1]

By $2\pi r = n\lambda$

$\therefore 2\pi(8.496 \times 10^{-10}) = (4)\lambda$

$\therefore \lambda = 1.33 \times 10^{-9}$ m [1]

Section C : Energy and Use of Energy

3.1 A

✓ (1) Inside an induction cooker, there is a coil which produces magnetic field when current flows. Since the current flowing through the coil is a.c., the magnetic field produced by the coil is varying.

× (2) Eddy current should be induced in the cooking pot, not in the induction cooker.

× (3) Only those cooking pot made of ferrous material (iron or steel) can be used.

3.2 C

✓ A. By $W = Pt$ $\therefore$ (1500 kWh) = P(1200 h) $\therefore$ P = 1.25 kW = 1250 W

✓ B. Cooling capacity = 2.75 kW

$\therefore$ Heat removed in 1 hour = 2.75 kW × 1 h = 2.75 kWh

× C. $\frac{Q_H}{t} = \frac{Q_C}{t} + \frac{W}{t}$ = 2.75 kW + 1.25 kW = 4 kW

$\therefore$ Rate of heat released should be 4000 W.

D. Q_C = 2.75 kW × 1200 h = 3300 kWh

$\therefore$ COP = $\frac{Q_C}{W} = \frac{(3300)}{(1500)} = 2.2$

3.3 A

× A. In cooling mode, COP = Q_C / W. In warming mode, COP = Q_H / W.

Since $Q_H = Q_C + W$, Q_H must be greater than Q_C.

Thus, the COP in warming mode must be greater than that in cooling mode.

B. Consider the compressor C, refrigerant is compressed to change from vapour to liquid in the next component to release latent heat to the hot reservoir.

Since it is in warming mode, heat is released to indoor, thus the flow of refrigerant must be from C to X.

C. After flowing through condenser X, the refrigerant is condensed to liquid state.

Thus, the refrigerant passing V is in liquid state.

D. In warming mode, Y is the evaporator where the refrigerant changes from liquid to vapour and latent heat of vaporization is absorbed here.

3.4 C

× A. There is no need to charge the car in charging station,

the battery is charged by the generator during braking, deceleration and slow motion.

B. Hybrid car must contain combustion engine, thus it produces pipe emission of gases.

C. Motor and generator have the same structure, during regenerative braking,

the motor is used as a generator to convert kinetic energy into electrical energy to charge the battery.

D. The battery in a hybrid car can be charged in two ways :

(1) braking of the car by regenerative braking system

(2) using engine mode and the excess mechanical power drives the generator to produce electricity

3.5 D

Binding energy of U-235 = 7.587 × 235 = 1782.9 MeV

Binding energy of Ba-144 = 8.269 × 144 = 1190.7 MeV

Binding energy of Kr-90 = 8.591 × 90 = 773.2 MeV

Energy release = (1190.7 + 773.2) − 1782.9 = 181 MeV

Mass defect = $\frac{181}{931}$ = 0.194 u

3.6 A

By $\Delta P \times t \times 75\,\% = m g h = \rho V g h$

$\therefore$ $[(500 - 180) \times 10^6] \times (8 \times 3600) \times 75\,\% = (1000)\, V (9.81)(250)$

$\therefore$ $V = 2.82 \times 10^6\ \text{m}^3$

3.7 B

Mechanical power input = $\frac{1}{2}\rho A v^3 = \frac{1}{2}(1.2)(\pi \times 15^2)(18)^3 = 2473$ kW

Efficiency = $\frac{650}{2473} \times 100\,\% = 26.3\,\%$

3.8 B

Intensity of sunlight reaching the Earth's surface = 1380 × (1 − 42.5%) = 793.5 W m^{-2}

Power input × efficiency = power output

$(793.5 \times A \times \cos 25°) \times 15\% = 4000$

$\therefore A = 37\ \text{m}^2$

Q3. (a) (i) Total area of the walls and ceiling = $12 \times 4 \times 2 + 3 \times 4 \times 2 + 12 \times 3 - 4 \times 2 = 148\ \text{m}^2$ [1]

Rate of heat transfer through walls and ceiling = $U A \Delta T = (1.5)(148)(10) = 2220\ \text{W}$ [1]

(ii) Rate of heat transfer through the window = $U A \Delta T = (2.8)(4 \times 2)(10) = 224\ \text{W}$ [1]

OTTV = $\dfrac{Q/t}{A} = \dfrac{2220 + 224}{148 + 4 \times 2} = 15.7\ \text{W m}^{-2}$ [1]

(iii) **Advantage** : (any **ONE** of the followings) < accept any reasonable answer > [1]

- More natural light can enter the house, thus less lamps can be used in day time.
- By opening the window, the house can have more ventilation.
- The house can have more attractive outlook.

Disadvantage : (any **ONE** of the followings) < accept any reasonable answer > [1]

- The OTTV will increase since more heat can enter the house by conduction and radiation.
- The window may break under strong wind.

(b) (i) Luminous flux = $85 \times 20 = 1700$ lumen < **OR** 1700 lm > [1]

(ii) Incident angle : $\tan\theta = \dfrac{3}{4}$ $\therefore\ \theta = 36.87°$

Distance of A from the lamp : $r = \sqrt{(3)^2 + (4)^2} = 5\ \text{m}$

$E = \dfrac{\Phi}{4\pi r^2}\cos\theta = \dfrac{(1700)}{4\pi(5)^2} \times \cos 36.87° = 4.33\ \text{lux}$ [1]

Total illuminance from two lamps = $2 \times 4.33 = 8.66$ lux [1]

(iii) Any **ONE** of the followings : [1]

- Install reflector above the lamp to increase the reflection of light to the floor.
- Paint the walls with white colour to increase the reflection of light from the walls.
- Cover the walls with white wall paper to increase the reflection of light from the walls.

Section D : Medical Physics

4.1 C

By $P = \frac{1}{u} + \frac{1}{v}$

$\therefore\ (40) = \frac{1}{(\infty)} + \frac{1}{v}$

$\therefore\ v = 0.025$ m

The distance between the eye lens and the retina is 0.025 m.

When looking at object at 25 cm away,

$P = \frac{1}{u} + \frac{1}{v} = \frac{1}{(0.25)} + \frac{1}{(0.025)} = 44$ D

4.2 A

Resolving power : $\theta = \frac{1.22\lambda}{d}$

To just resolve two objects, $\theta = \frac{a}{L} = \frac{1.22\lambda}{d}$

As a and λ are constant, therefore $L \propto d$

$\frac{L_2}{L_1} = \frac{d_2}{d_1}$

$\therefore\ \frac{L_2}{(15)} = \frac{(2.5)}{(3)}$

$\therefore\ L_2 = 12.5$ m

Distance moved :

$d = 15 - 12.5 = 2.5$ m

4.3 B

By $\frac{I_2}{I_1} = (\frac{d_1}{d_2})^2$

$\therefore\ \frac{I_2}{I_1} = (\frac{4}{4+1})^2 = 0.64$ m

By $L_2 - L_1 = 10 \log(\frac{I_2}{I_1})$

$\therefore\ L_2 - (50) = 10 \log(0.64)$

$\therefore\ L_2 = 48$ dB

4.4 D

For two circles of different sizes, area is proportional to the square of diameter by similar figures.

Ratio of area of eardrum to that of oval window $= (4.5)^2 = 20.25$

Total amplification $= 20.25 \times 1.6 = 32.4$

4.5 B

× (1) Only the coherent bundle is used to transmit images.
The incoherent bundle is used to transmit light for illumination.

× (2) Only light rays entering an optical fibre with incident angle within the range of guided mode can transmit through the fibre to the other end by successive total internal reflection.

(3) Total internal reflection occurs when light travels from a medium of greater refractive index to a medium of smaller refractive index.
Thus, the refractive index of the cladding must be smaller than that of the core.

4.6 D

$I = I_o e^{-\mu x}$

$\therefore\ 0.6 I_o = I_o e^{-\mu(4.5)}$

$\therefore\ \mu = 0.1135\ \text{cm}^{-1}$

$\text{HVT} = \frac{\ln 2}{\mu} = \frac{\ln 2}{0.1135} = 6.1\ \text{cm}$

4.7 D

By $m = m_o (\frac{1}{2})^{t/T_e}$

$\therefore\ (1) = (5)(\frac{1}{2})^{(12)/T_e}$

$\therefore\ T_e = 5.168$ hours

Effective half-life :

$\frac{1}{T_e} = \frac{1}{T_p} + \frac{1}{T_b}$

$\therefore\ \frac{1}{(5.168)} = \frac{1}{(12)} + \frac{1}{T_b}$

$\therefore\ T_b = 9.1$ hours

4.8 B

× A. A hot spot can only confirm that the cell activity increases there, but the reasons behind can be a variety. Tumour may only be one of the possible causes.

✓ B. Radionuclide imaging can give the information concerning the proper functioning of the organ, other scanning or imaging can only show the anatomy view of the organ or tissues.

× C. X-ray image gives a much clearer resolution.

× D. Radionuclide imaging involves the injection of radioactive substances into the body, thus the effective dose of radiation is much higher.

Q4. (a) When a varying voltage is applied across the piezoelectric crystal, the crystal is compressed or expanded. [1]

As the crystal changes shape and vibrates with a frequency higher than 20000 Hz, it produces ultrasound. [1]

(b) Intensity reflection coefficient : $\alpha = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2} = \frac{(1.66 - 1.37)^2}{(1.66 + 1.37)^2} = 9.16 \times 10^{-3}$ [1]

Intensity of reflected beam : $I_r = I_0 \alpha = 25 \times (9.16 \times 10^{-3}) = 0.229$ mW cm^{-2} [1]

(c) $(145 \times 10^{-6}) = \frac{(0.02) \times 2}{1450} + \frac{d \times 2}{1610}$ [1]

$\therefore d = 0.0945$ m < **OR** 9.45 cm > [1]

(d) **Advantage** : Low frequency ultrasound gives higher beam penetration. [1]

Disadvantage : Low frequency ultrasound gives lower image resolution. [1]

(e) (1) A-scan shows the amplitude of spikes against the depth while B-scan shows the brightness of dots against the depth. [1]

(2) A-scan gives one-dimensional (1-D) image while B-scan gives two-dimension (2-D) image. [1]