G.C.E. (Advanced Level) Examination - April 2005
PHYSICS - I
Two hours

Important :
- This question paper includes 60 questions in 7 pages.
- **Answer all the questions.**
- Write your **Index Number** in the space provided on the answer sheet, and then indicate your Index Number by shading the appropriate numbers in the drid.
- Instructions are given on the back of the answer sheet. Follow them carefully.
- In each of the questions **1** to **60**, pick one of the alternatives (1), (2), (3), (4), (5) which is **correct or most appropriate** and mark your response on the answer sheet **in accordance with the instructions given therein.**

Use of calculators is not allowed.

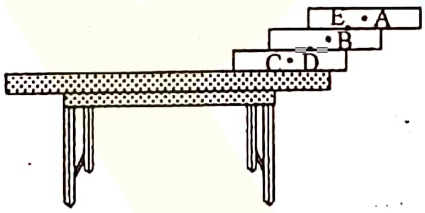
($g = 10N\ kg^{-1}$)

01. The variation of rate of decay (A) of a radioactive sample with time (t) is given by the relationship $A = A_0 e^{-\lambda t}$. The dimensions of λ is
(1) T (2) T^{-1} (3) MT (4) $M^{-1}T$ (5) MT^{-1}

02. In the equation $C = \sqrt{\frac{k}{\rho}}$, C is speed and ρ is density. The units of k are
(1) $kg\ ms^{-2}$ (2) $Kg^{1/2}\ s$ (3) $kg\ m\ s^{-1}$
(4) $kg\ m^{-1}\ s^{-2}$ (5) $kg\ m^{1/2}\ s$

03. The capillary rise of water, in a certain glass capillary tube is h. The angle of contact between glass and water is zero. Another capillary tube having the same dimensions as the glass tube is made with a material for which the angle of contact with water is 90. The capillary rise of water in the second tube is
(1) 0 (2) $\frac{h}{4}$ (3) $\frac{h}{2}$ (4) h (5) $2h$

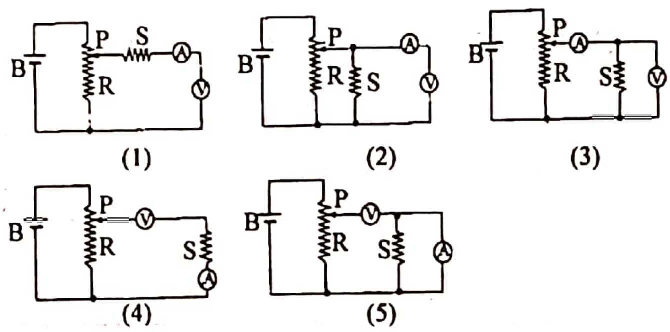
04. Three identical uniform books are placed on each other as shown in the figure. The centre of gravity of the set of books is likely to be found at



(1) A. (2) B.
(3) C. (4) D.
(5) E.

05. A violin string of length of 0.5 m is tuned to a fundamental frequency of 440Hz. To obtain a fundamental frequency of 550Hz, from this string, at what distance the finger be placed from the sound box end?
(1) 0.1m (2) 0.2m (3) 0.3m (4) 0.4m (5) 0.5m

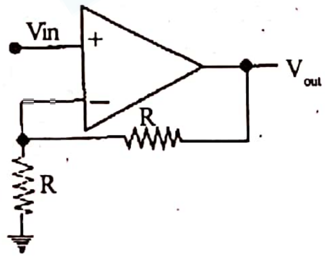
06. In the circuits shown B is a battery, R is a variable resistor with a sliding contact P, and S is a fixed resistor. Which of the following circuits is most suitable to verify Ohm's law.



07. Hydrogen gas is introduced into a container having Helium gas, until the pressure is doubled while keeping the volume and the temperature of the container.
The ratio $\frac{\text{number of Helium atoms}}{\text{number of Hydrogen molecules}}$ in the container is
(1) $\frac{1}{4}$ (2) $\frac{1}{2}$ (3) 1 (4) 2 (5) 4

08. A given parallel plate capacitor is connected to a battery. When the e.m.f. of the battery is doubled, the electric field between the plates
(1) remains unchanged. (2) is halved.
(3) is doubled. (4) is quadrupled.
(5) is trebled.

09. The voltage gain of the circuit shown is
(1) +2
(2) -2
(3) +1
(4) -1
(5) +4



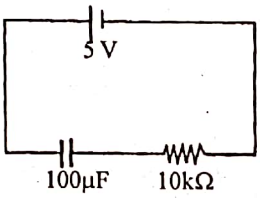
10. Consider the following statements made regarding the refraction of light.
(A) Refractive index of a medium is equal to the ration, $\frac{\text{speed of light in a vacuum}}{\text{speed of light in the medium}}$
(B) As light travels from one medium to another, its frequency does not change.
(C) The wavelength of light is reduced when it passes from vacuum to a medium.
Of the above statements
(1) only (A) and (B) are true.
(2) only (A) is true.
(3) only (B) is true.
(4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

11. The period of an object performing a simple harmonic motion depends on
(A) The amplitude of the oscillation.
(B) the speed of the object at the equilibrium point.
(C) the initial position of the object.

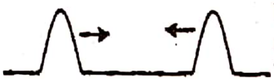
Of the above statements
(1) only (A) is true. (2) only (B) is true.
(3) only (C) is true. (4) only (A) and (B) are true.
(5) all (A), (B) and (C) are **not** true.

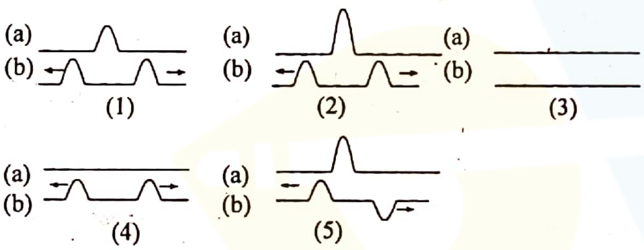
12. A glass vessel of volume V is completely filled with a liquid of volume expansivity γ_l The volume expansivity of glass is $\gamma g(\gamma_l > \gamma_g)$. If the temperature of the glass vessel is increased by an amount θ, the volume of liquid that expels from the vessel is
(1) $V(\gamma_l - \gamma_g)\theta$ (2) $V(\gamma_l - \gamma_g)\theta$
(3) $V\gamma_l\theta$ (4) $V\gamma_g\theta$
(5) zero

13. A 100mF capacitor connected in series with a $10k\Omega$ resistor is connected to a 5V battery. as shown is the figure. The charge stored in the capacitor in this circuit at the steady state is

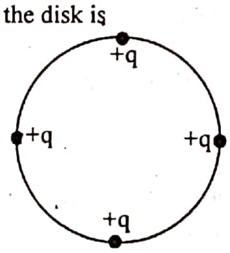


(1) $5.0 \times 10^{-5}C$ (2) $5.0 \times 10^{-4}C$
(3) $5.0 \times 10^{-3}C$ (4) $5.0 \times 10^{-2}C$
(5) $5.0 \times 10^{-1}C$

14. 
Figure shows two identical pulses moving towards other along a string. The two instants where (a), the two pulses overlap completely, and (b), some time after the overlapping occurs are best represented by



15. Four point charges, each having charge q are fixed to the circumference of an insulating disk of radius r as shown in figure. when the disk is rotating about an axis passing through its centre and perpendicular to its plane at n revolutions per second, the mean electric current along the circumference of the disk is

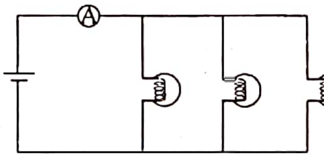


(1) $\frac{4q}{n}$ (2) $8\pi rqn$
(3) $4qn$ (4) $\frac{2qn}{\pi n}$
(5) qn

16. The concentration of water vapour inside a closed room at a certain temperature is $24.0gm^{-3}$, and the relative humidity is 60%. If the air inside the room is made to saturate with water vapour at the same temperature, the new water vapour concentration inside the room is
(1) $14.4gm^{-3}$ (2) $24.0gm^{-3}$ (3) $40.0gm^{-3}$
(4) $60.0gm^{-3}$ (5) $100.0gm^{-3}$

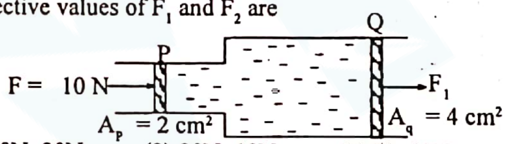
17. A metal block X of mass m at temperature 0°C is made to contact with another metal block Y of mass 2m at temperature 100°C. Heat transfer takes place between X and Y with on heat loss to the surrounding. The specific heat capacities of the X and Y metals are C_X and C_Y respectively. If the final equilibrium temperature of the metal blocks is 20°C, then
(1) $C_X = 8\,C_Y$ (2) $C_X = 4\,C_Y$ (3) $C_X = 2\,C_Y$
(4) $C_X = \frac{1}{2}\,C_Y$ (5) $C_X \frac{1}{4}\,C_Y$

18. The figure shows three identical bulbs which are being lit by a battery with zero internal resistance. The ammeter has a negligible internal resistance. If the filament of one bulb breaks,



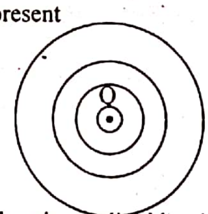
(1) ammeter reading decreases and brightness of each remaining bulb increases.
(2) ammeter reading decreases and brightness of each remaining bulb decreases.
(3) ammeter reading increases and brightness of each remaining bulb decreases.
(4) ammeter reading increases and brightness of each remaining bulb decreases.
(5) ammeter reading decreases and brightness of each remaining bulb remains the same.

19. A force F = 10N is applied to the smaller piston P of area 2 cm² of the hydraulic system shown in the figure to produce a force F_1 on the larger piston Q of area 4cm². When the surrounding temperature is decreased the liquid inside is solidified. The solidified block moves freely inside the system and the new force produced on Q due to the force F = 10N becomes F_2. The respective values of F_1 and F_2 are



(1) 20N, 20N (2) 20N, 10N (3) 5N, 10N
(4) 5N, 20N (5) 20N, 5N

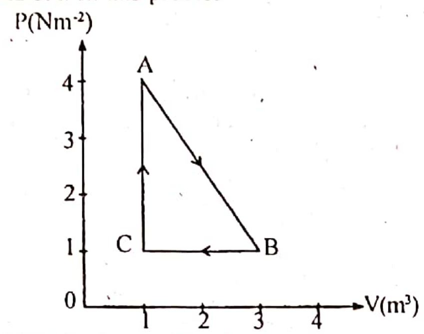
20. The figure shows a set of circles centred on a stationary point charge Q. The circles could be used to represent
(1) the electric field lines.
(2) the magnetic field lines.
(3) the magnetic equipotential lines.
(4) the gravitational field lines.
(5) the electric equipotential lines.



21. A small ball starting from rest rises through a viscous liquid and reaches its terminal velocity, Consider the following statements,
(A) The upthrust on the ball is greater than the weight of the ball.
(B) At the initial moment of the motion the viscous force on the ball is zero.
(C) The acceleration of the ball remains constant until the ball reaches the terminal velocity.
Of the above statements
(1) only (A) and (B) are true.
(2) only (A) and (C) are true.
(3) only (B) and (C) are true.
(4) only (A) is true.
(5) all (A), (B) and (C) are true.

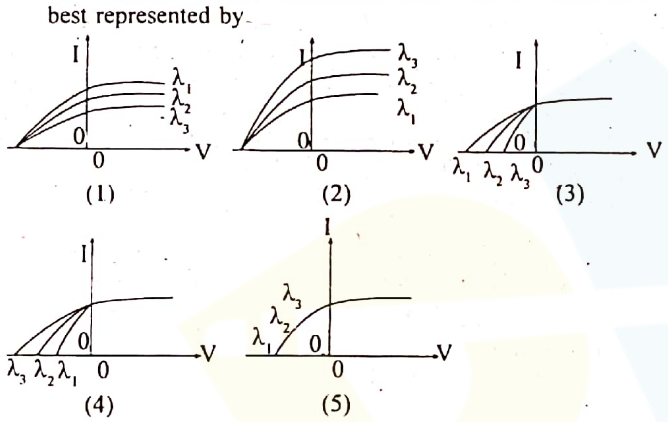
22. Ten persons are standing on a circle. When one of them shouts, the intensity level at the centre of the circle is 50 dB. If all ten persons shout at the same time each producing the above sound level, the intensity level at the centre becomes
(1) 40dB. (2) 50 dB. (3) 60 dB.
(4) 80 dB. (5) 90 dB.

23. Figure shows a PV diagram of a perfect gas subjected to a cyclic process ABCA. In this process

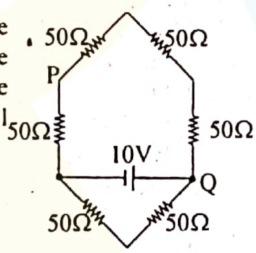


(1) 3 J of heat is absorbed by the system.
(2) 3 J of heat is removed from the system.
(3) 6 J of heat is absorbed by the system.
(4) 6 J of heat is removed from the system.
(5) no heat is absorbed or removed from the system.

24. A photosensitive surface is illuminated separately by light of wavelengths λ_1, λ_2 and λ_3 ($\lambda_1 > \lambda_2 > \lambda_3$). On all three occasions the intensity (number of photons incident per second) of the light used is kept at the same value. The current-voltage characteristics of the photo electrons for the three situations are best represented by.



25. Six resistors each of value 50 are connected in a circuit as shown in the figure. The 10 V battery has negligible internal resistance. The potential difference between P and Q is



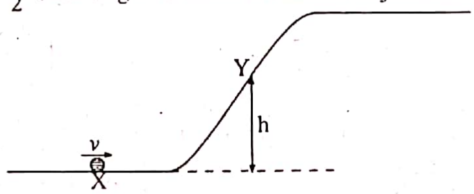
(1) 0.5 V (2) 2.5 V (3) 5.0 V
(4) 7.5 V (5) 10V

26. Consider the following statements regarding α and β particles.
(A) Both α and β particles travel with the speed of light.
(B) Generally α particles penetrate deeper into materials than β particles.
(C) Both α and β particles can ionize atoms when they travel through materials.
Of the above statements
(1) only (A) is true.
(2) only (C) is true.
(3) only (B) and (C) are true.
(4) only (A) and (C) are true.
(5) only (A) and (B) are true.

27. Which of the following figures shows the directions of the frictional forces acting on the two tyres of a bicycle when it is paddled by a rider on a surface with friction?

(1) (2) (3) (4) (5)

28. An object of mass m moving on a frictionless plane passes a point X with a velocity v and rises up a frictionless inclined plane to a point Y that is at a height h above X as shown in the figure. If a second object of mass $\frac{m}{2}$ passes the point X with a velocity $\frac{v}{2}$, the height to which the second object will rise is



(1) $\frac{h}{8}$ (2) $\frac{h}{4}$ (3) $\frac{h}{2}$ (4) h (5) $2h$

29. Figure 1 shows a book A placed on top of a box B which rests on the floor. Figure 2 shows the free body force diagram for the box. P, Q and R indicate the forces acting on the box. Which of the following statements is true?

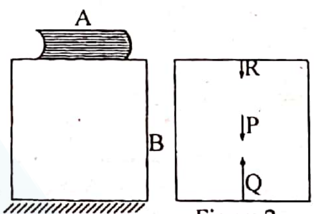


Figure 1 Figure 2

(1) $Q > P + R$
(2) Force on the floor exerted by the box is indicated by P
(3) Force on the floor exerted by the box is indicated by Q
(4) Force exerted on the box by the book is indicated by R
(5) $Q < P + R$

30.

A beam of electrons enters the region between two charged parallel plates with speed $10^6 ms^{-1}$ as shown in the figure. The potential difference across the plates is 200V. Magnetic field required to keep the beam along the y direction is
(1) 2.0 x 10^{-4} T, along the direction of the beam.
(2) 2.0 x 10^{-4} T, into the paper.
(3) 2.0 x 10^{-2} T, along the direction of the beam.
(4) 2.0 x 10^{-2} T, into the paper.
(5) 2.0 x 10^{-2} T, out of the paper.

31. An alarm is to be sounded in a car **at least** when the car is started while a door is open or the car is started while the driver is not wearing seat belt. Three sensors A, B and C provide signals such that $A = 1$ when at least one door is open, $B = 1$ when the engine is running and $C = 1$ when the driver is not wearing seat belt. If the alarm is activated when $F = 1$, the correct truth table for F is

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(1)

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

(2)

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

(3)

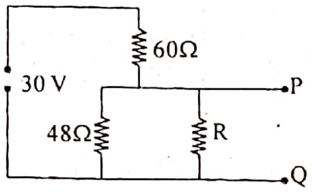
A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(4)

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

(5)

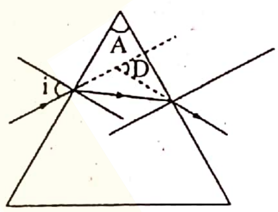
32. The potential divider circuit shown is powered by a 30v d.c. supply of negligible internal resistance. The potential difference across P and Q is 5V. The value of the resistance R is



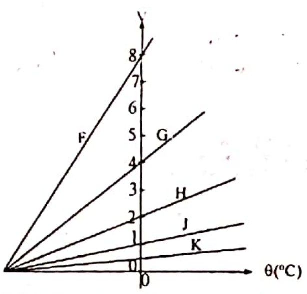
(1) 10Ω (2) 12Ω (3) 16Ω (4) 24Ω (5) 28Ω

33. The image of an erect virtual object which is situated between the lens and focus, formed by a diverging lens is
(1) real, erect and larger than the object.
(2) real, inverted and larger than the object.
(3) real, erect and smaller than the object.
(4) virtual, erect and smaller than the object.
(5) virtual, inverted and smaller than the object.

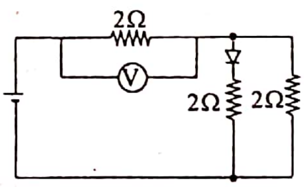
34. A monochromatic ray of light is incident upon a prism of refracting angle A and emerges as shown in the diagram. Consider the following statements made about the angle of deviation D.
(A) As the angle i is increased from zero the value of D Passes through a minimum.
(B) D is zero when the ray enters the prism normally.
(C) For a given value of i, D does not depend on A.
Of the above statements
(1) only (A) is true
(2) only (A) and (B) are true.
(3) only (A) and (C) are true.
(4) all (A), (B) and (C) are true.
(5) only (C) is true.



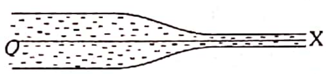
35. The variation of the volume V with the temperature θ of an ideal gas of mass m at a constant pressure P is shown by the line H of the graph. The variation of V with θ of the same ideal gas of mass $2m$ at constant pressure $\frac{P}{2}$ is shown by
(1) F. (2) G. (3) H.
(4) J. (5) K.



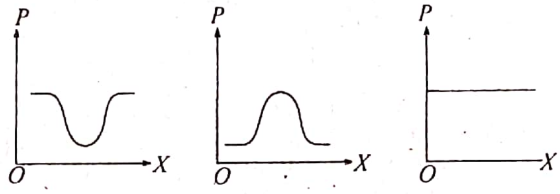
36. The diode in the circuit shown has zero forward bias resistance and a reverse break down voltage of 75 V. Internal resistance of the cell is negligible. The voltmeter reads 12V. When the terminals of the diode are reversed the voltmeter reading is



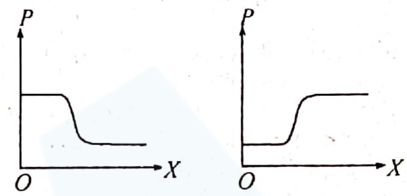
(1) 6 V (2) 8 V (3) 9 V (4) 10 V (5) 18 V

37. 

A non viscous and incompressible fluid flows through a tube in which the cross-section is varying as shown in the figure. The variation of pressure P along the axis, OX, is best represented by



(1) (2) (3)



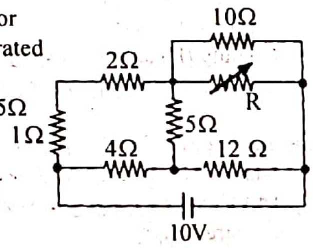
(4) (5)

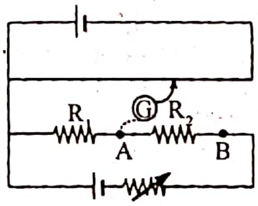
38. A uniform circular disk of radius R and mass M rotates with a uniform angular speed in a horizontal plane about an axis passing through its centre perpendicular to its plane. The moment of inertia of the disk about the axis described above is $\frac{1}{2}MR^2$. When a ball of clay of mass $\frac{M}{8}$ is placed gently on the edge of the disk and if it sticks, the new angular speed of the system is

(1) $\frac{2}{5}\omega$ (2) $\frac{8}{9}\omega$ (3) $\frac{4\omega}{5}$ (4) ω (5) $\frac{\omega}{5}$

39. A ray of light travelling in water (refractive index n_1) is incident on the air/water boundary at the critical angle. When a layer of oil (refractive index n_2) is floated on the water surface, the angle of refraction of this light ray in oil is
(1) $\text{Sin}^{-1}\frac{1}{n_2}$ (2) $\text{Sin}^{-1}\frac{1}{n_1}$ (3) $\text{Sin}^{-1}\frac{n_1}{n_2}$ (4) $\text{Sin}^{-1}\frac{n_2}{n_1}$ (5) 90°

40. The value of the variable resistor R that minimizes the heat generated in the 5Ω resistor in
(1) 6Ω (2) 9Ω (3) 15Ω
(4) 45Ω (5) 90Ω.

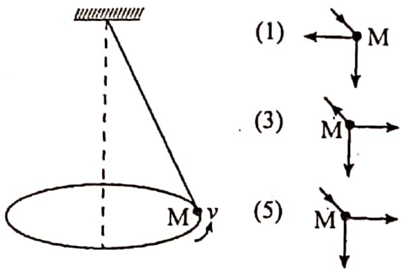


41. 

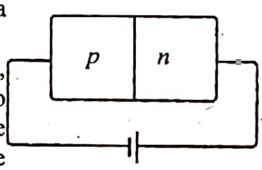
A potentiometer circuit is set up as shown in the figure. When the galvanometer is connected to point A and to point B respectively, the balance lengths obtained are 75cm and 300cm. The ratio of $\frac{R_2}{R_1}$ is

(1) 4 (2) $\frac{1}{2}$ (3) $\frac{1}{3}$ (4) $\frac{1}{4}$ (5) 3

42. A sphere M attached to a thread is whirled in a horizontal circle at a constant speed as shown in the figure. The forces acting on the sphere observed by a person who is at test in the laboratory are best represented by

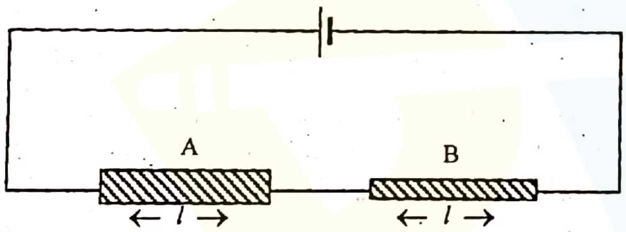


43. A p-n junction is connected to a battery as shown in the figure. When light is shone on the junction, electron-hole pairs are created due to the absorption of photons. The current in the circuit produced by the incident light is



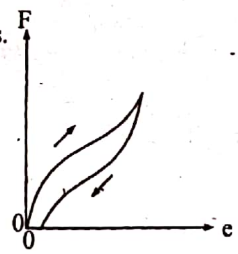
(1) due to electrons moving in the direction of n to p and holes moving in the opposite direction.
(2) due to electrons moving in the direction of p to n and holes moving in the opposite direction.
(3) due to electrons moving from p to n only.
(4) due to holes moving from n to p only.
(5) zero.

44. A thick wire A and a thin wire B made of the same material are connected to a battery as shown in the figure. The lengths of the two wires are the same. consider the following statements.
(A) Both A and B have the same resistance.
(B) Drift velocity of electrons in A is smaller than that in B.
(C) Free electron densities in A and B are different.



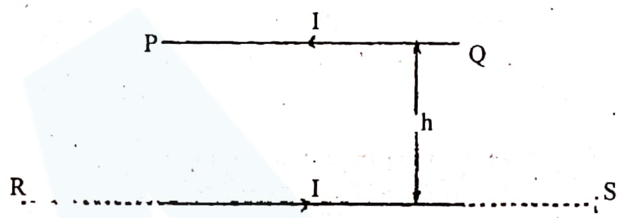
Of the above statements
(1) only (A) is true.
(2) only (B) is true.
(3) only (C) is true
(4) only (B) and (C) are true
(5) all (A), (B) and (C) are true.

45. The figure shows a force (F) - extension (e) graph for a rubber band. Consider the following statements.
(A) The rubber band does not return to its original length after stretching.
(B) The magnitude of the total work done during the increase of the length is less than the magnitude of the total work done during the decrease of the length.
(C) Heat can be generated in this process.
Of the above statements
(1) only (A) is true.
(2) only (A) and (B) are true.
(3) only (B) and (C) are true.
(4) only (A) and (C) are true.
(5) all (A), (B) and (C) are true.



46. The filament of a 100W bulb takes 200 ms to reach its full brightness when the bulb is connected across a constant voltage supply of 230V.
Consider the following statements
(A) During the 200ms period the resistance of the filament increases.
(B) During the 200ms period, power drawn from the supply decreases to 100W, starting from a higher value.
(C) Filament emits energy in the form of electromagnetic radiation.
Of the above statements
(1) only (A) is true.
(2) only (A), (B) are true.
(3) only (A), (C) are true.
(4) only (B), (C) are true.
(5) all (A), (B) and (C) are true.

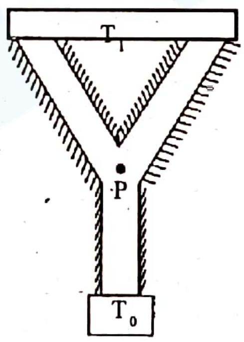
47. A thin uniform wire PQ carrying a current I could be held without any mechanical support above an infinitely long horizontal wire RS carrying the same current I. If the mass per unit length of the wire PQ is m, the equilibrium height h of PQ above RS is given by



(1) $h = \frac{\mu_0 I^2}{mg}$ (2) $h = \frac{\mu_0 I^2}{2mg}$ (3) $h = \frac{\mu_0 I^2}{2\pi mg}$

(4) $h = \frac{\mu_0 I^2}{\pi mg}$ (5) $h = \frac{\mu_0 I^2}{\pi^2 mg}$

48. A well lagged Y-shaped structure made of copper has three thin identical limbs. Free ends of two of the limbs are connected to a metal block which is maintained at temperature T_1 while the free end of the third limb is maintained at a temperature T_0. The steady state temperature of the junction P of the structure is



(1) $\frac{T_0 + T_1}{2}$ (2) $\frac{3T_0 + T_1}{2}$

(3) $\frac{2T_0 + T_1}{3}$ (4) $\frac{T_0 + 3T_1}{2}$

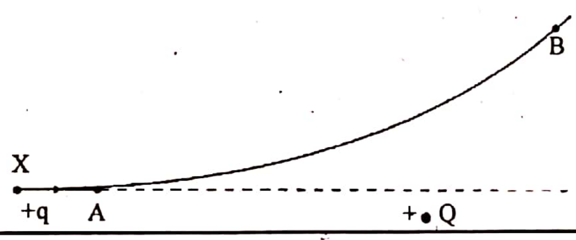
(5) $\frac{T_0 + 2T_1}{3}$

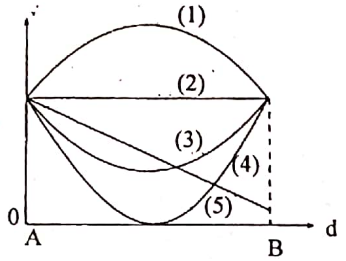
49. The oxygen molecule has 16 times the mass of the hydrogen molecule. Ar room temperature the ratio

$$\frac{\text{root mean square speed of oxygen molecules}}{\text{root mean square speed of hydrogen molecules}} \text{ is}$$

(1) 16 (2) 4 (3) 2 (4) $\frac{1}{4}$ (5) $\frac{1}{16}$

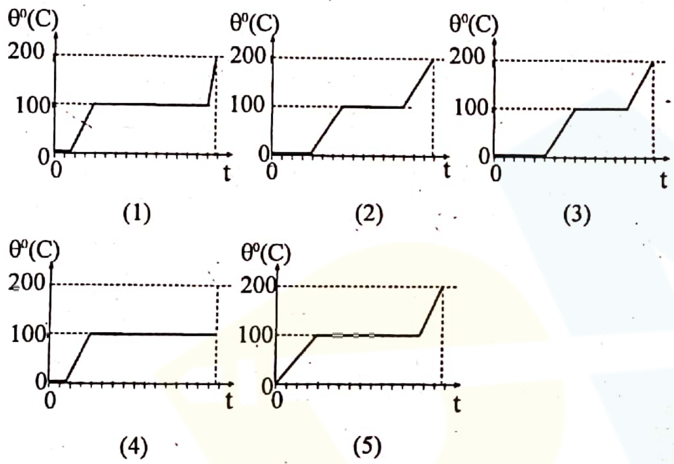
50.



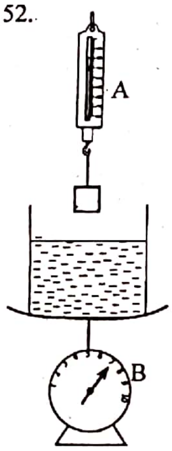


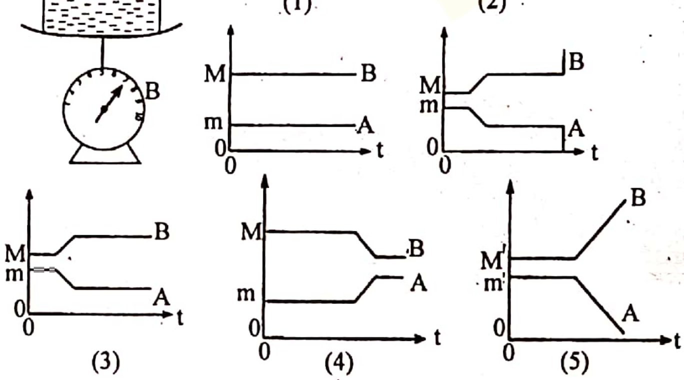
The figure shows the path of a particle X of charge $+q$ moving in the vicinity of another fixed particle of charge +Q. Variation of the speed v of the particle X with the distance d travelled from A along the path AB is best represented by the graph
(1) 1 (2) 2 (3) 3 (4) 4 (5) 5

51. Crushed ice pieces at 0°C are kept inside a thermally insulated closed container. Heat is supplied to the container at a constant rate and the pressure inside the container is kept constant. The variation of the temperature inside the container with time is best represented by



52. A uniform metal cylinder of mass m hangs from a spring balance A and is lowered slowly and steadily into a water container of mass M (M > m) until it rests totally submerged on the bottom of the container. The container is placed on the pan of a weighing scale B as shown in the figure. The variations of the readings of A and B with time t are best represented by

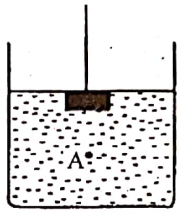




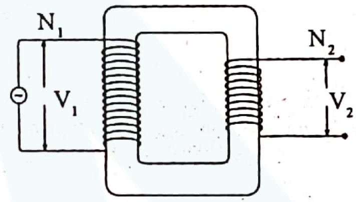
53. A metal block is suspended at rest below the surface of water in a tank as shown in the figure. When the block is released it falls to the bottom of the tank.

Consider the following statements.
(A) The block gradually losses its gravitational potential energy as it falls.
(B) Although the height of the water level dose not change the water gains gravitational potential energy.
(C) If water was not present, the kinetic energy of the block at the point A would be less than that at A when water was present.

Of the above statements
(1) only (A) and (B) are true.
(2) only (B) and (C) are true.
(3) only (A) and (C) are true.
(4) only (A) is true.
(5) all (A), (B) and (C) are true.

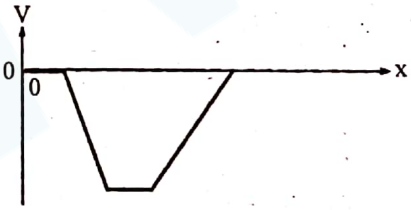


54. The transformer shown in the figure has N_1 turns in the primary and N_2 turns in the secondary. Root mean square voltages across primary and secondary are V_1 and V_2 respectively. The correct statement regarding the transformer is

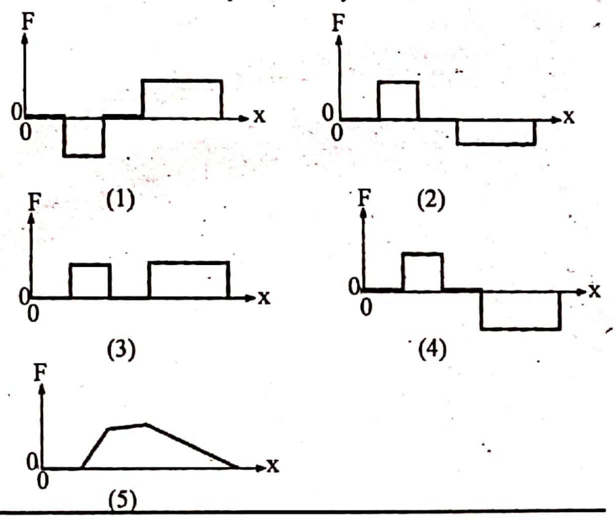


(1) $V_1N_1 = V_2N_2$
(2) if the A.C. source is replaced by a battery with the same voltage, V_2 will remain the same.
(3) when the secondary is connected to a load, the current in the secondary will not depend on the load.
(4) the only reason why the core becomes warm after sometime is the heat generated due to the resistance of the coils.
(5) if the core is removed, V_2 will decrease.

55.

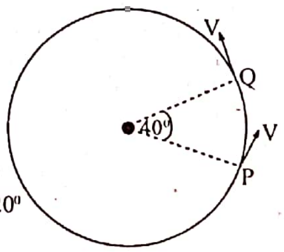


The graph shows the variation of electric potential V with distance x in a certain region.
The variation of the force F experienced by a positively charged particle with x is best represented by



56. A car travels at a speed of $20ms^{-1}$ towards a stationary sound source that produces sound at a frequency of lkHz. Waves that are reflected from the car and return to the source are used to produce beats with the original waves. The approximate value of the beat frequency is (use the speed of sound in air as $320ms^{-1}$)
(1) 59Hz (2) 62Hz (3) 111Hz (4) 118Hz (5) 133Hz

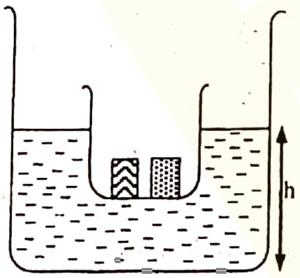
57. A particle is moving in a circle with constant speed V as shown in the figure. The magnitude of the change in velocity of the particle between points P and Q is



(1) 0 (2) $V\sin 40^0$
(3) $2V \sin 20^0$ (4) $2V \cos 20^0$
(5) V

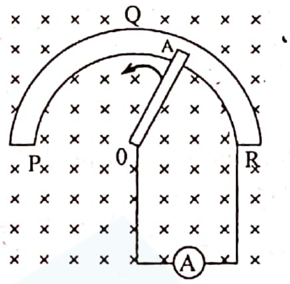
58. The furthest point of distinct vision of a long sighted person is at infinity. This person uses a magnifying lens to view close objects. He finds that he can see a clear magnified image of an object if it is held anywhere between 50mm and 60mm from the lens, but nowhere else. His least distance of distinct vision is
(1) 25mm (2) 50mm (3) 250mm (4) 300mm (5) 350mm

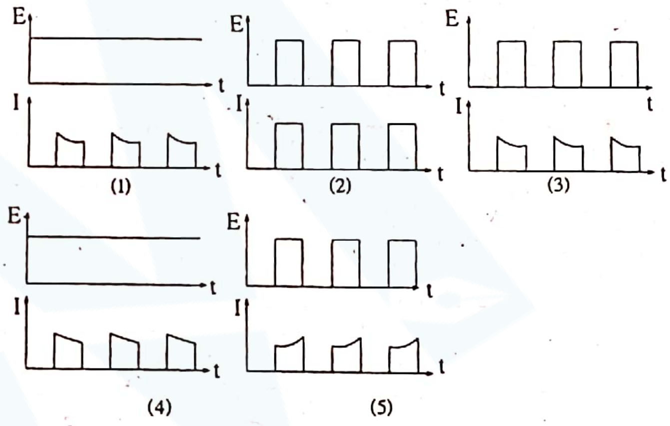
59. As shown in the figure, a small beaker containing a piece of wood and a piece of stone floats in water inside a larger beaker. The density of the stone is larger than that of water and the density of the piece of wood is smaller than that of water. Consider the follwing statements made about the height h of the water level inside the larger beaker.
(A) When the stone is taken out and dropped in water h decreases.
(B) When the piece of wood is taken out and put in water h remains unchanged.
(C) When the stone and the piece of wood are taken out, tied together and then put in water, if they go to the bottom of the beaker h will increase.
Of the above statements,



(1) only (A) is true. (2) only (A) and (B) are true.
(3) only (A) and (C) are true. (4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

60. A semicircular conductor PQR having a uniform cross-sectional area is placed vertically in a horizontal uniform magnetic field as shown in the figure. A conducting rod OA pivoted at the centre O of the semicircular conductor, rotates with a constant angular speed about a horizontal axis passing through O parallel to the magnetic field. PQR and OA are made of a material with the same resistivity. An ammeter is connected to the two ends O and R. If the end A touches PQR, the variations of the e.m.f. E induced across OA and the current I through the ammeter with time t are best represented the pair of graphs.





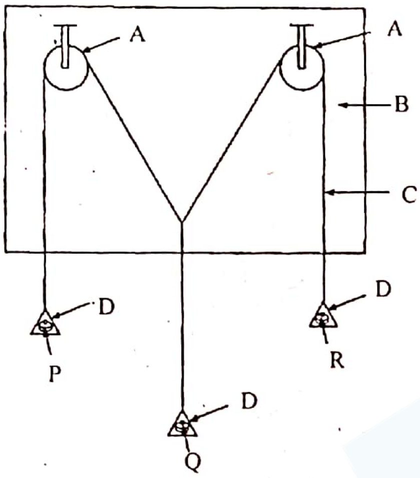
G.C.E. (Advanced Level) Examination - April 2005

PHYSICS - II

Three hours

Answer all four questions. PART A - Structured Essay [$g = 10\ N\ kg^{-1}$]

01. Figure shows a set-up used in a school laboratory to verify the principle of parallelogram of forces.



A - smooth small pulleys

B - vertical drawing board with a white paper pinned on

C - light string

D - light scale pans

P, Q, and R - weights

(*a*) Give a list of other items needed to carry out this experiment accurately.

....

....

(*b*) How do you test whethet the friction of the pulleys is negligible?

....

....

(*c*) If the above arrangement is set-up for you, briefly state the steps that you would adopt to verify the principle of paralleloram of forces.

1. ....
....
2. ....
....
3. ....
....
4. ....
....
5. ....
....

(*d*) In order to carry out this experiment light strings should be used. What is the reason for this?

....

(*e*) After completing the parallelogram correctly, a student noticed that the direction of the relevant diagonal was not exactly vertical. Give a reason for this.

....

(*f*) If the scale pans are not light what should you do in order to carry out the experiment correctly?

....

....

(*g*) This set-up is used by a student to find the weight of a stone. The relevant sides of the force parallelogram are shown in the figure. Evaluate the weight of the stone (1cm = 2N)

....

....

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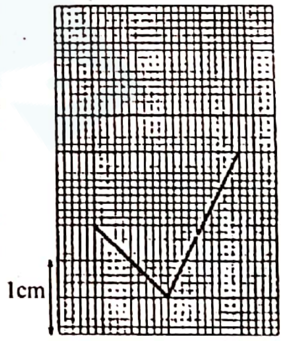
....



02. A student wants to determine the specific latent heat of fusion of ice using the method of mixtures in the school laboratory. A calorimeter containing water, ice and all other necessary items for the experiment have been provided.

(*a*) Should the initial temperature of water inside the calormeter be below, above or at the room temperature?

....

(*b*) Give the reason for your answer in (a) above.

....

....

(*c*) Give **three** precautionary steps that the student should follow when ice is added into the calorimeter.

....

....

....

(*d*) When stirring the ice and water mixture, ice pieces should not float on water. What is the reason for this?

(e) What experimental procedure the student should follow when obtaining the final temperature?

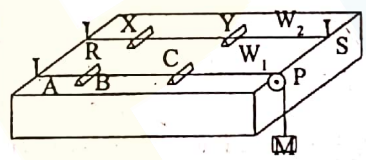
(f) The student obtained the following data and information from this experiment.

Heat capacity of calorimeter and stirrer	$= 40\text{J K}^{-1}$
Initial mass of water inside calorimeter	$= 100\text{g}$
Initial temperature of water	$= 35\text{C}$
Final temperature of water	$= 25\text{C}$
Mass of ice melted	$= 11\text{g}$

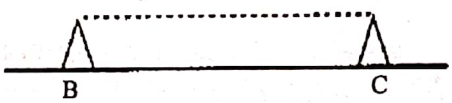
Calculate the specific latent heat of fusion of ice.
(Specific heat capacity of water $= 4 \times 10^3\ \text{Jkg}^{-1}\text{K}^{-1}$)

(g) On another day when the room temperature was the same, the student repeated the experiment with the same apparatus and with the same amount of water. But he observed that dew was formed on the surface of the calorimeter when obtaining the final temperature 25°C. The mass of the ice melted is 18g and the mass of dew formed on the calorimeter is 0.86g. Assuming that the dew point is 25°C and heat released by condensing water vapour is completely absorbed by the calorimeter, calculate the specific latent heat of vaporization of water at this temperature.

03. The sonometer shown in the diagram consists of two stretched thin metal wires W_1 and W_2. One end of W_1 is attached to the nail A and the other end carries a mass M as shown. The pulley P is smooth. W_2 is kept under tension by fixing to the nails R and S.



(a) (i) When W_1 is plucked in the middle of BC, the wire vibrates at the fundamental frequency. Draw the wave pattern of the wire produced between B and C in the figure shown below.



(ii) How is a stationary wave of this nature formed?

(iii) If l_0 is the distance between B and C, write down the relationship between the wavelength λ_0 of the transverse wave and l_0.

(iv) If T is the tension and m is the mass per unit length of W_1, write down an expression for the fundamental frequency f_0 in terms of T, m and l_0.

(b) The length XY corresponding to the fundamental frequency of vibration of W_2 in resonance with the fundamental frequency of W_1 is L_0.

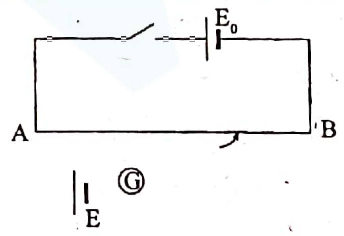
(i) Suggest an experimental procedure to be followed in order to obtain L_0.

(ii) If $M = 4\text{kg}$, $m = 4 \times 10^{-3}\ \text{kgm}^{-1}$ and $l_0 = 12.5\text{cm}$, what is the fundamental frequency of vibration of W_2.

(iii) The value obtained for L_0 in (b) (i) is 20.2cm. If the length between X and Y is changed to 20.0cm, find the new fundamental frequency of W_2.

(iv) Now if both wires are vibrated simultaneously with each of their fundamental frequency, what is the beat frequency obtained.

04. A partially drawn incomplete arrangement of a potentiometer circuir used to measure e.m.f. E of a cell is shown in the figure.



(a) (i) What are the items that you need to use to protect the galvanometer from high currents and to perform this experiment accurately?

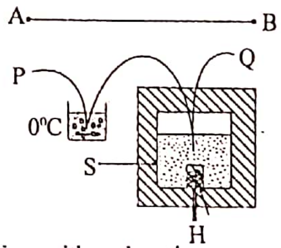
(1)

(2)

(ii) Complete the given circuit diagram adding the two itens mentioned in (i) above and showing all the connections.

(b) In the potentiometer circuit shown the length and the resistance of the potentiometer wire are 600cm and 8Ω respectively and E_0 = 2.0V. (Internal resistance of the accumulator is negligible). This potentiometer is needed to be modified in order to measure small voltages of the order of mV, instead of E.
If you are provided with a variable resistor R, show on a circit diagram how you would connect this resistor to modify the potentiometer circuit to measure small voltages.

(c) The figure shows a part of an experimental set-up with the above potentiometer circuit and a thermocouple arrangement used to measure the specific heat capacity of molten tin.



H - Heating coil
S - well-lagged container with molten tin

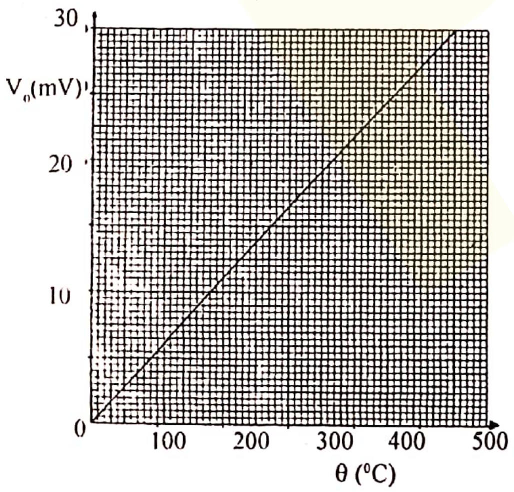
(i) If it is desired to have a potential drop of 40 mV across the full wire length of the potentiometer, what is the value of the resistor R that you should use?

....
....
....

(ii) The balance length at a certain instant, sometime after the heating coil was turned on, was observed to be 240cm. find the thermocouple voltage in mV at that instant.

....
....
....

(iii) Using the graph shown of the thermocouple voltage V_θ (mV) versus temperature θ (°C) find the temperature of molten tin at the instant mentioned in (c) (ii) above.



....

(iv) The balance length was obtained again two minutes later and its value was 360cm. If the mass of tin used is 375g and the power of the heating coil is 100w, calculate a value for the specific heat capacity of molten tin. Neglect the heat capacity of the container.

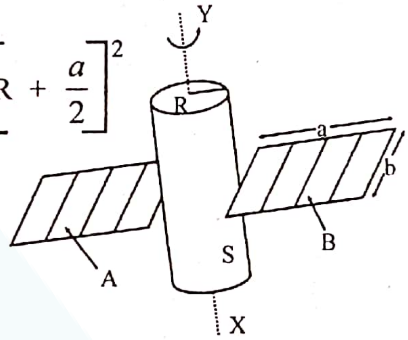
....
....
....

PART B

Answer four questions only $[g = 10\ N\ kg^{-1}]$

01. Figure shows a satellite having a cylindrical body S and two identical solar panels A and B. This satellite is moving in the space where gravity is negligible and rotates about the axis of the cylinder XY with an angular velocity of 6 revolutions per minute. The plane of the solar panels is perpendicular to the XY axis of the cylinder. Radius of the cylinder R = 0.4m and moment of intertia of the cylinder about XY axis I = 6kgm2. For each solar panel, mass m = 2kg, length a = 1.2m and width b=0.6m. The moment of inertia of each solar panel about XY is given by

$$m\frac{(a^2+b^2)}{12} + m\left[R + \frac{a}{2}\right]^2$$



(i) Calculate the moment of intertia of the satellite about XY.

(ii) Calculate the rotational kinetic energy of the satellite.

(iii) If the two solar panels are folded so that the new moment of intertia of each panel about XY becomes $\frac{1}{4}$ of the previous value, calculate the new moment of intertia and the new angular velocity of the satellite about XY.

(iv) In order to control the rotation of the satellite a mechanism is available to apply a torque τ on the satellite along XY. This mechanism does not change the moment of intertia of the satellite.

(a) If the angular velocity of the satellite has to be brought back to its original value, from the value calculated in (iii) above, by maintaining a uniform angular deceleration for a period of 5 minutes, calculate the mag nitude of the angular deceleration and the torque τ required.

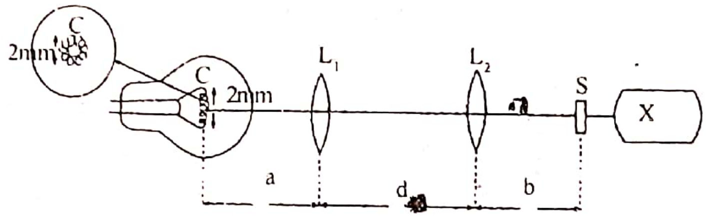
(b) Determine the energy required to bring the angular velocity of the satellite back to the original value.

02. (i) Drawing the usual ray diagram, show that the angular magnification M of a compound microscope is given by

$$M = \frac{l}{f_0}\,\frac{25}{f_E}$$

when the microscope is adjusted to form the final image at infinity. Here f_0 is the focal length of the objective, f_E is the focal length of the eyepiece and l is the distance between the focal points of the objective and the eyepiece lying between the two lenses. Here all distances are in cm.

(ii) When a microscope is used, care should be taken to illuminate the specimen to achieve better viewing. The following figure shows an arrangement consisting of a lens combination and a lamp, used to illuminate the specimen S. The microscope is indicated by X.



Each lens has focal length of 20 mm and diameter of 20mm. The filament C has an effective diameter of 2mm. The distances a and d are adjusted so that the image of the filament formed by L_1 is positioned on L_2 and fills all of L_2.

(a) In this situation.

(1) what linear magnification does L_1 produce?

(2) what are the values of a and d?

(b) For better viewing, the specimen S should be placed at the point where the image of L_1 is formed by L_2.

In this situation.

(1) what is the value of b?

(2) what is the illuminated area of the specimen?

03. **Read the follwing passage carefully and answer the questions given below.**

A thundercloud is formed by a strong updraft of warm and humid air. The humid air expands as it rises and its temperature decreases

Usually thunderclouds have, two main centres of charge, with the lower charge being negative as shown in the figure 1 (Note that the figure is not drawn to a scale)

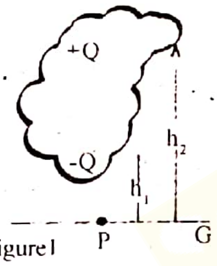


figure 1

In this figure the negative charge centre and the positive charge centre are situated at heights h_1 and h_2 above the ground (G). respectively. The magnitude of the electric field intensity under a thundercloud is one of the factors which determines the possibility of a lightning flash to the ground. Because the earth is a good conductor compared to air, an approximate value for this electric field can be calculated using a technique called 'method of images'

A charge - Q will induce a positive charge on the surface of the earth as shown in fig 2(a). It can be seen that the same pattern of lines of force in fig 2(a). will be obtained if the earth did not exist and a positive charge $+Q$ was placed, as in fig. 2(b). Therefore the actual electric field intensity at the point P on the ground will be the same as the field intensity halfway between these two charges - Q and its mirror image $+Q$

Lightning could cause human deaths and property damage. To save buildings from lightning, lightning, conductors are fixed at the highest points of the buildings. A conductor like this has a pointed end on one side and the other side is connected to a thick copper strip which runs down the building. The lower end of the copper strip has to be grounded properly

What should one not do during lightning? A discharge can be carried into a house through power lines, telephone wires or even through the water in pipe lines. Therefore we should avoid using electrical equipment such as televisions and telephones during lightning.

If you are in outdoor, avoid taking shelter under isolated trees or shacks that are obvious targets. When a lightning stroke hits a tree, a large current flows along the wet channels in the trunk and it may enter a person who is either standing near or leaning on the tree

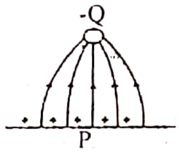


Figure 2 (a)

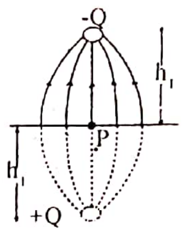


figure 2 (b)

This current that enters a tree subsequently flows along the surface of the ground. The potential difference produced between two points on the ground about 1m apart can result in a fatal current flow through animals or people. One can minimize the effect of such a potential difference by keeping one's feet together

(i) If you are inside a house during lightning list **two** things that you should avoid doing.

(ii) If you are at outdoor why is it dangerous to stand near or lean on a tall tree during lightning?

(iii) To protect buildings from lightning, lightning conductors are used. Give reasons for the following.

(a) Open end of a lightning conductor should be pointed.

(b) Lightning conductor should be properly earthed

(c) The connecting copper strip has to be thick.

(iv) Why do the air masses

(a) expand

(b) cool

as they ascend?

(v) (a) Using the method of images, show that the magnitude of the resultant electric field intensity E at point P in figure 1 is given by

$$E = \frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{h_1^{\,2}} - \frac{1}{h_2^{\,2}}\right]$$

(b) Taking $Q = 20C$, $h_1 = 3$ km and $h_2 = 6$ km calculate E.

$$\left[\frac{1}{2\pi\varepsilon_0} = 1.80 \times 10^{10}\ Nm^2C^{-2}\right]$$

What is the direction of this field?

Hence determine the induced surface charge density on the ground at point P.

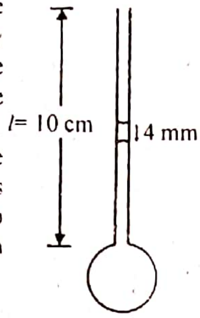
($\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 N^{-1}m^{-2}$)

(vi) Suppose a single lightning stroke transfers a charge of -5 C through a potential difference of 10^xV. Calculate the energy released by this lightning discharge assuming the potential difference remains constant. State **two** modes of dissipation of this energy.

(vii) During lightning, cattle standing on the ground have high risk of getting killed even in the absence of a direct lightning strike. Suggest a reason for this

04 A soap bubble of radius R = 2.5 mm is formed at the lower end of a narrow vertical glass tube of length l = 10cm and internal radius r = 0.8mm. The soap bubble is kept at equilibrium by having a small column of the same soap solution of length 4.0mm as shown in the diagram.

(i) Calculate the surface tension T of the soap solution. Assume that the density of the soap solution is 1050 kgm^{-3} and the angle of contact between glass and the soap solution is zero.



(ii) (a) If now the bubble is broken and the height of the liquid column is gradually increased by adding soap solution, calculate the height at which the lower meniscus becomes flat.

(b) What is the maximum height of the liquid column that can be kept inside the tube?

(iii) When a soap bubble of radius R is formed at the lower end of the narrow tube described above without trapping the air by a column of the soap solution air will escape through the upper end of the tube and the radius R of the bubble will decrease with time t according to the equation,

$$R^4 = \frac{-Tr^4}{2\eta l}t + A$$

where A is a constant and η is the viscosity of air.

A student decides to find the viscosity of air by finding the radius of the bubble at different times. Since it was difficult to measure the diameter of the bubble directly, the student obtains a real image of the bubble on a screen using a convex lens. His observations are as follows.

Distance between the soap bubble and the lens = 15.0cm

Distance between the lens and the screen = 27.0cm

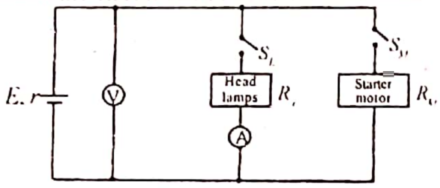
Time (s)	Diameter of image
0	51.0mm
30	36.5mm

(a) Find the radii of the soap bubble at t = 0 and t = 30s, to the nearest mm.

(b) Using the value of T obtained in (i) find a value for the viscosity of air.

05 **Answer either (a) or part (b) only.**

(a) Figure shows a part of the electrical circuit of a motor car. E and r are the e.m.f. and the internal resistance respectively of the car battery. The ammeter and the voltmeter connected to the circuit can be considered as ideal.



(i) When the switches S_l and S_M are opened, voltmeter reading is 12V. When S_M is opened and S_L is closed ammeter reading is 10A and voltmeter reading is 11.5V.

(a) Determine E and r

(b) If the two head lamps are identical and if they are connected in parallel, determine the power dissipation by a head lamp

(ii) The current that should be supplied to the starter motor in order to start the car is 50A. When the starter motor is turned on while the head lamps are on, the lights become dim and the ammeter reading drops to 8.0A.

(a) Is it possible to start this car engine while head lamps are on? Explain your answer.

(b) Determine the resistance RM of the starter motor

(c) Is it possible to start this car engine when head lamps are off? Explain your answer.

(iii) An old car battery can become 'sulphated' when this happens, chemical structure of the battery plates changes. As a result, the internal resistance of the battery increases without changing the e.m.f.

(a) How would this affect on starting a car? Give the reasons for your answer.

(b) However this battery can be used to light a 12V, 6 W bulb with almost full brightness

(b) (i)

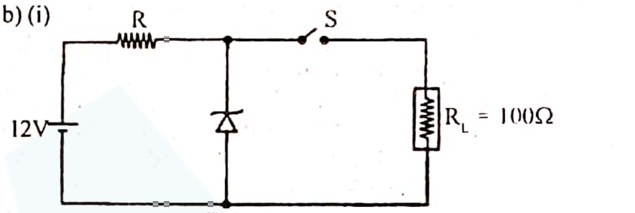


figure 1

It has become necessary to operate a certain electronic device that requires a precise 10V supply voltage, by a 12V battery. A circuit suitable for this purpose, which can reduce a 12V supply to 10V, is shown in figure 1. In this circuit, the load resistance of the electronic device is represented by R_L. The breakdown voltage of the Zener diode is 10V.

(a) Assuming that the battery has no internal resistance, calculate the value of R that will allow a 10mA current through the Zener diode, when the switch S is closed

(b) For the value of R obtained in (a) above, calculate the power dissipation of the Zener diode when

(1) the switch S is closed, and

(2) the switch S is opened.

Hence state the minimum power rating of the Zener diode required for the proper operation of the circuit

(ii) A better circuit that can be used for the purpose of obtaining 10V is shown is figure 2. The breakdown voltage of the Zener diode used in this circuit is 10.6V.

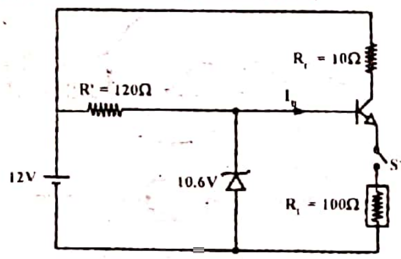


Figure 2

(a) If the transistor used in this circuit is a silicon transistor, show that the electronic device receives the correct supply voltage. (Assume that the potential difference across a forward biased silicon diode is 0.6V)

(b) If the current gain (β) of the transistor is 99, calculate the base current I_B when the switch S' is closed

(c) Calculate the maximum power dissipation of the Zener diode and determine whether a Zener diode of $\frac{1}{4}$ W power rating will be sufficient for the proper operation of the circuit

(d) What is the advantage of this circuit; compared to the circuit used in part (i) above?

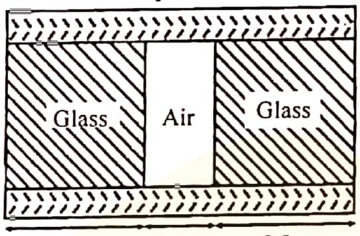
06. **answer either part (a) or part (b) only.**

(a) A small building having a wall area $100m^2$ exposed to the surrounding is made with brick walls of thickness 10cm. This building has a wooden door of area $3m^2$ of thickness 2cm and a glass window of area $4m^2$ made of a single glass sheet of thickness 0.5cm. The temperature inside the building is maintained at 25°C using an air conditioner. The outside temperature remains at 30°C. Heat transfer through the ceiling and the floor of the building can be neglected.

(i) What is the rate of heat transfer from the surroundings into the building?

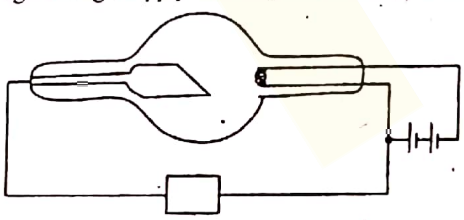
Thermal conductivity of brick	$= 0.6\ wm^{-1}\ K^{-1}$
Thermal conductivity of wood	$= 0.1\ wn^{-1}\ K^{-1}$
Thermal conductivity of glass	$= 0.8\ wm^{-1}\ K^{-1}$

(ii) Suppose instead of the single glass sheet the window is made of two glass sheets of equal thickness of 0.2cm with an air gap of thickness 0.1 cm, as shown in the figure. By what percentage the heat transfer rate through the window reduce due to this change?
(Thermal conductivity of air $= 3 \times 10^{-2}\ wm^{-1}K^{-1}$)



(iii) The dew point inside the building is 20°C and the dew point outside is 25°C. If the relative humidity outside is 80%, calculate the relative humidity inside the building Saturated vapour pressures of air at 30°C and 20°C are 30 mm Hg and 16 mm Hg respectively.

(b) (i) A sketch of an X-ray tube is given in the diagram. Copy the diagram and label the target, the filament and the high voltage supply showing the correct polarity.



(ii) Briefly state how the electrons inside the tube are produced.

(iii) Why should the X-ray tube be evacuated?

(iv) What is the supply voltage required to produce X-rays of maximum energy 100 keV?

(v) Find the wavelength of 100keV X-rays in Å.

(vi) When X-rays go through human tissue or bone, they are absorbed mainly through photoelectric effect. The effect of X-rays on living beings (effective dose) depends on the amount of X-ray energy absorbed by a unit mass of tissue or bone. It is measured by a unit called sievert (Sv). $1Sv = 1\ J\ kg^{-1}$. For persons who do not work with radiation an accumulated annual effective dose above 1 mSv is considered to be dangerous. (Effective dose due to the unavoidable background radiation is not included in this)

(a) If the accumulated annual background effective dose is 2 mSv, calculate the background effective dose rate in units of $\mu Svhr^{-1}$.

(b) The maximum permissible annual effective dose for a radiation worker in an X-ray laboratory is 20 mSv. If he works 40 hours per week and 40 weeks per year, determine the average maximum effective dose rate in μSvhr-1 allowed in the X-ray laboratory for him to be safe.

(c) The intensity I of an X-ray beam is normally considered as the number of photons travelling through a unit area per unit time. When exposed to an X-ray beam of intensity I, the effective dose rate H received by human tissue is given by $H = 0.57\ IEa$ $\mu Svhr^{-1}$, where E is the energy of an X-ray photon in MeV, a is the mass absorption coefficient of tissue in cm^2g^{-1} and I is the beam intensity in $cm^{-2}s^{-1}$.

(1) The time taken to get a chest X-ray photograph is 0.1s. If $I = 9.4 \times 10^8$ photons $cm^{-2}s^{-1}$, $a = 0.027 cm^2\ g^{-1}$ and $E = 100keV$, determine the effective dose received by tissue when a chest X-ray is taken.

(2) Assuming that the above dose is received by a 5 kg of body tissue, calculate the number of X-ray photons absorbed by the tissue.

Planck's constant	$= 6.6 \times 10^{-34}$ Js
Speed of light	$= 3.0 \times 10^8\ ms^{-1}$
1 eV	$= 1.6 \times 10^{-19}$J

G.C.E. (Advanced Level) Examination - April 2005

PHYSICS - I

Provisional Scheme of Marking

2005 - Answers

Q					
01	1	~~2~~	3	4	5
02	1	2	3	~~4~~	5
03	~~1~~	2	3	4	5
04	1	~~2~~	3	4	5
05	~~1~~	2	3	~~4~~	5
06	1	2	~~3~~	4	5
07	1	2	~~3~~	4	5
08	1	2	~~3~~	4	5
09	~~1~~	2	3	4	5
10	1	2	3	4	~~5~~
11	1	2	3	4	~~5~~
12	~~1~~	2	3	4	5
13	1	~~2~~	3	4	5
14	1	~~2~~	3	4	5
15	1	2	~~3~~	4	5
16	1	2	~~3~~	4	5
17	~~1~~	2	3	4	5
18	1	2	3	4	~~5~~
19	1	~~2~~	3	4	5
20	1	2	3	4	~~5~~
21	~~1~~	2	3	4	5
22	1	2	~~3~~	4	5
23	~~1~~	2	3	4	5
24	1	2	3	~~4~~	5
25	1	2	3	~~4~~	5
26	1	~~2~~	3	4	5
27	1	~~2~~	3	4	5
28	1	~~2~~	3	4	5
29	1	2	3	~~4~~	5
30	1	2	3	~~4~~	5
31	1	2	3	4	~~5~~
32	1	2	~~3~~	4	5
33	~~1~~	2	3	4	5
34	~~1~~	2	3	4	5
35	~~1~~	2	3	4	5
36	1	2	~~3~~	4	5
37	1	2	3	~~4~~	5
38	1	2	~~3~~	4	5
39	~~1~~	2	3	4	5
40	1	2	3	4	~~5~~
41	1	2	3	4	~~5~~
42	1	~~2~~	3	4	5
43	1	~~2~~	3	4	5
44	1	~~2~~	3	4	5
45	1	2	3	~~4~~	5
46	1	2	~~3~~	4	~~5~~
47	1	2	~~3~~	4	5
48	1	2	3	4	~~5~~
49	1	2	3	~~4~~	5
50	1	2	~~3~~	4	5
51	~~1~~	2	3	4	5
52	1	~~2~~	3	4	5
53	~~1~~	2	3	4	5
54	1	2	3	4	~~5~~
55	1	~~2~~	3	4	5
56	1	2	3	4	~~5~~
57	1	2	~~3~~	4	5
58	1	2	3	~~4~~	5
59	1	~~2~~	3	4	5
60	~~1~~	2	3	4	5

G.C.E. (Advanced Level) Examination - April 2005

PHYSICS - II

Provisional Scheme of Marking

A - PART

01 (a) set square, Ruler 01

(b) pull/displace the middle weight (any) slightly and check whether it return to the original position.

OR

Displace the system slightly and check whether it return to the original position. 01

(c) 01 Mark the positions of each string by making two dots on the paper by placing the set square perpendicular to the string

OR

[Place the piece of plane mirror underneath the string and mark two dots at each end of the image while viewing straight through the strings.]

02 Draw the lines, which go through the points Mark two lengths proportional to P and R from the point of intersection of the two inclined positions of the string.

03 Complete the parallelogram and measure the length of the diagonal at the point of intersetion.

04. Find out the weight (force) which corresponds to the length of the diagonal, check whether this is equal to Q

05. Check also whether the direction of the diagonal is vertical [OR along the marked direction of the string attached to the weight Q]

(d) The tensions of the strings must be equal to the hanging weights.

OR the tensions along a string segment must be the same

OR the sides of the force parallelogram must correspond to the weights P and R.

(A student can answer this in the negative way

ex. the tensions alongs a string seqment is not the same)

(e) String / pulleys are not free to move

OR

due to the friction between the string and the pulleys. 01

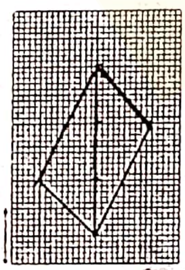
(f) weight the pans and add the corresponding weights to P, Q and R

OR

hang the weights without the pans directly from the strings. 01

(g) $2 \times 3N = 6N$ 01

0.6kg



(if the studend has identified that the vetical diagonal corresponds ot the weight of the stone.) 01

02 (a) above the room temperature 01

(b) To minimize the experimental error caused by the heat exchanged with the surroundings

OR

To compensate the heat exchanged with the surroundings

OR

To equate the heat gained from the surroundings to the heat lost to the surroundings

(c) Use small ice pieces

add one ice piece at a time

before adding ice pieces wipe out water on them dry the ice

avoid splashing of water any three - 02

any two - 01

(d) To prevent ice absorbing heat from outside 01

(e) when the temperature is about 5°C below room temperature step adding ice stir well and obtain the minimum temperature of water. 01

(f) Heat lost by the water and = Heat gained by ice calorimeter

$40 \times (35 - 25) + 100 \times 10^{-3} \times 4 \times 10^3 \times (35 - 25)$

$= 11 \times 10^{-3} \times L + 11 \times 10^{-3} \times 4 \times 10^3 \times 25$

(LHS - 01 RHS - 01)

$L = 3 \times 10^5\ Jkg^{-1}$ 01

(g) Mass of the addilional ice melted $= (18 - 11) \times 10^{-3}$ kg

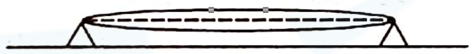
$= 7 \times 10^{-3}$kg

Heat released by the condensation of Water vapour = Heat gained to melt additional ice

$0.86 \times 10^{-3} \times L_v = 7 \times 10^{-3} \times 3 \times 10^5 + 7 \times 10^{-3} \times 4 \times 10^3 \times 25$ 01

$L_V = 32.6 \times 10^5\ Jkg^{-1}$

03. (a) (i)



01

(ii) Superposition of incident and reflected waves.

OR

Superposition of two transverse waves, of the same speed and wavelength (for frequency) moving in oppsite directions.

(iii) $\lambda_o = 2l_o$ -01 $\quad \frac{\lambda_o}{2} = l_o$, $\lambda_o = 2l_o$

(iv) $f_o = \frac{1}{2l_o}\sqrt{T/m}$ $\quad V = f\lambda$, $\sqrt{T/m} = f_o 2l_o$

(b) (i) Bring the two pegs X and Y closer together OR start with small values of xy. 01

while pluckung W_1 in the middle increase the distance XY 01

Until paper rider Jumps off

OR

Bring the two pegs X and Y closer together OR start with small values of XY 01

While plucking W_1 and W_2 in the middle increase the distance XY until no beats are heard]

(ii) $f_o = \frac{1}{2l_o}\sqrt{T/m}$

$f_o = \frac{1}{2 \times 0.125}\sqrt{\frac{4 \times 10}{4 \times 10^{-3}}}$ 01

$f_o = 400$ Hz 01

(iii) ferequency $\propto \dfrac{1}{\text{length xy}}$

$400 \propto \dfrac{1}{0.202}$ ②

$f \propto \dfrac{1}{0.200}$ ①

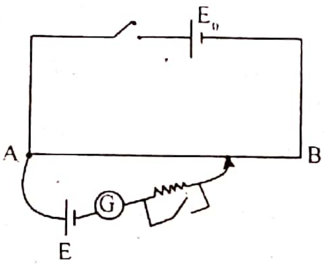
$\frac{②}{①}$ $f = \dfrac{0.202}{0.2} \times 400$ Hz

$f = 404$ Hz 01

(iv) beat frequency $= 404$ Hz $- 400$Hz
$= 4$Hz 01

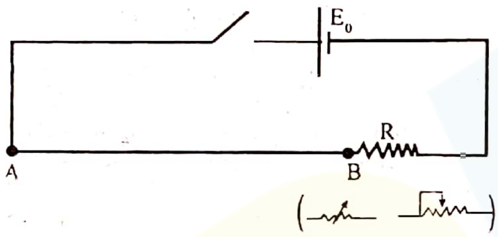
04 (a) (i) 1 High resistance 2. plag key / switch-01

(ii)



01

(b)



01

(c) (i)

$I \times 8 = 0.04$ $E_0 = IR + 0.04$ $\dfrac{(2 - 0.04)}{R} = \dfrac{0.04}{8}$ $R = 392\ \Omega$	$\dfrac{40}{2000} = \dfrac{8}{R+8}$ $R = 392\ \Omega$	$\dfrac{40}{1960} = \dfrac{8}{R}$ $R = 392\ \Omega$

(ii) $V_{AB} = 40$ mV $l = 600$ cm

Thermo - voltage $= \dfrac{40}{600} \times 240$ mV $= 16$ mV 01

(iii) 290 ^{0}C 01

(iv) Thermo- voltage after two minutes $= \dfrac{40}{600} \times 240$ mV
$= 24$ mV

The temperature of molten tin two mintues after the fist measurment = 440 ^{0}C

Heat absorbed by the molten tin = energy supplied by the heater

$ms(\theta_2 - \theta_1) = pt$ 02

(m - mass of tin, s - specific heat capacity of tin.
θ_1 - initial temperture. θ_2 - final temperature P - power of heater
t - time elapsed

$0.375 \times S \times (440 - 290) = 100 \times 2 \times 60$

$S = 213.3$ J kg^{-1} K^{-1} 01

(212 - 214)

PART - B

01 (i) I for a singel panel $= \dfrac{2(0.6^2 + 1.2^2)}{12} + 2(0.4 + 0.6)^2$

I for the satellite $= 2(0.3 + 2) + 6$
$= 10.6$ kgm^2 01

(ii) angular Velocity $\omega = \dfrac{6}{60} \times 2\pi$ ($\omega = 2\pi f$)
$= 0.63$ rads^{-1}

kinetic energy $= \dfrac{1}{2} I\omega^2$
$= \dfrac{1}{2} \times 10.6 \times 0.63^2$
$= 2.1$ J 01
(1.90 - 2.15) 01

(iii) New moment of inertia $I_{new} = \dfrac{4.6}{4} + 6 = 1.15 + 6$
$= 7.15$ kgm^2

Using conservation of angular momentum

$I_{new}\ \omega_{new} = I\omega$ $7.15 \times \omega_{new} = 10.6 \times 0.63$ $\omega_{new} = \dfrac{10.6 \times 0.63}{7.15}$ $= 0.93$ rads^{-1} $= (0.89 - 0.95)$	$7.15 \times \omega_{new} = 10.6 \times 6/60$ $\omega_{new} = 0.15$ revs^{-1}

(iv) (a) Angular deceleration $\alpha = \dfrac{\omega - \omega_{new}}{t}$
$= \dfrac{0.63 - 0.93}{5 \times 60}$
$= 0.001$ rads^{-2}
(0.0009 - 0.0011)

Torque $\tau = I\alpha$ 01
$\tau = 7.15 \times 0.001$ 01
$= 7.15 \times 10^{-3}$ Nm

(b) Rotational kinetic energy after folding panels

$E_K = \dfrac{1}{2} I_{new}\ \omega_{new}^2 = \dfrac{1}{2} \times 7.15 \times 0.93^2$ J

Rotational kinetic energy affer changing back to original angular angular velociy

$= \dfrac{1}{2} I_{new}\ \omega^2 = \dfrac{1}{2} \times 7.15 \times 0.63^2$ J

$\therefore$ energy required $= \dfrac{1}{2} \times 7.15\,(0.93^2 - 0.63^2)$ 01
$= 1.7$J

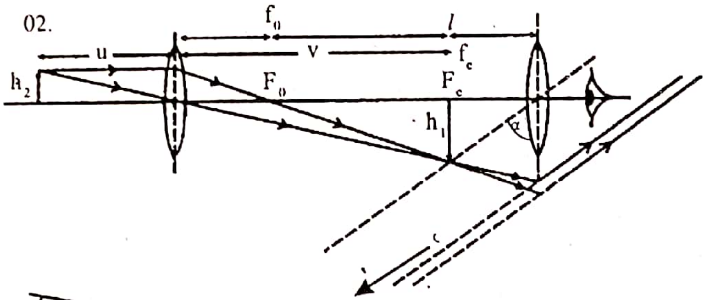
OR

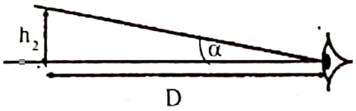
(b) Total angle of rotation durring 5min period

$\theta = \dfrac{\omega_{new}^2 - \omega^2}{2\alpha} = \dfrac{0.93^2 - 0.63^2}{2 \times 0.001}$

Work done during this rotation $= \tau\theta$
$= 7.15 \times 10^{-3} \times \dfrac{(0.93^2 - 0.63^2)}{2 \times 0.001}$
$= 1.7$ J
-01

02.





$M = \frac{\alpha'}{\alpha}$, if α and α' are shown in the above diagrams

OR $M = \frac{\text{Angle subtended on the eye by the final image}}{\text{Argle subtenended on the eye by the object when if is at near point.}}$

OR $M = - \cdot \frac{D}{h}$ OR $M = \frac{h_1 25}{f_e h}$ 01

Applying the lens formula for the objective.

$-\frac{1}{v} - \frac{1}{u} = -\frac{1}{f_0}$ OR $\frac{1}{v} + \frac{1}{u} = +\frac{1}{f_0}$ 01

$xv \Rightarrow 1 + \frac{v}{u} = \frac{v}{f_0}$

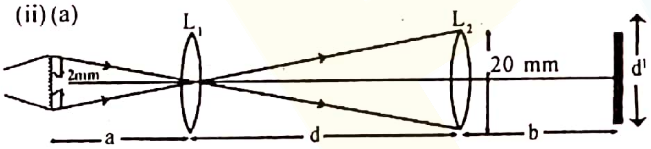
but $\frac{v}{u} = \frac{h_1}{h}$ 01

$\because \frac{h_1}{h} = \frac{v}{f_0} - 1$ 01

but $v - f_0 = l$

$\therefore M = \frac{25l}{f_e f_0}$

(ii) (a)



1. Linear magnification $= \frac{20}{2}$

$= 10$ 01

$\therefore \frac{d}{a} = 10$ 01

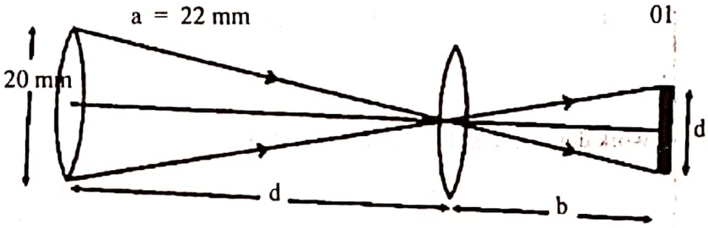
Applying the lens formula for L_1

$-\frac{1}{v} - \frac{1}{u} = -\frac{1}{f_0}$ OR $\frac{1}{v} + \frac{1}{u} = \frac{1}{f_0}$

$1 + d/a = d/20$ OR $\frac{1}{10a} + 1/a = 1/20$ 01

d = 220 mm 01

a = 22 mm 01



(i) Appying the lens formula for L_2

$-1/b - 1/220 = -1/20$ $\frac{1}{b} + \frac{1}{220} = 1/20$

b = 22mm

Let d'/r bethe diameter / radius of the image then

$d'/20 = \frac{b}{d} = \frac{22}{220}$ OR $r/10 = 22/220$

d = 2 mm OR r = 1 mm

Area illuminated $= \frac{22}{7} \times 1^2 mm^2$

$= 3.14\ mm^2$ OR $3.1\ mm^2$ 01

03. (i) Avoid using televisions, telephones, computers any electrical appliance that operated on the mains, Unplug all eletrical equipments
Donot switch on trip switches/ Do not replace bulbs.
Donot repair any electrical and telecomunication lines
Donot stay close to metallic frames.
Do not sleep on the floor
Avoid using water coming out of taps.

(ii) if a stroke hits the tree, the current / charge that flows along the trce may Jump from the tree to the person OR may go through the person. 01

(iii) (a) the surface charge density on a pointed object is large. The electric field intensity in the vicinity of a sharp Point is high.

(b) The charge / current in the stroke should flow into the earth so that charge / current flowing along the surface of the ground is avoided. 01

(c) The resistance of the connecting strip should below. otherwise the discharge may follow another path.
OR
to withstand heat generated
OR
to achieve low current densities 01

(iv) (a) it expands due to the fall/ decrease of the atmospheric Pressure

(b) it cools because the expansion is an adiabatic process. OR the gas expands quickly. OR the gas expands with minimum exchangs of heat with the surroundings OR the air does work aginst the surrounding pressure and Thereby loses its internal energy. 01

(v) (a) The magnitude of the electric field intencity (Ei) at P due fo the charge - Q and its image.

$E_1 = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{h_1^2} + \frac{Q}{h_1^2}\right]$ OR $E_1 = \frac{2Q}{4\pi\varepsilon_0 h_1^2}$ OR $E_1 = \frac{Q}{2\pi\varepsilon_0 h_1^2}$

Similarly the magnitude of the electric field intensity (E_2) at P due fo the charqe +Q and its image

$E_2 = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{h_2^2} + \frac{Q}{h_2^2}\right]$ OR $E_2 = \frac{2Q}{4\pi\varepsilon_0 h_2^2}$ OR $E_2 = \frac{Q}{2\pi\varepsilon_0 h_2^2}$

$\therefore$ net electric field intensity (E) at P

$E = E_1 - E_2$ 01

$$E = \frac{1}{2\pi\varepsilon_0}\left[\frac{Q}{h_1^2} - \frac{Q}{h_2^2}\right]$$

(b) $E = 1.8 \times 10^{10}\left[\frac{20}{(3 \times 10^3)^2} - \frac{20}{(6 \times 10^3)^2}\right]$

$E = 3 \times 10^4\ Vm^{-1}\ (NC^{-1})$ -01 [Do not merk if the unit is incorrect]

it is pointing upwards at the surface of the earth 01

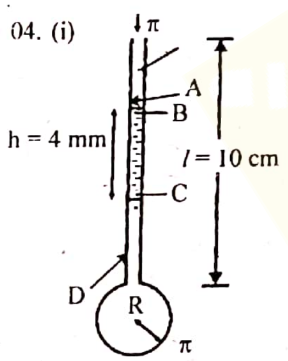
induced charge density (σ) $= \varepsilon_0 E$
$= 8.85 \times 10^{-12} \times 3 \times 10^4$
$= 2.66 \times 10^{-7}\ cm^{-2}$

(vi) energy relerased $= 5 \times 10^8\ J$ [E = QV] 01

Energy is dissipated as heat, light, sound, molecular excitation, creation of ions, kinetic energy of particles, radiation
any two - 01

(vii) The distance between the front and back legs of the cow is sufficient enough to generate a high potential difference so that the current / charge will flow through the body of the cow rather than along the earth surface. 01

04. (i)



$P_A = \pi$

$P_B = \pi - \frac{2T}{r}$

$P_C = \pi - \frac{2T}{r} + h\rho g$

$P_D = \pi - \frac{2T}{r} + h\rho g - \frac{2T}{r}$

$P_D = \pi + h\rho g$ 01

$P_D = \pi + \frac{4T}{R}$ 01

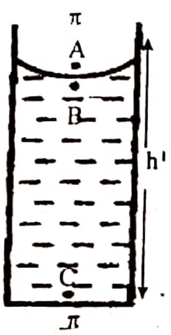
$\cancel{\pi} + h\rho g = \cancel{\pi} + \frac{4T}{R}$

$\therefore T = \frac{h\rho g R}{4}$ - 01

$T = \frac{4 \times 10^{-3} \times 1050 \times 10 \times 2.5 \times 10^{-3}}{4}$

$T = 0.026\ N\ m^{-1}$ 01
(0.025 - 0.027)

(ii) (a)



$P_A = \pi$

$P_B = \pi - \frac{2T}{r}$

$P_C = \pi - \frac{2T}{r} + h'\rho g = \pi$

$\frac{2T}{r} = h'\rho g$ 01

$h' = \frac{2 \times 0.026}{0.8 \times 10^{-3} \times 1050 \times 10}$

$= 6.2$ mm 01

(6.1 - 6.3)

(b) $P_A = \pi$

$P_B = \pi - \frac{2T}{r}$

$P_C = \pi - \frac{2T}{r} + H\rho g$

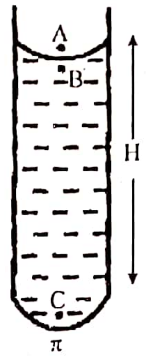
$\pi - \frac{2T}{r} + H\rho g = \frac{2T}{r}$ 01

$H = \frac{4T}{r\rho g}^{+\pi}$ 01

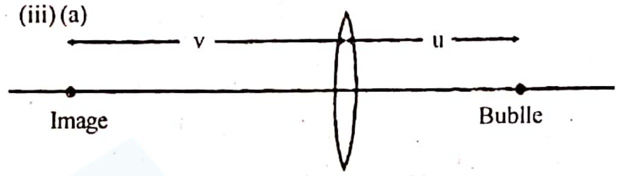
$H = \frac{4 \times 0.026}{0.8 \times 10^{-3} \times 1050 \times 10}$

$H = 12.4$ mm 01

(12.2 - 12.6)



(iii) (a)



Radius of the image at time t = 0, $51/2$ mm

Radius of the bubble at time t = 0, $= (u/v) \times \frac{51}{2}$

$= \frac{15}{27} \times \frac{51}{2}$ mm 01

$= 14$ mm 01

= (14-17 mm)

Radius of the bubble at (t + 30s) $= (u/v) \times \frac{36.5}{2}$

$= 10$ mm

(iii) (b) using $R^4 = \frac{-Tr^4 t}{2\eta l} + A$ (η - cofficient of viscosty of air)

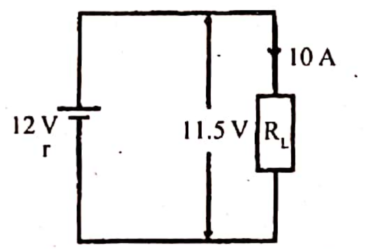
For t = 0 $(14 \times 10^{-3})^4 = A$
$3.84 \times 10^{-8} = A$ 01

For t = 30S, $(10 \times 10^{-3})^4 = \frac{0.026 \times (0.8 \times 10^{-3})^4 \times 30}{2\eta \times 10 \times 10^{-2}} + 3.84 \times 10^{-8}$
01

$\eta = 5.6 \times 10^{-5}\ Nsm^{-2}$ 01
(5.5 - 5.7)

05. (A)

(i) (a) E = 12.0v 01



$E = Ir + V$

$12 = 10r + 11.5$ 01

$r = \frac{0.5}{10}$

$r = 0.05\ \Omega$ 01

(b) Total power disspation from both head lamps = VI
$= 10 \times 11.5W$
$= 115$ W 01

Power disspation from each head lamp

$P = \frac{1}{2} \times VI$

$= \frac{1}{2} \times 115$ W

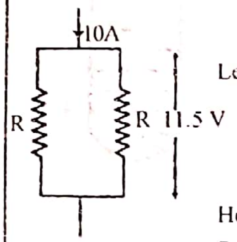
$= 57.5$ W

(b) [Alternative Method

For the Head Lamps

$10 \times R_L = 11.5$ (i)

$R_C = 1.15\ \Omega$



Let R be the resistance of each head lamps

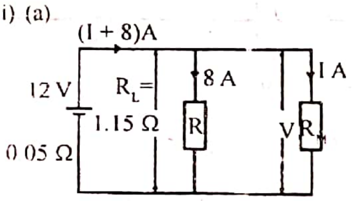
$\frac{1}{R_L} = \frac{1}{R} + \frac{1}{R} \Rightarrow R = 2R_1$

$R = 2.3\ \Omega$ 01

Heat dissipation by each head lamp.

$P = V^2/R = \frac{11.5^2}{2.3} = 57.5\ W$ 01

(ii) (a)



For the head lamps.

$V = IR$

$11.5 = 10 \times R_L$

$R_L = 1.15\ \Omega$

Voltage across the head lamps

$V = IR$

$V = R_L \times 8 = 1.15 \times 8.0$ 01

$V = 9.2\ V$

Let I be the current through the starter moter

$12 = (i + 8.0) \times 0.05 + 9.2$

$0.05i + 0.4 = 12 - 9.2$

$0.05\ I = 2.4$

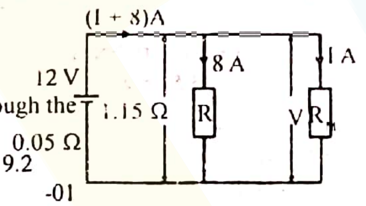
$i = 48A$ 01

it is not possible to start the car 01

(a) Voltage across the head lamps

$V = R_L \times 8 = 1.15 \times 8.0$ -01

$= 9.2\ V$



Let i be the current through the starter motor

$12 = (i + 8) \times 0.05 + 9.2$

$i = 48\ A$ -01

it is possible to start the car -01

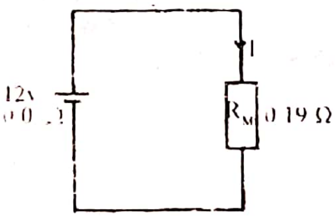
(b) From the above diagram

$R_M = \frac{9.2}{48}$

$0.19\ \Omega$

(0.190 - 0.192) -01

(c) Let I be the current through the starter motor



$i = V/R_v + r$

$i = \frac{12}{0.05 + 0.19} = \frac{12}{2.4}$

$= 50\ A$ (49.6 A) 01

It is possible to start the car

01

(iii) (a) increase of internal resistance of the battery cause a drop of current through the starter motor it this drop is below the minimum required car may not get started.

01

(b) Current required to ligth the bulb = $\frac{6W}{12\ V} = 0.5A$

Smaller current such as 0.5A can be drawn from the battery. 01

05 (B) (i) (a) Current through the load resistor $i_L = \frac{10}{100} = 0.1A$

01

Current through R = 0.1 + 0.01 = 0.11A -01

$(I = R_{iL} + R_i)$

Thre fore $12 = IR + 10$

$12 - 10 = 0.11R$

$R = \frac{2}{0.11}$

$= 18\ \Omega$ -01

(18.0 - 18.2)

(b) (1) when the switch is closed

Power dissipation (E) $= VI$

$= 10 \times 0.01\ W$

$= 0.1\ W$ -01

(2) When the switch is open

Zenor Current $I_z = \frac{12 - 10}{2/0.11}$ OR $\left(\frac{12 - 10}{18}\right)$

$= 0.11A$

Power dissipation (E) $= VI$

$= 10 \times 0.11\ W$

$= 1.1\ W$

$= (1.09 - 1.11)$

Therefore minimum power rating = 1.1W

(ii) (a) Voltage aross load resistor $= V_z - 0.6 = 10.6 - 0.6$

$= 10V$ 01

Therefore the device gets correct supply voltage

$\frac{10}{100} = 0.1\ A$ -01

(b) I_E (Emither current)

$I_E = (1 + \beta)\ I_B$ OR $I_C \approx I_E = 0.1\ A$ and $I_C = \beta I_B$

$I_B = \frac{0.1}{99+1}\ A$ $I_B = \frac{0.1}{99}$

$I_B = 0.001\ A$ -01 $I_B = 0.001\ A$

(c) Maximum power dissipation occurs when the switch is open 01

Then current through the diode

$120\ I_z = 12 - 10.6$

$I_z = \frac{12 - 10.6}{120}$

$= 0.012\ A$

Power dissipation (W) $= VI$

10.6×0.012

$0.13\ W$ -01

$(0.11 - 0.15\ W)$

This power dissipatron is lessthan 1/4 W

Therefore 1/4 W rating is sufficient -01

(ii) (d) Muximum power dissipation in the zener diode is 1.1W in the first circuit and 0.13W in the second. Therefore the advantage of the second circuit is low power wastage in the zener diode. OR

ability to use a zener diode with lower power rating -01

06. A (i) Using $Q = KA\left(\frac{\theta_{in} - \theta_{out}}{d}\right)$ -01

Rate of heat transfer through the wall

$$\left[\begin{array}{l} \text{OR wall Area} = 100 - 7 = 93m^2 \\ Q_{wall} = 0.6 \times 93 \times \frac{(30 - 25)}{10 \times 10^{-2}} \\ = 2.8 \times 10^3 W \end{array}\right]$$

$$Q_{wall} = 0.6 \times 10^2 \times \frac{(30 - 25)}{10 \times 10^{-2}}$$

$$= 3 \times 10^3 W$$

Rate of heat tranfer through the door

$$Q_{Door} = 0.1 \times 3 \times \frac{(30 - 25)}{2 \times 10^{-2}}$$

$$= 0.75 \times 10^2 W$$

Rate of heat transfer through the window

$$Q_{Window} = 0.8 \times 4 \times \frac{(30 - 25)}{0.5 \times 10^{-2}}$$

$$= 3.2 \times 10^3 W$$

The rate of heat trarsfer from the surrounding s into the building

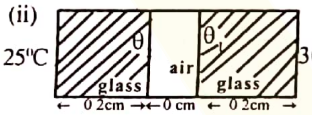
$= 3 \times 10^3 + 0.75 \times 10^2 + 3.2 \times 10^3$ 01

$= (3 + 0.75 + 3.2) \times 10^3 W$

$= 6.275 \times 10^3 W$

$= (6.0 - 6.3)$

(ii) -01



The rate of heat tranfer through the outer glass plate.

$$Q_1 = 0.8 \times 4 \times \frac{(30 - \theta_1)}{0.2 \times 10^{-2}}$$

The rate of heat franfer through the air gap

$$Q_2 = 0.03 \times 4 \times \frac{(\theta_1 - \theta_2)}{0.1 \times 10^{-2}}$$

The rate of heat transfer through the inner glass plate

$$Q_3 = 0.8 \times 4 \times \frac{(\theta_2 - 25)}{0.2 \times 10^{-2}}$$

under steady conditions $Q_1 = Q_2 = Q_3 = Q$

① $\Rightarrow 30 - \theta_1 = \frac{0.2 \times 10^{-2} Q}{4 \times 0.8}$

② $\Rightarrow \theta_1 - \theta_2 = \frac{0.1 \times 10^{-2} Q}{4 \times 0.03}$

③ $\Rightarrow \theta_2 - 25 = \frac{0.2 \times 10^{-2} Q}{0.8 \times 4}$

$$30 - 25 = \left(\frac{2 \times 10^{-3}}{3.2} + \frac{1 \times 10^{-3}}{0.12} + \frac{2 \times 10^{-3}}{3.2}\right)Q$$

$$5 = 10^{-3} Q \left(\frac{20}{32} + \frac{100}{12} + \frac{20}{32}\right)$$

$$5 = 10^{-3} Q \left(\frac{60 + 800 + 60}{96}\right)$$

$$Q = \frac{5 \times 96 \times 10^3}{920}$$

$$Q = 5.23 \times 10^2 W. \ (4.80 - 5.60)$$

The percentage reducton in the heat tranfer rate through the window.

$$= \frac{(Q_{old} - Q_{new})}{Q_{old}} \times 100\%$$

$$= \frac{(3.2 \times 10^3 - 5.28 \times 10^2)}{(3.2 \times 10^3)} \times 100\%$$

$= 83.5\%$

$(82.5 - 85.0)$

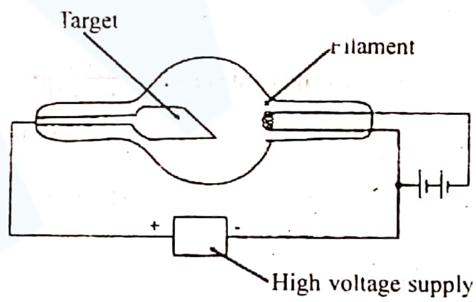
(b) (i) Relative Humidity $= \frac{\text{SV P at dew point}}{\text{S.V.P. at room temperature}}$

$$\frac{80}{100} = \frac{\text{S.V.P at } 25^\circ C}{30}$$

Relative Humidity inside the building $= \frac{16}{\text{S.V.P } 25^\circ C} \times 100\%$ -01

$= 66.7\%$

(66.67)



labeling	any two	02
	any one	01

(ii) when the filameat is heated electrons inside the metal are emitted due to thermionic emission

OR By heating the filament -01

(iii) To avoid minimize collisions

OR To avoid minimize scattering

To make the electrons reach the target

to avoid energy loss of electrons 01

(iv) Supply Vcltage = 100KV (correct unit) 01

(v) Wevelergth $\lambda = \frac{hc}{E}$ 01 01

$$\lambda = \frac{(6.6 \times 10^{-34}) \times (3 \times 10^8)}{100 \times 10^3 \times 1.6 \times 10^{-19}}$$

$= 0.12 \times 10^{-10}$ m

$= 0.12 \ A^\circ$ 01

(vi) (a) Annual effective background dose = 2mSv

Background effective dose rate $= \dfrac{20 \times 10^3}{365 \times 24}$

-01

$= 0.228\ \mu Svhr^{-1}$

-01

(b) Maximum permissible annual effective dose = 20 mSV

Number of hours the radiation worker works = 40 x 40 hr

Maximum effective dose rate allowed in the lab $= \dfrac{20 \times 10^3}{40 \times 40}$

$= 12.5\ \mu SVhr^{-1}$

-01

(c) (1) effective dose rate due to X - rays = 0.57IEa $\mu Svhr^{-1}$

01

$= 0.57 \times (9.4 \times 10^8) \times 0.1 \times (0.027)\ \mu Svhr^{-1}$

$= 1.45 \times 10^6\ \ \mu Svhr^{-1}$

Dose received due to x - rays $= 1.45 \times 10^6 \times \dfrac{0.1}{3600} \times \mu Sv$

$= 40\ \mu Sv$

(38 - 42)

(2) Dose received by 1 kg mass $= 40\ \mu Sv$

$= 40 \times 10^{-6}$ Sv

amount of energy absorbed by 1kg mass $= 40 \times 10^{-6}$ J -01

amount of energy absorbed by 5kg mass $= 5 \times 40 \times 10^{-6}$ J

$= 2 \times 10^{-4}$ J

Energy of an X - ray Photon = 100keV

$= 100 \times 10^3 \times 1.6 \times 10^{-19}$ J

$= 1.6 \times 10^{-14}$ J -01

number of X - ray photons abgorbed $= \dfrac{2 \times 10^{-4}}{1.6 \times 10^{-14}}$

$= 1.25 \times 10^{10}$ Photons

-01

(1.19 - 1.31)