G.C.E. (Advanced Level) Examination - April 2004

PHYSICS - I

Two hours

Important :
- This question paper consists of 60 questions in **12** pages.
- Enter your **Index Number** in the space provided on the answer sheet.
- **Answer all the questions.**
- 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. In the following expression I and V represent current and voltage respectively. C is a constant.

$$C \log\left[\frac{I}{I_0}+1\right]=\frac{qV}{kT}$$

The term $\frac{KT}{q}$ has

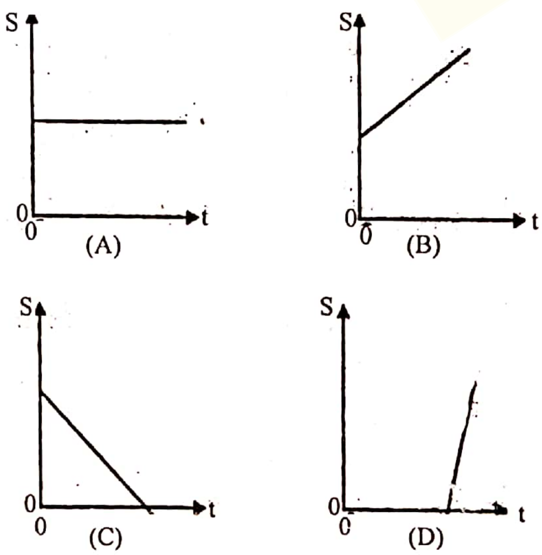
(1) no dimensions. (2) dimensions of resistance.
(3) dimensions of V^{-1}. (4) dimensions of I.
(5) dimensions of V.

02. Consider the following statements made regarding plane electromagnetic waves propagating in a vacuum.

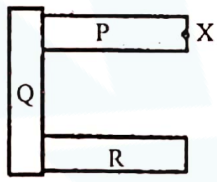
(A) Electromagnetic waves are transverse waves.
(B) The speed of electromagnetic waves is independent of the wavelength.
(C) The electric and magnetic fields associated with the wave are always directed along the direction of propagation of the wave.

Of the above statements

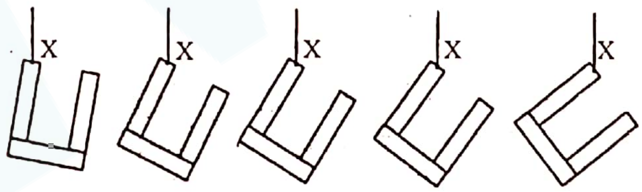
(1) only (A) is true (2) only (A) and (B) are true.
(3) only (A) and (C) are true (4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

03. 

Of the given distance (s)- time (t) graphs drawn to same scale, the magnitude of the velocity is
(1) minimum in A and maximum in C.
(2) minimum in C and maximum in D.
(3) minimum in A and maximum in D.
(4) minimum in B and maximum in C.
(5) minimum in D and maximum in B.

04. 

A frame is made by joining three uniform rods P, Q and R having identical geometrical dimensions as shown in the figure. Rods P and R are of the same mass, but the rod Q is twice as heavy as P or R. When the frame is suspended freely from the point X, its equilibrium position is most likely to be.



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

05. When an object is made to perform simple harmonic motion,
(1) the force acting on the object is proportional to the magnitude of its displacement from the equilibrium position.
(2) the force acting on the object is always directed away from the equilibrium position.
(3) the frequency of oscillation of the object is proportional to the amplitude of the oscillations.
(4) the total energy of the object does not depend on the amplitude of oscillations.
(5) the potential energy of the object is always constant.

06. Consider the following statements made about light passing through a prism.
(A) Frequency of light changes when passing through a prism.
(B) Light of different colours travel at different speeds inside a prism.
(C) Blue light deviates more than red light when passing through a prism.
Of the above statements

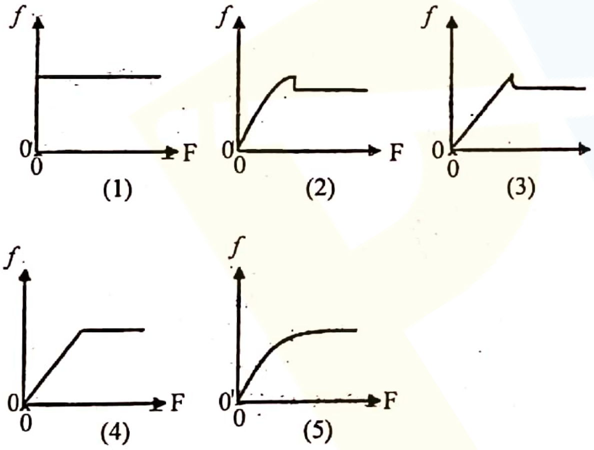
(1) only (C) is true.
(2) only (A) and (B) are true.
(3) only (B) and (C) are true.
(4) only (A) and (C) are true.
(5) all (A), (B) and (C) are true.

07. The most appropriate fuse for an electric heater of 1 kW con nected to the main house hold electric supply is
(1) 1 A fuse (2) 3 A fuse. (3) 4 A fuse.
(4) 5 A fuse (5) 15 A fuse.

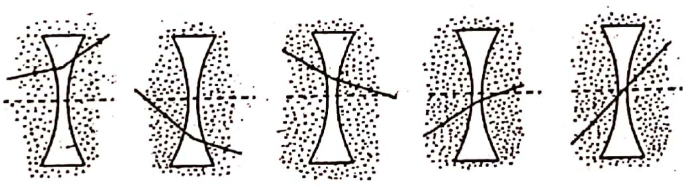
08. Total electric power generation capacity of Sri Lanka is ap proximately 2.1GW. If this power is to be generated by converting mass into energy, how much mass per second should be converted into energy?
(velocity of light = $3 \times 10^8 ms^{-1}$)
(1) 0.025mg/s (2) 23g/s (3) 2.3kg/s
(4) 6.9kg/s (5) 47.61kg.s

09. A horizontal force os 10N is applied for a period of 10 ms on a body placed on a smooth horizontal table. The change is mo mentum of the body is SI units will be
(1) 10^{-3} (2) 0.1 (3) 1.0
(4) 10^2 (5) 10^3

10. An object lies on a horizontal table. When the object is pulled by a horizontal force F that increases uniformly from zero, the variation of the frictional force f acting on the object is best represented by the graph



11. A thin glass (refractive index = 1.5) lens is immersed in water (refractive index = 1.33). Which of the following ray diagrams is **wrong?**



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

12. A certain person cannot clearly see objects located beyond 1m away from the eye. This defect can be corrected by wearing.
(1) a concave lens of focal length 1m
(2) a convax lens of focal length 1m
(3) a concave lens of focal length 0.5m
(4) a convex lens of focal length 0.5m
(5) a convex lens of focal length 0.25m

13. Among the following, identify the quantity which increases with temperature.
(1) Resistivity of a copper wire
(2) Resistivity of a piece of silicon
(3) Surface tension of water
(4) Viscosity of water
(5) Relative humidity of air in a closed room

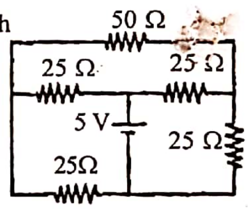
14. Which of the following responses contains **false** information regarding photons and electrons?

Photond	Electrons
(1) **Cannot** travel at different speeds in a vacuum.	Can travel at different speeds in a vacuum.
(2) Can have different energies.	Can have different energies.
(3) Can be deflected by electric fields.	Can be deflected by electric and magnetic fields.
(4) Can behave as particles and waves.	Can behave as particles and waves.
(5) Can eject electrons from materials.	Can ejet photons from materials.

15. The magnitude of the magnetic force acting on a current carrying straight wire in a uniform magnetic field is determined by

(1) the magnetic flux density, the current, the length of the wire and the angle between the magnetic field and the wire only.
(2) the magnetic flux density, the current and the length of the wire only.
(3) the magnetic flux density, the current and the angle between the magnetic field and the wire only.
(4) the magnetic flux density and the length of the wire only.
(5) the magnetic flux density and the current only.

16. In the circuit shown, the current through 50Ω resistor is



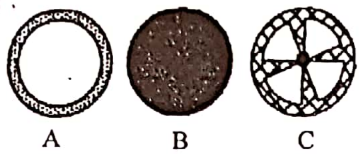
(1) 0. (2) 0.1 A.
(3) 0.2 A. (4) 0.4. A. (5) 0.5 A.

17. Which of the following procedures does **not** increase the accuracy of the indicated measuring quantity?

	Measuring Quantity	Procedure
(1)	Period of a simple pendulum	Measuring time for several oscillations
(2)	Thickness of a plate of uniform thickness	Measuring thickness with a micrometer screw gauge instead of a vernier callipers.
(3)	Diameter of a wire	Taking several measurements at different positions
(4)	Balanced length of the potentiometer wire	Inserting a high resistance in series with the galvanometer
(5)	Current in a circuit	Using an ammeter having a smaller internal resistance

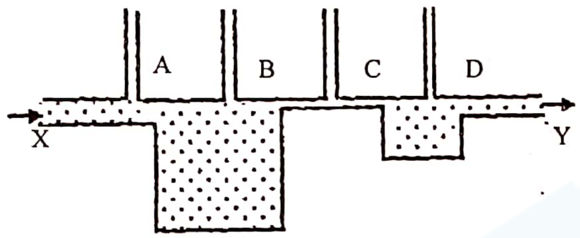
18. Three wheels A, B and C of the same mass and same external radius are made out of uniform sheets of different materials as shown in the figure. These wheels are released simultaneously

from rest from the same height at the top of an inclined plane. The wheels roll down without slipping. The order that they will reach the bottom of the inclined plane as first, second and third respectively is



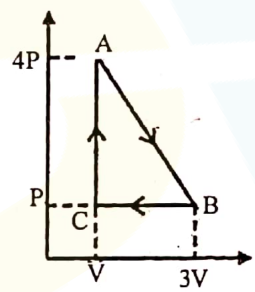
(1) *A, B, C* (2) *B, C, A* (3) *C, A, B*
(4) *B, A, C* (5) *A, C, B*

19. A water-flow system consisting of manometer tubes *A, B, C* and *D* is shown in the figure. Water enters the system at *X* at a constant rate and at a pressure greater than the atmospheric pressure, and leaves at *Y*. If the heights of the water levels (not indicated in the diagram) in manometer tubes *A, B, C* and *D* are H_A, H_B, H_C and H_D respectively, then



(1) $H_A = H_B = H_C = H_D$ (2) $H_C > H_A > H_D > H_B$
(3) $H_B > H_D > H_C > H_A$ (4) $H_D > H_C > H_A > H_B$
(5) $H_B > H_D > H_A > H_C$

20. Work done during the cyclic thermodynamic process *ABCA* indicated in the *P-V* diagram shown is



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

21.

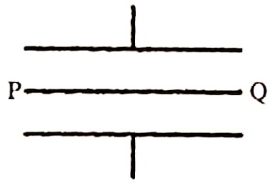
A coil of metal wire made of a material of linear expansivity $2 \times 10^{-5}\ K^{-1}$ has *n* turns. When the temperature of the coil is increased by 1 °C while keeping its radius *R* (see figure) constant, the number of turns becomes *n* + 1. The value of *n* is
(1) 2.5×10^9 (2) 10^5 (3) 5×10^4
(4) 2.5×10^4 (5) $\sqrt{5} \times 10^4$

22. When 1g of each of the gases helium (relative atomic mass = 4), neon (relative atomic mass = 20) and argon (relative atomic mass = 40) are separately enclosed in the same container at the same temperature, the ratio of pressures exerted by the gases respectively is

(1) $\frac{1}{4} : \frac{1}{20} : \frac{1}{40}$ (2) 4 : 20 : 40 (3) $4^2 : 20^2 : 40^2$

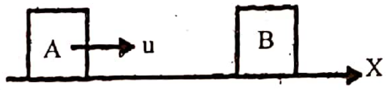
(4) $\frac{1}{4^2} : \frac{1}{20^2} : \frac{1}{40^2}$ (5)

23. A thin metal plate *PQ* is inserted between the plates of a parallel plate capacitor of capacitance *C*, so that it is parallel to the capacitor plates as shown in the diagram. If the area of the plate *PQ* is same as that of a capacitor plate, the new capacitance of the system will be



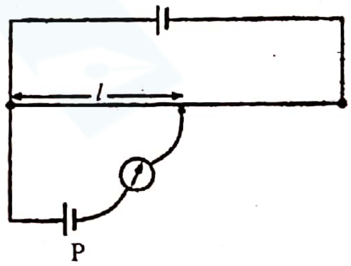
(1) $\frac{C}{4}$ (2) $\frac{C}{2}$ (3) C (4) $\frac{3C}{2}$ (5) 2C

24. The object A of mass m and velocity u moving on a smooth horizontal surface along positive *x* direction makes a perfectly elastic collision with an identical object B which is at rest as shown in the figure. After the collision, the velocities of A and B are,



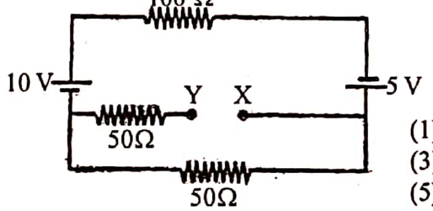
(1) 0, and u along positive *x* direction respectively.
(2) $\frac{u}{2}$ along positive *x* direction, and $\frac{u}{2}$ along positive *x* direction respectively.
(3) $\frac{u}{2}$ along negative *x* direction, and $\frac{u}{2}$ along positive *x* direction respectively.
(4) *u* along negative *x* direction, and 0 respectively.
(5) 0, and $\frac{u}{2}$ along positive *x* direction respectively.

25. In the potentiometer circuit shown, the indicated balance length *l* is obtained for a cell *P* having an internal resistance. When another resistor is connected with *p*, the value of



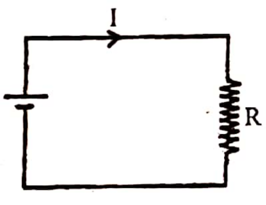
(1) *l* increases if the resistor is in parallel with *P*.
(2) *l* does not change if the resistor is in parallel with *P*.
(3) *l* increases if the resistor is in series with *P*.
(4) *l* decreases if the resistor is in series with *P*.
(5) *l* does not change if the resistance is in series with *p*.

26. In the circuit shown the internal resistances of the cells are negligible. The voltage across *XY* is



(1) 1.6 V (2) 3.75 V
(3) 5V (4) 7.5 V
(5) 15V

27. If the internal resistance of the cell in the circuit shown is negligible, current *I* in the circuit can be increased to 3*I* by connecting another resistor of value



(1) R in series with R.
(2) 2R in series with R. (3) R in parallel with R.
(4) 2R in parallel with R. (5) $\frac{R}{2}$ in parallel with R.

28. If the electrical energy costs Rs. 5.00 per kilowatt-hour, the cost to operate an electric appliance of resistance 60Ω for 6 minutes on a 240 V supply is

(1) Rs 0.08 (2) Rs 0.48 (3) rs 0.50
(4) Rs 2.80 (5) Rs 480.00

29. The force required to increase the length of an elastic string by a unit length is given by k. Comsider the following statements made about k.

(A) The value of k can be increased by increasing the Young's modulus of the material of the string.

(B) The value of k can be increased by increasing the cross-sectional area of the string.

(C) The value of k can be increased by decreasing the length of the string.

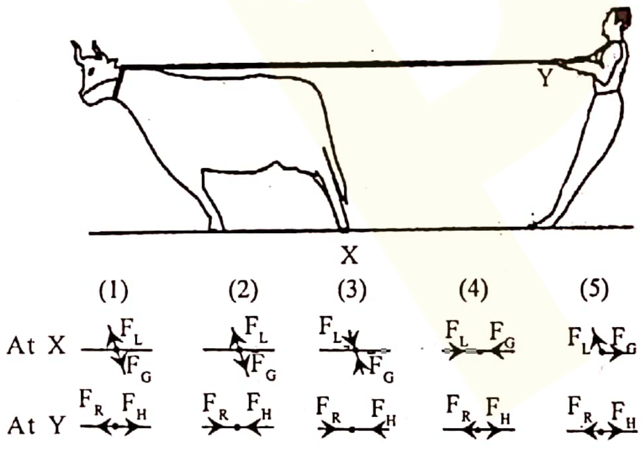
Of the above statements

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

30. A loop made of a string of length l is kept on a soap film. When the section of the film inside the loop is broken, the tension of the string becomes T. If the length of the string is $2l$ then the tension of the string would be

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

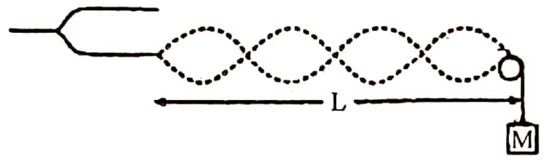
31. Figure shows an attempt made by a man to hold a bull tied to a rope trying to escape. The force at X acting on the bull's leg is F_L and that on the ground is F_G. The force at Y acting on the rope is F_R and that on the hand of the man is F_H. The forces F_L, F_G, F_R and F_H are correctly represented by.



32. A beam of light that appears to be converged to a point on the axis 10cm behind a lens is actually converged to a point on the axis 8cm behind it. The lens is

(1) a convex lens of focal length 40cm
(2) a convex lens of focal length 40cm
(3) a convex lens of focal length 4.4cm
(4) a convex lens of focal length 4.4cm
(5) a convex lens of focal length 20cm

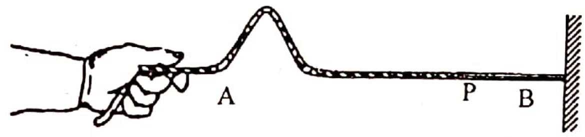
33. One end of a string of mass per unit length m is connected to a prong of a tuning fork and the other end is connected to a mass M after passing over a frictionless pulley as shown in the figure. When the tuning fork is vibrated, the string vibrates forming a standing wave as shown. The frequency of the tuning fork is



(1) $\frac{2}{L}\sqrt{\frac{Mg}{m}}$ (2) $\frac{2}{L}\sqrt{\frac{M}{m}}$ (3) $\frac{4}{L}\sqrt{\frac{Mg}{m}}$

(4) $\frac{1}{L}\sqrt{\frac{Mg}{m}}$ (5) $\frac{2}{L}\sqrt{\frac{m}{Mg}}$

34.



Two string A and B are connected end-to-end at P as shown in the figure and the free end of the lighter string B is attached to a rigid vertical wall. The masses per unit length of A and B are 0.04 kg m^{-1} and 0.01 kg m^{-1}, respectively. The composite string is first pulled by hand to create a tension of 1 N and then a pulse is created at the free end of A. After the pulse has reached the point P

(1) a non-inverted pulse would have travelled along B to the right with speed $10ms^{-1}$
(2) an inverted pulse would have travelled along B to the right with speed $10ms^{-1}$
(3) a non-inverted pulse would have travelled to the left along A with speed $10ms^{-1}$
(4) an inverted pulse would have travelled to the left along A with speed $10ms^{-1}$.
(5) no pulse would have travelled along A to the left.

35. A gas is confined to a closed container. Consider the following statements made regarding the speed of sound in the gas.

(A) The speed of sound does not change when the volume of the container is changed at a constant temperature.

(B) The speed of sound changes with temperature.

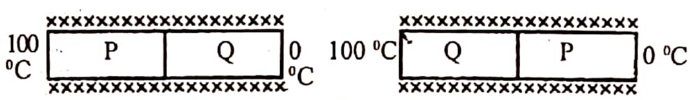
(C) The speed of sound changes when more gas is added to the container at a constant temperature. Of the above state ments

(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 true

36. A driver sitting in a parked car, seeing another car moving directly towards his car, sounds his horn. The frequency of the horn of the parked car is 340Hz and the speed of sound in air is 340ms-1. If the driver of the moving car detects the frequency of this sound as 348Hz, the speed of his is

(1) $2.0ms^{-1}$ (2) $3.0ms^{-1}$ (3) $4.0ms^{-1}$ (4) $6.0ms^{-1}$ (5) $8.0ms^{-1}$

37.



Temperatures at the two ends of a composite cylindrical rod made of two similar pieces of different metals P and Q are maintained at 100°C and 0 °C in two different situations (a) and (b) as shown in figures. The composite rod is well lagged, and the thermal conductivity of the metal P is twice that of Q. Consider the following statements made regarding the system at the steady state.

(A) The temperature variation along the composite rod from hot end to cold end is the same in both situations (a) and (b).

(B) Temperature at the junction between two metals of the composite rod is higher in the situation (a) than (b).

(C) The rates of flow of heat along the composite rod are the same in situations (a) and (b).

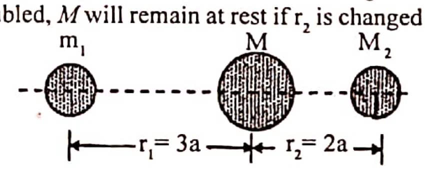
Of the above statements

(1) only (C) 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.

38. The figure shows an isolated system of three masses. The mass M is at rest under the influence of the masses m_1 and m_2, which are held in the positions indicated in the diagram. When mass m_1 is doubled, M will remain at rest if r_2 is changed to



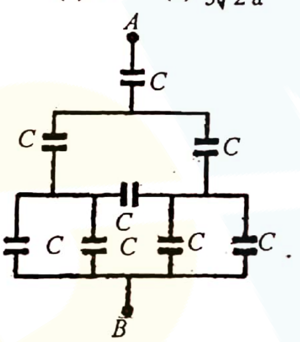
(1) $2\sqrt{2}a$ (2) $\sqrt{2}a$ (3) 2a (4) 4a (5) $3\sqrt{2}a$

39. The equivalent capacitance between points A and B of the network shown in the diagram is

(1) $8C$ (2) $2C$

(3) $\frac{7}{3}C$ (4) $\frac{3}{2}C$

(5) $\frac{4}{7}C$



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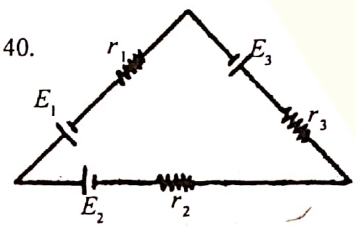


In the circuit shown, the internal resistances of all the cells are negligible. Current in the circuit is I. Which of the following equations is true for the circuit?

(1) $E_1 + E_2 + E_3 = I(r_1 + r_2 + r_3)$

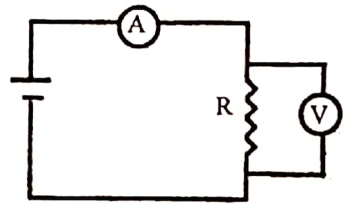
(2) $E_1 + E_2 + E_3 = I(-r_1 + r_2 + r_3)$

(3) $E_1 - E_2 - E_3 = I(r_1 - r_2 - r_3)$

(4) $-E_1 + E_2 + E_3 = I(r_1 + r_2 + r_3)$

(5) $-E_1 + E_2 - E_3 = I(-r_1 + r_2 - r_3)$

41. Consider the following statements made regarding the voltmeter V and the ammeter A in the circuit shown.



(A) Negative terminal of the ammeter and the positive terminal of the voltmeter should be connected together for proper opera tion.

(B) Internal resistance of the voltmeter should have a value lower than R for proper operation.

(C) If A and V are interchanged by mistake, the ammeter is now expected to read a smaller current than the reading obtained under proper operation.

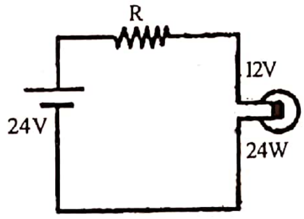
Of the above statements

(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.

42. In the circuit shown, the bulb operates at the given rated values. Internal resistance of the cell is negligible. The value of R is



(1) 1Ω (2) 3Ω (3) 6Ω

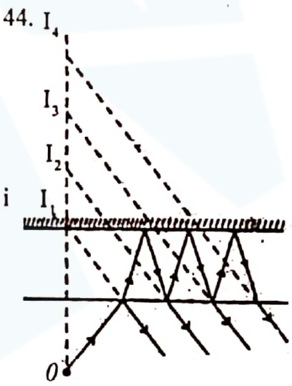
(4) 12Ω (5) 18Ω

43. Two wires of equal cross-sectional areas but having lengths l and $2l$, and resistivities ρ_1 and ρ_2 respectively, are connected end to end to form a composite wire as shown in the figure. The effective resistivity of the composite wire is

(1) $\frac{\rho_1 + \rho_2}{2}$ (2) $\frac{\rho_1 - \rho_2}{\rho_1 + \rho_2}$ (3) $\rho_1 + \rho_2$

(4) $\frac{\rho_1\rho_2}{\rho_1 + \rho_2}$ (5) $\frac{\rho_1 + 2\rho_2}{3}$

44.



When an object 0 is kept in front of a thick plane mirror formed by silvering one side of a thick glass plate as shown in the figure, a series of images $I_1, I_2, I_3, ...$ can be observed. Which of the following statements s correct?

(1) I_1 is the brightest and the intensities of images $I_2, I_3, ...$ decrease gradually.

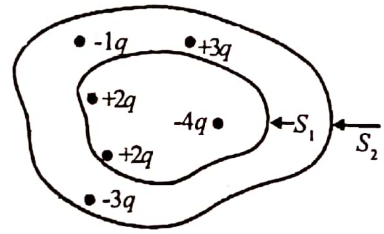
(2) I_2, is the brightest and the intensities of images $I_3, I_4, ...$ decrease gradually.

(3) I_2, is the brightest and intensities of images $I_3, I_4, ...$ are the same.

(4) I_3 is the brightest and intensities of images $I_2, I_4, ...$ are the same.

(5) I_1 is the brightest and intensities of images $I_2, I_3, ...$ are the same.

45. Consider the following statements made regarding the charge distribution shown.



(A) No electric field lines cross the closed surface $S1$.

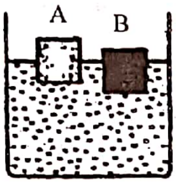
(B) Total electric flux due to the charge $+3q$ does not depend on the rest of the charges present.

(C) Net electric flux through the closed surface S_2 is not zero.

Of the above statements

(1) only (C) 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. Two cubes A and B of the same geometrical dimensions float in water as shown in the figure. Cube A has half of its volume above the water level whereas B has only $\frac{1}{4}$ of its volume above the water level. If the cube B is carefully placed on cube A, which of the following responses indicates the correct positions of the cubes A and B?



	Cube A	Cube B
(1)	$\frac{3}{4}$ of the volume is under water	Completely above the water level
(2)	Completely submerged	Completely above the water level
(3)	Completely submerged	$\frac{1}{4}$ of the volume is under water
(4)	Completely submerged	$\frac{1}{2}$ of the volume is under water
(5)	Completely submerged	$\frac{3}{4}$ of the volume is under water

47. A particle P moving with a uniform velocity of $4\,ms^{-1}$ along x - axis passes the origin 0 at time $t = 0$. A second particle Q moving along the same direction with a uniform velocity of $5\,ms^{-1}$ passes origin 0 at $t = 1s$. Particle Q will reach the particle P when they have travelled a distance of

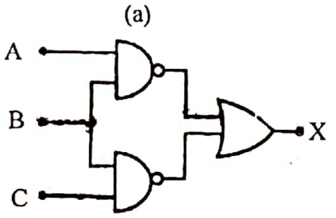
(1) 10 m from the origin. (2) 16 m from the origin.
(3) 20 m from the origin. (4) 25 m from the origin.
(5) 30m from the origin.

48. The intensity of sound emitted from a point source is inversely proportional to the square of the distance from the source. If the intensity level of sound at a distance of 1.0m from a point source of sound is 50 dB, the sound intensity level at a distance of 10.0 m from the source will be

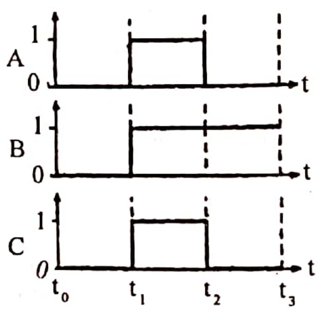
(1) 0.5 dB (2) 3 dB (3) 5 dB
(4) 30 dB (5) 70 dB

49. Figure (a) shows a digital circuit. The variations of the logic values of its inputs A, B and C with time (t) are shown in figure (b).

(a)



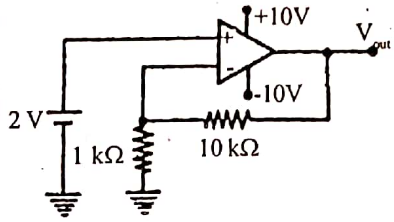
(b)



The output X will be 0 during the time interval/ intervals

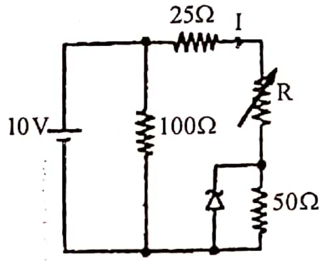
(1) from t_0 to t_1 (2) from t_1 to t_2
(3) from t_2 to t_3 (4) from t_1 to t_3
(5) from t_0 to t_1, and from t_2 to t_3

50. The operational amplifier circuit shown operates with +10V and -10V power supplies. What would be the approximate output voltage (V_{out}) of the circuit?



(1) +22V (2) -22V (3) +20V (4) +10V (5) -10V

51. The breakdown voltage of the zener diode of the circuit shown is 5V. The internal resistance of the cell is negligible. When the value of R is changed from 25Ω to 0, the current I in the circuit will change from

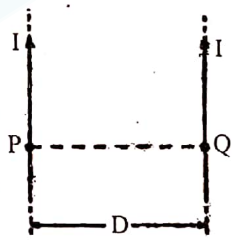


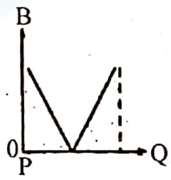
(1) 0.10 A to 0.13A. (2) 0.20 A to 0.40 A.
(3) 0.13 A to 0.20 A. (4) 0.10 A to 0.20 A.
(5) 0.20 A to 0.27 A.

52. A metal sphere of radius r carrying a charge $+q$ is connected by a conducting wire to another metal sphere of radius $2r$ carrying a charge $+q$. After the connection, the amount of charge in the sphere of radius r is (Assume that the amount of charge residing in the connecting wire is negligible.)

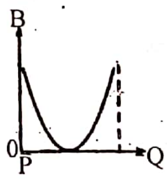
(1) 0 (2) $+\frac{q}{3}$ (3) $+\frac{q}{2}$ (4) $+\frac{2}{3}q$ (5) $+\frac{3}{2}q$

53. Two long, parallel, thin wires placed at a distance D apart as shown in the figure, carry equal currents I in the same direction. Variation of the magnitude of the resultant magnetic flux density B along the line PQ from P to Q, is best represented by

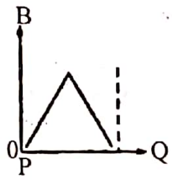




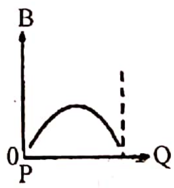
(1)



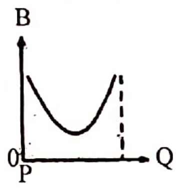
(2)



(3)

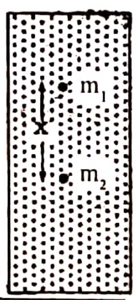


(4)



(5)

54. Two spheres each of radius a but of different masses m_1 and m_2, ($m_1 > m_2$) move down at their terminal velocities in a liquid of viscosity η. At the instant shown in the figure, the separation x between the two spheres is being



(1) increased at a rate of $\frac{m_1 m_2}{6\pi a\eta}$ g per second.

(2) decreased at a rate of $\frac{6\pi a\eta}{(m_1 - m_2)\,g}$ per second.

(3) increased at a rate of $\frac{(m_1 + m_2) g}{6\pi a\eta}$ per second.

(4) decreased at a rate of $\frac{(m_1 + m_2) g}{6\pi a\eta}$ per second.

(5) decreased at a rate of $\frac{(m_1 - m_2) g}{6\pi a\eta}$ g per second.

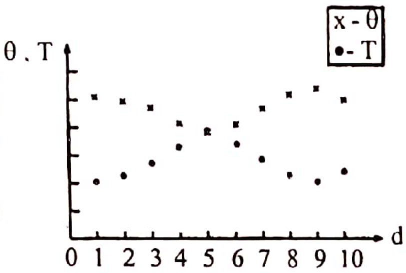
55. The mean temperature (θ) and the dew point (T) of the atmo sphere between 6.00 a.m. and 8.00 a.m. in10 consecutive days (d), 1 - 10, are shown in the figure.

Consider the following statements made about the atmosphere.

(A) Relative humidity is maximum on day 9.

(B) Day 6 has more water vapour in the atmosphere than on day 8.

(C) Mist is possible in none of the days.



Of the above statements

(1) only (B) is true. (2) only (A) and (B) are true.

(3) only (B) and (C) are true. (4) only (A) and (B) are true.

(5) all (A), (B) and (C) are true.

56. A mass m_i of ice at 0 °C is added to a mass m_w of water at the room temperature of 30 °C, and the mixture is stirred until the ice is completely dissolved in water. If the minimum hemperature of the mixture is found to be 10 °C, the amount of heat absorbed by the mixture from the container and the environment is

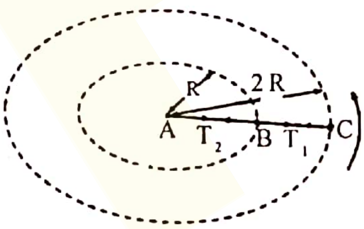
(Specific heat capacity of water = S_w, Latent heat of fusion of ice = L)

(1) $\frac{M_i(L + 10 S_W)}{20 m_W S_W}$ (2) $m_i(L + 10 S_W) - 20 m_W S_W$

(3) $10m_W S_W + m_i (L + 10 S_W)$ (4) $m_i (L + 10 S_W) - 10m_W S_W$

(5) $20m_W S_W + m_i (L + 10 S_W)$

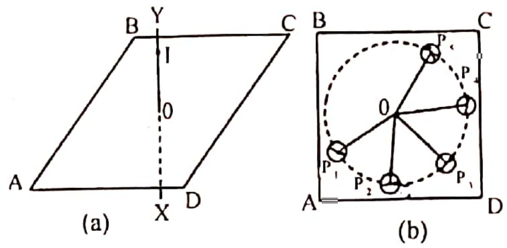
57. Two small objects of equal masses are attached to each other by a light string BC, and this system is con nected to a fixed point A with another light string AB as shown in the figure. The masses are then made to move in horizontal circular paths of radii R and $2R$ (see figure) with the same angular speed so that points A, B and C are always in a straight line. If T_1 and T_2 are the tensions of the strings BC and AB respectively, then



(1) $T_2 = \frac{1}{2} T_1$ (2) $T_2 = \frac{2}{3} T_1$ (3) $T_2 = T_1$

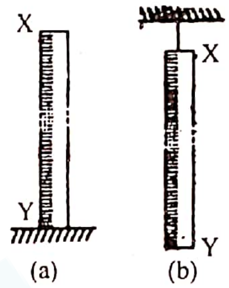
(4) $T_2 = \frac{3}{2} T_1$ (5) $T_2 = 2T_1$

58. XY is a long vertical wire carrying a current I in the upward direction as shown in figure (a). $ABCD$ is a horizontal plane perpendicular to the wire. The directions of the magnet of a compass kept at positions P_1, P_2, P_3, P_4 and P_5 on the plane $ABCD$ near the wire are shown in figure (b). The position at which the direction indicated by the magnet of the compass is the same as the direction of the horizontal component of the earth's magnetic field is



(1) P_1 (2) P_2 (3) P_3 (4) P_4 (5) P_5

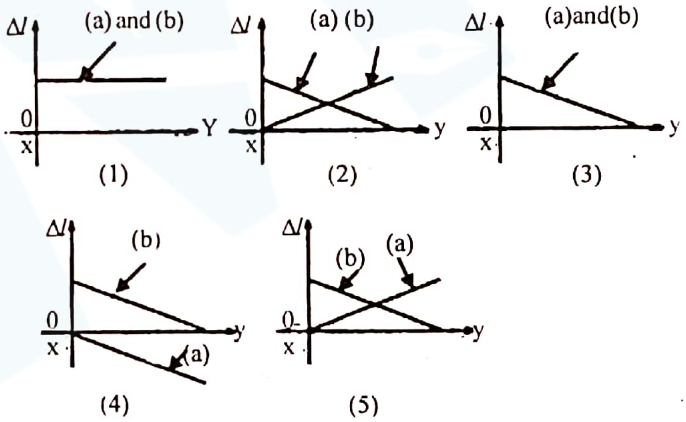
59.



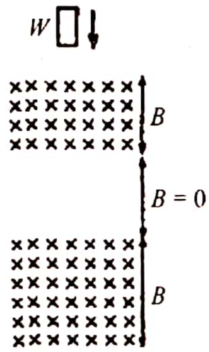
A 1 m long cylindrical copper rod XY of mass M is accurately calibrated in (standard) millimetres when it is in horizontal po sition. In two separate occasions, this rod is kept in vertical position by placing on a horizontal platform [see figure (a)]. and by hanging from a ceiling [see figure (b)]. If

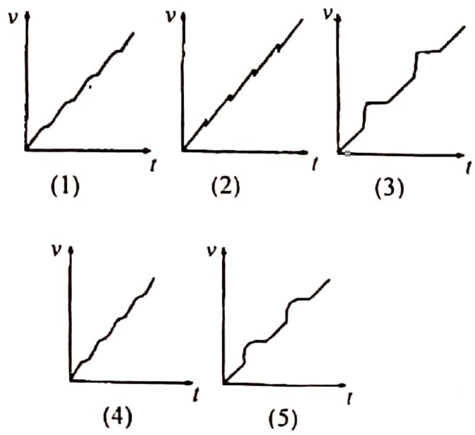
'the distance between two consecutive millimetre marks' - 'length of a standard millimeter' = Δl,

then the variation of Δl along the rod in the occasions (a) and (b) is best represented by



60. A closed rectangular wire loop (W) falls vertically through two uniform magnetic field regions of flux density B as shown in the figure. If viscous and upthrust forces on the loop are negligible, the velocity (v) - time (t) graph of the loop is best repre sented by





G.C.E. (Advanced Level) Examination - April 2004

PHYSICS - II

Three hours

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

01.

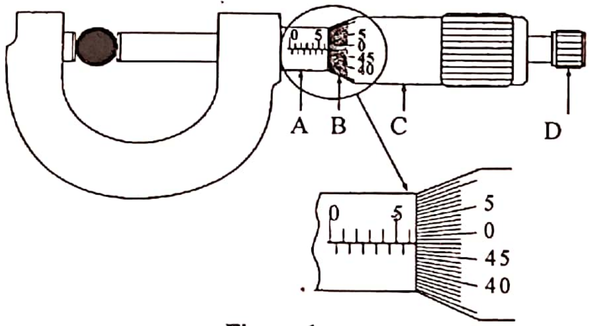


Figure 1

(a) Name the parts of the micrometer screw gauge labelled as *A, B, C,* and *D* in figure 1.

(i) A .... (ii) B ....

(iii) C .... (iv) D ....

(b)(i) What is the least count of the above micrometer screw gauge in mm?

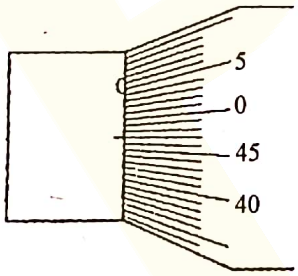
.... mm

(ii) Write down the scale reading for the diameter of the ball shown in figure 1 in mm.

.... mm

(iii) Figure 2 shows a situation in which the micrometer screw gauge is adjusted to determine the zero error.

Figure 2



State the correct value for the diameter of the ball in mm

.... mm

(iv) Write down the fractional error of the measurement for the diameter of the ball (numerical simplification is **not** necessary.)

....

(v) What is the precaution taken in the micrometer screw gauge to avoid over-pressing the object?

....

....

(c) A wire of circular cross section (Length $l \simeq$ 55 cm and diameter $d_1 \simeq$ 4mm) is fixed to a disk (diameter $d_2 \simeq$ 5cm and thickess $t \simeq$ 3mm) as shown in figure 3. Magnitudes given in parentheses are approximate values.

(i) Of the measuring instruments, metre rule, spherometer, vernier callipers, and the micrometer screw gauge, write down the most suitable instrument for the measurement of each of the above quanitites.

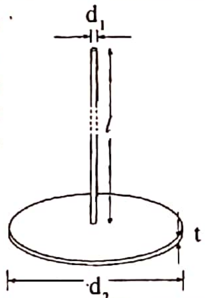


Figure 3

Measurement	Instrument
l	....
d_1	....
d_2	....
t	....

(ii) What experimental procedure would you follow to obtain a better value for the thickness of the disk?

....

....

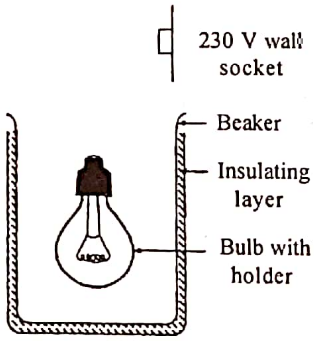
(d) The thickness of a certain type of polythene sheet is much smaller than the least count of a micrometer screw gauge. Propose a method to estimate the thickness of a sheet using a micrometer screw gauge.

....

....

....

02. Figure showe some of the appartus provided to you to experimentally determine the electric power dissipated as heat from a 230V, 25W fila ment bulb. You are asked to use water to collect heat given out by the bulb.



(a) (i) Complete the above diagram by including the other required apparatus, to show the experimental set up that you would use to perform this experiment, and label the items.

(ii) Mark on the diagram the level up to which you fill water.

(b) Give **two** reasons as to why it is advantageous to use a small beaker in this experiment.

(1) ....

(2) ....

(c) Give a list of apparatus needed to **take measurements** in this experiment.

....

....

(d) When this experiment was performed with a 230V, 25W filament bulb, the temperature of water was found to in crease from 28°C to 37°C in 10 minutes. Mass of the water used was 240g. Estimate the electrical power that was transferred to water as heat (specific heat capacity of water = 4200 J kg^{-1} K^{-1})

....

....

....

(e) The value obtained in (*d*) above may not be exactly equal to the power dissipated as heat from the bulb. Give **two** possible modes of heat loss which are not taken into ac count in this experiment.

(1) ....

(2) ....

(f) Certain manufacturers indicate a maximum power rating for electric **lamp shades**. Briefly explain the reason for this.

03.

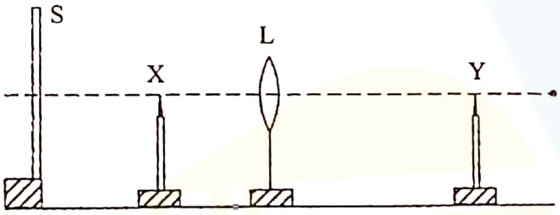


Figure 1

Figure 1 shows a schematic diagram of a **properly** arranged experimental set up used by a student to determine the focal length of a convex lens *L*. In this experiment the position of the real image of pin *X* is found with the help of pin *Y*.

(a) What is the advantage of having the sereen *S*?

....

(b) (i) Figure 2 shows the field of view (with the pin *Y*) that the student sees when he keeps his eye at point *E* on the principal axis of the lens to observe the real image of *X*. (The image of *X* is **not** shown.) Draw the image of *X* on figure 2.

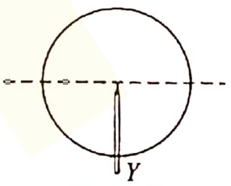


figure 2

(ii) If the student moves his eye sideways observing the movements of *Y* and the image of *X*, what will he see when

(I) the image of *X* is **not** formed at the position of *Y*?

....

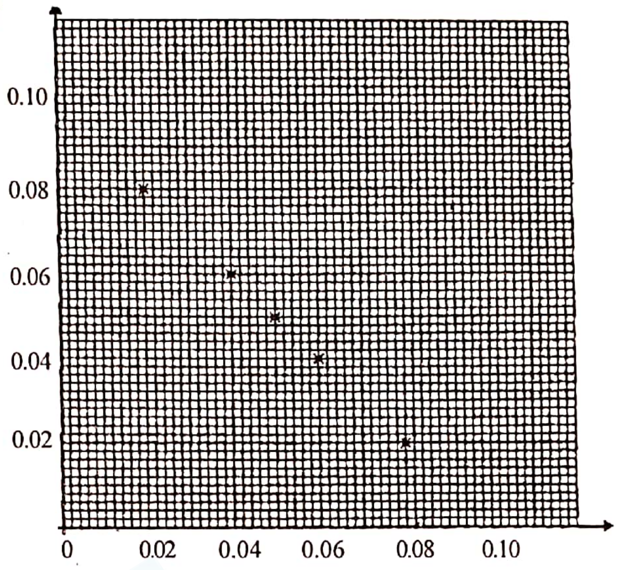
(II) the image of *X* is formed at the position of *Y*?

....

(c) Write down the relationship among the object distance *U*, image distance *V* and the focal length *f* of the lens, for this experiment, after applying the sign convention to the lens equation.

....

(d)



The student recorded *U* and *V* in cm and plotted the graph shown, with properly selected axes, to determine the focal length of the lens. Note that the student used the values recorded in cm to draw the graph.

(i) Label the axes of the graph.

(ii) Detemine the focal length of the lens *L*.

....

(*e*) For a certain position of *X*, a virtual image is observed by the student. He decided to find the position of this virtual image using a plane mirror.

By drawing in fiure 1, show how he should place the plane mirror and the pin *Y* for this. Label the plane mirror as *M* and the new position of *Y* as *Y'*.

04.

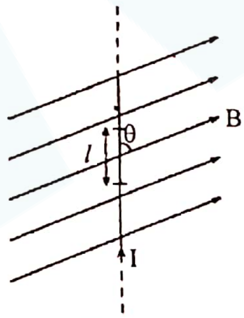


Figure 1

A straight wire carrying a current *I* is placed in a uniform magnetic field of fiux density *B*, as shown in figure *1*. The angle between the dirctions of the magnetic field and current is θ.

(a) (i) Write down an expression for the magnitude of the magnetic force *F* acting on a length *l* of the wire in terms of *I, B, l* and θ.

....

(ii) Write down the rule that gives the direction of the magnetic force (for the case θ = 90°).

....

....

....

....

(b) Now the above wire is bent to form a rectangular coil *PQRS* of *N* turns and of length *a* and breadth *b*. This coil is placed in a uniform magnetic field of flux density *B* as shown in figure 2. The angle between the plane of the coil and the direction of *B* is *a*. *A* cur rent *I* is passed through the coil.

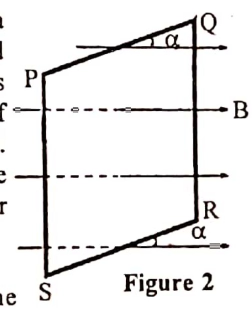


Figure 2

(i) Write down expressions for the magnetic forces acting on the arms *PS* and *QR* of the coil at the instant shown in figure 2, and hence derive an expression for the magnitude of the couple acting on the coil in terms of N, I, B, a, and the area A of the coil.

....

....

....

(ii) The couple due to the magnetic forces on the arms. PQ and RS is zero. Explain the reason for this.

....

....

(c) Figure 3 shows a schematic diagram of a moving coil galva nometer in which the magnetic field in **not** shown.

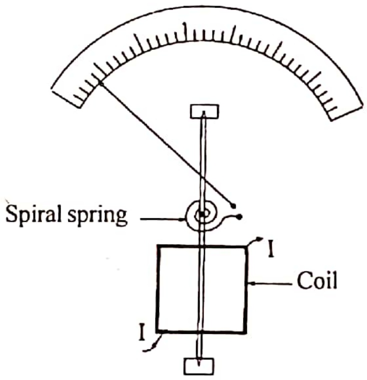


Figure 3

(i) How is the dependence of the couple on a, [mentioned in (b) (i) above] avoided in this instrument?

....

....

(ii) The galvanometer coil has N turns and area A. The flux density of the magnetic field is B and the spiral spring has a torsion constant C. When a current I is flowing through the galvanometer, the deflection of the pointer is θ.

Write down an expression relating I and θ .

....

(iii) this galvanometer has a full scale deflection of 5 mA. How would you connect an external resistor to convert this instrument into an ammeter having a full scale deflection of 5A?

....

....

(iv) If the resistance of the galvanometer coil is 20Ω, calculate the value of the resistor needed in c (iii).

....

....

....

(v) Propose a method to modify this instrument internally to measure currents in the range of μA.

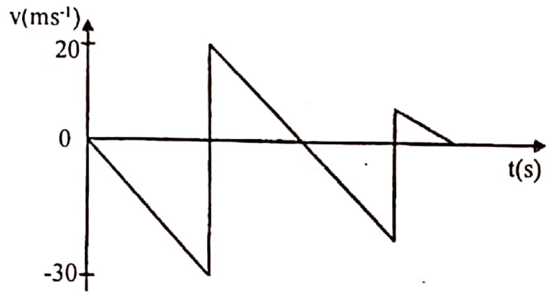
....

....

PART B - Essay

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

01. A small ball of mass 0.1 kg is dropped from rest at t = 0 onto a horizontal floor. The ball was initially at a height H from the floor, and it bounces back vertically after each and every collision. Figure shows a portion of the velocity (v) - time (t) graph of the ball.



(i) Neglecting air resistance and the upthrust, calculate the following for the ball.
   (a) The initial height H.
   (b) The change in momentum of the ball, and the momentum transferred to the floor at the first collision.
   (c) The value of t at which the second collision occurs.

(ii) If the collision between the ball and the floor is perfectly elastic, draw the v - t graph for this motion.

(iii) A paricle of mass 6 x 10^{-26}kg in an empty cubical box of side length 1m is made to move back and forth, while making collisions with tow opposite walls of the box normally. The collisions between the particle and the walls are perfectly elastic, and the speed of the particle is 2 x 10^3 ms^{-1} (Assume that the gravitaitonal force on the particle is negligible.)
   (a) Calculate the rate at which the particle collides with **one** of the tow wals.
   (b) What is the rate at which the particle transfers momentum to that wall?
   (c) Suppose that the box contains 2 x 10^{23} such particles performing the same motion mentioned above. Assume also that these particles do not make collisions among themselves, and that the collisions are uniformly distributed over the entire area of the wall.
   Calculate the pressure exerted by the particles on one of the two walls.

02. Read the following passage carefully and answer the questions given below.

The source of any sound, including musical notes, is a vibrating object. A sound is characterized by its louderss, its pitch and also by a third property called quality. Quality of sound enables us to distinguish a given type of musical instrument from others For example, when a note is played separately in a violin and in a flute with the same loudness and pitch, there is a clear difference between the two sounds heard This is due to the difference in quality of sound of these two instruments Just as loudness and pitch can be related to measurable physical quantities of the sound wave, so too can the quality. Generally, when a note is played in a musical instrument, overtones are present in addition to the fundamental frequency of the sound. Quality of sound depends on the number of these overtones and their relative amplitudes

Figure 1 shows a sound pattern of a **note** produced by a violin. It indicates the variation of the total amplitude of the sound produced by this instrument with time. Figure 2 shows the 'Fourier spectrum' of this sound patterm giving the frequencies of its fundamental and the overtones, and their relative amplitudes. The Fourier spectrum is generated from the sound pattern using a mathematical technique called Fourier Analysis. In contrast to the musical notes, sounds which are normally called noise have nearly continuous Fourier Spectrum than discrete specter.

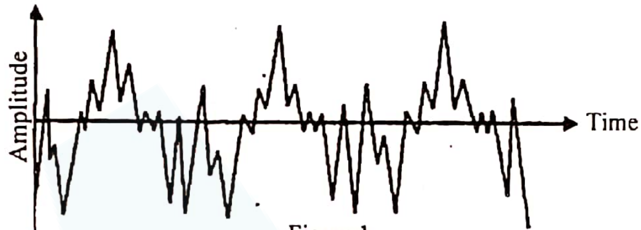


Figure 1

Today we have electronic organs that can reconstruct music produced by any musical instrument available to us. For such reconstructions, first the Fourier spectra of the musical notes must be obtained. After that, it is possible to electronically generate an electric wave pattern for each note by mixing electrical signals having frequencies and their corresponding relative amplitudes present in the fourier spectrum. These electrical wave patterns can then be converted to sound wave patterns. All these can be done with near perfection using digital techniques.

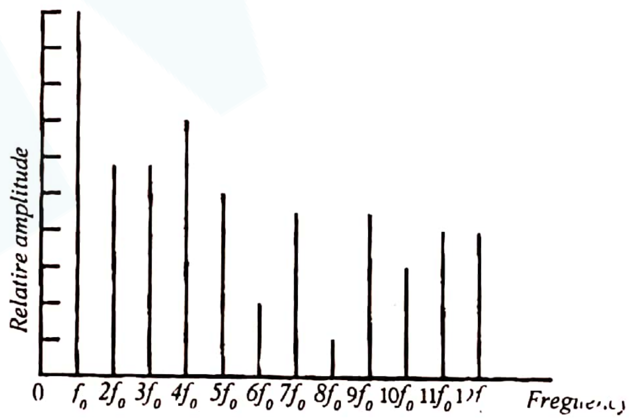


Figure 2

In standard musical instruments, the source is set into vibration by striking, blowing, plucking or bowing. Among the common musical instruments, the drum has a membrane that vibrtes when struck The flute and trumpet make use of vibrating columns of air to produce musical notes. Flute can be considered as a tube with both ends open. When the flute is played the air inside it resonates.

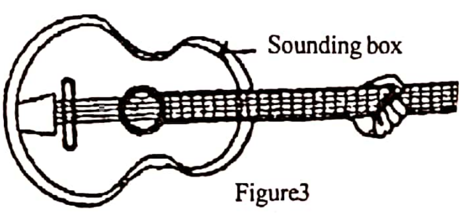


Figure3

Violin, guitar and piano all have vibrating stretched strings. In guitar, different musical notes are obtained by varying the vibrating length of a string fingers, and the guitar has several such strings to produce all required notes. In piano, there is a separate string for each note. In general, the mechanical vibrations in thin strings do not produce sounds loud enough to be heard directly. In stringed instruments, therefore, a sounding box is used (figure 3) to amplify the sound. When steings are set into vibration, the sounding box resonates with the same sound pattern producing a much stronger sound. However, in electric guitars, mechanical vibration of a string is converted to an electrical signal which is subsequently amplified electronically.

(i) What physical property of the sound wave determines the loudness of a sound?

(ii) What physical property of a sound wave is associated with the pitch of the sound?

(iii) The fundamental frequency f_0 of the Fourier spectrum of the violin, shown in figure 2, is 400Hz.

(a) What is the frequency of the 3rd overtone produced of the violin?

(b) What is the value of $\dfrac{\text{amplitufe of the 5th overtone}}{\text{amplitude of the fundamental frequency}}$?

(iv) A note produced by a musical instrument has a fundamental frequency at 420Hz, and the first and second overtones each having an amplitude equal to one half of that of the fundamental. Assuming that no other overtones are present, draw the Fourier spectrum of the note.

(v) State the steps that should be taken to electronically generte the sound described in (iv) above.

(vi) Electronic guitars have no sounding boxes. Give the reason.

(vii) Write down an expression relating the length l, tension T, mass per unit length m and the fundamental frequency f_0 of a vibrating stretched string.

(viii) A 0.68 m long guitar string is tuned to play a note of fundamental frequency 330Hz when unfingured. How far from the end of this string must the finger be placed to play a note of fundamental frequency 440Hz.

(xi) A flute is designed to produce a note of fundamental frequency 262Hz when played at a temperature of 27°C, with all the holes closed.

(a) If the speed of sound in air at 27°C is 340ms^{-1}, calculate the approximate length of the flute.

(b) If this fiute is platyed, with all holes closed, in a place where environmental temperature is -30°C, what will be the fundamental frequency of the sound?

03. A particle of charge $+q$ and mass m is moving along the positive x direction in a vacuum where the electric field is zero. This particle then enters at $x = 0$ a uniform electric field of intensity E extended over a large region, with velocity v as shown in figure 1. The electric field is directed along the negative x direction. Describe qualitatively the motion of the particle after entering the electric field. (Neglect the effects of gravity.)

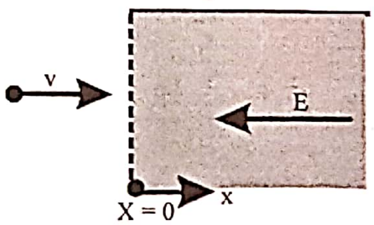


Figure 1

Two particles P and Q each of charge $+q$ and mass m, start to move at time t = 0 in a vacuum simultaneously with two initial velocities v_1 and v_2 respectively, ($v_1 > v_2$) along the positive x direction from two points corresponding to x = 0 as shown in figure 2.

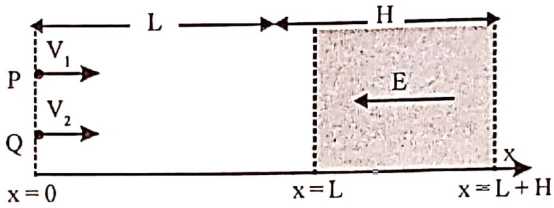


Figure 2

(i) If the two particles travel in a field free region from $x = 0$ to $x = $ L, obtain an expression for the separation d between the two particles, at the instant when the faster particle reaches $x = $ L.

(ii) At $x = $ L, the two particles enter a uniform electric field of intensity E directed along the negative x direction. If the electric field is extended from $x = L$ to $x = L + H$, as shown in figure 2, obtain an expression for the minimum value E_M of the intensity of the electric field required to turn **both particles** back and make them travel in the negative x direction.

(iii) Now consider a situation where E is greater than E_M.

(a) Obtain expressions for the times, t_P and t_Q, spent by the particles P and Q respectively in the electric field.

(b) When the intensity of the electric field E is equal to a certain value E_0, both particles P and Q, which had entered the electric field at different times due to the difference in initial velocities at $x = 0$, leave the electric field at $x = L$ simultaneously. Write down an expression relating E_0 to other relevant parameters given above.

04. Write down poiseuille's equation for the flow of a viscous liquid through a tube, identifying the symbols.

(i) State **two** of the conditions under which Poiseuille's equation is valid.

(ii) Suppose that the radius of cross section of the tube is r, the pressure difference across the tube is ΔP, and the volume rate of flow is Q.

(a) Write down an expression for the resultant force acting on the liquid in the tube due to this pressure difference ΔP.

(b) The average speed v of the liquid through the tube is given be $v = h\dfrac{\theta}{\pi r^2}$. Show that this equation is dimensionally correct.

(c) Hence show that the **rate** of work done by the pressure difference against the viscous force is $Q\Delta P$.

(iii) Poiseuille's equation is often used for approximate calculations of blood flow in human body.

(a) State **two** reasons why Poiseuille's equation is not strictly valid for blood flow through vessels in human body.

(b) If the average rate of blood flow through a horizontally situated artery with uniform cross section having radius 2mm, and length 20cm is 2.5cm^{3}s^{-1}, calculate the pressure difference between its two ends. (Average viscosity of blood at body temperature is 4 x 10^{-3}Nsm^{-2})

(c) Suppose the radius of cross section of the above artery has decreased to half the original value due to fat deposition.

(1) By how many times will the pressure difference across the artery have to be increased in order to maintain the same rate of blood flow mentioned in (iii) (b) above?

(2) by how many times will the rate of work done by the heart against viscous force have to be increased to maintain the same rate of blood flow as mentioned in (c)(1)?

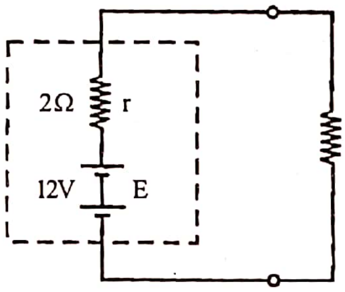
(d) Sometimes doctors prescribe drugs that reduce blood viscosity, to patients having high blood pressure. Briefly explain how such drugs bring relief to patients.

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

(a) The battery in the circuit shown has an e.m.f. (E) of 12v and an internal resistace (r) of 2Ω.

(i) Find the power (P) transferred by the battery to the resistance R in each of the following cases.

(a) $R = 1\Omega$ (b) $R = 2\Omega$, (c) $R = 3\Omega$,
(d) $R = 0$ and (e) R is infinite.



(ii) Hence draw a rough sketch to show how power P varies with resistance R.

(iii) Write down the relationship detween r and R when the power transfer from the battery to R is maximum.

(iv) The above mentioned battery is used to light a **set** of 6V, 0.36W bulbs at the recommended rating.

(a) find the maximum number of bulbs that can be connected to the battery for this purpose.

(b) Draw a circuit diagram to show how you would connect the bulbs to teh battery.

(v) (a) The battery is rated as 90 ampere-hours. This indicates that when it is fully charged, it can deliver a current of 1A for 90 hours, or 2A for 45 hours, and so forth.

For how long the above mentioned battery can provied power to the maximum number of bulbs calculated in part (iv) (a)?

(b) If the mass of the battery is 15kg and its average specific heat capacity is $900 Jkg^{-1 0}C^{-1}$, find the maximum possible increase in temperature of the battery after lighting the set of bulbs for 30 minutes.

(b) (i) Draw a circuit diagram of a *NOT* gate built using a single npn transistor, indicating its input, output, and the power supply connection.

(ii) The circuit shown in figure 1 is made using two germanium diodes and a $1k\Omega$ resistor.

The table under (a) below shows combinations of voltages connected to the inputs A and B of the circuit. All voltages are indicated telative to the point G. (Voltage across a forward biased germanium diode is 0.2V)

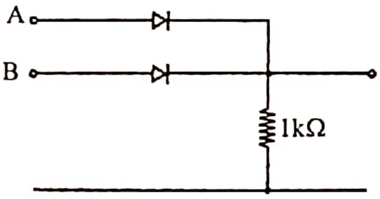


Figure 1

(a) Determine the corresponding output voltages at X and complete the following table. (**Important** : Copy the table on to your answer script.)

A (volts)	B (volts)	X (volts)
0.0	0.0	
0.0	5.0	
5.0	0.0	
5.0	5.0	

(b) Hence identify the gate and writre down its turn table.

(iii) A Student wants to design a digital circuit to turn on a battery powered lamp automatically when there is a mains electricity failure at night. In addition, the circuit must have a facility for it to be turned on at any time by pressing a button.

A block diagram of his circuit, having three inputs and one output, is shown in figure 2.

Assume that he has the means to generate the three inputs A, B and C with logic values (0 and 1) as follows.

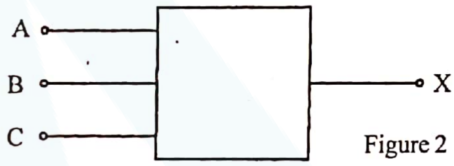


Figure 2

A = 0 when the button is **not** pressed
A = 1 when the button is pressed
B = 0 during day time
B = 1 at night
C = 0 when there is a mains electricity failure
C = 1 when mains electricity is available

The circuit is to be desined so that the lamp will be on when $X = 1$ and off when $X = 0$.

(a) Write down a logic expression for X in terms of A, B and C.

(b) Draw a circuit diagram for your expression, using basic logic gates, and label A, B, C and X.

(c) You are given a Light Dependent Resistor (LDR) having a resistance $10M\Omega$ at dark and 100Ω at bright light, a 5V battery and an additional $100k\Omega$ resistor.

(1) Using these items draw a suitable circuit diagram to generate the logic. values for the input B.

(2) Calcuate the voltage provided by this circuti, for B when dark.

(b) Will the lamp function properly if the circuit is installed in a place where the light dependent resistor is exposed to the lamp itself? Briefly explain your answer.

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

(a) A rubber balloon is filled upto a volume of $4.2 \times 10^{-2} m^3$ with helium gas at 7^0C. The balloon is then held until the tem perature of the gas inside the balloon reaches the outside temperature, which is at 27^0C.

(i) Assuming that the pressure inside the balloon remains the same, find the final volume of the balloon.

(ii) When the balloon is released, it climbs to a height at which the **outside** temperature is 2^0C, when the inside temperature of the ballon reaches 2^0C its inside pressure becomes $\frac{2}{3}$ of that at the groind level. Find the new volume of the balloon.

(iii) While remaining at this height, the balloon enters into a region of low pressure (air pocket) which is also at 2°C. Consider the balloon entering this region under following conditions.

(a) Very slowly (b) Suddenly

Answer the following questions *separately* for the above two situations (*a*) and (*b*).

(1) What happens to the temperature of the gas inside the balloon?

(2) During this process, does the gas inside the balloon absord heat from the surrounding or give out heat to the surrounding?

(3) How does the gas inside the balloon get energy to do work?

(c) In the situation (iii) (a) above, if the pressure inside the balloon reduces to $\frac{1}{3}$ of that at the ground level, find the new volume of the balloon.

(d) Sketck a P - V diagram for the process in part (iii) (*c*) above.

(b) The intensity (I) of the radiation emitted by a black body at a temperature T=4000K as a funcition of wavelength (λ) is shown in figure 1. The peak of the distribution is at a wavelength (λ_p) = 724.5nm.

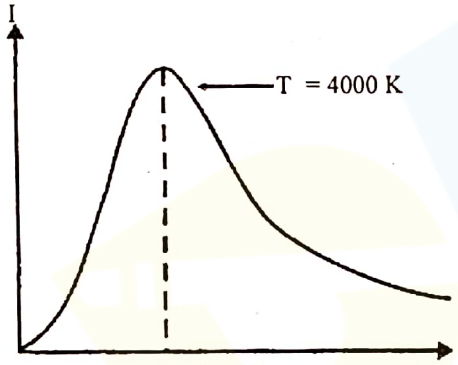


Figure 1

(i) What does the area under the curve shown in figure 1 represent?

(ii) Calculate the energy of a photon having a wavelength λ = 724.5nm.
Planck's constant h = 6.63 x 10^{-34}Js and speed of light c = 3.0 x 108ms^{-1}.

(iii) (a) The wavelength λ_p corresponding to the radiation emitted by the sun is 500nm. Considering the sun to be a black body, determine its surface termperature

(b) The radius of the sun is 7.0 x 10^8 m. Calculate the total energy radiated per second by the sun. Stefan constant σ =5.67 x 10^{-8}Wm^{-2}K^{-4}.

(c) Consider a distant star, barely visible to the naked eye at night and having properties similar to those of the sun. If the threshold of dark-adapted vision of the eye at wavelengths near 500nm is 4.0 x 10^{-11}Wm^{-2}, and 40% of the total radiation emitted by the star is in the near 500nm region, calculate the approximate distance to the star from the earth.

(iv) Figure 2 shows the intensity distribution of the light emitted by a firefly. The wavelength λ_p corresponding to the peak of the distribution is 570nm. Determine the temperature of a black body that would emit the radiation peaked at the same wavelength.
Hence conclude, giving reasons, whether the radiation emitted by the firefly can be considered as black body radiation.

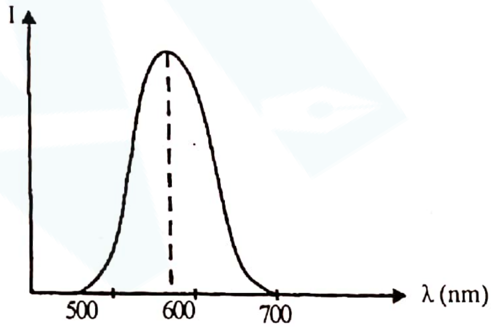


Figure 2

G.C.E. (Advanced Level) Examination - April 2004

PHYSICS - I

Provisional Scheme of Marking

2004 - Answers

No.	1	2	3	4	5
01	X	X	X	X	X
02	1	X	3	4	5
03	X	X	X	X	X
04	1	X	3	4	5
05	X	2	3	4	5
06	1	2	X	4	5
07	1	2	3	X	5
08	X	2	3	4	5
09	1	X	3	4	5
10	1	2	X	4	5
11	1	X	3	4	5
12	X	2	3	4	5
13	X	2	3	4	5
14	1	2	X	4	5
15	X	2	3	4	5
16	X	2	3	4	5
17	1	2	3	X	5
18	1	X	3	4	5
19	1	2	3	X	5
20	1	2	X	4	5
21	1	2	X	4	5
22	X	2	3	4	5
23	1	2	X	4	5
24	X	2	3	4	5
25	1	2	3	4	X
26	1	2	X	4	5
27	1	2	3	4	X
28	1	X	3	4	5
29	1	2	3	4	X
30	1	2	3	X	5
31	1	X	3	4	5
32	X	2	3	4	5
33	X	2	3	4	5
34	X	2	3	4	5
35	1	2	3	X	5
36	1	2	3	4	X
37	1	2	X	4	5
38	1	X	3	4	5
39	1	2	3	4	X
40	1	2	3	X	5
41	1	2	3	X	5
42	1	2	X	4	5
43	1	2	3	4	X
44	1	X	3	4	5
45	1	2	X	4	5
46	1	2	X	4	5
47	1	2	X	4	5
48	1	2	3	X	5
49	1	X	3	4	5
50	1	2	3	X	5
51	1	2	3	X	5
52	1	2	3	X	5
53	1	X	3	4	5
54	1	2	3	4	X
55	X	2	3	4	5
56	1	X	3	4	5
57	1	2	3	X	5
58	1	2	X	4	5
59	1	2	3	X	5
60	X	2	3	4	5

G.C.E. (Advanced Level) Examination - April 2004

PHYSICS - II

Provisional Scheme of Marking

A - PART

(01) (a)
(i) A - Main Scale (linear Scale)
(ii) B - Circular Scale
(iii) C - Thimble
(iv) D - Thimble head

(b)
(i) 0.01 mm

(ii) 6.48 mm

(iii) 6.51 mm

(iv) $\frac{0.01}{6.51}$ OR $\frac{0.005}{6.51}$

(v) Thimble head is provided to press the object when taking a measurement which automatcally stops over pressing.

(c) (i)

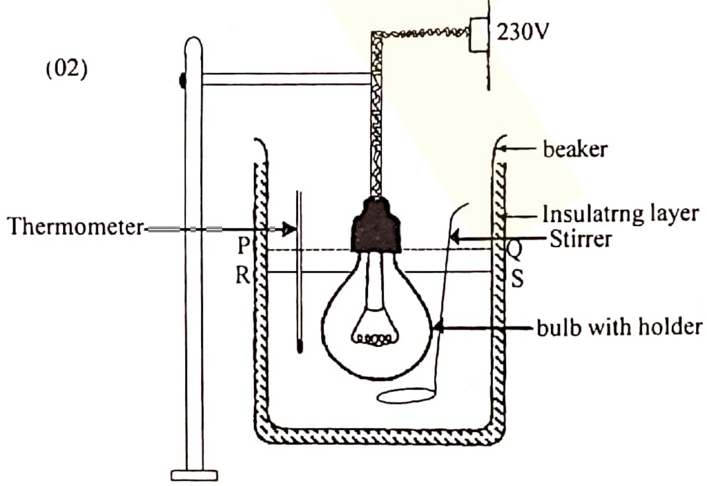
Measurement	Instrument
ℓ -	Meter ruler
d_1 -	Micrometer Screw gauge
d_2 -	Vernier Calliper
t -	Micrometer Screw gauge

any two 01
all correct 02

(ii) Take several measurments at different places and get the average 01

(d) Fold the sheet many times so that the thickness is significantly larqer than the least count
OR
Use large number of sheets together so that the thickness is significantly larger than the least count 01

(02)



(a) (i) Thermometer + Stirrer + wire connection 01
(ii) Water level anywhere between PQ and RS 01

(b) (1) Heat absorbs by the beaker is Small
(2) Significant temperature increase can be obtained.
(3) Heat dissipation from the water surface is small
OR Heat loss to the surrounding is small

any Correct two 02
any Correct one 01

(c) Thermometer, Stop watch, balance 01

(d) Heat absorbed by water $= 240 \times 10^{-3} \times 4200 \times 9$

Electrical power transferred to water $= \dfrac{240 \times 10^{-3} \times 4200 \times 9}{10 \times 60}$

$= 15.12$ W
(15 w - 15.2 w)

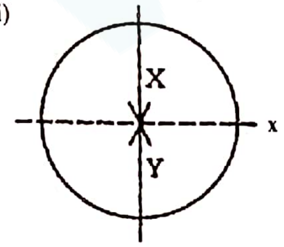
(e) (1) Hcat absorbed by the beaker
(2) Heat loss to the surroundings
(Convection/ radiation / evaporation)
(3) Heat absorb the bulb and the bulb holder.

ang two -01

(f) lamp shade may burn
OR
Bulb and the lamp shade will he over heated
OR
The heat generated by the bulb may damage the lamp shade.

03. (a) To avoid obstructions from other objects for a clear veiw.
OR
To veiw only the image of x and y 01

(b) (i)

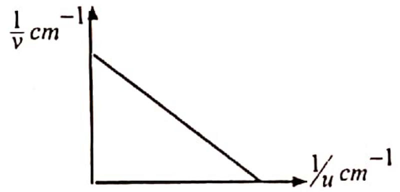


01

(ii) (I) There is a relative motion between y and image of x 01
(II) Y and image of x move together 01

(c) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\left(\frac{-1}{v} - \frac{1}{u} = \frac{-1}{f}\right)$ 01

(d)

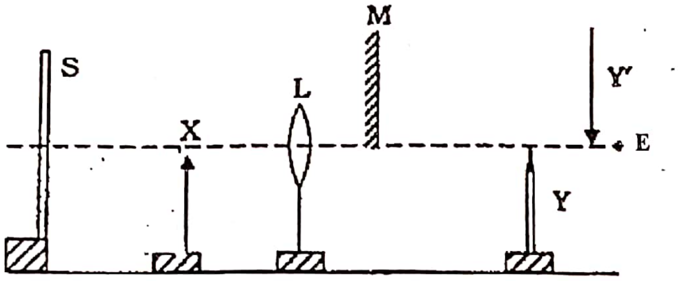


For labeling the axes of the graph with correct unit 01
For drowing the straightline properly 01
For identification of the intercept

as $\frac{1}{f}$

$0.1 = \frac{1}{f}$

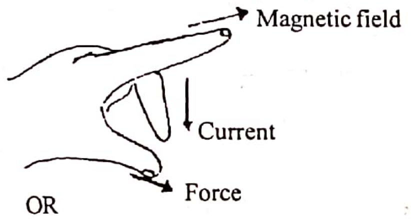
f = 10 cm (9.8 cm - 10.2 cm)



(e) For drawing M and Y' in the above diagram.

04. (a) (i) $F = BIL\sin\theta$

(ii)



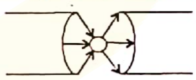
OR

When the middle finger, fore finger and the thumb of the leff hand are held at right angles of one another so that the middle finger is in the direction of the current and the fore finger is in the direction of the magnetic field, then the dirccton of the magnetic force is in the direction of the thumb.

(b) (i) Magnetic foree acting on PS = BINa
Magnefic force acting on QR = BINa
Couple due to the magnetic forces = BINa x b cosα
= BINA cos α

(ii) Force acting on the arms PQ and RS are equal and opposite and act along the same line therefore the couple duc to these force is zero 01

OR

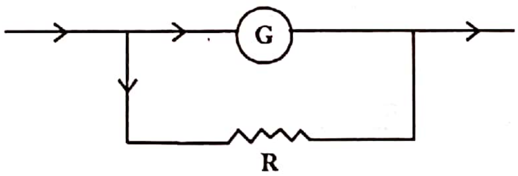


(c) (i) In the galvanometer the coil is placed in a radial magnetic field so that the direction of the magnetic field is in the plane of the coil for any position of the coll. Thre fore $\alpha = 0$ and $\cos\alpha = 1$

(ii) $NIBA = C\theta$

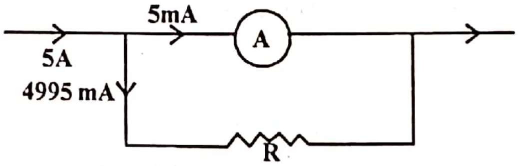
$$I = \frac{C}{(NAB)} \times \theta$$

(iii)



OR A resistor must be connected in parallel with the galvanometer 01

(iv)



$20 \times 5 \times 10^{-3} = R \times 4995 \times 10^{-3}$

$R = 0.02\ \Omega$ 01

(v) Radial magnetic field can be increased /Number of turns of the coil can be increased / suspension wire of a very small torsion constant can be used
Area of the coil can be increased ony one 01

Part B

(01) (i) (a) Using $V^2 = u^2 + 2as$ OR $mgh = \frac{1}{2}mv^2$

$30^2 = 0 + 2 \times 10 \times H$ 01

$h = 45\ m$ 01

(b) change of momentum of a collision

$= 0.1 \times 30 - 0.1 \times (-20)$ 01

$= 5\ kgms^{-1}$ 01

Momentum transfer to the floor ot a collision (of ball at a collision)

= change of momentum

$= 5\ kg\ ms^{-1}$ 01

(c) Time at first collision $t_1 = \frac{30}{10} = 3S$

Time taken for the second collision after the first collision $t_2 = \frac{2 \times 20}{10} = 4S$

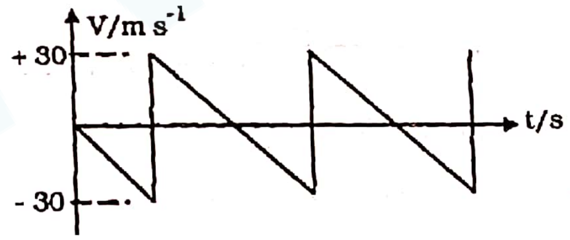
[Using the corresponding triangles

$\frac{30}{3} = \frac{20}{t}$, $t = 2S$

$t_2 = 2 \times t_1 = 2 \times 2 = 4S$ - 01]

The Value $t = t_1 + t_2 = 3 + 4 = 7S$ 01

(ii)



(iii) (a) Time interval between two collisions $= \frac{2}{2 \times 10^3}$ 01

$= 10^{-3}\ S$

Rate at which the particle collides with one of the walls $= \frac{1}{10^{-3}}$

$= 10^3$ 01

(b) Mometum transfer Per Collision $= 2 \times 6 \times 10^{-26} \times 2 \times 10^3$

Rate of which the particle transfer momentum to the wall

$= 2 \times 6 \times 10^{-26} \times 2 \times 10^3 \times 10^3$ 01

$= 2.4 \times 10^{-19}\ kgms^{-2}$ 01

(c) Total rate of momentum transfer by 2×10^{23} Partrcles

$= 2.4 \times 10^{-19} \times 2 \times 10^{23}$ 01

Force acting on the flocr = total rate of momntum transfer by particles 01

Pressure exerted by the particles on a wall

$$= \frac{2.4 \times 10^{-19} \times 2 \times 10^{23}}{1 \times 1}$$

$$= 4.8 \times 10^{4}\ Nm^{-2}\ (Pa) \qquad 01$$

02. (i) Amplitude of the wave 01

(ii) Frequency of the wave 01

(iii) (a) Frequency of the 3rd overtone $= 4 f_0$

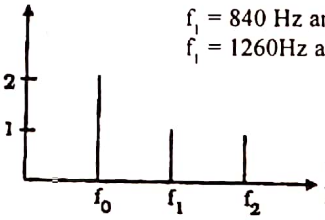
$= 4 \times 400$

$= 1600$ Hz 01

(b) 0.2 01

(iv) $f_1 = 840$ Hz and $f_2 = 1260$Hz OR

$f_1 = 1260$Hz and $f_2 = 2100$ Hz



Frequency (correct hieghts and equal Spacing)

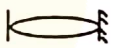
(v) Three **electrical Signals** having frequencies of, f_1 and f_2 and respective **relative amplitude** 1, 1/2 and 1/2 are **superrimposad** (mixed)

All Correct - 02

Any two - 01

(vi) In electric guitars the sound of the strings is **amplified electronically.** 01

(vii) $f_0 = \frac{1}{2l}\sqrt{\frac{T}{m}}$

(viii) $330 = \frac{1}{2 \times 0.68}\sqrt{\frac{T}{m}}$ —— (A) 

$440 = \frac{1}{2 \times L^{I}}\sqrt{\frac{T}{m}}$ —— (B) 

(A)/(B) ⇨ $\frac{330}{440} = \frac{L^{I}}{0.68}$ 01

$L^{I} = 0.51$ m OR $L^{I} = 0.17$ m 01

(ix) (a) $2L = \lambda = \frac{V}{f_0} = \frac{340}{262}$ 01

$L = \frac{340}{2 \times 262} = 0.65$ m 01

(0.64 m - 0.65 m)

(b) $v \ \alpha \ \sqrt{T}$

$$\frac{V_{300}}{V_{243}} = \frac{340}{V^{I}} = \sqrt{\frac{27 + 273}{-30 + 273}} = \sqrt{\frac{300}{243}}$$

$$V^{I} = \sqrt{\frac{243}{300}} \times 340 = 306\ ms^{-1}$$

$$f = \frac{V^{I}}{2L} = \frac{306}{2 \times 0.65} = 235.4\ Hz \qquad 01$$

(235 - 239)

03. Particles expcriences a decleration, Stop at a certain distance, starts to move back along the same path with an accleration whose magnitude equal to that of the deceleration and leaves the eleetric field with the speed V 03

[Come back along the same path 01

Decelerates. stops. acclerates and come back along the same path -02]

(i) Time taken by P to move from x = 0 to x = L. $t_1 = \frac{L}{V_1}$

Distance traveled by Q during time $t_1 = \frac{L}{V_1} V_2$ 01

$\therefore d = L - \left(\frac{LV_2}{V_1}\right) = L\left(1 - \frac{V_2}{V_1}\right)$ 01

(ii) Particle P penetrates more into the electric field and Therefore E_{min} must be Calculate for P 01

Applying $V^2 = u^2 + 2as$ 01

Magnitude of $a = \frac{q E_{min}}{m}$. $v = o$, $u = v_1$, $s = H$ 01

$E_{min} = mV_1^2 / 2gH$ 01

[alternative method , Conservatiom of energies

$\frac{1}{2} mv^2 = qv$ 01

$V = E_{min} H$ 01

$E_{min} = \frac{mV_1^2}{2qH}$ 01

(iii) $E > E_{min}$

Applymg $V = u + at$ 01

Magnitude of $a = \frac{qE}{m}$ ←

$V = O, u = v_1, t = \frac{t_P}{2}$ 01

$\left[\begin{array}{l} F = ma \\ q\epsilon = ma \end{array}\right]$

$a = \frac{q\epsilon}{m}$

$O = V_1 - \frac{qE}{m} \times \frac{t_P}{2}$

$t_P = \frac{2mV_1}{qE}$ 01

$t_Q = \frac{2mV_2}{qE}$ 01

(b) Total trme spent both P and Q are the same 01

Considering the tine spent by P and Q in the field free region and in the electic field region we can write

$$\frac{L}{V_2} + \frac{2mV_1}{qE_0} = \frac{L}{V_2} + \frac{2mV_2}{qE_0} \qquad -01$$

04. $Q = \frac{\pi r^4 \Delta P}{8\eta \ell}$ - 01

Q = Volume rate of flow of the liqud

r = Radius of corss section of the tube

ΔP = Pressure difference across the tube

η = Viscosity of the liquid (Cof·cient of Viscosity of the Iquid)

l = length of the tube 02

(any thre 01

all corre 02

(i) The flow should be laminar
Tube should be Straight and / or horizontal
Tube Should be narrow
The flow should be steady (constant rate)
The liquid should be compressible 02
(any two 02 any one 01)

(ii) (a) $F = \Delta P \pi r^2$

(b) Dimension of Q $= [L]^3 [T]^{-1}$ $\left[\frac{F}{A} = p\right]$

Dimension of r $= [L]$ $F = A \times P$

Dimension of v $= [L][T]^{-1}$

Dimension of $\frac{Q}{\pi r^2} = \frac{[L]^3 [T]^{-1}}{L^2} = [L]\ [T]^{-1}$

= Dimension of V 01

(c) rate of work done = force x $\frac{\text{distance}}{\text{time}}$

$= \Delta P \pi r^2 \times \frac{Q}{\pi r^2}$

$= \Delta PQ$ - 01

(iii)(a) Blood vessels are not Horizontasl
OR not straight
Blood vessels are elastic
Blood vessels do not have uniform cross sections
Blood flow is not steady
Blood is not homogeneous ony two - 02
one - 01

(b) $\Delta P = \frac{8 \eta \ell Q}{\pi r^4}$

$= \frac{8 \times 4 \times 10^{-3} \times 20 \times 10^{-2} \times 2.5 \times 10^{-6}}{\pi \times (2 \times 10^{-3})^4}\ m^{-2}$ - 01

$= \underline{\underline{3.2 \times 10^2\ Nm^{-2}}}$ - 01

(3.1 - 3.2)

(c) (i) New pressure difference - ΔP^1

$\Delta P^1 = \frac{8 \eta \ell Q}{\pi (\frac{r}{2})^4} = \frac{8 \eta \ell Q}{\pi r^4} \times 16$

$= \Delta P \times 16$

Therefore the pressure difference will have to be increased by 16 times 01

(ii) Rate of work done by the heart under original pressure dif. ference $w = Q \Delta P$

Rate of workdone by the heart under new pressure difference is

$w^1 = Q\Delta P^1$
$= Q\Delta P \times 16$
$= w \times 16$

Therefore the rate of work done will increase by 16 times. 01

(d) When η is decrased, the same flow rate can be maintained with a lower pressure difference P. Therefore it reduces blood pressure of the patient.
OR
When η decreased, the resistance to blood flow decreases 01

05. (a) (i) Power P fransferred by a battery = I^2R

$I = \left\{\frac{12}{R+2}\right\}^2 R$ 01

(a) $R = 1\Omega$ $P = \left\{\frac{12}{1+2}\right\}^2 \times 1 = 16\ W$

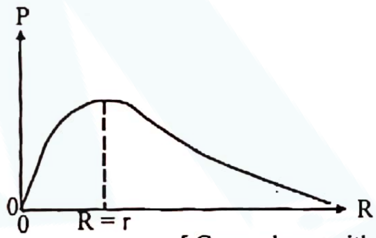
(b) $R = 2\Omega$ $P = \left\{\frac{12}{2+2}\right\}^2 \times 2 = 18\ W$

(c) $R = 3\Omega$ $P = \left\{\frac{12}{3+2}\right\}^2 \times 3 = 17.3\ W$

(two correct - 01)

(d) $R = 0$ $P = 0$ 01

(e) $R = \infty$ $P = 0$ 01

(ii) 

02

[Camy shape with amaximum - 01]

(iii) R = r 01

(iv) (a) At the maximum power transfer power dissipated by R = Power dissipated by r. 01

Voltage across r = 12/2 = 6V

Power dissipated in r $= V^2/r$

$= 36/2 = 18w$ 01

= Power dissipated by r

Since each bulb dissipates 0.36W

total number of bulbs = 18/0.36 = 50 01

Alternative method.

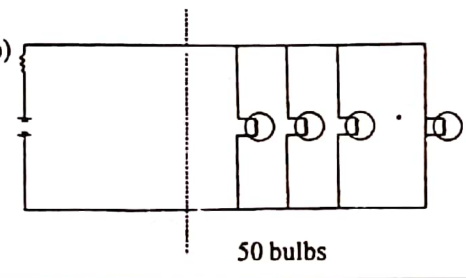
Resistance of a bulb $= V^2/P$

$= 36/0.36 = 100\ \Omega$

At the maximum power transfer

$R = 2\ \Omega$ 01

Operation of each bulb at 6V and R = 2 can be obtained by Connecting 50 such bulbs in parallel - 01

(b) 
01

50 bulbs

(iv) (a) Current drawn from the battery = 12/4 = 3A - 01

Therefore the battery can be used for 30hrs - 01

(b) Power dissipated inside the battery

$= I^2r \quad = 9 \times 2 = 18w$

If is the increase of temperature

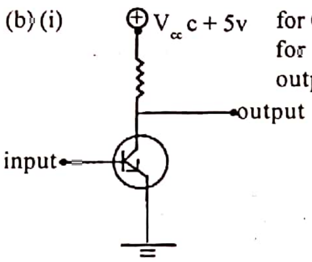
$ms\,\theta \quad = Pt$

$15 \times 900 \times \theta \quad = 18 \times 30 \times 60$ - 01

$\theta \quad = 12/5\ ^0C$

$\theta \quad = 2.4\ ^0C$ - 01

(b) (i)



for Circuit - 01

for labels (power supply, input and output) - 01

(ii)(a)

A (volts)	B (volts)	X (volts)
0.0	0.0	0.0
0.0	5.0	4.8
5.0	0.0	4.8
5.0	5.0	4.8

-01 (row 1); } - 01 (rows 2–3); - 01 (row 4)

OR

(b) The circuit is on or gate - 01

Truth table

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

- 01

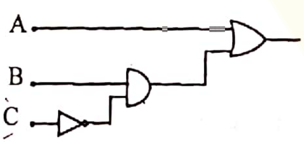
(iii) (a) $X \; = A + B.\overline{C}$

(A + - 01 and $B.\overline{C}$ - 01)

OR $X \; = A\overline{B}\,\overline{C} + A\overline{B}C + AB\overline{C} + ABC + \overline{A}BC$

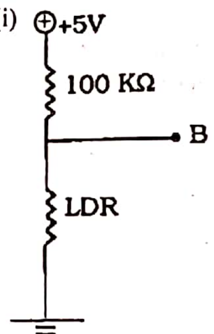
(any threecorrect terms - 01 all correct - 02)

(b)



- 01

(c) (i)



voltaqe divider concept - 01

LDR & resister - 02

(2) At dark resistance of LDR = 10M Ω

Therefore $V_B = \dfrac{5 \times 10 \times 10^6}{(10 \times 10^6 + 100 \times 10^3)}$

$= 5\,V$

(4.95 V - 5.00 V)

(d) The lamp will not function properly

When power fails at night the lamp will turn on. Then if light from the lamp itself falls on the LDR, it will cause the lamp to turn off again. There fore until power returns. the lamp will keep turning on and off repeatedly. 01

06. (a) (i) Pressure and the amount of gas remain the same

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad 01$$

$$\frac{42 \times 10^{-3}}{280} = \frac{V_2}{300} \qquad 01$$

$$V_2 = 4.5 \times 10^{-2}\ m^3 \qquad 01$$

(ii) Pressure, Volume and temperature change but the amount of gas remains the same.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Lef P_1 be the pressure inside the balloon at the ground level.

$$\frac{P_1 \times 4.5 \times 10^{-2}}{300} = \frac{\frac{2}{3}P_1 \times V_2}{275}$$

$6.19 \times 10^{-2} m^3 = V_2$

(6.1 - 6.3)

(iii) (a) The balloon enters the low - Pressure area very solwly. Threfore the process in isothermal.

(1) Temperataure remains the same 01

(2) gas absorbs heat from the surroundings 01

(3) $dQ = du + dw$

$du = 0$ (T is constant)

$dw = dQ$ 01

OR

Internal energy remains the same since T is not changed. The heat absorbed will provide energy to do work.

(b) The balloon enters the low - Pressure area very rapidly. Therfore the process is adiabatic.

(1) The temperture decreases. 01

(2) No exchange of heat 01

(3) $dQ = du + dw.$

$o \quad = du + dw$

$dw = -du$ 01

(OR internal energy of the gas will be reduced by Providing energy to do work)

(c) For an isothermal process

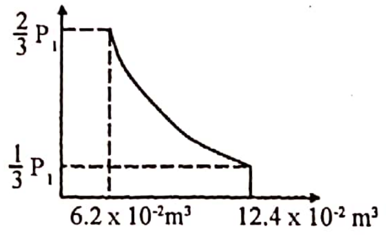
$P_1V_1 \; = P_2V_2$

$\frac{2}{3}P_1 \times 6.19 \times 10^{-2} = \frac{1}{3}P_1V_2$

$V_2 = 12.38 \times 10^{-2}\ m^3$

$(12.4 \pm 0.2) \times 10^{-2}\ m^3$

(or twice the value obtained under (ii) - 02)

(d) 

06. (b) (i) Total energy per unit time Per unit Area Corresponding to all wavelengths emitted by the black body.

OR

Total intensity corresponding to all wavelengths. emitted by the black body. 01

(ii) $E = h\nu$ 01

$f = C/\lambda$ 01

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

$$= \frac{(6.63 \times 10^{-34}) \times (3.0 \times 10^{8})}{724.5 \times 10^{-9}}$$ 01

$= 2.74 \times 10^{-19}$ J 01

(2.74 ± 0.1)

(iii) (a) $T \times 500 = 4000 \times 724.5$ 01

$T = 5796$ K 01

(b) $W = \sigma T^4 \times 4\pi R^2$

$= (5.67 \times 10^{-8}) \times (5796)^4 \times 4 \times \pi \times (7.0 \times 10^{8})^2$ 01

$= 4.0 \times 10^{26}$ JS^{-1} 01

(4.0 ± 0.1)

(c) Let R be the distance to the star

$$\frac{W}{4\pi R^2} \times \frac{40}{100} = 4.0 \times 10^{-11}$$ 01

Subsitiuting for the power emitted by the star

$W = 4 \times 10^{26}$ J 01

$$R^2 = \frac{(4 \times 10^{26}) \times 40}{4\pi \times (4.0 \times 10^{-11}) \times 100}$$

$R = 5.64 \times 10^{14}$ km 01

(5.64 ± 0.1)

(iv) $T \times 570 = 4000 \times 724.5$

$T = 5084$ K

Not black body Radiation

If so the temperature of 5084 k would burn the firefly. 01