G.C.E. (Advanced Level) Examination - August 2011

PHYSICS - I

Two hours

Important :
- ❋ This question paper includes **50** questions in **10** pages.
- ❋ **Answer all the questions.**
- ❋ Write your **Index Number** in the space provided on the answer sheet.
- ❋ Instructions are given on the back of the answer sheet. Follow them carefully.
- ❋ In each of the questions **1** to **50**, 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.

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

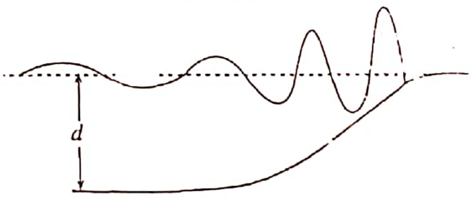
01. The unit of thermal conductivity is
(1) $Jm^{-1}K^{-1}$ (2) $Wm^{-1}K^{-1}$ (3) $Wm^{-2}K^{-1}$
(4) $J\ m^{-2}\ K^{-1}$ (5) $W\ m^{-2}\ K^{-2}$

02. The most suitable measuring instrument to measure the external diameter of a soft rubber tube having its value of the order of 1cm is
(1) meter ruler (2) vernier callipers
(3) spherometer (4) micrometer screw gauge
(5) teavelling microscope

03. A simple pendulum of period T on the earth is brought to the moon. If the rotio of the acceleration due to gravities of the earth and the moon is 6, the period of oscillation of the pendulum on the moon is
(1) T (2) 6T (3) $\sqrt{6T}$
(4) $\frac{T}{\sqrt{6}}$ (5) $\frac{T}{6}$

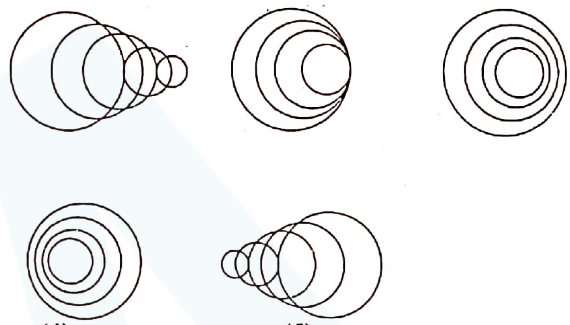
04. Final image of a compound microscope at normal adjustment is
(1) virtual, inverted and larger than the object.
(2) virtual, erect and larger than the object.
(3) real, inverted and larger than the object.
(4) real, erect and larger than the object.
(5) real, inverted and smaller than the object.

05. The figure shows the shape of a tsunami wave of wavelength and amplitude A reaching the beach. The speed of the wave can be approximately given by $\upsilon = \sqrt{gd}$, where d is the depth of the sea. When the wave reaches the beach



(1) λ decreases and υ and A increase.
(2) λ and υ decrease and A increase.
(3) λ remains the same but A and υ increase
(4) λ . A and υ increase.
(5) λ, A and υ decrease

06. A source of sound is moving to the right with a speed faster than the speed of sound. Which of the following figures correctly shows the propagation of wave fronts?



(4) (5)

07. Which of the following gates **cannot** have more than one input?
(1) AND gate (2) OR gate (3) NAND gate
(4) NOT gate (5) EX-OR gate

08. In an automobile engine, the gas (a mixture of air and petrol) in the cylinders is compressed to $\frac{1}{9}$ of its original volume. The initial pressure is 1.0 atm and the initial temperature is 27°C. If the pressure after compression is 21 atm, the temperature of the compressed gas is (Assume that the gas behaves as ideal.)
(1) 700 °C (2) 523 °C (3) 427 °C
(4) 327 °C (5) 227 °C

09. A planet of uniform density has a mass of 2.0×10^{27} kg. Its radius is 6.7×10^{7} m. The gravitational potential at the surface of the planet is ($G = 6.7 \times 10^{-11}\ Nm^2\ kg^{-2}$)
(1) $-2.0 \times 10^{9}\ J\ kg^{-1}$ (2) $-2.0 \times 10^{2}\ J\ kg^{-1}$
(3) 0 (4) $2.0 \times 10^{9}\ J\ kg^{-1}$
(5) $6.0 \times 10^{2}\ J\ kg^{-1}$

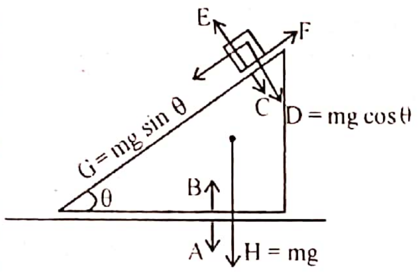
10. When a beam of 100 keV electrons is stopped in a metel target, it produces
(1) β^- particles (2) β^+ particles (3) α particles
(4) neutrons (5) X rays

11. An electron of mass m_e when accelerated through a potential difference, has a de Broglie wavelength λ. The de Broglie wavelength associated with a proton of mass m_p accelerated through the same potential difference would be

(1) $\lambda\sqrt{\frac{m_p}{m_e}}$ (2) $\lambda\sqrt{\frac{m_e}{m_p}}$ (3) $\lambda\frac{m_e}{m_p}$

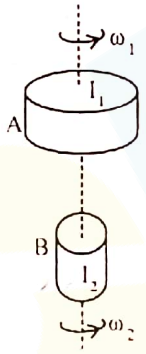
(4) $\lambda \dfrac{m_p}{m_e}$ (5) $\lambda \dfrac{m_e^2}{m_p^2}$

12. A block of mass m is placed on a wedge of mass M which is placed on a horizontal plane. The free body diagram of the system is shown in figure Out of the forces marked on the diagram what could be considered as action - reaction pairs?



(1) E and C, F and G
(2) E and D, B and A
(3) E and D, B and H
(4) E and C, B and A
(5) E and C, B and H

13. A space shuttle B of moment of inertia I_2 and angular speed ω_2 joins smoothly with a space station A of moment of inertia I_1, and angular speed ω_1 along the common axis as shown in the figure. Neglect the linear motions of both objects. The angular speed of the system about the common axis after joining the two objects would be



(1) $\omega_1 + \omega_2$

(2) $I_1\omega_1 + I_2\omega_2$

(3) $\dfrac{I_1\omega_1 - I_2\omega_2}{I_1 + I_2}$

(4) $\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

(5) $\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 - I_2}$

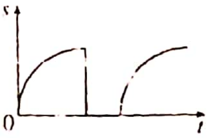
14. An empty, thin walled container of volume V and mass M_0 is filled with n number of glass and steel balls out of which x are glass balls. If M_s and M_g are the masses of a steel and a glass ball respectively, then the effective density of the container with balls would be

(1) $\dfrac{nM_g + xM_s + M_0}{nV}$ (2) $\dfrac{M_g + (n-x)M_s}{V}$

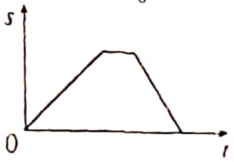
(3) $\dfrac{xM_g + (n-x)M_s + M_0}{nV}$ (4) $\dfrac{xM_g + (n-x)(M_s + M_0)}{V}$

(5) $\dfrac{xM_g + (n-x)M_s + M_0}{V}$

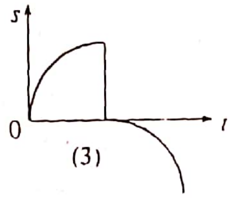
15. Velocity (v) - time (t) curve for the motion of a particle is shown in the figure. The corresponding displacement (s) - time (t) curve would be



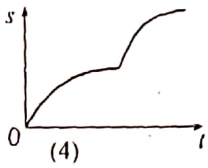
(1)



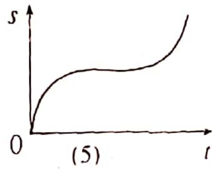
(2)



(3)



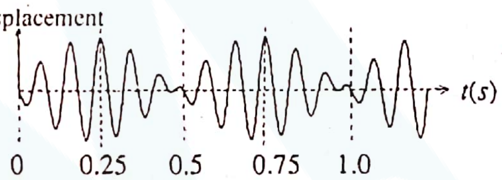
(4)



(5)

16. A patient with cataract got his eye lens replaced by an artificial lens that has a fixed focal length, after a surgery. His vision was then found to be best for viewing objects at a distance of 10m The lens that he should use for reading is (near point is 25cm)

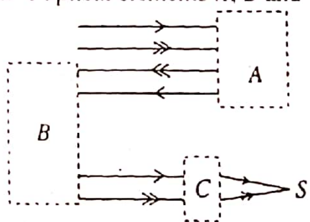
(1) a convex lens of approximate focal length 4 cm
(2) a concave lens of approximate focal length 4 cm
(3) a convex lens of approximate focal length 25 cm
(4) a concave lens of approximate focal length 25 cm
(5) a convex lens of approximate focal length 8 cm

17. 

The figure shows the resultant wave produced by two sound waves of slightly different frequencies. The beat frequency is equal to

(1) 1 Hz (2) 2 Hz (3) 4 Hz
(4) 6 Hz (5) 8 Hz

18. The set up shown in the diagram is used to focus a parallel beam of light to the point S.
The respective optical elements A, B and C should be



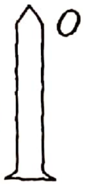
(1) a plane mirror, a plane mirror and a 60°- 60°- 60° prism.
(2) a 60° - 60°- 60° prism, a 60° - 60° - 60° prism and a convex lens
(3) a 45° - 90° - 45° prism, a 45° - 90° - 45° prism and a 60° - 60° - 60° prism
(4) a 45° - 90°- 45° prism, a 45° - 90° - 45°- prism and a concave lens
(5) a 45° - 90°- 45° prism, a 45° - 90° - 45° prism and a convex lens

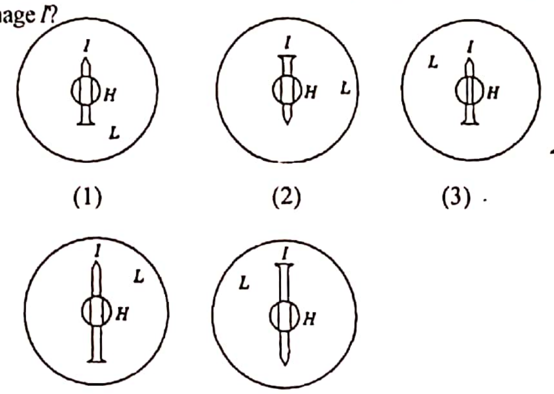
19. How much more thumb pressure should a nurse apply in administering an injection with a needle of inside diameter 0.2 mm compared to a needle of inside diameter 0.4 mm? Assume that the two needles have the same length and that the volume flow rate is the same in both cases

(1) 2 times (2) 4 times (3) 8 times
(4) 10 times (5) 16 times

20. The image I formed by a concave lens L of an object pin O mounted on a stand is set to align with the object pin. and viewed through a small circular hole H cut at the centre of the lens Which of the following figures

correctly indicates the view of the object pin O and the image I?

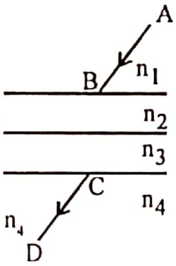




(1) (2) (3)

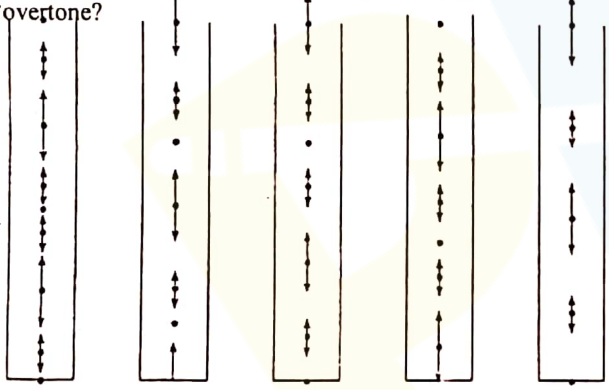
(4) (5)

21. A monochromatic ray of light passes through four layers of transparent plastic with refractive indices n_1, n_2, n_3 and n_4 as shown. If the emergent ray CD is parallel to the incident ray AB, then



(1) $n_1 > n_2 > n_3 > n_4$ (2) $n_1 < n_2 < n_3 < n_4$
(3) $n_1 > n_2 > n_3 = n_4$ (4) $n_1 = n_4$
(5) $n_1 = n_2 > n_3 = n_4$

22. If the length and arrow head of arrows in the figures represent the magnitudes and directions of motion of air molecules which of the following figures correctly shows the displacement of air molecules in a closed tube when it resonates at its first overtone?

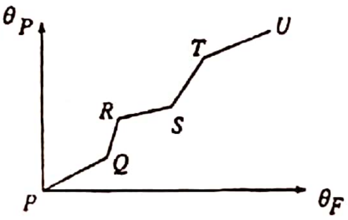


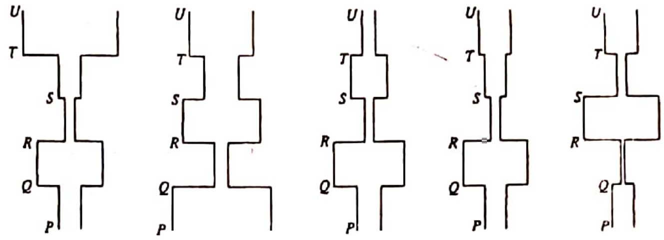
(1) (2) (3) (4) (5)

23. The figure shows a speaker mounted at B, at a certain distance form a smooth wall A, and emitting a sound of single frequency. When a sound detector which is sensitive to pressure variations is taken from A to B, a minimum of sound level is detected at 2 m from the wall. Speed of sound in air is 320ms^{-1}. The frequency of the sound emitted by the speaker could be

(1) 40 Hz (2) 60 Hz (3) 80 Hz
(4) 100 Hz (5) 160 Hz

24. A mercury in glass thermometer made of a glass capillary of uneven bore radius when calibrated against a correct thermometer produces the curve shown in the figure. Here θ_P is the reading of the correct thermometer and θ_F is the corresponding reading of the uneven thermometer. Several students have deduced the shape of the bore of the capillary tube by considering the above curve as follows. Which of the following figures represents the best model for the shape?



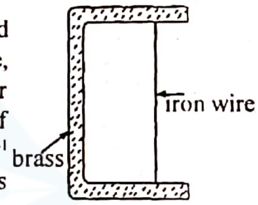


(1) (2) (3) (4) (5)

25. Heat is supplied at a steady rate to a block of ice in a container at 0 °C. After a time t, the block of ice has converted completely to steam at 100 °C. (Specific latent heat of fusion of ice = 3×10^5 J kg^{-1}; specific heat capacity of water = 4×10^3 J kg^{-1} K^{-1}; specific latent heat of vaporisation of water = 2×10^6 J kg^{-1}; Neglect the heat capacity of the container and heat loss to the surroundings.) At time $\frac{t}{2}$, the container has

(1) ice and water at 0 °C. (2) water at 30 °C.
(3) water at 50 °C. (4) water at 70 °C
(5) water and steam at 100 °C.

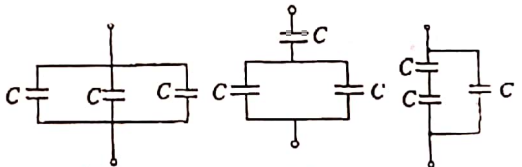
26. The figure shows an iron wire fastened to a brass frame. At room temperature, the wire is neither slack nor undr stress. The linear expansivities of brass and iron are 18×10^{-6} K^{-1} and 10×10^{-6} K^{-1} respectively. Young's modulus of iron is 30×10^9 Nm^{-2}.



When the temperature of the whole system is increased by 1 °C. the stress on the wire will become

(1) 2.4×10^5 N m^{-2} (2) 3×10^5 Nm^{-2} (3) 5.4×10^5 N m^{-2}
(4) 8.4×10^5 N m^{-2} (5) 3×10^6 N m^{-2}

27. Three arrangements (a), (b) and (c) made of identical capacitors of capacitance C are shown in the figures. Equivalent capacitances of the arrangements when arranged in ascending order would be

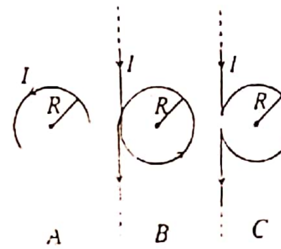


(a) (b) (c)

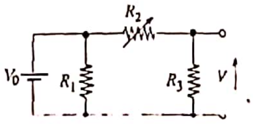
(1) (a), (b), (c) (2) (b), (c), (a) (3) (c), (a), (b)
(4) (a), (c), (b) (5) (c), (b), (a)

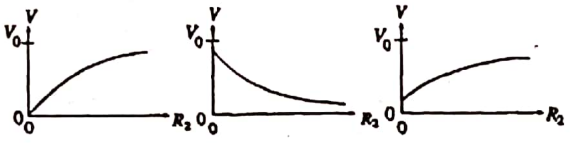
28. Equal currents I flow through three isolated wires A, B and C. wire A is a circular loop of radius. R. B and C are infinitely long straight wires, parts of which are bent to form circular loops of radius R as shown in the figure. If B_A, B_B and B_C represent the magnitudes of the magnetic flux densities produced at the centre of respective loops, then

(1) $B_A > B_B > B_C$
(2) $B_B > B_A > B_C$
(3) $B_A < B_B < B_C$
(4) $B_B = B_C > B_A$
(5) $B_A = B_B = B_C$

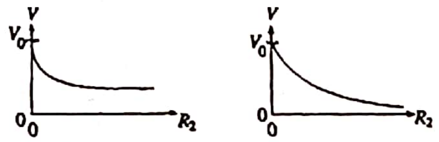


29. In the circuit shown, V_0 represents the voltage of a battery with negligible internal resistance. Variation of V with R_2 is best represented by



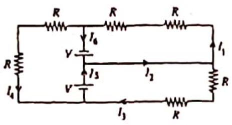


(1) (2) (3)



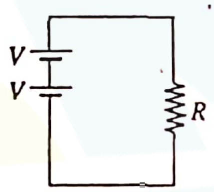
(4) (5)

30. In the circuit shown, batteries have negligible internal resistances. Which of the following is **not** true with regard to the magnitudes of the currents in the circuit?



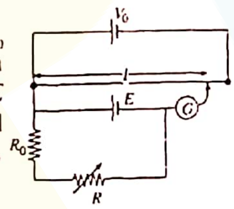
(1) $I_1 = I_3$ (2) $I_3 = I_5$ (3) $I_2 = 0$
(4) $I_4 = 0$ (5) $I_6 = I_1$

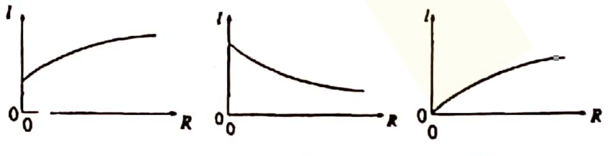
31. Two identical batteries having negligible internal resistances and connected in series as shown in the figure are capable of delivering power to a load resistor of resistance R at a constant rate of P for a time t_0. If only one of the two batteries is connected across R it will deliver power at a constant rate of



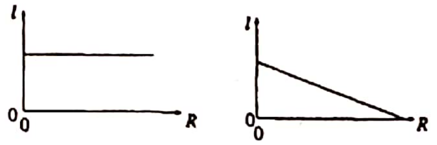
(1) P for a time t_0 (2) $\frac{P}{2}$ for a time t_0 (3) $\frac{P}{2}$ for a time $\frac{t_0}{2}$
(4) $\frac{P}{4}$ for a time $\frac{t_0}{2}$ (5) $\frac{P}{4}$ for a time $2t_0$

32. In the potentiometer circuit shown, V_0 represents the voltage of a battery with negligible internal resistance, and E represents a cell with finite interanl resistance. variation of balanced length L with R is best represented by



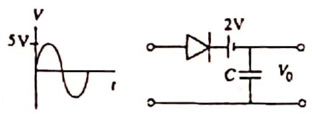


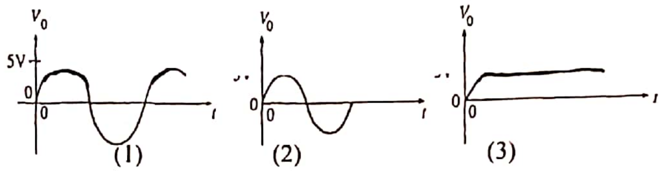
(1) (2) (3)



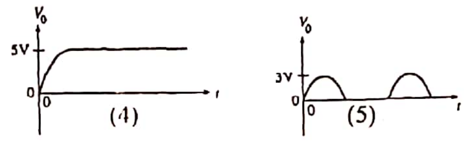
(4) (5)

33 The circuit shown in the figure is made of ideal elements. When a sinusoidal voltage of peak amplitude 5V is applied to the input, the waveform of the out put voltage V0 would be.



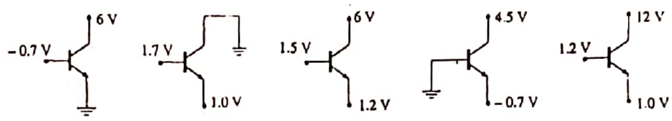


(1) (2) (3)



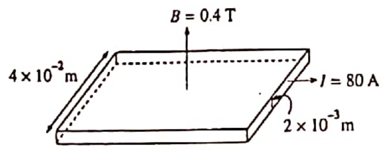
(4) (5)

34. Which of the Si transistors shown operates in the active mode?



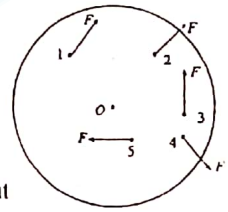
(1) (2) (3) (4) (5)

35. A plate of copper. 2×10^{-3} m thick and 4×10^{-2} m wide, is placed in a uniform magnetic field of flux density B of 0.4 T as shown in the figure.



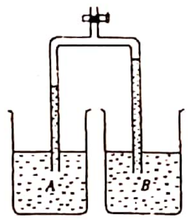
When a current of 80 A is being passed through the plate, it generates a Holl voltage of 0.8×10^{-6}V. What is the number of free electrons per unit volume of copper?
($e = 1.6 \times 10^{-19}$C)
(1) 1.25×10^{29} m^{-3} (2) $1.25 \times 10^{28}$$m^{-3}$
(3) $5 \times 10^{27}$$m^{-3}$ (4) $5 \times 10^{28}$$m^{-3}$
(5) 2×10^{10} m^{-3}

36. A thin disc has freedom to rotate around an axis passing through its centre O perpendicular to the plane of the disc. The disc is acted upon by five coplanar forces (1 - 5), equal in magnitude. as shown in the figure.

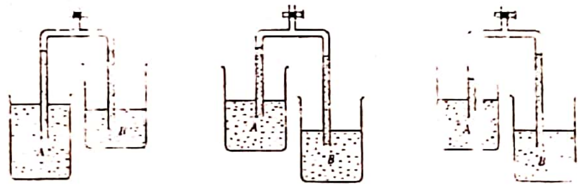


Conside the following statements made about duced by the forces.
(A) Maximum torque is produced by the force 2.
(B) Rotation of the disc due to the resultant torque will be in clockwise direction.
(C) When the magnitudes of the forces are doubled the magnitude of the torque will also be doubled.
Of the 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.

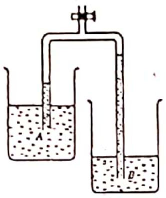
37. The figure (a) shows a Hare's apparatus used to compare the densities of two liquids A and B If the same experiment is done by changing the positions of the limbs of the Hare's apparatus as shown in figures 1 to 5, which of the figures correctly indicates the levels of the liquid columns?



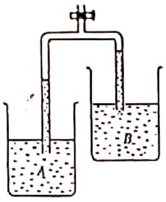
figure(a)



(1) (2) (3)

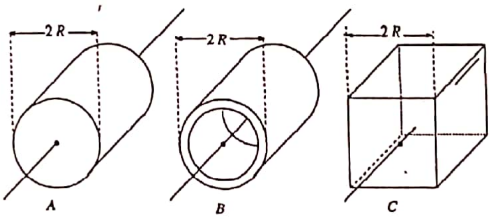


(4)



(5)

38.

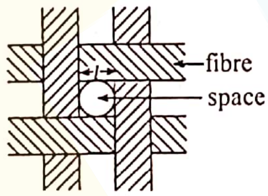


The three uniform objects shown in the figure have equal masses. Object A is a solid cylinder of radius R. Object B is a hollow thin cylinder of radius R. Object C is a solid cube whose sides are of length $2R$. If the moments of inertia of the objects about the axes shown are I_A, I_B and I_C respectively then

(1) $I_B < I_C < I_A$ (2) $I_B > I_C > I_A$ (3) $I_B > I_C < I_A$
(4) $I_A = I_B < I_C$ (5) $I_B > I_A = I_C$

39. A particle of mass m_1 moving with speed υ along positive (+) x direction collides elastically with another particle of mass m_2 at rest. Which of the following statements made regarding the motion of the particles after the collision is **incorrect?**
(1) If $m_1 < m_2$ then m_1 and m_2 would move in $-x$ and $+x$ directions respctively.
(2) If $m_1 > m_2$ then both m_1 and m_2 would move in +x direction.
(3) m_1 and m_2 would move together as a single mass with a speed lower than υ in the $+x$ direction.
(4) The speed of m_1 would be lower than υ unless m_2 is infinitely large.
(5) If $m_1 = m_2$ then the speed of m_2 would be υ.

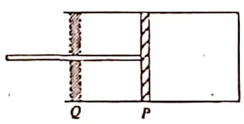
40. As shown in the figure, spaces between the nylon fibres of an umbrella made of nylon cloth could be considered approximately as circular. If the diameter of these spaces is l and the density of water is d, the minimum surface tension that the water should have in order to prevent water from seeping through the spaces is (Take the contact angle between water and nylon to be zero.)



(1) $l^2 dg$ (2) $\frac{1}{2}l^2dg$ (3) $\frac{1}{4}l^2dg$

(4) $\frac{1}{12}l^2dg$ (5) $\frac{1}{16}l^2dg$

41. An ideal gas in a cylinder is expanded by moving the piston from P to Q,
(A) very slowly (B) very rapidly

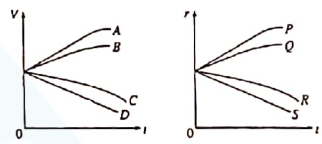


Which of the following answres correctly represents the change in temperature ΔT, (+or-) and the sign (+or -) of quantities ΔQ, ΔU and ΔW for the two processes (A) and (B)? (All symbols have their usual meaning)

	Process	ΔT	ΔQ	ΔU	ΔW
(1)	(A)	0	+	0	+
	(B)	-	0	-	+
(2)	(A)	0	+	0	+
	(B)	-	0	-	-
(3)	(A)	-	+	-	+
	(B)	0	-	0	+
(4)	(A)	0	+	0	+
	(B)	-	0	+	+
(5)	(A)	+	+	+	+
	(B)	-	0	-	-

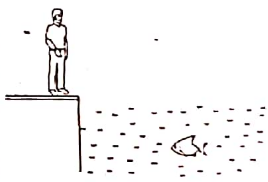
42. A person wearing a pair of spectacles claims that he experiences a film of moisture being formed suddenly on his glasses when he
(A) gets down from an air-conditioned vehicle.
(B) gets into a closed vehicle parked under the sun for a long time.
(C) moves into a heated building in Nuwaraeliya on a cold night when the ambient temperature is around 5 ^{0}C.
Of the above claims.
(1) only (A) can be true
(2) (B) can never be true
(3) only (A) and (B) can be true
(4) (C) can never be true
(5) all (A), (B) and (C) can be true

43. The quality of a dry cell can be evaluated by studying the variation of voltage (V) and the internal resistance (r) of the cell with time (t) while drawing a constant current from the cell for a long period of time. The following graphs drawn between V and t, and r and t include possible curves, as well as impossible curres. Out of the possible curves which curve in each graph reprvesents the best cell?



(1) A and P (2) C and Q (3) D and S
(4) B and R (5) B and Q

44. As shown in the figure, a person is standing on the shore of a lake. He spots a fish some distance below the water surface. If he uses a laser to locate the fish, he should aim the laser



(1) above the apparent position of the fish.
(2) below the apparent position of the fish.
(3) directly at the apparent postiton of the fish.
(4) directly at the actual postiton of the fish.
(5) above the actual position of the fish.

45. A metal wire of radius a and resistance R per unit length has an insulation cover of thickness d and thermal conductivity k. When a current I is sent through the wire, it becomes hot and is cooled by immersing the wire in a liquid which is kept at a constant temperature. Which of the following in true regarding the steady state temperature difference $\Delta\theta$ across the insulation cover?

(1) If $d << a$. $\Delta\theta = \dfrac{I^2Rd}{2\pi k\left(a+\dfrac{d}{2}\right)}$

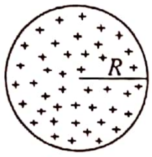
(2) If $d > a$. $\Delta\theta = \dfrac{I^2Rd}{2\pi k\left(a+\dfrac{d}{2}\right)}$

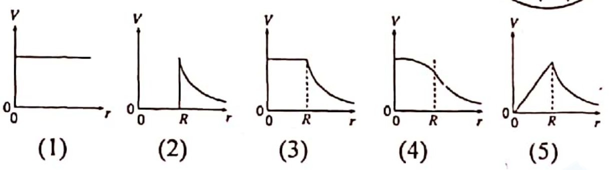
(3) For all d, $\Delta\theta = \dfrac{I^2Rd}{2\pi k\left(a+\dfrac{d}{2}\right)}$

(4) If $d << a$, $\Delta\theta = \dfrac{I^2Rd}{\pi k\left(a+\dfrac{d}{2}\right)^2}$

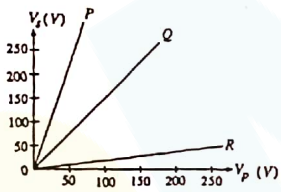
(5) For all d, $\Delta\theta = \dfrac{I^2Rd}{\pi k\left(a+\dfrac{d}{2}\right)^2}$

46. A nonconducting sphere of radius R has a uniform positive charge density distributed within the sphere. The variation of the electric potential (V) with radial distance (r) is best represented by





47. Input (V_P) = Output (V_S) voltage characteristics of three ideal transformers P, Q and R which can be connected to 230V ac mains are shown in the figure. Consider following statements



(A) Transformer P can deliver a larger current then Q at a given value of V_P.

(B) Transformer of the type P is suitable to construct a low voltage dc power supply.

(C) Transformers of the type R has the tatio

$\dfrac{\text{number of turns in the secondary}}{\text{number of turns in the primary}}$ less than 1

Of the above statements

(1) only (A) is true

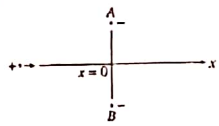
(2) only (B) is true

(3) only (C) is true.

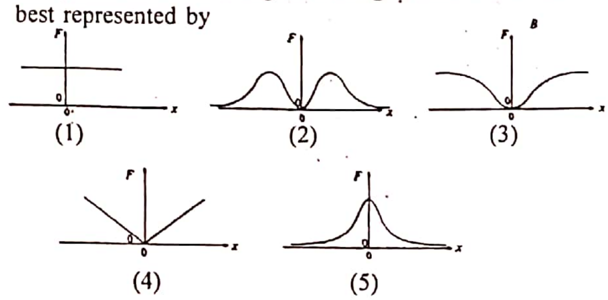
(4) only (B) and (C) are true

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

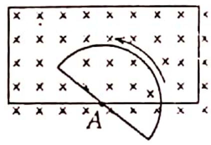
48. The figure shows a positive, point-like charge moving along a straight path between two fixed equal negative point charges.

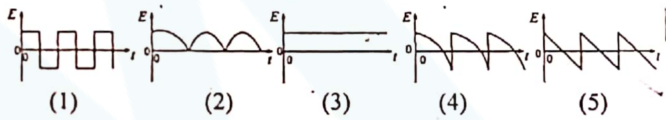


The variation of magnitude F of the net force on the positive charge due to the two negative charges, with the distance x is best represented by

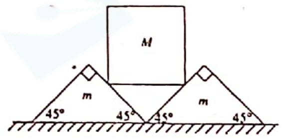


49. A uniform magnetic field is directed perpendicularly into the plane of the paper everywhere within a rectangular region as shown. A wire loop in the shape of a semicircle is rotated counter clockwise with a constant angular velocity in the plane of the paper about an axis perpendicular to the paper and passing through A. Which of the following graphs best represents the variation of the e.m.f. (E) induced in the loop with time t?





50. Two identical wedges each of mass m are placed next to each other on a flat floor. A cube of mass M is placed on the wedges as shown in the figure. Assume that there is no friction between the cube and the wedges. The coefficient of static friction between the wedges and the floor is μ. The largest M that can be balanced without moving the wedges is given by



(1) $\dfrac{\mu m}{\sqrt{2}}$ (2) $\dfrac{\mu m}{1-\mu}$ (3) $\dfrac{2\mu m}{1-\mu}$ (4) $(1-\mu)m$

(5) $\sqrt{2}(1-\mu)m$

G.C.E. (Advanced Level) Examination - August 2011

PHYSICS - II

Three hours

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

01. Figure 1 shows a spherometer used in a laboratory. Number of divisions in the circular scale is 50. Linear progress made by the circular scale on the vertical scale in **two** complete rotations is 1 mm.

Figure 1

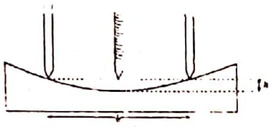


Figure 2

Spherometer is used to determine the radius of curvature of the curved surface of a plano-concave lens. In such a determination, spherometer is placed on the curved surface of the lens as shown in figure 2. After obtaining the measurements h and b which are shown in the figure, the radius of curvature (R) can be determined by the following formula

$$R = \frac{b^2}{6h} + \frac{h}{2}$$

(a) What is the least count of this spherometer?

(b) Before placing the spherometer on the curved surface, it has to be adjusted by placing it on a flat glass plate. How do you experimentally make sure that the tip of the screw just touches the glass plate?

(c) Then the spherometer is placed on the curved surface of the lens.

(i) What adjustment would you make before taking the next measurement in order to determine h?

(ii) What is the reading that you would take from the spherometer after the above mentioned adjustment?

(d) After extensive use, the reading taken from the vertical scale may not be so accurate in some spherometers, what is the reason for this?

(e) In order to determine R you need to measure the mean distance between the spherometer legs

(i) What measuring instrument would you use to determine b?

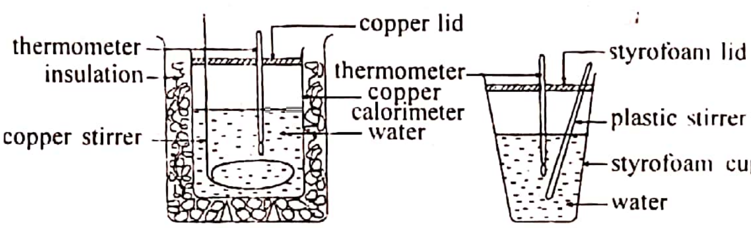
(ii) What experimental steps would you follow in order to determine b?

(f) Give another use of a spherometer except the measurement of radius of curvature.

(g) Suggest a method to further decrease the least count of the spherometer given above.

02. The material called Styrofoam, Rigifoam or polystyrene is widely used for making disposable cups. The thermal conductivity of this material is less than 0.0001 times that of copper while its specific heat capacity is about 4 times that of copper.

In order to investigate the suitability of using a styrofoam cup instead of a copper calorineter in heat experiments, a student selected the 'experiment of determination of specific heat capacity of iron in the form of iron balls using method of mixtures', and arranged two experimental setups to perform the experiment, one using a copper calorimeter and the other using a Styrofoam cup. The figure shows his experimental arragement.



After taking the required initial temperature and mass measurements, he added iron balls heated to 100°C to the water in the calorimeter / Styrofoam cup and obtained the necessary temperature and mass measurements. The readings he obtained are shown below.

	Experiment with copper calorimeter	Experiment with Styrofoam cup
Mass of the empty vessel with stirrer	100g	10g
Mass of the vessel with water and stirrer	150g	60g
Initial temperture of water	30 °C	30 °C
Maximum temperature of water after adding iron balls	45 °C	47 °C
Mass of the final system	300 g	210g

(a) (i) Calculate the amount of heat absorbed by the calorimeter with stirrer (Take specific heat capacity of copper as 375 J kg^{-1} K^{-1}).

(ii) Using the data obtained with the copper calorimeter, show that the specific heat capacity of iron is 450 J kg^{-1} K^{-1}. (Specific heat capacity of water is 4200 J kg^{-1} K^{-1})

(b) Taking the specific heat capacity of iron as 450 J kg^{-1} K^{-1}, calculate the amount of heat absorbed by the styrofoam cup. (Assume that heat lost to surroundings from the Styrofoam cup and heat absorbed by the plastic stirrer are negligible.)

(c) In heat experiments where Styrofoam cups are used the amount of heat absorbed by the cups can be neglected com pared to copper calorimeters. Justift this statement using the results obtained under (a) (i) and (b) above.

(d) State a practical advantage of using a Styrofoam cup com pared to a copper calorimeter in this expriment.

(e) A copper calorimeter cannot be replaced by a Styrofoam cup in the verification of Newton's law of cooling. Give two experimental reasons for this

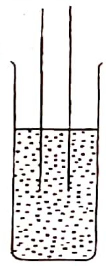
(i)

(ii)

3 (a) When a tuning fork is at resonance with a tube with one end closed, what is the type of the wave being produced in the tube? Longitudinal or transverse? Travelling or standing?

(b) You are provided with a set of tuning forks of frequencies (f) 288 Hz, 320 Hz, 362 Hz and 480 Hz, a suitable glass tube, a glass jar and other necessary items to determine the speed of sound (υ) in air using a graphical method.

(i) What is the purpose of immersing the tube in water?



(ii) Inside the tube shown in the diagram, draw the wave pattern of the mode of vibration that you would setup for taking data. Clearly indicate the end correction (e) in the diagram

(iii) Which tuning fork would you select first to take data? Give the reason for your selection.

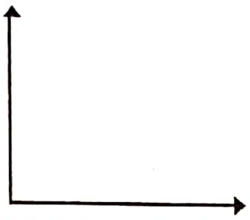
(iv) Calculate the minimum length of the glass tube required to take data using the given set of tuning forks? Take the value of υ in air as 345.6 m s^{-1}.

(v) Obtain the necessary equation in terms of f and the resonance length l to determine υ and e by plotting a graph.

(vi) If you are asked to use another tuning fork in addition to the tuning forks given in (b) above to do the experiment, which one out of the given set below would you select considering the requirement to have a uniform distribution of points on the plot?

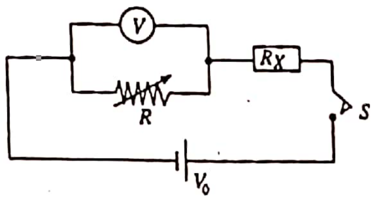
f(Hz)	288	320	341.3	362	406.4	426.6	480
$\frac{1}{f}(Hz^{-1})$	3.5×10^{-3}	3.1×10^{-3}	2.9×10^{-3}	2.8×10	2.5×10^{-3}	2.3×10^{-3}	2.1×10^{-3}

(vii) Draw a rough sketch of the graph that you would expect in this experiment in the following figure. Label the axes. The dependent variable should be on the vertical axis



(viii) If the room temperature was uniformly increasing during the period of data taking, draw the curve that you would expect theoretically on the same figure above. Label it as curve - 2.

4.



A student is asked to find the value R_x of an unknown resistor connected to the circuit shown, using a graphical method. R is a variable resistance provided by a resistance box. V is the reading of the voltmeter Connected across R. The internal resistance of the voltmeter is large. Tow new dry cells of voltage 1.5 V each is used to provide a voltage V_0 of 3 V. Assume that the internal resistance of such a dry cell battery is negligible.

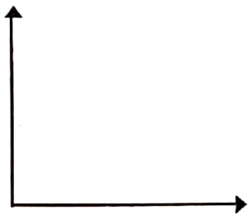
(a) Indicate the polarity of the voltmeter by labeling its terminals with + and - signs.

(b) In order to plot a graph, the student is asked to take severel voltmeter readings (V) by varying the resistance R.

(i) Write down an expression relating V, R, V_0 and R_x

(ii) Rearrange the variables in order to plot a straight line graph with $\frac{1}{V}$ on the Y axis.

(iii) Draw a rough sketch of the expected curve. Label the axes.



(iv) How would you find the value of R_x from the graph?

(v) How would you find the voltage V_0 of the battery using the graph?

(c) You are given that the internal resistance of the voltmeter is 1500Ω and the value of R_x is of the order of 100Ω. Of the following ranges given, indicate with a tick (✓) the range of values that you would choose for R in order to obtain the straight line graph.

25 Ω - 500 Ω (..........)

25 Ω - 1500 Ω (..........)

25 Ω - 200 Ω (..........)

Give the reason for your choice.

(d) (i) How would you check experimentally whether the data have been affected by the possible run-down of the battery?

(ii) If you have discovered that the battery has run-down, how would you desing another battery which lasts longer time, using new 1.5V cells to give 3V, before repeating the experiment. (If necessary you may also draw a diagram to illustrate the answer.)

* * *

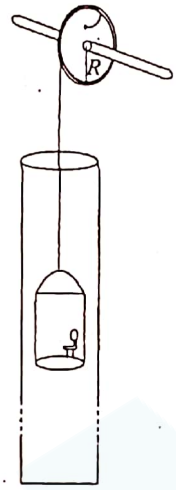
G.C.E. (Advanced Level) Examination - August 2011

PHYSICS - II

Three hours

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

05. A capsule which is free to move through a vertical cylindrical tube as shown in figure can be used to rescue a person trapped in an underground mine. A wire, one end of which is fixed to a pulley of redius R, and wrapped around the pulley, is used to hang the capsule. Assume that the mass of the wire and the friction between the wire and the pulley are negligible. The pulley is free to rotate about a horizontal axle. Answers to the following questions should consist of only relevant quantities represented by the given symbols. (g = gravitational acceleration)



(a) For this part assume that the mass of the pulley and the frictional force against the rotational motion of the pulley are negligible.

(i) If the capsule of total mass M is released from rest, use the law of conservation of energy to obtain an expression for the speed of the capsule after it has moved down a depth h.

(ii) Find the angular speed of the pulley after the capsule has moved down the depth h.

(b) If the mass m of the pulley is **not** negligible and the moment of inertia of the pulley about the rotating axis is $\frac{1}{2}mR^2$, repeat parts (a) (i) and (a) (ii) neglecting the frictional forces.

(c) Under practical situations the mass m of the pulley and the friction against the rotational motion are not negligible. Assume that the friction exerts a constant frictional torque, τf against the rotational motion of the pulley.

(i) What is the work done against the frictional torque (τf) when the pulley has rotated by an angle θ_0 in redians?

(ii) Answer parts (a) (i) and (a) (ii) under these conditions.

(iii) After moving down a depth h_0 the capsule reaches the bottom of the tube and stops. However, the pulley keeps rotating against the frictional torque. Use the law of conservation of energy to find the number of turns (n) that the pulley would rotate further after the capsule has stopped.

(d) A person of mass m_0 gets into the capsule When it is at the bottom of the tube. Find the external torgue (Je) that must be applied on the pulley to rotate it at a constant angular speed while raising the capsule. Assume the conditions given in part (c) for this.

06

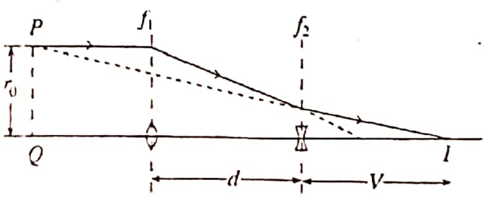


Figure (1) shows a zoom lens arrangement used in a camera. It consists of a convex lens of focal length f_1 and a concave lens of focal length f_2 separated by a variable distance d. The purpose of a zoom lens is to vary the effective focal length of the lens combination significantly with a small variation of d thereby providing variable magnification of the object.

(a) What is the inequality that should be satisfied by d and f_1 in order to form a real image at I?

(b) The lens combination forms an image I at a distance V to the right of the concave lene. Derive an expression for V in terms of f_1, f_2 and d.

(c) (i)

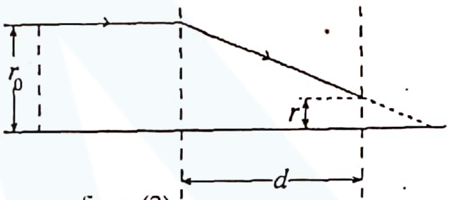


figure (2)

To determine the effective focal length of the combination, consider a parallel ray incident on the convex lens at a distance r_0 from the principal axis. Show that the distance r from the optical axis to this ray at the point it enters the concave lens is give by $r = \frac{r_0(f_1 - d)}{f_1}$. Use the geometry of the diagram in figure (2) to obtain your experssion.

(ii) If the ray shown in figure (1) that emerges from the concave lens and reaches the final image I is extended backward to the left of the concave lens, it will eventually meet the incident ray at point P. The distance from the final image I to the point Q is the effective focal length f of the lens combination.

Show that this focal length is given by $f = \frac{f_1 f_2}{f_2 - f_1 + d}$

(**Hint**. Use the results obtained in (b), (c) (i) above, and geometry to obtain your expression.)

(iii) $f_1 = 12.0$ cm, $f_2 = 18.0$ cm and the separation d is adjustable between 0 and 4.0 cm, find the minimum and maximum focal lengths of the combination.

(iv) Do your results justify the purpose of the zoom lens? Give reasons for you answer.

07. (a) A capillary tube of internal radius r is immersed vertically in water under atmospheric pressure. Show that the value of the capillary rise h in the tube is given by $h = \frac{2T}{\rho gr}$ where T is the surface tension of water and P is the density of

water. Take the contact angle between water ρ and the material of the tube to be zero.

(b) In plants, water ascends through capilliaries known as xylem tubes. When answering parts (b) (i) and (b) (ii) consider a xylem tube having both ends open to atmospheric pressure.

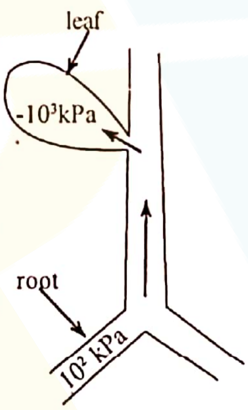
(i) Calculate the height to which water rises in such a capillary of radius 100μm. (Surface trnsion of water = 7.2×10^{-2} Nm^{-1}, density of water = 10^3 kg m^{-3})

(ii) Water rises up to a height of even 100 m in tall trees. If water goes up the xylem tubes due to capillary action alone, calculate the internal radius of a capillary that would raise water by 100 m to the top of a tree.

(c) However scientists have never found such small capillaries calculated in (b) (ii) above in tree xylem. Therefore capillary action cannot be solely responsible for water getting to the top of trees.

To explain how water ascends from roots to leaves, scientists use the concept known as the water pressure (water potential per unit volume.) At standard temperature and pressure, pure water is given a water pressure of zero. Adding solute molecules to the water has the effect of lowering the water pressure, i.e. making it negative. When water evaporates from leaf tissues it raises the solute concentration of water in leaves. This results the water pressure of leaves to be relatively low compared with the water pressure at roots. This water pressure gradient pushes the water up from roots to leaves.

(i) The figure shows a root and a leaf of a tree. If the water pressures of the root and the leaf are -10^{-2}kPa and -10^3 kPa respectively, estimate the height of the water column that can be sustained by this pressure difference. Neglect the surface tension of water.



(d) (i) Assuming the water flow in the xylem tube (internal radius = 100μm) to be streamilned, use the Poiseuille's equation to determine the average speed of rising water. Neglect the weight of the rising water column. Viscosity of water = 10^{-3} Pa s. Take the length of the xylem tube to be equal to the height calculated in (c) (i) above.

(ii) Calculate the power needed to raise this water column up in the xylem tube. (Take $\pi = 3$)

08. Use of satellites is expanding due to many applications in areas such as communication, meteorology, defence and scientific exploration about the earth as well as the outer space. Satellites are placed on certain orbits depending on their applications. The gravitational force provides the required centripetal force to maintain a satellite in an orbit.

Geosynchronous satellites orbit the earth with a period of 24 hours, thus matching the period of the earth's rotational motion. **A geostationary satellite (GSS)** is a Geosynchronous satellite in an approximately circular orbit on the plane passing through the earth's equator (0° latitude) that appears motionless in the sky, to a ground observer. The idea of a GSS was first proposed by the science friction writer Arthur C. Clarke. Communication satellite and weather satellites are often given Geostationary orbits as they can continuosly observe the same areas on the earth. GSS use directional antennas for communication with ground stations. There are also several disadvantages of a satellite being operated as a GSS. The number of satellites that can be maintained in Geostationary orbits without interfering one another is limited. An electromagnetic (EM) signal emitted from a ground station, travels at the speed of light (3×10^8ms^{-1}) Due to the great distance to the satellite a significant time delay is introduced between the original signal emitted from an earth station and the signal receiced by another station after travelling via a satellite. Furthermore, due to the greater height, the clarity of pictures of the earth taken by GSS are poor, especially at locations away from the equator. Another problem would be the damage caused by the EM radiation from the sun when a GSS comes closer to the sun especially when the sun passes through the equatorial plane at late March and late September.

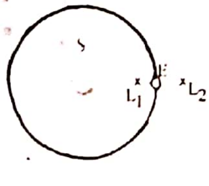
Low Earth Orbit Satellites (LEOS), typically operating at the heights of 160-2000 km from the **surface of the earth** with shorter periods; have become popular in recent years. Their orbits could be on any plane passing through the centre of the earth. However, for continuous data acquisition pertaining to a specific location (eg: observation of weather over a given country) a system of a group of LEOS is needed. Some advantages of a LEOS are the use of simple non-directional antennas, reduced time delay for EM signals, higher clarity pictures of the earth and less EM radiation from the sun. Also, it needs less energy and resources to place a satellite into a Low Earth Orbit and need less powerful amplifiers for successful communication. A polar satellite which passes over the poles of the earth is a special case of LEOS. Hubble space telescope is another example of LEOS.

For scienific exploration of outer space, experiments are conducted in observatories placed on the orbits which are far away from the earth. There are five specific locations called Lagrange points or L-Points where satellites could be placed to perform such experiments. Satellites placed at L-points appear stationary relative to the sun-Earth system. The following figure shows two of the L-points called L_1 and L_2. When the earth orbits the sun with a period of 1 year, satellites placed at L_1 and L_2 also move with the sun-Earth system but the relative locations of them remain the same. There are four satellites at the vicinity of L_1 and three satellites including the latest Planck Space Observatory have been placed at the vicinity of L_2. L_2 is especially useful for observation of outer space because, the earth partially blocks solar radiation falling towards the satellite at L_2 throughout the motion. (Radius of the earth is 6.4×10^6m).

(a) What is the value of the period of a GSS?

(b) Draw a 3-dimensional digram of the orbit of a GSS around the earth. Clearly indicate the geometrical North, South and the equatorial plane of the earth.

(c) Give an example for a LEOS.



(d) Obtain an expression for the radius r of a GSS in terms of universal gravitational constant G, mass of the earth M_E and the period T of GSS. Substitute the correct numerical values in the expression $GM_E = 40 \times 10^{13}$ m^3 s^{-2}. No need to simply the answer.

(e) Calculate the time delay in receiving an electromagnetic test signal emitted from a ground station to a GSS located 36000 km vertically above it, if the signal is received again by the same station

(f) International space station orbiting around the earth is in an orbit with a radius of 6700 km inclined to the equatorial plane. Calculate its period. Is this a GSS or LEOS? Give the reason for your answer.

$(\sqrt{67^3} = 67^{\frac{3}{2}} = 548.4$; Take π^2 as 10)

(g) Give **three** advantages of LEOS.

(h) Why is the location L_2 bet ter for placing an outer space observatory?

(i) Calculate the angular speed (ω) of the planck Space Observatory in umits of rad year^{-1}.

(j) Write down an equation for the orbital motion of the Planck Observatory in terms of mass of the sun (M_s), mass of the earth (M_E), distances from the earth to the sun (R) and to the satellite (r), ω and G. Neglect the effect of other planets and the moon.

(k) Periods of satellites around any object, in general, should increase with the distance from the centre of the object. Satellites at L_1 and L_2 are at different distances from the sun but have equal periods. Explain the reason for this.

09. **Answer either part (A) or part (B) only.**

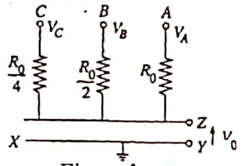


Figure 1

(A) The circuit shown in figure 1 has three inputs A, B and C and voltages V_A, V_B and V_C of either zero or 7 V can be applied be tween the inputs and the common grounded line XY.

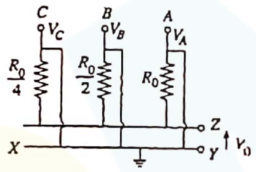


Figure 2

(a) If a zero voltage is applied (i. e. $V_A = V_B = V_C = 0$) to all three inputs by grounding each input terminal as shown in figure 2, find

(i) the equivalent resistance across ZY.

(ii) output voltage V_0.

Now copy the table given below onto your answer script and complete the row 1 (i. e. V_0 value) of the table.

Important: All calculations and corresponding circit diagrams nust be shown clearly in order to earn marks for the parts (b), (c) and (d).

	V_C (volt)	V_B (volt)	V_A (volt)	V_0 (volt)
Row 1	0	0	0	
Row 2	0	0	7	
Row 3	0	7	0	
Row 4	0	7	7	
Row 5	7	0	0	
Row 6	7	0	7	
Row 7	7	7	0	
Row 8	7	7	7	

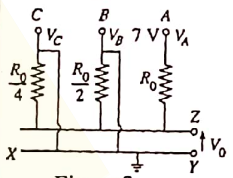


Figure 3

(b) Now the A input is connected to 7V and B and C inputs are grounded as shown in figure 3. Calculate the new value of V_0 and nence fill in the row 2 of the table.

(c) (i) Draw the circuit-diagram similar to figure 3 connecting the inputs A and C to ground and input B to 7 V.

(ii) Find the value of V_0 and fill in the row 3.

(d) Draw the circuit diagrams corresponding to the situations depicted in rows 4 and 5 of the table, find the values of V_0 and fill in the corresponding rows.

(e) (i) Hence deduce V_0 values for the rest of the input voltage combinations of the table and complete the V_0 column of the table.

(ii) If the voltages 7V and 0 are considered to represent binary 1 and 0 respectively, explain the function of the above circuit given in figure 1.

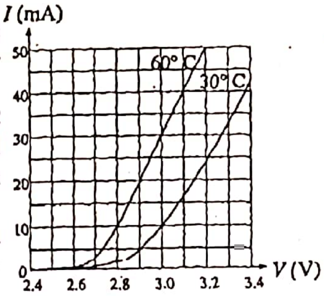


figure 1

(B) (a) Figure 1 shows I - V characteristics of a light emitting diode (LED) for two different temperatures.

(i) Suppose the LED at a 30°C room temperature is connected to a 3 V battery as shown in figure 2. According to the I - V characteristics, it will draw a 10 mA current. After some time, if the LED reaches a temperatire of 60 °C due to its heat dissipation, what will be the current through the LED?

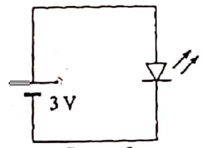


figure 2

(ii) Why would a current through a semiconductor device depend on the temperature?

(iii) It is possible to control the current through the LED by connecting a resistor in series. Calculate the value of the resistor that would limit the current through the LED (at 30 °C) to 10mA, when connected to a 9V battery.

(iv) With a resistor having the value calculated in part (iii) above, suppose the temperature of the LED goes above 30 °C and the current through the LED reaches 10.3 mA. Calculate the voltages across the resistor and the LED under this condition. When this happens, will the power dissipated in the LED increase or decrease? Justify your answer. If the current futher increases due to higher LED temperature, what will happen to the voltage drops across the resistor and the LED?

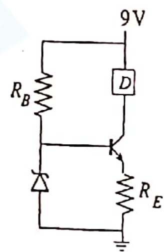


figure 3

(b) Figure 3 shows a circuit commonly used for providing a constant current to a device such as an LED (marked as D in the figure.)

(i) If the value of R_B is 3000Ω, and the voltage drop across the Zener diode is 3 V, calculate the current through the Zener diode. (Assume that the base current is negligible.)

(ii) If the voltage across the base-emitter junction of the transistor is 0.7V, calculate the value of R_E that will make the collector current 10mA. (Assume that the emitter current is equal to the collector current.)

(iii) If the LED in part (a) above is used as the device D, calculate the voltage across the collector and emitter terminals of the transistor (V_{CE}). (Assume that the LED temperature is 30 °C.)

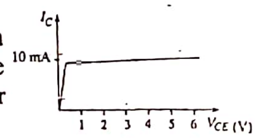


figure 4

(iv) Assume that the graph in figure (4) represents the I_C - V_{CE} curve for the transistor for the releveant I_B value. Copy this graph to your answer script and mark the operating point (V_{CE}, I_C) as point A

(v) If the LED temperature now increases, indicate on the graph with an arrow which way the operating point will move.

(vi) Now suppose two identical LEDs, connected in series, are used as the device D. Calculate the new V_{CE} value and indicate the operating point of the transistor in the graph as point B.

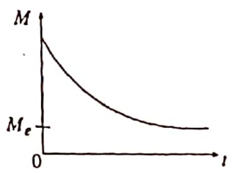
10. **Answer either part (A) or part (B) only.**

(A) A closed transparent chamber of volume 1 m³ contains air at 30 °C and 80% relative humidity. Air inside the chamber is first dride by means of an equipment (dehumidifier) which removes moisture without changing its temperature so that the absolute humidity of the air is dropped to 50% of its initial value. Absolute humidity of air saturated with water vapour at 30 ^{0}C is 30g m^{-3}.

(a) Calculate the absolute humidity of dried air.
The dehumidifier is then removed and the chamber with dried air is used to study the drying of paddy. For this, 750g of wet paddy is introduced into the chamber at time t = 0. The initial omisture content of the paddy sample amounts to 20% of its initial mass. paddy sample is kept on the pan of an electronic balance placed inside the chamber and its mass can be read from outside.

(b) Find the mass of the moisture present in the given paddy sample before placing it in the chamber.

(c) As the paddy dries, the variation of its mass (M) with time (t) as displayed by the electronic balance is shown in the figure.



(i) Give a reason
  (1) for the shape of the curve,
  (2) as to why the mass attains a equilibrium value M_e after some time.
(ii) What is the relative humidity of air inside the chamber when the mass of paddy reaches M_e?
(iii) Calculate the equillibrium mass M_e.
(iv) Calculate the remaining moisture content in grammes of the paddy sample when its mass becomes M_e.

(d) If the percentage moisture content of the paddy sample is to be reduced to 10% what should be the minimum volume of the chamber that has to be employed with dried air prepared in the same manner as given at the beginning of this question?

(e) Atmospheric air heated to higher temperature (without using a dehumidifier) can also be used for drying. If the closed chamber of 1 m^3 is filled with air which was originally at 30 ^{0}C and relative humidity 80% now heated to 70 ^{0}C to perform this study calculate.

(i) the initial relative humidity of heated air inside the chamber before introducing the paddy sample.
(ii) expected value of M_e.
Assume that the temperature of air inside the chamber is maintained at 70 ^{0}C throughout the time of the study. Absolute humidity of air at 70 ^{0}C saturated with water vapour is 216 g m^{-3}.

10. (B) In the medical imaging technique called positron Emission Tomography (PET), a patient is injected with a radioactive isotope that decays by emitting positrons (β^+ or e^+) to a blood vessel. Next, the radiation coming out of the body is detected by detectors placed around the patient. Using this information, an image is constructed by a computer, which shows the concentration of that isotope in different regions of the body.

Suppose a patient is injected with 20 pico grams of ^{15}O-water (water prepared by replacing ^{16}O atoms by ^{15}O atoms). ^{15}O atoms decay by emitting positrons with a half life ($T_{\frac{1}{2}}$) of 2 minutes. (1 pico gram = 10^{-12} gram.)

(a) (i) The activity of a radioactive sample that has an N number of atoms is given by the formula $A = \frac{0.7N}{T_{\frac{1}{2}}}$.

Calculate the activity (in Bq) of the amount of ^{15}O- water injected, at the time of injection. (Take the mass of one ^{15}O- water molecule as 2.8×10^{-26} kg).

(ii) Calculate the activity (in Bq) inside the brain due to ^{15}O decay, after 2 minutes of the injection. Assume that 10% of the injected water reached the brain of the patient during that period.

(iii) Due to the naturally present radioactive isotopes (such as ^{14}C) in the body, there is an activity of about 10^4 Bq in the body of a normal person. Show that, 40 minuter after giving the above injection, the activity due to ^{15}O decay in the body of the patient will become less than the naturally present activity. (Take $2^{20} = 10^6$)

(iv) What could be the advantage of using an isotope with a very short half-life?

(b) Inside the body, the positrons emitted by the decaying ^{15}O atoms interact with electrons in the body to produce two gamma rays according to the reaction $e^+ + e^- \rightarrow 2\gamma$. These gamma rays can be detected by detectors placed outside the body.

(i) If an electron (β-) emitting isotope is used instead of a positron (β+) emitting isotope, explain why no radiation will come out of the body of the patient.

(ii) If a gamma ray has an energy E, the magnitude p of its momentum is given by $p = E/c$ where c is the speed of light. Using the law of conservation of momentum, show that both gamma rays in the above reaction must have the same energy and that they will be travelling in opposite directions. (assume that both e^+ and e^- have zero momentum.)

(iii) Both e^+ and e^- have the same mass. In energy units, this mass is 511ke V. How much is the energy of one gamma ray in the above reaction?

(c) The maximum dose of radiation a patient could get from an ^{15}O- water injection can be estimated by assuming that all the gamma rays produced are absorbed by the body of the patient. If the weight of the patient mentioned above is 51.1kg, calculate this maximum dose (acerage over the body) he could receive from the injection of 20 pico gram ^{15}O- water, in Gy. (1 ke V = 1.6×10^{-16}J and 1 Gy = 1 Jkg^{-1})

* * *

G.C.E. (Advanced Level) Examination - August 2011
PHYSICS - I
Provisional Scheme of Marking

2011 - Answers

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

G.C.E. (Advanced Level) Examination - August 2011

PHYSICS - II

Provisional Scheme of Marking

A - PART

(01) (a) 0.01mm / 0.001 cm / 0.00001m

(b) By ensuring that the tip of the screw touches its image formed by the glass plate. 01

(c) (i) Turn the screw until its tip touches the surface. 01

(ii) The number of rotations of the circular scale and reading of the circular scale.

OR

the readings of the vertical seale and the circular scale. 01

(d) Waste of the serew/ threads OR

The screw might travel through the thimble loosely

OR

The crrcular scale might wobble OR

The coroular scale might be inclined OR

The circular scale may not be horizontal 01

(e) (i) Meter Ruler / half meter ruler / veriner calipers 01

(ii) Place the spherometer on a sheet of paper and press to imprint/ emboss its leg marks 01

mesure the distances between adjacent marks produced by the spherometer legs.

(f) Thickness of a microscope slide OR Thickness of a small glass slide / Thickness of a small disc (CD) OR small depth of a cavity OR small depressions / elevations of a structure.

(g) Reduce the progress made by the circular scale on the vertical scale.

Reduce the pitch of the screw / Reduce the progress made by the circular scale on the vertical scale after one complete rotation of the circular scale/ Divide the circular into more divisions. 01

02. (a) (i) Heat absorbed by Calorimeter $= 100 \times 10^{-3} \times 375 \times (45-30)$

$= 562.5$ J

(ii) Heat absorbed by water $= 50 \times 10^{-3} \times 4200 \times (45-30)$

$= 5 \times 42 \times 15$

Heat given out by Iron balls $= 150 \times 10^{-3} \times C_{Fe} \times (100-45)$

$= 0.15 \times 55 \times C_{Fe}$

$$562.5 + 5 \times 42 \times 15 = 0.15 \times 55 \times C_{Fe}$$

$$C_{Fe} = \frac{562.5 + 5 \times 42 \times 15}{0.15 \times 55}$$

$$= 450\ Jkg^{-1}k^{-1}$$

(b) Heat absorbed by styrofoam cup = heat given out by iron balls - heat absorbed by water

$= 150 \times 10^{-3} \times 450 \times (100-47) - 50 \times 10^{-3} \times 4200 \times (47-30)$ -01

$=$ 7.5 J

(c) Heat absorbed by styrofoam cup is very small compared to heat absorbed by the water OR

Heat absorbed by styrofoam cup (7.5J) is very small compared to heat absorbed by the calorimeter (562.5J)

01

(d) Setting up and handling of items will be easy compared to the calorimeter experiment / with styorfoam it is not necessary to use a heat insulation / Heat absorbed by the styrofoam cup can be neglected. 01

(e) (i) Measured Temperature will not be equal to that of the outer surface of the cup OR

Outer surface will not reach the same temperature as its contents OR.

There will be a temperture gradient across the wall of the cup. 01

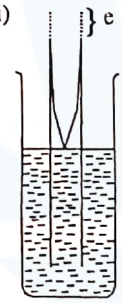
(ii) Rate of cooling will be very small OR

Temperature of the outer surface of the cup will be almost that of air.

03. (a) longitudinal or standing (any one or both) 01

(b) (i) To produce a closed - end tube with variable length 01

(ii)



Correct wave pattern with end correction and labeled (e)

01

(iii) The tuning fork of 480Hz or highest frequcncy.

The resonance length is lowest for highest frequecy.

Then, the fundamental resonace length for other tuning forks can be obtained, without being missed out by continuously raising the tube.

Correct answer and reason 01

(iv) Minimum length $= \frac{\lambda}{4} = \frac{V}{4f} = \frac{345.6}{4 \times 288}$

$= 0.30m$ 01

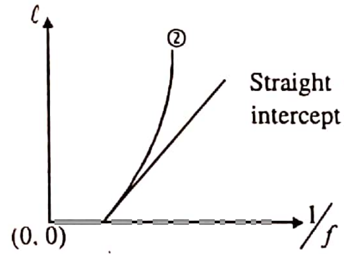
(v) $V = f\lambda$

$V = 4f(l + e)$ 01

$l = \frac{V}{4}\left(\frac{1}{f}\right) - e$ 01

(vi) The tuning fork with f=406. 4. Hz (or 1/f=2.5 x 10^{-3}) 01

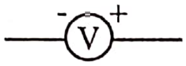
(vii)



Straight line with negative intercept labels as shown 01

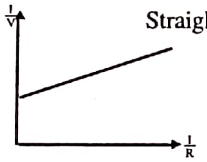
(viii) For correct curve drawn on the plot and labeled as ②

($V \propto \sqrt{T}$) 01

04. (a)  01

(b) (i) $V_0 = \frac{V}{R}(R + R_x)$ 01

(ii) $\frac{1}{V} = \frac{R_x}{V_0}\,\frac{1}{R} + \frac{1}{V_0}$ 01

(iii) 

Straight line with positive intercept 01
labels as shown 01

(iv) $\frac{\text{gradient}}{\text{intercept}}$ 01

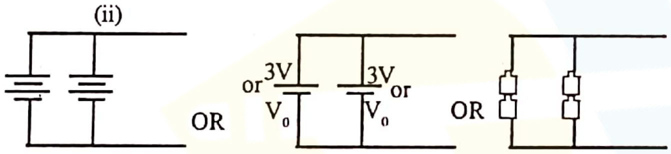
(v) from intercept OR $\frac{1}{\text{intercept}}$

(c) 25Ω - 500Ω range

Reason : Equation of the form $y = mx + c$. can be obtained only when R <<< the internal resistance of the voltmeler/ strallght line is possible only when the value of R chosen is very much smaller than the internal resistance of the voltmeter.

as the internal resistance of the voltmeter is in parallel with R its influence on R can be neglected only if R is small compared fo 1500Ω 01

(d) (i) Repeat the first readings at the end of the experiment

(ii) 

PART B

05. (a) (i) let v be the speed of the capsule at depth h Applying law of conservation of energy.

$Mgh = 1/2\ MV^2$ 01

$\upsilon = \sqrt{2gh}$ 01

(ii) ω- is the Angular speed

$\upsilon = R\omega$

$\omega = \frac{\sqrt{2gh}}{R}$ 01

(b) kinetic energy of the pulley $= \frac{1}{2}I\omega^2$

$= \frac{1}{2}(\frac{1}{2}mR^2)\omega^2$ 01

From the law of conservation of energy

$Mgh = \frac{1}{2}MV^2 + \frac{1}{2}I\omega^2$

$Mgh = \frac{1}{2}MV^2 + \frac{1}{2}.\frac{1}{2}mR^2\omega^2$

$Mgh = \frac{1}{2}MV^2 + \frac{1}{4}mV^2$

$Mgh = \frac{V^2}{4}(2M + m)$

$$V = \sqrt{\frac{4Mgh}{2M+m}}$$

$$\omega = V/R$$

$$\omega = \frac{1}{R}\sqrt{\frac{4Mgh}{2M+m}}$$

(c) (i) work done against the frictional torque $= \tau_f\theta_0$ 01

(ii) Applying the law of conservation of energy

$$Mgh - \tau_f h/R = \frac{1}{2}MV^2 + \frac{1}{2}I\omega^2$$

$$Mgh - \frac{\tau_f h}{R} = \frac{1}{2}MV^2 + \frac{1}{4}mR^2\omega^2$$

$$Mgh - \frac{\tau_f h}{R} = \frac{1}{2}MV^2 + \frac{1}{4}mV^2$$

$$V = \sqrt{\frac{4\left(Mgh - \frac{\tau_f R}{h}\right)}{2M+m}}$$

$$\omega = V/R$$

$$\omega = 1/R\sqrt{\frac{4\left(Mgh - \frac{\tau_f R}{h}\right)}{2M+m}}$$

(iii) let w_0 be the Angular speed of the pulley when Capsule the depth h_0.

Work done against the frictional torque = Rotational K. E. of the pulley.

$$n\cdot 2\pi\tau_f = \frac{1}{2}I\omega_0^2$$

$$n\ 2\pi\tau_f = \frac{1}{4}mR^2\omega_0^2$$

$$n\ 2\pi\tau_f = \frac{1}{4}mR^2\cdot\frac{4}{R^2}\left(\frac{Mgh - \tau_f h/R}{2M+m}\right)$$

$$n = \frac{m}{2\pi\tau_f}\left(\frac{Mgh - \tau_f h/R}{2M+m}\right)$$

(d) For Constant angular speed the net torgue acting on the pulley should be zero 02

$$\tau_e = \tau_f + (M + m_0)gR$$ 01

06. (a) $d < f_1$ OR d is smaller than f_1 01
$(f_1 - d < f_2)$

(b) Applying the lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Considering object as vertical and image as real.
Object distance Without the sign convention $u = f_1 - d$
The Applying the lens formula

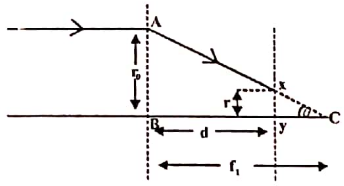
$$\frac{-1}{V} + \frac{1}{f_1 - d} = \frac{1}{f_2} \quad \text{OR} \quad \frac{1}{V} + \frac{1}{f_1 - d} = \frac{1}{f_2}$$

Alternative method - considering object as real and image as virtual
Image distance without the sign convention $V = (f_1 - d)$ 01
The applying the lens formula $\frac{1}{f_1 - d} - \frac{1}{v} = \frac{1}{f_2}$ 01

$$\frac{1}{v}=\frac{1}{f_1-d}-\frac{1}{f_2}$$

$$v=\frac{f_2(f_1-d)}{(f_2-f_1+d)}\ \text{OR}\ v=\frac{-f_2(f_1-d)}{(f_2-f_1+d)}\ \text{OR}\ v=\frac{f_2(f_1-d)}{(f_1-f_2-d)}$$

c. (i) Using similar triangles (ABC Δ and XYC Δ) or tan θ

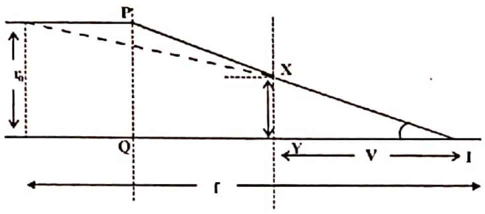


$$\frac{r}{f_1-d}=\frac{r_o}{f_1}\ or$$

$$r/r_o=\frac{f_1-d}{f_1}$$

01

(ii) Using similar triangles PQIΔ and XYIΔ or tan θ



01

$r/r_0 = v/f$ 01

$f = r/r_0$ V 01

Substituting for ro/r and V

$$f=\frac{f_1}{(f_1-d)}\ \frac{f_2(f_1-d)}{(f_2-f_1+d)}\ \text{OR}\ f=\frac{f_1f_2(f_1-d)}{(f_1-d)(f_1-f_2-d)}$$

$$f=\frac{f_1f_2}{(f_2-f_1+d)}\ \text{OR}\ f=\frac{f_1f_2}{(f_1-f_2-d)}$$

(iii) minimum value for f is d = 4cm

$$f=\frac{12\times18}{18-12+4}\ \text{OR}\ f=\frac{12\times18}{12-18-4}$$

f = 21.6 cm OR f = -21.6cm 01

maximum value for f is d = 0

$$f=\frac{12\times18}{18-12}\ \text{OR}\ f=\frac{12\times18}{12-18}\ \text{cm}$$

f = 36cm OR f = -36cm 01

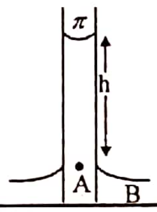
(iv) yes for a change of 4cm in *d* there is a change of 14.4cm in *f* OR
for a change of 4cm in *d* there is a considerable change in *f*.
OR
f has changed more than 3 times compared to a change of 4cm in *d*. 01

07. (a) Equating the pressure differences

$$P_A = P_B$$

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

$$h=\frac{2T}{\rho rg}$$



[equating the surface tension forces to the weight of the water column. $2\pi rT = \pi r^2h\rho g$ -01]

(b) (i) $h=\frac{2\times7.2\times10^{-2}}{10^3\times100\times10^{-6}\times10}$ 01

$h=0.144m(14.4\times10^{-2}m, 14.4cm)$ 01

(ii) $r=\frac{2\times7.2\times10^{-2}}{10^3\times100\times10}$ 01

$r=1.44\times10^{-7}m(0.144\mu m)$ 01

(c) (i) hρg = pressure difference OR hρg = Δ P 01

$h \times 10^3 \times 10 = [-10^2 - (-10^3)] \times 10^3$ 01

$$H=\frac{10^2(10-1)}{10}$$

$$H=90\ m$$

(d) (i) V - speed of water
Applying poiseuille's equation

$$\pi r^2 V=\frac{\Delta P\pi r^4}{8\eta\ell}$$

$$V=\frac{\Delta Pr^2}{8\eta\ell}$$

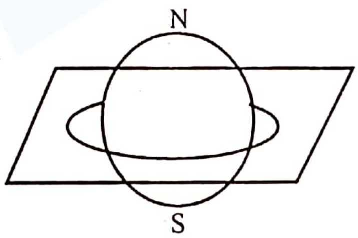
$$V=\frac{9\times10^5(100\times10^{-6})^2}{8\times10^{-3}\times90}$$

$$V=1.25\times10^{-2}ms^{-1}(1.25\ cms^{-1})$$

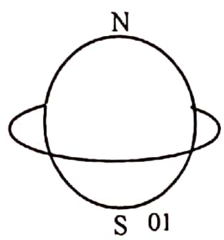
(ii) Power = $\Delta P . \pi r^2 V$ (P = FV) -01
$= 9 \times 10^5 \times 3 \times (100 \times 10^{-6})^2 \times 1.25 \times 10^{-2}$ 01
$= 3.375 \times 10^{-4}$ W $(3.37 - 3.40) \times 10^{-4}$ W 01

08. (a) The period of geostationary satellite (GSS) = 24 hours 01

(b)



OR



01

(c) Polar Satellite
Hubble space telescope
International space station Anyone 01

(d) $\frac{GM_E}{r^2} = \frac{mv^2}{r}$ OR mrw^2 OR $mr\left(\frac{2\pi}{T}\right)^2$

$\frac{GM_E}{r^2} = \frac{v^2}{r}$ OR rw^2 OR $r\left(\frac{2\pi}{T}\right)^2$

$$r=\left[GM_E\left(\frac{T}{2\pi}\right)^2\right]^{\frac{1}{3}}$$

$$r=\left[40\times10^{13}\left(\frac{24\times60\times60}{2\pi}\right)^2\right]^{\frac{1}{3}}$$

01
01

(π = 22 /7 OR 3.14)

(e) Time delay $= \dfrac{2\times 36000\times 10^3}{3\times 10^8}$

$= 0.24$ S 01

(f) $\dfrac{GM_E\, m}{r^2} = \dfrac{mv^2}{r}$ OR mrw^2 OR $mr\left(\dfrac{2\pi}{T}\right)^2$

OR $T^2 = \dfrac{r^3(2\pi)^2}{GM_E}$ 01

$T^2 = \dfrac{(6700 \times 10^3)^3 \times 4 \times 10}{40 \times 10^{13}}$

$T = 67\, ^2/_3 \times 10$

T = 5484 S -01

This is LEOS Because

_ it is in an inelined plane

_ the height is in the range of 160 - 2000km

_ Period is less then 24 hours

Any one reasons

01

(g) advantages of LEOS

_ Reduced time delay for EM signals

_ Possibility of using of Simple non - directional antennas

_ Higher clarity pictures of the earth.

_ Less exposoure fo EM radiation from the sun

_ less energy and resources to place the satellite in to a LEO

_ need less powerful amplifiers

any three correct 01

(h) L_2 is better because at this locatron the earth partially blocks solar radiation falling on the satellite.

(i) Angular speed of the plank space absservatory 2π rad year^{-1} 01

(j) Orbital equation for plank observatory

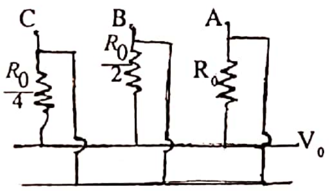
$$\frac{GM_S m}{(R+r)^2}+\frac{GM_E m}{r^2}=\frac{mV^2}{(R+r)} \text{ OR } \frac{GM_S m}{(R+r)^2}+\frac{GM_E m}{r^2}=m(R+r)\omega^2$$

(k) For a Satallite at L_1 $\dfrac{GM_S m}{(R-r)^2}-\dfrac{GM_E m}{r^2}=m(R-r)\left(\dfrac{2\pi}{T}\right)^2$

For a Satallik at L_2 $\dfrac{GM_S m}{(R+r)^2}+\dfrac{GM_E m}{r^2}=m(R+r)\left(\dfrac{2\pi}{T}\right)^2$

At L_1 the force on the satellite is reduced due to the earth and at L_1 the force increased due of the earth 01

09. (A) (a) (i)



R - the equivalent resistance across ZY

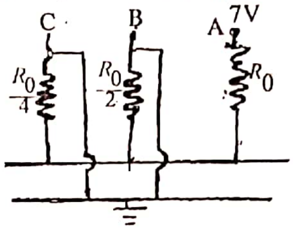
$$\frac{1}{R} = \frac{1}{R_0}+\frac{2}{R_0}+\frac{4}{R_0}$$

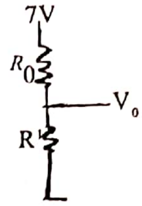
$$= \frac{7}{R_0}$$

$$R = \frac{R_0}{7}$$

(ii) Output Voltage , $V_0 = 0$ 01

(b)





$$\frac{1}{R_1} = \frac{2}{R_0}+\frac{4}{R_0}$$

$$R_1 = \frac{R_0}{6}$$

$$V_0 = \left(\frac{7}{\frac{7}{6}R_0}\right)\times\frac{R_0}{6}$$

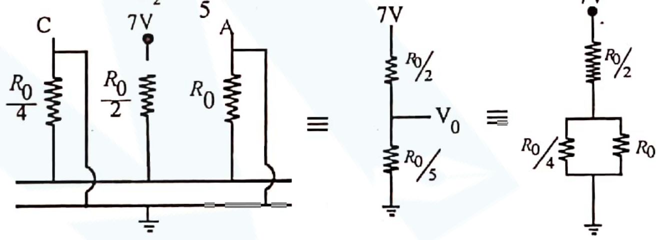
$$V_0 = 1\text{V}$$

(c) (i) R" ⇨Parallel Comnination of $\frac{R_0}{4}$ and R_0

Equivalent resistance.

$$\frac{1}{R_2} = \frac{4}{R_0}+\frac{1}{R_0}$$ 01

$$R_2 = \frac{R_0}{5}$$

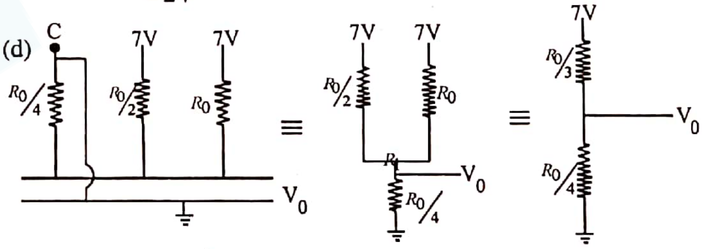


Digram 1 OR 2 OR 3 01

$$V_0 = \frac{7}{\frac{7R_0}{10}}\times\frac{R_0}{5}$$

$= 2$V

(d)



For diagram (1) OR (2) OR (3) 01

(OR Diagram 2 OR 3) 01

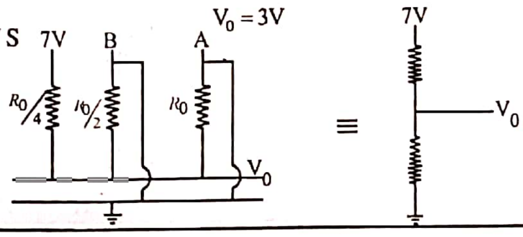
$$\frac{1}{R^{iii}} = \frac{1}{R_0}+\frac{2}{R_0}$$

$$R^{iii} = \frac{R_0}{3}$$

$$V = \frac{R_0/4}{\frac{7R_0}{12}}\times V_0$$

$V_0 = 3$V

R.W.S



$$\frac{1}{R^{iiii}} = \frac{1}{R_0} + \frac{2}{R_0}$$

$$R^{iiii} = \frac{R_0}{3}$$

$$V_0 = \frac{R_0/3}{\frac{7R_0}{12}} \times 7$$

$V_0 = 4V$ 01

(For the diagram (1) OR (2) and Calculation of V_0)

(e) (i)

	V_c(Volts)	V_B(Volts)	V_A(Volts)	V_0(Volts)
Row 1	0	0	0	0
Row 2	0	0	7	1
Row 3	0	7	0	2
Row 4	0	7	7	3
Row 5	7	0	0	4
Row 6	7	0	7	5
Row 7	7	7	0	6
Row 8	7	7	7	7

(Complete V_0 column) 01

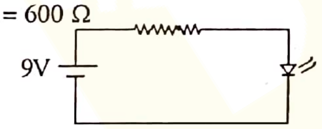
(ii) Binary to decimal convertor
OR The circuit will act as a Digital of Analogue Convertor (DAC) 01

09. (B) (a) (i) 30mA 01

(ii) Because the minority Carrier concentration depends on temperature. 01

(iii) $9 - 3 = 10 \times 10^{-3} R$

$R = 600\ \Omega$ 01



(iv) $V_R = 600 \times 10.3 \times 10^{-3}$
$= 6.18V$ 01

$V_D = 9 - 6.18$
$= 2.82V$ 01

Power dissipated by the LED at 30 °C = 3 x 10 = 30mV
power dissipated when heated = 2.82 x 10.3 = 29mV
Therefore power dissipated has decreated 01
when current increases, V_R will increase and V_D will decrease 01

(b) (i) Since i_D flows through R_B aswell

$i_D R_B = 9 - 3$

$i_D = 6 / 3000$

$= 2 \times 10^{-3}$ A , 2mA 01

(ii) $3 = 0.7 + 10 \times 10^{-3} \times R_E$, OR $2.3 = 10 \times 10^{-3} \times R_E$ 01

$R_E = 2.3 \times 10^3 + 3$ 01

$R_E = 230\ \Omega$ 01

(iii) $9 = V_D + V_{CE} + iR_E$

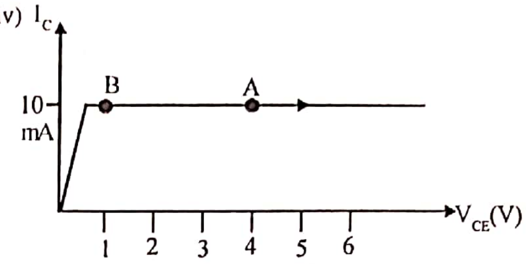
$9 = 3 + V_{CE} + 10 \times 10^{-3} \times 230$ 01

$V_{CE} = 3.7V$ 01

OR $9 = V_D + V_{CE} + V_E$

$= 3 + V_{CE} + 2.3$ 01

(iv)



For making point A 01

(v) For making the arrow 01

(vi) $V_{CE} = 0.7V$

For making point B 01

10. A. (a) Absolute Humidity (AH) of atmospheric air at 30°C is given by the expression.

$$\text{Relative humdity (AH)} = \frac{(AH)30}{\text{(AH of air saturated with water vapour)30}}$$

OR

$$\text{Relatlve hiumdity (AH)} = \frac{\text{mass of water vapour pressent in a given volume of air}}{\text{mass required to saturate it at the same temperature.}}$$

01

$(AH)_{30} = 30 \times \frac{80}{100}$ 01

Ab solute humidity of atmospheric air $= 24 gm^{-3}$

AH of dried air $= 24 \times \frac{50}{100}$ 01

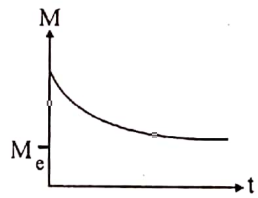
$= 12\ gm^{-3}$ 01

(b) mass of the moisture present in paddy sample.

$= 750 \times \frac{20}{100}$

$= 150g$ 01

(C) (i)



1. Rate of decrease of M with t graduallg becomey smaller as the air becomes more and more humid due to evaporation of misture from the paddy. and therefore the rate of evaporation decrease with time. 01

2. Finally M attains a constant value because air becomes saturated with water vapour and no further evaporation is possible. 01

(ii) RH = 100% 01

(iii) $M_e = 750 - (30 - 12)$

$= 732g$ 01

(iv) Remaining moisture content in the paddy sample

$= 150 - 18$

$= 132g$ 01

(d) Since each $1m^3$ of dry air can absorb 18g of moistre from paddy, the minimum volume of the requied chamber would be $75/18\ m^3$

$= 4.17m^3$ OR 4.2m3 01

(e) (i) Initial relative humidity $= \frac{24}{216} \times 100\%$
$= 11\%$ 01

(ii) $1m^3$ of air at 70°C is capable of absorbing (216-24)g. 192g of moisture from the paddy sample Therefore $M_e = 600g$ 01

10. (B) (a) (i) $N = \frac{20 \times 10^{-12}}{2.8 \times 10^{-26} \times 10^3} = \frac{10^{12}}{1.4}$ 01

$A = \frac{0.7}{120} \times \frac{10^{12}}{1.4}$ 01

$= 4.2 \times 10^9 Bq$ 01
(4.16 - 4.20)

(ii) Activity in the brain 2 min after the injection
$= 4.2 \times 10^9 \times 0.1 \times 0.5$ 02
$= 2.1 \times 10^8 Bq$ 01
(2.08 - 2.10)

(iii) 40 min = 20 half fives. There fore, the activity after 40min
$= \frac{A}{2^{20}} = \frac{4.2 \times}{10^9\ 10^6}$
$= 4.2 \times 10^3$ Bq

This is less than the natural activity of 10^4Bq

(vi) Most of the radioactvity will be removed from the body very quickly OR

If is possible to obtain a very high activity from the body using a small amount of radsoactive matcrial.
01

(b)(i) β^- rays will be absorbed by the body tissues OR
β^{-1} rays cannot produce γ rays in the body. 01

(ii) Suppose the momenta of the two γ rays are p_1 and p_2.
Initial momentum = 0 Final momentum = $p_1 + p_2$
Therefore, from the law of consevration of momentum
$O = P_1 + P_2$
$P_1 = - P_2$ 01
The directrons will be opposite
Because the magnitudes of the momentum are equal. the energies will be equal. 01

(iii) From the law of coservation of energy.
Mass of the positron + mass of the electron = 2 x γ ray energy 01
Therefore γ rays energy $E_r = 511$kev 01

(c) Total energy released $= 2NE_r = 2 \times \frac{10^{12}}{1.4} \times 511 \times 1.6 \times 10^{-16}$
01

absorbed dose $= 2 \times \frac{10^{12}}{1.4} \times 511 \times 1.6 \times 10^{-16} \times \frac{1}{51.1}$

(Fer dividing by 51.1)
$= 2.3 \times 10^{-6}$ Gy 01
(2.28 - 2.30)