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INDIAN SCHOOL SALALAH
FIRST TERM EXAMINATION - SEPTEMBER 2026
PHYSICS (042)



Class: XII

Date: 14/09/2026

Time: 3 hours

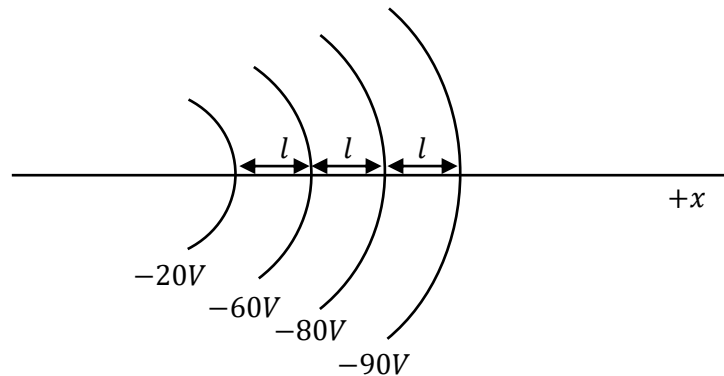
Maximum Marks: 70

General Instructions:

- a. There are 33 questions in all. All questions are compulsory.
 - b. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
 - c. All the sections are compulsory.
 - d. Section A contains sixteen questions, twelve MCQ and four assertion reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.
 - e. There is no overall choice. However, an internal choice has been provided in two questions in Section B, one question in Section C and all three questions in Section E. You must attempt only one of the choices in such questions.
 - f. Use of calculators is not allowed.
 - g. You may use the following values of physical constants wherever necessary
 - (i) $c = 3 \times 10^8 \text{ m/s}$
 - (ii) $m_e = 9.1 \times 10^{-31} \text{ kg}$
 - (iii) $m_p = 1.7 \times 10^{-27} \text{ kg}$
 - (iv) $e = 1.6 \times 10^{-19} \text{ C}$
 - (v) $\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$
 - (vi) $h = 6.63 \times 10^{-34} \text{ J s}$
 - (vii) $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
 - (viii) Avogadro's number = 6.023×10^{23} per gram mole.
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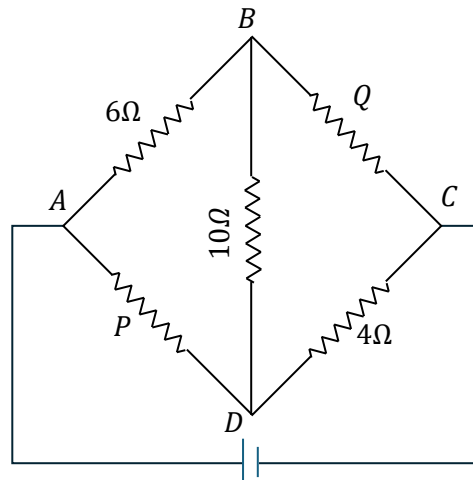
SECTION A

- 1 Identify the charge distribution that produces uniform electric field 1
 - (A) An isolated point charge
 - (B) A uniformly charged spherical shell
 - (C) An infinite uniformly charged straight wire
 - (D) An infinite uniformly charged plane sheet
- 2 An electric dipole of dipole moment $\mathbf{p}$ lies along the positive x –axis with its center at the origin. If -50 J of work is done by an external force to move a charge from $(10, 0)$ cm to $(0, -10)$ cm, what is the work required to move the same charge from $(-10, 0)$ cm to $(10, 0)$ cm? 1
 - (A) 50 J
 - (B) -50 J
 - (C) 100 J
 - (D) -100 J
- 3 The diagram below shows a section of equipotential surfaces belonging to a charge distribution. Choose the correct conclusion regarding the direction and magnitude of the electric field along the x –axis. 1

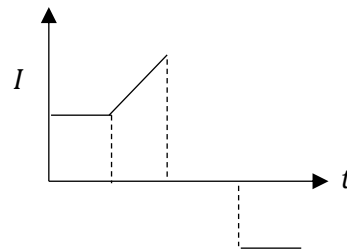


- (A) Direction – along $+ve\ x$ – axis, and magnitude is constant
 - (B) Direction – along $+ve\ x$ – axis, and magnitude is increasing along $+ve\ x$ –axis.
 - (C) Direction – along $+ve\ x$ – axis, and magnitude is increasing along $-ve\ x$ –axis.
 - (D) Direction – along $-ve\ x$ – axis, and magnitude is increasing along $-ve\ x$ –axis.
- 4 An electron moving in a circular orbit of radius r makes n rotations per second. The magnetic field produced at the centre has magnitude. 1
 - (A) Zero
 - (B) $\frac{\mu_0 n e}{2\pi r}$
 - (C) $\frac{\mu_0 n^2 e}{2r}$
 - (D) $\frac{\mu_0 n e}{2r}$

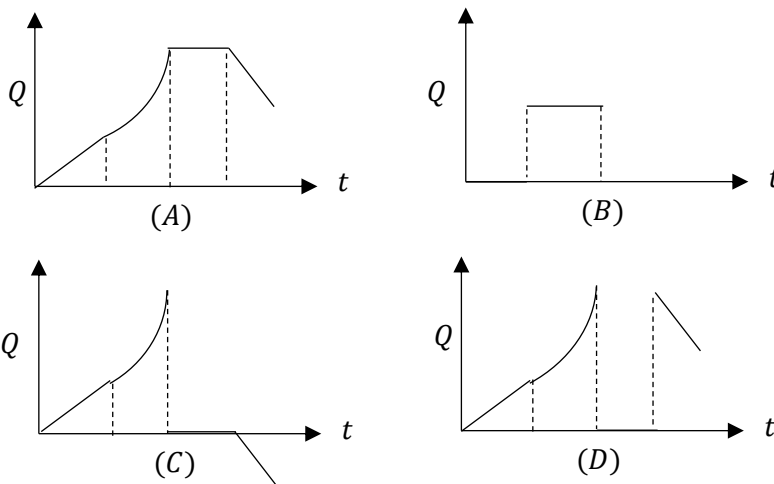
- 5 In the given Wheatstone bridge network, find the specific pair of resistances P and Q for which the total current drawn from the cell is maximized, while the current flowing through the central arm BD remains exactly zero. 1



- (A) $P = 2\Omega, Q = 12\Omega$ (B) $P = 12\Omega, Q = 2\Omega$
 (C) $P = 3\Omega, Q = 2\Omega$ (D) $P = 2\Omega, Q = 3\Omega$
- 6 The variation of electric current I with time t through a circuit element is shown in the graph below. 1



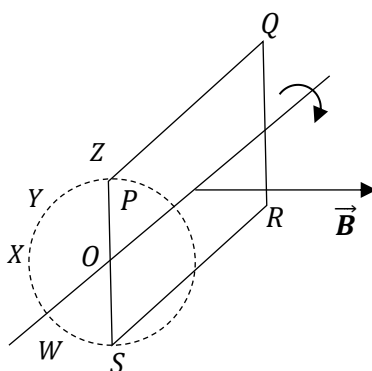
Which of the following options correctly represents the corresponding charge-time ($Q - t$) graph for the same time interval, assuming the initial charge is zero?



- 7 A certain material cooled below its critical temperature exhibits a magnetic susceptibility of $\chi = -1$ and a relative permeability of $\mu_r = 0$. This material belongs to which of the following categories? 1

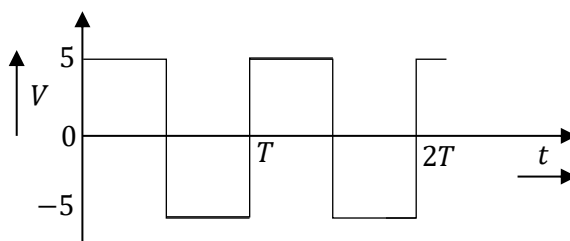
(A) Paramagnetic material (B) Perfect diamagnetic material
(C) Ferromagnetic material (D) Antiferromagnetic material

- 8 The diagram shows a rectangular loop of wire that rotates at a steady rate about a diameter O that is perpendicular to a uniform magnetic field. The maximum induced emf occurs when the point P on the loop passes: 1



(A) W (B) X (C) Y (D) Z

- 9 The voltage V across an electrical device varies over time t as a square wave, as shown in the graph below. Determine the root-mean-square (rms) value and the mean (average) value of the voltage. 1



(A) 5V, 5V (B) $5/\sqrt{2}$ V, 0V (C) 5V, 3V (D) $5/\sqrt{2}$ V, 3V

- 10 The magnetic field amplitude of a plane electromagnetic wave traveling in a vacuum along the y -axis is given as $B_0 = 2.0 \times 10^{-7} \text{ T}$ oriented along the z -axis. The amplitude and direction of the corresponding electric field vector $\vec{E}_0$ are: 1

(A) 60 V/m along the $+x$ -axis (B) $1.5 \times 10^{-15} \text{ V/m}$ along the $+x$ -axis
(C) 60 V/m along the $-x$ -axis (D) $1.5 \times 10^{-15} \text{ V/m}$ along the $-x$ -axis

- 11 A ray of light is incident normally on one of the shorter faces of a right-angled isosceles glass prism $\mu_g = 1.5$ surrounded by air. A thin layer of a liquid of refractive index μ_l is applied to the hypotenuse face of the prism. What is the maximum value of μ_l that will still allow the ray to undergo Total Internal Reflection (TIR) at the hypotenuse face? 1
- (A) $1.5/\sqrt{2}$ (B) $1.5\sqrt{2}$ (C) $\sqrt{2}/1.5$ (D) 1.2
- 12 For a glass prism, the angle of minimum deviation will be smallest for the light of 1
- (A) blue colour. (B) green colour. (C) yellow colour. (D) red colour.

For Questions 13 to 16, two statements are given, one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options given below.

- (A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
- (B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
- (C) Assertion is true, but Reason is false.
- (D) Both Assertion and Reason are false.
- 13 **Assertion (A):** Electric field lines are imaginary curves in an electric field such that the tangent drawn at any point gives the direction of the electric field intensity at that point. 1
- Reason (R):** A positive charge released from rest in an electric field will always move from strong field to weak field.
- 14 **Assertion (A):** The overall current sensitivity of an ammeter is significantly lower than that of the original galvanometer. 1
- Reason (R):** Connecting a low resistance shunt in parallel drastically decreases the total effective electrical resistance of the device.
- 15 **Assertion (A):** The line integral $\vec{E} \cdot \vec{dl}$ around a closed loop is non zero provided $\vec{E}$ is induced electric field. 1
- Reason (R):** Induced electric field is not a conservative field.

- 16 **Assertion (A):** Electromagnetic waves cannot exert pressure on the surface of matter when they fall on it. 1

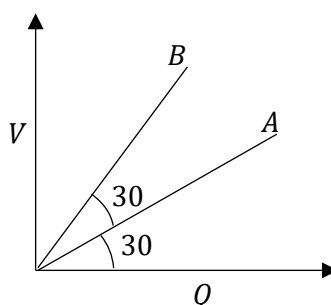
Reason (R): Since electromagnetic waves do not have mass, they do not transport momentum.

SECTION B

- 17 (a) Quantization of electric charge is significant only at the microscopic charge level. Why? Also write the approximate magnitude of a charge handled at this microscopic level. 2

(b) (i) Define the term dielectric constant of a medium. (ii) What is the numerical value of the dielectric constant for Copper (Cu)?

- 18 Figure shows the variation of voltage V across the plates of two capacitors A and B versus charge stored on them. It is given that they have same plate area but plate separation of A is x_A and that of B is x_B . You are asked to make their capacitance equal using a metallic slab. (i) Identify the capacitor into which metallic slab must be introduced? (ii) Calculate thickness of metallic slab in terms of x_A . 2



- 19 (a) Ohm's law is not a universal law. Justify this statement with two suitable examples. 2
- (b) Justify Kirchhoff's rules in current electricity.
- 20(I) A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry a current of 2A. If the number of turns is 1000 per metre, calculate (a) Magnetic intensity (H), and (b) Intensity of magnetisation (M) 2

OR

- 20(II)** (a) A magnetised needle in a uniform magnetic field experiences a torque but no net force. An iron nail near a bar magnet, however, experiences a force of attraction in addition to a torque. Why? **2**
- (b) Two identical looking iron bars A and B are given, one of which is definitely known to be magnetised. (We do not know which one.) How would one ascertain whether or not both are magnetised? If only one is magnetised, how does one ascertain which one? [Use nothing else but the bars A and B.]
- 21(I)** A parallel-plate capacitor consists of two circular plates of radius R . The capacitor is being charged such that the electric field E between the plates increases at a constant rate $\frac{dE}{dt} = \alpha$. Find an expression for the magnitude of the induced magnetic field B at a point located at a perpendicular distance r from the central axis of the plates, where: (a) $r < R$, (b) $r > R$. **2**

OR

- 21(II)** A plane electromagnetic wave traveling in a vacuum along the positive y –axis has an angular frequency of $\omega = 6 \times 10^{10} \text{ rad/s}$. If the time-averaged total energy density of the wave is $7.08 \times 10^{-11} \text{ J/m}^3$, determine: **2**
- (a) The peak amplitude of its electric field vector E_0 .
- (b) The wave vector k of the wave.

SECTION C

- 22** Two identical metallic spheres attract each other with a force F at a fixed distance. Magnitude of charge(smaller) on one sphere is $1 \mu\text{C}$. If they are brought into contact and returned to their original positions, magnitude of the new force becomes $9F/16$. **3**
- (a) Determine the magnitude of initial charge on the second sphere.
- (b) Determine the magnitude of final charge on the first sphere.
- (c) What is the nature of new force between them, attraction or repulsion?

- 23 (a) Define the term electric potential and state its SI unit. 3
 (b) Consider an electric dipole of dipole moment $\vec{p}$. Derive an expression for the net electric potential due to this dipole at a point located at a distance r from its center, where the position vector of the point makes an angle θ with the dipole axis.

- 24(I) Derive the expression for the force per unit length between two long parallel straight current carrying conductors. Hence define one ampere. 3

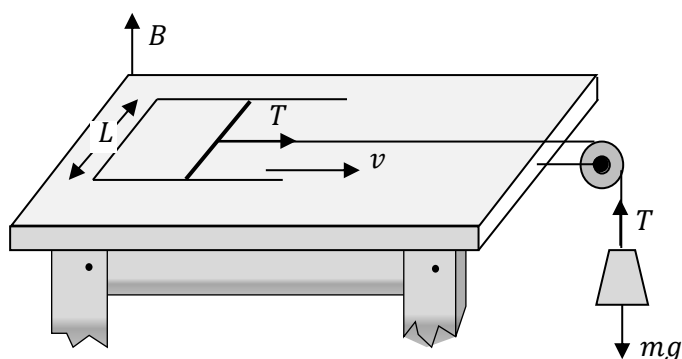
OR

- 24(II) (a) State the working principle of moving coil galvanometer. 3
 (b) Show that the deflection of the galvanometer needle is directly proportional to the current passing through the coil. Also explain how this is achieved.

- 25 (a) State Gauss's theorem in magnetism and write its significance. 3
 (b) List any four properties of magnetic field lines.

- 26 (a) State lenz's law. 3

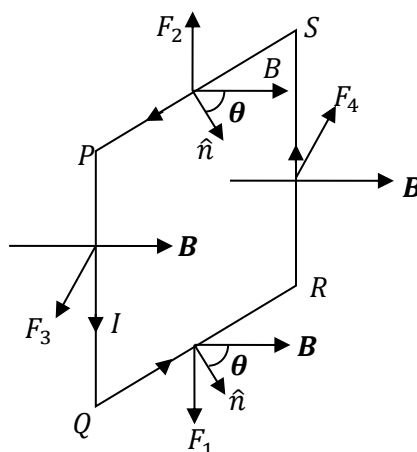
- (b) A pair of parallel horizontal conducting rails of negligible resistance shorted at one end is fixed on a table. The distance between the rails is L . A conducting massless rod AB of resistance R can slide on the rails frictionlessly. The rod is tied to a massless string which passes over a pulley fixed to the edge of the table. A mass m , tied to the other end of the string hangs vertically. A constant magnetic field B exists perpendicular to the table. If the system is released from rest, calculate (i) the constant velocity obtained by the rod. (ii) Direction current in the rod AB .



- 27(I) (a) State the working principle of a transformer. 3
- (b) Obtain relation between transformation ratio and currents in primary and secondary of an ideal transformer.
- (c) List any two energy loss in the transformer.
- 28 A ray of light passes through a glass prism of refracting angle A . 3
- (a) Plot a graph between deviation suffered by the ray versus angle of incidence.
- (b) If the angle of minimum deviation is equal to the angle of the prism $A = \delta_m$, derive the expression for the refractive index μ of the prism material solely in terms of A .

SECTION D

- 29 A rectangular current carrying coil of N turns and area A is placed in a uniform horizontal magnetic field B . The coil carries a current I and suspended freely to rotate about a vertical axis. The normal to the plane of the coil makes an angle θ with the magnetic field. The magnetic forces acting on opposite sides of the coil are equal in magnitude and opposite in direction. Although the net force on the coil is zero, these forces form a couple and produce a torque.



- I If the torque on the coil is $NIAB/2$, the angle between the plane of the coil and the magnetic field can be 1
- (A) 0° (B) 30° (C) 45° (D) 60°

- II Choose the correct statement about the forces acting on the arms of loop 1
- (A) Force on arm SP is minimum when loop is in stable equilibrium.
- (B) Magnitude and direction of force on arm PQ remains constant for any orientation of the loop.
- (C) Loop experiences torque due to forces on arms SP and QR
- (D) Angle between force on QR and magnetic field changes with orientation of the loop.
- III Assume that magnetic moment of the coil is 10 Am^2 , and a moment of inertia is 0.1 kgm^2 . The angular speed acquired by the coil when it has turned through 90° when released from its most unstable position in a uniform magnetic field of magnitude $2T$ is 1
- (A) 5 rad/s (B) 10 rad/s (C) 15 rad/s (D) 20 rad/s
- IV If the loop PQRS is reshaped into a circular loop without changing its orientation, then 1
- (A) Torque on the loop vanishes but a net force appears.
- (B) Torque on the loop increases but its direction changes.
- (C) Torque on the loop decreases but direction does not change.
- (D) Torque on the loop increases but direction does not change.

30 Wireless charging pads for smartphones operate on the principle of electromagnetic induction. The charging pad contains a primary transmitter coil connected to an alternating current (AC) source, which produces a continuously changing magnetic field. When a smartphone containing a secondary receiver coil is placed on the pad, this changing magnetic field passes through the receiver coil. As a result, an electromotive force (emf) is induced in the smartphone's coil, which is then rectified to charge the phone's battery. The efficiency of this energy transfer depends heavily on the coefficient of mutual induction (M) between the two coils, which is governed by their geometry, number of turns, and relative orientation.

- I If the current flowing in the primary coil is $I = 2 \sin 20t$ and mutual inductance of the pair of coils is 0.5 H , then the maximum induced emf developed in the secondary is 1
- (A) 5V (B) 10 V (C) 15 V (D) 20 V

- II Current flowing through the primary charging coil changes from $2A$ to $-2A$ in 0.01 s . If the coefficient of mutual inductance between the charging pad and the phone coil is 0.5 H , calculate the average emf induced in the secondary coil. 1
- (A) 100 V (B) 200 V (C) -200 V (D) -100 V
- III How does the mutual inductance between the primary and secondary coils change if a thin sheet of soft iron is inserted between the charging pad and the smartphone? 1
- (A) M decreases because soft iron reflects the magnetic lines of force.
 (B) M increases because the high relative permeability (μ_r) of soft iron concentrates the magnetic flux lines through the secondary coil.
 (C) M becomes zero because iron shields the secondary coil completely from electromagnetic radiation.
 (D) M remains identical, but energy transfer stops due to electrostatic repulsion.
- IV Two concentric, coplanar circular loops L_1 and L_2 have radii R and r respectively, where $R \gg r$. The mutual inductance M between the two loops is directly proportional to:
- (A) $\frac{r}{R}$ (B) $\frac{r^2}{R}$ (C) $\frac{R^2}{r}$ (D) $\frac{r^2}{R^2}$

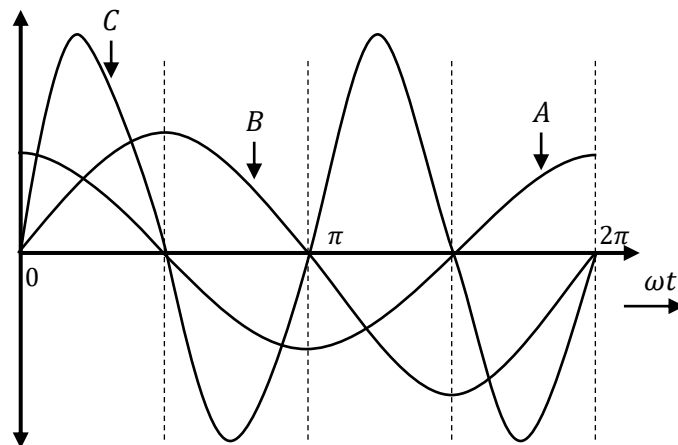
SECTION E

- 31(I)** A heavy-duty motorized display operates at a constant power rating of 12 W and requires a steady voltage of 6 V . You need to build a battery bank to run this device for exactly 5 hours using identical individual cells. 5
- Each cell has the following specifications:
- EMF (Open-circuit Voltage): 1.6 V
- Internal Resistance (r): $0.25\ \Omega$
- Total Energy stored: 3.2 Wh
- (a) Current drawn from each cell so that it lasts exactly 5 hours.
- (b) Minimum number of cells required in each row to provide the necessary operating voltage under load.

- (c) Number of parallel rows required, and the total minimum number of cells needed for the entire battery bank.
- (d) Total power lost as heat inside the internal resistance of the battery bank during operation.

OR

- 31(II)** (a) Define the term electron mobility and state its SI unit. **5**
- (b) Deduce the expression relating electron mobility μ to the average relaxation time τ of free electrons inside a conductor.
- (c) An ultra-thin micro-conductor in a high-power circuit has a uniform cross-sectional area of $3.2 \times 10^{-8} \text{ m}^2$ and a material resistivity of $6.4 \times 10^{-6} \Omega \text{ m}$. If a steady continuous current of 2 A is maintained through this conductor, calculate the magnitude of the internal electric field E driving the charge carriers.
- 32(I)** A device X is connected to an ac source $v = v_o \sin \omega t$. The variation of voltage, **5**
current and power in one cycle is shown in the following graph:

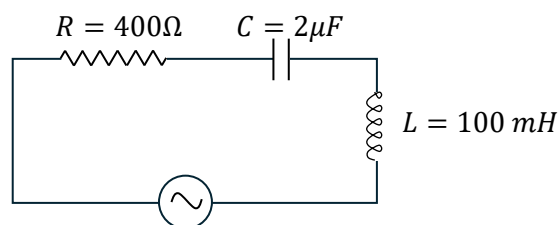


- (a) Identify the device X.
- (b) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify your answer.
- (c) How does its impedance vary with frequency of the ac source? Show graphically.
- (d) Obtain an expression for the current in the circuit and its phase relation with ac voltage.

OR

- 32(II)** (a) An alternating current flowing through a series combination of electrical devices is given by $I = I_0 \sin \omega t$, while the alternating voltage across the combination is given $V = V_0 \sin(\omega t + \phi)$, where ϕ is the phase difference between the voltage and the current. Derive an expression for the average power dissipated in the circuit over a complete cycle. **5**

- (b) Determine the value of phase difference between the current and the voltage in the LCR series circuit shown below.



- (c) Calculate the value of the additional capacitor which may be joined suitably to the capacitor C that would make the power factor of the above circuit unity.

$$v = v_0 \sin(1000t + \phi)$$

- 33(I)** (a) A point-object is placed on the principal axis of a convex spherical surface of radius of curvature R, which separates the two media of refractive indices n_1 and n_2 ($n_2 > n_1$). Draw the ray diagram and deduce the relation between the distance of the object (u), distance of the image (v) and the radius of curvature (R) for refraction to take place at the convex spherical surface from rarer to denser medium. **5**
- (b) Use the above relation to obtain the condition on the position of the object and the radius of curvature in terms of n_1 and n_2 when the real image is formed.

OR

- 33(II)** (a) Draw a labelled ray diagram showing the formation of image by a compound microscope in normal adjustment. Derive the expression for its magnifying power. **5**
- (b) A astronomical telescope is configured for normal adjustment (final image at infinity). The objective lens has a focal length of 150 cm and the eyepiece has a focal length of 6 cm. If this telescope is used to view a 100 m tall tower located at a distance of 3 km, determine:
- The angular magnification of the telescope.
 - The height of the inverted image formed by the objective lens.
