

PHYSICS
(THEORY)
(Three hours)

*Answer **all** questions in **Part I** and **six** questions from **Part II**, choosing **two** questions from **each of the Sections A, B and C.***

All working, including rough work, should be done on the same sheet as, and adjacent to, the rest of the answer.

PART I (20 Marks)

*Answer **all** questions.*

Question 1

A. Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below:

[5]

- (i) Two point charges $17.7 \mu\text{C}$ and $-17.7 \mu\text{C}$, separated by a very small distance, are kept inside a large hollow metallic sphere. Electric flux emanating through the sphere is:

- (a) $2 \times 10^6 \text{ Vm}$
- (b) $-2 \times 10^6 \text{ Vm}$
- (c) Zero
- (d) $4 \times 10^6 \text{ Vm}$

- (ii) Ohm's Law, in vector form is:

- (a) $\vec{J} = \rho \vec{E}$
- (b) $\vec{J} = \sigma \vec{E}$
- (c) $V = IR$
- (d) $\vec{E} = \sigma \vec{J}$

- (iii) If the current (I) flowing through a circular coil, its radius (R) and number of turns (N) in it are each doubled, magnetic flux density at its centre becomes:
- Two times
 - Four times
 - Eight times
 - Sixteen times
- (iv) If two thin lenses having focal lengths f_1 and f_2 and dispersive powers (of their materials) ω_1 and ω_2 respectively, are kept in contact, condition for their achromatism is:
- $\omega_1 f_1 + \omega_2 f_2 = 0$
 - $\omega_1 (f_1)^2 + \omega_2 (f_2)^2 = 0$
 - $\frac{\omega_1}{f_1} = -\frac{\omega_2}{f_2}$
 - $\frac{\omega_1}{f_1^2} = -\frac{\omega_2}{f_2^2}$
- (v) Ratio of the radius of third Bohr orbit to the radius of second Bohr orbit in hydrogen atom is:
- 2:3
 - 4:9
 - 9:4
 - 3:2

B. Answer **all** questions given below briefly and to the point:

[15]

- A dielectric slab of relative permittivity (i.e. dielectric constant) 6 is introduced between the two plates of an $8\mu\text{F}$ air capacitor, in order to completely occupy the space between the two plates. Find the new capacitance of the capacitor.
- What is the ratio $P_1 : P_2$ of electric power developed in R_1 and R_2 shown in **Figure 1** below?

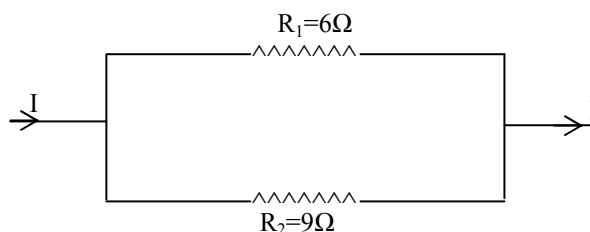


Figure 1

- (iii) Current 'I' flowing through a metallic wire of area of cross-section 'a' is given by the equation $I = naev_d$. What is the meaning of the symbols 'n' and ' v_d '?
- (iv) State *two* conditions which must be satisfied in order to apply Tangent law in magnetism.
- (v) A metallic wire carrying a current is kept in a uniform magnetic field, at different angles. At what angle, is the force acting on it maximum?
- (vi) What type of wave front is associated with a line source of light?
- (vii) Calculate the polarizing angle for glass whose refractive index is 1.6.
- (viii) What is the optical power in dioptre of a concave lens of focal length 50 cm?
- (ix) What is meant by 'resolving power' of a telescope?
- (x) How can the defect of short sightedness be corrected?
- (xi) Out of the following, which one cannot be the charge of a body?
 $+8.0 \times 10^{-19} \text{C}$, $-3.2 \times 10^{-19} \text{C}$, $2.4 \times 10^{-19} \text{C}$, or $6.4 \times 10^{-19} \text{C}$
- (xii) Name the *series* of lines in the hydrogen spectrum which lies in the *infrared* region.
- (xiii) Explain the statement: "Half life of Polonium is 3.8 days."
- (xiv) How much matter has to be destroyed to create $9 \times 10^{13} \text{J}$ of energy?
- (xv) In Semi-Conductor Physics, what is LED?

PART II (50 Marks)

*Answer **six** questions in this part, choosing **two** questions from **each** of the Sections A, B and C.*

SECTION A

*Answer any **two** questions.*

Question 2

- (a) **Figure 2** below shows an electric dipole AB of length l kept in a uniform electric field $\vec{E}$:

[3]

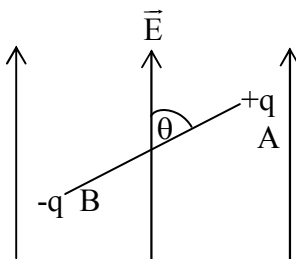


Figure 2

- (i) Show the electrostatic force acting on *each* of the charges forming the dipole.

- (ii) Hence, obtain an expression for the torque acting on the dipole.
- (b) Two plates of a charged parallel plate capacitor are pulled apart with the help of insulating handles, till their separation is doubled. [3]

Compare the new electrostatic potential energy of the capacitor with the old.

- (c) In **Figure 3** below, find the reading of the voltmeter(V), having a resistance of 2000Ω : [3]

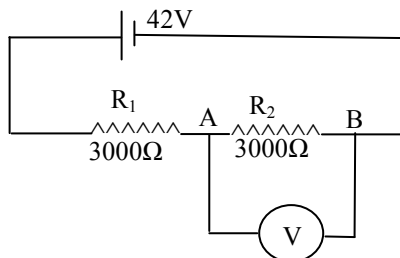


Figure 3

Question 3

- (a) Draw a labelled diagram of a potentiometer circuit used to measure internal resistance of a cell. In this experiment, what is the expression for the internal resistance 'r'? [3]
- (b) Apply Kirchoff's Laws to determine the currents I_1 and I_2 in the circuit shown in **Figure 4** below: [3]

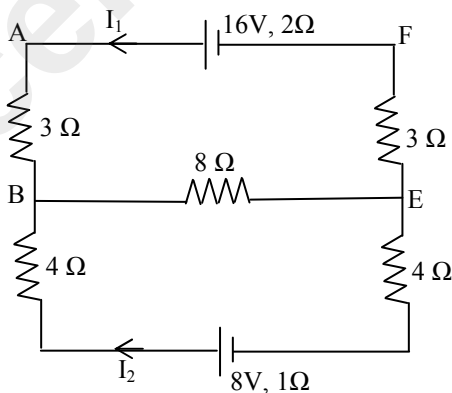


Figure 4

- (c) You are given a bar. How will you identify experimentally whether it is made of a ferro-magnetic, paramagnetic or a diamagnetic material? [3]

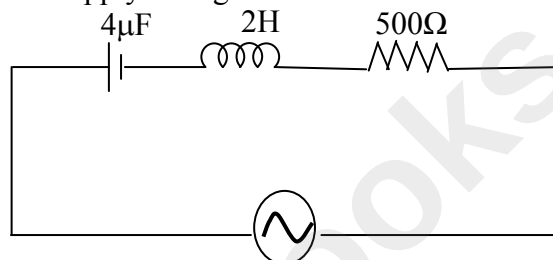
Question 4

- (a) Using Ampere's Circuital Law and with the help of a labelled diagram, show that magnetic flux density 'B' at a distance r from a long straight conductor is given by: [3]

$$B = \frac{\mu_0 I}{2\pi r}, \text{ where the terms have their usual meaning.}$$

- (b) Define 'time constant' of an LR circuit. What is its MKS unit? [2]

- (c) (i) In the circuit shown in **Figure 5** below, calculate phase difference between the current and the supply voltage: [4]



$$E = 300 \sin(500t)$$

Figure 5

- (ii) What is meant by the term *band width* of an LCR circuit?

SECTION B

Answer any two questions

Question 5

- (a) With reference to radio wave communication, explain the terms: [2]

- (i) Amplitude modulation
- (ii) Frequency modulation

- (b) In Young's double slit experiment, using light of wavelength 600 nm, 10th bright fringe is obtained on a screen, 3mm from the centre of the pattern. If the screen is 120 cms away from the slits, calculate: [3]

- (i) Distance between the two slits
- (ii) Fringe width, i.e. fringe separation.

- (c) What is meant by *diffraction of light*? What is an *optical grating*? State its use. [3]

Question 6

- (a) A ray of light, LM, incident **normally** on one face AB of a prism ABC having refracting angle $A = 50^\circ$ grazes the adjacent face AC (See **Figure 6** below). What is the refractive index of its material? [2]

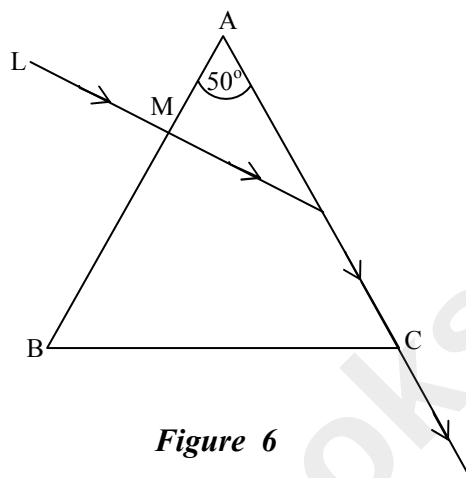


Figure 6

- (b) A convex spherical surface having radius of curvature of 20cm separates air from glass. [3]
) When a point object 'O' is kept in air, on its axis, at a distance of 50 cm from its pole, (see **Figure 7**), a real image 'I' is formed in glass at 300 cm from the pole P. Calculate the refractive index of glass.

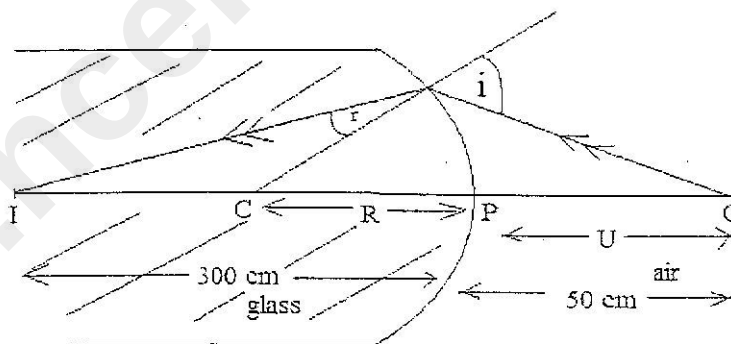


Figure 7

- (c) An optical system consists of a thin convex lens 'L' of focal length $f = 15$ cm and a convex mirror M having radius of curvature $R = 36$ cm, arranged co-axially at a distance of 24 cm. (See **Figure 8** below). [3]
- Where should an object O be kept so that its inverted image I formed by the lens mirror combination coincides with the object itself?

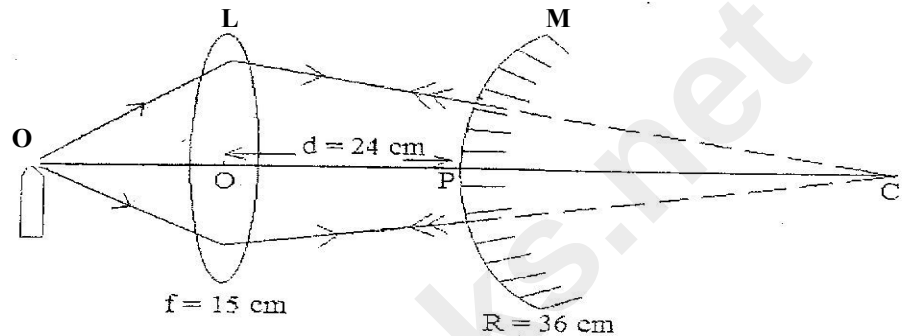


Figure 8

Question 7

- (a) A narrow and parallel beam of white light is incident on a convex lens, parallel to its principal axis. Draw a labelled diagram to show how coloured images are formed by the lens. [2]
- (b) Find the distance between the two lenses of a Compound Microscope if the final image formed by the microscope is virtual and lies at a distance of 25 cm to the left of the eye-piece. Magnifying power of the microscope is 30 and focal lengths of objective and eyepiece are 2cm and 5cm, respectively. [4]
- (c) You are provided with two convex lenses having focal lengths 4 cm and 80 cm, respectively, to form an astronomical telescope. [2]
- Which lens would you use as an objective of an astronomical telescope and which one as an eyepiece?
 - If the telescope is in normal adjustment, what is its:
 - Magnifying power?
 - Length?

SECTION C

Answer any **two** questions.

Question 8

- (a) An electron is passed through a potential difference of 400 V. [3]
- (i) Calculate the speed acquired by the electron.
- (ii) If it enters a transverse and uniform magnetic field, what is the nature of the path described by the electron?
- (b) (i) Explain the statement: “**Work function** of a certain metal is 2.0 eV.” [3]
- (ii) Calculate the maximum wavelength of electro-magnetic radiation which will cause photo emission from this metal.
- (c) What is *de Broglie hypothesis*? What conclusion can be drawn from **Davisson and Germer’s experiment**? [2]

Question 9

- (a) **Figure 9** below shows a simple diagram of a modern X ray tube. (i.e. **Coolidge tube**). [3]

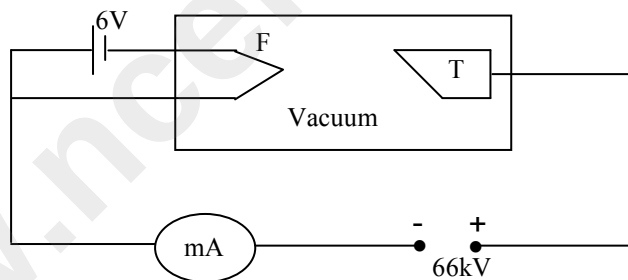


Figure 9

- (i) Find the *minimum* wavelength of the X rays emitted by the X ray tube.
- (ii) What will be the effect of replacing the 6 V battery by a 9 V battery on the emitted X rays?
- (b) What is meant by *mass defect* of a nucleus? How is it related to its binding energy? [2]
- (c) Starting with the Law of Radioactive Disintegration, show that: [3]
- $N = N_0 e^{-\lambda t}$, where the terms have their usual meaning.