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 μC and -17.7 μC, separated by a very small distance, are kept inside a large hollow metallic sphere. Electric flux emanating through the sphere is:

(a) 2×10^6 Vm

(b) -2×10^6 Vm

(c) Zero

(d) 4×10^6 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:

(a) Two times

(b) Four times

(c) Eight times

(d) 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:

(a) $\omega_1 f_1 + \omega_2 f_2 = 0$

(b) $\omega_1 (f_1)^2 + \omega_2 (f_2)^2 = 0$

(c) $\dfrac{\omega_1}{f_1} = -\dfrac{\omega_2}{f_2}$

(d) $\dfrac{\omega_1}{f_1^2} = -\dfrac{\omega_2}{f_2^2}$

(v) Ratio of the radius of third Bohr orbit to the radius of second Bohr orbit in hydrogen atom is:

(a) 2:3

(b) 4:9

(c) 9:4

(d) 3:2

B. Answer **all** questions given below briefly and to the point: **[15]**

(i) A dielectric slab of relative premittivity (i.e. dielectric constant) 6 is introduced between the two plates of an $8\,\mu F$ air capacitor, in order to completely occupy the space between the two plates. Find the new capacitance of the capacitor.

(ii) What is the ratio P_1: P_2 of electric power deveoloped in R_1 and R_2 shown in ***Figure 1*** below?

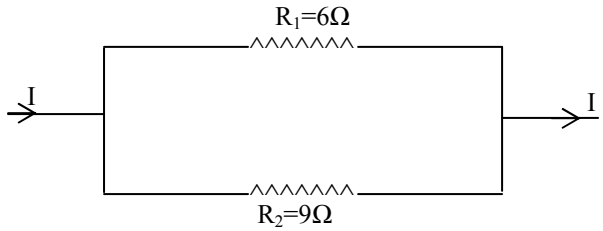


Figure 1

(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 ito 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?
$+8.0\times10^{-19}$C, -3.2×10^{-19}C, 2.4×10^{-19}C, or 6.4×10^{-19}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 9×10^{13}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]**

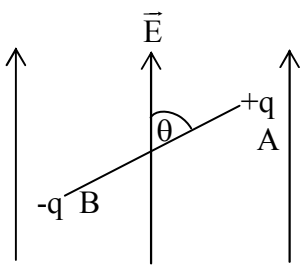


Figure 2

(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]**

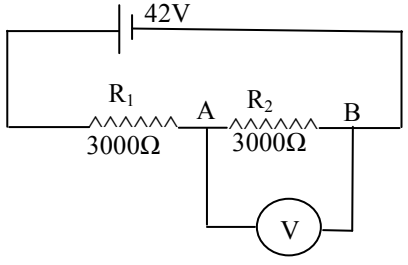


Figure 3

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]**

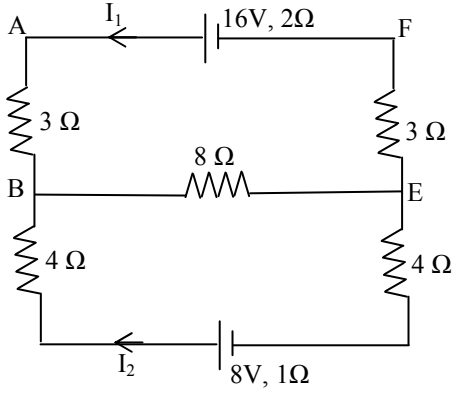


Figure 4

(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]**

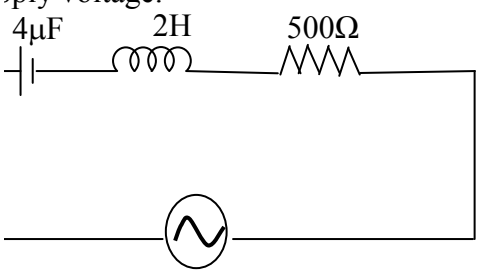
Question 4

(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]**

$$B = \frac{\mu_o I}{2\pi r}$$, 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 **[4]**
pply voltage:



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, 10^{th} 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^o grazes the adjacent face AC (See ***Figure 6*** below). What is the refractive index of its material? **[2]**

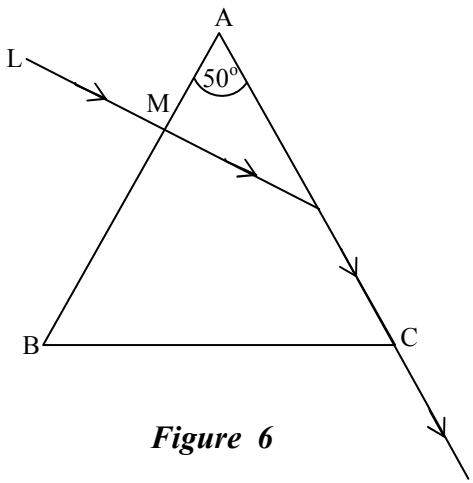


Figure 6

(b) A convex spherical surface having radius of curvature of 20cm separates air from glass. 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. **[3]**

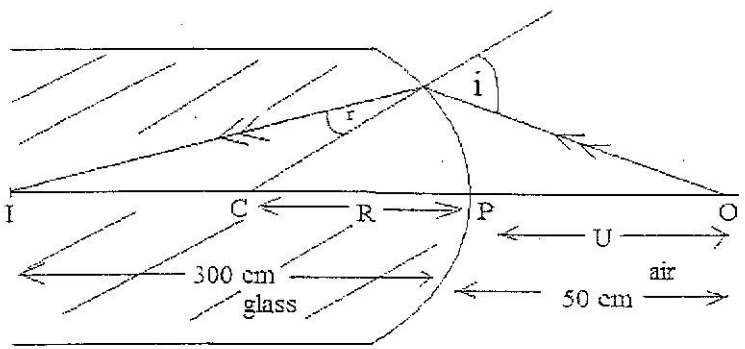


Figure 7

(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?

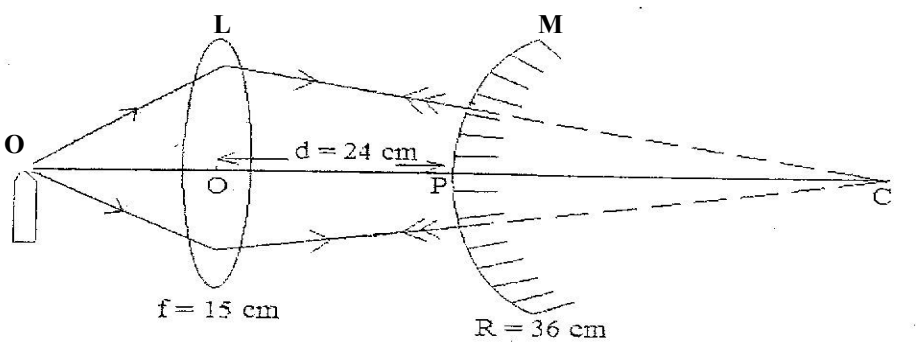


Figure 8

Question 7

(a) A narrow and parallel beam of white light is incident on a convex lens, parallel to its principal axis. Draw a labelleld 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]**

(i) Which lens would you use as an objective of an astronomical telescope and which one as an eyepiece?

(ii) If the telescope is in normal adjustment, what is its:

(1) Magnifying power?

(2) 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]**

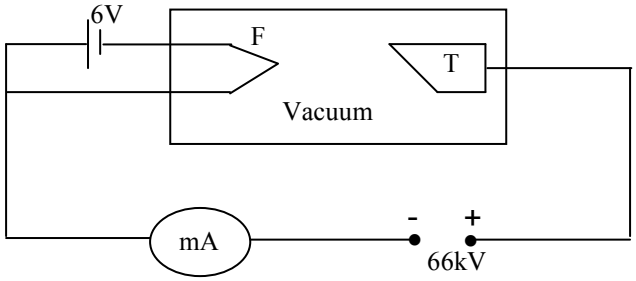


Figure 9

(i) Find the *minimum* wavgelength 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]**
$N = N_o e^{-\lambda t}$, where the terms have their usual meaning.