Physics (Theory)

Marks 70

1. Answer the following as directed: 1×8=8

a) Force between two points electric charges kept at a distance d apart in air is F. If these charges are kept at the same distance in water of dielectric constant k, how does the force between them change?

b) What are the mobile charge carriers in an electrolyte?

c) What are values of resistance of an ideal ammeter and ideal voltmeter?

d) If L and C represent inductance and capacitance respectively, then what is the dimension of $\frac{1}{\sqrt{LC}}$

e) If f = 0.5m for a glass lens, what is the power of the glass.

f) Choose the correct alternative from the clues given at the end of the statement – "An atom has a nearly continuous mass distribution in a _____, but has a highly non-uniform mass distribution in _____" (Thomson's model / Rutherford's model)

g) Fill in the blanks:
In an extrinsic semiconductor doped with pentavalent impurity, _____ becomes the majority carriers and _____ minority carriers.

h) Oxygen (O_2) is a polar/non polar molecule. (choose the correct word)

2. Answer the questions from the following:

a) A parallel plate capacitor with air between the plate has a capacitance of 8 PF. What will be the capacitance if the distance between the plates is reduced to half and the space between them is filled with a substance of dielectric constant 6 2

b) With the help of graphs, show how resistivity changes with temperature in the cases of
(i) Nichrome and (ii) semi-conductor . 1+1 = 2

c) Static charges produce _____ field, while moving charges produce _____ field. 1+1 = 2

d) Current in a circuit falls from 5.0 A to 0.0 A in 0.1s. If an average emf of 200 v induced, give an estimate of the self – inductance of the circuit. 2

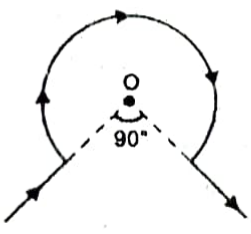
e) Draw a diagram to show refraction and internal reflection of rays of light from a point A in the denser medium incident at different angles at the interface with a rarer medium, as shown in your Text book. 2

f) Name two phenomenon which establish that light is a wave. 1+1 = 2

g) Define atomic mass unit and find its value in kilogram. 1+1 = 2

h) An infinite Line change produces a field of 9×10^4 N/c at a distance of 2 cm. Calculate the Linear charge density. 2

i) A wire as shown in the figure carries a current of 60 A. Determine the magnitude of the magnetic field induction at 0. Given radius of the bent coil is 2 cm. 2



j) Find an expression for resonance frequency for an LCR circuit. 2

3.

a) Derive an expression for energy stored in a parallel plate ~~circuit~~ capacitor. 3

b) Establish the following relation for drift speed where the symbols have their usual meaning. 3

$V_d = \frac{eE}{m}\tau$

c) Using ampere's circuital law, derive an expression for magnetic flux density at a point inside a long current carrying solenoid. 3

d) A series LCR circuit with R = 20Ω L= 1.5H and C= 35μF is connected to a variable frequency 200v AC supply equals the natural frequency of the circuit, what is the average power transferred to the circuit in one complete cycle? 3

e) (i) obtain the expression for the magnetic energy stored in a solenoid in terms of magnetic field B, area A and length L of the solenoid. $1\frac{1}{2} + 1\frac{1}{2} = 3$

(ii) how does this magnetic energy compare with the electrostatic energy stored in a capacitor?

f) Using Gauss's law of electrostatics derive an expression for electric field intensity due to a uniformly charged infinite plane sheet. 3

g) Derive an expression for equivalent focal length of two thin convex lenses in contact. 3

h) Discuss the intensity of transmitted light, when a polaroid sheet is rotated between two crossed polaroid. 3

i) Obtain the binding energy (in MeV) of a nitrogen nucleus ($^{14}_{7}N$). Given m ($^{14}_{7}N$) = 14.00307u m_H =1.007825u, m_n = 1.008665u. 3

4.

a) An early model for an atom considered it to have a positive charged point nucleus of charge Ze, surrounded by a uniform density of negative charge upto a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance (i) r < R and (ii) r > R from the nucleus. 5

b) For refraction at a convex spherical surface of radius of curvature R from a medium of refractive index n_1 to a medium of refractive index n_2 ($n_2 > n_1$), establish the relation

$$\frac{n_2}{V} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

What will be the behaviour of a convex lens of refractive index 1.47 when it is immerged in a liquid of refractive index 1.47? 4+1=5

or

Establish the conditions for formation of bright fringe and dark fringe in young's double slit experiment and hence find the bright fringe width and dark fringe width. 3+2=5

c) Derive an expression for torque acting on a current carrying rectangular coil placed in a uniform magnetic field.

If the plane of the coil is parallel to the direction of magnetic field, then what is torque acting on the coil? 4+1=5