Physics (Theory)

Time allowed: 3 hours] [*Maximum marks:70*

General Instructions:

(i) ***All*** *questions are compulsory.*

(ii) *There are* ***30*** *questions in total. Question Nos.* ***1*** *to* ***8*** *are very short answer type questions and carry one mark each.*

(iii) *Question Nos.* ***9*** *to* ***18*** *carry two marks each, question* ***19*** *to* ***27*** *carry three marks each and question* ***28*** *to* ***30*** *carry five marks each.*

(iii) *There is no overall choice. However, an internal choice has been provided in* ***one*** *question of* ***two*** *marks;* ***one*** *question of* ***three*** *marks and all three questions of* ***five*** *marks each. You have to attempt only one of the choice in such questions.*

(iv) *Use of calculators is* ***not*** *permitted.*

(v) *You may use the following values of physical constants wherever necessary:*

$c = 3 \times 10^8\ ms^{-1}$

$h = 6.626 \times 10^{-34}\ Js$

$e = 1.602 \times 10^{-19}\ C$

$\mu_0 = 4\pi \times 10^{-7}\ Tm\ A^{-1}$

$\frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \mathrm{Nm^2C^{-2}}$

Mass of electron $m_e = 9.1 \times 10^{-31}\ kg$

Q 1. Why must electrostatic field be normal to the surface at every point of a charged conductor? **1**

Solution:

In case of conductors the charge is present only on the outer surface. Inside the conductor the field is zero. And at the surface it has to be normal. If it is not normal to the surface, then it would have some non-zero component along the surface. The free charges on the surface would then experience a force and start moving. In a static situation, electrostatic field should not have tangential component, which in turn implies that the surface of a charged conductor must be normal to the surface at every point. If a conductor has no surface charge, then the field is zero.

Q 2. Under what conditions does a biconvex lens of glass having a certain refractive index act as a plane glass sheet when immersed in a liquid? **1**

Solution:

A biconvex lens will act like a plane sheet of glass if it is immersed in a liquid having the same index of refraction as itself. In this case, the focal length $1/f = 0$ or $f \to \infty$.

Q 3. State de-Broglie hypothesis. **1**

Solution:
de-Broglie Hypothesis states that—
Moving object sometimes acts as a wave and sometimes as a particle; or a wave is associated with the moving particle, which controls the particle in every respect. This wave associated with the moving particle is called matter wave or de Broglie wave, its wave length is given as

$$\lambda = \frac{h}{mv}$$

Where
$h \rightarrow$ planck's constant
$m \rightarrow$ mass of the object
$v \rightarrow$ velocity of the object

Q 4. Name of physical quantity which remains same for microwaves of wavelength 1 mm and UV radiations of 1600 Å in vacuum. **1**

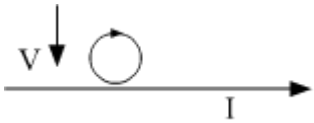
Solution:
Both microwaves and UV rays are a part of the electromagnetic spectrum. Thus, the physical quantity that remains same for both types of radiation will be their speeds, equal to *c*.

Q 5. When electrons drift in a metal from lower to higher potential, does it mean that all the free electrons of the metal are moving in the same direction? **1**

Solution:
No, when electric field applied the electrons will have net drift from lower to higher field but locally electrons may collide with ions and may change its direction of motion.

Q 6. Predict the direction of induced current in a metal ring when the ring is moved towards a straight conductor with constant speed *v*. The conductor is carrying current I in the direction shown in the figure. **1**

Solution:



Using Lenz's law we can predict the direction of induced current in the ring. Induce current oppose the cause of increase of magnetic flux in moving towards the conductor. The direction of the induce current in the ring will be clockwise.

Q 7. The horizontal component of the earth's magnetic field at a place is B and angle of dip is 60°. What is the value of vertical component of earth's magnetic field at equator? **1**

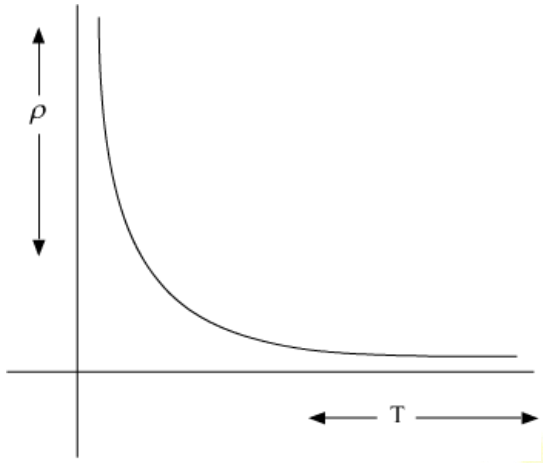
Solution:

On the equator, the values of both angle of dip (δ) and vertical component of earth's magnetic field is zero. So, in this case, $B_v = 0$.

Q 8. Show on a graph, the variation of resistivity with temperature for a typical semiconductor. **1**

Solution:

The following curve shows the variation of resistivity with temperature for a typical semiconductor.



This is because, for a semiconductor, resistivity decreases rapidly with increasing temperature.