Case Based Questions

Q.No.1: Attempt any 4 sub parts from the following question. Each sub part carries 1 mark.

The phenomenon of making a region free from any electric field is called electrostatic shielding. It has got a variety of applications. One such is During the lightning thunderstorm, it is advised to stay inside the car and not under trees or in the open ground because the outer metallic body of the car acts as an electromagnetic shield from the lightning.

(i) The total charge inside a conductor is

(a) Non-zero

(b) Zero

(c) Depends on the electric field

(d) Depends on the electric field present inside the conductor.

(ii) Electric field lines

(a) are always perpendicular to the surface of a conductor

(b) are always along the tangential direction to the conductor

(c) are always zero inside the conductor

(d) None of the above

(iii) The first step involved in using Gauss's law is

(a) Choose a closed Gaussian surface

(b) Calculate the electric field

(c) Estimate the size of the surface

(d) None of the above

(iv) The amount of flux moving radially outward depends on

(a) Surface area of the gaussian surface

(b) Charge present inside the gaussian surface

(c) Both the above

(d) None of the above

(v) A point charge of $2\mu C$ is placed at center of Faraday cage in the shape of a cube with a surface of 9 cm edge. The number of electric field lines passing through the cube normally will be

$\left(\mathrm{a}\right)\ 2.25\times10^{5}\ Nm^{2}/C$

$\left(\mathrm{b}\right)\ 2.50\times10^{5}\ Nm^{2}/C$

$\left(\mathrm{c}\right)\ 2.25\ Nm^{2}/C$

$\left(\mathrm{d}\right)\ none\ of\ the\ above$

Q.No.2: Attempt any 4 sub parts from the following question. Each sub part carries 1 mark.

Total internal reflection has various applications in daily life be it the sparkling of diamond or the formation of mirage. All the phenomena can be explained on the basis of total internal reflection only. The common thing about all the phenomena is the critical angle.

(i) The relationship between the critical angle and the refractive index is given by

(a) $\mu = \sin i_c$

(b) $\mu = \frac{1}{\sin i_c}$

(c) $\sqrt{\mu} = \sin i_c$

(d) $\mu = \sqrt{\frac{1}{\sin i_c}}$

(ii) The necessary condition for total internal reflection is that the light should be incident on the surface of

(a) Rarer to denser medium
(b) Denser to Rarer medium
(c) Both the above
(d) None of the above

(iii) The outer concentric shell in fiber optic is called

(a) cladding
(b) core
(c) coat
(d) mantle

(iv) In case of an optical fiber the core has the material of refractive index n_1 and the cladding has the refractive index as n_2. which of the following gives the correct relationship between n_1 and n_2

(a) $n_1 > n_2$
(b) $n_1 = n_2$
(c) $n_1 < n_2$
(d) Both (b) and (c)

(v) A fish looks from the bottom of the fish tank up at the surface of the water. If the minimum angle to the vertical resulting in total internal reflection is 25^0. What is the index of refraction of water in the tank

(a) 2.37

(b) 1.90

(c) 0.49

(d) 1.12

Q.No.3:
Attempt any 4 sub parts from the following question. Each sub part carries 1 mark.
A soap bubble when seen on bright daylight is seen to exhibit different colors. This is predominantly due to the interference of white light. This naturally occurring phenomenon is called as interference in thin films.
(i) The necessary condition for the interference of light is that
(a) The two sources must be Coherent
(b)The two sources must be in the same direction.
(c)The two sources must be perpendicular to each other
(d)None of the above
(ii) Coherent sources are the one which
(a) Originates from the same source
(b) Originates from different source
(c) Terminates at the same point
(d) None of the above
(iii) The main principle used in Interference is
(a) Heisenberg's Uncertainty Principle
(b) Superposition Principle
(c) Quantum Mechanics
(d) Fermi Principle

(iv) When Two waves of the same amplitude add constructively, the intensity becomes
(a) Double
(b) Half
(c) Four Times
(d) One-Fourth
(v) The shape of the interference pattern depends on the

(a) Distance between the slits
(b) Distance between the slits and the screen
(c) Wavelength of light
(d) Shape of the slit

Case Based Questions

Solution 1

(i) The charge given to a conductor resides on the surface of the conductor. So the total charge inside the conductor is zero. Thus, option (b) is the correct answer.

(ii) Electric field is Perpendicular to the surface of the conductor. Thus, option (a) is the correct answer.

(iii) The first condition to be applied while using the gauss law is first to choose the gaussian surface. Thus, option (a) is the correct answer.

(iv) The amount of flux moving out of a closed Gaussian surface is only dependent on the charge placed inside the Gaussian surface. Thus, option (b) is the correct answer.

(v) The flux of the electric field through a closed Gaussian surface is
$\phi = \frac{q}{\varepsilon_0} = \frac{2\times10^{-6}}{8.85\times10^{-12}} = 2.25 \times 10^5 \ Nm^2/C$
$\phi = \frac{q}{\varepsilon_0} = \frac{2\times10^{-6}}{8.85\times10^{-12}} = 2.25 \times 10^5 \ Nm^2/C$

Thus, option (a) is the correct answer.

Solution 2

(i) The relationship between the critical angle and the refractive index of the medium is given by $\mu = \frac{1}{\sin i_c}$. Thus, option (b) is the correct answer.

(ii) The total internal reflection of light takes place only when the light ray is incident on the denser to rarer interface. Thus, option (b) is the correct answer.

(iii) The outer concentric shell in the fiber optic is called cladding. Thus, option (a) is the correct answer.

(iv) $n_1 > n_2$ is the correct relationship between the refractive index of the inner and the outer material. Thus, option (a) is the correct answer.

(v) Snell's law can be used to calculate the index of refraction for the water the second medium is air and the first medium is water

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$n_1 = \frac{n_2 \sin\theta_2}{\sin\theta_1} = \frac{1 \sin 90^0}{\sin 25^0} = 2.37$$

Thus, option (a) is the correct answer.

Solution 3

(i) The necessary condition for interference is that the two sources must be coherent. Thus, option (a) is the correct answer.

(ii) The sources originating from the same parent source are known as the coherent source. Thus, option (a) is the correct answer.

(iii) Superposition of light is the basic principle that is used in the interference of light. Thus, option (b) is the correct answer.

(iv) The intensity is dependent on the square of the amplitude if the two waves. If the two waves adds constructively then there intensity is four times the original value. Thus, option (c) is the correct answer.

(v) The shape of the pattern depends on the shape of the slits. Thus, option (d) is the correct answer.