

**DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**18PYB101J-Electromagnetic Theory, Quantum Mechanics, Waves
and Optics**

Module I Lecture-4

Solving Problems

1. If 2000 flux through lines enter a given volume of space 4000 lines diverge from it, find the total charge within the volume.

Solution:

It is given that,

$$\Phi_1 = 2000 \text{ Vm and } \Phi_2 = 4000 \text{ Vm.}$$

According to Gauss's theorem

$$\Phi = q/\epsilon_0$$

Net flux emerging out of the surface, i.e.,

$$\Phi = \Phi_2 - \Phi_1 = 4000 - 2000 = 2000 \text{ Vm}$$

$$\text{Then, } q = \epsilon_0 \Phi = 8.854 \times 10^{-12} \times 2000$$

$$\text{Answer: } q = 1.77 \times 10^{-8} \text{ C}$$

2. Find the total charge enclosed by a closed surface if number of lines entering is 20000 and emerging out is 45000.

Solution:

It is given that,

$$\Phi_1 = 20000 \text{ Vm and } \Phi_2 = 45000 \text{ Vm.}$$

According to Gauss's theorem

$$\Phi = q/\epsilon_0$$

Net flux emerging out of the surface, i.e.,

$$\Phi = \Phi_2 - \Phi_1 = 45000 - 20000 = 25000 \text{ Vm}$$

$$\text{Then, } q = \epsilon_0 \Phi = 8.854 \times 10^{-12} \times 25000$$

$$\text{Answer: } q = 22.125 \times 10^{-8} \text{ C}$$

3. A point charge of $13.5 \times 10^{-6} \text{ C}$ is enclosed at the centre of the cube of side 6.0 cm. Find the electric flux 1. through the whole volume and 2. through one face of the cube.

Solution

Given:

$$q = 13.5 \times 10^{-6} \text{ C and } a = 6 \text{ cm}$$

According to Gauss's theorem, the total flux through the whole volume

$$\Phi = q/\epsilon_0$$

$$\Phi = 13.5 \times 10^{-6} / 8.854 \times 10^{-12}$$

$$\text{Ans: } \Phi = 1.525 \times 10^6 \text{ Nm}^2/\text{C}$$

Since a cube has 6 faces of equal area, the flux through one face of the cube would

$$\phi = \frac{1}{6}(q/\epsilon_0)$$

$$= 13.5 \times 10^{-6} / 8.854 \times 10^{-12}$$

$$= (1.525 \times 10^6) / 6 \text{ Nm}^2/\text{C}$$

$$\text{Ans} = 2.54 \times 10^5 \text{ Nm}^2/\text{C}$$

4. A point charge of 11 C is located at the centre of a cube of side 5.0 cm. Calculate the electric flux through each surface.

Solution

Given:

$$q = 11 \text{ C and } a = 5 \text{ cm}$$

As a cube has 6 faces of equal area, the flux through one face of the cube is

$$= 1/6(q/\epsilon_0)$$

$$\Phi = 11/(6 \times 8.854 \times 10^{-12})$$

$$\text{Ans: } \Phi = 2.07 \times 10^{11} \text{ Nm}^2/\text{C}$$