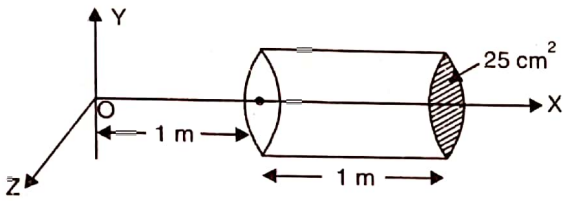
17. A hollow cylinderical box of length 1 m and area of cross-section 25 cm^2 is placed in a three-dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50\, x\hat{i}$, where E is in NC^{-1} and x is in metres. Find

(i) net flux through the cylinder.

(ii) charge enclosed by the cylinder.



OR

(a) Define electric flux. Write its S.I. units.

(b) Obtain an expression for the potential energy of a system of four charges q_1; q_2; q_3 and q_4 placed at points A, B, C and D with position vectors $\vec{r}_1$; $\vec{r}_2$; $\vec{r}_3$ and $\vec{r}_4$ respectively.

18. (a) An infinitely long positively charged straight wire has a linear charge density λ Cm^{-1}. An electron is revolving around the wire with a constant speed in a circular path of radius r in plane perpendicular to the wire. Deduce the expression for its kinetic energy.

(b) Plot a graph of the kinetic energy as a function of charge density λ and radius r of the path.

OR

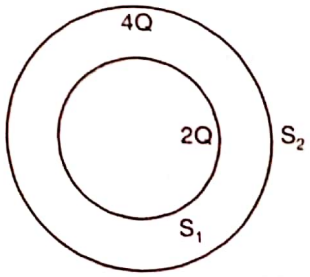
A positive point charge $(+q)$ is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines originating from the point on to the surface of the plate.

Derive expression for the electric field at the surface of a charged conductor.

SECTION D

19. (a) Deduce the expression for the torque acting on an electric dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$.

(b) Consider two hollow concentric spheres, S_1 and S_2 enclosing charges $2Q$ and $4Q$ respectively are shown in the figure. (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'ε_r' is introduced in the space inside S_1 in place of air? Deduce the necessary expression.



OR

(a) Define electric field intensity. Write its S.I. units.

(b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

(c) How is the field directed if the sheet is

(i) positively charged

(ii) negatively charged?