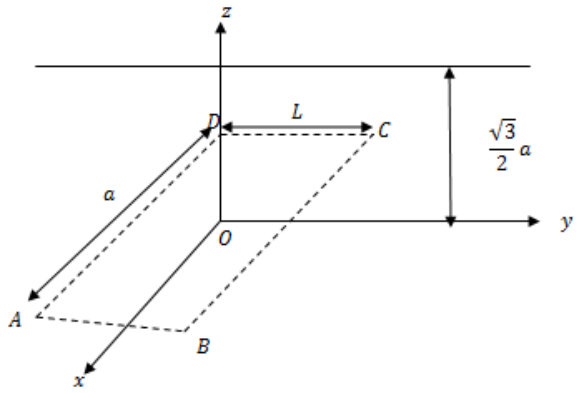
SelfStudy.in

1. An infinitely long uniform line charge distribution of charge per unit length λ lies parallel to the y-axis in the y-z plane at $z = \frac{\sqrt{3}}{2}a$(see figure). If the magnitude of the flux of the electric field through the rectangular surface ABCD lying in the x-y plane with its centre at the origin is $\frac{\lambda L}{n\epsilon_0}$ (ϵ_0 = permittivity of free space), then the value of n is



Answer: Here the sectional view shown in this figure to be understood first, we have one infinitely long charge with linear charge density λ, we know that flux is dot product of intensity and area, since lines of force are radial it is simply product of intensity and area.

To find area of the section which will cut the lines of force, we have taken sectional view for better understanding.

$$\phi = EA = \frac{\lambda}{2\pi\epsilon_0 a} \times \left(\frac{\pi}{3} aL\right) \rightarrow (1)$$

Given $\phi = \frac{\lambda L}{n\epsilon_0} \rightarrow (2)$

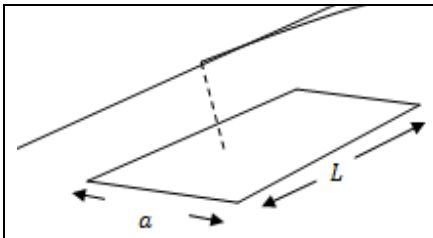


Figure -1

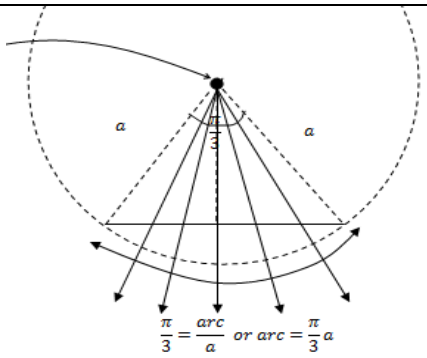


Figure -2

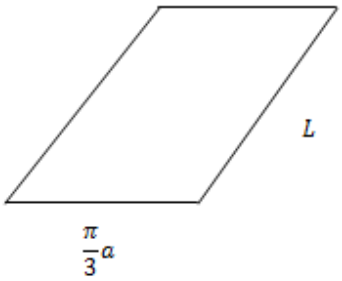


Figure -3

$$\frac{\lambda L}{n\epsilon_0} = \frac{\lambda}{2\pi\epsilon_0 a} \times \left(\frac{\pi}{3} aL\right) \; or \; n = 6$$

Answer: 6