Answer on Question #73248 - Physics / Electromagnetism

A non-conducting rod with radius equal to $R = 5$ cm has a volume charge density of $\rho = 1.6 \times 10^{-5}$ C/m^3. What is the electric flux passing through a cylindrical plane of distance

a) 4.15 cm

b) 6.50 cm

from the outside of the rod?

Solution:

The Gauss law for the electric flux through a closed surface S enclosing any volume V gives

$$\Phi = \frac{Q}{\varepsilon_0},$$

$$Q = \int \rho dV$$

where Q is a total charge enclosed within volume V, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m is an electric constant. Thus

a)

$$\Phi = \frac{\int \rho dV}{\varepsilon_0} = \frac{\rho \pi R^2 h}{\varepsilon_0}$$

The electric flux per unit length of a cylindrical plane

$$\Phi = \frac{\rho \pi R^2}{\varepsilon_0} = \frac{1.6 \times 10^{-5} \times 3.14 \times 0.05^2}{8.85 \times 10^{-12}} = 1.42 \times 10^4 \text{ V}$$

b) In this case answer would be the same, because total charge enclosed within volume not changed.

Answers:

a) $\Phi = 1.42 \times 10^4$ V
b) $\Phi = 1.42 \times 10^4$ V