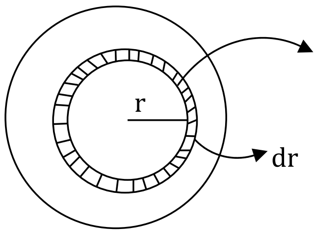
DPP - 6

Solution

Link to View Video Solution: Click Here

1



$\oint \vec{E}\cdot\overrightarrow{ds} = \frac{q_{in}}{\varepsilon_0} = 0$

$\underline{q_{in} = 0}$

$dq = \rho_0\left(1-\frac{nr}{3R}\right)4\pi r^2 dr$

$q_{T_{otal}} = \int_0^{R\pi} S_0\left(r^2 dr - \frac{nr^3 dr}{3R}\right)$

$\downarrow = \left[\frac{r^3}{3} - \frac{nr^4}{12R}\right]_0^R$

$0 = \frac{R^3}{3} - \frac{nR^4}{12R} \Rightarrow \frac{nR^3}{12} = \frac{R^3}{3}$

$0 = n = 4$

2. $S = Ar^2$

$\oint \vec{E}\cdot\overrightarrow{dS} = \frac{q_{in}}{\varepsilon_0}$

$E \times 4\pi r^2 = \frac{q_{in}}{\varepsilon_0}$

$q_{in} = \int_0^{R/2} dV = \int Ar^2 4\pi r^2 dr$

$q_{in} = 4\pi A\left[\frac{r^5}{5}\right]_0^{R/2}$

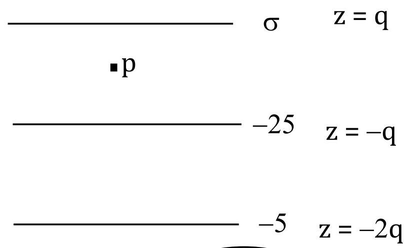
$q_{in} = 4\pi A\frac{R^S}{S \times 32} = \frac{\pi AR^5}{40}$

$E \times 4\# \left(\frac{R}{2}\right)^2 = \frac{\cancel{\pi} AR^5}{40\varepsilon_0}$

$\boxed{E = \frac{AR^3}{40\varepsilon_0}}$

Link to View Video Solution: Click Here

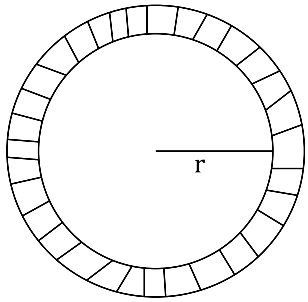
3. $E_p = \frac{\sigma}{2\varepsilon_0}(-\hat{k}) + \frac{2\sigma}{2\varepsilon_0}(-\hat{k}) + \frac{\sigma}{2\varepsilon_0}(-\hat{k})$



$= \frac{4\sigma}{2\varepsilon_0}(-\hat{k}) = \frac{2\sigma}{\varepsilon_0}(-\hat{k})$

$= -\frac{2\sigma}{\varepsilon_0}\hat{k}$

4. $\oint \vec{E} \cdot \vec{A} = \frac{q_{in}}{\varepsilon_0}$



$E \times 4\pi r^2 = \frac{\int_0^r \frac{\alpha}{r} 4\pi r^2 dr}{\varepsilon_0}$

$E \cdot r^2 = \int_0^r \frac{r dr \alpha}{\varepsilon_0}$

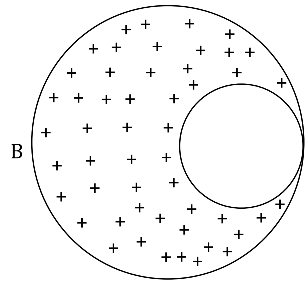
$E \cdot r^2 = \frac{r^2 \alpha}{2\varepsilon_0}$

$\boxed{E = \frac{d}{2\varepsilon_0}}$

$q_{\text{inside sphere}} = \int_0^R \frac{\alpha}{r} \cdot 4\pi r^2 dr$

$(q_{\text{inside}}) = 2\pi a R^2$

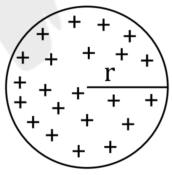
5. $\xleftarrow{E_{big}}$ $\frac{\rho r_0}{3\varepsilon_0}$ due to sphere of riadius (ro)

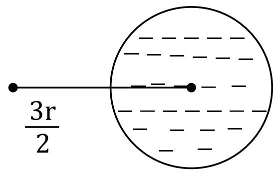


$\longrightarrow \frac{\rho r_0}{27\varepsilon_0}$

$\oint \vec{E} \cdot \vec{dA} = \frac{q_{in}}{\varepsilon_0}$

$E \times 4\pi \frac{9r_0^2}{4} = \frac{\rho \times \frac{4}{3}\pi \frac{r_0^3}{8}}{\varepsilon_0}$



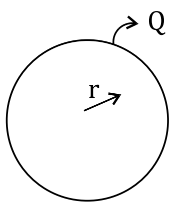


$E = \frac{\rho r_0}{54\varepsilon_0}$ $E_{net} = \frac{S r_0}{3\varepsilon_0}\left(1 - \frac{1}{18}\right)$

$\text{Enet} = \frac{179 r_0}{54\varepsilon_0}$ legt

6. (i) $r < R$

$\vec{E}_r = \frac{S\vec{r}}{3\varepsilon_0}$



$\vec{E} \propto \vec{r}$

option D

(ii) $r > R$ Sphere behave like Point charge

Link to View Video Solution: Click Here

$$E = \frac{kQ}{\pi^2}$$

$$E \propto \frac{I}{r^2}$$

7. First we find electric field due to solid cylinder has a uniform volume charge density 3 + electric field due to sphere has uniform volume charge density (-9)

due to cylinder $\lambda = 3 \cdot \pi R^2$

$$E = \frac{2K\lambda}{2R} = \frac{K\lambda}{R} = \frac{1}{4\cancel{\varepsilon}_0 \cdot R}$$

$$E = \frac{SR}{4\varepsilon_0} \longrightarrow [+\text{Y axis}]$$

4 due to sphere ⇒ charge on sphere

$$E = \frac{1}{4\pi\varepsilon_0}\frac{S\pi R^3}{6 \times 4R^2} = 3 \times \frac{4}{3}\pi\frac{R^3}{8} = \frac{3\pi R^3}{6}$$

$$E = \frac{SR}{96\varepsilon_0}(-\text{Y axis})$$

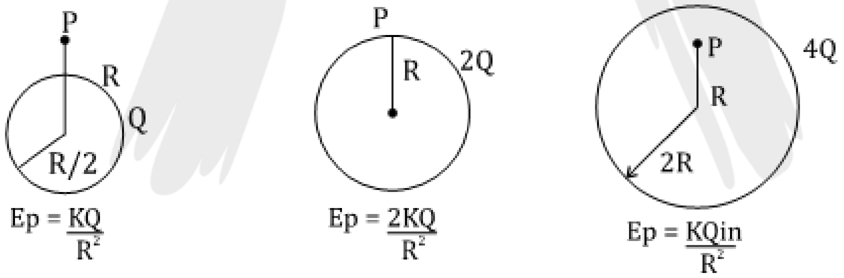
$$E_{net} = \frac{SR}{4\varepsilon_0} - \frac{3R}{96\varepsilon_0}$$

$$= \frac{3R}{4\varepsilon_0}\left(1 - \frac{1}{24}\right) = \frac{239R}{96\varepsilon_0}$$

$$\frac{239R}{96\varepsilon_0} = \frac{239R}{16K\varepsilon_0}$$

$$K = 6$$

8.



$$Sin = \frac{4Q\times}{\frac{4}{3}\pi 8R^3}\frac{4}{3}\pi R^3$$

$$Qin = \frac{9}{2}$$

$$E_p = \frac{k\varphi}{2R}$$