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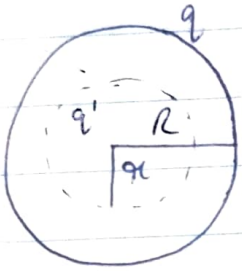
ROLL NO. :- 20221124

P) Find $\bar{E}$ inside and outside a sphere of radius R which carries uniform charge density.

Sol^n



Electric field due to q' amt. q charge enclosed by Gaussian surface, is,

$$\bar{E} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q'}{r^2} \longrightarrow (i)$$

Electric field due to q charge,

$$\bar{E} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{R^2} \longrightarrow (ii)$$

Charges are distributed uniformly inside & outside the sphere, so we can say that the charge per unit volume remains same.

$$\therefore \frac{q'}{\frac{4}{3}\pi r^3} = \frac{q}{\frac{4}{3}\pi R^3}$$

$$\Rightarrow \frac{q'}{q} = \frac{r^3}{R^3}$$

$$\Rightarrow \boxed{q' = \frac{q r^3}{R^3}}$$

Putting the value of q' in eq^n (1),

$$\bar{E} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q r^3}{R^3 \cdot r^2}$$

$$\boxed{\bar{E} = \frac{q r}{4\pi\epsilon_0 R^3}\,\hat{r}} \leftarrow \text{Electric field inside the sphere}$$

$r \leq R \rightarrow$ point lying inside the sphere.

when $r \geq R$, point outside the sphere,

$$\bar{E} = \frac{q r}{4\pi\epsilon_0 r^3}\,\hat{r}$$

$$\boxed{\bar{E} = \frac{q}{4\pi\epsilon_0 r^2}\,\hat{r}} \leftarrow \text{Electric field outside the sphere.}$$