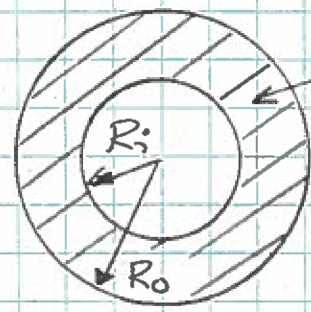
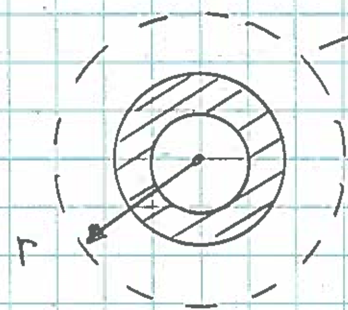


Q, $\rho = \text{const.}$

a.) for $r > R_o$:

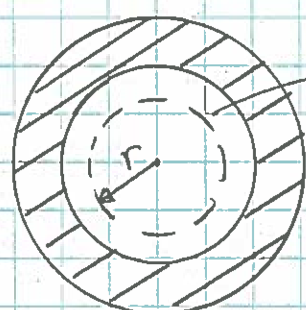


Gaussian surface

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{Q}{\varepsilon_0} \implies E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} \quad \text{for } r > R_o$$

b.) for $r < R_i$

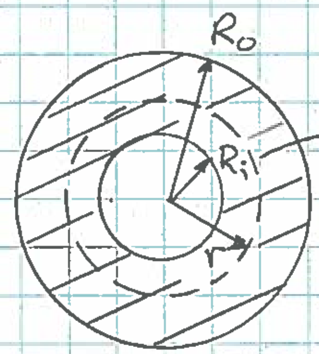


Gaussian surface

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$E\, 4\pi r^2 = 0 \implies E = 0 \quad \text{for } r < R_i$$

c.) $R_i < r < R_o$



$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{1}{\varepsilon_0}\, \rho \cdot (\text{Volume of charge inside})$$

$$= \frac{\rho}{\varepsilon_0} \left\{ \frac{4}{3}\pi r^3 - \frac{4}{3}\pi R_i^3 \right\}$$

Now:

$$\rho = \frac{Q}{\text{Vol of charge}} = \frac{Q}{\left[\frac{4}{3}\pi R_o^3 - \frac{4}{3}\pi R_i^3\right]}$$

So:

$$E\, 4\pi r^2 = \frac{Q}{\varepsilon_0} \left\{ \frac{r^3 - R_i^3}{R_o^3 - R_i^3} \right\}$$

$$\therefore \quad E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \left\{ \frac{r^3 - R_i^3}{R_o^3 - R_i^3} \right\} \quad \text{for } R_i < r < R_o$$

where for $r = R_i \Rightarrow E \to 0$

and for $r = R_o \Rightarrow E \to \frac{1}{4\pi\varepsilon_0} \frac{Q}{R_o^2}$

so, the solution match at

$r = R_o$ & $r = R_i$.