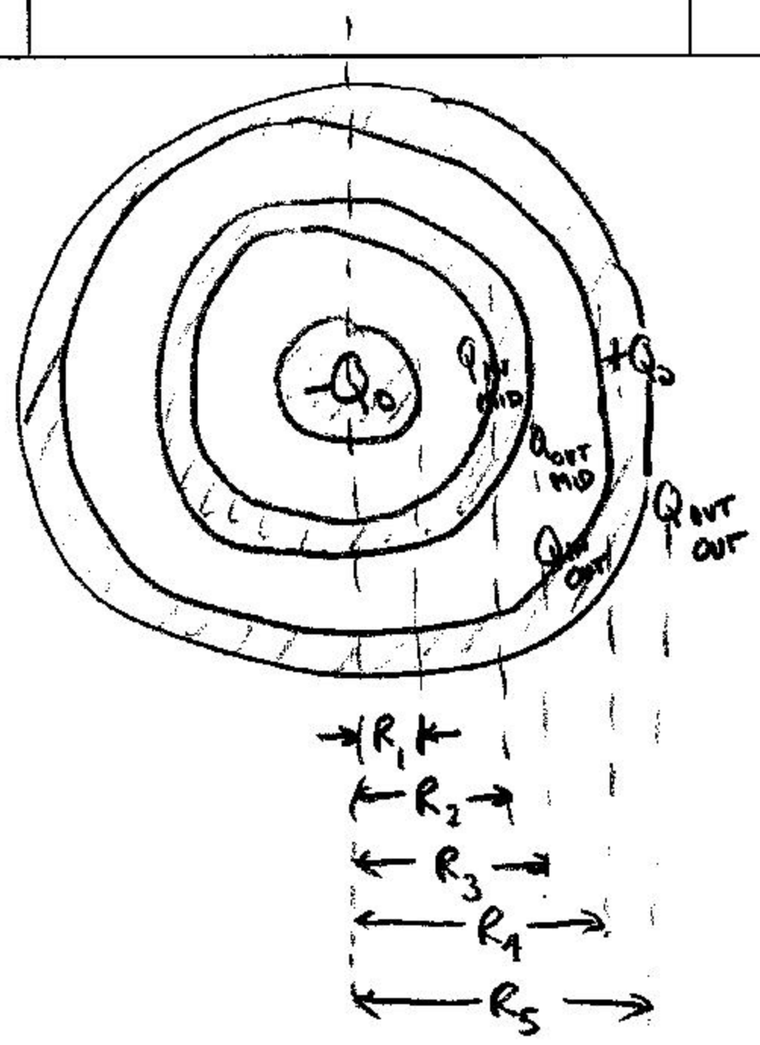
22-66 GIVEN:



FIND: E DIRECTION $(R_1 < r < R_2)$

$Q_{IN\ MID}$

$Q_{OUT\ MID}$

$Q_{IN\ OUT}$

$Q_{OUT\ OUT}$

$E(r)$

$R_2 < r < R_3 \qquad E = 0 \Rightarrow \Phi = 0 = \frac{q_{IN}}{\epsilon_0} = \frac{-Q_0 + Q_{IN\ MID}}{\epsilon_0}$

$$\boxed{Q_{IN\ MID} = Q_0}$$

SO E POINTS <u>RADIALLY IN</u>

$$Q_{IN\ MID} + Q_{OUT\ MID} = 0 \Rightarrow Q_{OUT\ MID} = -Q_{IN\ MID}$$

$$\boxed{Q_{OUT\ MID} = -Q_0}$$

$R_4 < r < R_5 \qquad E = 0 \Rightarrow \Phi = 0 = \frac{q_{IN}}{\epsilon_0} = \frac{-Q_0 + Q_{IN\ OUT}}{\epsilon_0}$

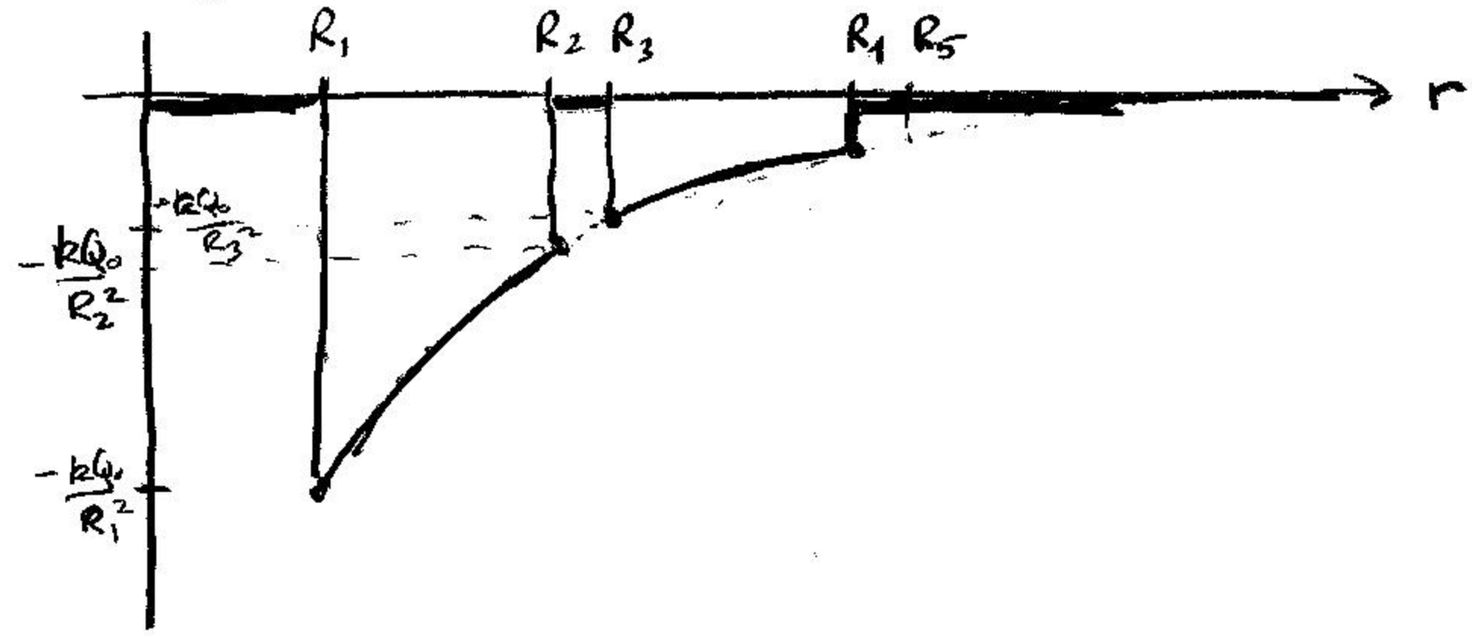
$$\boxed{Q_{IN\ OUT} = Q_0}$$

$$Q_{IN\ OUT} + Q_{OUT\ OUT} = +Q_0$$

$$\boxed{Q_{OUT\ OUT} = 0}$$

$R_1 < r < R_2 \qquad \oint \vec{E} \cdot d\vec{A} = |\vec{E}|(4\pi r^2) = \frac{q_{IN}}{\epsilon_0} = \frac{-Q_0}{\epsilon_0} \Rightarrow |\vec{E}| = \frac{-Q}{4\pi\epsilon_0 r^2}$

$R_3 < r < R_4$

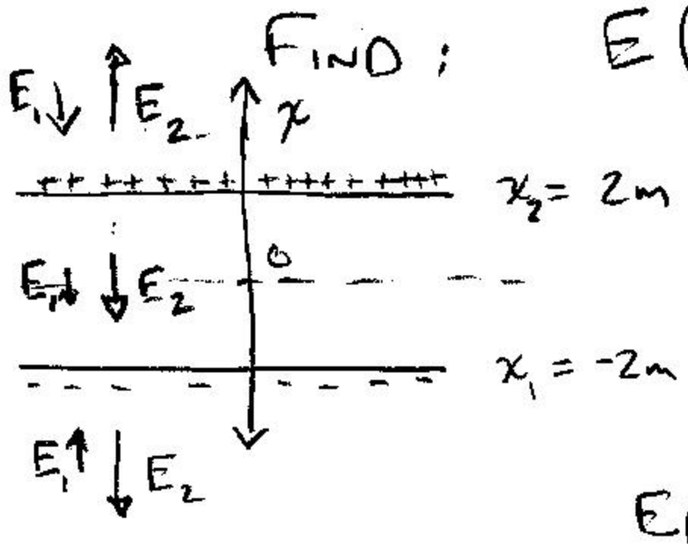


22-72 GIVEN: 2 INFINITE PLANES // yz PLANE

$x_1 = -2m \quad \sigma_1 = -3.5\ \mu C/m^2$

$x_2 = 2m \quad \sigma_2 = 6\ \mu C/m^2$

FIND: $E(x<-2m)$, $E(-2m<x<2m)$, $E(x>2m)$



$$E_1 = \frac{\sigma_1}{2\epsilon_0} = \frac{3.5\ \mu C/m^2}{2(8.85\times10^{-12}\ C^2/N\text{-}m^2)} = 1.98\times10^5\ \frac{N}{C}$$

$$E_2 = \frac{\sigma_2}{2\epsilon_0} = \frac{6\ \mu C/m^2}{2(8.85\times10^{-12}\ C^2/N\text{-}m^2)} = 3.39\times10^5\ \frac{N}{C}$$

$$E(x<-2m) = -3.39\times10^5\frac{N}{C} + 1.98\times10^5\frac{N}{C} = \boxed{-1.41\times10^5\frac{N}{C}\downarrow}$$

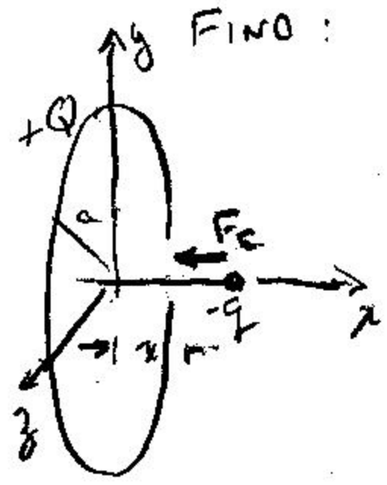
$$E(-2m<x<2m) = -3.39\times10^5\frac{N}{C} - 1.98\times10^5\frac{N}{C} = \boxed{-5.37\times10^5\frac{N}{C}\downarrow}$$

$$E(x>2m) = 3.39\times10^5\frac{N}{C} - 1.98\times10^5\frac{N}{C} = \boxed{+1.41\times10^5\frac{N}{C}\uparrow}$$

22-80 GIVEN: RING OF RADIUS = a IN y-z PLANE, CHARGE = Q
MASS = m WITH $-q$

SHOW: IF $x \ll a$ $F \propto x$, SMALL DISPLACEMENTS RESULT IN SHO

FIND: FORCE ON CHARGED MASS, W



$$E_{RING} = \frac{kQx}{(a^2+x^2)^{3/2}} \Rightarrow F_E = \frac{kQx}{(a^2+x^2)^{3/2}}q$$

$$x \ll a \qquad F_E = \frac{kQqx}{(a^2)^{3/2}} = \boxed{\left[\frac{kQq}{a^3}\right]x}$$

$$\boxed{F \propto x}$$

$$\Sigma F = -\frac{kQq}{a^3}x = m\frac{d^2x}{dt^2}$$

$$\frac{d^2x}{dt^2} + \frac{kQq}{ma^3}x = 0 \leftarrow \text{EQUATION OF MOTION FOR SHO}$$

$x = A\cos(\omega t+\delta)$

$\frac{dx}{dt} = -A\omega\sin(\omega t+\delta)$

$\frac{d^2x}{dt^2} = -A\omega^2\cos(\omega t+\delta)$

$$-\cancel{A}\omega^2\cos(\omega t+\delta) + \frac{kQq}{ma^3}\cancel{A}\cos(\omega t+\delta) = 0$$

$$\left[-\omega^2 + \frac{kQq}{ma^3}\right]\cos(\omega t+\delta) = 0$$

$$\therefore \omega^2 = \frac{kQq}{ma^3}$$

$$\boxed{\omega = \sqrt{\frac{kQq}{ma^3}}}$$