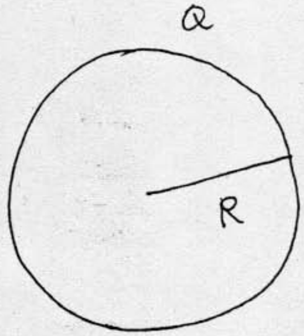
Ch. 24.

24.

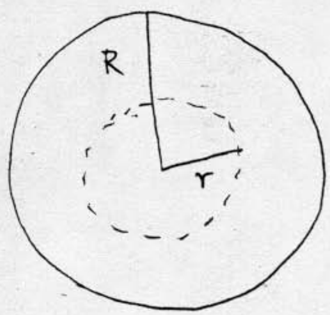


Charge is Uniformly distributed throughout its volume.

$$\rho_{\text{charge density}} = \frac{Q}{\frac{4}{3}\pi R^3}$$

Electric Field $\vec{E}(r)$

i) Inside of the sphere : $r < R$



$$\vec{E}(r) = E_r \hat{r}$$

There is no tangential component of $\vec{E}$ field.

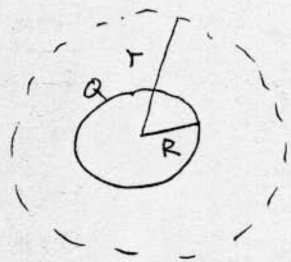
$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{inside}}{\epsilon_0}$$

$$\Rightarrow E_r 4\pi r^2 = \frac{1}{\epsilon_0}\left(\rho \frac{4}{3}\pi r^3\right)$$

$$\therefore E_r = \frac{\rho}{3\epsilon_0} r$$

$$\therefore \vec{E} = \frac{\rho}{3\epsilon_0} \vec{r}$$

ii) Outside of the sphere : $r > R$

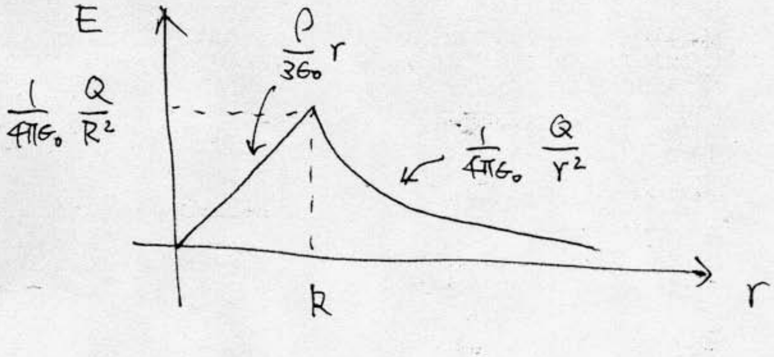


$$\vec{E}(r) = E_r \, \hat{r}$$

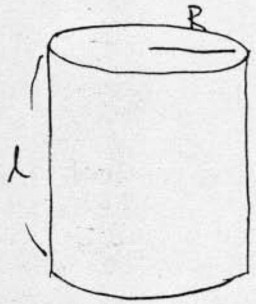
$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{inside}}{\epsilon_0}$$

$$\Rightarrow E_r \, (4\pi r^2) = \frac{Q}{\epsilon_0}$$

$$\therefore \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2} \hat{r}$$

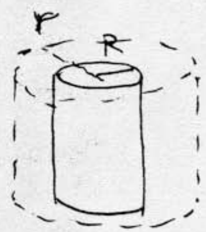


26. cylindrical shell and charge is distributed on the surface.



$\vec{E}$ outside of the shell at the midpoint of the cylinder.

:



$$\oint E(r)\, dA = 2\pi r l \, E(r)$$

$$Q_{in} = Q$$

$$\therefore \vec{E}(r) = \frac{1}{2\pi \epsilon_0 l} \frac{Q}{r}$$

(a) Total charge Q

$$= E(r)\,(2\pi \epsilon_0 r l)$$

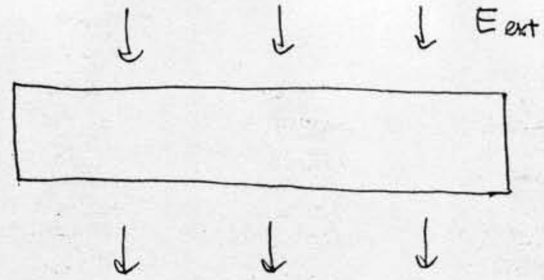
we know this given by problem.

(b)

$$E(r) = \frac{Q}{2\pi \epsilon_0 l} \frac{1}{r}$$

we got this from (a).

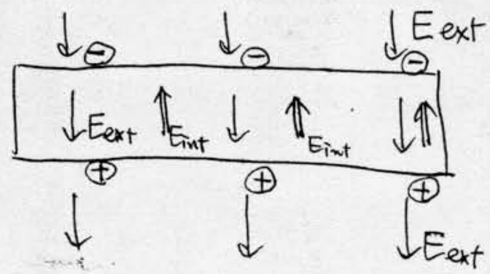
43.



Copper plate is in ~~electric~~ fied E_{ext}.

Since copper is a conductor, inside of the copper plate doesn't have electric field.

Which means copper plate will arrange charge distribution to compensate E_{ext} by its own E_{int} field.

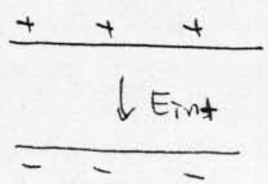


Inside of copper,

$$\vec{E} = \vec{E}_{ext} + \vec{E}_{int} = 0$$

$$\therefore \vec{E}_{int} = -\vec{E}_{ext}$$

If we consider copper plate as "two parallel plates",



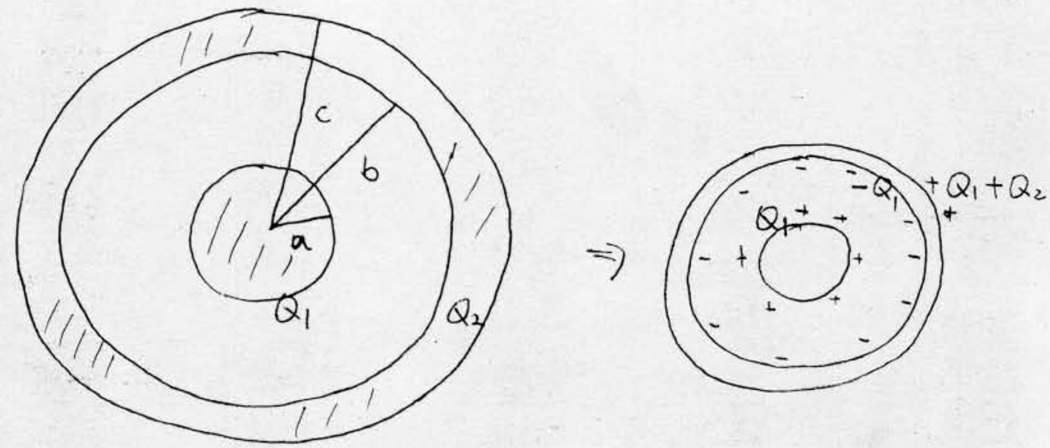
Inside of these plates

$$E_{int} = \frac{\sigma}{\epsilon_0}.$$

$$\Rightarrow \frac{\sigma}{\epsilon_0} = E_{ext}$$

$$\therefore \sigma = \epsilon_0 E_{ext} \quad , \quad Q_{tot} = \sigma \cdot \text{Area}$$

44.



i) $r < a$

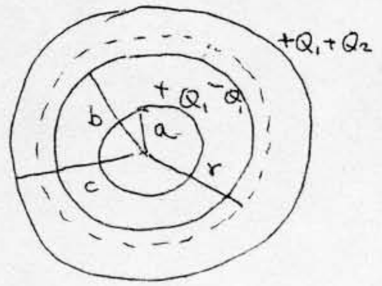
$\vec{E}(r) = 0$ ← since it is a conductor, it doesn't have charge inside.

ii) $a < r < b$

$$\vec{E}(r) = \frac{1}{4\pi\epsilon_0}\frac{Q_1}{r^2}\hat{r}$$

iii) $b < r < c$

On the inner surface of the outer shell, $-Q_1$ will be induced due to $+Q_1$ on the inside sphere.



$\boxed{E(r) = 0}$

Since $Q_{tot} = +Q_1 - Q_1 = 0$.
Also it is a conductor.

iv) $r > c$

$Q_{tot} = Q_1 + Q_2$

$$\therefore E(r) = \frac{1}{4\pi\epsilon_0}\frac{Q_1+Q_2}{r^2}\hat{r}$$

Chapter 25

1 PSE6 25.P.001

$$W = q\Delta V = -N_A e(V_f - V_i)$$

2 PSE6 25.P.003

a. Proton moves from higher potential to lower potential. So $V_f = 0$. Energy is conserved. Therefore

$$K_i + U_i = K_f + U_f$$

$$0 + q_p V_i = \frac{1}{2} m_p v^2 + 0$$

$$v = \frac{2q_p V_i}{m_p}$$

b. Electron moves from lower potential to higher potential. So $V_i = 0$. Energy is conserved. We have

$$K_i + U_i = K_f + U_f$$

$$0 + 0 = \frac{1}{2} m_e v^2 + q_e \Delta V$$

$$v = \frac{-2q_e V_f}{m_e}$$

3 PSE6 25.P.009

Label the intermediate point C with coordinates (C_x, C_y). The potential difference between point A and B is

$$V_{\mathrm{B}} - V_{\mathrm{A}} = -\int_{A_y}^{C_y} E \mathrm{d}y - \int_{C_x}^{B_x} E \mathrm{d}x = -E\cos 180^\circ (C_y - A_y) - E\cos 90^\circ (B_x - C_x) = E(C_y - A_y)$$

4 PSE6 25.P.015

a.

$$V = \frac{k_e q_p}{r}$$

b.

$$\Delta V = k_e q_p \left(\frac{1}{r_2} - \frac{1}{r_2} \right)$$

c. Same as part (a) and (b).

5 PSE6 25.P.021

$$U = k_e q^2 \left(\frac{1}{L} + \frac{1}{\sqrt{L^2 + W^2}} + \frac{1}{W} \right)$$

6 PSE6 25.P.037

a. Plug different x values into the expression for electric potential.

b. $E = -\frac{dV}{dx} = -b$.

7 PSE6 25.P.045

The distance r from the rod to point O is the same throughout the rod, $r = L/\pi$ where L is the length of the rod. So the electric potential at point O is

$$V = \int \mathrm{d}V = \frac{k_e}{r} \int \mathrm{d}q = \frac{k_e Q}{r}$$

8 PSE6 25.P.051

a.

$$E_{max} = 3.00 \times 10^6 V/m = \frac{k_e Q}{r^2} = V_{max} \frac{1}{r}$$

$$V_{max} = E_{max} r$$

b.

$$\frac{k_e Q_{max}}{r} = V_{max}$$

$$Q_{max} = \frac{V_{max} r}{k_e}$$