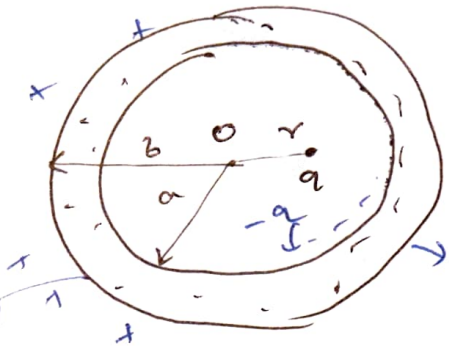
(1)



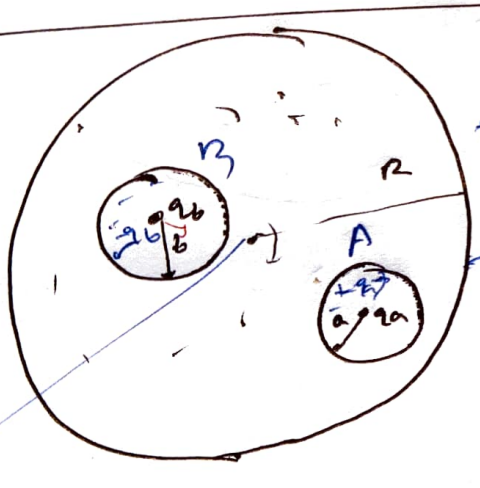
$$V_O = \frac{Kq}{r} - \frac{Kq}{a} + \frac{Kq}{b}$$ ✓

Total charge induced on inner surface $= -q$.

∵ complete sphere is neutral

∴ outer surface $= +q$.

(4)



(a)

$$\sigma_R = \frac{q_a + q_b}{4\pi R^2}$$

In cavity of radius $= b$.

$$\sigma_b = \frac{-q_b}{4\pi b^2}$$

radius $= a$

$$\sigma_a = -\frac{q_a}{4\pi a^2}$$

(b) For $r > R$

$$\vec{E} = \frac{K(q_a + q_b)}{r^2}\hat{r}$$

(c) $\vec{E}$ in cavity B

$$E_b = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_b^2}\hat{r_b}$$

$\vec{r_b}$ → vector from centre of cavity

In cavity A,

$$E_a = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_b^2}\hat{r_b}.$$

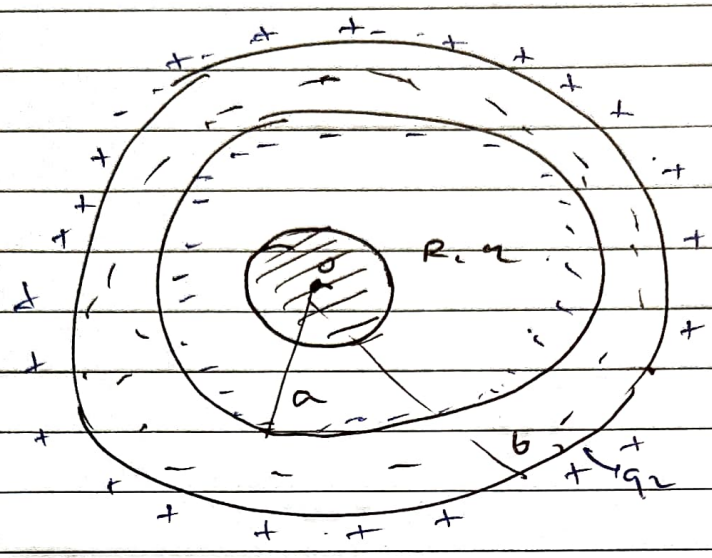
(d) Only the charge induced outside the sphere will change.

$\vec{E_a}$, $\vec{E_b}$ will not be affected.

σ_R changes.

$E_{outside}$ changes.

(3)



(a)

$$\sigma_R = \frac{q}{4\pi R^2}.$$

$$\sigma_a = \frac{-q}{4\pi a^2}.$$

$$\sigma_b = \frac{q}{4\pi b^2}.$$

$\frac{Kq_1}{R_1} - \frac{Kq_1}{R_2}$.

$R_1 \neq R_2$.

(b) $$V_0 = \frac{Kq}{R} + \frac{K(-q)}{a} + \frac{Kq}{b}.$$

$$= \frac{q}{4\pi\epsilon_0}\left(\frac{q}{R}\frac{1}{R} - \frac{1}{a} + \frac{1}{b}\right)$$

$$V(0) = -\int_{\infty}^{0} \vec{E}\cdot d\vec{l}$$

$$= -\int_{\infty}^{b} E\,dr - \int_{b}^{a} E\cdot dr.$$

(c) If outer sphere is grounded $-\int_{a}^{R} E\,dr$

It's pot = 0. $-\int_{R}^{0} E\cdot dr$

$\frac{Kq_2}{b} = 0$

$+q_2 = 0$

$\therefore \sigma_b \to 0$ charge drain off.

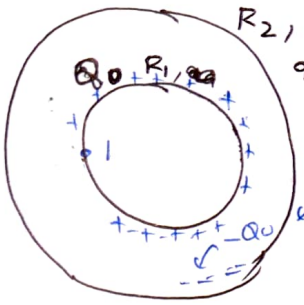
$\therefore$ Now, $V_0 = \frac{Kq}{R} + \frac{K(-q)}{a}$.

$$\Rightarrow \frac{1}{4\pi\epsilon_0}\left(\frac{q}{R} - \frac{q}{a}\right)$$

10/6/2023

Tutorial – 7

(2)



$q_2 = ?$

$Q_0 = q_1$

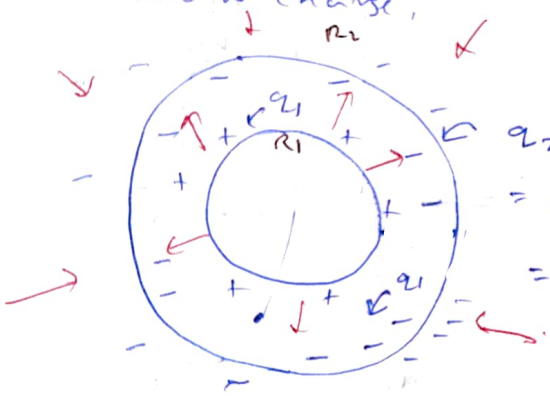
$V_1 = 0$

$$\frac{KQ_0}{R_1} + \frac{K(-Q_0 + q_2 + Q_0)}{R_2} = 0$$

$$q_2 = -Q_0 \frac{R_2}{R_1}$$

$$= -q_1 \left(\frac{R_2}{R_1}\right).$$

∴ Now change,



$q_2 + q_1$

$= q_1\left(1 - \frac{R_2}{R_1}\right)$

$= -ve$

since, $R_2 > R_1$

$E = -\frac{dV}{dr}$.

For $r < R_1$

$V = \frac{Kq_1}{R_1} = \text{const}.$

$V =$

$r \geq R_2$

$V = \frac{K(q_2 + q_1)}{r}$

At $r = R_1$

$V = 0$.

$R_1 \leq r \leq R_2$.

$V = \frac{Kq_1}{r} + \frac{Kq_2}{R_2}$.

$= \frac{Kq_1}{r} + \frac{K}{R_2} \cdot -q_1\left(\frac{R_2}{R_1}\right)$

$= \frac{Kq_1}{r} - \frac{Kq_1}{R_1}$

For $r < R_1$

$V = \frac{kq_1}{R_1} = \text{const.}$ | $E = 0$

For $R_1 \le r < R_2$

$= kq_1\left(\frac{1}{r} - \frac{1}{R_1}\right)$ | $E = +\frac{kq_1}{r^2}\hat{r}$

At $r = R_2^-$

$kq_1\left(\frac{1}{R_2} - \frac{1}{R_1}\right) \to$

$r = R_2$

$\frac{kq_1}{R_2}\left(\frac{R_1 - R_2}{R_1}\right)$

$\therefore$ continuous.

For $r \ge R_2$

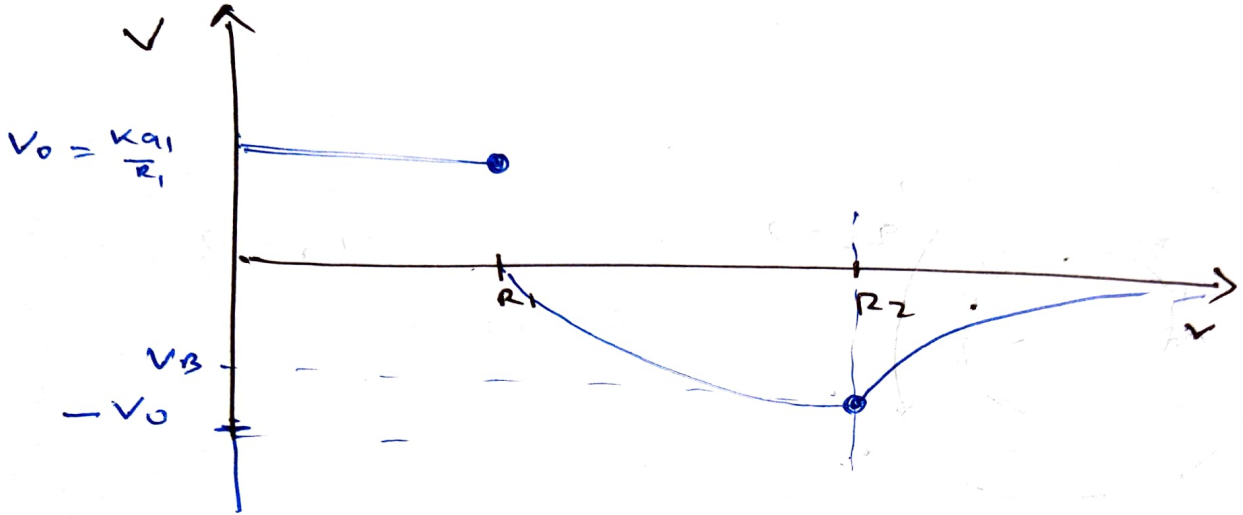
$V = \frac{kq_1}{r}\left(1 - \frac{R_2}{R_1}\right)$

$-ve$

$V \uparrow +$

$V \downarrow \ominus$

$E = \frac{kq_1}{r^2}\left(1 - \frac{R_2}{R_1}\right)\hat{r} \to (-ve)$


V
$V_0 = \frac{Kq_1}{R_1}$
R_1
R_2
r
V_B
$-V_0$