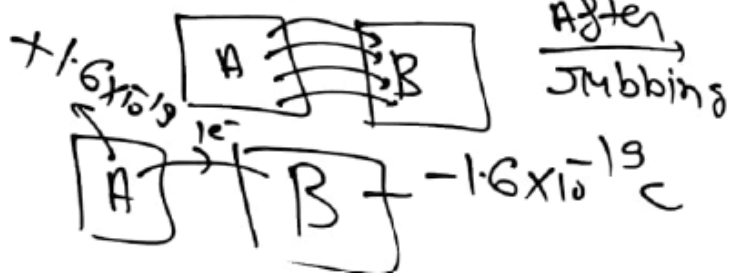
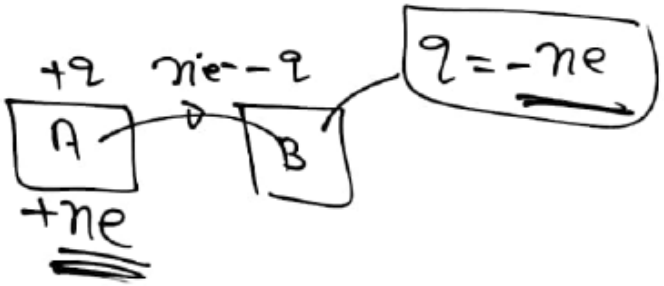
Method of charging $q = ne$

(i) Charging by friction (ii) Charging by conduction (iii) Charging by induction

Charging by friction :- When two object rub each other due to frictional work, temperature of both body increases due to increase in temperature, electron transfer from one body to other body.

↳ One body must be insulator.

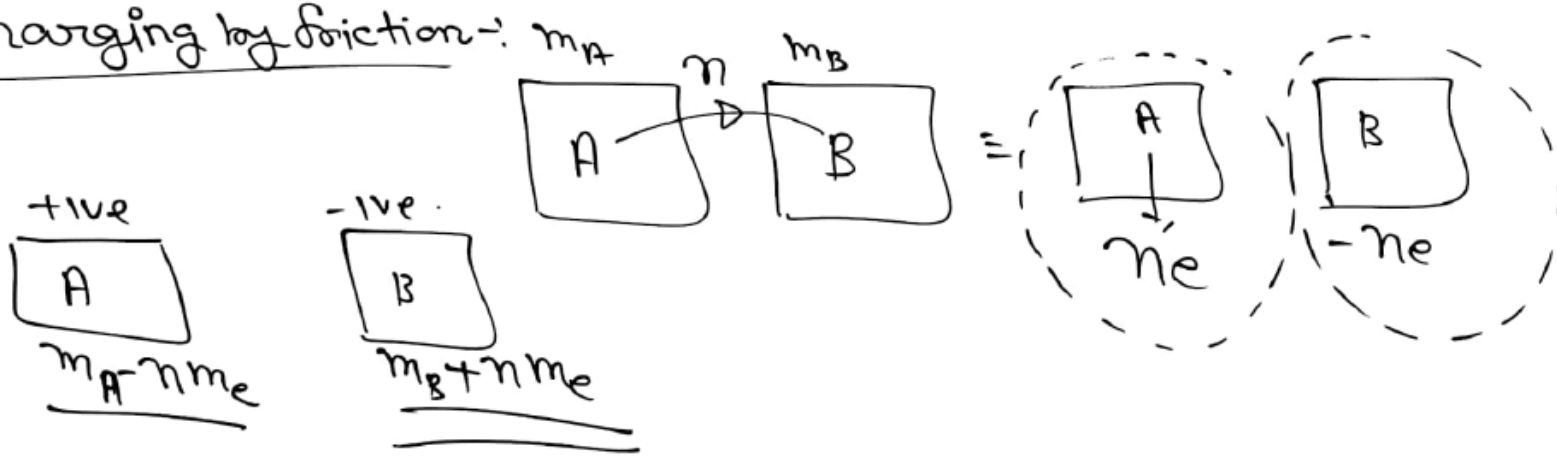




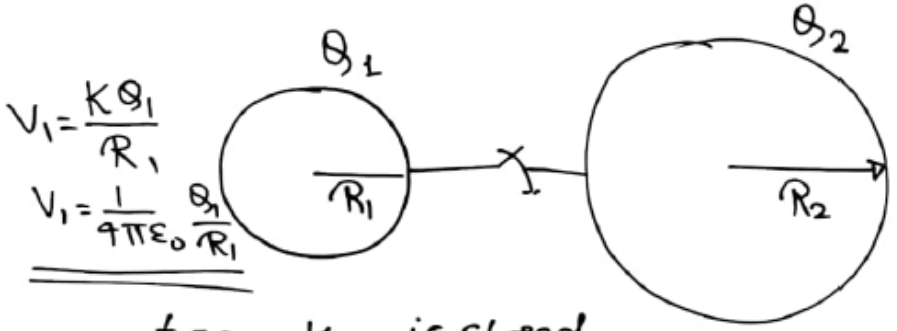
Method of charging $q = ne$

(i) Charging by friction (ii) Charging by conduction (iii) Charging by induction

Charging by friction :-



(ii) Charging by Conduction :



$V_1 = \frac{KQ_1}{R_1}$

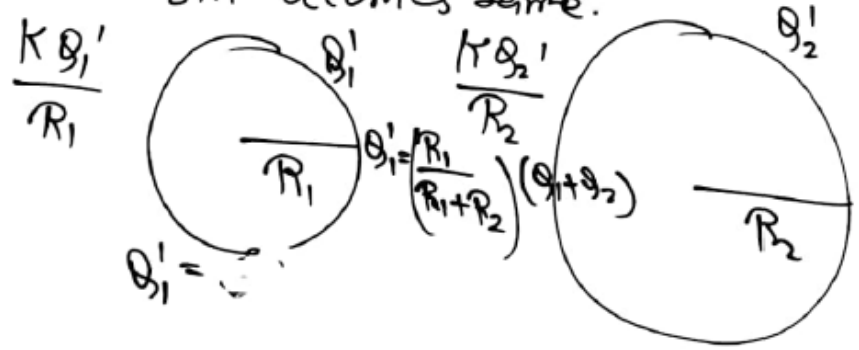
$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1}$

$\frac{KQ_2}{R_2} = V_2$

$\frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2} = V_2$

$t = 0$ Key is closed

Charge transfer from one body to other body till Potential of both both becomes same.



$Q_1 + Q_2 = Q_1' + Q_2'$ —— (i)

$\frac{KQ_1'}{R_1} = \frac{KQ_2'}{R_2}$

$Q_1' = \frac{Q_2'(R_1)}{R_2}$

$Q_1' = \left(\frac{R_1}{R_2}\right)Q_2'$

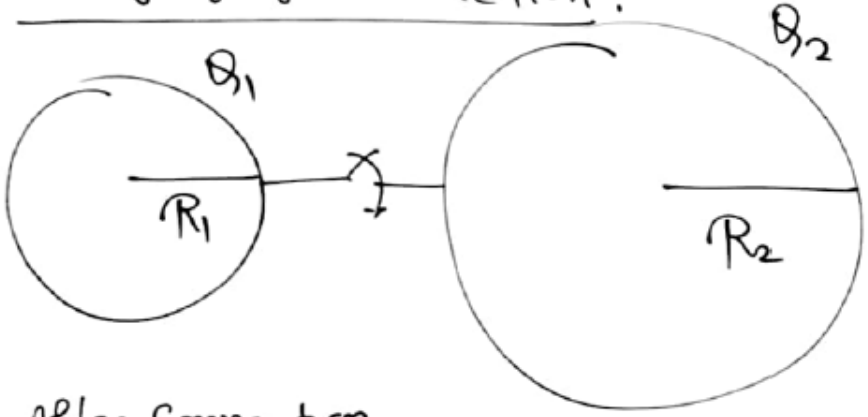
$Q_1 + Q_2 = \frac{Q_2' R_1}{R_2} + Q_2'$

$Q_1 + Q_2 = Q_2'\left(\frac{R_1}{R_2} + 1\right)$

$Q_1 + Q_2 = Q_2'\left(\frac{R_1+R_2}{R_2}\right)$

$Q_2' = \left(\frac{R_2}{R_1+R_2}\right)(Q_1+Q_2)$

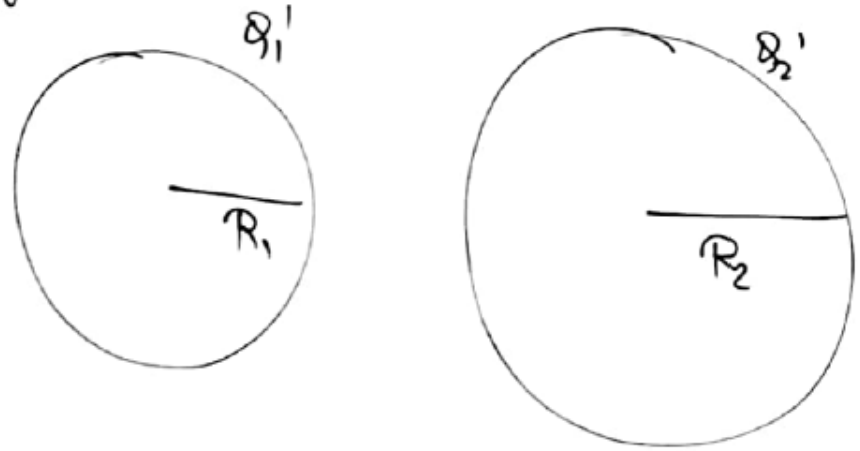
(ii) Charging by Conduction :



$$Q_1' = \left(\frac{R_1}{R_1+R_2}\right)(Q_1+Q_2)$$

$$Q_2' = \left(\frac{R_2}{R_1+R_2}\right)(Q_1+Q_2)$$

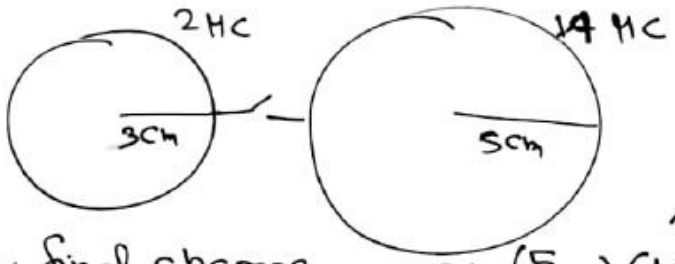
(i) After Connection



(i) $Q_1 + Q_2 = Q_1' + Q_2'$

$$V_{1f} = V_{2f}$$

Q1)



Find, final charge after connection

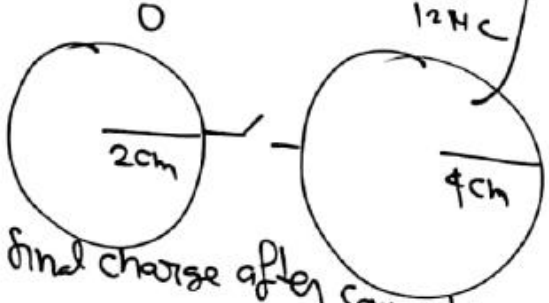
Sol) $Q_1' = \left(\frac{3}{3+5}\right)(16\,HC)$

$= \frac{3}{8} \times 16\,HC = 6HC$

$Q_2' = \left(\frac{5}{3+5}\right)^2 (16HC)$

$Q_2' = 10HC$

Q2)



find final charge after connection.

$Q_2' = \frac{4}{8} \times 12 \times 2$

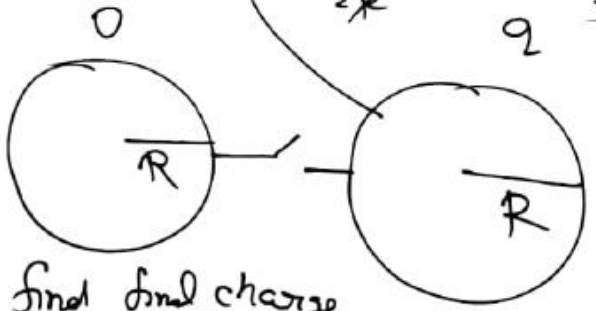
$Q_2' = 8HC$

$Q_1' = \frac{2}{(2+4)}(0+12)$

$Q_1' = \frac{2}{6} \times 12\,HC$

$Q_1' = 4HC$

Q3)



find final charge after connection.

Sol) $Q_1' = \left(\frac{R}{R+R}\right)(0+q) = \frac{R}{2R} \times q$

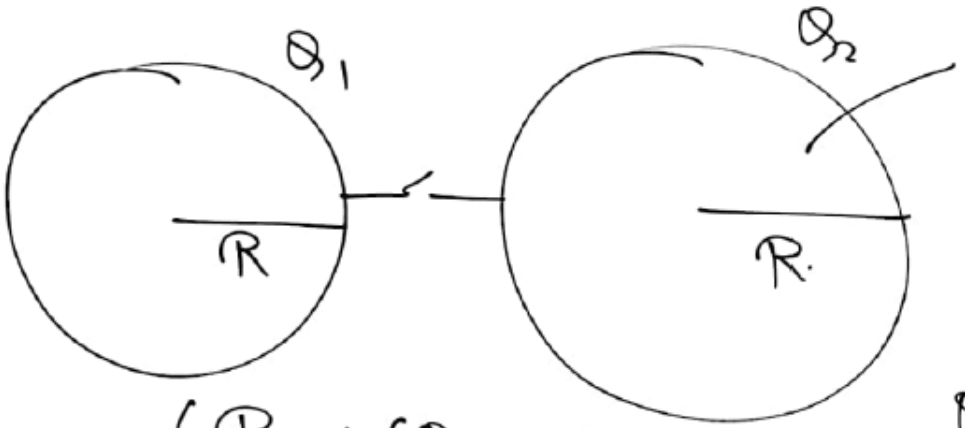
$Q_1' = \frac{q}{2}$

$Q_2' = \frac{R}{(R+R)}(0+q)$

$= \frac{R}{2R} \times q = \frac{q}{2}$

q

Identical sphere (Q_1+Q_2)



$$Q_1' = \left(\frac{R}{R+R}\right)(Q_1+Q_2)$$

$$Q_1' = \left(\frac{R}{2R}\right)(Q_1+Q_2) = \left(\frac{Q_1+Q_2}{2}\right)$$

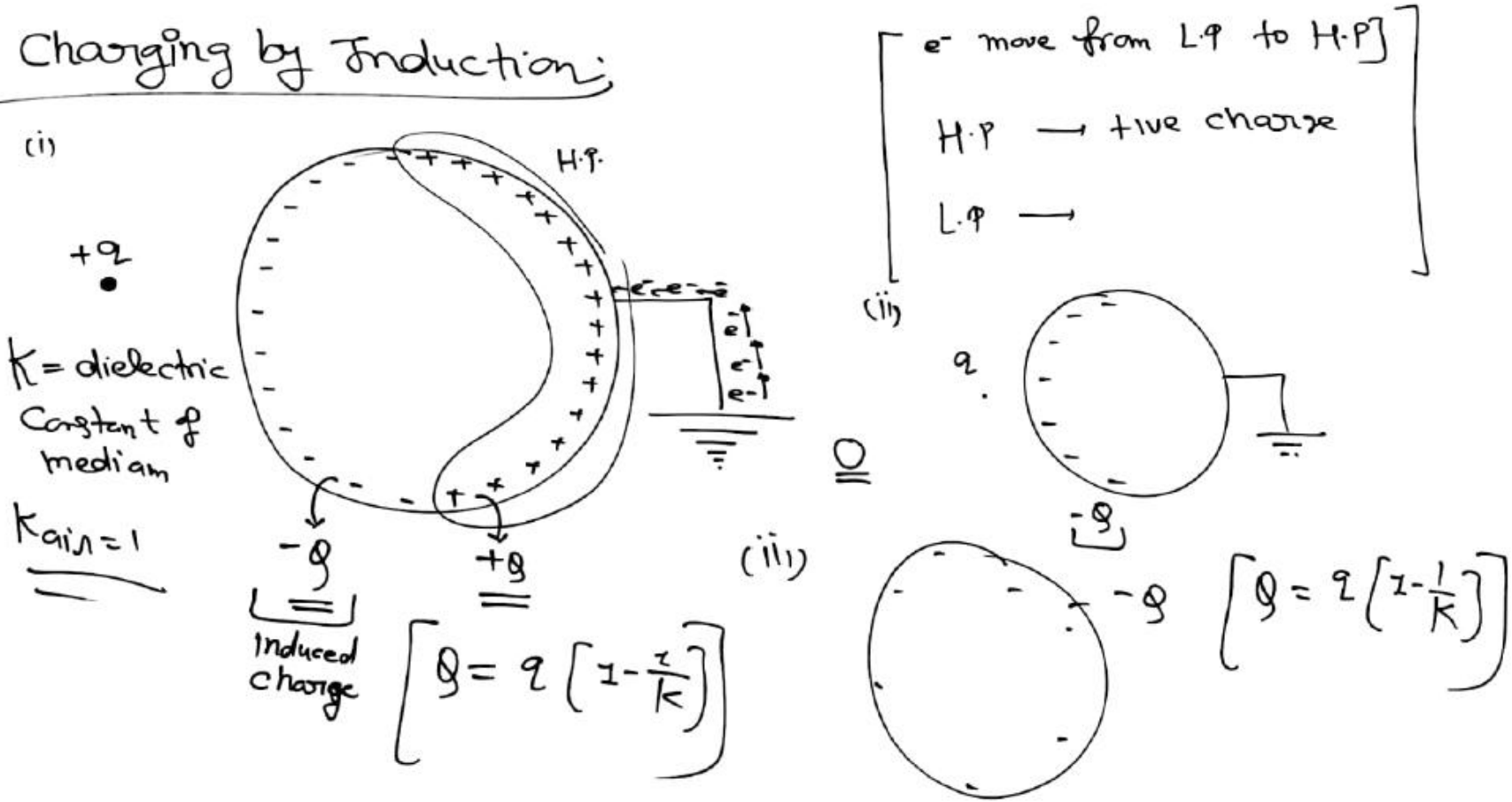
$$Q_2' = \left(\frac{R}{R+R}\right)(Q_1+Q_2)$$

$$Q_2' = \left(\frac{R}{2R}\right)(Q_1+Q_2)$$

$$= \frac{1}{2}(Q_1+Q_2)$$

$$Q_2' = \left(\frac{Q_1+Q_2}{2}\right)$$

Charging by Induction:

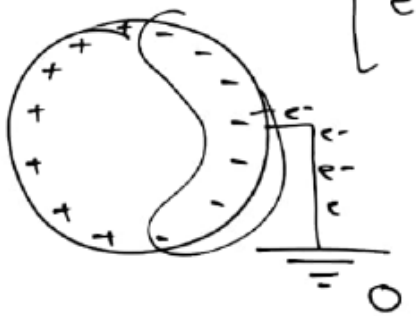


Charging by Induction:

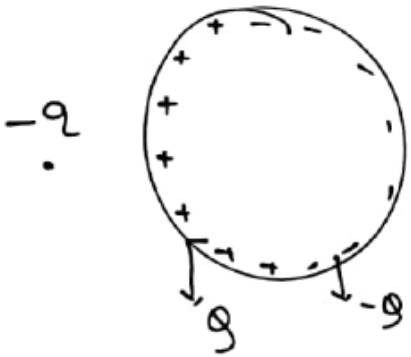
[e^- move from L.P to H.P]

(1)

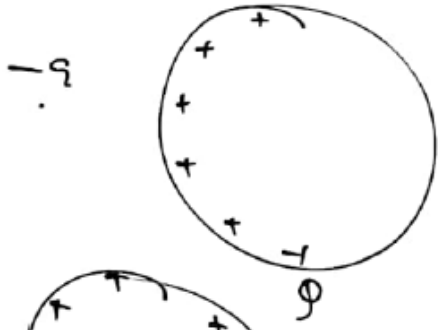
Step II)



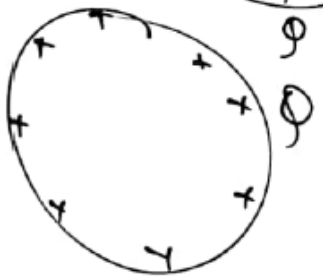
Step I)



Step III)



Step IV)



$$Q = q\left[1 - \frac{1}{K}\right]$$

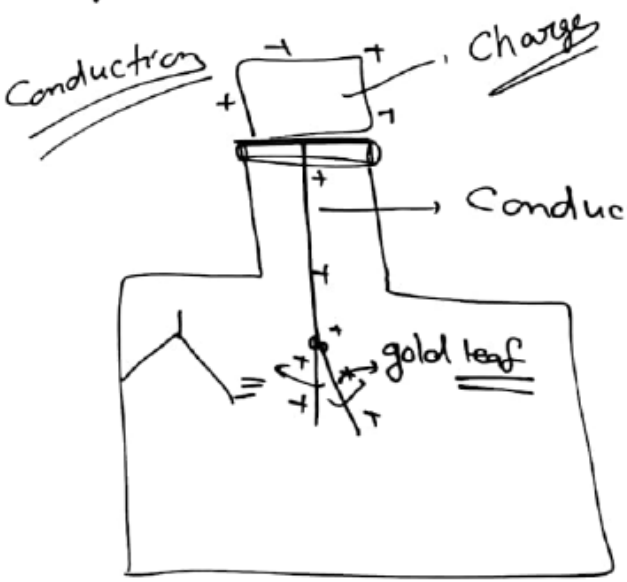
$K_{air} = 1$

$K_{water} = 81$

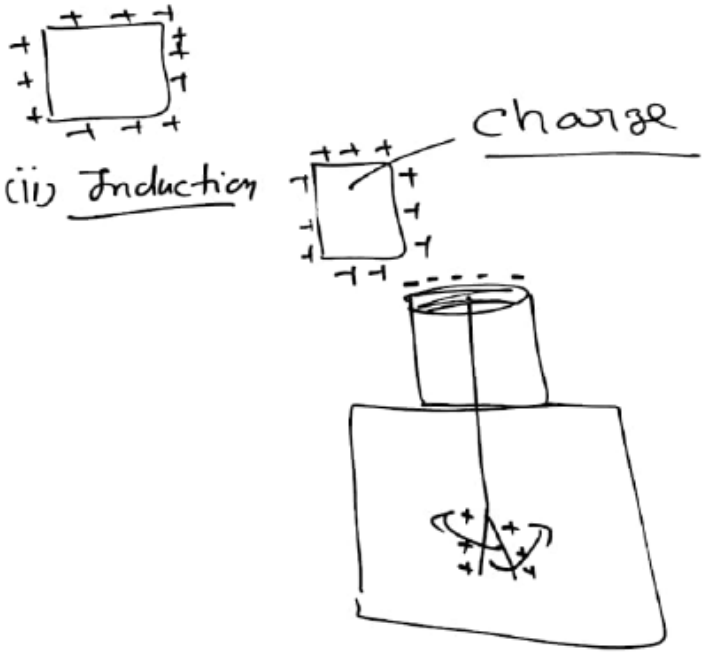
$K_{metal} = \infty$

Electroscope:- It is a simple device which detect charge on a body.

* Not find Magnitude & Nature of charge

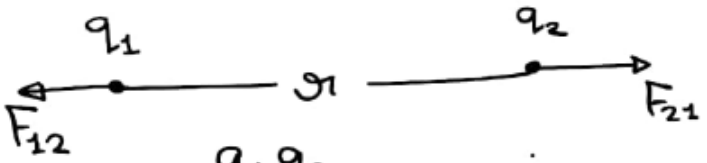


(ii) Induction



Coulomb's Law :- Force b/w "two point charges".

$q = it$ $\quad [q] = [A][T] = [AT]$



$$|\bar{F}_{12}| = |\bar{F}_{21}|$$

$$\bar{F}_{12} = -\bar{F}_{21}$$

$$\varepsilon_0 = \frac{1}{4\pi F}\frac{q_1 q_2}{r^2}$$

$$[\varepsilon_0] = \frac{[AT][AT]}{[MLT^{-2}][L]^2}$$

$$= \frac{[A^2T^2]}{[M L^3 T^{-2}]}$$

$$\boxed{\varepsilon_0 = [M^{-1}L^{-3}T^4A^2]}$$

$F \propto q_1 q_2$ ——— (i)

$F \propto \frac{1}{r^2}$ ——— (ii)

$F \propto \frac{q_1 q_2}{r^2}$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \ \frac{N\text{-}m^2}{C^2}$$

(#) $\varepsilon_0 \rightarrow$ Permitivity of free space.

$$\varepsilon_0 = 8.85\times10^{-12}\ \frac{C^2}{N\text{-}m^2}$$

JEE Mains 2013 find dimensional formula of $[\varepsilon_0]$