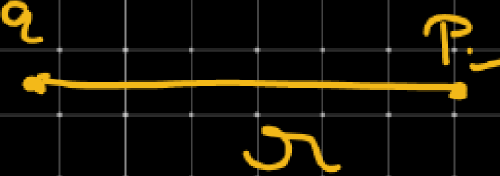
Chapter-2 → Electric Potential & Capacitor

Electric potential) It is work done to bring a charge(q_0) from infinite to distance r divided by charge q_0 is Electric potential at that point.



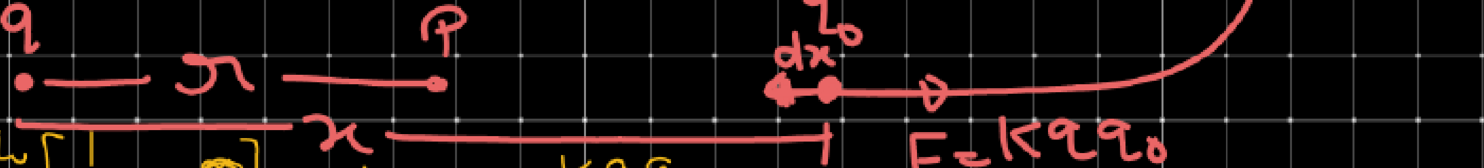
q_0 ∞

$$\boxed{\frac{W_{\infty-r}}{q_0} = V_r}$$

$$V_r - \underset{}{\overset{0}{V_\infty}} = \frac{W_{\infty-r}}{q_0}$$

$$V_r = \frac{kq}{r}$$

#. $W_{ext} = kqq_0\left[\frac{1}{r} - \frac{1}{\infty}\right]$ $\qquad \int x^n \, dx = \frac{x^{n+1}}{n+1}$



$W_{ext} = kqq_0\left[\frac{1}{r} - 0\right]$ $\qquad W_{ext} = \frac{kqq_0}{r}$

$F = \frac{kqq_0}{x^2}$

$dW_{ext} = F \, dx$

$dW_{ext} = -\frac{kqq_0}{x^2} \, dx$

$\int \frac{1}{x^2} dx = \int x^{-2} dx$

$= \frac{x^{-2+1}}{-2+1} = \frac{x^{-1}}{-1} = -x^{-1} = \boxed{-\frac{1}{x}}$

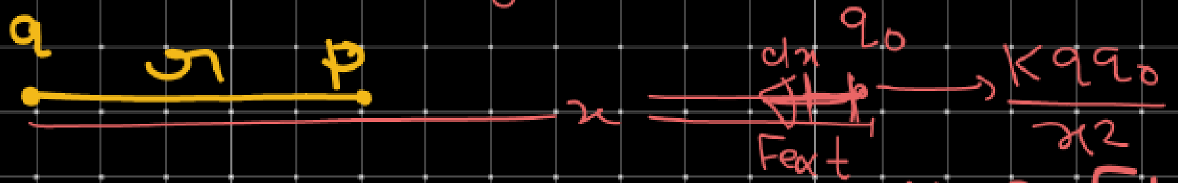
$W_{ext} = -kqq_0 \int_{\infty}^{r} \frac{dx}{x^2}$

$W_{ext} = -kqq_0\left[-\frac{1}{x}\right]_{\infty}^{r}$

$W_{ext} = kqq_0\left[\frac{1}{x}\right]_{\infty}^{r}$

Work done to bring a charge (q_0) from infinite to distance r from charge q.

W



$$dW_{ext} = F_{ext}\,dx$$

$$dW_{ext} = -\frac{kqq_0}{x^2}\,dx$$

$$W_{ext} = \int -\frac{kqq_0}{x^2}\,dx$$

$$W_{ext} = -kqq_0\int_{\infty}^{r}\frac{dx}{x^2}$$

$$W_{ext} = -kqq_0\left[-\frac{1}{x}\right]_{\infty}^{r}$$

$$W_{ext} = kqq_0\left[\frac{1}{x}\right]_{\infty}^{r}$$

$$W_{ext} = kqq_0\left[\frac{1}{r} - \frac{1}{\infty}\right] \quad 0$$

$$\boxed{W_{ext} = \frac{kqq_0}{r}}$$

$W_{ext} = \frac{kqq_0}{r}$ [Work done to bring a charge q_0 from infinite to r.

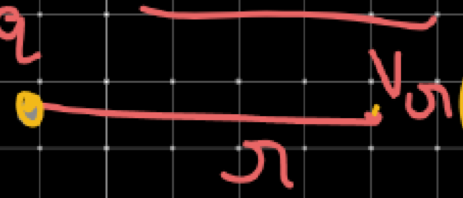
$$V_r - V_\infty = \frac{W_{\infty - r}}{q_0}$$

$$\boxed{V_r = \frac{kq}{r}}$$

$$\underline{V_\infty = 0}$$

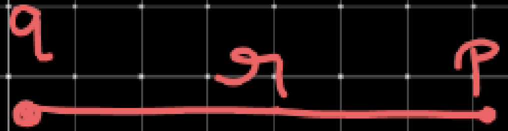
$$V_r = \frac{kq\cancel{q_0}}{r \times \cancel{q_0}}$$

$V_\infty = 0$ q_0



$$V_r - V_\infty = \frac{W_{\infty - r}}{q_0}$$

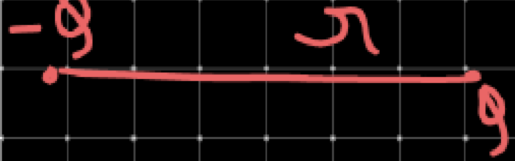
Potential due to point charge-



$$V_P = \frac{Kq}{r}$$

"In Formula of Electric potential, Charges put with sign"

\#



$$V_Q = \frac{-KQ}{r}$$

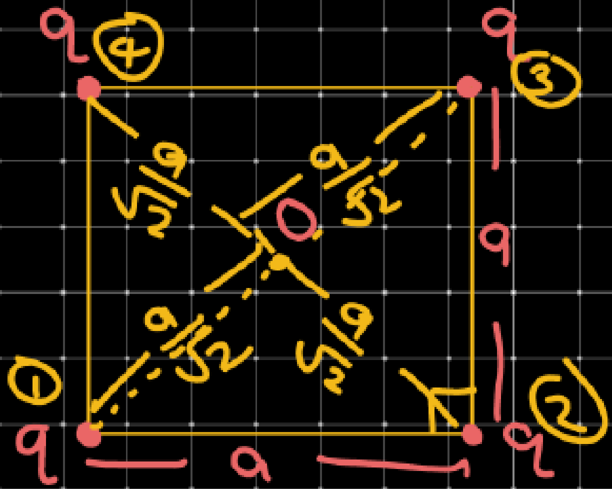
$$\int x^4\,dx = \frac{x^{4+1}}{4+1} = \frac{x^5}{5}$$

$$\int x^n\,dx = \frac{x^{n+1}}{n+1}$$

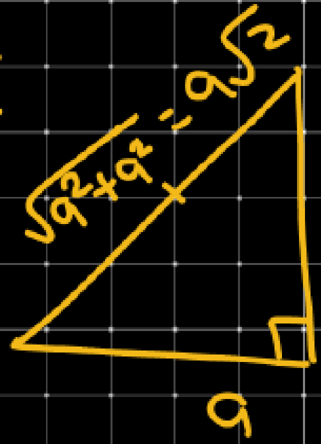
$$\int \frac{1}{x^2}\,dx = \int x^{-2}\,dx = \frac{x^{-2+1}}{-2+1}$$

$$= \frac{x^{-1}}{-1} = -x^{-1} = -\frac{1}{x}$$

Q1:- find Potential at Centre of Square.



$a\sqrt{2}$



$$\frac{a\sqrt{2}}{2} = \frac{a\sqrt{2}}{\sqrt{2}\times\sqrt{2}} = \boxed{\frac{a}{\sqrt{2}}}$$

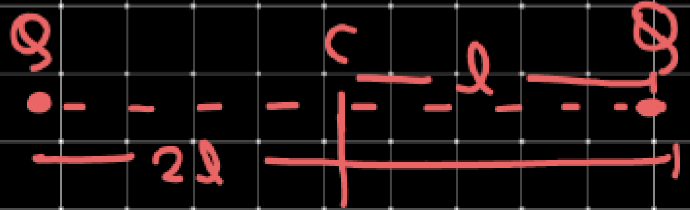
$$V_0 = V_1 + V_2 + V_3 + V_4$$

$$V_0 = \frac{kq}{\frac{a}{\sqrt{2}}} + \frac{kq}{\frac{a}{\sqrt{2}}} + \frac{kq}{\frac{a}{\sqrt{2}}} + \frac{kq}{a\sqrt{2}}$$

$$V_0 = \frac{\sqrt{2}kq}{a} + \frac{\sqrt{2}kq}{a} + \frac{\sqrt{2}kq}{a} + \frac{\sqrt{2}kq}{a}$$

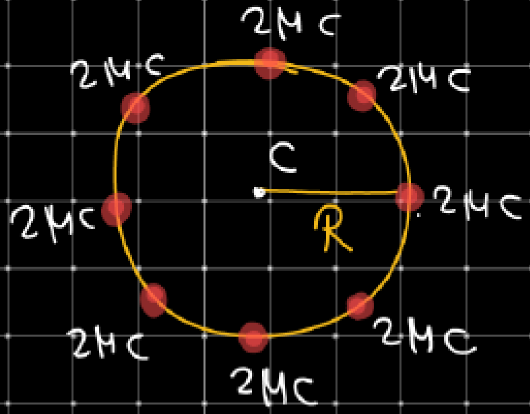
$$\boxed{V_0 = \frac{4\sqrt{2}kq}{a}}$$

Q2)



$V_c = ?$ $\quad \dfrac{kQ}{l} + \dfrac{kQ}{l} = \dfrac{2kQ}{l}.$

Q3)



SI Unit of Potential $\frac{W}{q_0} = J/C$

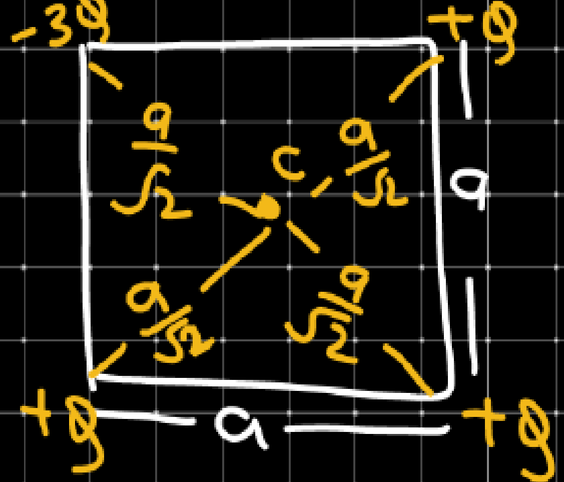
$= \text{Volt}$

$$\frac{K\,2\times10^{-6}}{R} + \frac{K\times2\times10^{-6}}{R} + \frac{K\times2\times10^{-6}}{R} + \text{---} \text{———}$$

$$= \frac{8\times K\times2\times10^{-6}}{R} = \frac{8\times9\times10^{9}\times2\times10^{-6}}{R}$$

$$= \frac{16\times9\times10^{3}}{R}\ \text{Volt}$$

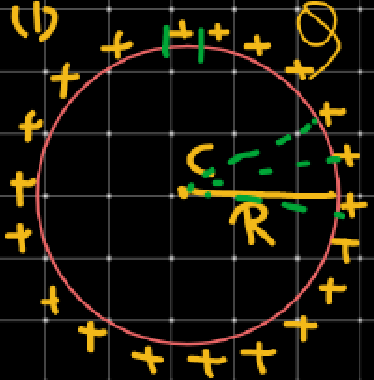
Q4) find Electric Potential at Centre



$$3 \times \frac{kq}{\frac{a}{\sqrt{2}}} + \frac{(-3q)k}{\frac{a}{\sqrt{2}}} = 0$$

Electric potential due to charge ring at centre.

(i)



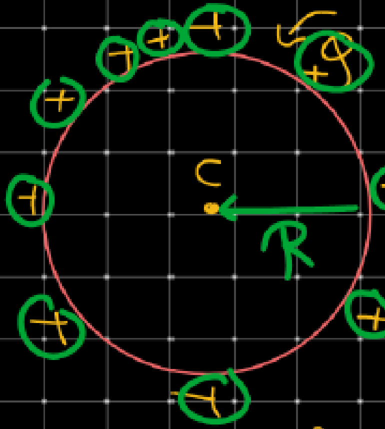
$\frac{KQ}{R}$

Uniform charge distribution

$dV + dV + dV + \text{-- ---}$

$\frac{kdQ}{R} + \frac{kdQ}{R} + \frac{kdQ}{R} \text{-- ---}$

(ii)



$\frac{KQ}{R}$

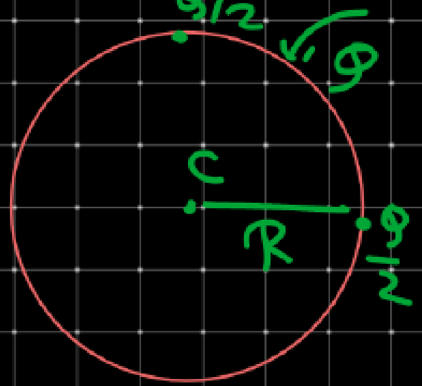
non-Uniform charge distribution

$\frac{kdQ}{R} + \frac{kdQ}{R} \text{-- ---}$

$\frac{K}{R}(dQ + dQ + dQ - -)$

$\frac{KQ}{R}$

(iii)

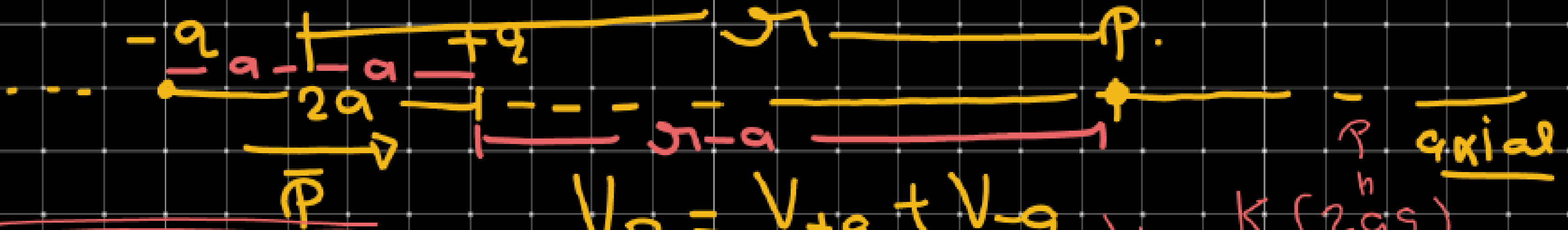


$\frac{KQ/2}{R} + \frac{KQ/2}{R}$

$= \frac{KQ}{2R} + \frac{KQ}{2R}$

$= \frac{KQ}{R}$

Electric potential due to dipole at axial point-



$$\boxed{\vec{P} = (q \times 2a)}$$

dir^n (-q to +q)

$$V_P = V_{+q} + V_{-q}$$

$$V_P = \frac{kq}{r-a} + \frac{k(-q)}{r+a}$$

$$V_P = kq\left[\frac{1}{r-a} - \frac{1}{r+a}\right]$$

$$V_P = kq\left[\frac{\cancel{r}+a-\cancel{r}+a}{r^2-a^2}\right]$$

$$V_P = \frac{k(2aq)}{r^2-a^2}$$

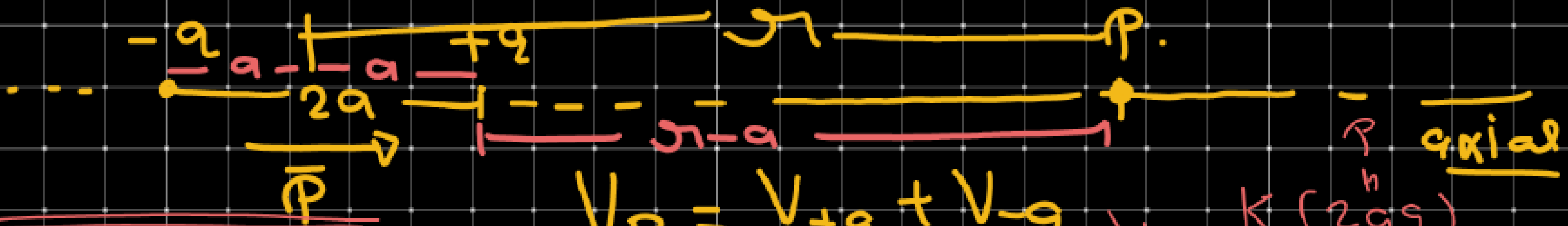
$$V_P = \frac{kP}{r^2-a^2}$$

For short dipole

$r >> a$

$$V_P = \frac{kP}{r^2}$$

Electric potential due to dipole at axial point -



$$\boxed{\bar{P} = (q \times 2a)}$$

dirn (-q to +q)

$$V_p = V_{+q} + V_{-q}$$

$$V_p = \frac{kq}{r-a} + \frac{k(-q)}{r+a}$$

$$V_p = kq\left[\frac{1}{r-a} - \frac{1}{r+a}\right]$$

$$V_p = kq\left[\frac{\cancel{r}+a-\cancel{r}+a}{r^2-a^2}\right]$$

$$V_p = \frac{k(2aq)}{r^2-a^2}$$

$$V_p = \frac{kP}{r^2-a^2}$$

For short dipole

$r >> a$

$$V_p = \frac{kP}{r^2}$$