LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI

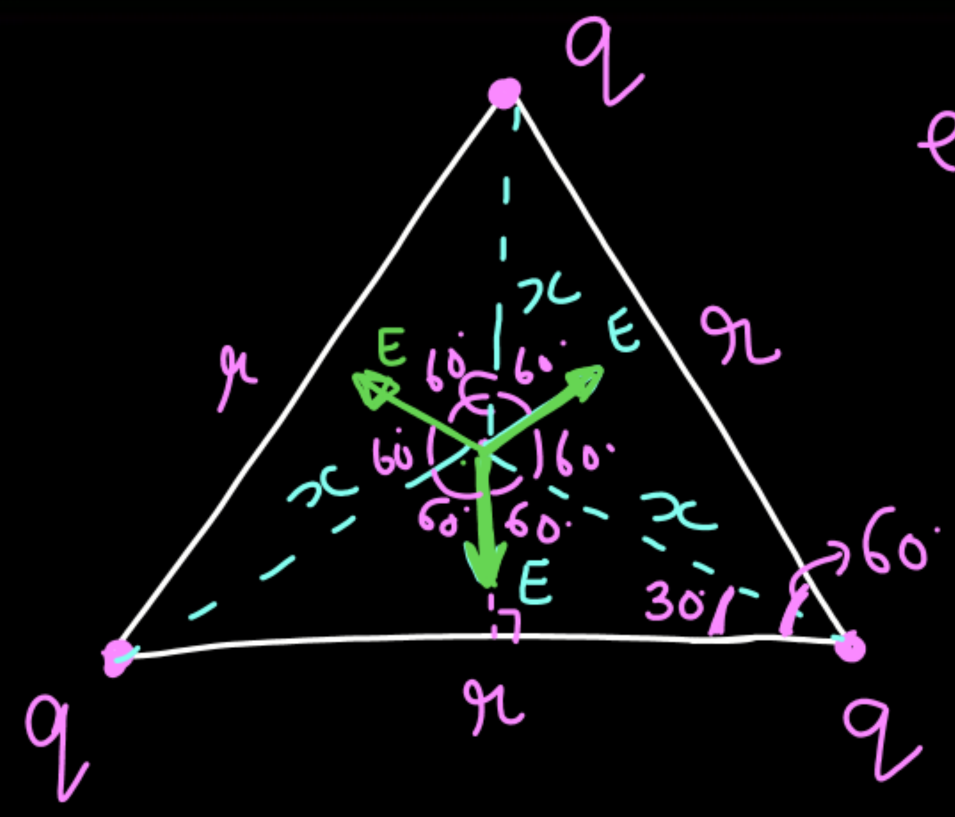
Electric Charges and Field

-Er. Rohit Gupta

Today's GOALS!

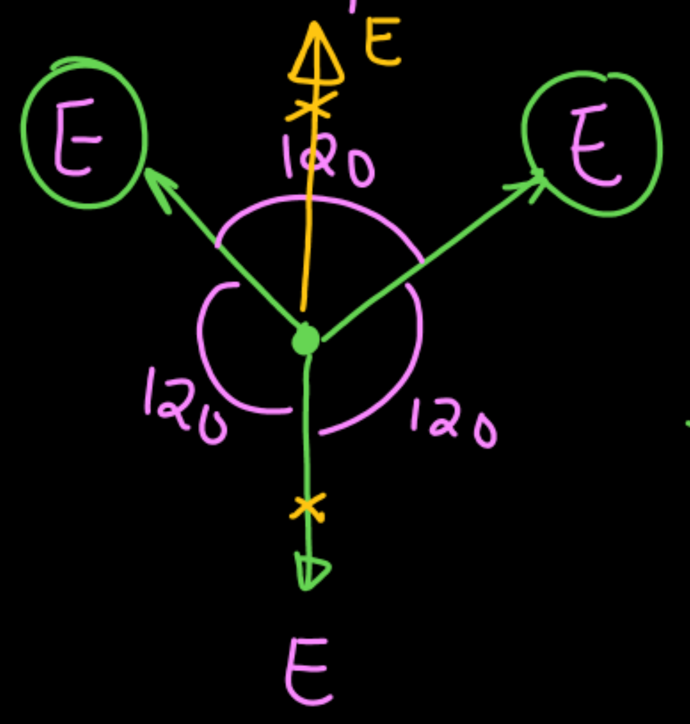
- Electric field due to a group of charges
- Electric field due to continuous charge distribution (Ring)
- Electric field due to straight wire
- Electric field dues to arc

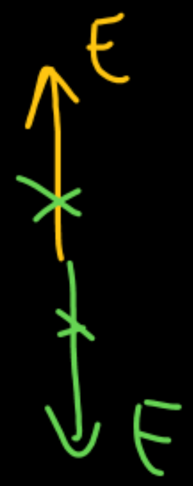
Electric field due to group of charges



equilateral Δ.

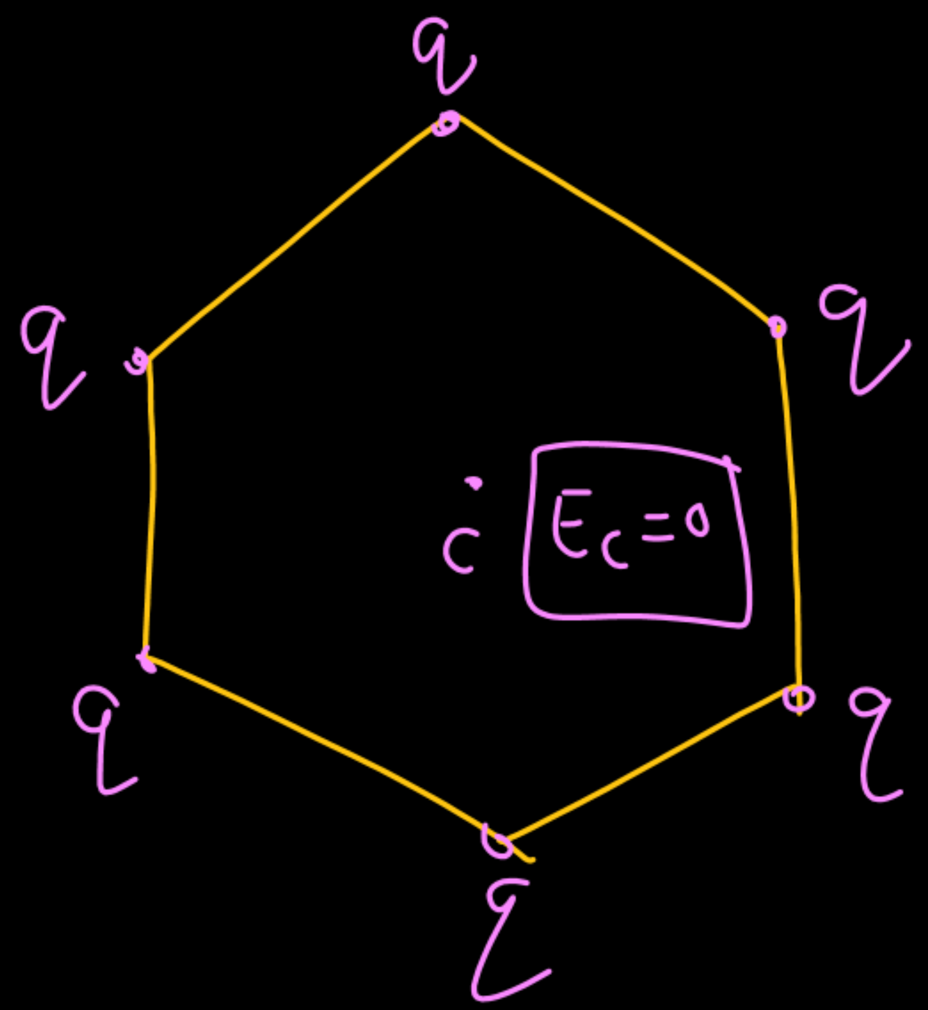
Find the net field at center 'C'



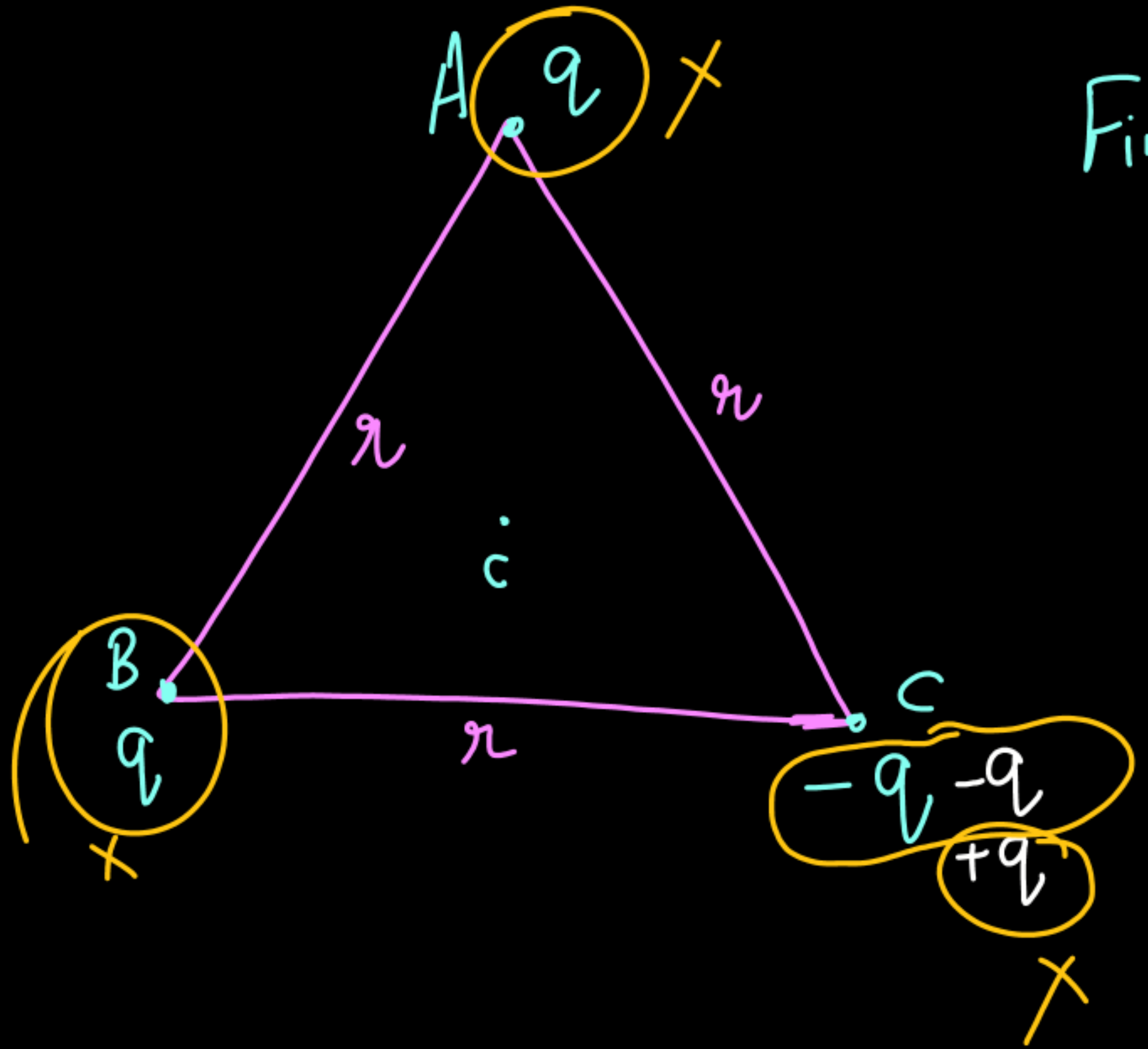


$\boxed{E_{net} = E}$

NOTE:- If equal charges (with same sign) are put on all the corners of a regular polygon, then the net field at the center of the polygon is zero.

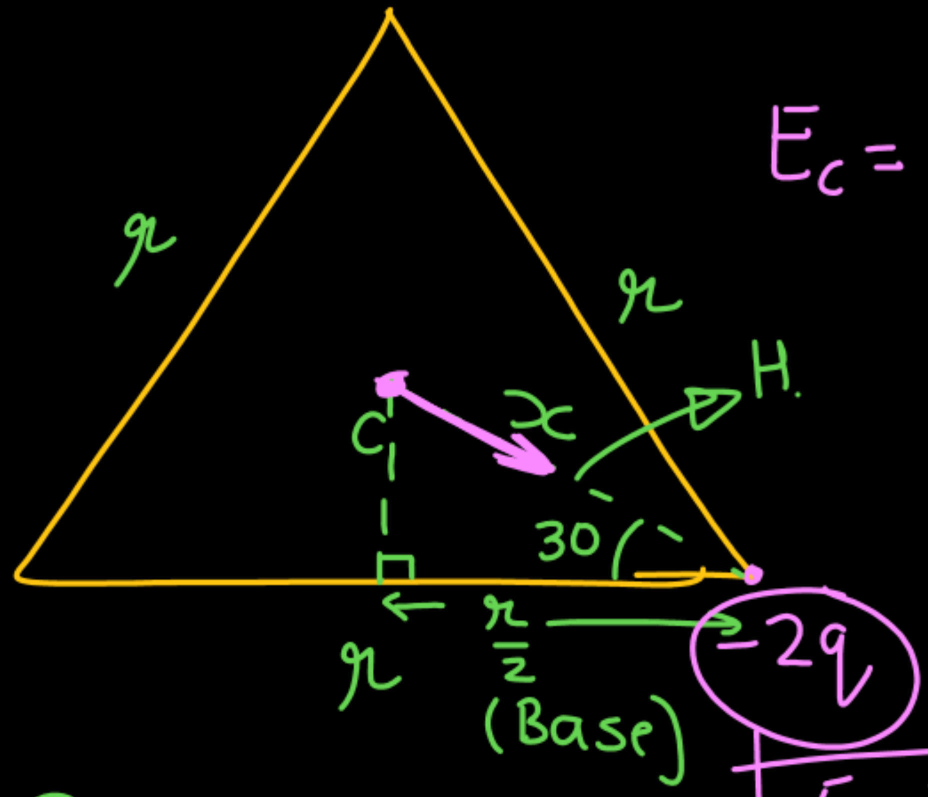


hexagon



Find E_c.

$\equiv$



$$\cos 30 = \frac{r}{2x}$$

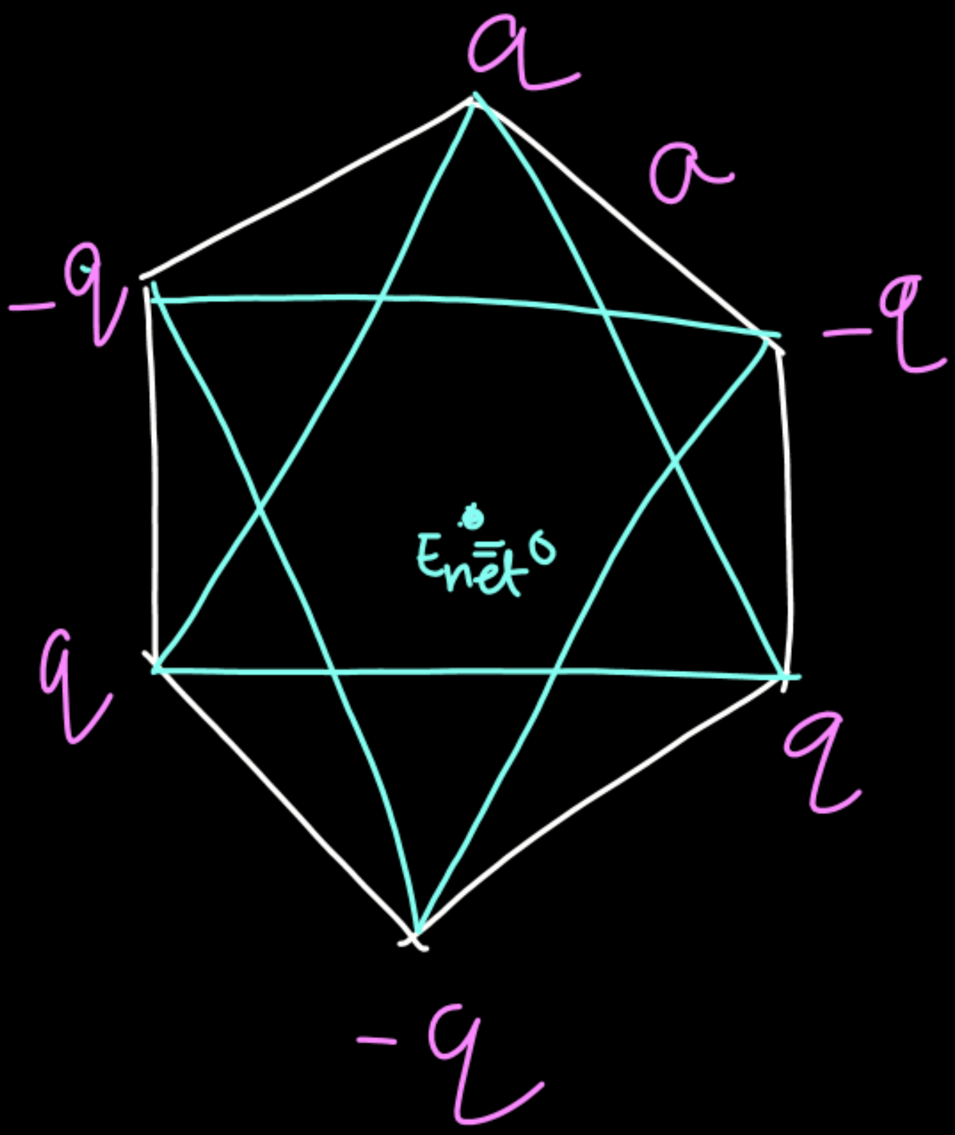
$$\frac{\sqrt{3}}{\cancel{2}} = \frac{r}{\cancel{2}x}$$

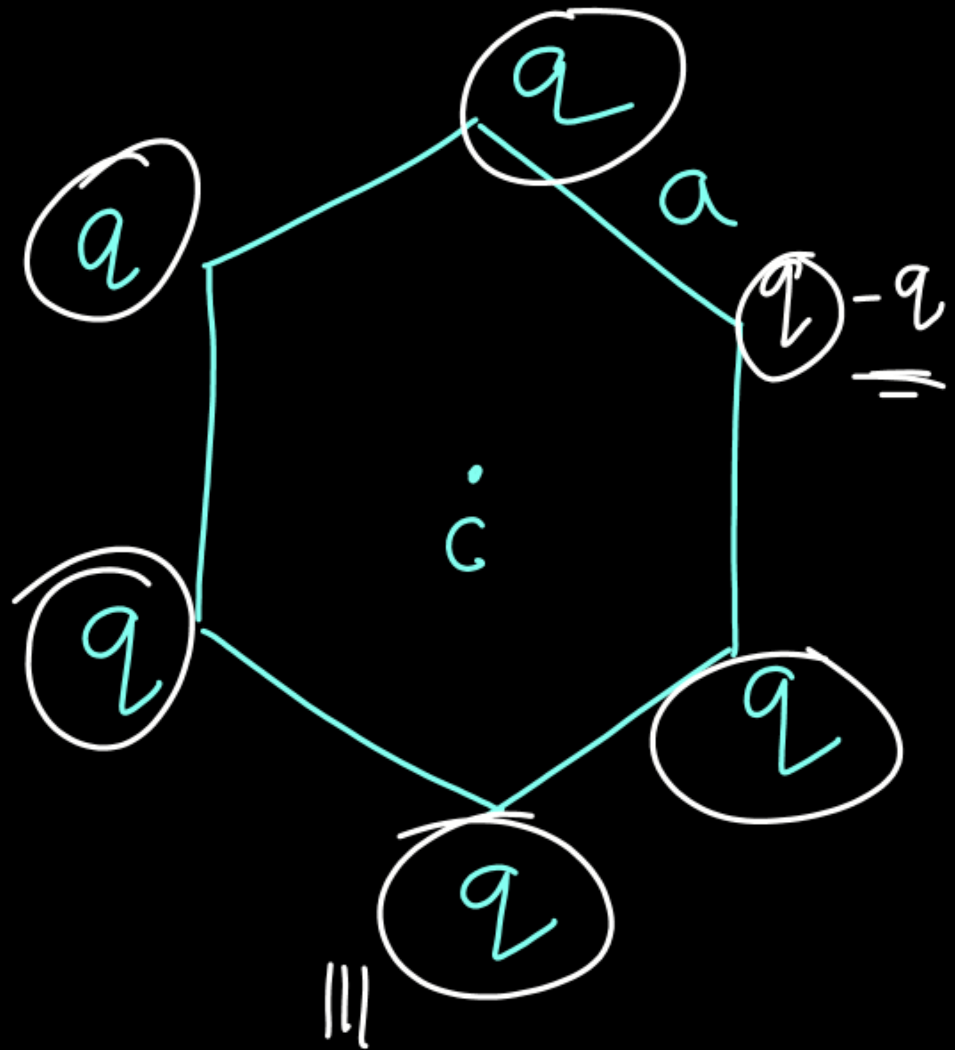
$$* \boxed{x = \frac{r}{\sqrt{3}}}$$

$$E_c = \frac{K\,2q}{x^2}$$

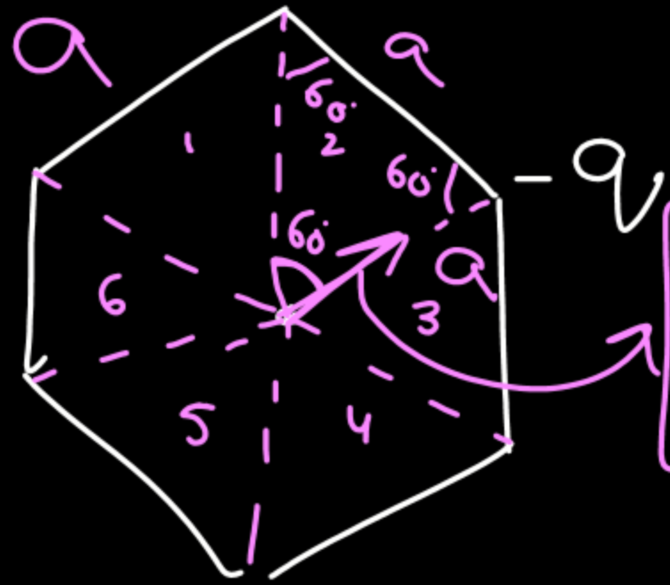
$$\frac{K\,2q}{\left(\frac{r}{\sqrt{3}}\right)^2}$$

$$\boxed{E_c = \frac{6kq}{r^2}}$$

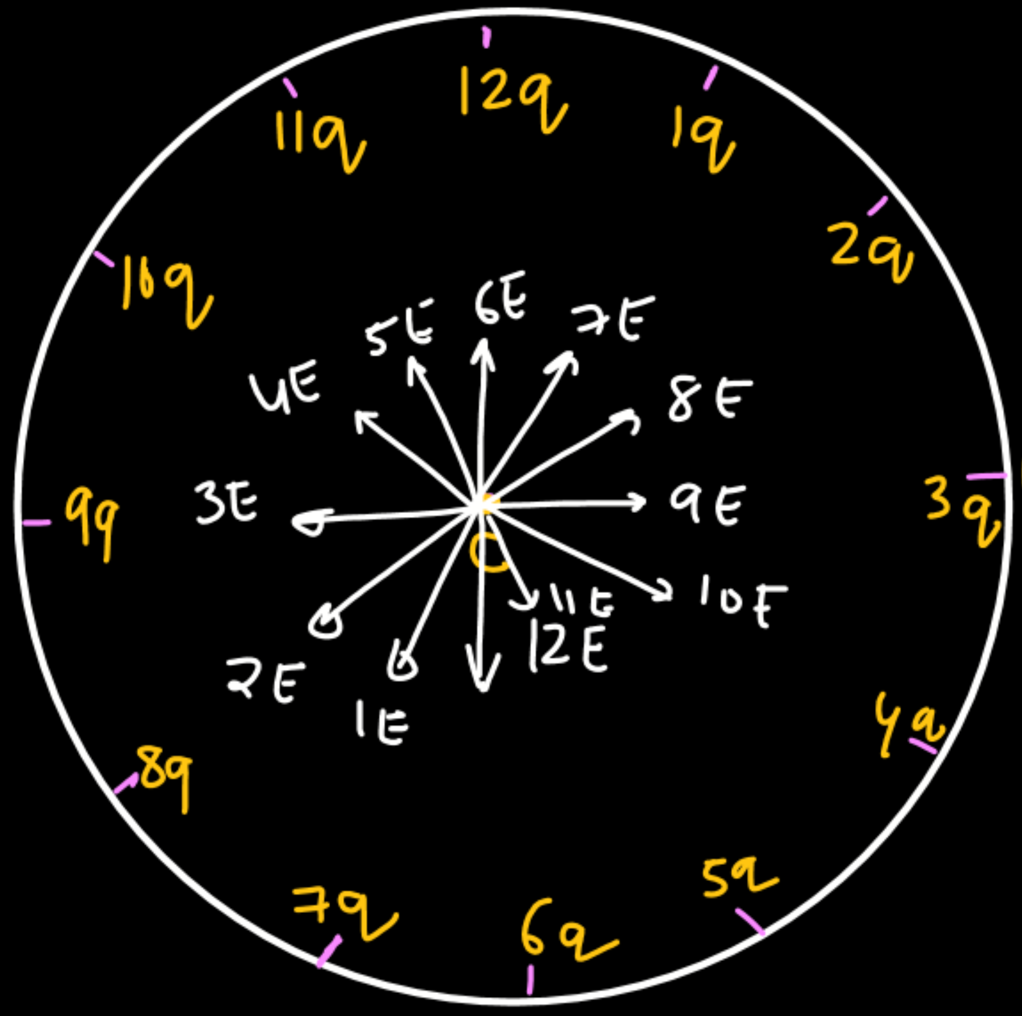




find the field at center c?



$$\boxed{E = \frac{Kq}{a^2}}$$



R

Find field at the center?

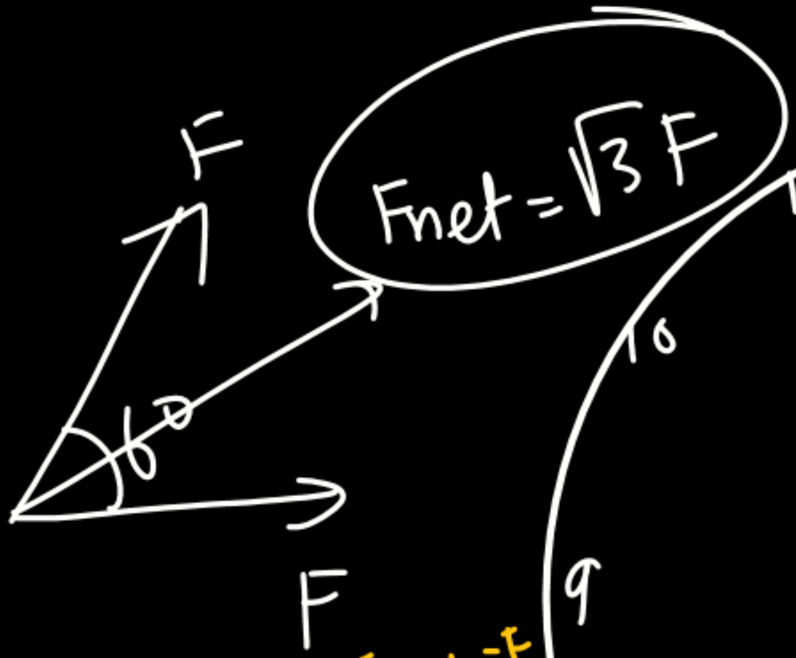
$$E = \frac{Kq}{R^2}$$

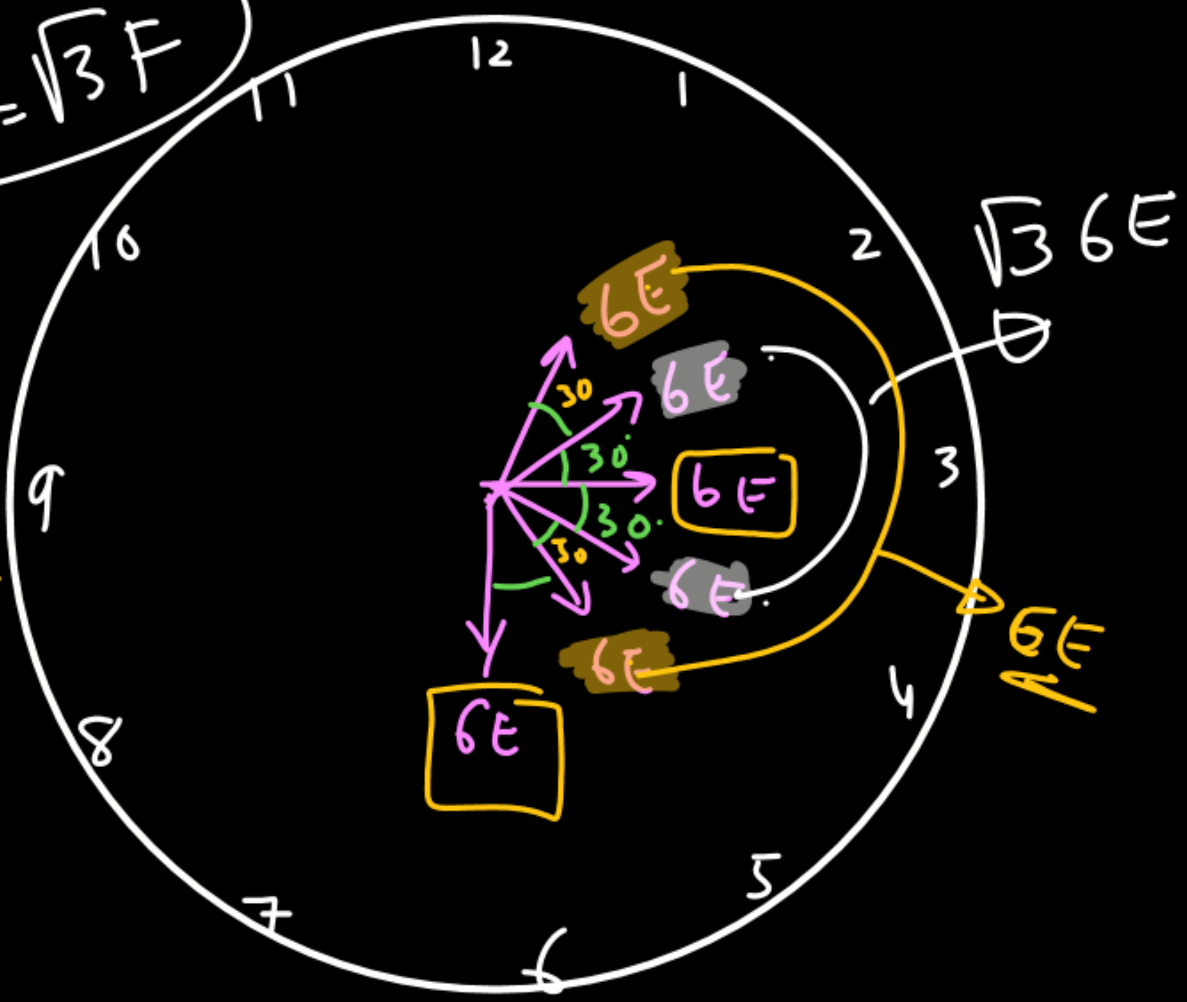
$12 - 6 = 6$

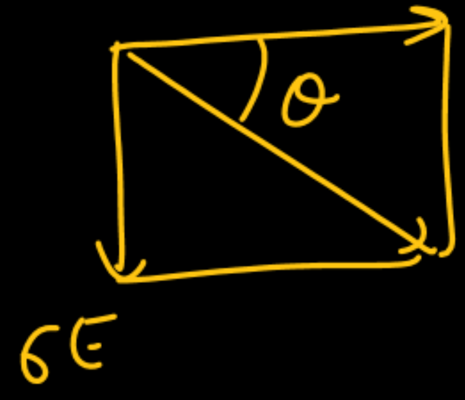
$7 - 1 = 6$

$8 - 2 = 6$

$11 - 5 = 6$



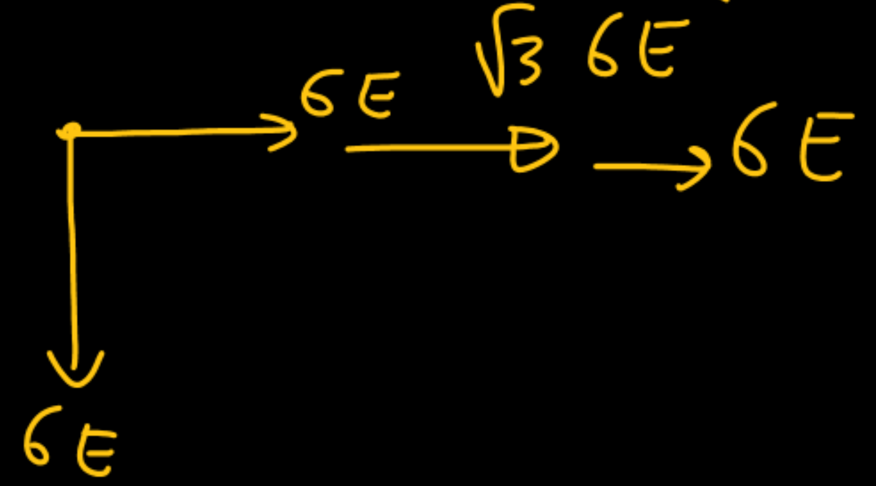


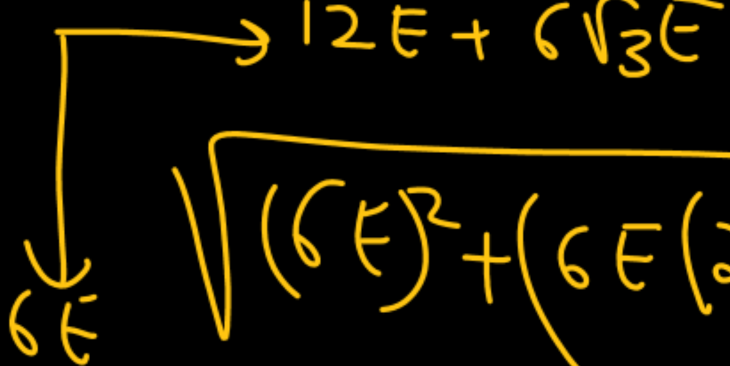


$6E(2+\sqrt{3})$

$$\tan\theta = \frac{\cancel{6E}}{\cancel{6E}(2+\sqrt{3})}$$

$$\theta = \tan^{-1}\left(\frac{1}{2+\sqrt{3}}\right)$$

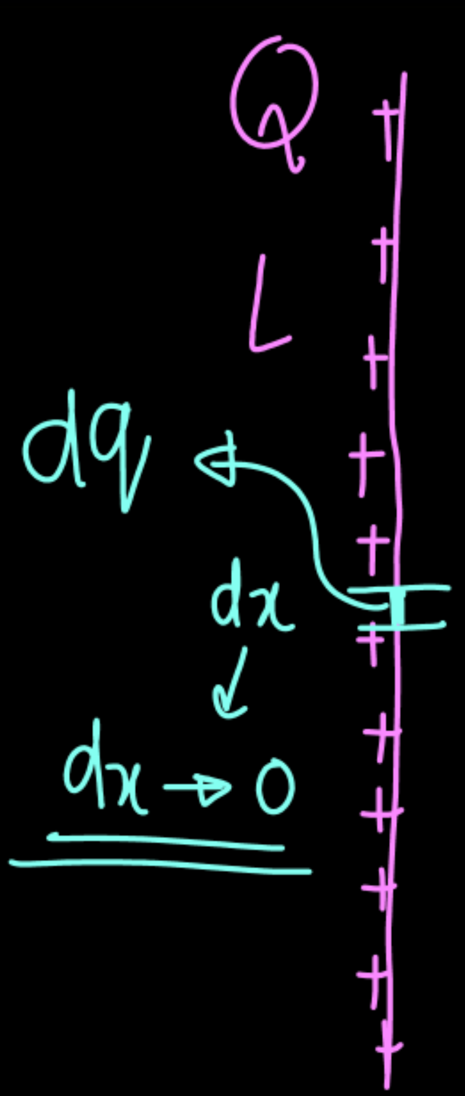




$$\sqrt{(6E)^2 + \left(6E(2+\sqrt{3})\right)^2}$$

$$6E\sqrt{1+(2+\sqrt{3})^2}$$

Electric field due to continuous charge distribution



$dx \to 0$

line charge distribution

linear charge density

$$\lambda = \frac{\text{charge}}{\text{length}}$$

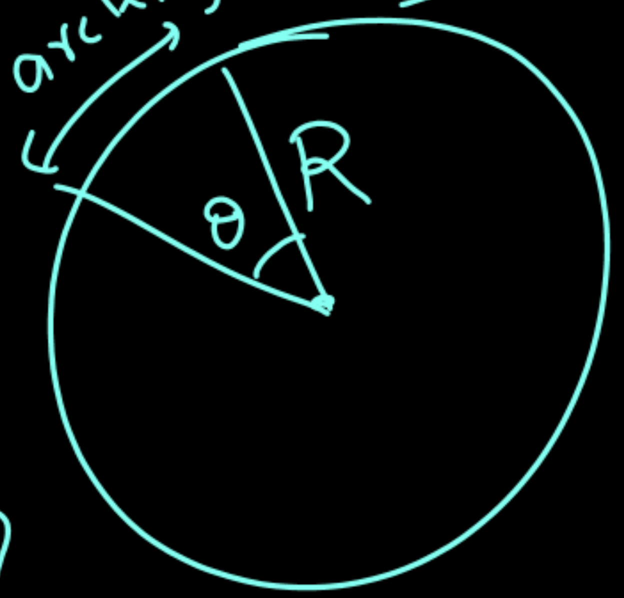
$$\boxed{\lambda = \frac{Q}{L}} \leftarrow \text{uniform}$$

$$\boxed{\lambda = \frac{dq}{dx}} \leftarrow \text{Non uniform}$$

$dx = R\,d\theta$

$$\boxed{\lambda = \frac{dq}{dx}}$$

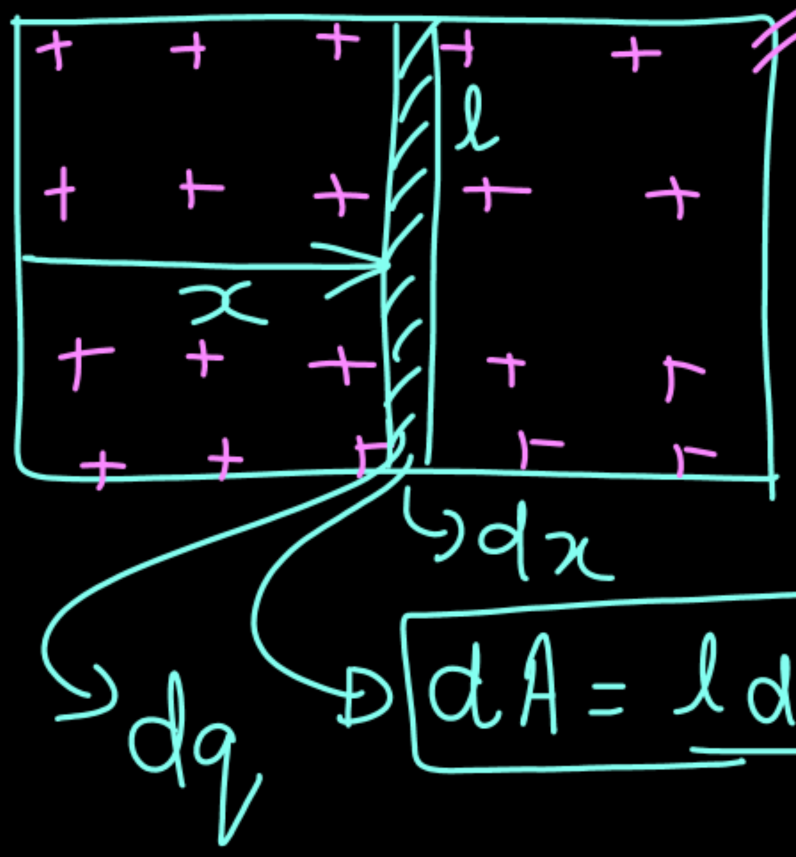
arc length $= R\theta$



Radian

π radian $= 180^\circ$

areal charge distribution



$\boxed{dA = l\,dx}$

surface charge density

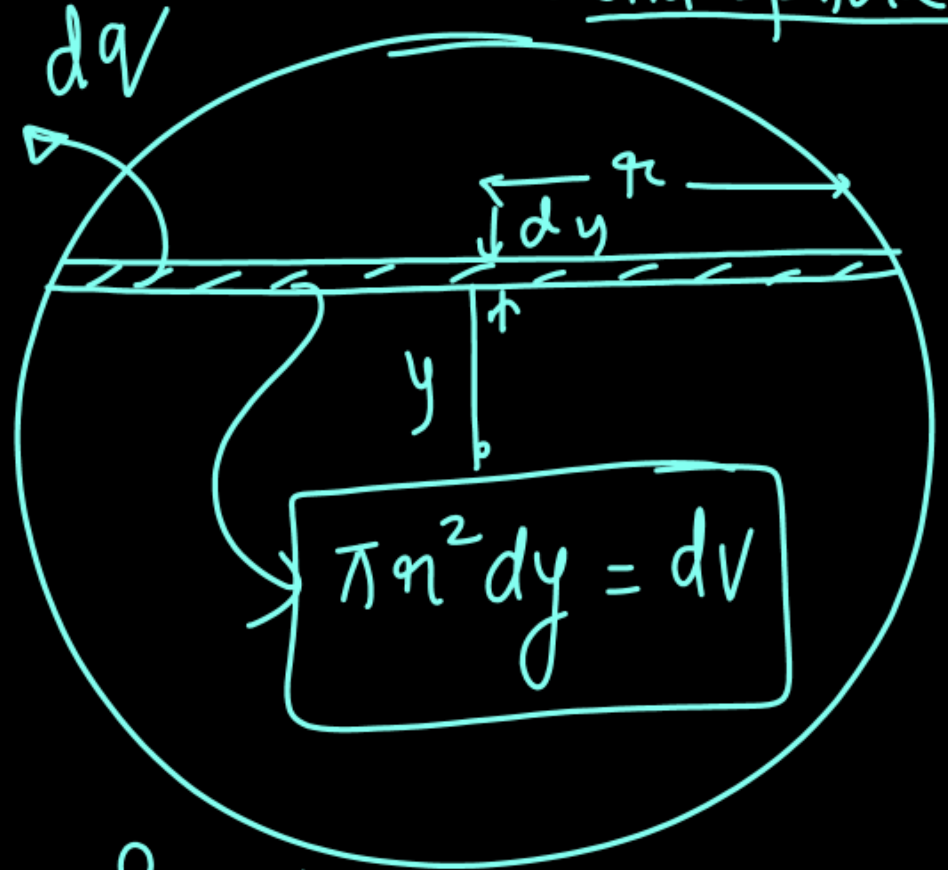
$$\sigma = \frac{dq}{dA}$$

$$=$$

Volume charge density

$$\rho = \frac{dq}{dV}$$

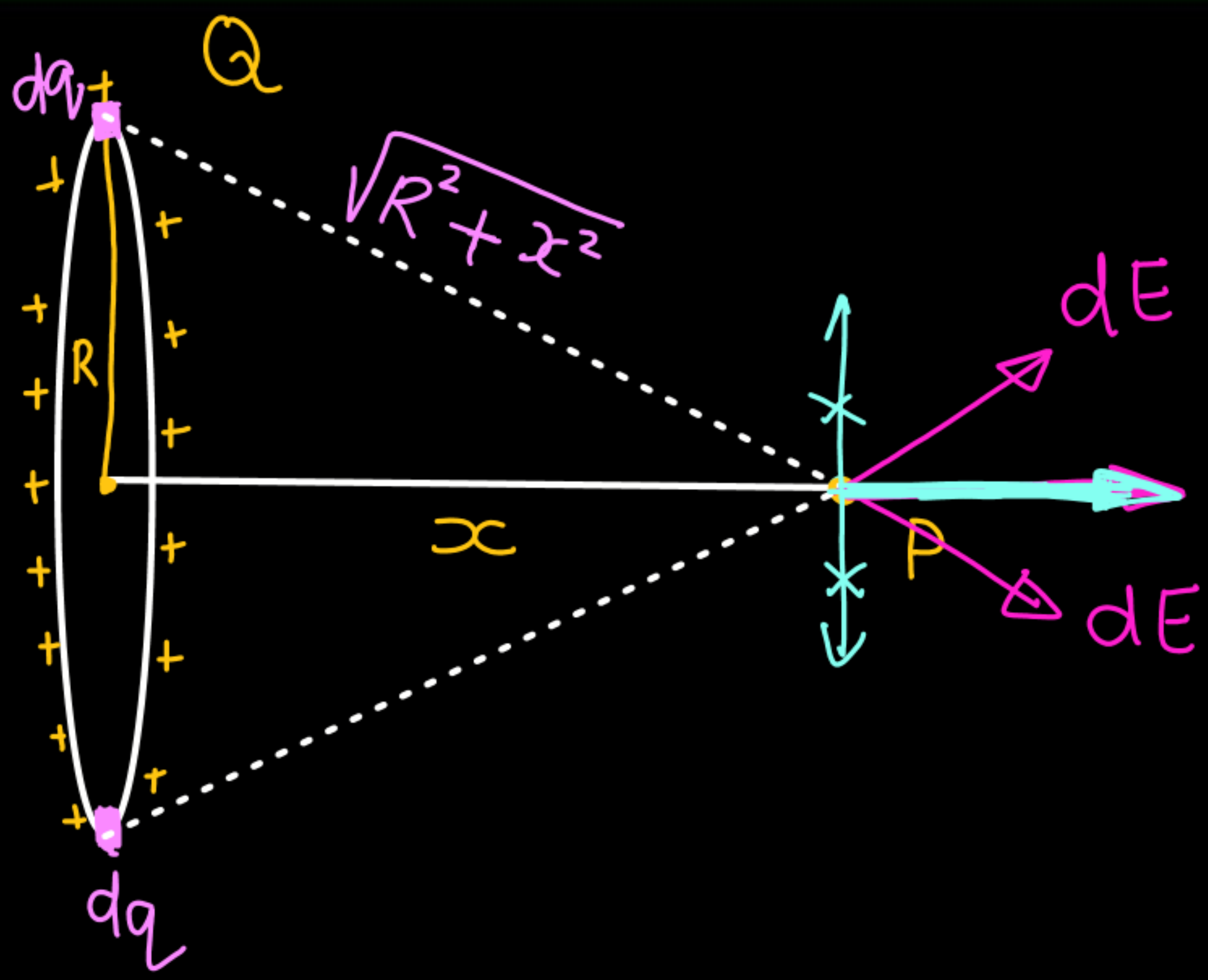
Solid sphere



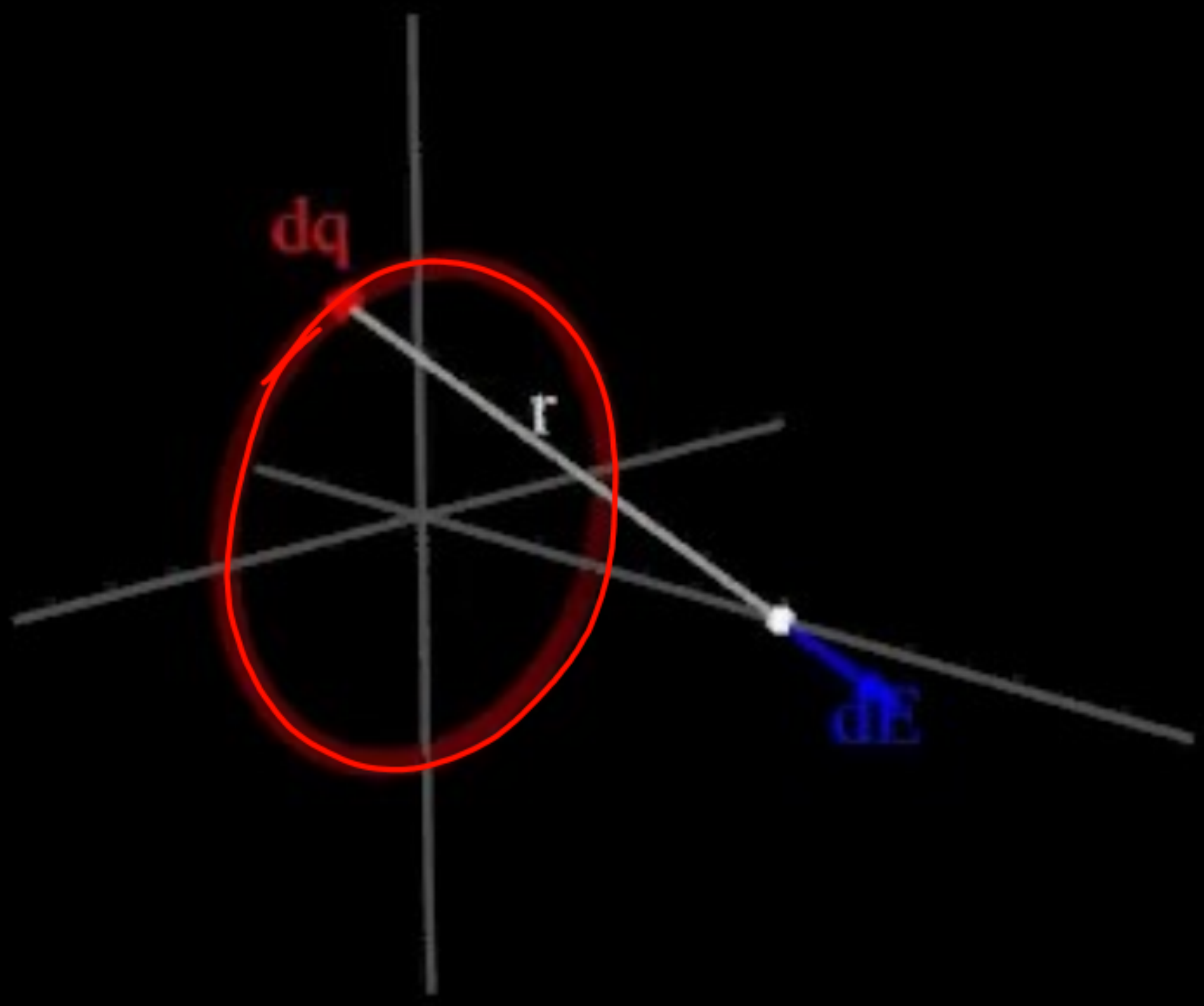
$\boxed{\pi r^2 dy = dV}$

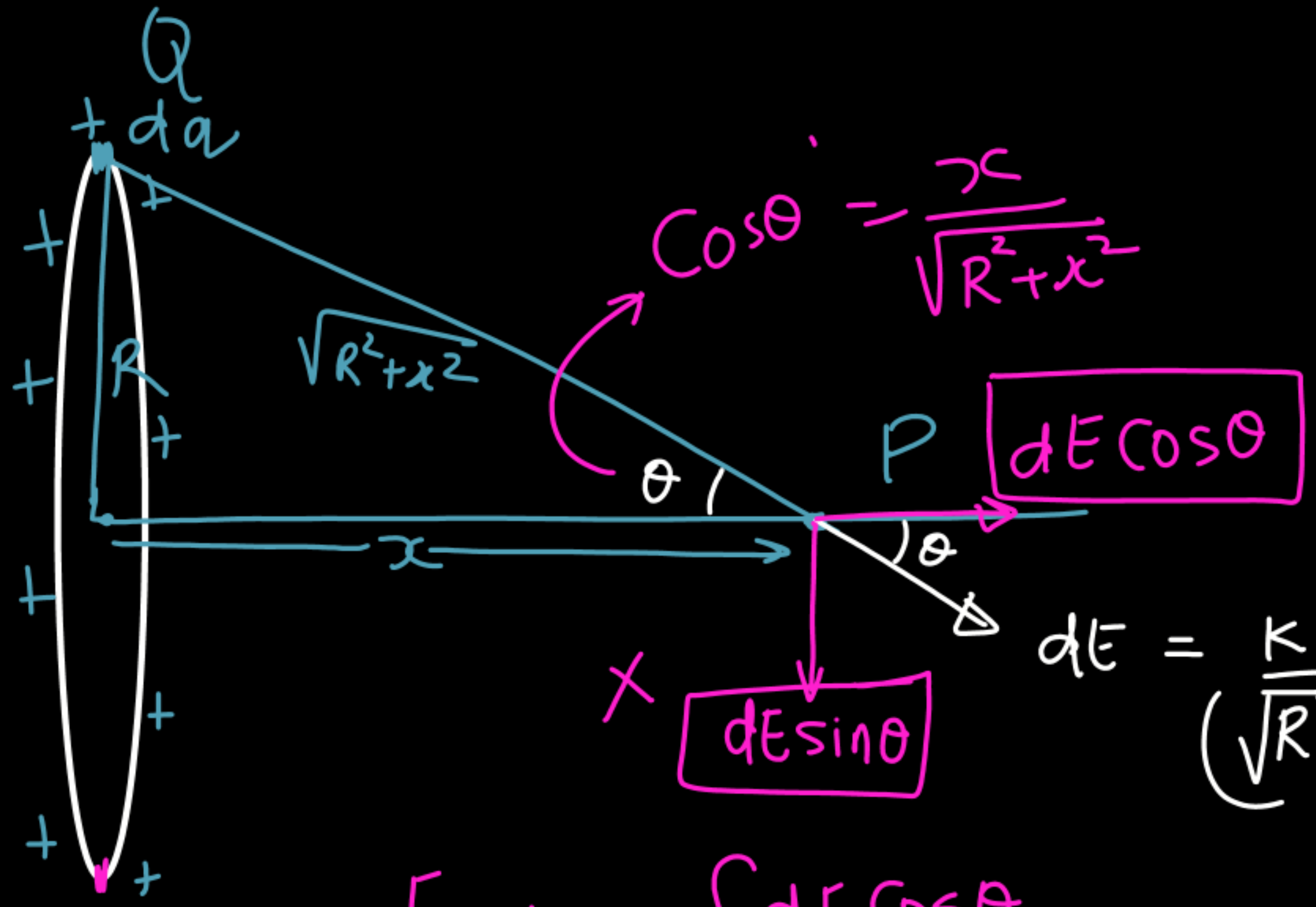
$$\rho = \frac{dq}{\boxed{dV}}$$

Electric field due to Ring



$$dE = \frac{K\,dq}{\left(\sqrt{R^2+x^2}\right)^2}$$


dq
r
dE



$$\cos\theta = \frac{x}{\sqrt{R^2+x^2}}$$

$$dE = \frac{k\,dq}{\left(\sqrt{R^2+x^2}\right)^2} = \frac{k\,dq}{R^2+x^2}$$

$$E_{net} = \int dE\cos\theta$$

$$= \int \frac{k\,dq}{R^2+x^2}\cos\theta = \int_{\text{Ring}} \frac{k\,dq}{R^2+x^2}\,\frac{x}{\sqrt{R^2+x^2}} = \frac{kx}{\left(R^2+x^2\right)^{3/2}}\int dq$$

$$= \frac{kxQ}{\left(R^2+x^2\right)^{3/2}}$$

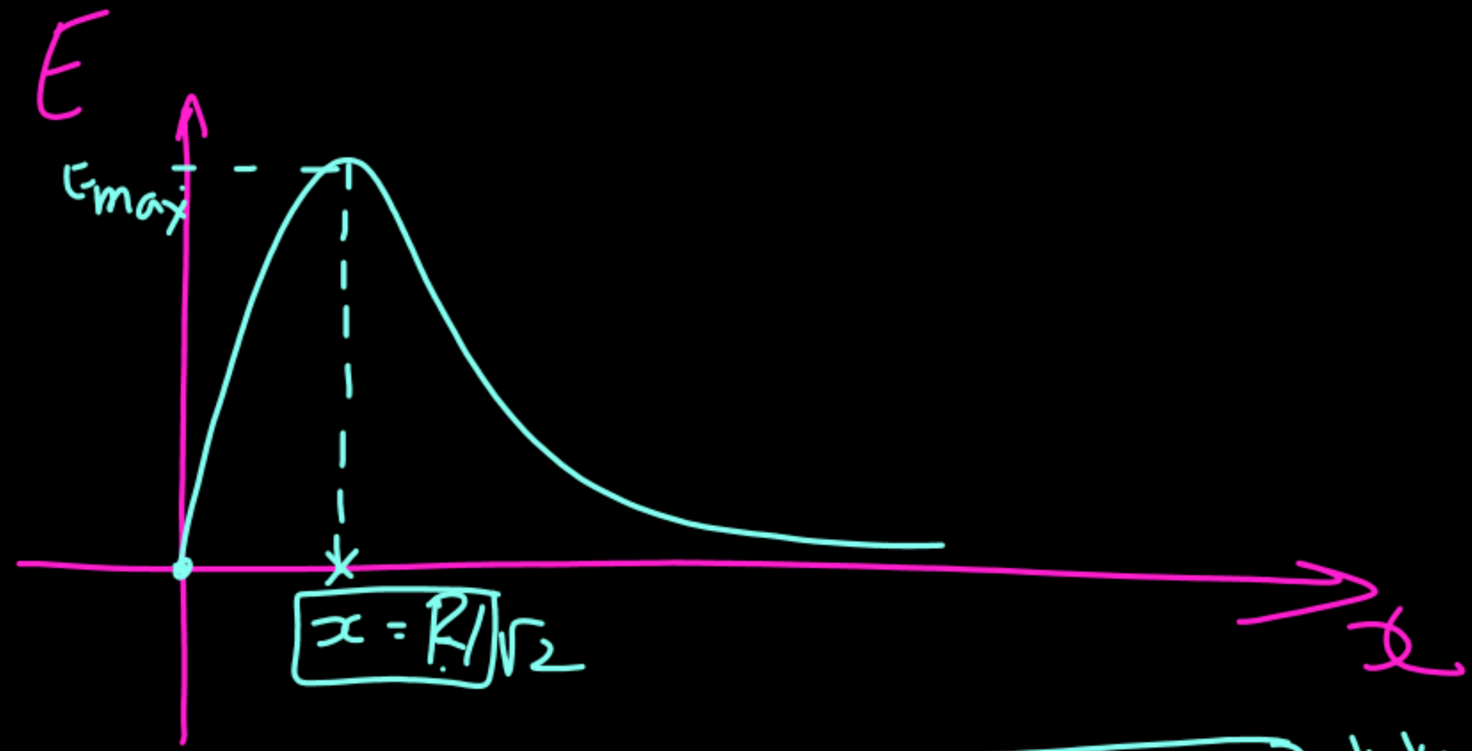
$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$

$$\boxed{E_{center} = 0}$$

$$E_{\infty} = 0$$

$$E_{max} = \frac{KQ\, R/\sqrt{2}}{\left(R^2+\left(\frac{R}{\sqrt{2}}\right)^2\right)^{3/2}}$$

$$= \frac{KQR}{\sqrt{2}\left(\frac{3R^2}{2}\right)^{3/2}}$$



$$\frac{dE}{dx} = 0$$

$$\boxed{x = \frac{R}{\sqrt{2}}} \quad **$$

Electric field due to Straight Wire

Electric field due to Circular Arc

Thank You Lakshyians