Chap 22: Electric field

- The electric field: ($\vec{E}$) vector Field meaning that we pay attention to directions when we calculate it

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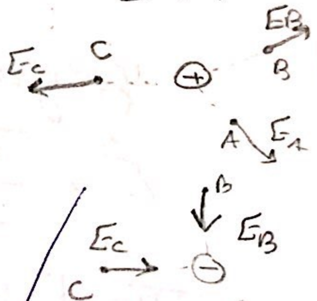
→ E due to a point charge
- To know the direction :- we place a positive charge at the point that we wanna calculate $\vec{E}$ at



$$\boxed{\vec{E} = \frac{\vec{F}}{q_0} = \frac{Kq}{r^2}\hat{r} \qquad [\vec{E}] = N/C \qquad \vec{E}_{net} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 \ldots}$$

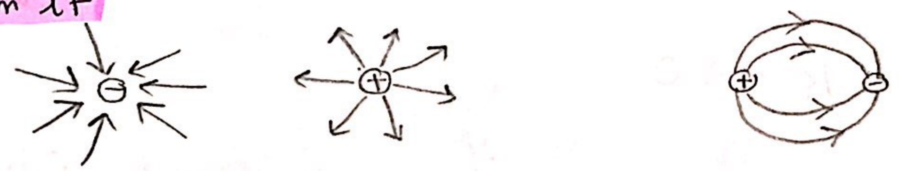
- Electric field lines :

First :- if the field line is straight : $\vec{E}$ is in it's direction
if the field line is curved : $\vec{E}$ is in the direction of the tangent

Secondly : If the field lines are close toghether : $\vec{E}$ is large
if the field lines are far apart : $\vec{E}$ is small

$\vec{E}$ is large $\qquad$ $\vec{E}$ is small

Thirdly : If the charge is negative the lines points toward it
If the charge is positive the lines points away from it

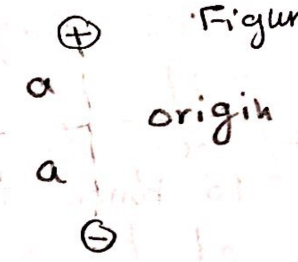


Uniform electric field :- The electric field is called uniform if it was equal in magnitude ......

and direction at every point

An Electric dipole: 2 charges equal in magnitude and opposite in charges between them distance 2a (Figure 1)

Figure(1)



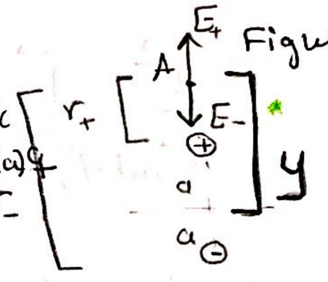
at point A:-

(Figure 2) $\vec{E} = \frac{2y}{4\pi\epsilon_0}\frac{qd}{r^2}\hat{j} = \frac{Py}{(2\pi\epsilon_0)(y^2-a^2)^2}\hat{j}$

if $y >> a$ then

$\vec{E} = \frac{P}{2\pi\epsilon_0 y^3}\hat{j}$ where P is the Electric field moment and $= (2a)q$

Figure(2)



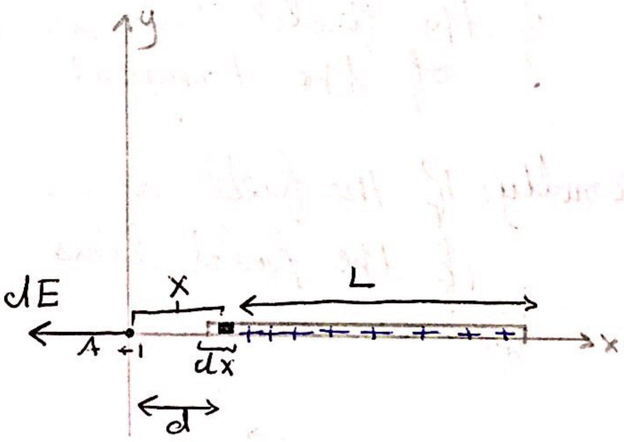
- **The Electric Field due to line of Charge**

(E due to a continuous charge distribution)

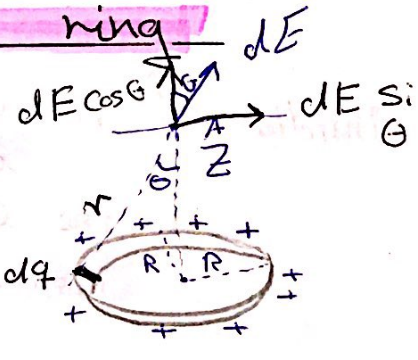
$$E = \frac{q}{4\pi\epsilon_0(L+d)d}(-\hat{i})$$

If $d \gg L$, $L \to 0$

$$E = \frac{q}{4\pi\epsilon_0(d^2)} - \hat{i}$$



- **$\vec{E}$ due to a uniformly Charged ring**



$$E_{ring} = \frac{qZ}{[R^2+Z^2]^{\frac{3}{2}}}\frac{1}{4\pi\epsilon_0}$$

If $R^2 \to 0$

$$E_{ring} = \frac{q}{4\pi\epsilon_0(Z)^2}$$ (as a point charge)

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$\vec{E}$ due to a uniformly charged disk

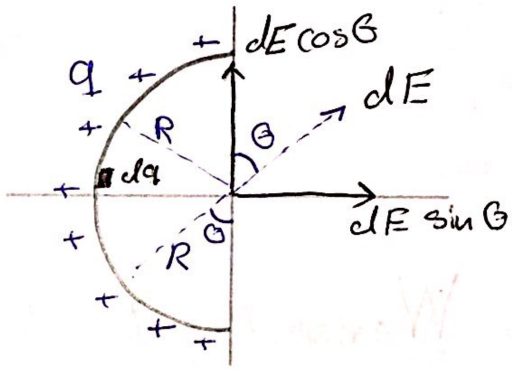
$$E_{disk} = \frac{\sigma}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right]$$

if $R \gg z$, $\frac{z}{\sqrt{R^2+z^2}} \to 0$

$$E_{disk} = \frac{\sigma}{2\epsilon_0} \Rightarrow$$ E for infinit plane of charge is constant

$\vec{E}$ due to a uniformly charged Arc

$$E_{Arc} = \frac{\lambda}{2\pi\epsilon_0 R}$$



Note: in a uniform Electric field

$$F = q\vec{E}$$

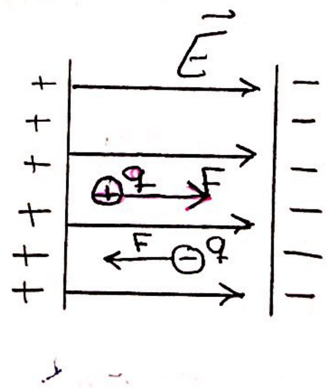
Newton's second law ← $ma = q\vec{E}$

$$\vec{a} = \frac{q\vec{E}}{m}$$

F same direaction as E if $q > 0$

F oppositie direction of E if $q < 0$

Constant : So we use equations of a constant acceleration



- $V_x = V_{0x} + a t$
- $V_x^2 = V_{0x}^2 + 2a_x \cdot \Delta X$
- $\Delta X = V_{0x} t + \frac{1}{2} a_x t^2$
- $\Delta X = \frac{V_{0x} + V_x}{2} \Delta t$

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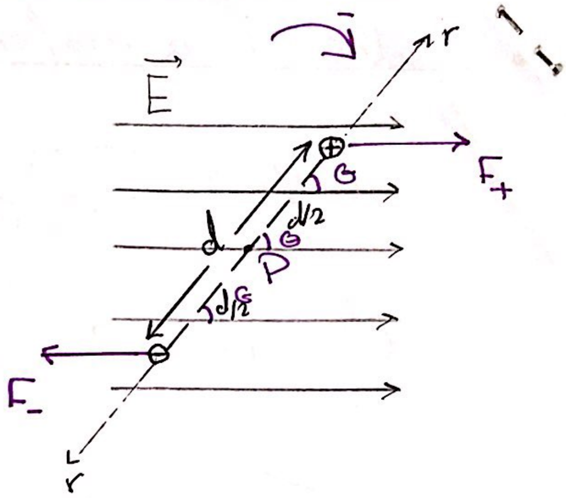
Torque :-

P will rotate around origin

$$\vec{\tau}_{net} = \vec{P} \times \vec{E}$$



Potential Energy of an Electric Dipole

$$W_{conservative\ F} = -\Delta U$$

$$= -[U_f - U_i]$$

$$= -[PE\cos\theta_f - PE\cos\theta_i]$$

$$W_{external\ agent} = W_a = +\Delta U$$

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