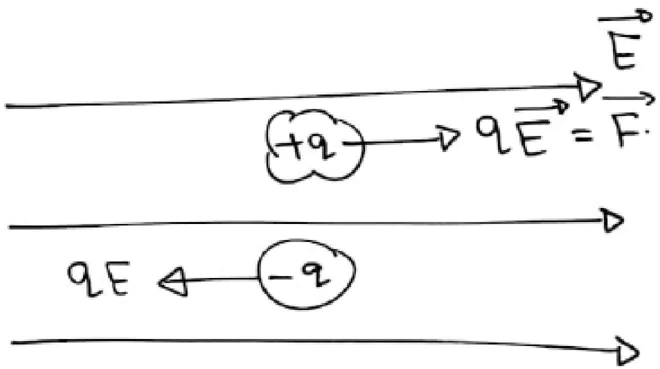
⇒ **Electric field lines :-**

Charge in Uniform Electric field lines :-

$$v = u + at$$

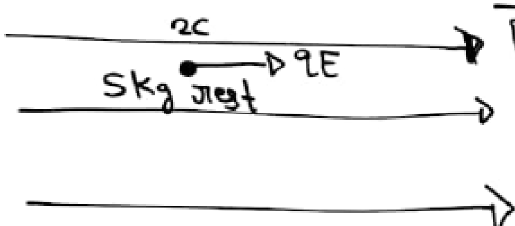


Uniform Electric field lines :-

When lines placed equidistance to each other.

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

Q1 :-



$\vec{E} = 5\hat{i}\ N/C$

$u = 0$

find momentum of charge at $t = 2$ sec.

Force on charge $= q\vec{E} = 2 \times 5 = 10\hat{i}\ N$

$\vec{a} = \frac{\vec{F}}{m} = \frac{10\hat{i}}{5} = 2\ m/s^2\ (\hat{i})$

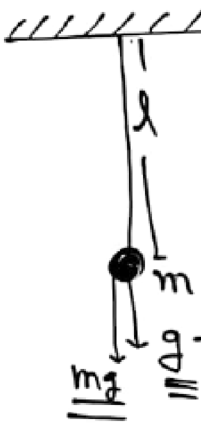
$v = 0 + 2 \times 2 \Rightarrow \vec{v} = 4\hat{i}\ m/s$

$\vec{P} = (m\vec{v})$

$\vec{P} = (5 \times 4)\hat{i}$

$= 20\ kg\ m/s\ \hat{i}$

⇒ Electoric field lines :-



$$T = 2\pi\sqrt{\frac{l}{g}}$$

$g \rightarrow$ "gravitational acceleration"

mg ≡

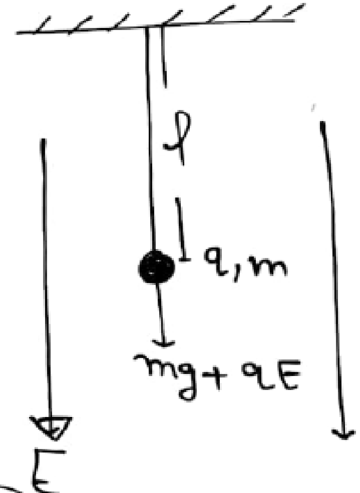
$l \rightarrow$ length of String.

T = Time period of pendulum

General formula

$$T = 2\pi\sqrt{\frac{l}{a_{eff}}}$$

(a)



$T' < T$

Net Force on bob

$$F_{net} = mg + qE$$

Net acceleration of bob ⇒

$$a_{net} = \frac{F_{net}}{m} = \frac{mg + qE}{m}$$

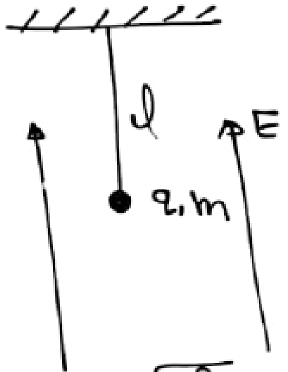
$$a_{net} = \left(g + \frac{qE}{m}\right)$$

$$T' = 2\pi\sqrt{\frac{l}{a_{net}}}$$

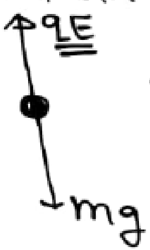
$$T' = 2\pi\sqrt{\frac{l}{g + \frac{qE}{m}}}$$

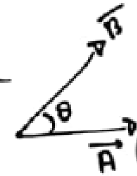
⇒ Electric field lines-: $T = 2\pi\sqrt{\frac{l}{g}}$

(a)



Find Time Period of Pendulum.





$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

$T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

$T = 2\pi\sqrt{\frac{l}{g - \frac{qE}{m}}}$

(a) $T = 2\pi\sqrt{\frac{l}{g}}$

(b) $T = 2\pi\sqrt{\frac{l}{g + \frac{qE}{m}}}$

(c) $T = 2\pi\sqrt{\frac{l}{g - \frac{qE}{m}}}$

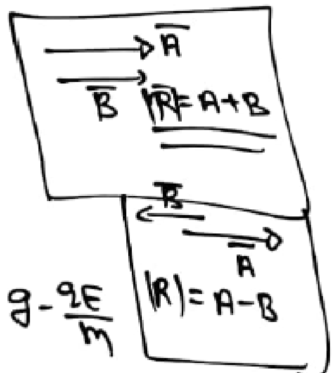
(d) $T = 2\pi\sqrt{\frac{l}{g^2 + \left(\frac{qE}{m}\right)^2}}$

$F_{net} = mg - qE$

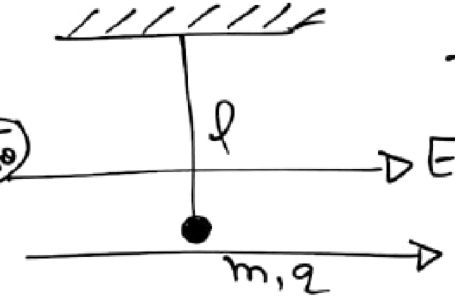
$a_{net} = \frac{F_{net}}{m}$

$= \frac{mg - qE}{m}$

$= \frac{mg}{m} - \frac{qE}{m} = g - \frac{qE}{m}$



(b)



T = ?

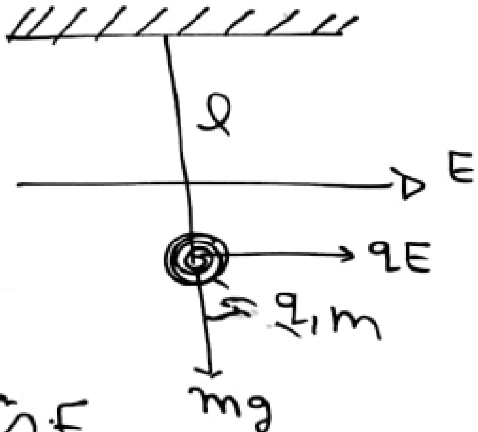
$F_{net} = \sqrt{(mg)^2 + (qE)^2 + 2(mg)(qE)\cos 90}$, where $\cos 90 = 0$

$F_{net} = \sqrt{m^2g^2 + q^2E^2}$

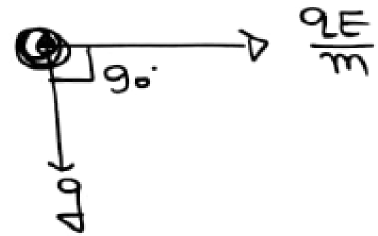
$a_{net} = \frac{F_{net}}{m} = \frac{\sqrt{m^2g^2 + q^2E^2}}{m}$

$= \sqrt{\frac{m^2g^2 + q^2E^2}{m^2}} = \sqrt{g^2 + \frac{q^2E^2}{m^2}}$

⇒ Electric field lines:-



$$F = ma$$



G.F

$$T = 2\pi\sqrt{\frac{l}{a_{eff}}}$$

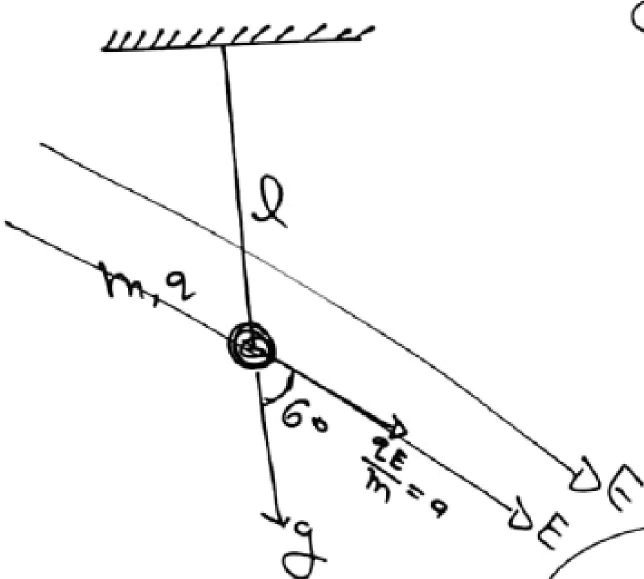
$$= 2\pi\sqrt{\frac{l}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$$

$$a_{net} = \sqrt{g^2+\left(\frac{qE}{m}\right)^2+2g\left(\frac{qE}{m}\right)\cos 90^\circ}$$

($\cos 90^\circ = 0$)

$$a_{net} = \sqrt{g^2+\left(\frac{qE}{m}\right)^2}$$

⇒ Electric field lines :-



$$a_{net} = \sqrt{g^2 + \left(\frac{qE}{m}\right)^2 + 2g\left(\frac{qE}{m}\right)\cos 60}$$

$$a_{net} = \sqrt{g^2 + \left(\frac{qE}{m}\right)^2 + 2g\left(\frac{qE}{m}\right)\times\frac{1}{2}}$$

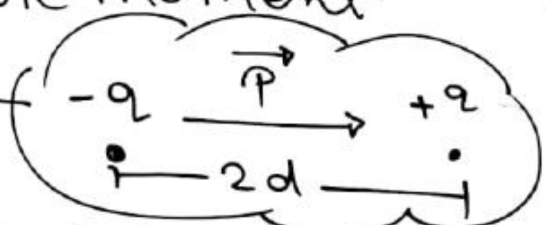
$$= \sqrt{g^2 + \left(\frac{qE}{m}\right)^2 + g\left(\frac{qE}{m}\right)}$$

$$T = 2\pi\sqrt{\frac{l}{a_{eff}}}$$

$$T = 2\pi\sqrt{\frac{l}{\sqrt{g^2 + \left(\frac{qE}{m}\right)^2 + g\left(\frac{qE}{m}\right)}}}$$

Dipole moment :- ($\vec{P}$) :- When two charge of equal magnitude & opposite sign placed at short distance. This system of charge called Dipole moment.

Dipole ←

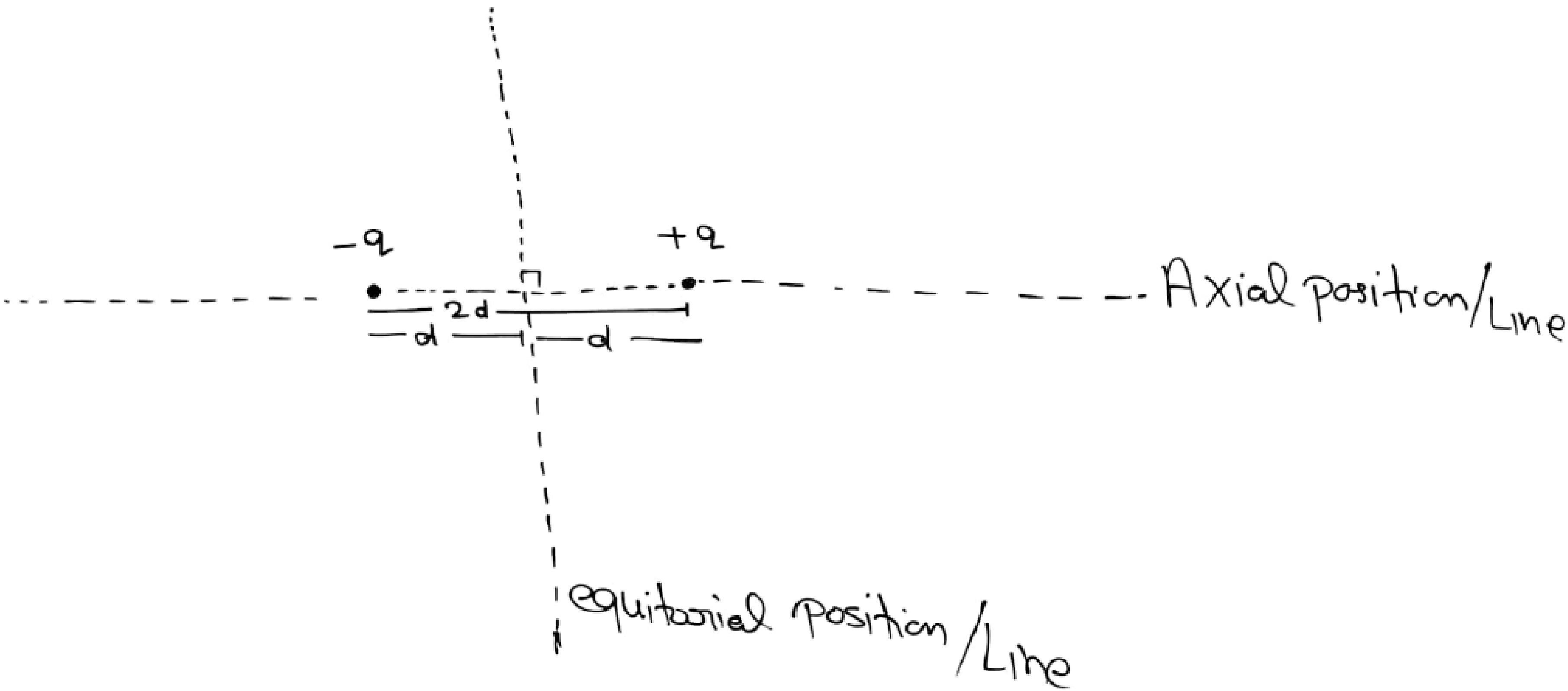


2d → distance b/w charges.

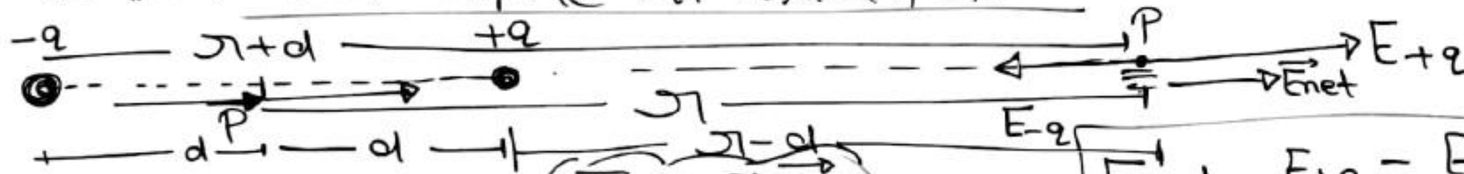
$$\vec{P} = q \times 2d$$

→ Dir^n → ⊖ to ⊕

→ Dipole moment


-q
+q
2d
d
d
Axial position/Line
equitorial position /Line

ctoric field due to dipole at axial position:-



$\vec{E}_{net} = \dfrac{2K\vec{P}}{r^3}$

$E_{net} = E_{+q} - E_{(-q)}$

$E_{net} = E_{+q} - E_{(-q)}$

$= \dfrac{Kq}{(r-d)^2} - \dfrac{Kq}{(r+d)^2}$

$= Kq\left[\dfrac{1}{(r-d)^2} - \dfrac{1}{(r+d)^2}\right]$

$= Kq\left[\dfrac{(r+d)^2 - (r-d)^2}{(r-d)^2(r+d)^2}\right]$

$= Kq\left[\dfrac{(r^2+d^2+2rd) - (r^2+d^2-2rd)}{(r^2-d^2)^2}\right]$

$E_{net} = Kq\left[\dfrac{r^2+d^2+2rd - r^2 - d^2 + 2rd}{(r^2-d^2)^2}\right]$

$E_{net} = \dfrac{2KP}{r^3}$

$E_{net} = \dfrac{Kq(4rd)}{(r^2-d^2)^2}$

$[P = (q\times 2d)]$

$= \dfrac{2Kr(q\times 2d)}{(r^2-d^2)^2} = \dfrac{2KPr}{(r^2-d^2)^2}$

Short dipole $r >> d$ $d^2 \to 0$

$E_{net} = \dfrac{2KPr}{r^4} = \dfrac{2KP}{r^3}$