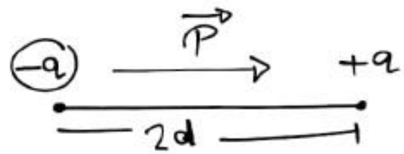
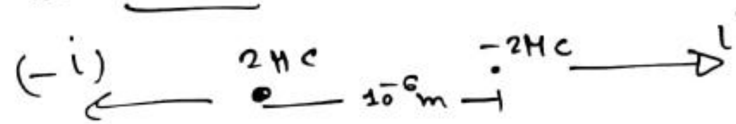
Dipole moment ($\vec{P}$) :-



$\vec{P} = q(2d)$ dirⁿ ⊖ to + .

Q) Find $\vec{P}$



$P = q \times$ (distance b/w them)

$= 2\times10^{-6}\,C \times 10^{-6}\,m$

$P = 2\times10^{-12}$ Cm $\vec{P} = 2\times10^{-12}(-\hat{i})$

Q:- find dipole moment of two charge system of charge 2C & −2C placed at 1Å distance.

Sol) $q = 2C$ $(2d) = 1\text{Å}$

$P = 2C \times 1 \times 10^{-10}\,m$

$P = 2\times10^{-10}$ C-m

SI Unit of $\vec{P}$ = C-m

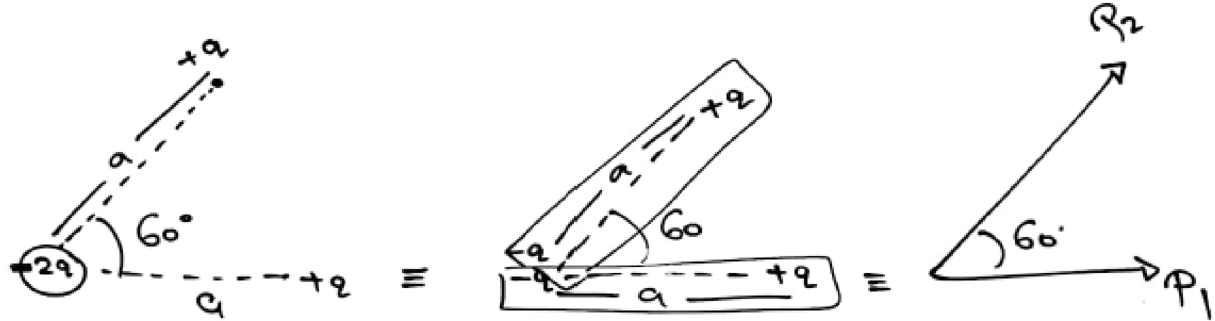
$[\vec{P}] = [AT][L] = [LAT]$

① Dipole moment is a vector quantity.

find Net dipole moment of System:

$P_2 = qa = P$

$P_1 = qa = P$



(a) $qa\sqrt{3}$.

(b) $qa\sqrt{2}$.

(c) qa.

(d) N.O.T

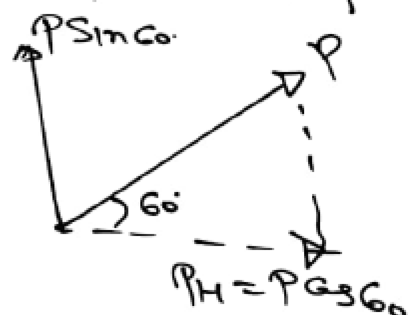
$$P_{net} = \sqrt{P_1^2 + P_2^2 + 2P_1P_2\cos 60}$$

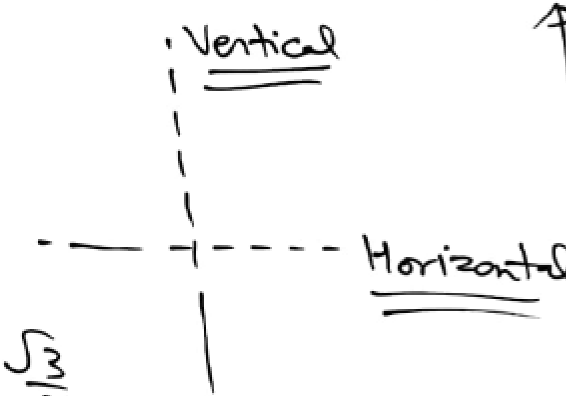
$$= \sqrt{P^2 + P^2 + 2P^2 \times \frac{1}{2}} = \sqrt{3P^2} = P\sqrt{3}$$

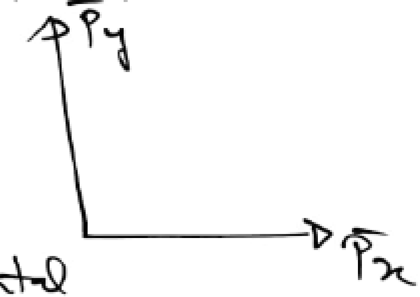
$$P_{net} = qa\sqrt{3}$$

Dipole moment is a vector quantity -

find horizontal & vertical component of dipole.



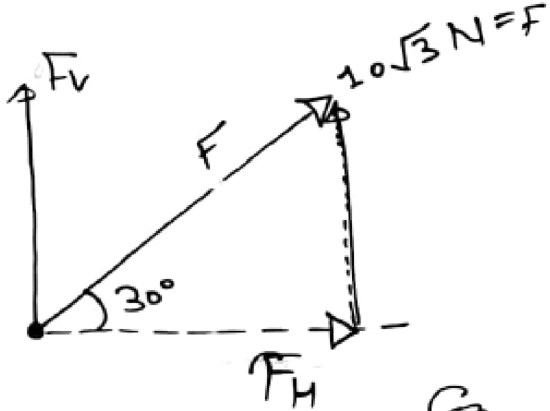


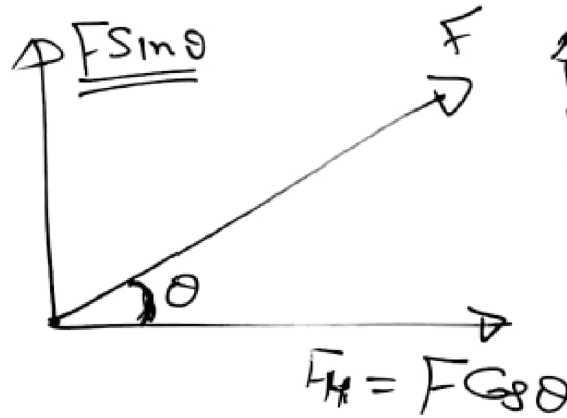


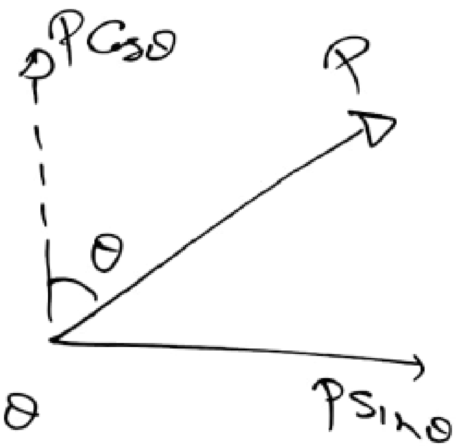
$$P_H = P \times \frac{1}{2} \qquad P_V = P \times \frac{\sqrt{3}}{2}$$

$$P_H = \frac{P}{2} \qquad P_V = \frac{P\sqrt{3}}{2}$$

(1) Dipole moment is a vector quantity -1







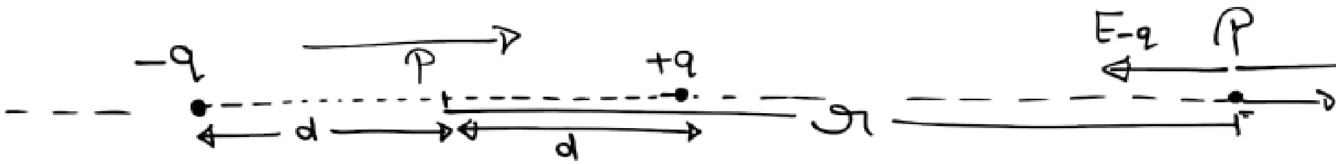
$$\cos 30^\circ = \frac{F_H}{F}$$

$$\boxed{F_H = F\cos 30}$$

$$\sin 30 = \frac{F_V}{F}$$

$$F_V = F\sin 30$$

Electric field due to dipole at axial position:



$$E_{net} = |E_{+q}| - |E_{-q}|$$

$$E_{net} = \frac{2kpr}{(r^2 - d^2)^2}$$

$$p = (q \times 2d)$$

$$\vec{E}_{net} = \frac{2k\vec{p}r}{(r^2 - d^2)^2}$$

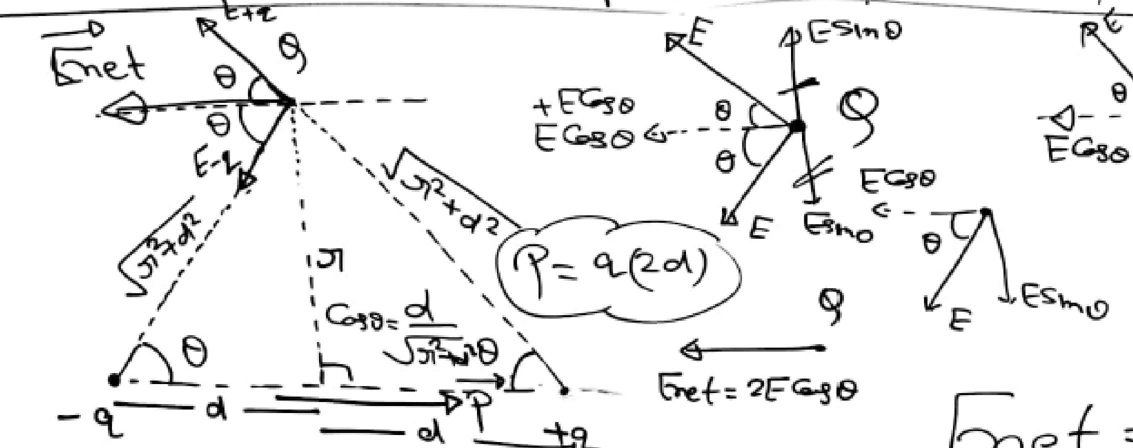
for short dipole $r >> d$

$$d^2 \simeq 0$$

$$\vec{E}_{net} = \frac{2k\vec{p}r}{r^4} = \frac{2k\vec{p}}{r^3}$$

$$\vec{E}_{net} = \frac{2k\vec{p}}{r^3}$$

Electric field due to dipole At equitorial position



$$\vec{E}_{net} = \frac{-K\vec{p}}{r^3}$$

$$|E_{+q}| = |E_{-q}| = \frac{Kq}{(\sqrt{r^2+d^2})^2} = \frac{Kq}{r^2+d^2}$$

$$E_{net} = 2E\cos\theta$$

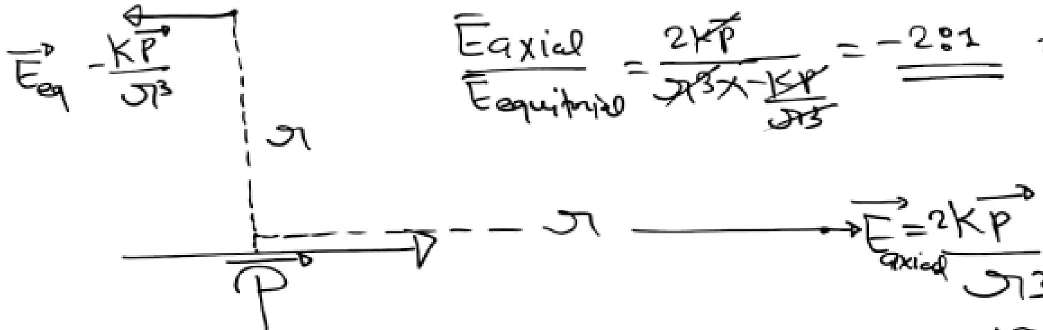
$$= 2 \times \frac{Kq}{(r^2+d^2)} \times \frac{d}{\sqrt{r^2+d^2}}$$

$$E_{net} = \frac{2Kqd}{(r^2+d^2)^1(r^2+d^2)^{1/2}} = \frac{Kp}{(r^2+d^2)^{3/2}}$$

For short dipole

$r >> d$ $\quad d^2 \simeq 0$

$$E_{net} = \frac{Kp}{(r^2)^{3/2}} = \frac{Kp}{r^3}$$



$$\frac{E_{axial}}{E_{equitorial}} = \frac{2K\vec{p}}{r^3 \times -\frac{K\vec{p}}{r^3}} = -2:1 = 2:1$$

$$E_{axial} = 2E_{equitorial}$$

(a) find ratio of Electric field at axial & equitarial point due to short dipole

(a) 1:2

(b) 2:1 ✓ [$\frac{E_{axial}}{E_{equitorial}}$]

(3) 1:1

(iv) 4:1

(b) find ratio of Electric field at axial & equitorial point due to short dipole.

(a) 1:2

(b) 2:1

(c) −2:1 ✓

(iv) −1:2

Electric field due to point charge & short dipole depends on r as respectively.

(a) $\frac{1}{r}, \frac{1}{r^2}$

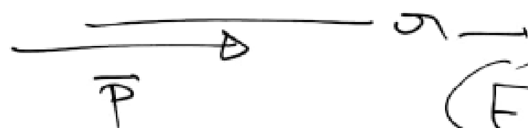
(b) $\frac{1}{r^2}, \frac{1}{r^3}$

(c) $\frac{1}{r}, \frac{1}{r^3}$

(d) $\frac{1}{r^2}, \frac{1}{r^2}$

$E = \frac{kq}{r^2}$

$E \propto \frac{1}{r^2}$

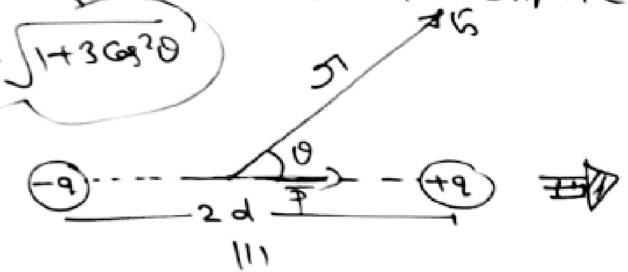


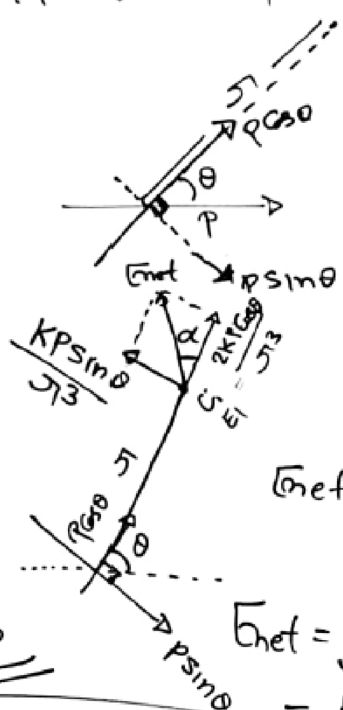
$E = \frac{2kP}{r^3}$

$E \propto \frac{1}{r^3}$

Electoric field due to dipole at General point (r, θ)

$$\frac{Kp}{r^3}\sqrt{1+3\cos^2\theta}$$





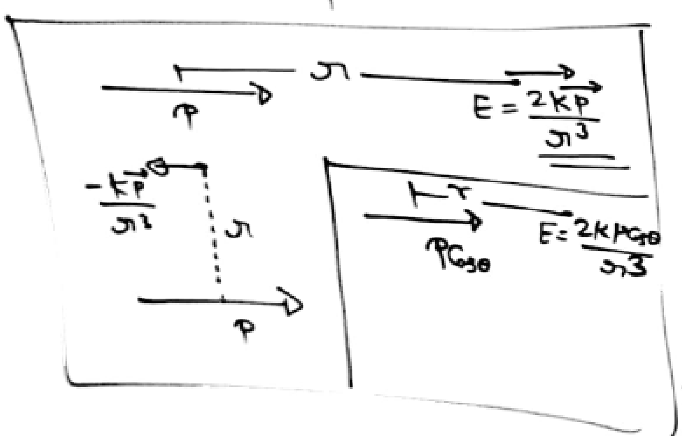
$$E_{net} = \sqrt{E_1^2 + E_2^2 + 2E_1E_2\cos 90}$$

$$= \sqrt{\left(\frac{2Kp\cos\theta}{r^3}\right)^2 + \left(\frac{Kp\sin\theta}{r^3}\right)^2}$$

$$E_{net} = \sqrt{\frac{4K^2p^2\cos^2\theta}{r^6} + \frac{K^2p^2\sin^2\theta}{r^6}}$$

$$E_{net} = \sqrt{\frac{K^2p^2}{r^6}\left(4\cos^2\theta + \sin^2\theta\right)}$$

$$= \frac{Kp}{r^3}\sqrt{3\cos^2\theta + \cos^2\theta + \sin^2\theta}$$



G.P.

$$E_{net} = \frac{Kp}{r^3}\sqrt{1+3\cos^2\theta}$$

θ → Angle b/w $\vec{r}$ & $\vec{p}$