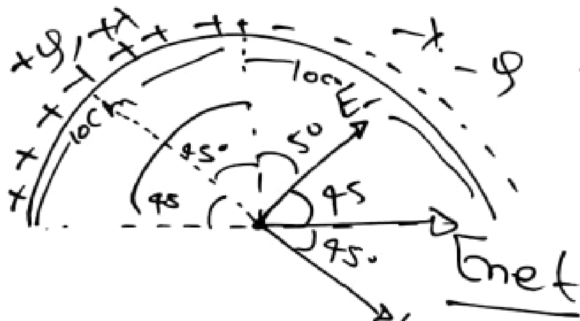
Q AMAN



$\pi R = 20\,cm$ $\quad L = 20\,cm$

$R = \frac{20}{\pi}\,cm$ $\quad 10C,\ -10C$

$R = \frac{.2}{\pi}\,m$

$$E = \frac{2\times 9\times 10^{9}\times 10^{2}}{\frac{.2}{\pi}}(\sin 45)$$

$$|E_+| = \frac{2k\lambda}{R}\sin\left(\frac{90}{2}\right)$$

$\lambda = \frac{Q}{.1m}$

$\lambda = \frac{10C}{.1}$

$\lambda = 100C/m$

$$= \frac{\pi\times\cancel{2}\times 9\times 10^{11}}{\cancel{2}\times 10^{-1}}\times\frac{1}{\sqrt{2}}$$

$$= \frac{9\pi}{\sqrt{2}}\times 10^{12}$$

$$|E_+| = |E_-|$$

$$E_{net} = \sqrt{|E_+|^2 + |E_-|^2 +}$$

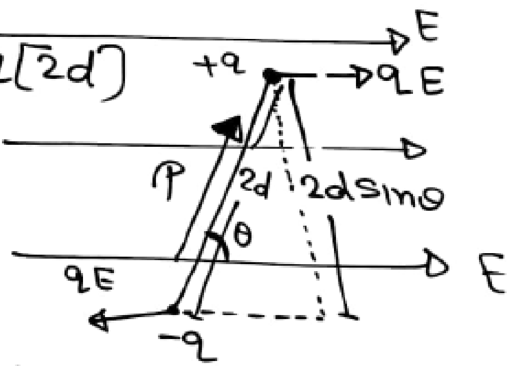
$$= \sqrt{E^2 + E^2} = E\sqrt{2}$$

$$E_{net} = \frac{9\pi}{\cancel{\sqrt{2}}}\times 10^{12}\times\cancel{\sqrt{2}} = \boxed{9\pi\times 10^{12}\ N/C}$$

Torque on dipole in Uniform Electric field :-

$$\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta$$
$$= 2d \times qE\sin\theta$$
$$= 2qEd\sin\theta$$

$P = q[2d]$



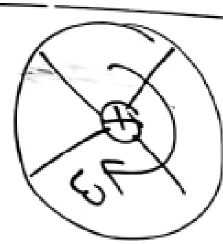
$$F_{net} \text{ on dipole} = \underline{\underline{0}}$$
$$qE(\hat{i}) + qE(-\hat{i}) = \underline{\underline{0}}$$
$$qE\hat{i} - qE\hat{i} = 0$$

τ = Torque

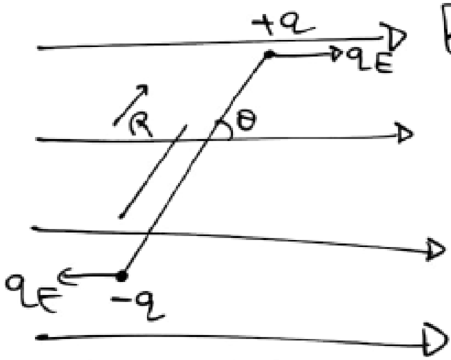
$\otimes$

τ = (Couple of force) x distance b/w them.

$$\tau = (qE)\, 2d\sin\theta$$
$$= (q2d)\, E\sin\theta$$
$$\tau = PE\sin\theta \Rightarrow \vec{\tau} = \vec{P} \times \vec{E}$$



Torque on dipole in Uniform Electric field :-



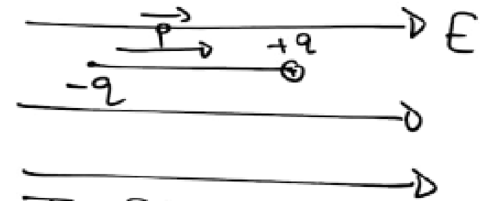
θ = angle b/w Electric field & dipole moment vector.

$$\overline{\tau} = r \times \overline{F}$$

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

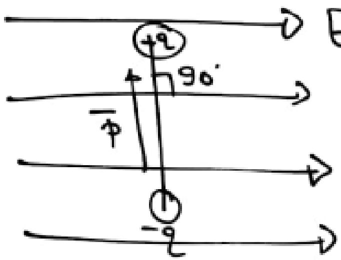
$$\boxed{\tau = PE\sin\theta}$$

① If θ = 0° [dipole is parallel to electric field vector]



$\tau = PE\sin 0° = 0$

ⓑ θ = 90° [dipole ⊥ to $\overline{E}$]

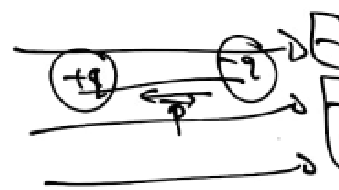


$\tau = PE\sin 90°$

$\boxed{\tau = PE}$

τ_{max}

ⓒ If θ = 180° [dipole is antiparallel to electric field]



$\boxed{\tau = 0}$

Q10) NCERT) An electric dipole with dipole moment 4×10^{-9} C-m is aligned at 30° with the dirn of a uniform electric field of magnitude 5×10^{4} N/C. Calculate the magnitude of the torque acting on the dipole.

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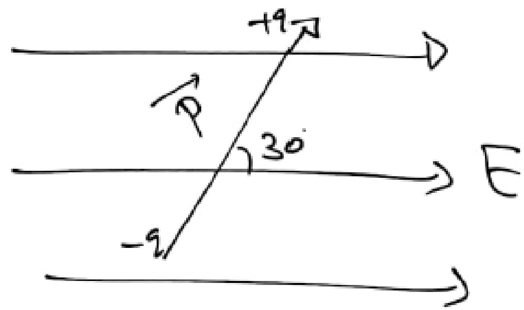
$P = 4\times10^{-9}$ C-m $\quad \bar{E} = 5\times10^{4}$

$\theta = 30^\circ$



$\tau = PE\sin30^\circ$

$= 4\times10^{-9}\times5\times10^{4}\times\frac{1}{2}$

$= 10\times10^{-5}$

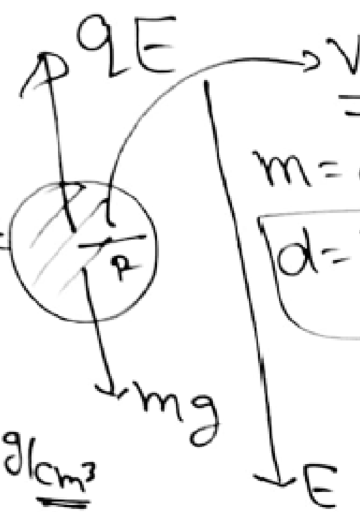
$= 10^{-4}$ N-m

Q25 NCERT

27 **

$$\boxed{qE = mg}$$

$q = -19.2 \times 10^{-19}\,C$



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30 27
33

$$\text{Volume} = \boxed{\frac{4}{3}\pi r^3}$$

$m = dV$

$$\boxed{d = \frac{m}{V}}$$

12 electron excess

$q = 12\,e^-$

$= 12 \times -1.6 \times 10^{-19}\,C$

$= -19.2 \times 10^{-19}\,C$

$d_{oil} = 1.26\,g/cm^3$

$r = ?,\ g = 9.8\,m/s^2$ $\quad 2.55 \times 10^4\,N/C$

$d_{oil} = 1.26 \times 10^{-3}\,kg/(10^{-2})^3 m^3$

$= 1.26 \times 10^{-3} \times 10^{6}\,kg/m^3$

$$\boxed{d = 1.26 \times 10^{3}\,kg/m^3}$$

$qE = mg$

$19.2 \times 10^{-19} \times 2.55 \times 10^4 = 1.26 \times 10^3 \times \frac{4}{3}\pi r^3 \times 9.8$

$$\boxed{r = ?}$$

Q NCERT 27) (AIIMS) In a certain region of space, electric field is along the z-dirn throughout. The magnitude of electric field is, however, not constant but increases uniformly along the +z-dirn at the rate of 10^5 N/m-C. What are the force and torque experienced by a system having total dipole moment equal to 10^{-7} C-m in negative z dirn.

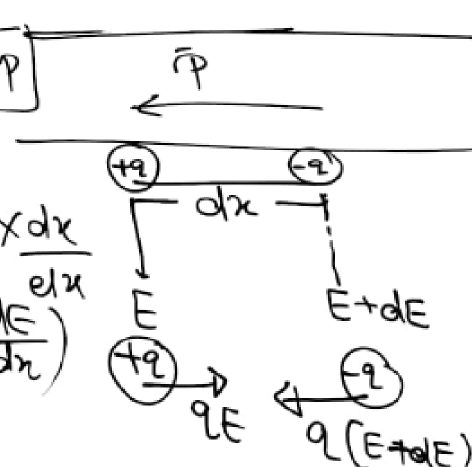
Solve

$P = 10^{-7}$ C-m

$$\boxed{F = P\left|\frac{dE}{dx}\right|}$$

$$\boxed{q \times dx = p}$$

$$\frac{dE}{dx} = 10^5 \frac{N}{m\text{-}C}$$



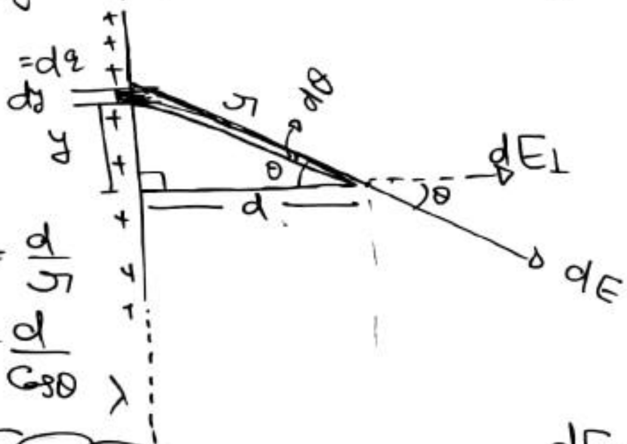
$$q\,dE \times \frac{dx}{dx}$$

$$(q\,dx)\times\left(\frac{dE}{dx}\right)$$

$$F_{net} = q(E+dE) - qE$$
$$= q\,dE$$
$$= (q\,dx)\left(\frac{dE}{dx}\right)$$
$$= P\left(\frac{dE}{dx}\right)$$
$$= 10^{-7}\times 10^{5} = 10^{-2}\ N \ (-z \text{ dirn})$$

30) (NCERT) Obtain the formula for the electric field due to a long thin wire of uniform linear-charge density λ without using Gauss' Law?

Sol)



$\cos\theta = \frac{d}{r}$

$r = \frac{d}{\cos\theta}$

$r = d\sec\theta$

$$\boxed{dq = \lambda\, dy}$$

$$dE = \frac{K\,dq}{r^2} = \frac{K\lambda\, dy}{d^2 \sec^2\theta}$$

$$\tan\theta = \frac{y}{d} \Rightarrow y = d\tan\theta$$

$$dy = d\sec^2\theta\, d\theta$$

$$dE = \frac{K\lambda \cancel{d}\,\cancel{\sec^2\theta}\, d\theta}{d^{\cancel{2}}\,\cancel{\sec^2\theta}} = \frac{K\lambda\, d\theta}{d}$$

$$dE_\perp = dE\cos\theta$$

$$\int dE_\perp = \int_{-\pi/2}^{\pi/2} \frac{K\lambda\cos\theta\, d\theta}{d} \Rightarrow E_\perp = \frac{K\lambda}{d}\left(\sin\theta\right)_{-\pi/2}^{\pi/2}$$

$$\therefore E_\perp = \frac{K\lambda}{d}\left[\sin\frac{\pi}{2} - \sin\left(-\frac{\pi}{2}\right)\right]$$

$$E_\perp = \frac{K\lambda}{d}\left[1+1\right] = \boxed{\frac{2K\lambda}{d}} = \frac{2\lambda}{4\pi\varepsilon_0 d} = \boxed{\frac{\lambda}{2\pi\varepsilon_0 d}}$$