Padasalai's
Telegram Groups!

(தலைப்பிற்கு கீழே உள்ள லிங்கை கிளிக் செய்து குழுவில் இணையவும்!)

- Padasalai's NEWS - Group

https://t.me/joinchat/NIfCqVRBNj9hhV4wu6_NqA

- Padasalai's Channel - Group

https://t.me/padasalaichannel

- Lesson Plan - Group

https://t.me/joinchat/NIfCqVWwo5iL-21gpzrXLw

- 12th Standard - Group

https://t.me/Padasalai_12th

- 11th Standard - Group

https://t.me/Padasalai_11th

- 10th Standard - Group

https://t.me/Padasalai_10th

- 9th Standard - Group

https://t.me/Padasalai_9th

- 6th to 8th Standard - Group

https://t.me/Padasalai_6to8

- 1st to 5th Standard - Group

https://t.me/Padasalai_1to5

- TET - Group

https://t.me/Padasalai_TET

- PGTRB - Group

https://t.me/Padasalai_PGTRB

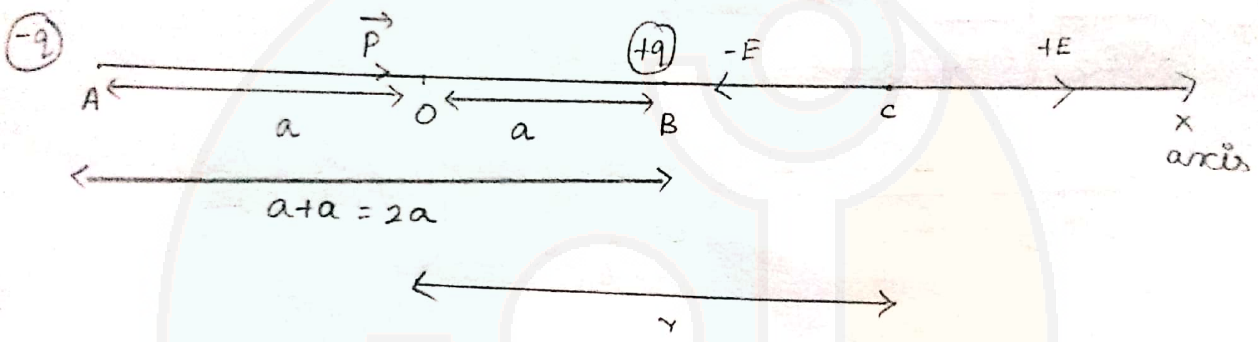
- TNPSC - Group

https://t.me/Padasalai_TNPSC

factor was discarded

Unit 1 XII - Physics - 2020

Axial line Electric field in electric dipole moment



$-q \rightarrow$ negative charge

$+q \rightarrow$ Positive charge

$P \rightarrow$ dipole moment

$2a \rightarrow$ Very small distance

A and B $\rightarrow$ two points

$O \rightarrow$ centre of the Point

$r \rightarrow$ distance

$E \rightarrow$ Total electric field

+q charge (Electric field)

$$E_+ = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{(r-a)^2}$$

-q charge (Electric field)

$$E_- = \frac{1}{4\pi\varepsilon_0}\left[\frac{-q}{(r+a)^2}\right]$$

$$E_- = -\frac{1}{4\pi\varepsilon_0}\frac{q}{(r+a)^2}$$

Total Electric field

$$\boxed{E_{total} = E_+ + E_-}$$

$$E_{total} = \left(\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)^2}\right) + \left(-\frac{1}{4\pi\varepsilon_0}\frac{q}{(r+a)^2}\right)$$

$$E_{total} = \left(\frac{q}{4\pi\varepsilon_0} \cdot \frac{1}{(r-a)^2}\right) - \frac{q}{4\pi\varepsilon_0} \cdot \frac{1}{(r+a)^2}$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right]$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{(r+a)^2 - (r-a)^2}{(r-a)^2(r+a)^2}\right]$$

$$(r+a)^2 = r^2+a^2+2ra$$

$$(r-a)^2 = r^2+a^2-2ra$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{(r^2+a^2+2ra)-(r^2+a^2-2ra)}{(r^2-a^2)^2}\right]$$

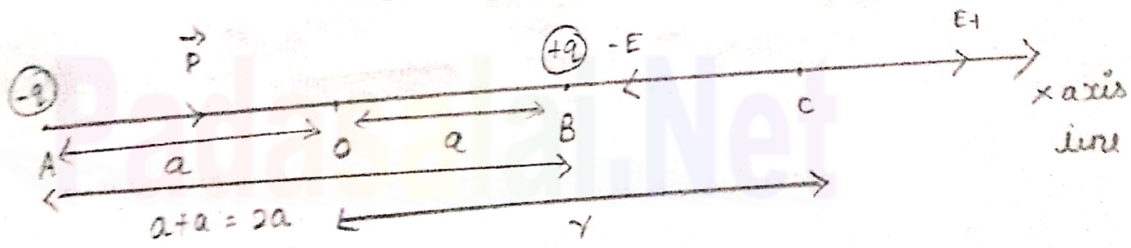
$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{\cancel{r^2}+\cancel{a^2}+2ra-\cancel{r^2}-\cancel{a^2}+2ra}{(r^2-a^2)^2}\right]$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{2ra+2ra}{(r^2-a^2)^2}\right]$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{4ra}{(r^2-a^2)^2}\right] \quad (r>>a)$$

$\therefore$ a is neglected

$(r>>a)$



$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{4ra}{(r^2)^2}\right]$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0}\left[\frac{4ra}{r^4}\right]$$

$$E_{total} = \frac{q}{4\pi\varepsilon_0} \cdot \frac{4a}{r^3}$$

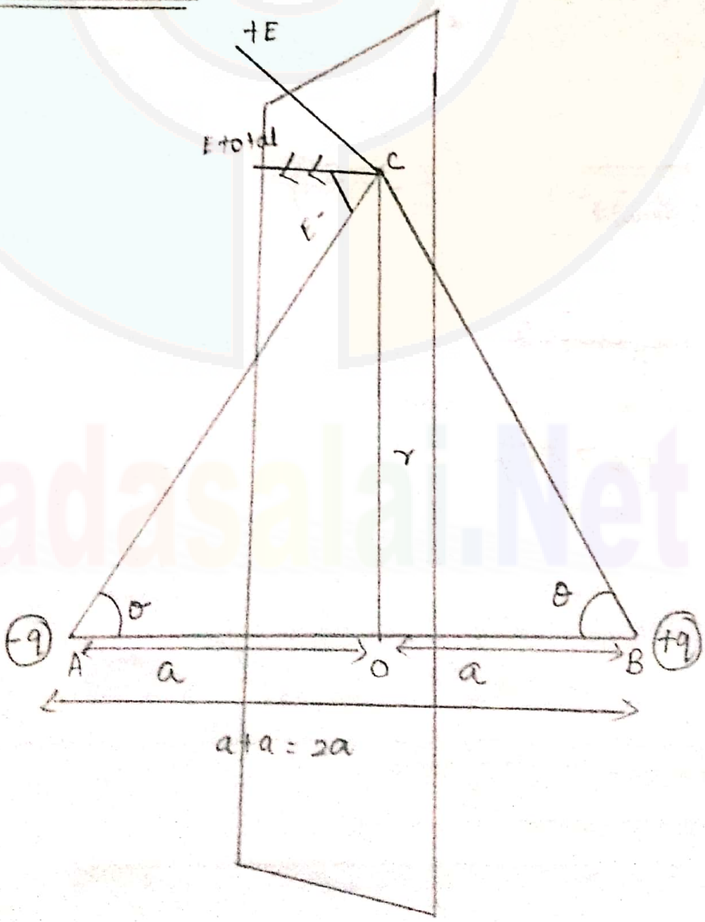
$$E_{total} = \frac{q \times 4a}{4\pi\varepsilon_0 r^3}$$

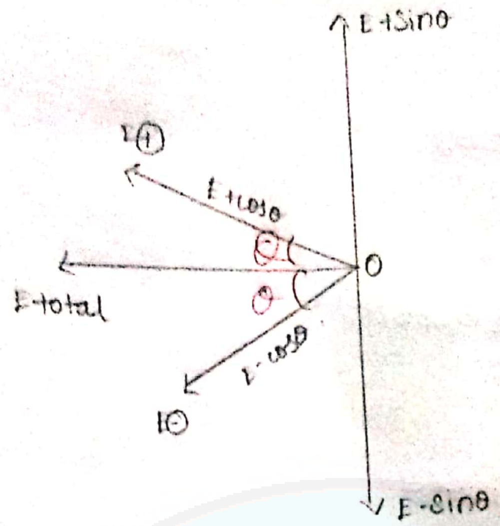
$\therefore [q \times 4a = 2p]$

$$E_{total} = \frac{2p}{4\pi\varepsilon_0 . r^3}$$

$$\boxed{E_{total} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3}}$$

2) Equatorial line





-q→ negative charge

+q→ Positive charge

O→ centre of point

r→ distance

E→ Total electric field

2a→ very small distance

θ → angle

A and B → two points

E+Sinθ and E-sinθ perpendicular component.

E+sinθ and E-Sinθ in a opposite direction.

E+cosθ and E-cosθ in a parallel component

E+cosθ and E-cosθ in a ~~opposite~~ same direction

E+Sinθ and E-Sinθ cancelled each other (opposite direction).

+q charge (B point)

$$E_+ = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r^2+a^2)^2}$$

-q charge (A point)

$$E_- = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r^2+a^2)^2}$$

Total electric field

$$E_{total} = -(E+\cos\theta) - (E-\cos\theta)$$

$$E_{total} = -\frac{1}{4\pi\epsilon_0} \frac{q}{(r^2+a^2)^2} 2\cos\theta$$

$$E_{total} = -\frac{q}{4\pi\epsilon_0} \cdot \frac{1}{(r^2+a^2)^2} 2\cos\theta$$

$$\boxed{\cos\theta = \frac{a}{\sqrt{r^2+a^2}}}$$

$$E_{total} = \frac{-q}{4\pi\epsilon_0} \frac{1}{(r^2+a^2)^2} \frac{a}{\sqrt{r^2+a^2}} \times 2$$

$$E_{total} = \frac{-q}{4\pi\epsilon_0} \cdot \frac{a}{(r^2+a^2)^2\sqrt{(r^2+a^2)}} \times 2$$

$$E_{total} = \frac{-q}{4\pi\epsilon_0} \cdot \frac{a}{(r^2+a^2)^{2+1/2}} \times 2$$

$$E_{total} = \frac{-q}{4\pi\epsilon_0} \cdot \frac{a}{(r^2+a^2)^{3/2}} \times 2$$

$$E_{total} = -\frac{q}{4\pi\epsilon_0} \cdot \frac{2a}{(r^2+a^2)^{3/2}}$$

$(r >> a)$ a is neglected

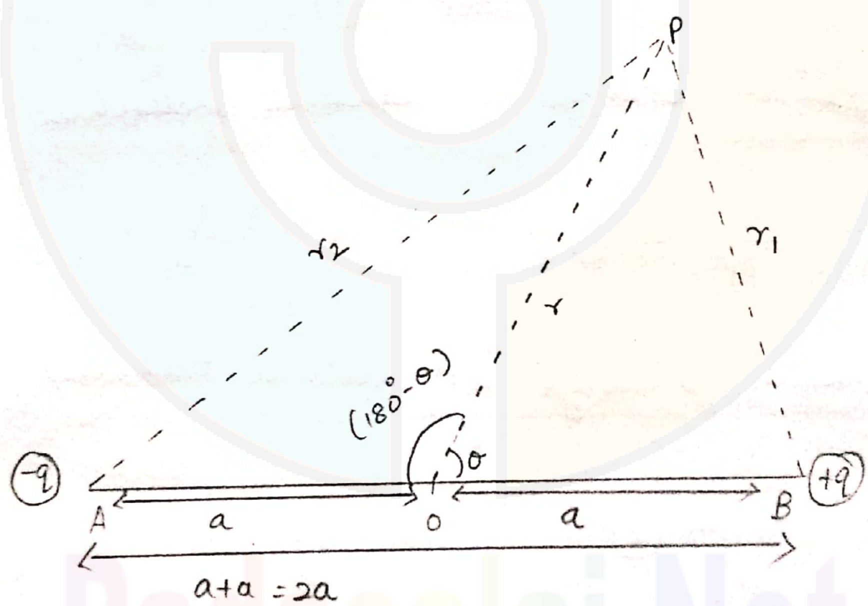
$$E_{total} = -\frac{q}{4\pi\epsilon_0} \cdot \frac{2a}{(r^2)^{3/2}}$$

$$E_{total} = \frac{-q}{4\pi\varepsilon_0} \cdot \frac{2a}{r^3}$$

$$E_{total} = -\frac{q \times 2a}{4\pi\varepsilon_0 . r^3} \qquad \boxed{q \times 2a = P}$$

$$\boxed{E_{total} = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{P}{r^3}}$$

3) Electrostatic Potential in electric dipole



-q → negative charge

+q → Positive charge

O → centre of the Point

2a → very small distance

r → distance

Angle range θ and $(180°-\theta)$

P → electric dipole moment

A and B → two points

A point in negative charge $(-q)$

B point in Positive charge $(+q)$

$OA = a$

$OB = a$

$AB = 2a$

$OP = r$

$BP = r_1$

$AP = r_2$

B point positive charge in electric potential

$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1} \rightarrow (1)$$

A point positive charge in electric Potential

$$V_2 = \frac{1}{4\pi\varepsilon_0}\left(\frac{-q}{r_2}\right) \rightarrow (2)$$

Total electric field Potential

$$\boxed{V = V_1 + V_2}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1} + \left(\frac{1}{4\pi\varepsilon_0}\left(\frac{-q}{r_2}\right)\right]$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1} - \frac{1}{4\pi\varepsilon_0}\frac{q}{r_2}$$

$$V = \frac{q}{4\pi\varepsilon_0}\frac{1}{r_1} - \frac{q}{4\pi\varepsilon_0}\frac{1}{r_2}$$

$$\boxed{V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_1} - \frac{1}{r_2}\right] \rightarrow (3)}$$

$$\frac{1}{r_1} = ?$$

cosine law

$$\boxed{r_1^2 = r^2 + a^2 - 2ra\cos\theta}$$

$$r_1^2 = r^2\left(1 + \frac{a^2}{r^2} - \frac{2ra\cos\theta}{r^2}\right)$$

$\frac{a^2}{r^2}$ is neglected $(r >> a)$

$$r_1^2 = r^2\left(1 - \frac{2ra\cos\theta}{r^2}\right)$$

$$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$

$$r_1 = r\left(1 - 2a/r\cos\theta\right)^{1/2}$$

Inverse

$$\frac{1}{r_1} = \frac{1}{r}\left(1 - 2a/r\cos\theta\right)^{-1/2}$$

$$\boxed{\frac{1}{r_1} = \frac{1}{r}\left(1 + \frac{a}{r}\cos\theta\right)} \rightarrow 4$$

$$\frac{1}{r_2} = ?$$

$$r_2^2 = r^2 + a^2 - 2ra\cos(180^\circ - \theta)$$

$$\boxed{\begin{array}{l} \cos(180^\circ) = -1 \\ \cos(180^\circ - \theta) = -\cos\theta \end{array}}$$

$$r_2^2 = r^2 + a^2 - 2ra - \cos\theta$$

$$r_2^2 = r^2 + a^2 + 2ra\cos\theta$$

$$r_2^2 = r^2\left(1 + \frac{a^2}{r^2} + \frac{2ra\cos\theta}{r^2}\right)$$

$$r_2^2 = r^2\left(1 + \frac{a^2}{r^2} + \frac{2a\cos\theta}{r}\right) (r >> a) \quad \frac{a^2}{r^2} \text{ is neglected.}$$

$$r_2^2 = r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$

$$r_2 = r\left(1 + \frac{2a\cos\theta}{r}\right)^{1/2}$$

$$\boxed{\frac{1}{r_2} = \frac{1}{r}\left(1 - \frac{a}{r}\cos\theta\right)} \rightarrow 5$$

From 3 equation

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

$$\frac{1}{r_1} = \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$$

$$\frac{1}{r_2} = \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$$

$$V = \frac{q}{4\pi\varepsilon_0}\left[\left(\frac{1}{r}\left(1+\frac{a}{r}\cos\theta\right)\right) - \frac{1}{r}\left(1-\frac{a}{r}\cos\theta\right)\right]$$

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r}\left(1+\frac{a}{r}\cos\theta\right) - \frac{1}{r} + \frac{a}{r}\cos\theta\right]$$

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r}\left[\cancel{1}+\frac{a}{r}\cos\theta - \cancel{1} + \frac{a}{r}\cos\theta\right]\right]$$

$$V = \frac{q}{4\pi\varepsilon_0} \times \frac{1}{r}\left[\frac{a}{r}\cos\theta + \frac{a}{r}\cos\theta\right]$$

$$V = \frac{q}{4\pi\varepsilon_0} \times \frac{1}{r}\left[\frac{2a\cos\theta}{r}\right]$$

$$V = \frac{q}{4\pi\varepsilon_0} \times \frac{2a\cos\theta}{r^2}$$

$$V = \frac{q \times 2a}{4\pi\varepsilon_0 r^2} \times \cos\theta$$

$$V = \frac{p}{4\pi\varepsilon_0 r^2} \times \cos\theta$$

$$\boxed{V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p\cos\theta}{r^2}}$$

case (i) $\theta = 0°$ (Axis line) $+q$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos(0°)}{r^2} \qquad \cos(0°) = 1$$

$$\boxed{V = \frac{1}{4\pi\varepsilon_0} \cdot P/r^2}$$

case (ii) $\theta = 180^\circ$ (axis line) $(-q)$

$$V = \frac{1}{4\pi\varepsilon_0} \frac{P\cos\theta}{r^2} \qquad \boxed{\cos(180^\circ) = -1}$$

$$V = \frac{1}{4\pi\varepsilon_0} \frac{P\cos(180^\circ)}{r^2}$$

$$\boxed{V = -\frac{1}{4\pi\varepsilon_0} \frac{P}{r^2}}$$

case (iii) $\theta = 90^\circ$ (equatorial line)

$$V = \frac{1}{4\pi\varepsilon_0} \frac{P\cos\theta}{r^2} \qquad \boxed{\cos(90^\circ) = 0}$$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{P\cos(90^\circ)}{r^2}$$

$$\boxed{V = 0}$$

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