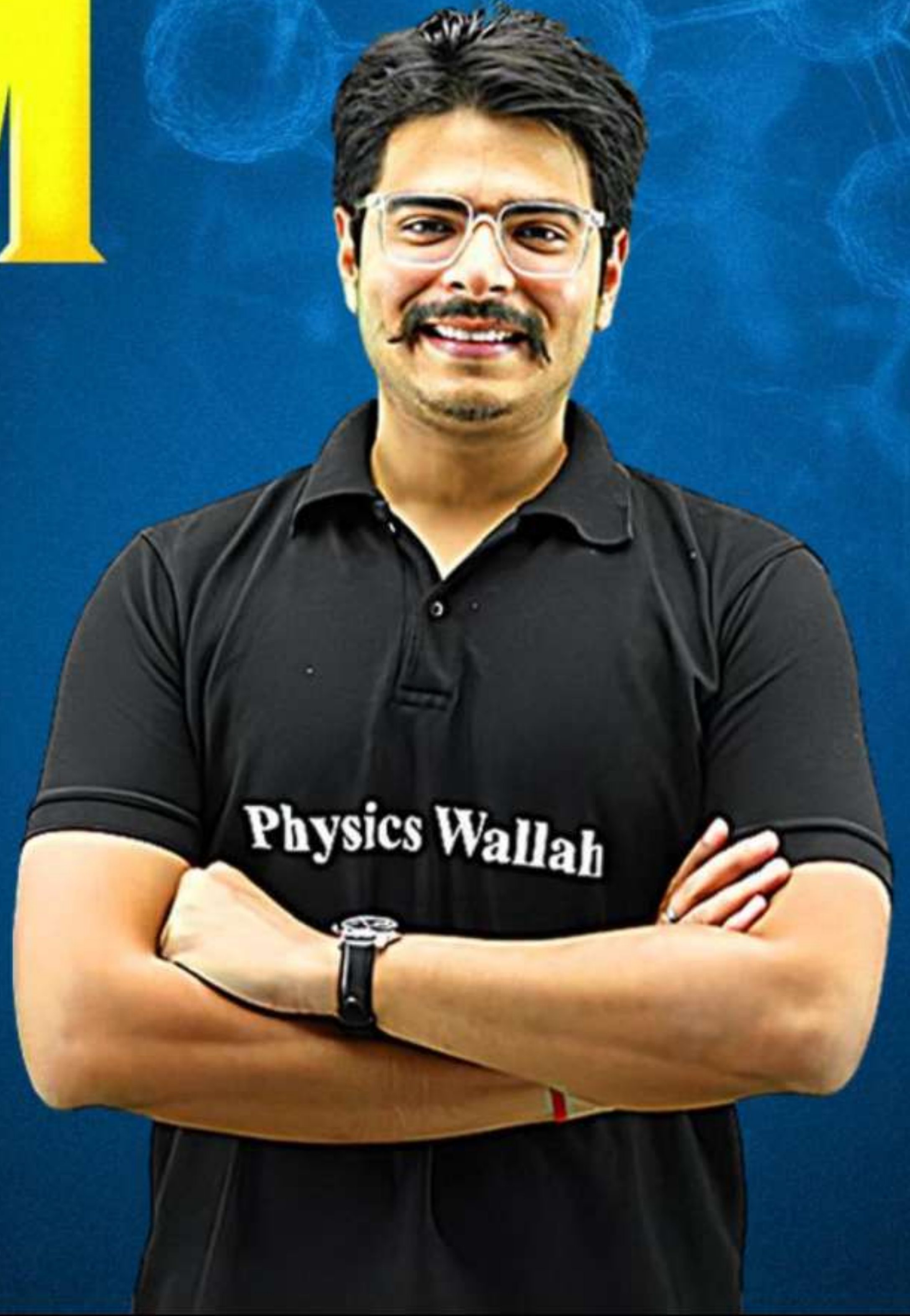
PARISHRAM

2026

Electric Charges and Fields

PHYSICS **LECTURE-1**

BY - RAKSHAK SIR



Topics to be covered

- **A** Introduction to Class XII Physics
- **B** Charge and its properties
- **C**

CLASS XII PHYSICS Kaisi hai ?

Kya Class XII Physics ki Padhai Easy hai Class XI se ?

YES !!!

Kya Class XII Physics ka Board Exam Tough hai Class XI se ?

Yes !!! (last 4 years)

Daudoge to……….. Thak Jaoge
Rukoge to……… Pahuch nahi paaoge

Chalte rahoge to……. Manzil Zarur Mil Jayegi

YAAD RAKHO

DAUDNA NAHI HAI
RUKNA NAHI HAI
BAS
CHALTE REHNA HAI

MY CONTRIBUTION & YOUR CONTRIBUTION

MY CONTRIBUTION	YOUR CONTRIBUTION
I WILL START FROM BASICS (YKB)	I will listen Carefully, try to understand with full efforts
Tricks for CUET/NEET/NDA/JEE (RDx)	Application for MCQs only
Question Practice NCERT, PYQs (SBS)	Written Practice of every subjective question
# Summary Videos after each Chapter for Revision	I will Make short notes
Last what I can offer you is DISCIPLINE ✓	Last what I can offer you is DISCIPLINE ✓

Class XII (2025-2026)

Time: 3 hrs.

Physics (Theory)

Max Marks: 70

Unit

0. Bridge course - 2hr

1. Electric charges and field
2. Potential & capacitance

Electrostatics

3. Current electricity
4. Moving charges and Magnetism
5. Magnetism and matter

Magnetism

6. EMI
7. AC
8. EM Waves

Book - I

Electromagnetism

Class XII (2025-2026)

Time: 3 hrs.

Physics (Theory)

Max Marks: 70

		Marks
Unit-I	**Electrostatics**	
	Chapter-1: Electric Charge and fields	5
	Chapter-2: Electrostatic Potential and Capacitance	5
Unit-II	**Current Electricity**	
	Chapter-3: Current Electricity	6

Big Chapter

Electric Charges and Fields

(2025-26)

Unit I: Electrostatics

Chapter–1: Electric Charges and Fields

Electric charges, Conservation of charge, Coulomb's law-force between two- point charges, forces between multiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric field.

Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Electric Charge

Matter → Molecules → Atom → Electron

Neutron + Proton = 'Nucleons'

Andruni

Its is an intrinsic property of the elementary particles like electrons, protons, etc. of which all the objects are made up of.

- It is a scalar quantity.
- Its SI unit is coulomb (C).
- CGS unit is statcoulomb (e.s.u. of charge)
- **1C = 3 × 10^9 statcoulomb**

+10
−10

Net Charge = 0
(Neutral)

* NOTE

Neutron

Uncharged (Charge absent)

Neutral (Net charge = 0)

- ***Charge on one e = - 1.6 × 10^{-19} coulomb***
- ***Charge on one p = + 1.6 × 10^{-19} coulomb***
- **Mass of one e = 9.1 × 10^{-31} Kg**
- **Mass of one p = 1.6 × 10^{-27} Kg**
- **Mass of one n = 1.6 × 10^{-27} Kg**

Sabse halka Kaun = electron (1800 times Halka)

Electric Charge Transfer

Proton Nahi Hilte

* RDx :-
  - e^- add - Negative charge
  - e^- remove - Positive charge

$5e^-$
$5p^+$

Total charge = 0 (Neutral)

$2e^-$ add

$3e^-$ remove

$e^- > p^+$

$Q_{net} = -Ve$
(Net charge)

$7e^-$
$5p^+$

$2e^-$
$5p^+$

$p^+ > e^-$
(Positively charged)

Negative Bodies (adding electrons)

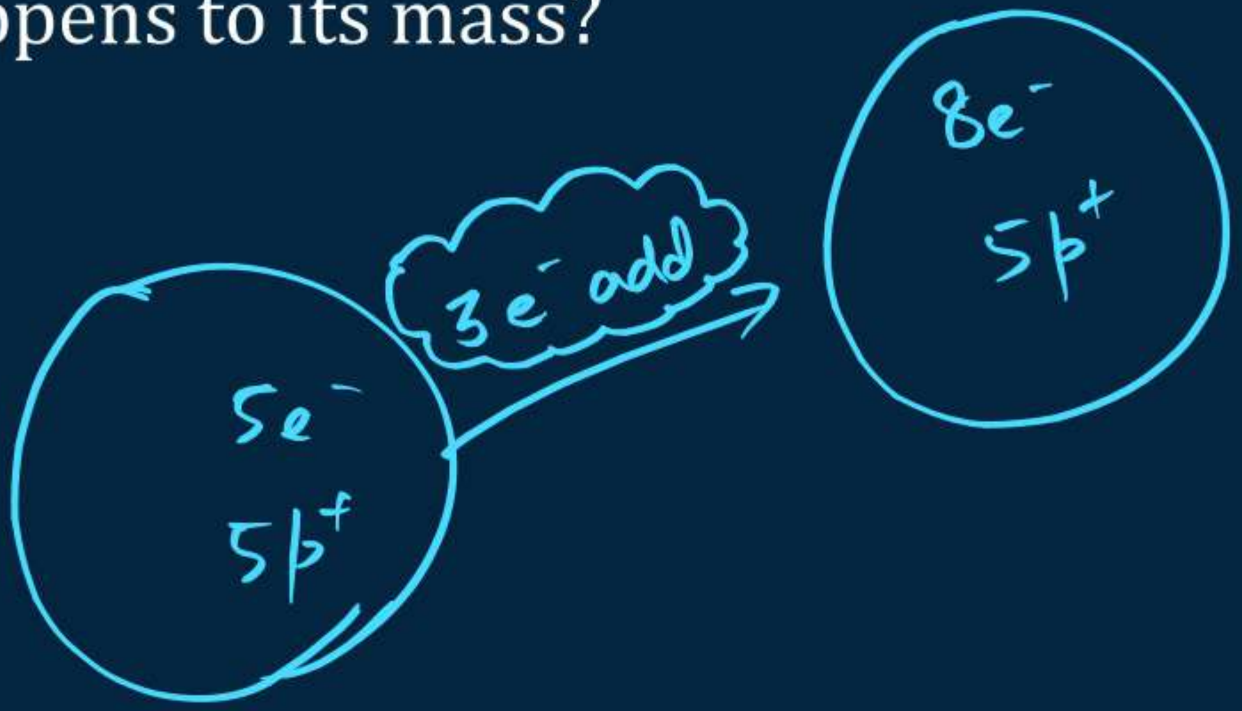
Positive Bodies (removing electrons)

SOCH BETA SOCH (SBS)

A neutral body is charged negatively. What happens to its mass?

- A) Increases
- B) Decreases
- C) Remains Same
- D) Can't Say

e^- add
↓
Mass ↑



SOCH BETA SOCH

A neutral body is charged Positively. What happens to its mass?

e^- remove $\Rightarrow$ Mass $\downarrow$

- A) Increases
- B) Decreases
- C) Remains Same
- D) Can't Say

Basic Properties of Charge

1. Additivity
2. Quantization
3. Conservation
4. Charge is invariant
5. Accelerated Charge radiates Energy

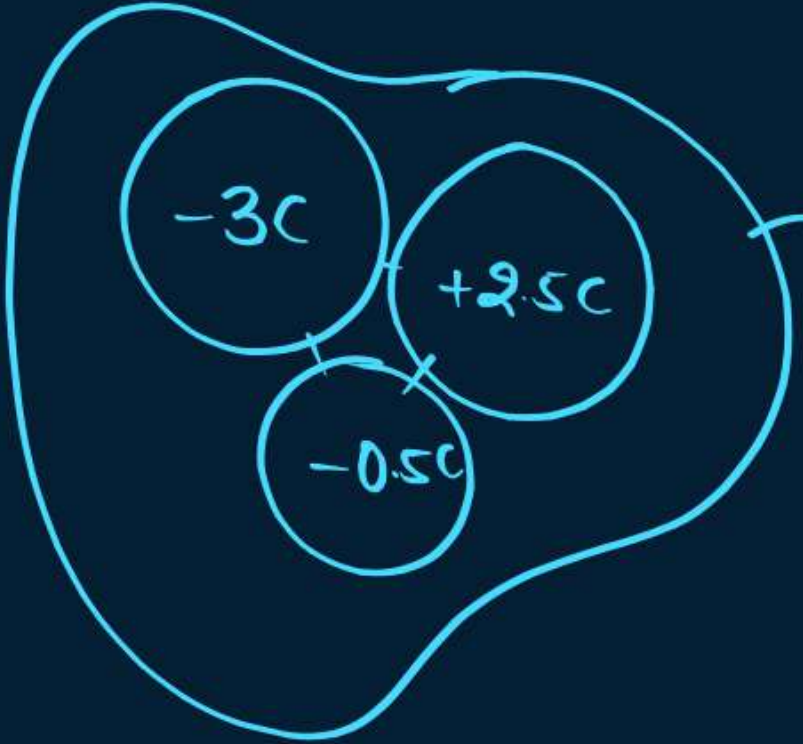
Basic Properties of Charge

1) **Addition of Charges** = $\boxed{\text{Scalar}}$ property

If a system contains three point charges q_1, q_2 and q_3, then the total charge of the system will be algebraic addition of q_1, q_2 and q_3, i.e., charge will add up

$$\boxed{q = q_1 + q_2 + q_3}$$

Eg -



Total charge ⇒ $Q_{net} = Q_1 + Q_2 + Q_3$

$= -3 + 2.5 - 0.5$

$Q_{net} = -1C$

Basic Properties of Charge

Packets Banana

$e^- \rightarrow$ Sabse chota Packet of charge

electronic charge $\Rightarrow \boxed{1e^- = -1.6 \times 10^{-19}\,C}$

* **Quantization of charges**

Electric charges is always quantized, i.e., electric charge is always an integral multiple of charge '*e*'.

$q = ne$, where $n = 0, \pm1, \pm2, \ldots\ldots\ldots$

'Integer'

$\boxed{Q = ne}$

Net Charge

Integer

electronic charge ($1.6 \times 10^{-19}\,C$)

$1e^- = 1.6 \times 10^{-19}\,C$

$2e^- = 2 \times 1.6 \times 10^{-19}\,C$

$3e^- = 3 \times 1.6 \times 10^{-19}\,C$

$4e^- = 4 \times 1.6 \times 10^{-19}\,C$

$5e^- = 5 \times 1.6 \times 10^{-19}\,C$

Not Allowed $\leftarrow \boxed{5.5e^- = 5.5 \times 1.6 \times 10^{-19}\,C}$

$6e$

$7e$

$\vdots$

ne

QUESTION

positively

पाप

How many electrons to be removed from a body to charge it by 1C ? $= 6.25 \times 10^{18}$

$n = ?$

$$Q = ne$$

?

$$1 = n \times 1.6 \times 10^{-19}$$

$$n = \frac{1}{1.6 \times 10^{-19}}$$

$$= \frac{10^{19}}{16} \times 10$$

$$n = \frac{10^{18}}{\cancel{16}} \times \cancel{100} = 6.25 \times 10^{18}$$

$$\boxed{n = 6.25 \times 10^{18} \text{ electrons add / remove}}$$

Negatively

positively

QUESTION

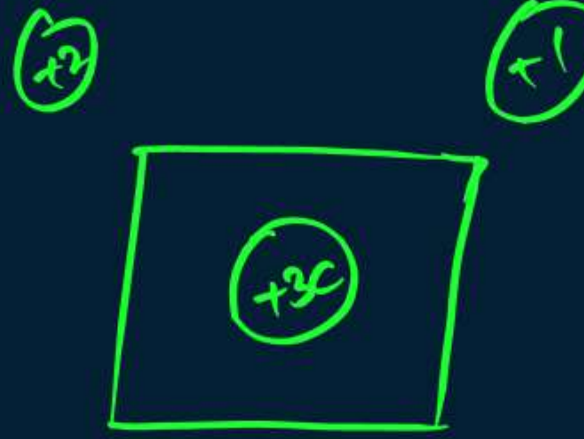
How many electrons to be removed from a body to charge it by 2C ?

$1C \longrightarrow 6.25 \times 10^{18}$ electrons

$2C \longrightarrow 2 \times 6.25 \times 10^{18}$

$= 12.5 \times 10^{18}$ electrons

Basic Properties of Charge



Conservation of charges

Law of conservation of charge

Cut-off

1. The total charge of an isolated system remains constant.
2. The electric charges can neither be created nor destroyed, they can only be transferred from one body to another.

Basic Properties of Charge

4. **Charge is $\boxed{\text{invariant}}$** $\to$ Same / $\to$ change

Charge is independent of frame of reference. i.e., charge on a body does not change whatever be its speed.

* Mass

$m \longrightarrow$

$v \approx c \to$ speed of light

$m \to \infty \to$ infinite mass

$$\boxed{m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}}$$

* Charge

$+q \longrightarrow$

$v = c$

$q = q$

$$\cancel{q = \frac{q_0}{\sqrt{1-\frac{v^2}{c^2}}}}$$

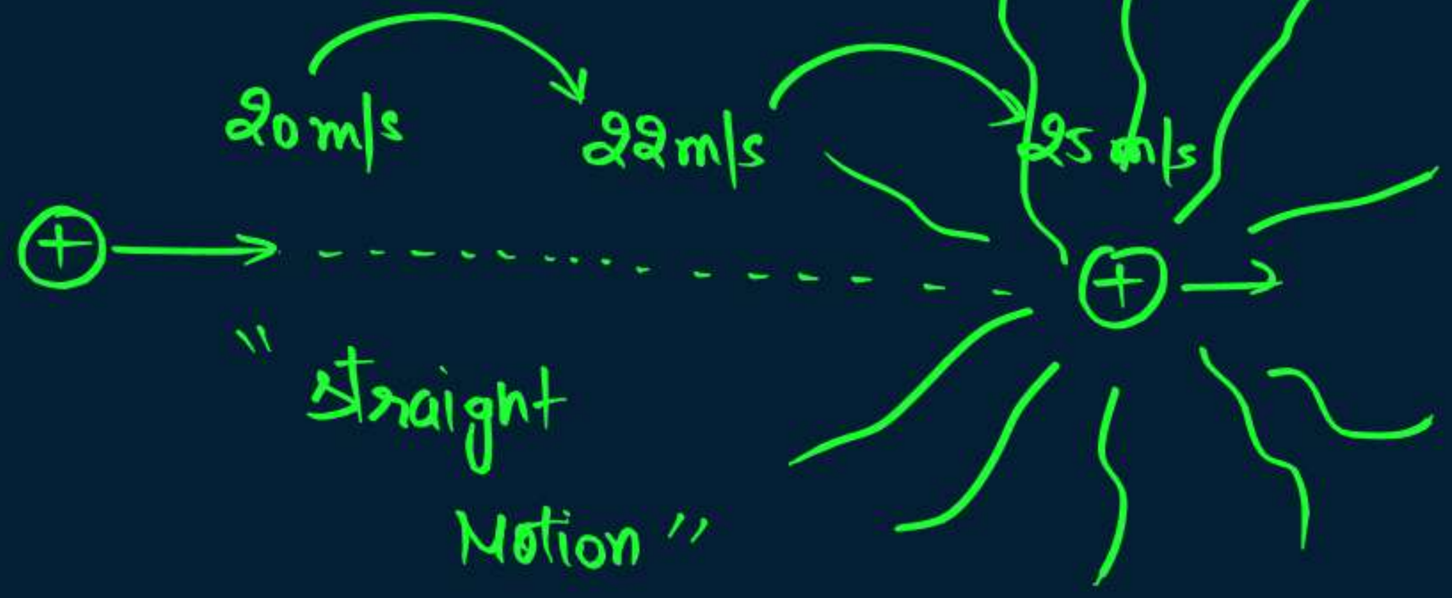
Basic Properties of Charge

Drawback

Rutherford Atomic Model

5. Accelerated Charge $\boxed{\text{Radiates Energy}}$ → E.M. Waves.

"Circular Motion"



Neils Bohr ✓

BOARDS PYQ

Calculate the charge carried by 12.5×10^{8} electrons.

$$\boxed{Q = ne}$$

$$= 12.5 \times 10^{8} \times 1.6 \times 10^{-19}$$

$$\boxed{Q = -20 \times 10^{-11}\ C}$$

NCERT

H.W.

If a body gives out 10^9 electrons every second, how much time is required to get a total charge of 1C from it?

Permanant

Homework

→ 1. Notes complete (within 45 mins)

→ 2. Revision of prvs. lec before coming to class.

AAKHRI SAAL HAI

JAAN LAGA DE

Thank You


PARISHRAM
2026
Electric Charges and Fields
PHYSICS
LECTURE-2
BY - RAKSHAK SIR
Physics Wallah

Topics to be covered

- **A** Methods of Charging
  - By friction
  - By conduction
  - By induction
- **B** Specific Charge ✓
- **C** Coulomb's Law ✓

HW QUESTION

1s

#Q. If a body gives out 10^9 electrons every second, how much time is required to get a total charge of $\boxed{1C}$ from it?

How many e^- are there in 1C?

Ans- 6.25×10^{18} ✓

10^9 electrons $\longrightarrow$ 1 s $\Rightarrow$ $1e^- \longrightarrow \frac{1}{10^9}$ s

6.25×10^{18} electrons $\longrightarrow 6.25 \times 10^{\cancel{18}\,9} \times \frac{1}{\cancel{10^9}}$

$= 6.25 \times 10^9$ s

$= \frac{6.25 \times 10^9}{60 \times 60 \times 24 \times 365} \approx$ '198 years'

Types of materials on the basis of charge flow

1. **Conductors**
   - free flow of electrons are allowed
   - abundance of free electrons
   - Yes, they can be charged, by conduction

Class 12th Last ch

2. **Semi-conductors**
   - electrons flow moderately
   - Charge carriers - (electrons + holes) → Later ON!!!
   - Yes, they can also be charged.

3. **Insulators**
   - Almost zero flow
   - Absence of free electrons (Almost Nil)
   - Yes, they can also be charged :- By friction, By induction

Methods of Charging

1. Charging by Friction ⇒ Rubbing ⇒ Heat generate ⇒ e^- ka Thermo-emission

When two bodies are rubbed together, electrons are transferred from one to another

e^-

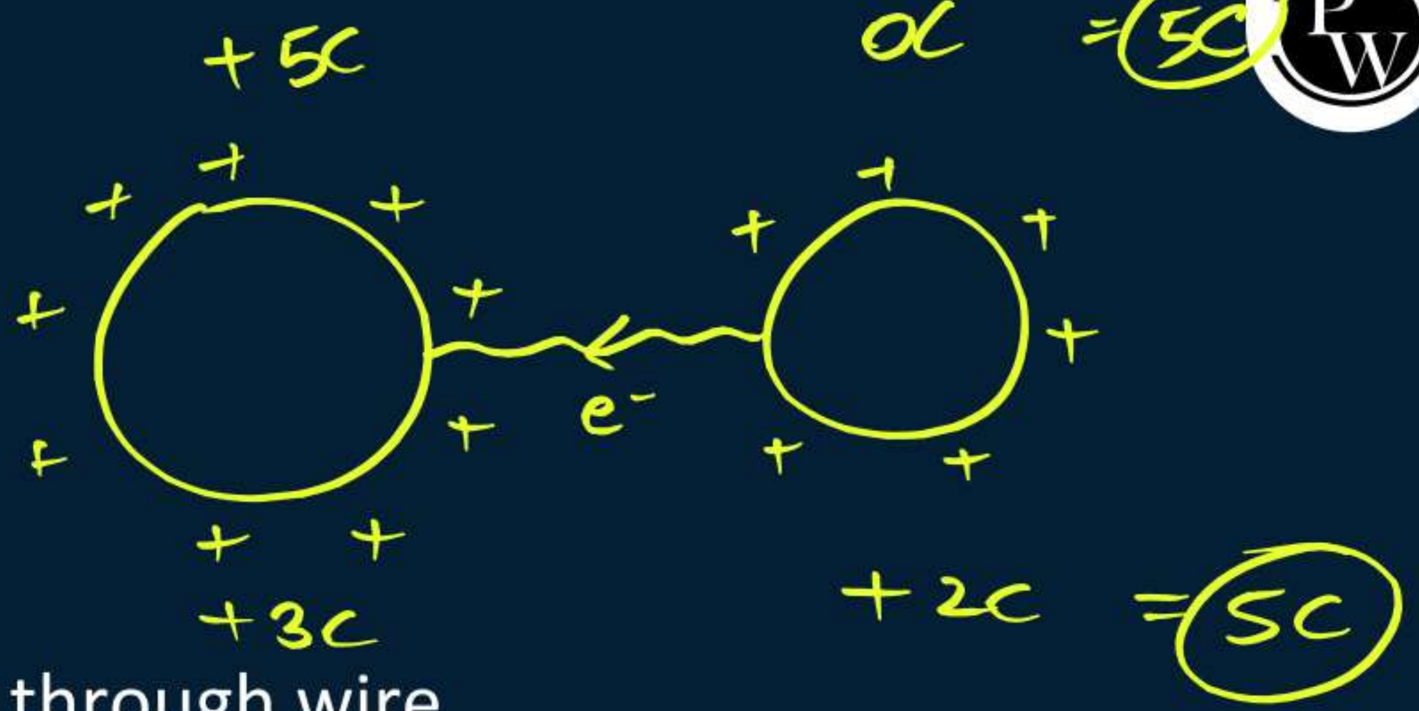
Ex- Glass Rod rubbed with Silk , $\boxed{E}$bonite Rod rubbed with Fur

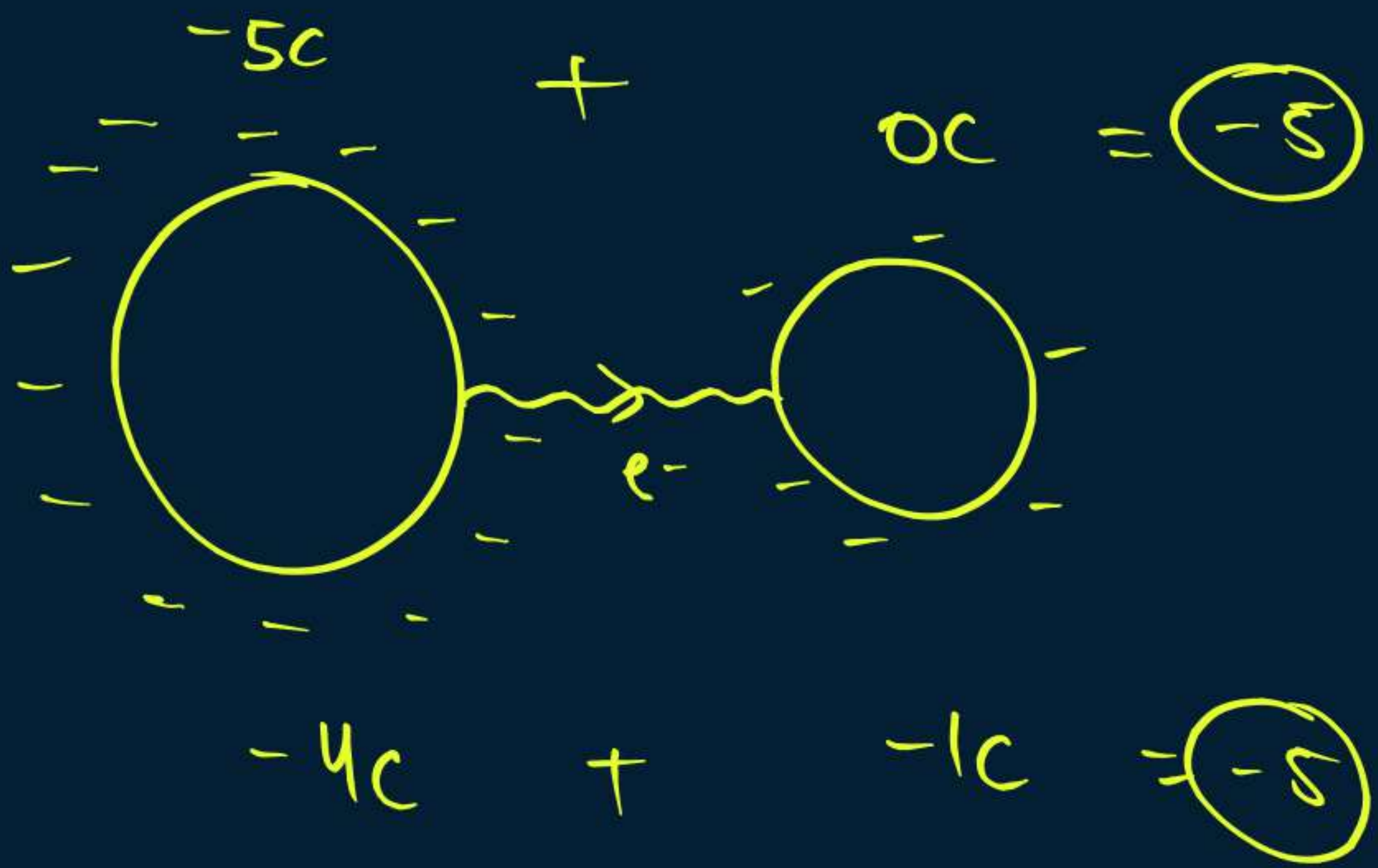
RDx :- Ebonite ke E se e^- YAAD RAKHO

Methods of Charging

2. Charging by Conduction

- Only for Conductors — charge flow is allowed.
- By touching two conducting bodies or connected through wire
- One of the bodies must be charged.



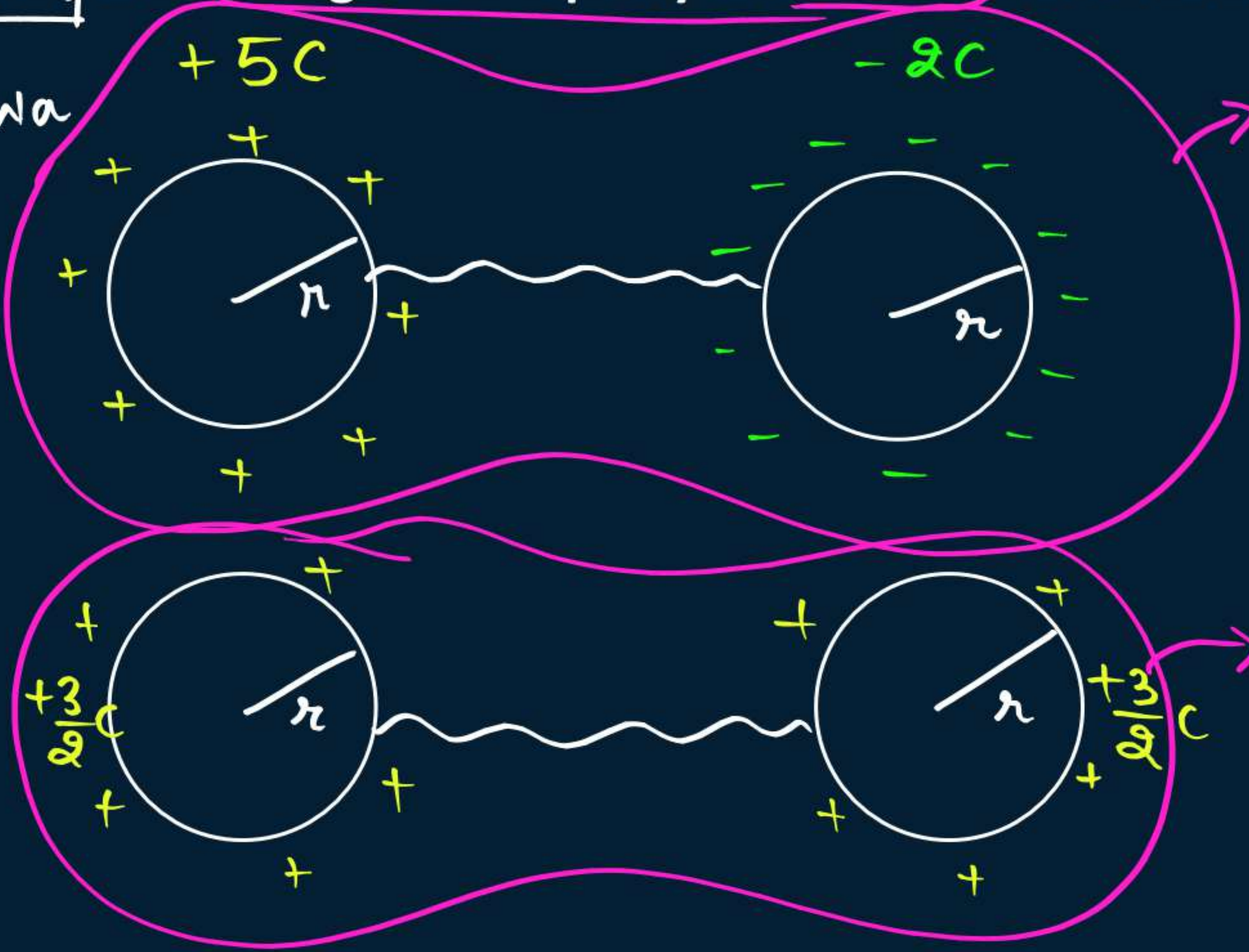


Methods of Charging

Imp.

If bodies are $\boxed{\text{identical}}$, then charges are equally distributed after conduction

Judwa



Total charge (Before) $= +5-2$
$= +3C$

$= +\frac{3}{2}+\frac{3}{2} =$

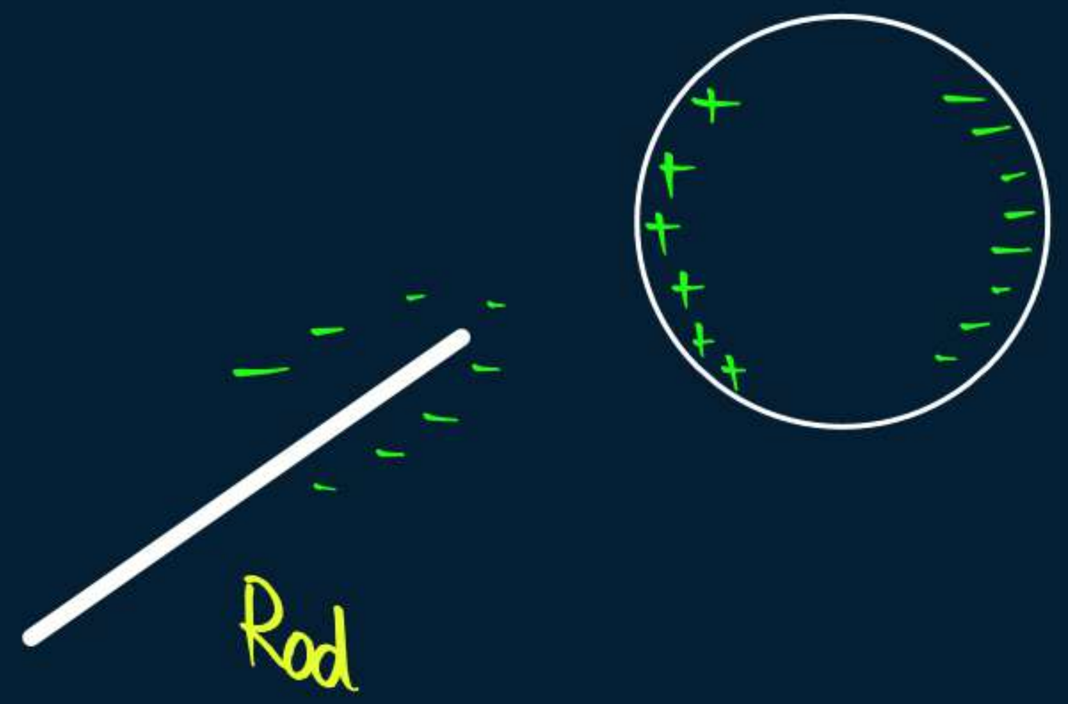
Total charge (After) $= +3C$

Methods of Charging

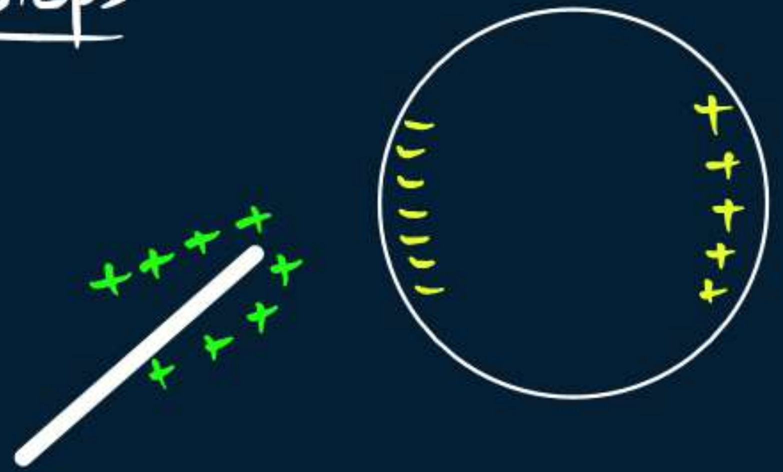
3. Charging by Induction → 'Insulators'

Charged bodies are created using other charged bodies without touching them.

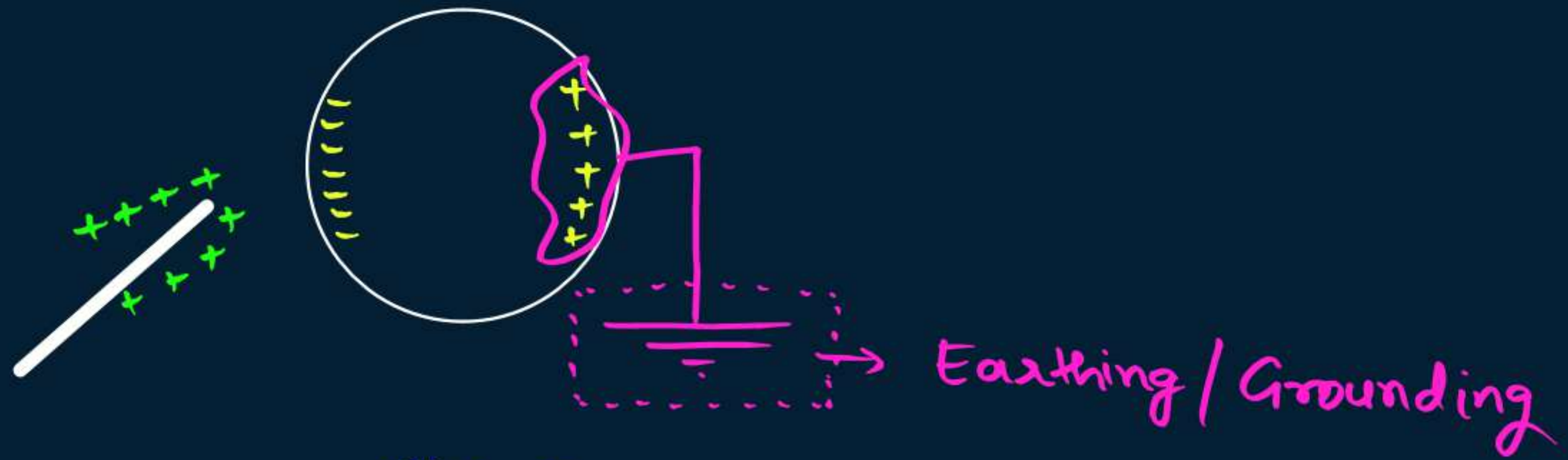
Steps :-



Steps

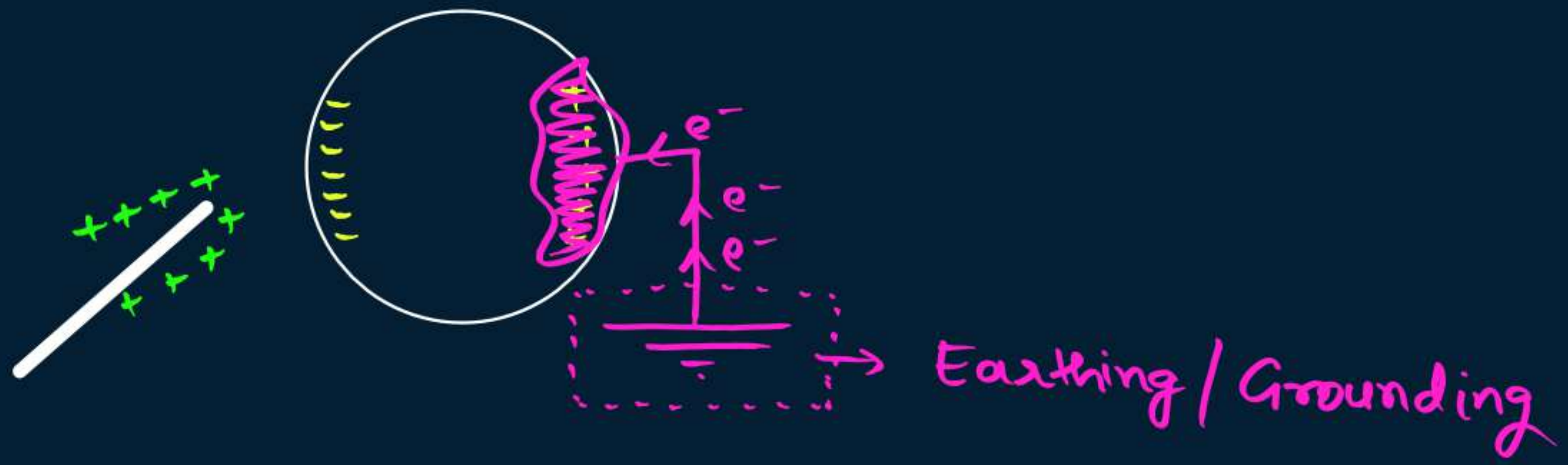


Step- 1



Step- 2

Step - 4



Step - 3

Specific Charge

→ ratio of charge to mass

$$\boxed{S = \frac{q}{m}}$$

q → charge (C)

m → mass (kg)

C/kg

Ex

$S_e > S_p$

$\left(\frac{q}{m\downarrow}\right)_e \uparrow > \left(\frac{q}{m\uparrow}\right)_p \downarrow$

$m_e \downarrow$ $m_p \uparrow$

Forces between Charges = Electrostatic Force

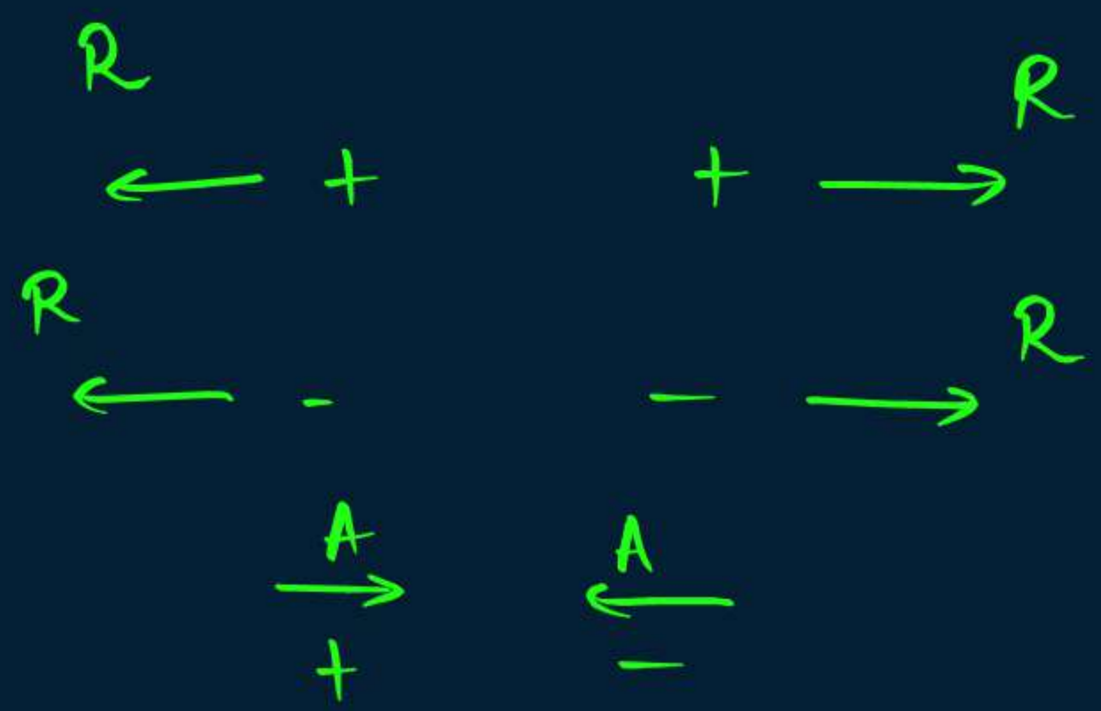
Electro → Charge ki Baat

static → At Rest

Force → Coulombian Force or Coulomb's Force

(Electric force)

6th class



How Much Force? (Coulomb's Law)

Y.K.B.

$$\vec{F}_{1,2} = -\vec{F}_{2,1}$$

(Newton III Law)

$$|F_{1,2}| = |F_{2,1}| = F$$

$\epsilon \rightarrow$ Epsilon

$\epsilon_0 \rightarrow$ Epsilon Not

$$\left.\begin{aligned} F &\propto q_1 q_2 \\ &\propto \frac{1}{r^2} \end{aligned}\right\}$$

$$F \propto \frac{q_1 q_2}{r^2}$$

$$K = \frac{1}{4\pi\epsilon_0}$$

$$F = \left[\frac{1}{4\pi\epsilon_0}\right]\frac{q_1 q_2}{r^2}$$

याद

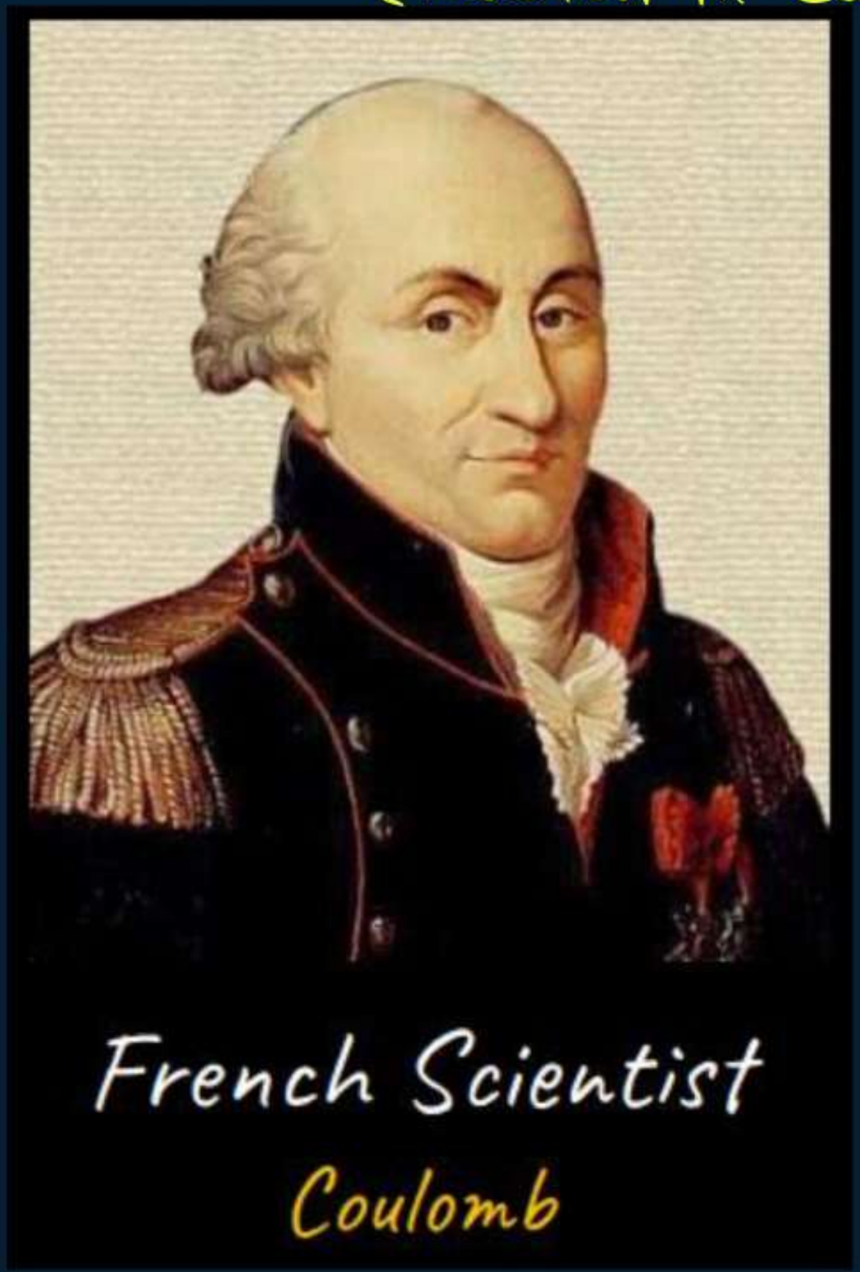
$K \rightarrow$ Coulomb's Constant

* $K = 9 \times 10^9 \ Nm^2C^{-2}$

$\epsilon_0 \rightarrow$ Permittivity of free space

$$\boxed{F = \frac{K q_1 q_2}{r^2}}$$

* $\epsilon_0 = 8.85 \times 10^{-12} \ N^{-1}m^{-2}C^2$



Meaning of Point Charges

Coulomb's Law is valid for $\boxed{\text{point Charges}}$ → in b/w dist >> size of body

When the size of charged bodies are much smaller than the distance between them, then charged bodies are called point Charges.

$r >> r_1$

$r >> r_2$

Ex. Stars in the sky

Not Small, but looks Small

Important Concepts

(1)

Two Charges exert equal and opposite forces on each other.

They form Action-Reaction Pair (Follow Newton's 3rd Law)

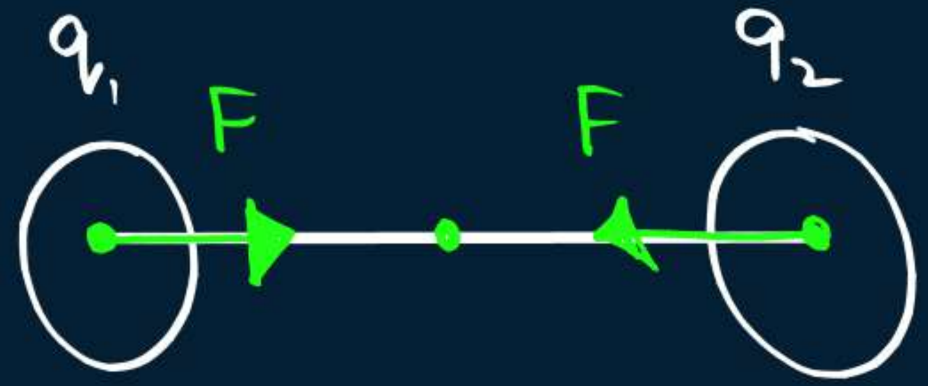
$$\vec{F}_{1,2} = -\vec{F}_{2,1}$$

(2)

Coulomb's Force is a Central Force

(towards centre)

They act along the line joining the centres of two bodies



(3)

Coulomb's Law follows inverse Square Law

$$F = \frac{G m_1 m_2}{r^2}$$

$$F = \frac{K q_1 q_2}{r^2}$$

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

Important Concepts

Y.K.B.

$m_1 \xleftrightarrow{r} m_2$

$F = \frac{G m_1 m_2}{r^2}$

Medium independent

(4)

Coulomb's Force is a long range Force

(upto ∞)

From Nuclear dimension ($r = 10^{-15}$ m) To ($r = 10^{18}$ m)

Q → inside Nucleus ⇒ Nuclear force

(Short range)

(5)

Coulomb's Force depends on the medium

$q_1 \xleftrightarrow{r} q_2$

$F = \frac{k q_1 q_2}{r^2}$

$q_1 \xleftrightarrow{r} q_2$

Water

$F' = \frac{F}{80}$

(6)

Coulomb's Force is a Conservative Force

(Details in ch-2)

i.e., the work done against these forces stored as Potential Energy

Y.K.B.

Conservative

ex - Gravit"

- spring (Elastic)

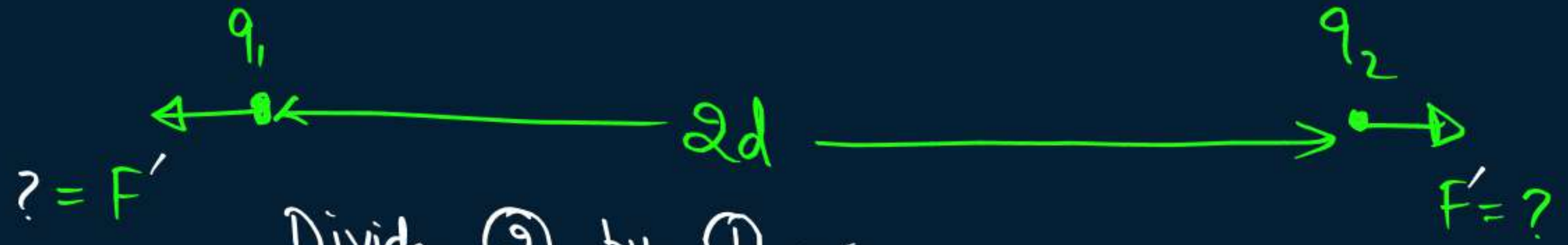
- Electrostatic

SBS

Q1. Two point charges are separated by a distance d repel each other with a force of 4N. If distance between them is changed to 2d, then force will :

$$F = \frac{kq_1q_2}{r^2} \qquad r \to d \qquad F = 4N$$

$$4 = \frac{kq_1q_2}{d^2} \quad \dots\dots (1)$$



$$F' = \frac{kq_1q_2}{(2d)^2}$$

$$F' = \frac{kq_1q_2}{4d^2} \quad \dots\dots (2)$$

Divide (2) by (1) . .

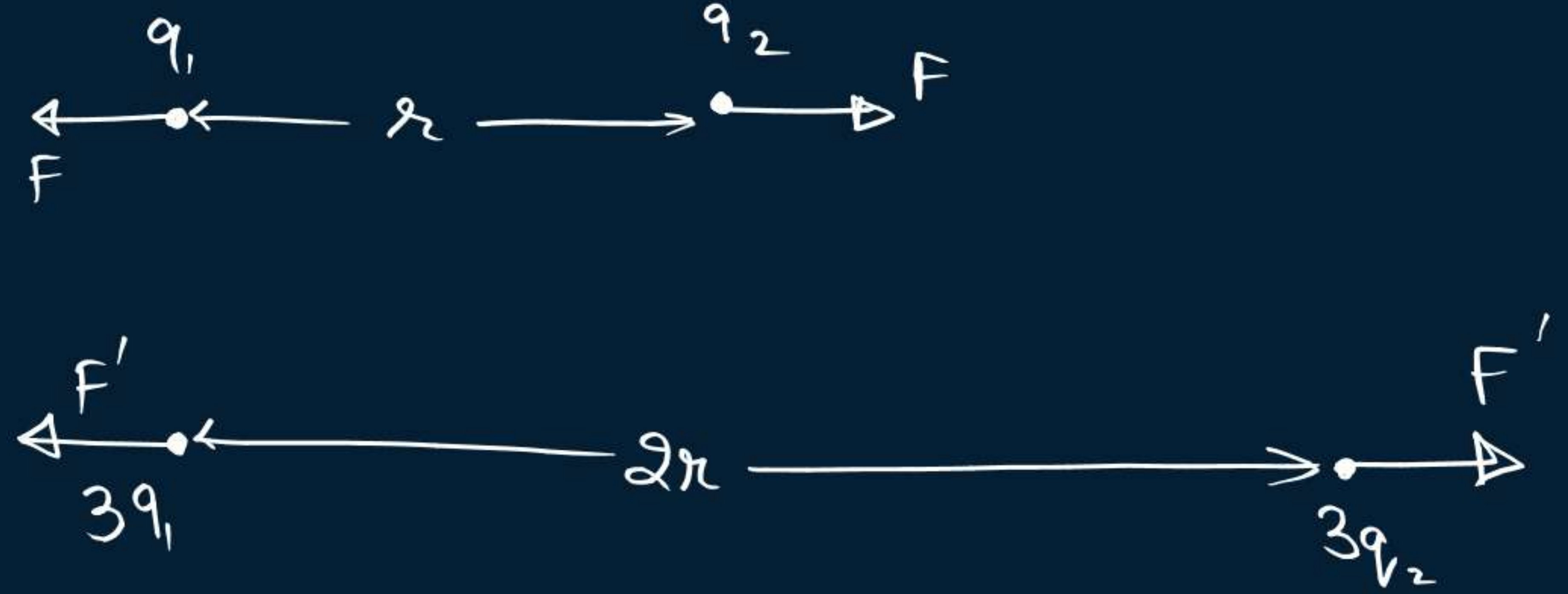
$$\frac{F'}{4} = \frac{\frac{\cancel{k}\cancel{q_1}\cancel{q_2}}{4\cancel{d^2}}}{\frac{\cancel{k}\cancel{q_1}\cancel{q_2}}{\cancel{d^2}}} = \frac{1}{4} \Rightarrow \frac{F'}{4} = \frac{1}{4}$$

$$F' = \frac{\cancel{4}\,1}{\cancel{4}\,1} = 1N \checkmark$$

SBS

H.W.

Q2. Two point charges are separated by some distance, exert a force F. If distance between them is doubled and charges are tripled, then force will :



$F' = \boxed{?}\,F$

SBS

$1nC = 10^{-9}C$

Q3. Two point charges of 1nC are separated by 3cm distance, Find Force ?

$q_1 = 10^{-9}C \qquad q_2 = 10^{-9}C \qquad r = \frac{3}{100}\,m$

$\bullet \longleftarrow r \longrightarrow \bullet$

$$F = \frac{Kq_1q_2}{r^2}$$

$$= \frac{\cancel{9}\times\cancel{10^{9}}\times\cancel{10^{-9}}\times 10^{-9}}{\frac{\cancel{3}}{100}\times\frac{\cancel{3}}{100}} = 10^{-9}\times 10^{4}$$

$$= 10^{-5}N$$

Ans : $F = 10^{-5}N$

Homework

→ Notes ✓

→ DPP ✓

PARISHRAM

2026

Electric Charges and Fields

PHYSICS LECTURE-3

BY - RAKSHAK SIR

Topics to be covered

- **A** Vector form of Coulomb's Law
- **B** Superposition Principle
- **C**

HW QUESTION

#Q. Distance between charges is doubled and charges are tripled in value

$$q_1 \xleftrightarrow{\quad r \quad} q_2 \longrightarrow F = \left[\frac{k q_1 q_2}{r^2}\right]$$

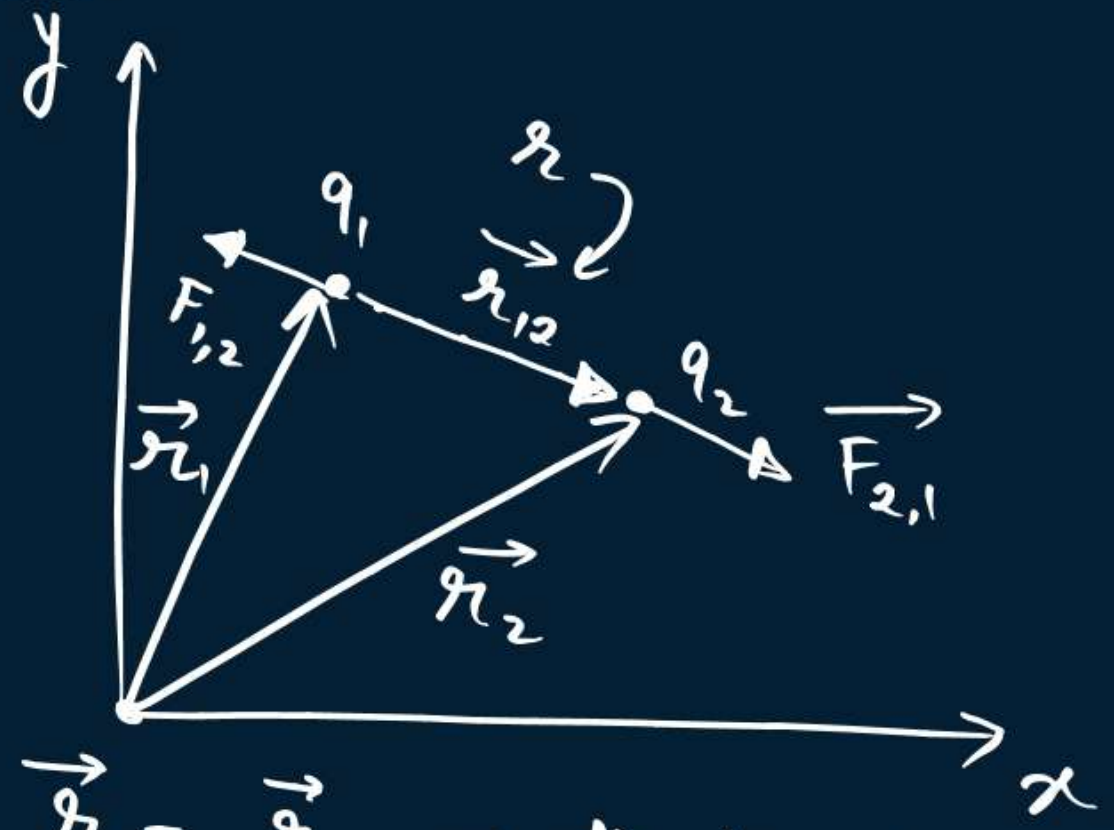
$$3q_1 \xleftrightarrow{\qquad 2r \qquad} 3q_2$$

$$F' = \frac{k\, 3q_1 3q_2}{(2r)^2} = \frac{9}{4}\left(\frac{k q_1 q_2}{r^2}\right)$$

$$F' = \frac{9}{4} F$$

Vector Form of Coulomb's Law

Boards



$\vec{r} = \vec{r}_{1,2} \rightarrow$ direction from 1 to 2

$\vec{r}_{1,2} = |r_{1,2}|\,\hat{r}_{12}$

$\hat{r}_{12} = \dfrac{\vec{r}_{12}}{|r|_{12}}$

$F_{1,2}$ = force on q_1 due to q_2

$F_{2,1}$ = Force on q_2 due to q_1

$$\vec{F}_{2,1} = \left(\frac{kq_1q_2}{r^2}\right)\hat{r}_{1,2}$$

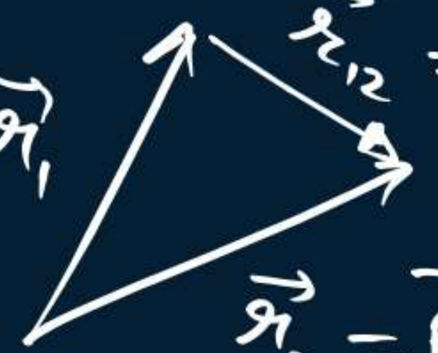
$$\vec{F}_{2,1} = \frac{kq_1q_2}{r^2} \times \frac{\vec{r}_{1,2}}{|r_{12}|}$$

$$\boxed{\vec{F}_{2,1} = \frac{kq_1q_2}{|r_{12}|^3}\,\vec{r}_{1,2}}$$

Y.K.B.

$\vec{A} = |\bar{A}|\,\hat{A}$

$\hat{A} = \dfrac{\vec{A}}{|\bar{A}|}$



$\vec{B} = \vec{r}_1$

$\vec{r}_{12} = \vec{A}$

$\vec{r}_2 = \vec{R}$

$\vec{R} = \vec{A} + \vec{B}$

$\vec{r}_2 = \vec{r}_{12} + \vec{r}_1$

$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1$

$$\vec{F}_{2,1} = \frac{k q_1 q_2}{|r_{12}|^3} \vec{r}_{12}$$

$$\boxed{\vec{F}_{2,1} = \frac{k q_1 q_2}{|\vec{r}_2 - \vec{r}_1|^3} \vec{r}_2 - \vec{r}_1}$$

$$\boxed{\vec{F}_{1,2} = \frac{k q_1 q_2}{|\vec{r}_1 - \vec{r}_2|^3} \vec{r}_1 - \vec{r}_2}$$

$$\vec{F}_{2,1} = -\vec{F}_{1,2}$$

Importance of Vector form of Coulomb's Law

It gives us additional information :

- Two Charges exert equal and opposite force, coulomb's force obeys Newton's III Law
- It is a central force

$\rightarrow$ line ke along

Limitations of Coulomb's Law

'Kami'

- Charges must be at rest ✓
- Charges must be point charges ✓
- Separation between charges must be greater than nuclear distance otherwise nuclear force starts dominating

$1 \text{ fermi} = 10^{-15} m$

Permittivity (ϵ)

$F = \dfrac{K q_1 q_2}{r^2}$

K = coulomb's const.

$K = 9 \times 10^9 \ Nm^2C^{-2}$

* Property of a medium which determines the electric force between two charges placed in that medium

$k = \dfrac{1}{4\pi\epsilon_0}$

ϵ_0 → 'Epsilon Not'

ϵ_0 → permittivity of free space/vacuum/air

$\epsilon_0 = 8.85 \times 10^{-12} \ N^{-1}m^{-2}C^2$

Permittivity

- ϵ_0 → 'free space'
- ϵ → 'Another medium'
- $\epsilon_r = K$ → relative permittivity OR Di-electric constant (K)

Relative Permittivity or Dielectric Constant

ϵ_r 'K'

Relative permittivity, also known as the dielectric constant, is a measure of how much a material's permittivity deviates from the permittivity of a vacuum. It's defined as the ratio of a material's absolute permittivity (ε) to the permittivity of free space (ε_0)

$$\boxed{K = \epsilon_r = \frac{\epsilon}{\epsilon_0}}$$

ϵ → permittivity of Medium

ϵ_0 → permittivity of free space

K: Di-electric Constant

ϵ_r: relative Permittivity

SBS PYQ

* <u>NOTE</u> - New Force becomes $\frac{1}{K}$ times the old Force

Q1. Two point charges have F force between them separated by 1m, if they are taken in water (dielectric constant = 5). Find the new Force.

free space = ϵ_0

Medium (ϵ)

Water $(K = 5)$

$(\epsilon_r = 5)$

$$F = \frac{K q_1 q_2}{r^2}$$

$$\boxed{F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}}$$

$$F' = \frac{1}{4\pi\epsilon}\frac{q_1 q_2}{r^2}$$

$$\boxed{F' = \frac{1}{4\pi K\epsilon_0}\frac{q_1 q_2}{r^2}}$$

$$\frac{F'}{F} = \frac{1}{K}$$

$$F' = \frac{F}{K} = \frac{F}{5}$$

$$K = \epsilon_r = \frac{\epsilon}{\epsilon_0}$$

$$\epsilon = \epsilon_r \epsilon_0$$

$$\epsilon = K\epsilon_0$$

Range of values of dielectric constant $\Rightarrow 1$ to ∞

1) Conductors $\longrightarrow$ $\boxed{K \to \infty}$

2) Insulators $\longrightarrow$ $\boxed{K > 1}$

3) Vacuum / Air / Free Space $\longrightarrow$ $K = \epsilon_r = \frac{\epsilon_m}{\epsilon_0} = \frac{\cancel{\epsilon_0}^{1}}{\cancel{\epsilon_0}_{1}} = 1$

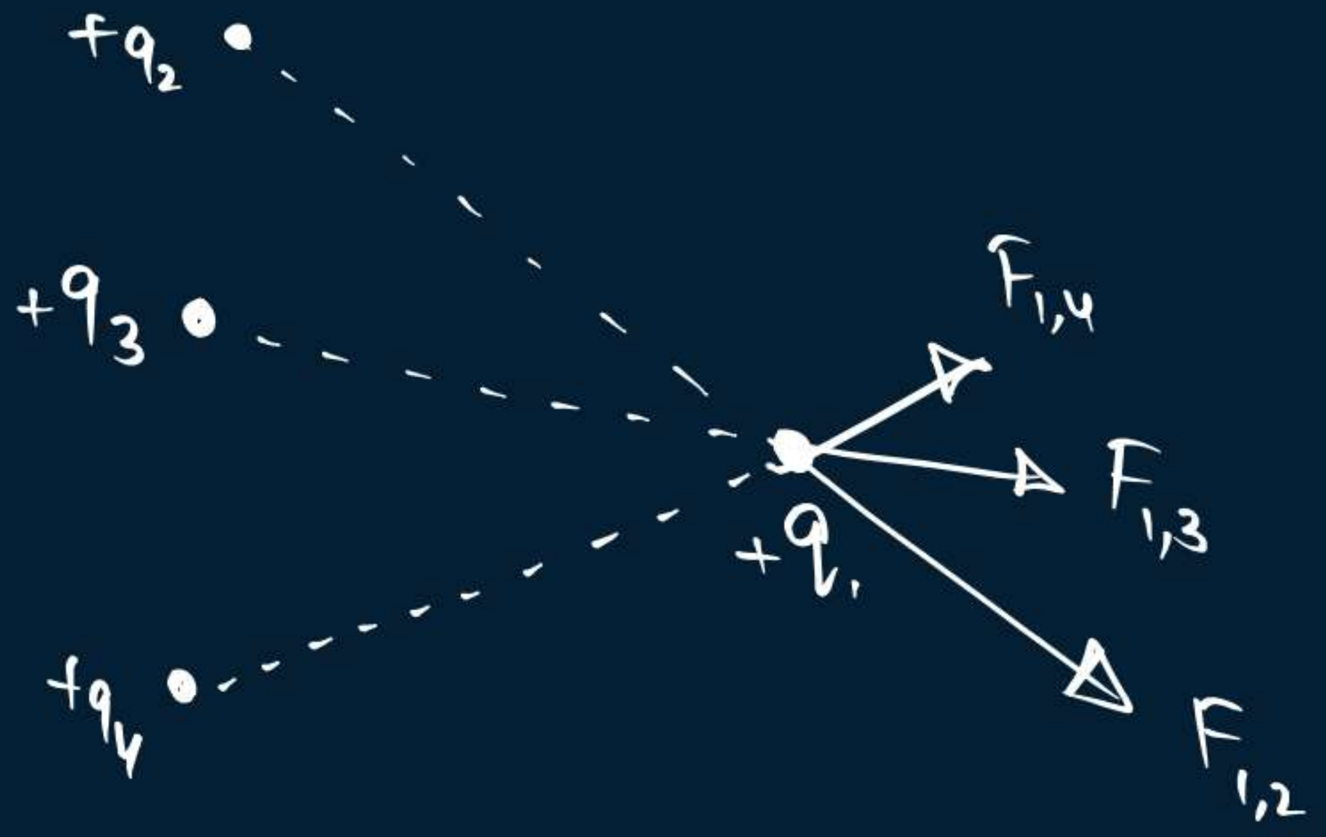
4) Never $\longrightarrow$ $\boxed{K = 0}$

$K = 0.5$

Superposition Principle

→ Class 11

the total force on a charge due to multiple other charges is the vector sum of the forces exerted by each of those charges individually.

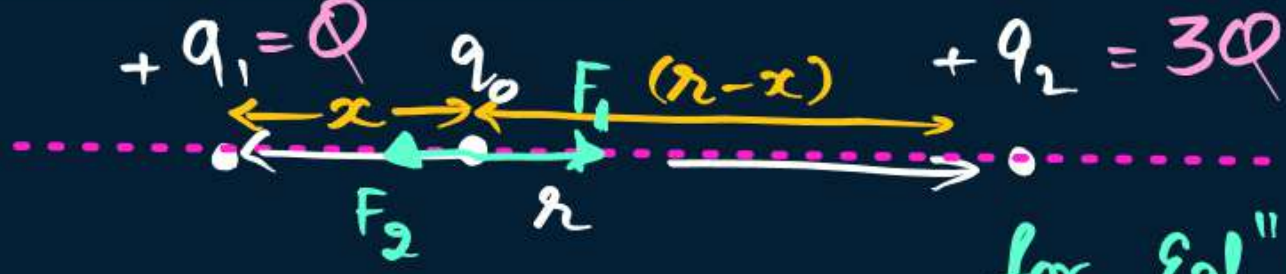


Equilibrium

$\rightarrow F_{net} = 0 \;,\; a_{net} = 0$

- $u = 0 \rightarrow v = 0$ (Static eq rest)
- $u = 5 \rightarrow v = 5$ (dynamic eqⁿ → Same velocity)

Q



$$F_1 = \frac{k q_1 q_0}{x^2} \quad \ldots \text{(I)}$$

$$F_2 = \frac{k q_2 q_0}{(r-x)^2} \quad \ldots \text{(II)}$$

for Eqlⁿ ($F_{net} = 0$)

$$|F_1| = |F_2|$$

$$\frac{\cancel{k} q_1 \cancel{q_0}}{x^2} = \frac{\cancel{k} q_2 \cancel{q_0}}{(r-x)^2}$$

$$\frac{\cancel{Q}}{x^2} = \frac{3\cancel{Q}}{(r-x)^2}$$

$$\frac{1}{x^2} = \frac{3}{(r-x)^2}$$

Sq. root both sides . . .

$$\frac{1}{x} = \frac{\sqrt{3}}{r-x}$$

$$r - x = x\sqrt{3}$$

$$r = x\sqrt{3} + x$$

$$r = x(\sqrt{3}+1)$$

$$\boxed{x = \frac{r}{\sqrt{3}+1}}$$

RDx

Q $\qquad$ Eqⁿ → Null point $\qquad$ nQ

$\leftarrow x \rightarrow$

$\leftarrow r \rightarrow$

$$\boxed{x = \frac{r}{\sqrt{n}+1}}$$

Q $\quad$ Q $\qquad$ Eqⁿ $\qquad$ 4Q

$\leftarrow x \rightarrow$

$$x = \frac{r}{\sqrt{n}+1} \qquad n = \frac{\text{Big charge}}{\text{Small charge}}$$

$$x = \frac{r}{\sqrt{4}+1} = \frac{r}{2+1} \qquad = \frac{4\cancel{Q}}{\cancel{Q}} = 4$$

$$x = \frac{r}{3} \qquad n = 4$$

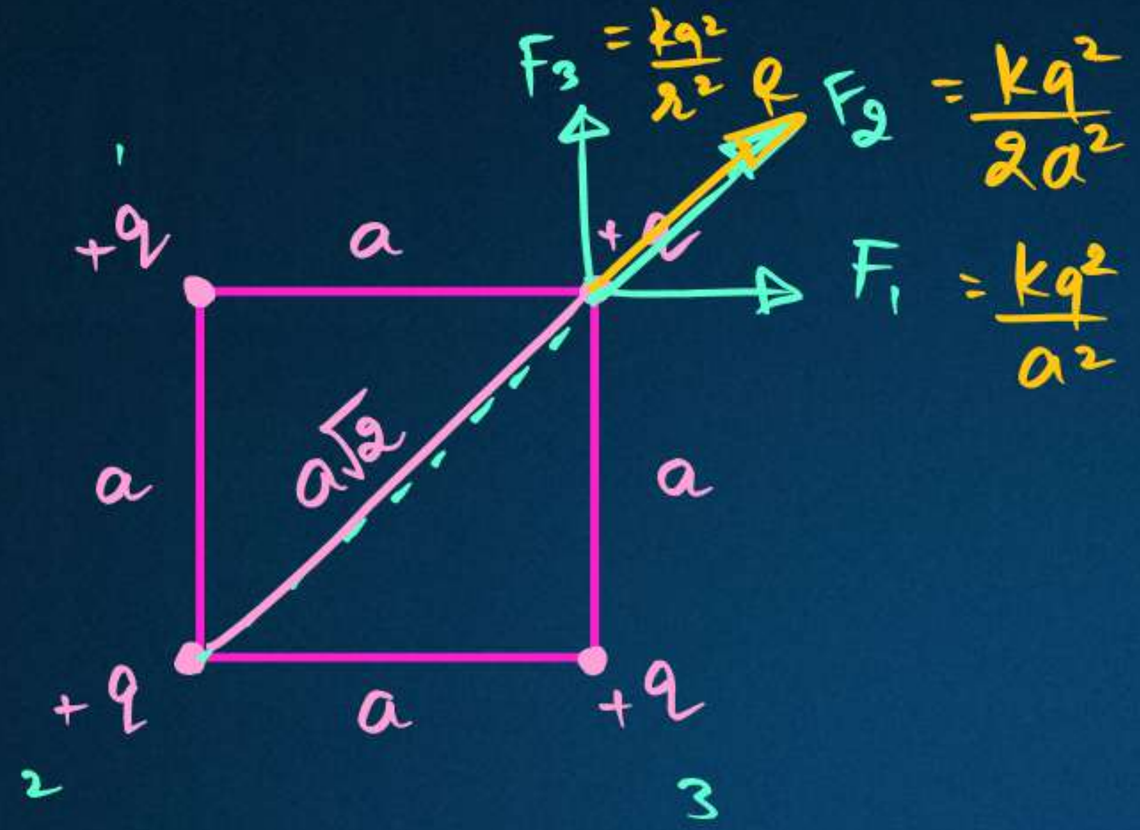
Q $\quad$ 4C $\qquad \leftarrow$ 8m $\rightarrow \qquad$ 12C

$\leftarrow x \rightarrow \leftarrow y \rightarrow$

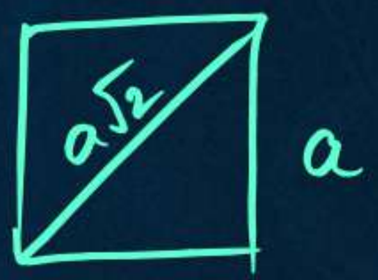
$$n = \frac{\cancel{12}}{\cancel{4}} = 3$$

$$x = \frac{r}{\sqrt{n}+1} = \frac{8}{\sqrt{3}+1}\ \text{m Ans}$$

Q



$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$$
$$= \vec{R} + \vec{F}_2$$
$$= \sqrt{2}\,\frac{kq^2}{a^2} + \frac{kq^2}{2a^2}$$



$$\boxed{F_{net} = \frac{kq^2}{a^2}\left[\sqrt{2} + \frac{1}{2}\right]}$$

$$F_1 = \frac{kqq}{a^2} = \frac{kq^2}{a^2} \qquad F = \frac{kq^2}{a^2} = F_3$$

$$F_1 = \frac{kq^2}{a^2} = F$$

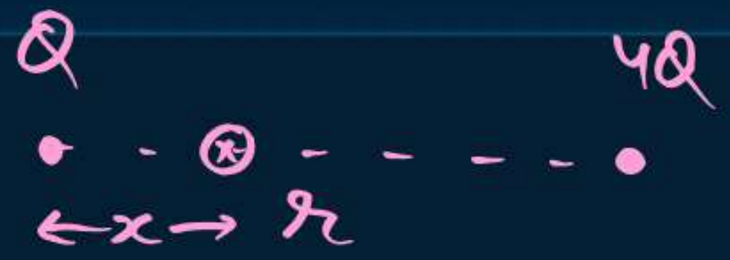
$$F_2 = \frac{kqq}{(a\sqrt{2})^2} = \frac{kq^2}{2a^2}$$

$$F_3 = \frac{kqq}{a^2} = \frac{kq^2}{a^2}$$

$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$
$$= \sqrt{F^2 + F^2 + \cancel{2FF\cos 90^\circ}} = \sqrt{2F^2} = \sqrt{2}F = \sqrt{2}\,\frac{kq^2}{a^2} = \vec{R}$$

SBS

Q2. Two point charges Q and 4Q are separated by some distance, Find the position of 3rd charge q so that net force is zero



$$x = \frac{r}{\sqrt{n}+1}$$

$$n = \frac{4\cancel{Q}}{\cancel{Q}}$$

$$n = 4$$

$$= \frac{r}{\sqrt{4}+1}$$

$$= \frac{r}{2+1} = \frac{r}{3} \text{ Ans}$$

Homework

→ Notes ✓

→ Revise before coming to Next class


PARISHRAM
2026
Electric Charges and Fields
PHYSICS
LECTURE-4
BY - RAKSHAK SIR
Physics Wallah

Topics to be covered

- **A** Superposition Principle - 2
- **B** Electric Field Intensity
- **C** Electric Field Lines

KHATARNAAK PYQ

RDx

Two Identical Charges, Q each, are kept at a distance r from each other. A third charge q has to be placed on the line joining above two charges such that all three charges are in equilibrium. Find magnitude, position and sign of charge?

$+Q \qquad -q = ? \qquad +Q$

$\longleftarrow r \longrightarrow$

$\longleftarrow x \longrightarrow \longleftarrow (r-x) \longrightarrow$

Condt. for eqlm

$$|F_{QQ}| = |F_{qQ}|$$

$$\frac{\cancel{K}\cancel{Q}Q}{r^2} = \frac{\cancel{K}\cancel{Q}q}{x^2}$$

$$\frac{Q}{r^2} = \frac{q}{x^2} \quad (1)$$

$Q/4 \qquad \frac{r}{2}$ ✓ $\qquad$ → −ve

put $x = \frac{r}{2}$ in eq (1)

$$\frac{Q}{r^2} = \frac{q}{\left(\frac{r}{2}\right)^2}$$

$$\frac{Q}{\cancel{r^2}} = \frac{q}{\frac{\cancel{r^2}}{4}}$$

$$Q = 4q \rightarrow \boxed{q = -\frac{Q}{4}}$$

$$|F_{Qq}| = |F_{Qq}|$$

$$\frac{\cancel{KQ}q}{x^2} = \frac{\cancel{KQ}q}{(r-x)^2}$$

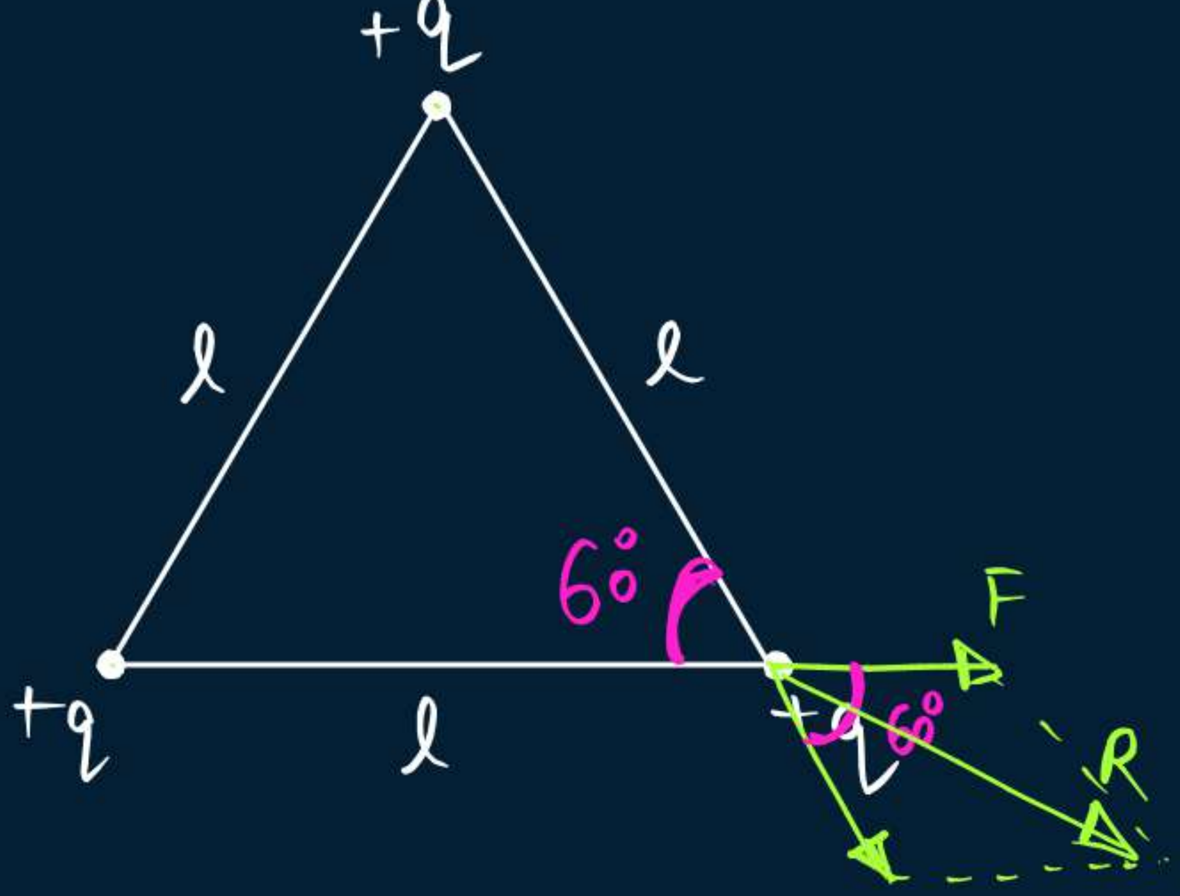
$$\frac{1}{x^2} = \frac{1}{(r-x)^2}$$

$$(r-x)^2 = x^2$$

$$r - x = x$$

$$r = 2x \rightarrow \boxed{x = \frac{r}{2}}$$

SOME MORE PYQs



$$F = \frac{kqq}{l^2}$$

$$|F| = \frac{kq^2}{l}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2$$

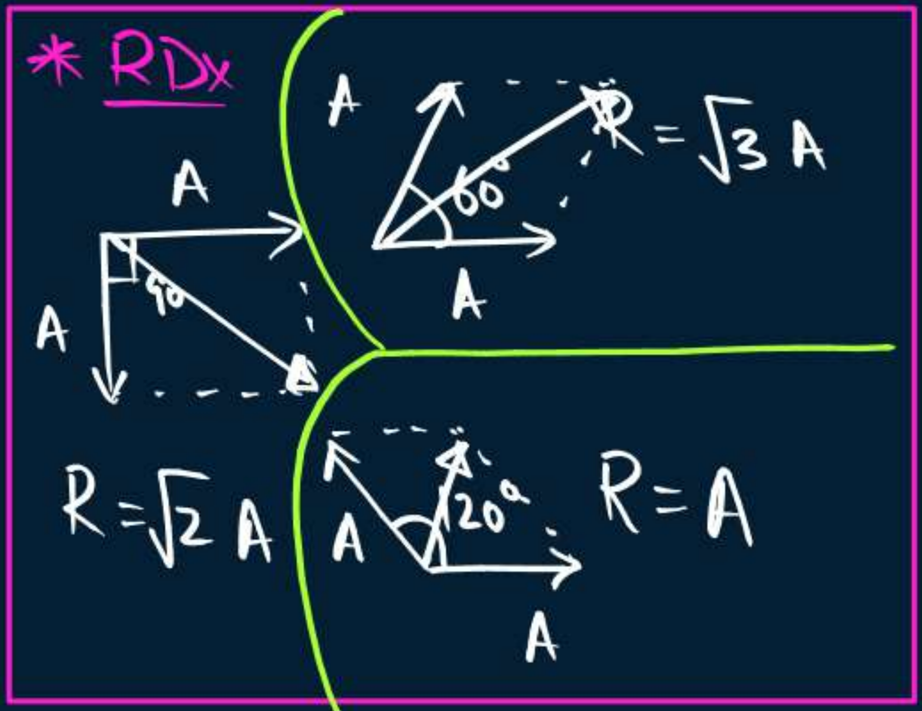
$$|F_{net}| = \sqrt{F^2 + F^2 + 2FF\cos 60^\circ}$$

$$= \sqrt{2F^2 + \cancel{2}F^2 \times \frac{1}{\cancel{2}}}$$

$$= \sqrt{3F^2}$$

$$= \sqrt{3}\,F$$

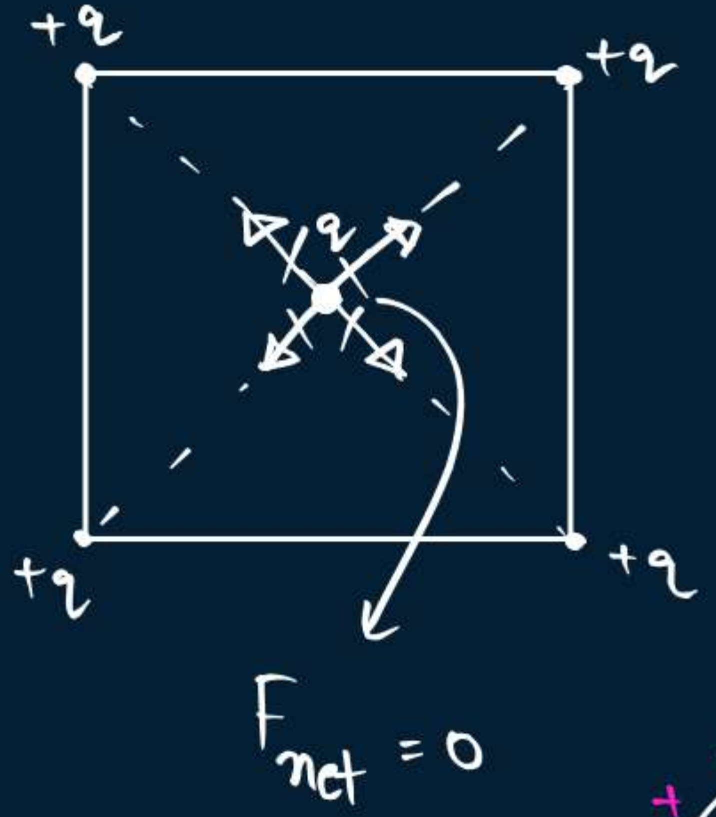
$$= \sqrt{3}\,\frac{kq^2}{l^2}$$ Ans

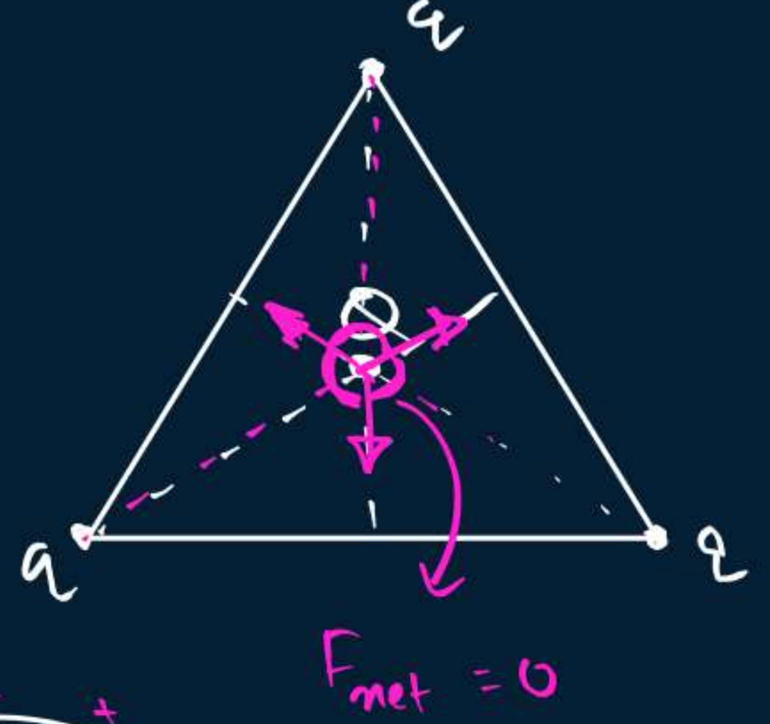


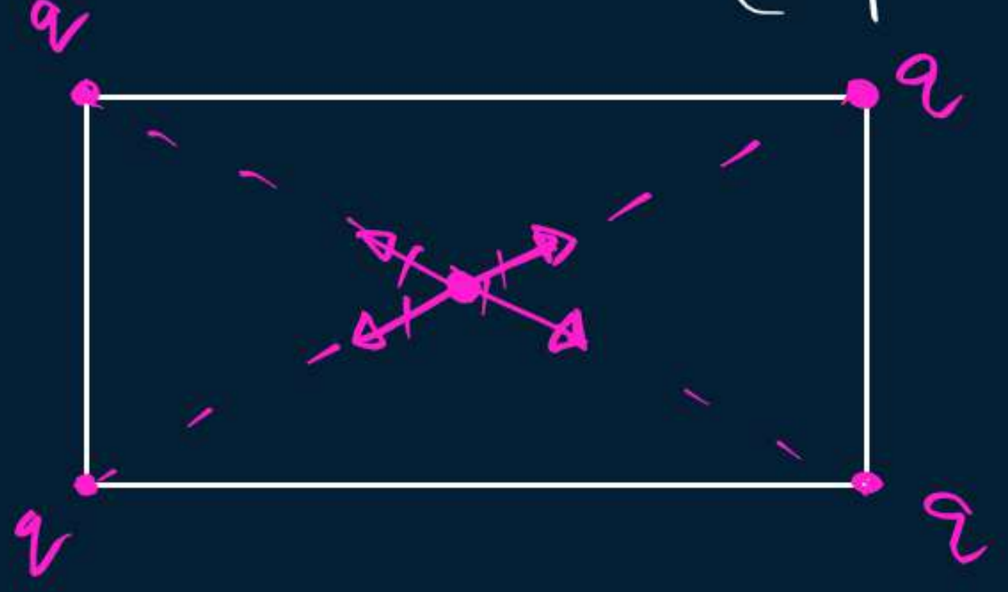
SYMMETRIC FIGURES

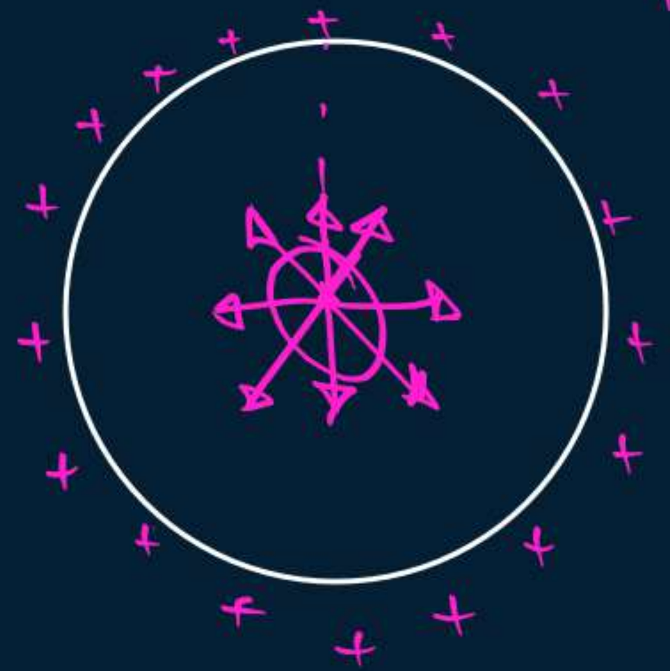
⇒ Regular Polygons (Unka Centre)

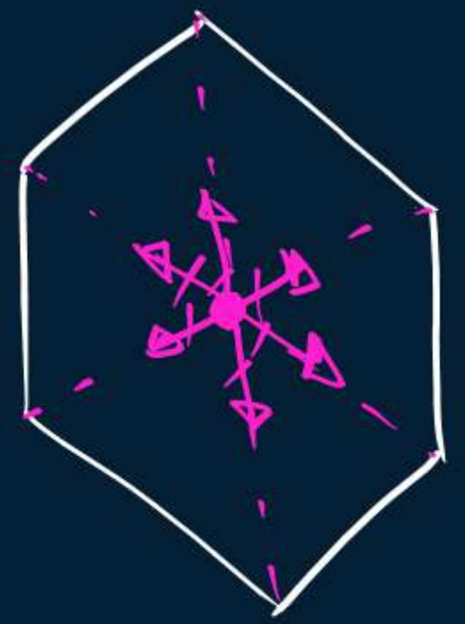
↳ Null point (eq^{m} point)











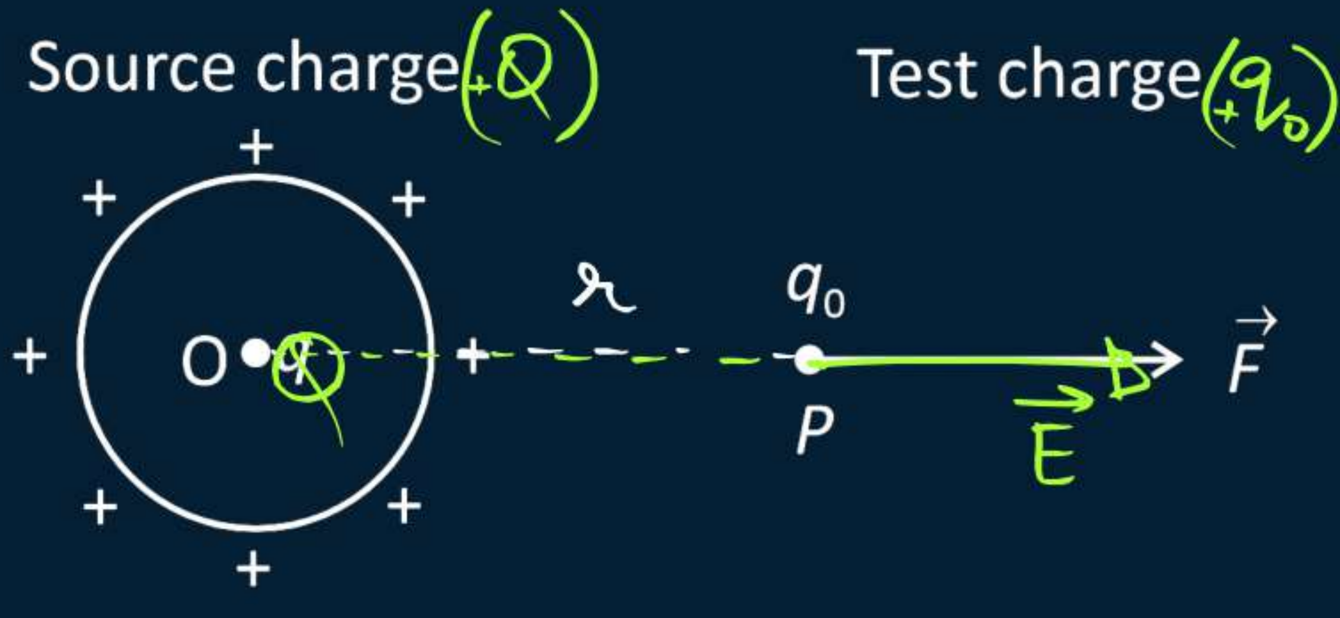
Electric Field Intensity = Electric field.

SI unit → N/C OR V/m

The electric field at a point is defined as the electrostatic force per unit test charge acting on a vanishingly small positive test charge placed at that point.

$$\vec{E} = \frac{\vec{F}}{q_0} \rightarrow \left(\frac{N}{C}\right) \qquad \vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0}$$

Note: The electric field $\vec{E}$ is a vector quantity whose direction is same as that of force $\vec{F}$ exerted on a positive charge test charge.

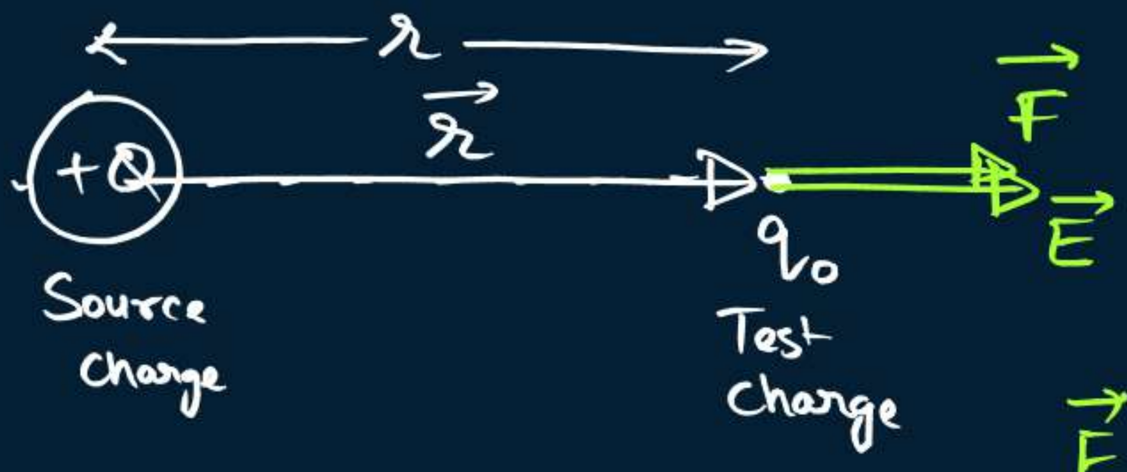


$$F = \frac{kQq_0}{r^2}$$

$$E = \frac{F}{q_0} = \frac{kQ\cancel{q_0}}{r^2 \times \cancel{q_0}} = \frac{kQ}{r^2}$$

$$\boxed{E = \frac{kQ}{r^2}}$$

Electric field due to a point charge (Also Vector Form)



$$\vec{E} = \frac{\vec{F}}{q_0}$$

$$\vec{E} = \frac{kQ\cancel{q_0}}{r^2 \cancel{q_0}}\hat{r}$$

$$\boxed{\vec{E} = \frac{kQ}{r^2}\hat{r}}$$

$$\vec{E} = \frac{kQ}{r^2}\hat{r}$$

$$\vec{E} = \frac{kQ}{r^2}\frac{\vec{r}}{|\vec{r}|}$$

$$\boxed{\vec{E} = \frac{kQ}{r^3}\cdot\vec{r}}$$

Y.K.B.

$$\vec{A} = |A|\,\hat{A}$$

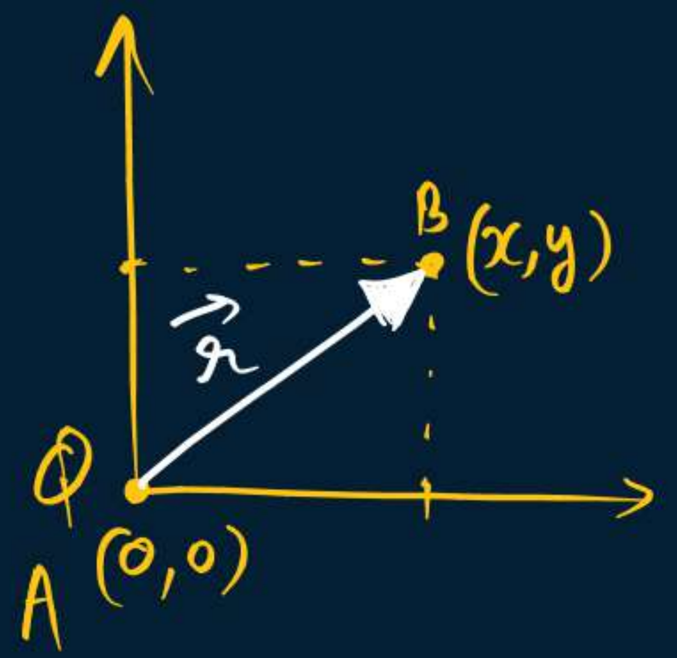
$$\hat{A} = \frac{\vec{A}}{|A|}$$

QUESTION

A point charge Q is placed at a point A (0,0). Calculate the electric field at B (x, y) in vector form.

$$\vec{E} = \frac{kQ}{r^3}\vec{r}$$

$$\boxed{\vec{E} = \frac{kQ}{(x^2+y^2)^{3/2}} \cdot (x\hat{i}+y\hat{j})}$$



$$\vec{r} = x\hat{i}+y\hat{j}$$

$$|\vec{r}| = \sqrt{x^2+y^2}$$

$$= (x^2+y^2)^{\frac{1}{2}}$$

SBS PYQ

H.W.

A point charge of 0.009 μC is placed at the origin. Calculate the intensity of electric field due to this point charge at point $(\sqrt{2}, \sqrt{7}, 0)$ m.

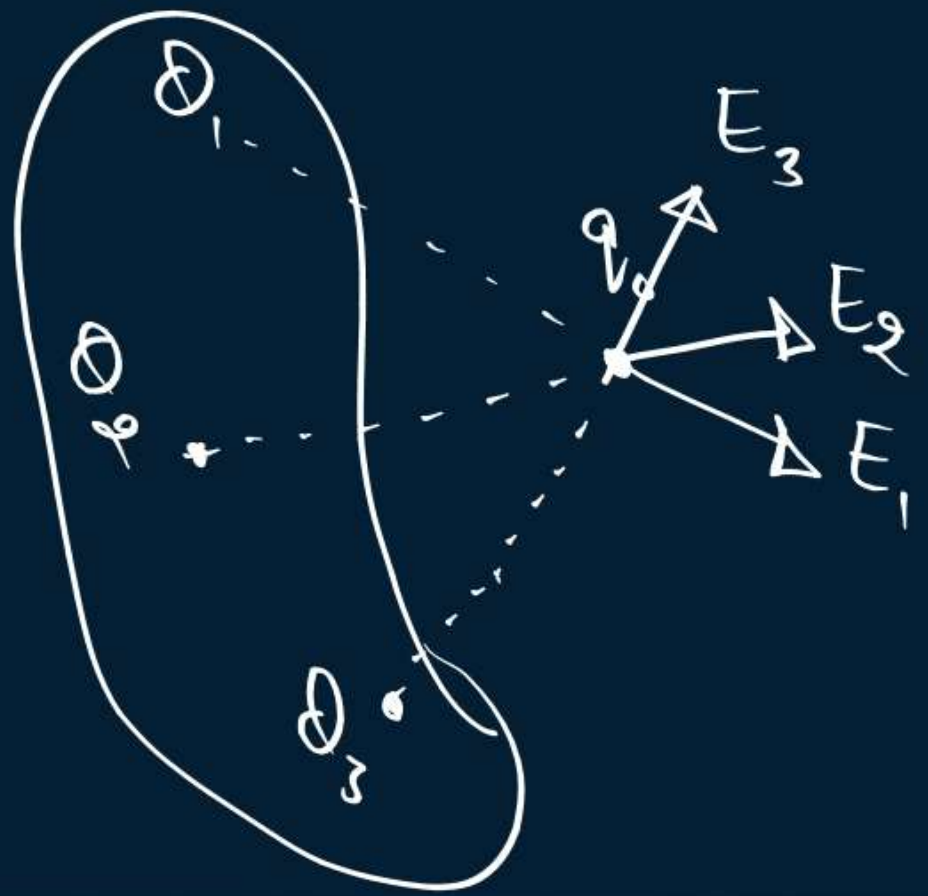
Electric Field Due To A System Of Point Charges

The electric field at any point due to a group of charges is equal to the vector sum of the electric fields produced by each charge individually at that point, when all other charges are assumed to be absent.

Superposition Principle also followed here

Hence, the electric field at point P due to the system of N charges is

$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \ldots + \vec{E}_N$$

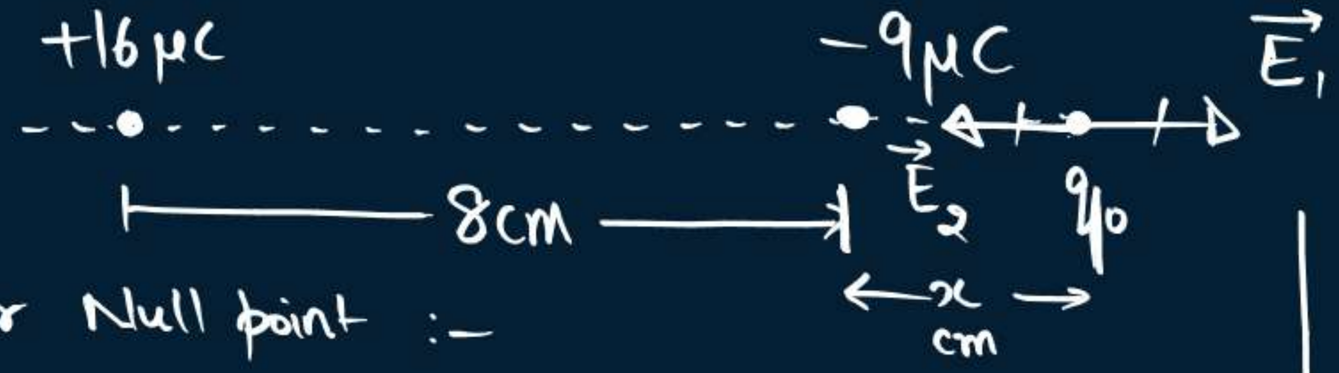


QUESTION

$1\mu C = 10^{-6} C$ $E = \frac{kQ}{r^2}$

Two point charges of +16 μC and – 9 μC are placed 8 cm apart in air. Determine the position of the point at which the resultant field is zero.

→ Null point



for Null point :-

$$\vec{E}_{net} = 0$$

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

$$|E_1| = |E_2|$$

$$\frac{\cancel{K} \times 16 \times \cancel{10^{-6}}}{(8+x)^2} = \frac{\cancel{K} \times 9 \times \cancel{10^{-6}}}{(x)^2}$$

$$\frac{16}{(8+x)^2} = \frac{9}{x^2}$$

sq. root both sides

$$\frac{4}{8+x} = \frac{3}{x}$$

$$4x = 24 + 3x$$

$$4x - 3x = 24$$

$$x = 24\,cm = 0.24\,m$$

QUESTION

$F_{net} = ma$

A charged particle is kept in equilibrium in an electric field between the plates in the Millikan oil drop experiment. If the direction of the electric field between the plates is reversed, then calculate the acceleration of the charged particle.

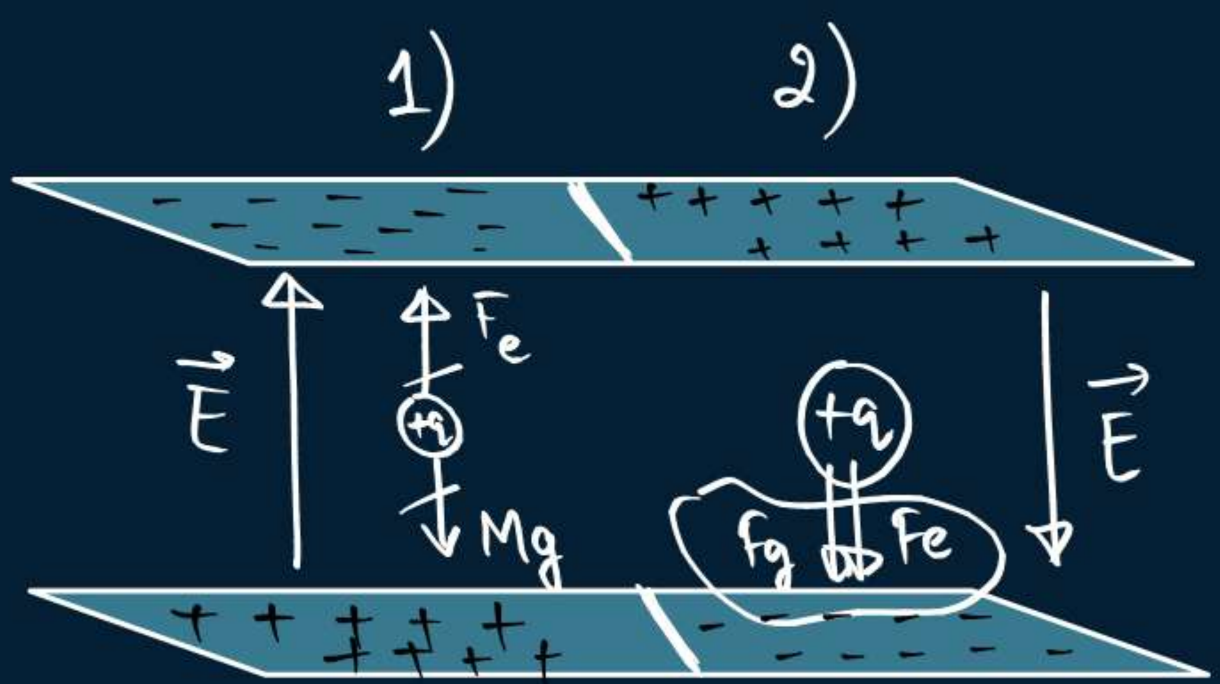
1) At eqⁿ

$F_e = F_g$

$qE = Mg$

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

$qE = F$



$F_{net} = F_e + F_g$

$F_{net} = qE + Mg$

$F_{net} = Mg + Mg$

$F_{net} = 2Mg$

$\cancel{M}a = 2\cancel{M}g$

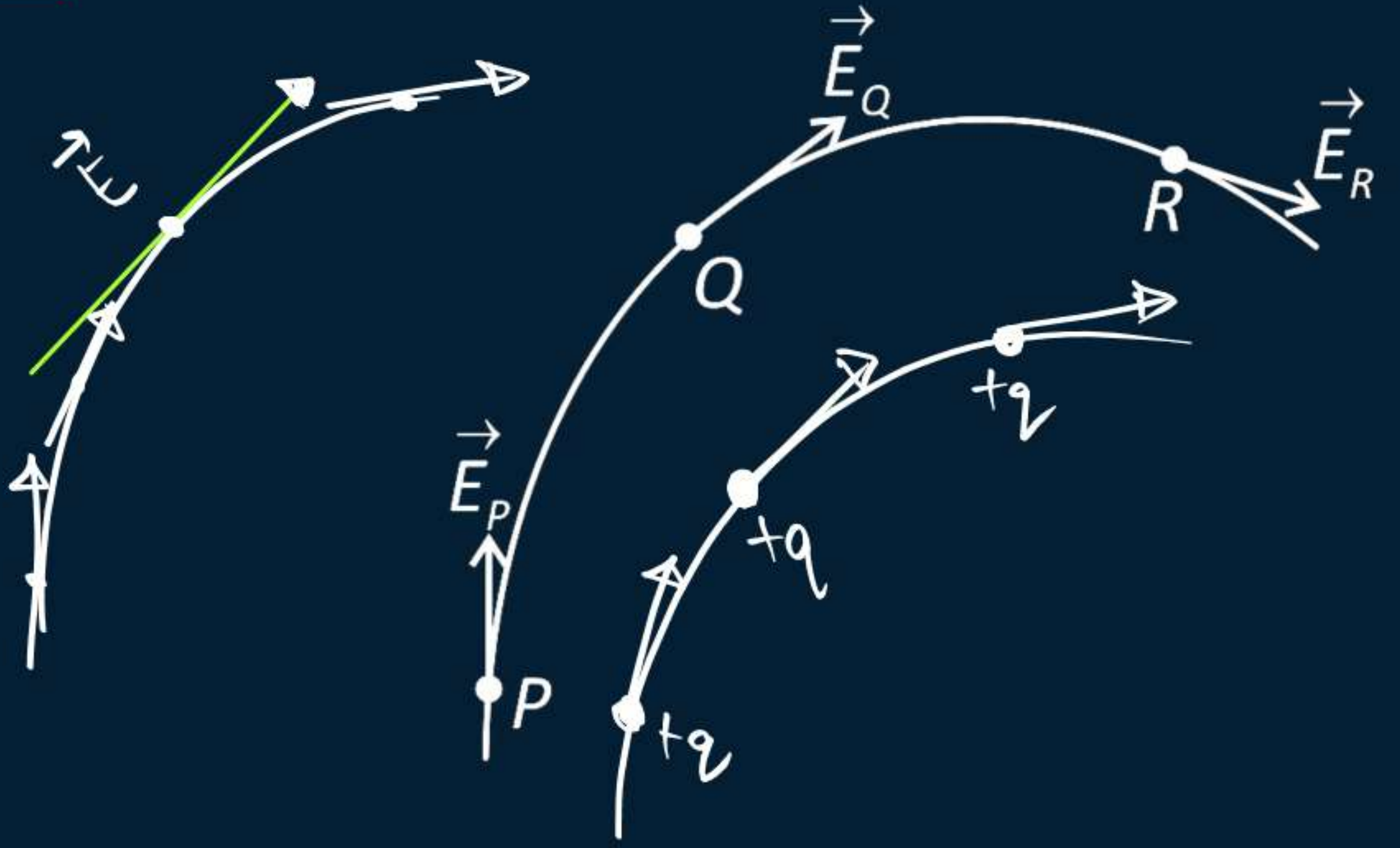
$a = 2g$

Electric lines of force = EFL or ELF

An electric line of force may be defined as the curve along which a small positive charge would tend to move when free to do so in an electric field and the tangent to which at any point gives the direction of the electric field at that point.

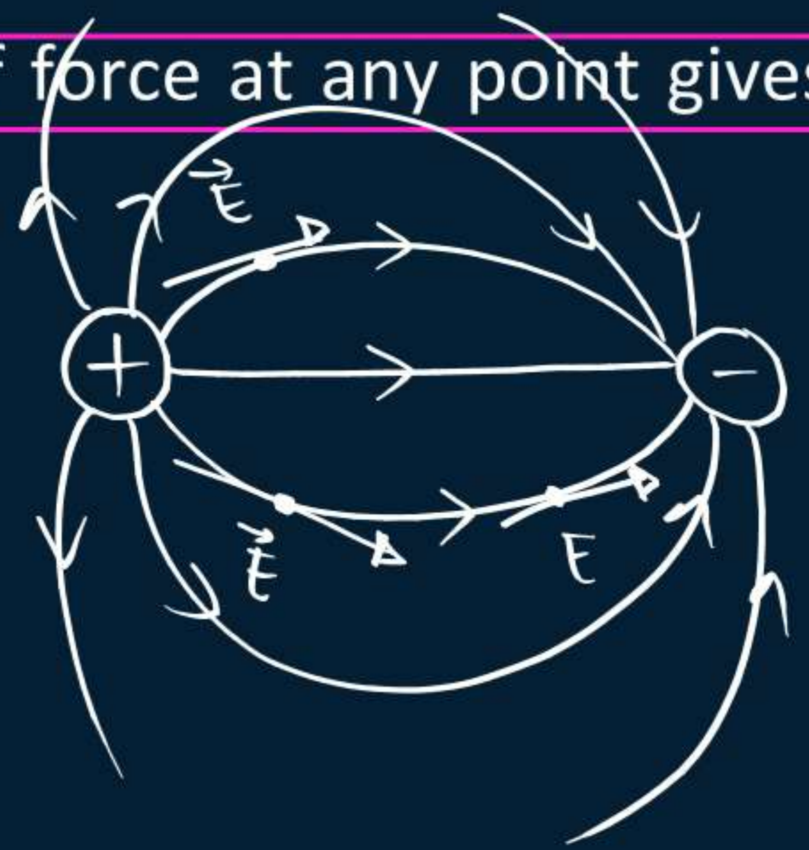
* NOTE: The lines of force do not really exist, they are imaginary curves. Yet the concept of lines of force is very useful.

\# Michael Faraday gave simple explanations for many of his discoveries (in electricity and magnetism) in terms of such lines of force.



Properties of electric lines of force

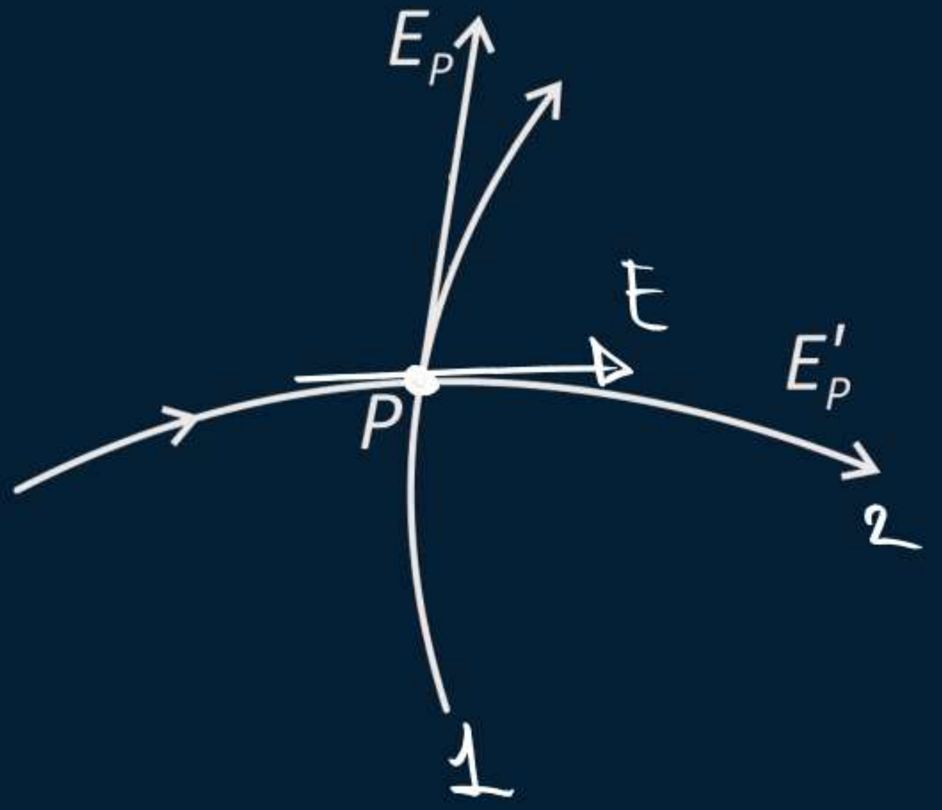
1. The lines of force are continuous smooth curves without any breaks.
2. The line of force start at positive charge and end at negative charges they cannot form closed loops. If there is a single charge, then the lines of force will start or end at infinity.
3. The tangent to a line of force at any point gives the direction of the electric field at that point.



Properties of electric lines of force

4. No two lines of force can cross each other.

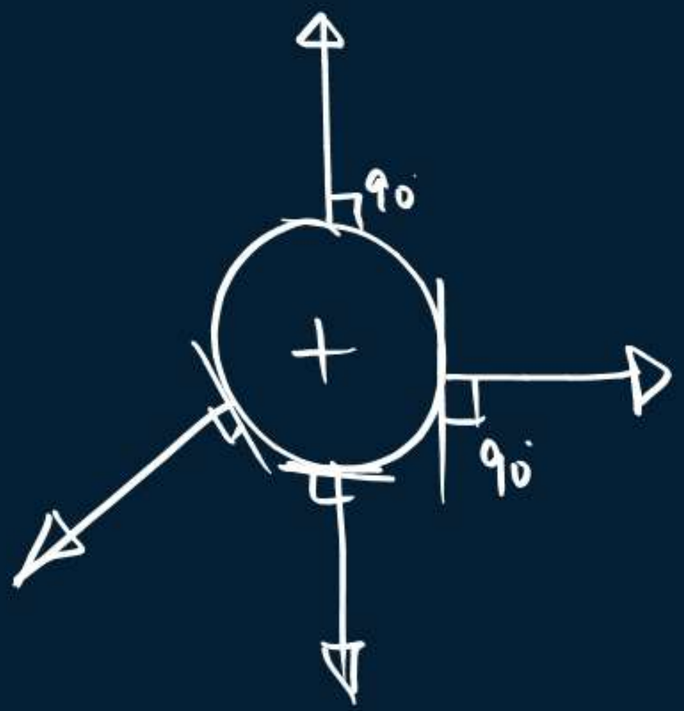
Reason. If they intersect, then there will be two tangents at the point of intersection (Fig.) and hence two directions of the electric field at the same point, which is not possible.

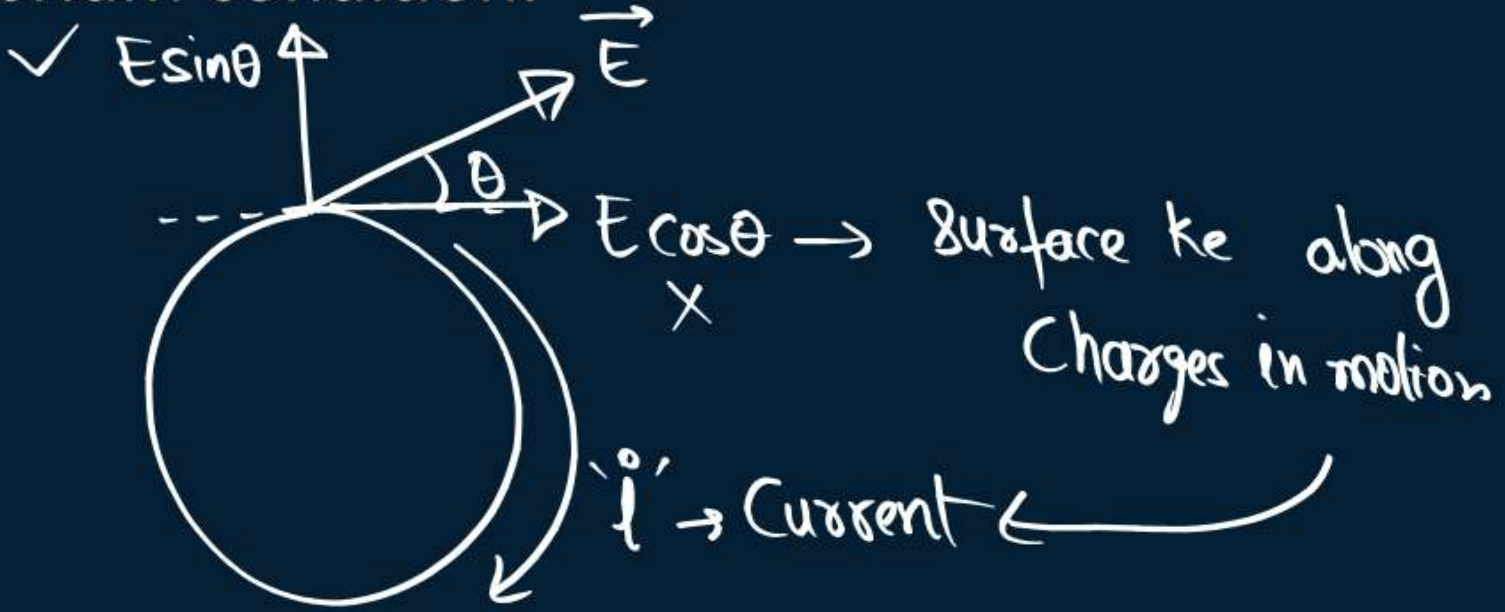


Properties of electric lines of force

5. The lines of force are always normal to the surface of a conductor on which the charges are in equilibrium.

Reason. If the lines of force are not normal to the conductor, the component of the field E parallel to the surface would cause the electrons to move and would set up a current on the surface. But no current flows in the equilibrium condition.

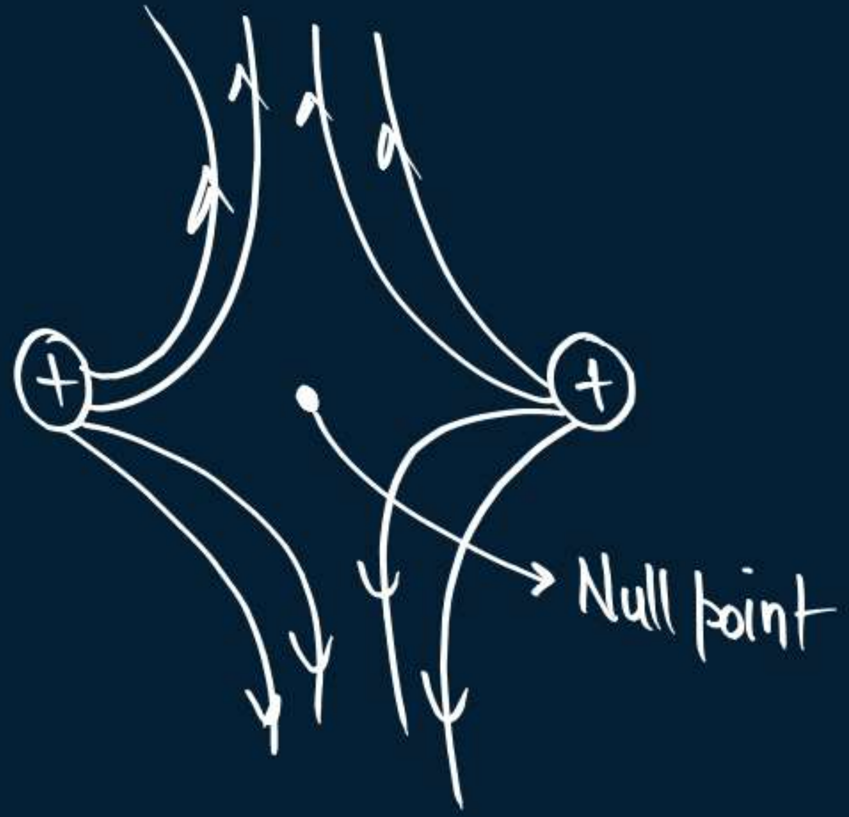




Properties of electric lines of force

6. The lines of force have a tendency to contract lengthwise. This explains attraction between two unlike charges.
7. The lines of force have a tendency to expand laterally so as to exert a lateral pressure on neighbouring lines of force. This explains repulsion between two similar charges.

6. 

7. 

Properties of electric lines of force

~~8~~. The relative closeness of the lines of force gives a measure of the strength of the electric field in any region. The lines of force are

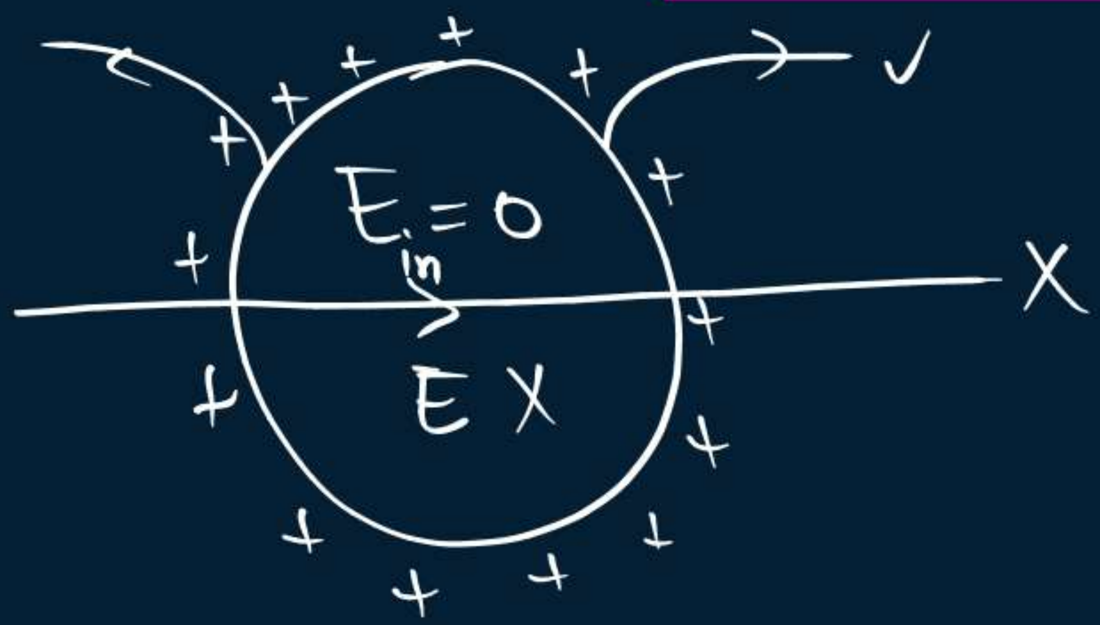
(i) close together in a strong field.

(ii) far apart in a weak field.

(iii) parallel and equally spaced in a uniform field.

~~9~~. The lines of force do not pass through a conductor because the electric field inside a charged conductor is zero. : Electrostatic shielding

Next class Exp^n



Electric field lines for different charged conductors

(i) Field lines of a positive point charge.
radially outwards
They extend to infinity.
The field is spherically symmetric

(ii) Field lines of a negative point charge.
radially inwards
They start from infinity.
spherically symmetric

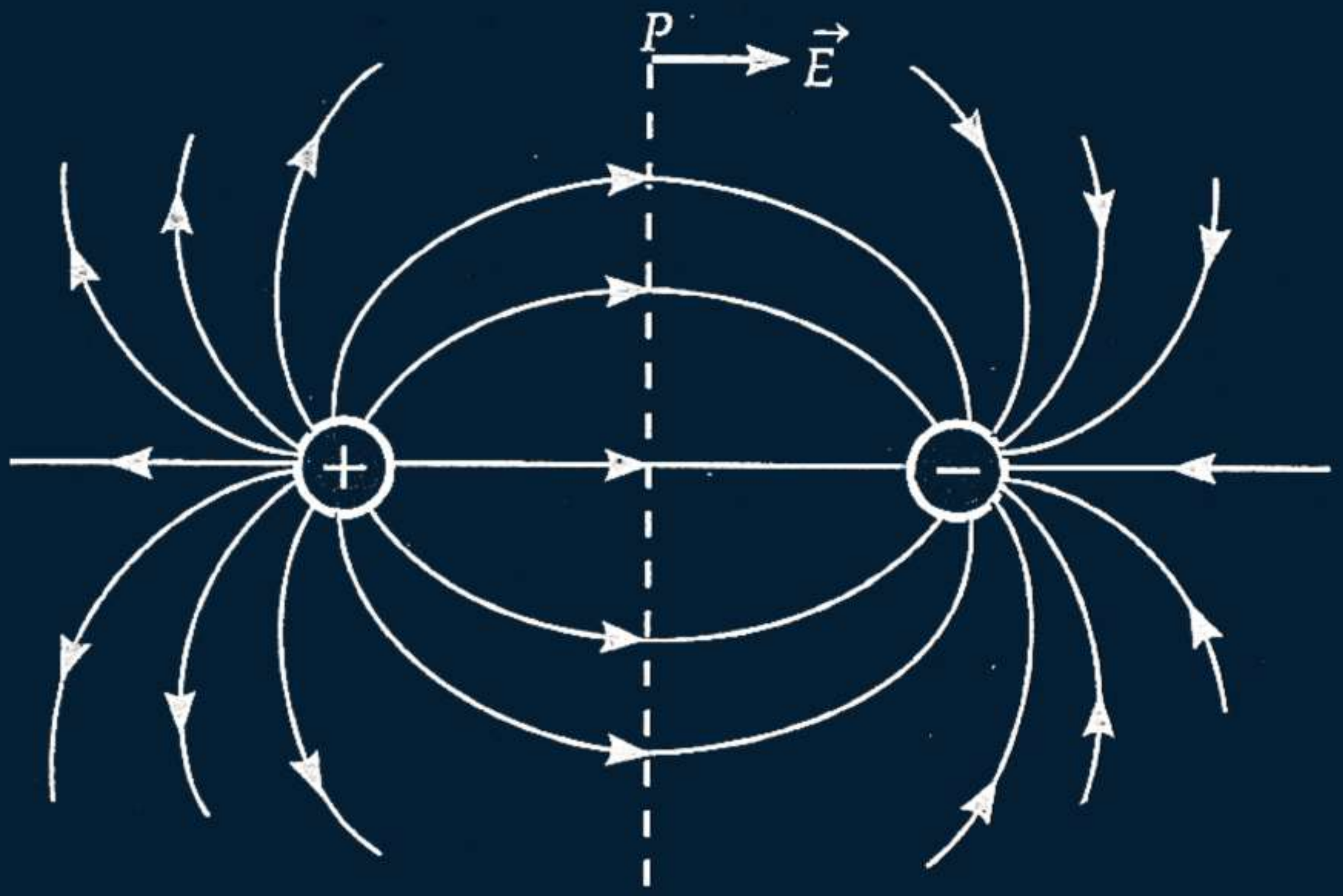
∞

Field lines of a positive point charge.

Field lines of a negative point charge.

Electric field lines for equal & opposite Charges (Dipole)

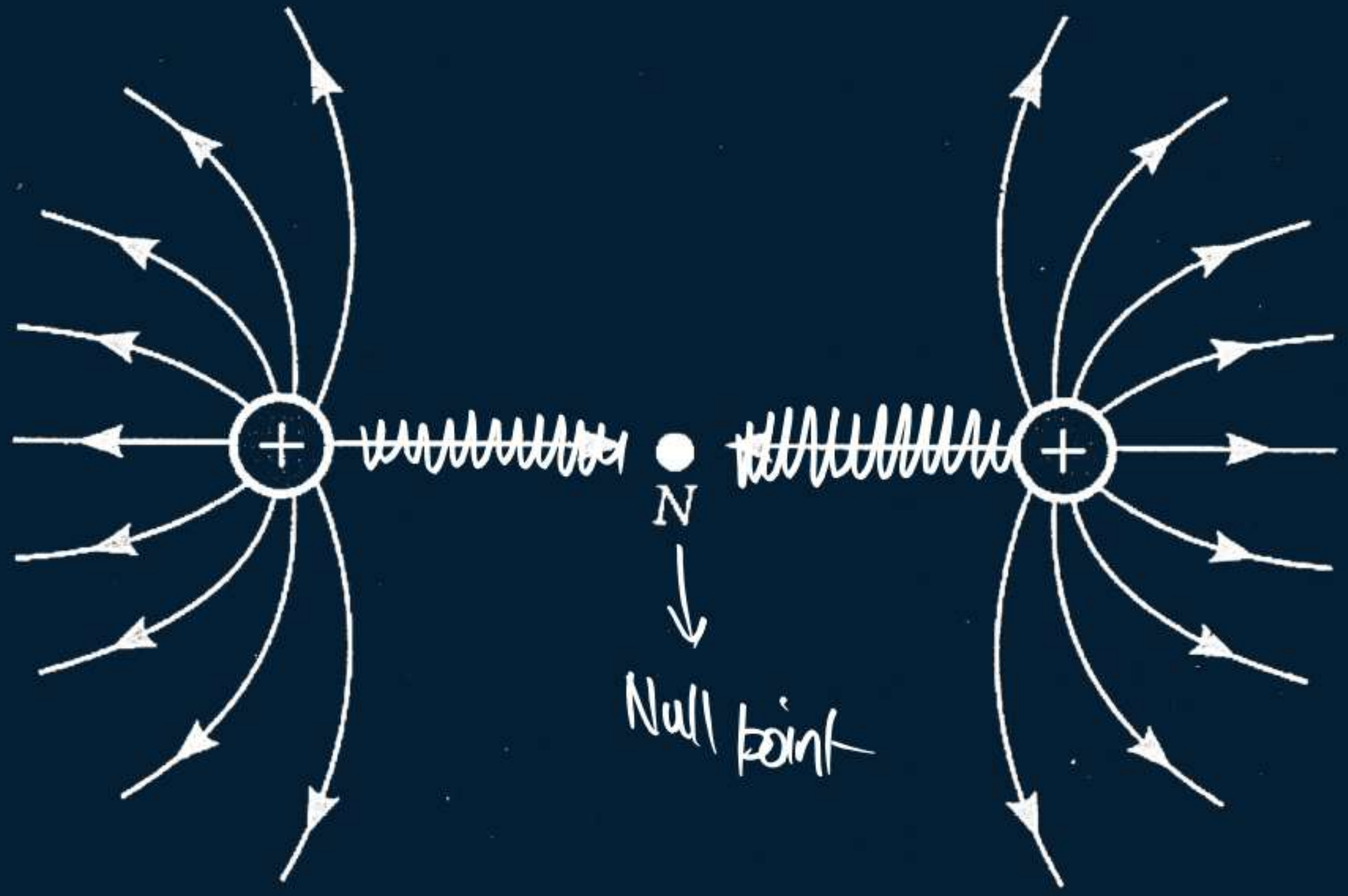
The field is Cylindrically Symmetric about the dipole axis.



Electric field lines for equal & positive Charges

The field $\vec{E}$ is zero at the middle point N of the join of two charges. This point is called neutral point from which no line of force passes.

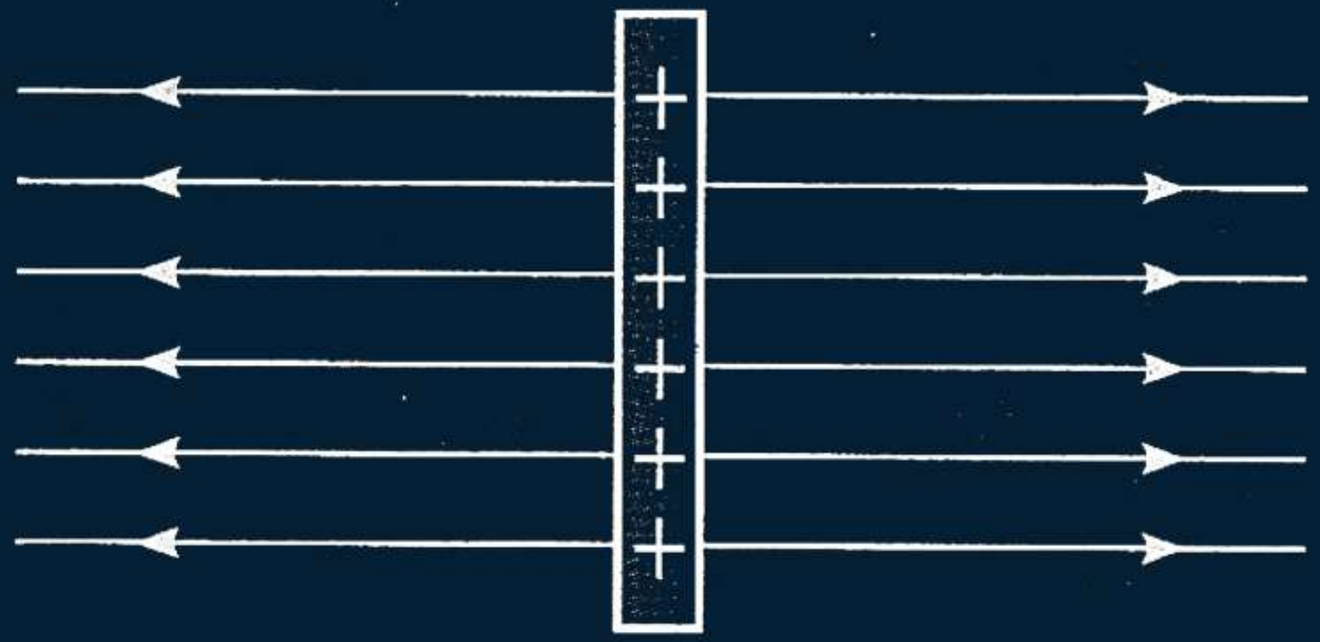
This field also has cylindrical symmetry.



Electric field lines for Charged Plane Conductor

Thus the lines of force are parallel and normal to the surface of the conductor.

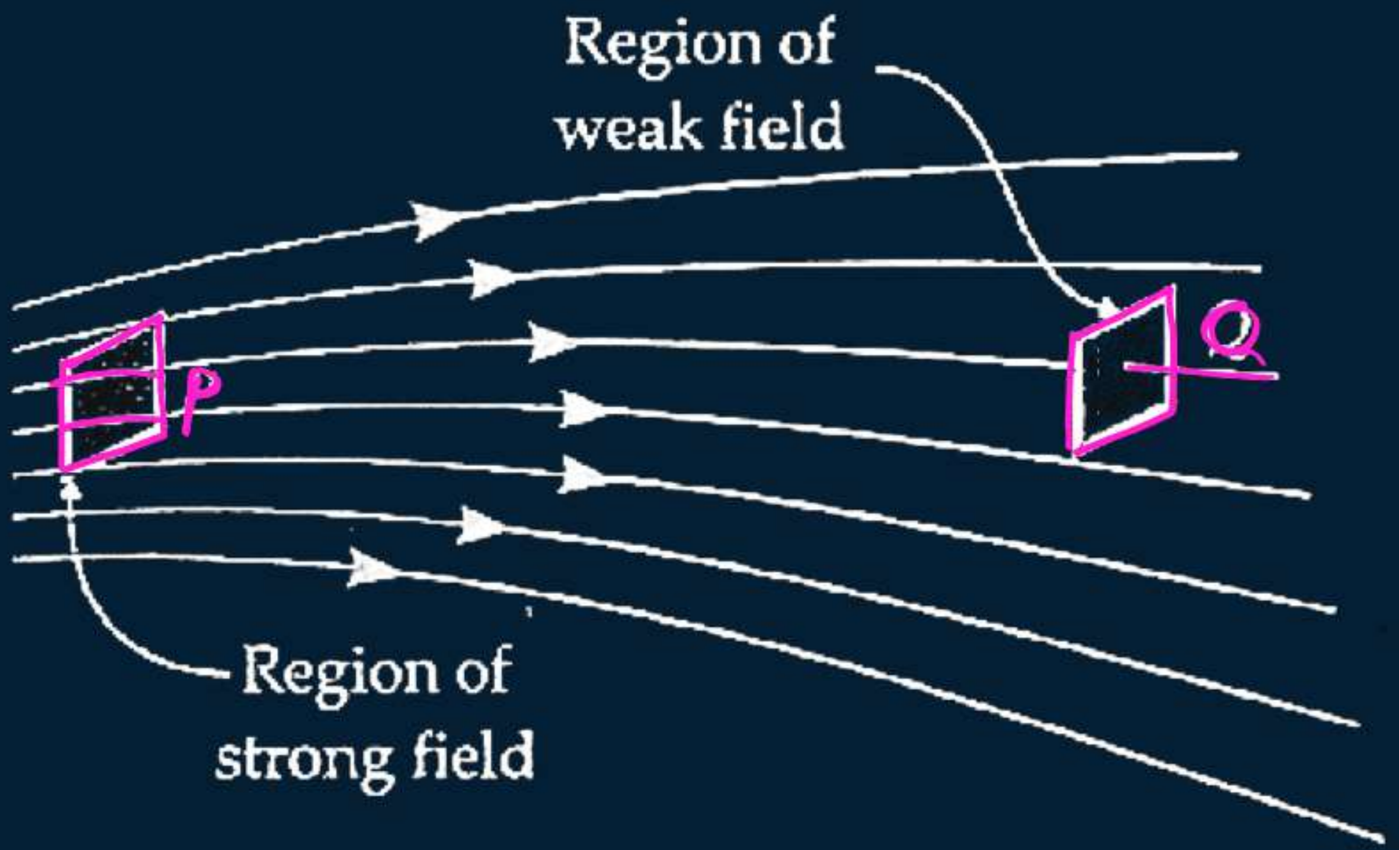
They are equispaced, indicating that electric field $\vec{E}$ is uniform at all points near the plane conductor.



Relation between electric field strength and density of lines of force:

Electric field strength is proportional to the density of lines of force.

$E_P > E_Q$



Density of lines of force is proportional to the electric field strength.

Homework

→ Notes

→ "Reading theory"

→ Diagrams are must ✓

PARISHRAM

2026

Electric Charges and Fields

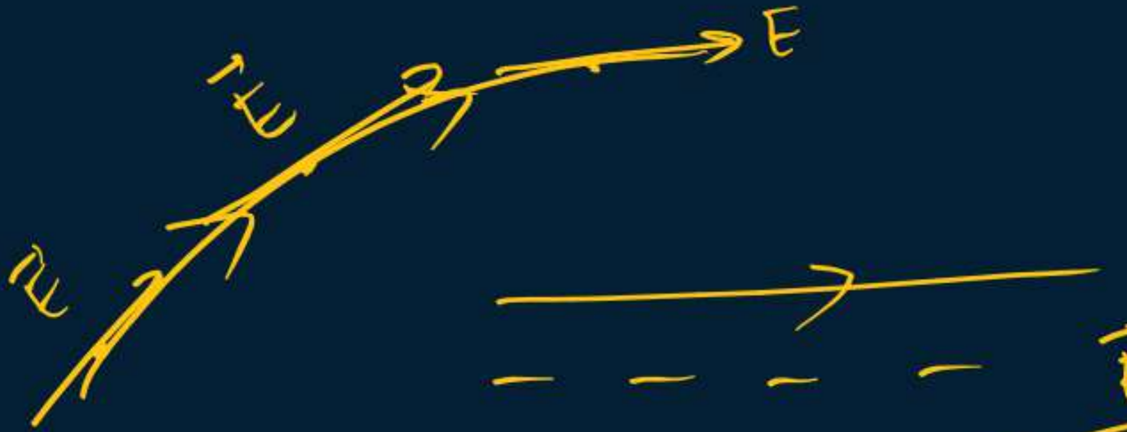
PHYSICS **LECTURE-5**

BY - RAKSHAK SIR

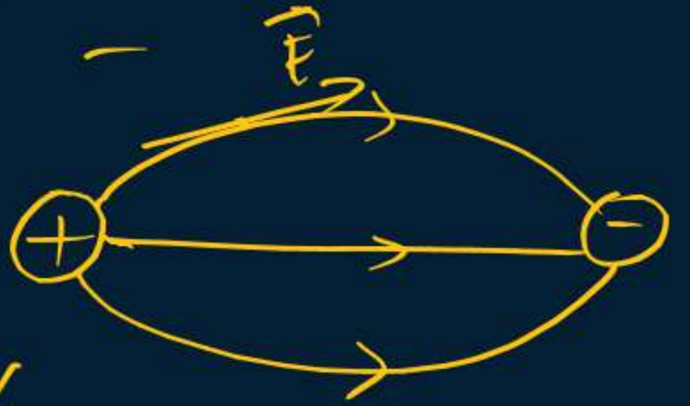
Topics to be covered

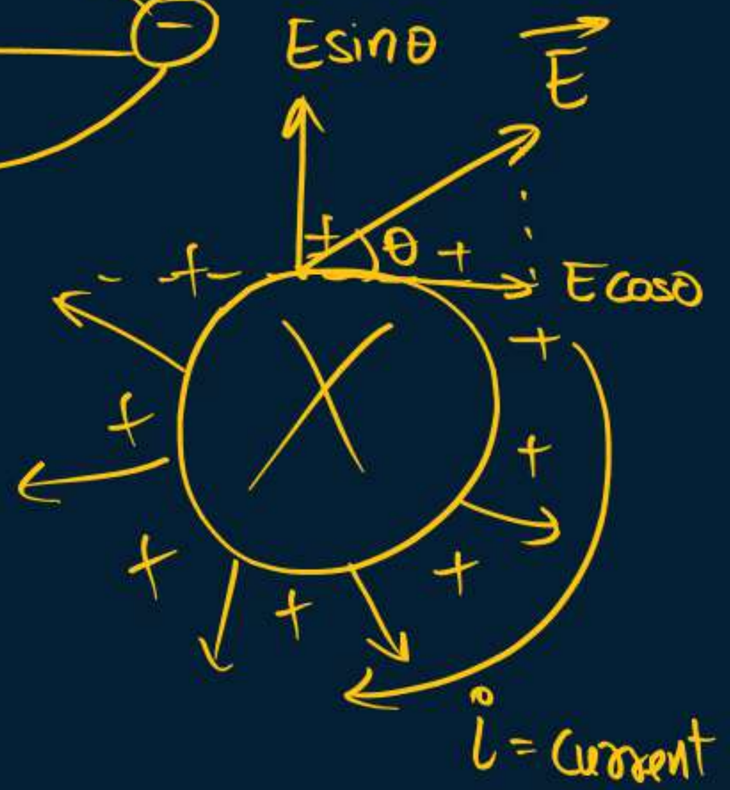
- **A** Continuous Charge Distribution
- **B** Electric Field due to charged Ring
- **C** Electric Dipole

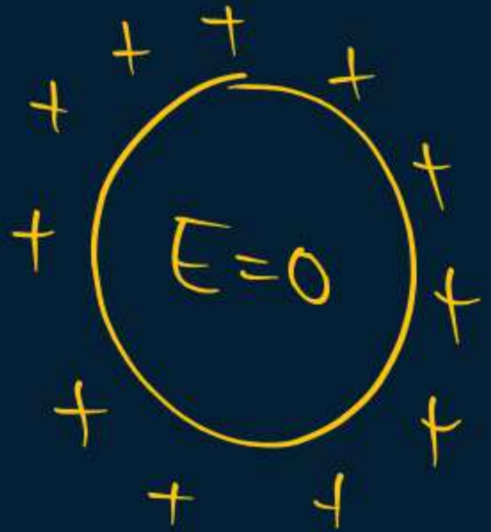
REVISION FOR E F L PROPERTIES

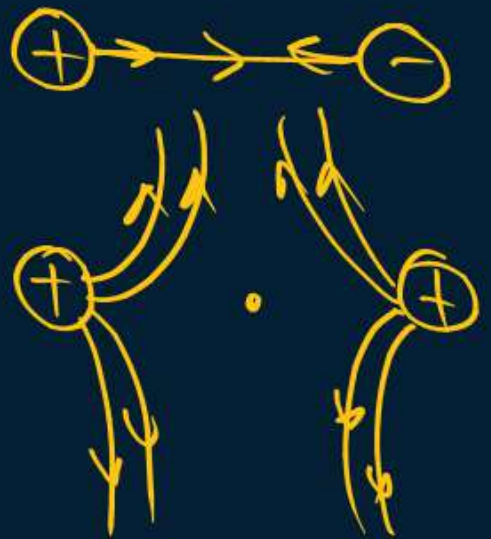


1. Continuous Line not distorted
2. Start from Positive, end at negative, no loop formation
3. Tangent gives direction of E
4. Cannot cross
5. Normal to the surface of conductor
6. Contract Lengthwise shows attraction, Expand Laterally shows repulsion
7. Relative Closeness shows more strength
8. E F inside conductor is zero

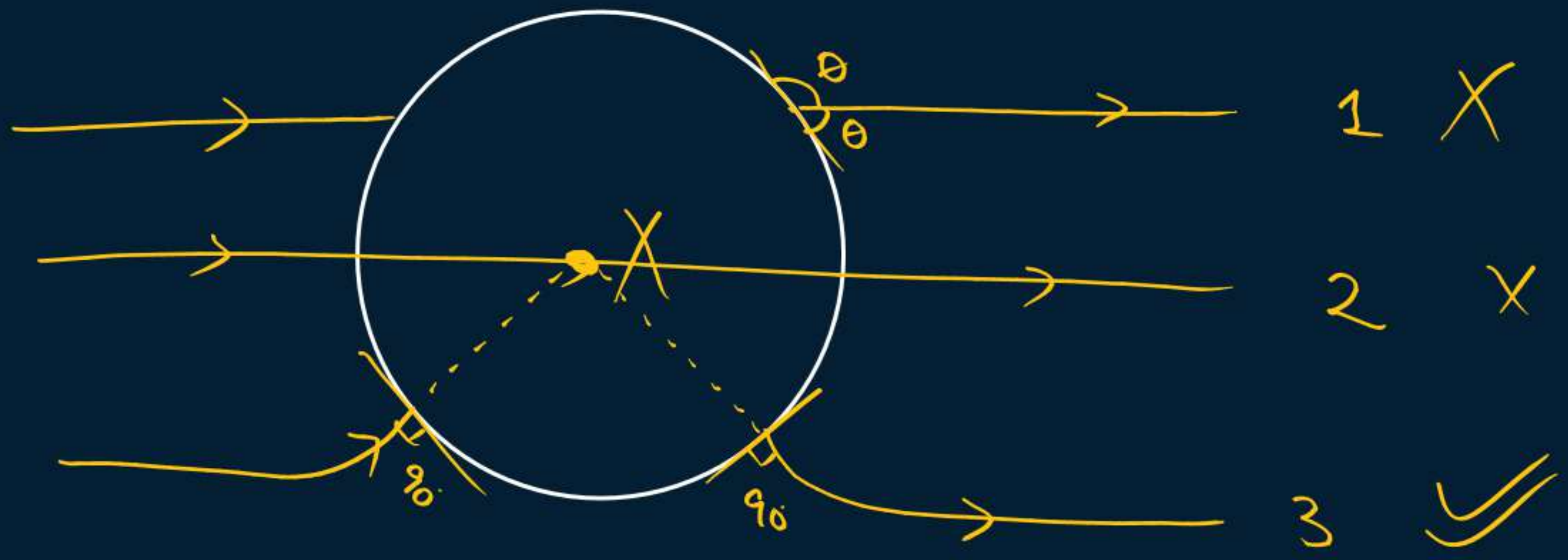




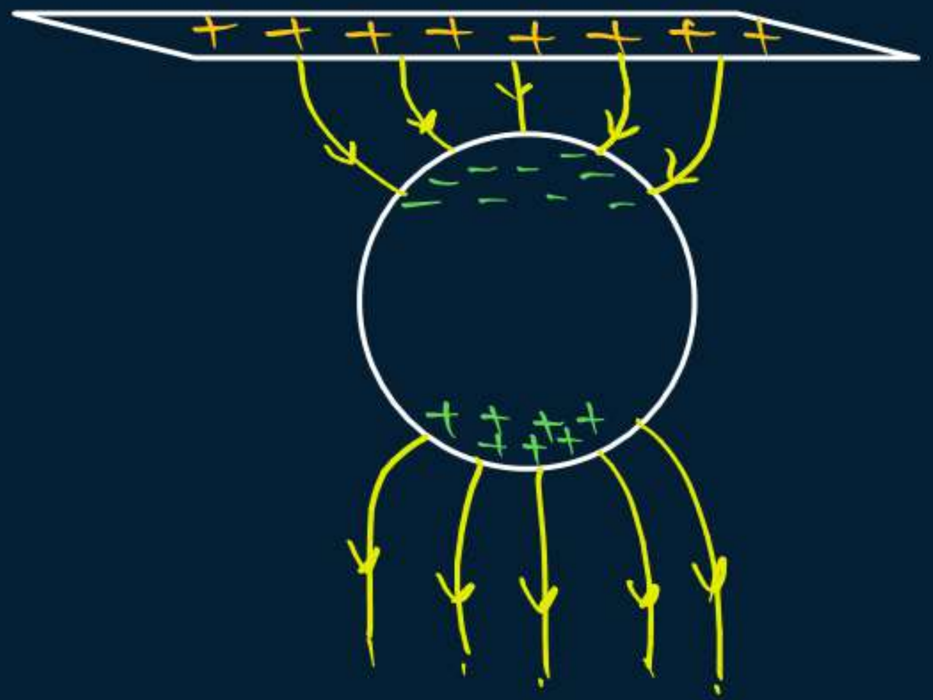




SBS PYQ



SBS PYQ



HOMEWORK

A point charge of 0.009 μC is placed at the origin. Calculate the intensity of electric field due to this point charge at point $\left(\sqrt{2}, \sqrt{7}, 0\right)$ m.

$$Q = 0.009\ \mu C$$

$$Q = 0.009 \times 10^{-6}\ C$$

$$\vec{r} = \sqrt{2}\,\hat{i} + \sqrt{7}\,\hat{j} + 0\hat{k}$$

$$\vec{r} = \sqrt{2}\,\hat{i} + \sqrt{7}\,\hat{j}$$

$$|r| = \sqrt{(\sqrt{2})^2 + (\sqrt{7})^2}$$

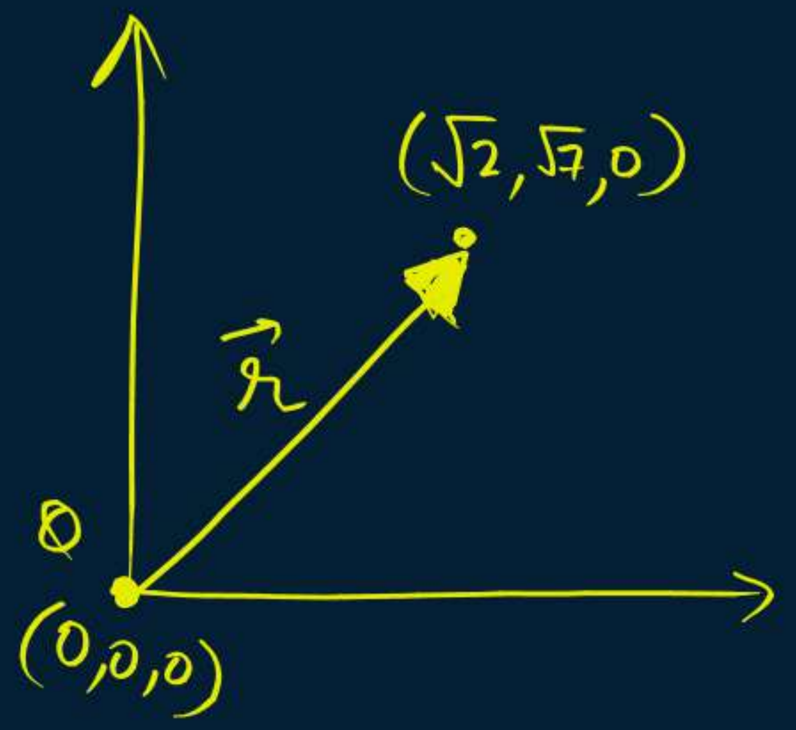
$$= \sqrt{2+7} = \sqrt{9} = 3$$

$$\boxed{\vec{E} = \frac{kQ}{r^3}\,\vec{r}}$$

$$= \frac{9\times10^{9} \times 0.009\times10^{-6}}{(3)^3} \times \vec{r}$$

$$= \frac{\cancel{9}\times\cancel{10^{9}}^{6} \times \cancel{9}^{3} \times \cancel{10^{-6}}}{\cancel{9}\times\cancel{3}_{1}\times\cancel{10^{3}}} \times \left(\sqrt{2}\,\hat{i} + \sqrt{7}\,\hat{j}\right)$$

$$= 3\left(\sqrt{2}\,\hat{i} + \sqrt{7}\,\hat{j}\right) = \left(3\sqrt{2}\,\hat{i} + 3\sqrt{7}\,\hat{j}\right) N/C \quad \underline{\text{Ans}}$$



Continuous Distribution of Charge

1D → Wire, ring

2D → plate, Conductor

3D → Solid conductor (Spherical)

1. Linear charge density (λ)

$$\boxed{\lambda = \frac{Q}{L}} \; \frac{Q \to C}{L \to m} \left(\frac{C}{m}\right) \text{ or } Cm^{-1}$$

λ_1

λ_2

$\lambda_2 > \lambda_1$

2. Surface charge density (σ)

$$\boxed{\sigma = \frac{Q}{A}} \; \frac{Q \to C}{A \to m^2} \text{ or } Cm^{-2}$$

σ_1

σ_2

$\sigma_1 > \sigma_2$

3. Volumetric charge density (ρ)

$$\boxed{\rho = \frac{Q}{V}} \; \frac{Q \to C}{V \to m^3} \text{ or } Cm^{-3}$$

ρ_1

$\rho_1 > \rho_2$

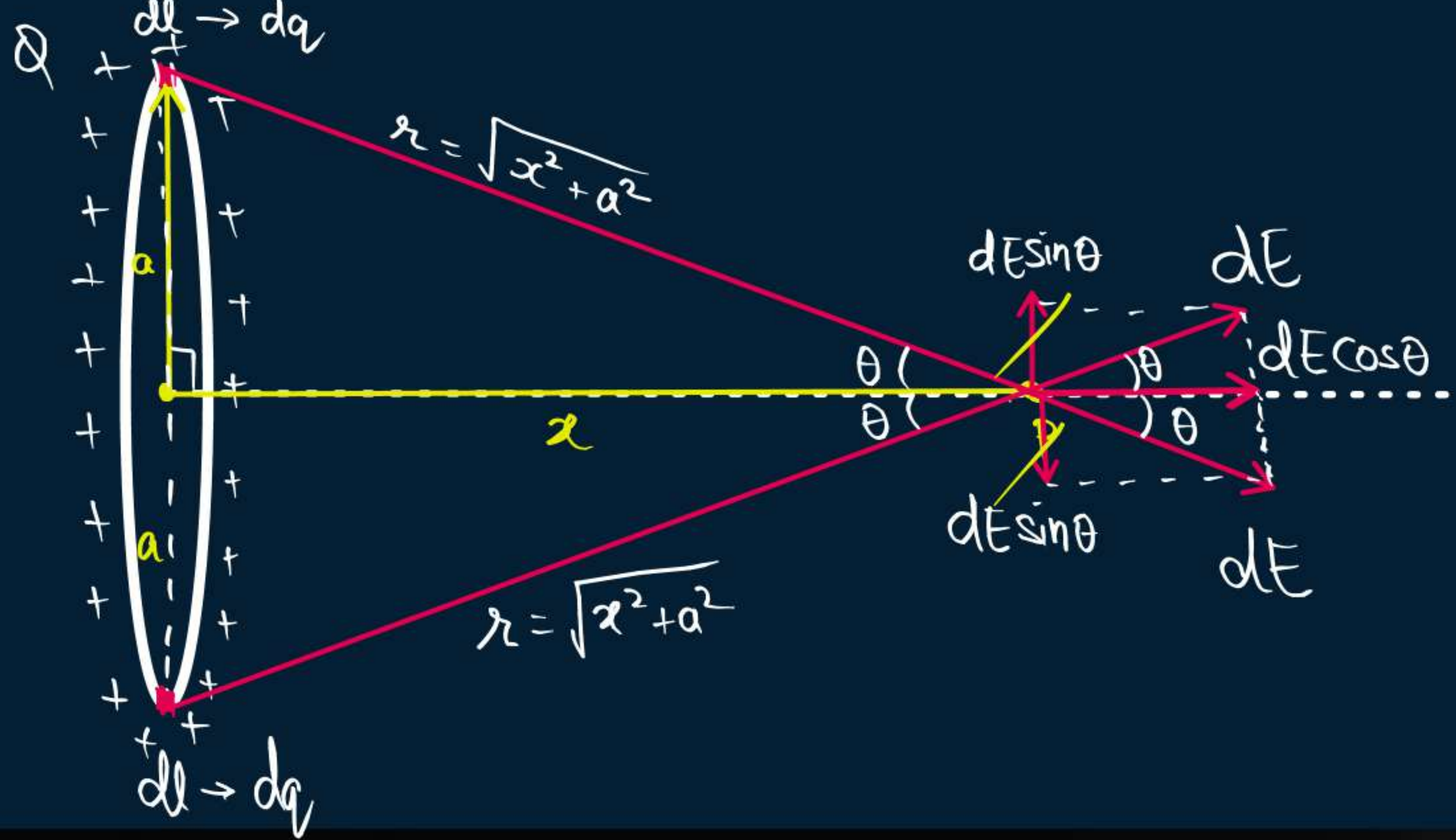
ρ_2

Electric Field Due to Charged Ring on the Axis

Suppose that the ring is placed with its plane perpendicular to the x-axis, as shown in fig. consider a small element *dl* of the ring.

As the total charge *q* is uniformly distributed, the charge *dq* on the element *dl* is

radius of ring = a



$$E_p^{net} = \int dE \cos\theta$$

$$E_p^{net} = \int dE\cos\theta$$

$$= \int \frac{k\,dq}{r^2}\cdot\frac{x}{r} \qquad \therefore \cos\theta = \frac{B}{H} = \frac{x}{r}$$

$$= \int \frac{k\,dq\cdot x}{r^3}$$

$$= \int \frac{k\,dq\,x}{\left(\sqrt{x^2+a^2}\right)^3}$$

$$= \int \frac{k\,dq\,x}{(x^2+a^2)^{3/2}}$$

$$= \frac{Kx}{(x^2+a^2)^{3/2}}\int dq$$

$$\boxed{E_p^{net} = \frac{KQx}{(x^2+a^2)^{3/2}}}$$

Spl. Case :-

1) Ring acts as point charge :- $x >> a$

$$x^2+a^2 \approx x^2$$

$$E_p = \frac{KQx}{(x^2)^{3/2}} = \frac{KQ\cancel{x}}{x^{\cancel{3}2}}$$

$$E_p = \frac{KQ}{x^2}$$

2) At centre of Ring :- $x = 0$

$$E_p = 0$$

Electric Dipole

Opp Charge
Same mag
Short Dist.

'Two' 'Power strengths'

A pair of equal and opposite charges separated by a small distance is called an electric dipole.

Dipole Moment

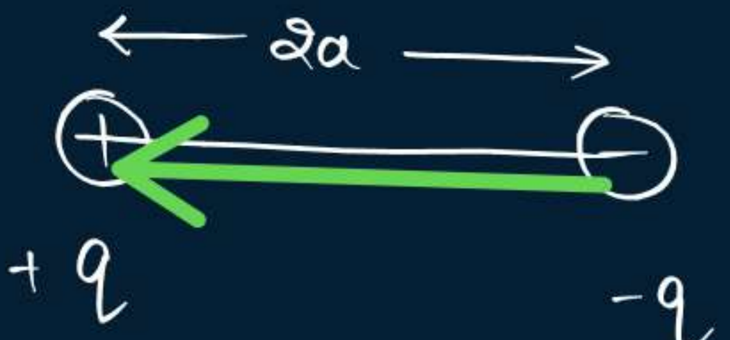
$$\vec{p} = \text{Charge} \times \text{separation} \quad \text{(Coulomb)} \times \text{(metre)} \Rightarrow \text{'Cm'}$$

$$= q \times 2a$$

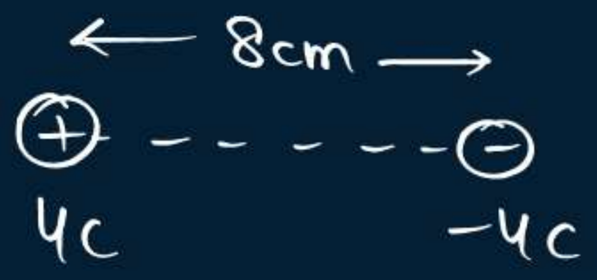
$$\boxed{p = q2a}$$

Direction of $\vec{p}$ is from -ve to +ve

SI unit → Cm



Q



$$p = q \times 2a$$

$$= 4 \times \frac{8}{100}$$

$$= \frac{32}{100} = 0.32\ \text{Cm}$$

Examples of electric Dipoles

Dipoles are common in nature. ✓

In molecules like HCl, H_2O, C_2H_5OH etc.

The centre of positive charge does not fall exactly over the centre of negative charges. Such molecules are electric dipoles. They have a permanent dipole moment.

Ideal or Point Dipole

Separation = 0 , $2a \longrightarrow 0$

Charge = ∞ , $q \longrightarrow \infty$

We can think of dipole in which size $2a \to 0$ and charge $q \to \infty$

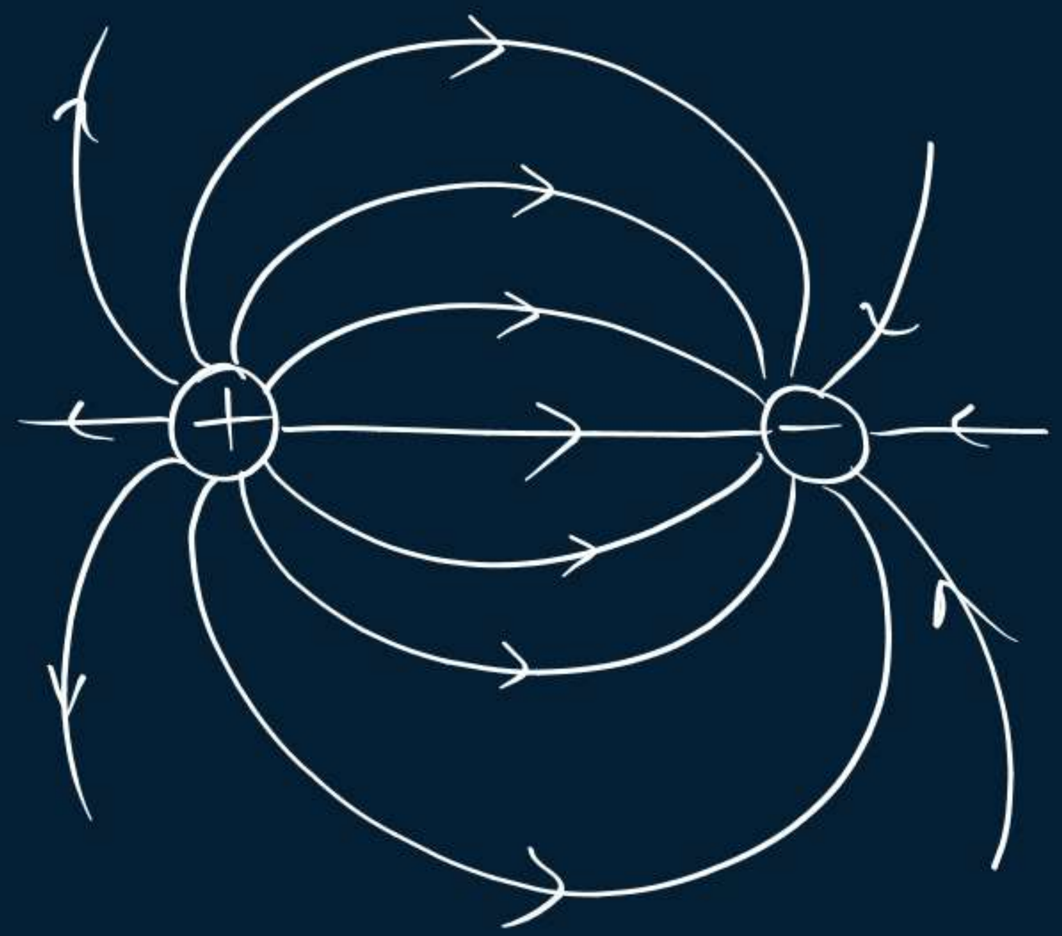
$$p = q\,2a$$

$$\infty \times 0$$

In such a way that the dipole moment, $p = q \times 2a$ has a finite value. Such a dipole of negligibly small size is called an ideal or point dipole.

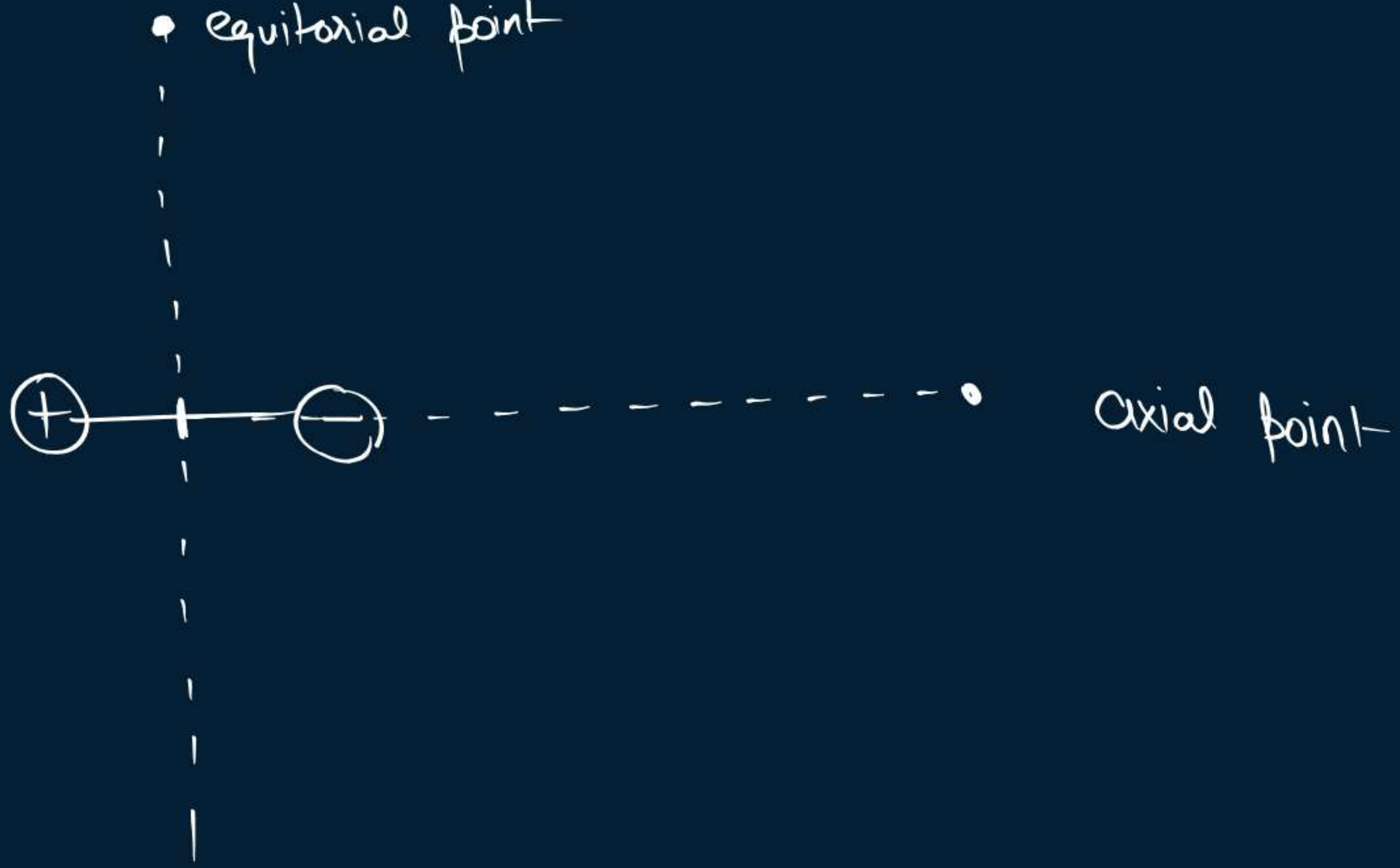
Dipole Field

The electric field produced by an electric dipole is called dipole field.

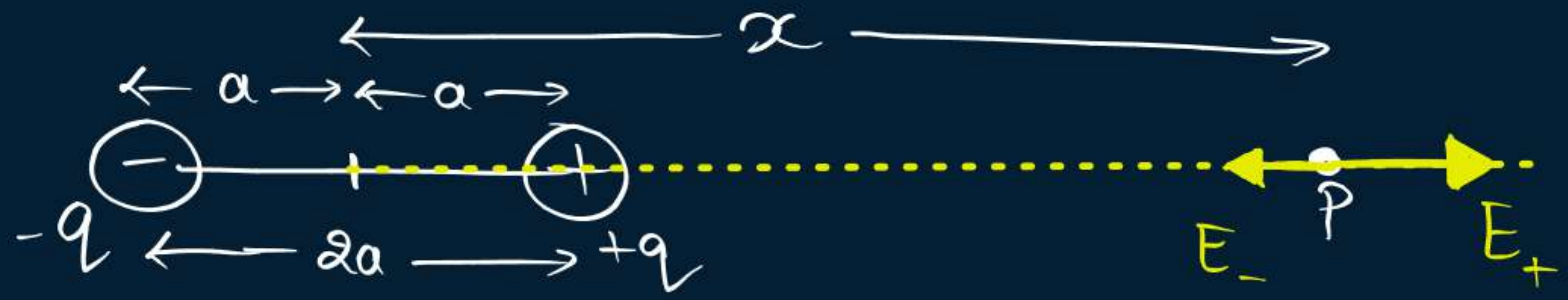


Variation of dipole field with distance

The total charge of an electric dipole is zero. But the electric field of an electric dipole is not zero.



E.F. at Axial Point



$$|E_+| = \frac{kq}{(x-a)^2}$$

$$|E_-| = \frac{kq}{(x+a)^2}$$

$$|E_p^{net}| = |E_+| - |E_-|$$

$$= \left|\frac{kq}{(x-a)^2}\right| - \left|\frac{kq}{(x+a)^2}\right|$$

$$= kq\left[\frac{1}{(x-a)^2} - \frac{1}{(x+a^2)}\right]$$

$$= kq\left[\frac{(x+a)^2-(x-a)^2}{(x-a)^2(x+a)^2}\right]$$

$$= kq\left[\frac{x^2+a^2+2xa-(x^2+a^2-2xa)}{(x^2-a^2)^2}\right]$$

$$= kq\left[\frac{\cancel{x^2}+\cancel{a^2}+2xa-\cancel{x^2}-\cancel{a^2}+2xa}{(x^2-a^2)^2}\right]$$

$$= kq\left[\frac{4xa}{(x^2-a^2)^2}\right]$$

$$= \frac{2k(q\,2a)x}{(x^2-a^2)^2}$$

* $$\boxed{E_{axial} = \frac{2kpx}{(x^2-a^2)^2}}$$

* Spl. case : Very short dipole

$$x >> a$$

$$x^2 - a^2 \approx x^2$$

$$E_{axial} = \frac{2kpx}{(x^2-a^2)^2}$$

$$= \frac{2kpx}{(x^2)^2} = \frac{2kp\cancel{x}}{x^{\cancel{4}3}}$$

* $$\boxed{E_{ax} = \frac{2kp}{x^3}}$$

QUESTION

Two point charges, each of 5 μC but opposite in sign, are placed 4 cm apart. Calculate the electric field intensity at a point distance 4 cm from the midpoint on the axial line of the dipole.

$2a = 4\,\text{cm}$

$a = 2\,\text{cm}$

$$E_{axial} = \frac{2kpx}{(x^2-a^2)^2} = \frac{2\times 9\times 10^{9}\times 5\times 10^{-6}\times \frac{4}{100}\times\frac{4}{100}}{\left(\left(\frac{4}{100}\right)^2-\left(\frac{2}{100}\right)^2\right)^2}$$

$$= \boxed{}\ N/C$$

Homework

→ 'Notes'

→ 'Revision'

→ DPP ke saare sawaal X

PARISHRAM

2026

Electric Charges and Fields

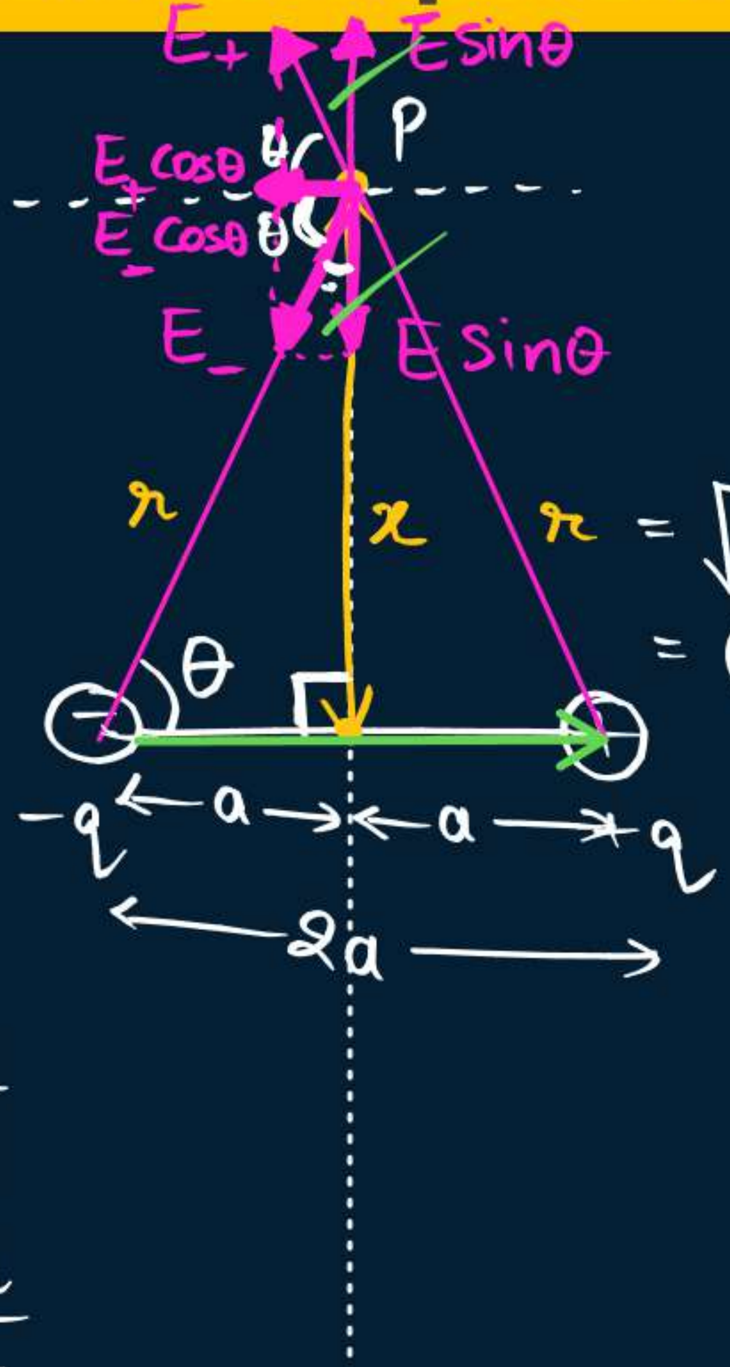
PHYSICS **LECTURE-6**

BY - RAKSHAK SIR

Topics to be covered

- **A** E F at Equatorial Point of a Dipole ✓
- **B** Dipole placed in Uniform E F ✓
- **C** Electric Flux ✓ Torque

E.F. at Equatorial Point



$$r = \sqrt{x^2+a^2} = (x^2+a^2)^{\frac{1}{2}}$$

$$\cos\theta = \frac{B}{H} = \frac{a}{r}$$

$$\vec{E}_{net} = \vec{E}_+ + \vec{E}_-$$

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

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

$$= 2\frac{kq}{r^2}\cdot\frac{a}{r}$$

$$= \frac{2kqa}{r^3}$$

$$\boxed{E_{equa} = \frac{2kqa}{(x^2+a^2)^{3/2}}}$$

for short dipole

Spl. case :- $x >> a$

$x^2 + a^2 \approx x^2$

$$E_{equa} = \frac{2kqa}{(x^2+a^2)^{3/2}}$$

$$= \frac{2kqa}{(x^2)^{3/2}}$$

$$= \frac{2kqa}{x^3}$$

* $\boxed{E_{equa} = \frac{kp}{x^3}}$ $\Rightarrow$ $\boxed{\vec{E}_{equa} = -\frac{k\vec{p}}{x^3}}$

NOTE- Direction of $\vec{p}$ is opp to $\vec{E}_{eq}$

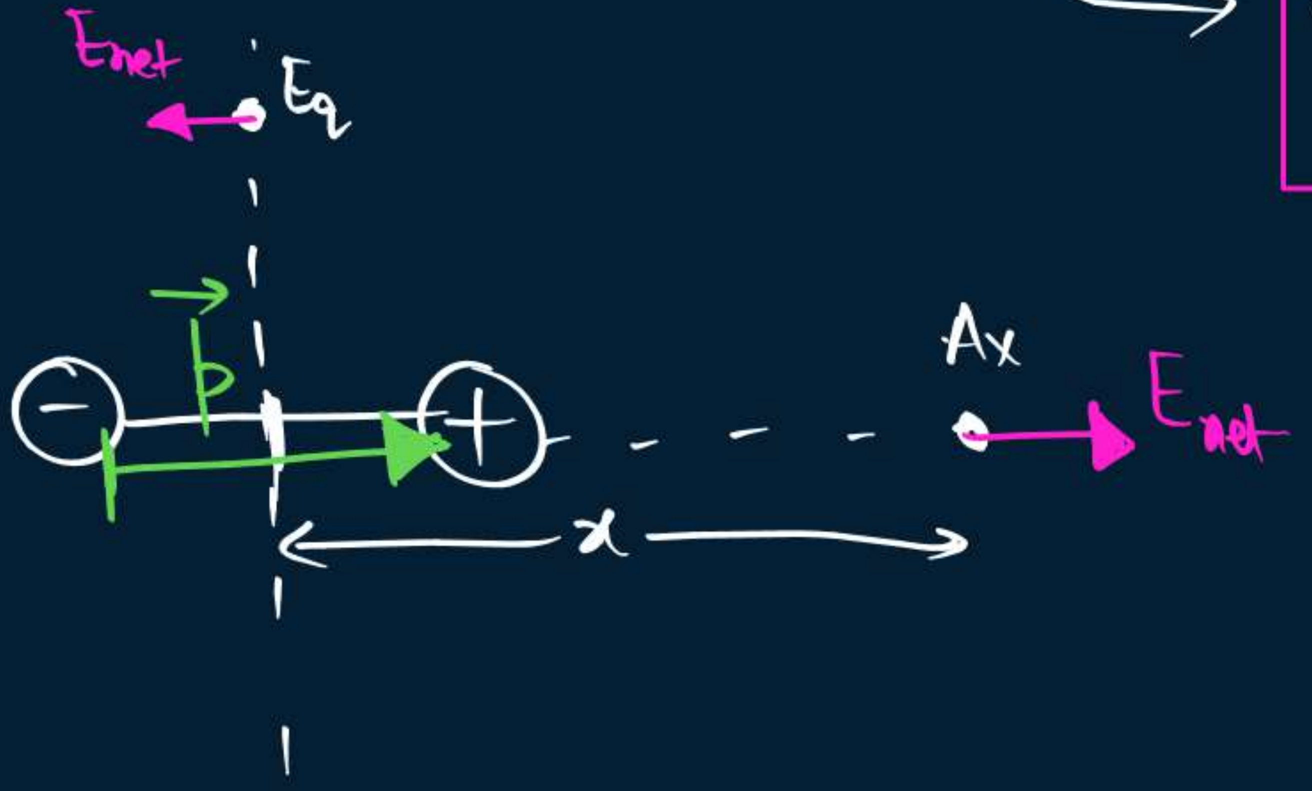
Comparison of electric fields of a short dipole at axial and equatorial points

*

$$\boxed{\begin{aligned} E(\text{axial}) &= \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2p}{r^3} = \frac{2kp}{x^3} \\ E(\text{equa}) &= \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{p}{r^3} = \frac{kp}{x^3} \end{aligned}}$$

for a short dipole : $\dfrac{E_{axial}}{E_{equa}} = \dfrac{\dfrac{2\cancel{kp}}{\cancel{x^3}}}{\dfrac{\cancel{kp}}{\cancel{x^3}}} = \dfrac{2}{1}$

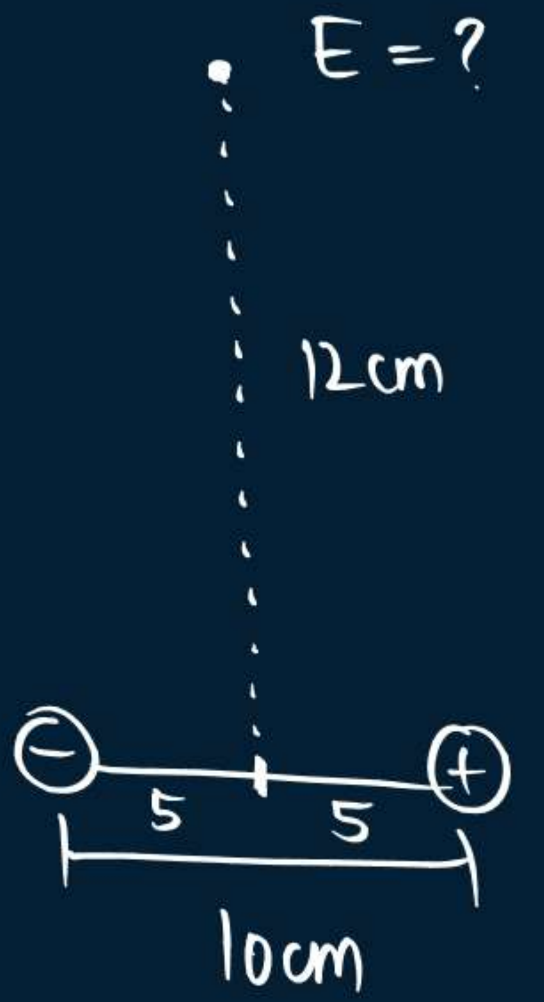
$$\boxed{E_{axial} : E_{equa} = 2:1}$$



Note - direction of $\overrightarrow{E_{axial}}$ is same as $\vec{p}$

QUESTION

Calculate the electric field due to an electric dipole of length 10 cm having charge of 1 μC at an equatorial point 12 cm from the centre of the dipole.



$$E_{equa} = \frac{2kqa}{(x^2+a^2)^{3/2}}$$

$$= \frac{2 \times 9 \times 10^9 \times 10^{-6} \times 5 \times 10^{-2}}{(12^2+5^2)^{3/2}}$$

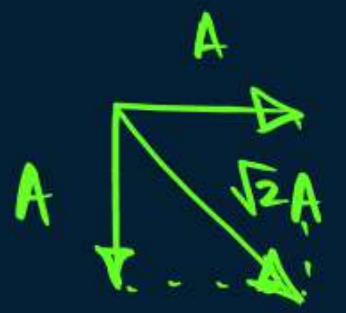
$$= \boxed{}\ N/C$$

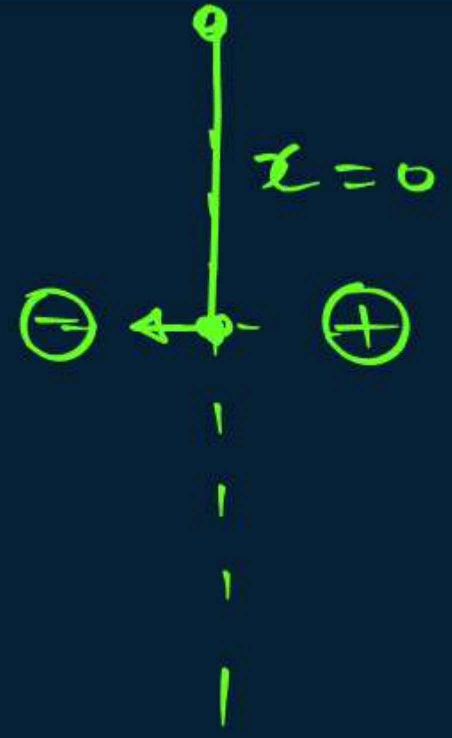
QUESTION

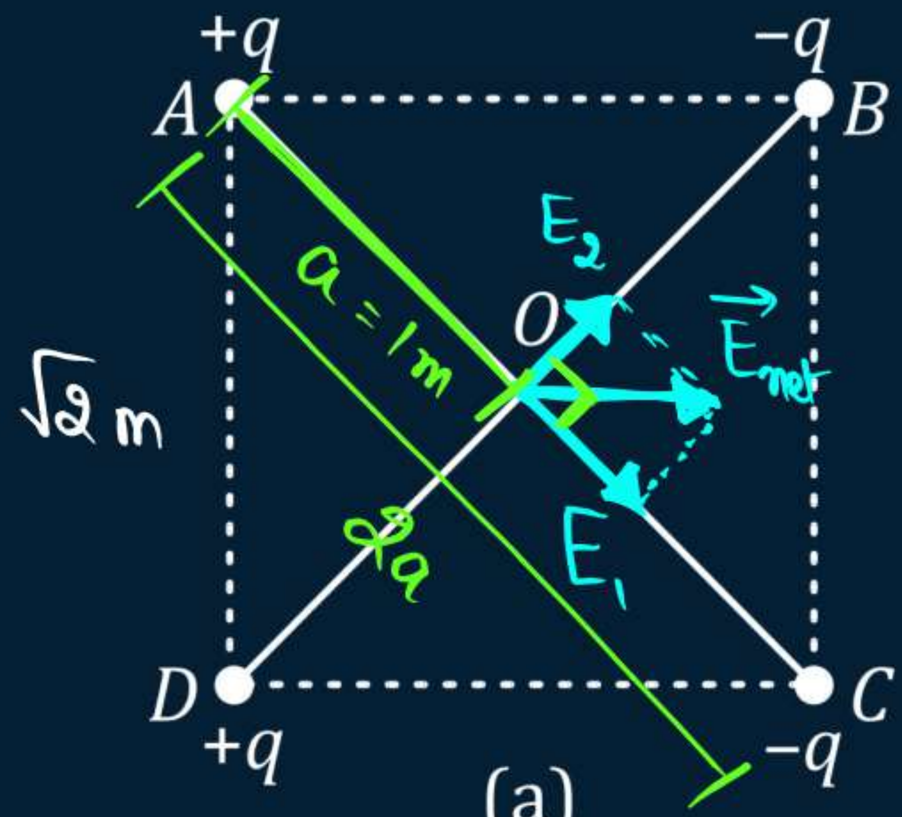
$\boxed{\sqrt{2}a}$ $a = \sqrt{2}$, Diagnol $= \sqrt{2}\sqrt{2} = 2$

Two identical electric dipoles are placed along the diagonals of a square ABCD of side $\sqrt{2}$ m as shown in fig. Obtain the magnitude and direction of the net electric field at the center O of the square. **[CBSE OD 2023]**

Y.K.B.







(a)

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$$

$$\vec{E}_{net} = \sqrt{2}E$$

$$= \sqrt{2}\,\frac{2kqa}{(x^2+a^2)^{3/2}}$$

$$= \sqrt{2}\,\frac{2kqa}{a^{3}}$$

$$= \sqrt{2}\,\frac{2kq}{a^2} = \frac{2\sqrt{2}\times 9\times10^9\times q}{1^2}$$

QUESTION

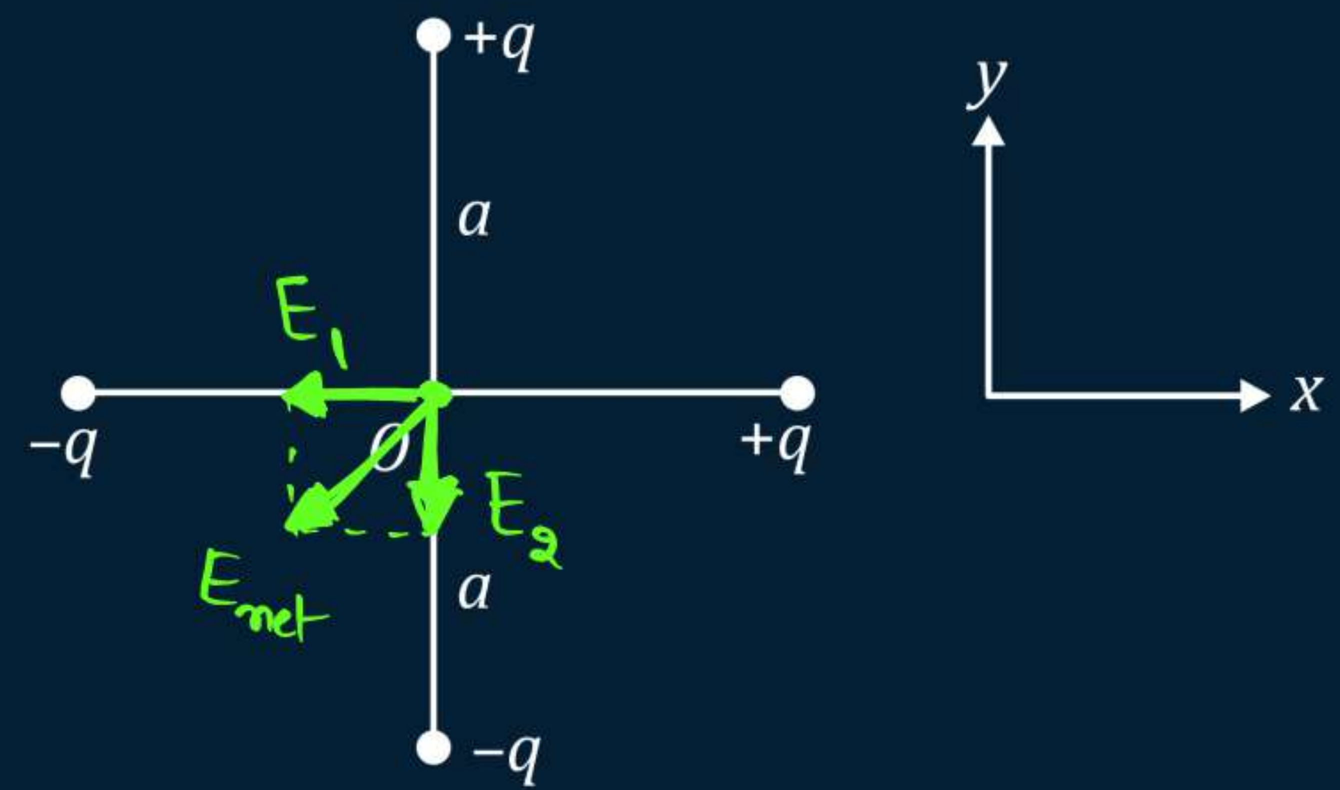
Two identical dipoles are arranged in x-y plane as shown in fig. Find the magnitude and the direction of net electric field at the origin O. [CBSE F 2023]

$$E_{net} = \sqrt{2}\,E$$

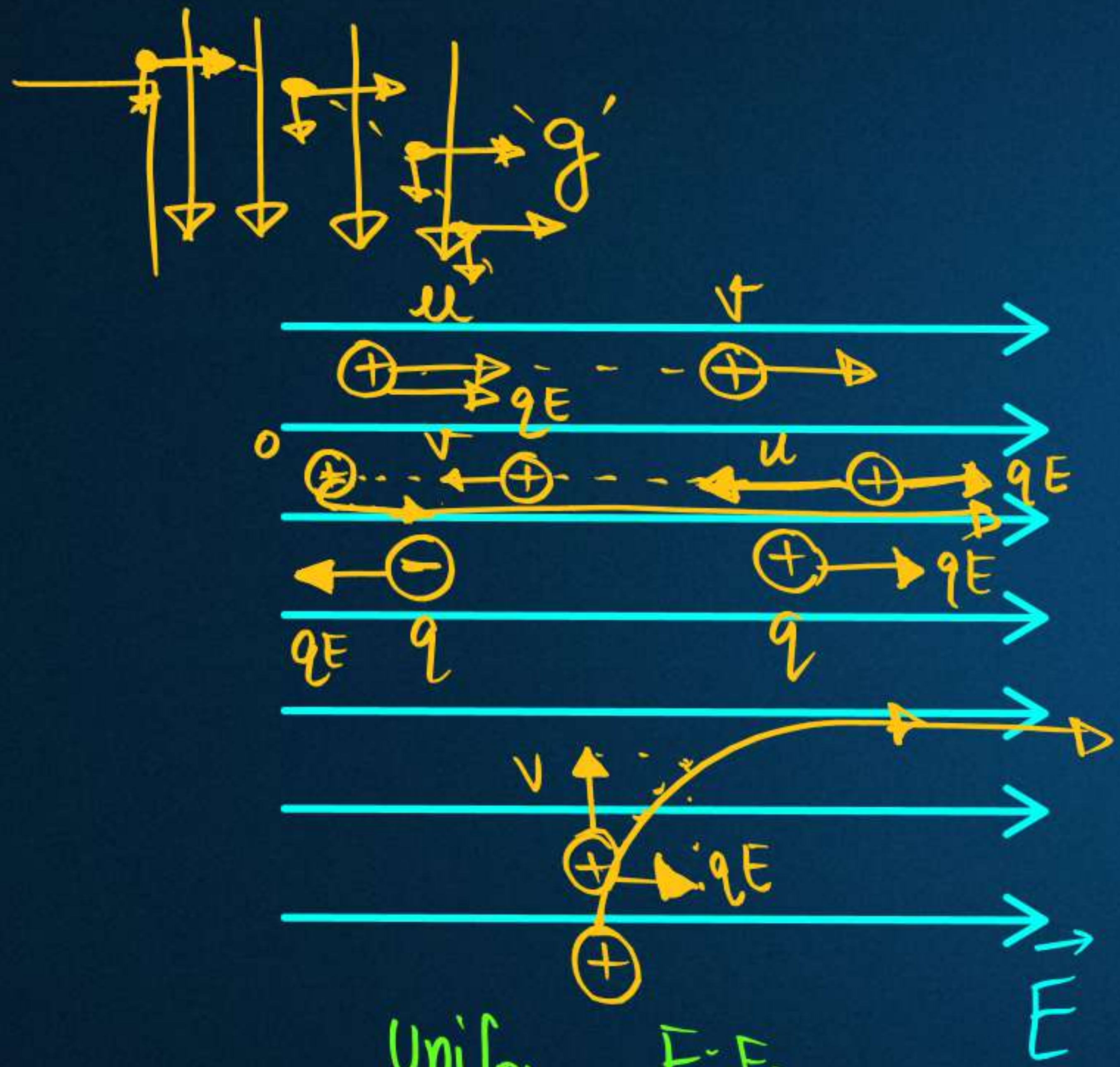
$$= \sqrt{2}\,\frac{2kqa}{(x^2+a^2)^{3/2}}$$

$$= \sqrt{2}\,\frac{2kq\cancel{a}}{(a^2)^{3/\cancel{2}}}\,{}^{2}$$

$$= \frac{2\sqrt{2}\,kq}{a^2}$$



* Charge behaves in Uniform E.F.



Uniform E.F.

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

$$\boxed{F = qE}$$

Force on a charged particle by Electric field

Torque on a Dipole in Uniform E F

TORQUE = |Either force| · |perpendicular distance b/w them|

$$|\tau| = qE\,2a\sin\theta$$

$$= pE\sin\theta$$

$$\boxed{\vec{\tau} = \vec{p}\times\vec{E}}$$

Max TORQUE

$\theta = 90^\circ$

$\tau = pE\sin 90^\circ$

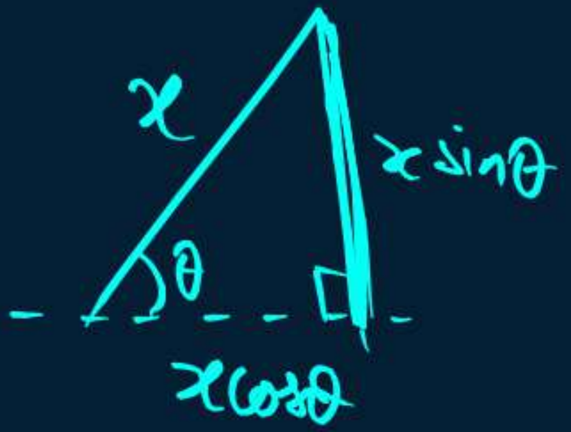
$\boxed{\tau_{Max} = pE}$

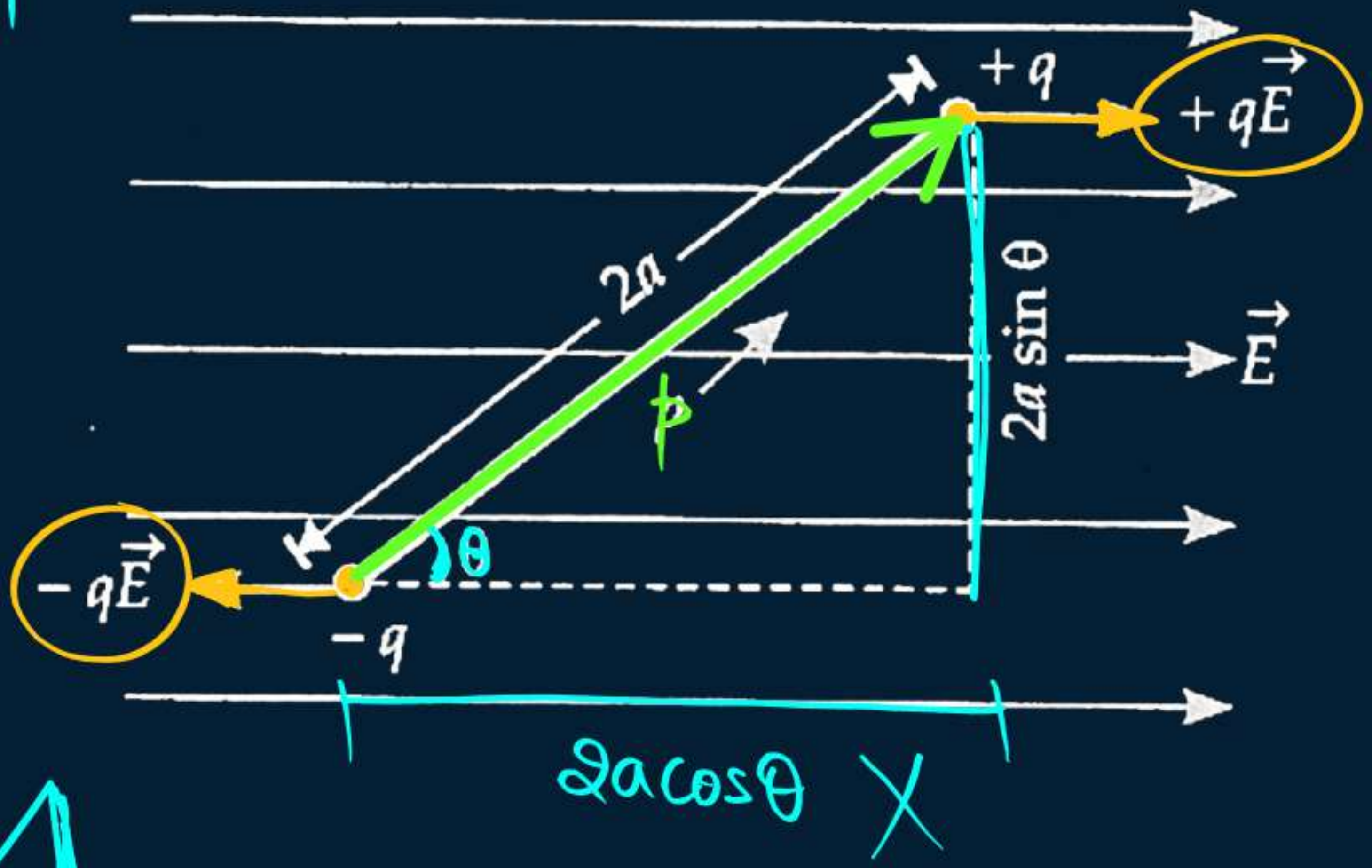
MINIMUM TORQUE (zero)

$\theta = 0^\circ$

$\tau = pE\sin 0^\circ$

$\boxed{\tau = 0}$





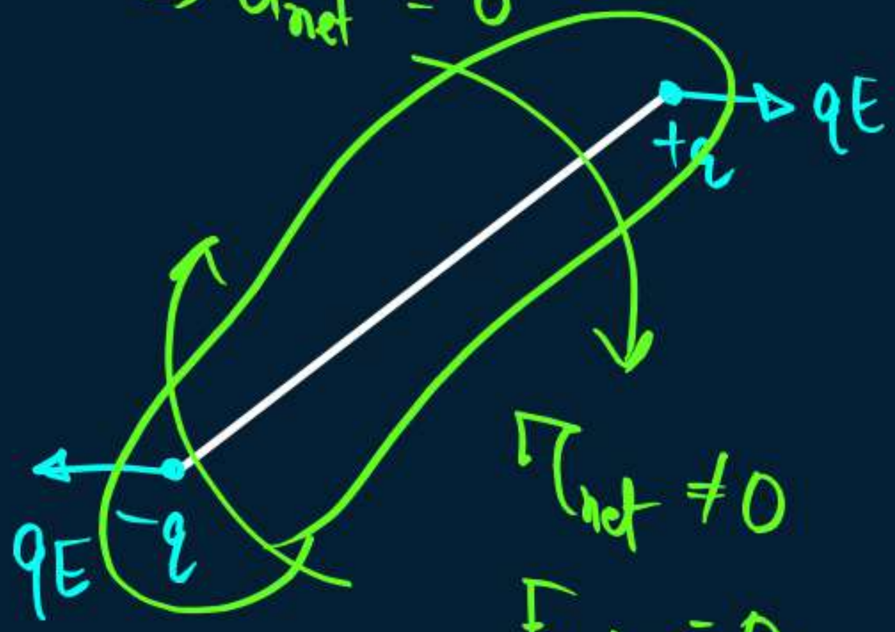
Net Force and Net Torque on a Dipole

$\vec{E}$ (uniform)

$F_{net}=0, \tau_{net}=0$

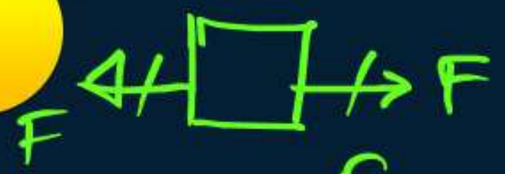
$F_{net}=0$ ✓

$a_{net}=0$



$\tau_{net}\neq 0$

$F_{net}=0$



$F_{net}=0$

if $F_{net}=0$, then $\tau_{net}\neq 0$

Homework

- Notes
- Revision
- Promise Yaad Rakhna!!!

PARISHRAM

2026

Electric Charges and Fields

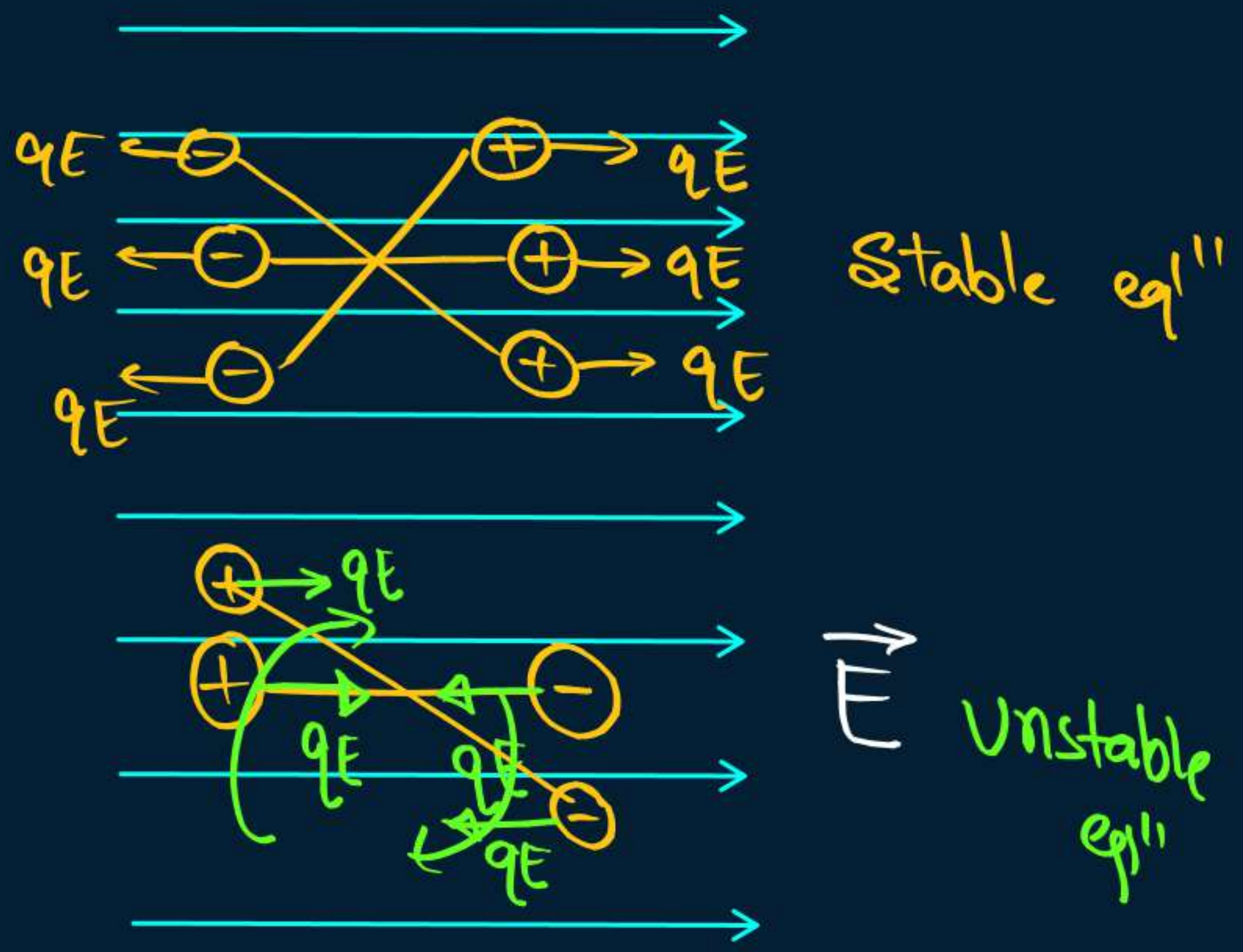
PHYSICS **LECTURE-7**

BY - RAKSHAK SIR

Topics *to be covered*

- **A** Area Vector ✓
- **B** Flux ✓
- **C** Gauss's Law
- **D**
- **E**

Stable and unstable equilibrium of Dipole in a Uniform Electric Field

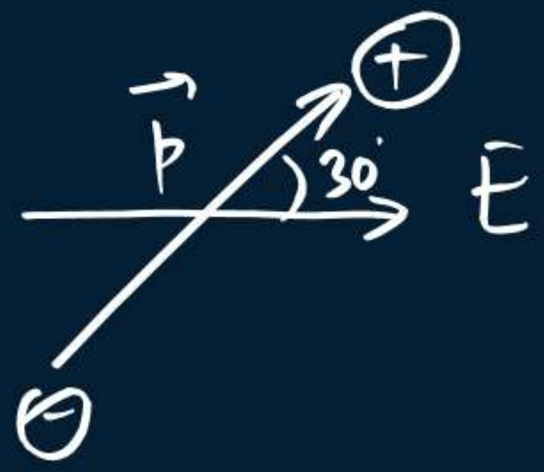


Y.K.B.

PYQ SBS

An electric dipole, when held at 30° with respect to a uniform electric field of 10^4 NC^{-1} experiences a torque of 9×10^{-26} Nm. Calculate dipole moment of the dipole.

$p = ?$



$\theta = 30^\circ$

$E = 10^4$ N/C

$\tau = 9 \times 10^{-26}$ Nm

$p = ?$

$$\tau = pE\sin\theta$$

$$9 \times 10^{-26} = p \times 10^4 \times \sin 30^\circ$$

$$p = \frac{9 \times 10^{-26}}{10^4 \times \frac{1}{2}} = 18 \times 10^{-30} = 1.8 \times 10^{-29} \text{ Cm}$$

Gauss's law

Area Vector

Flux

Theorem

Area Vector

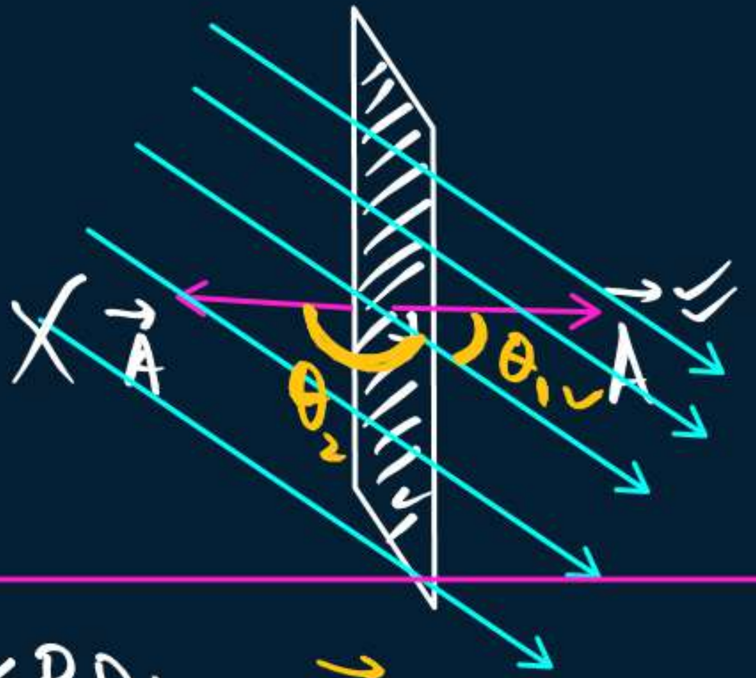
$\vec{A} = |A|\hat{A}$

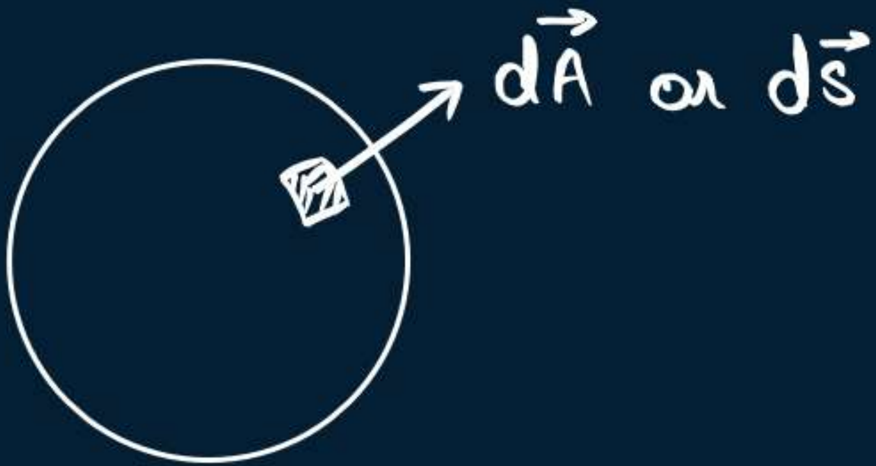
$|A|$ → formula (shape)

$\hat{A}$ → direction = ?

2D ✓ 3D ✓

"outward Normal"



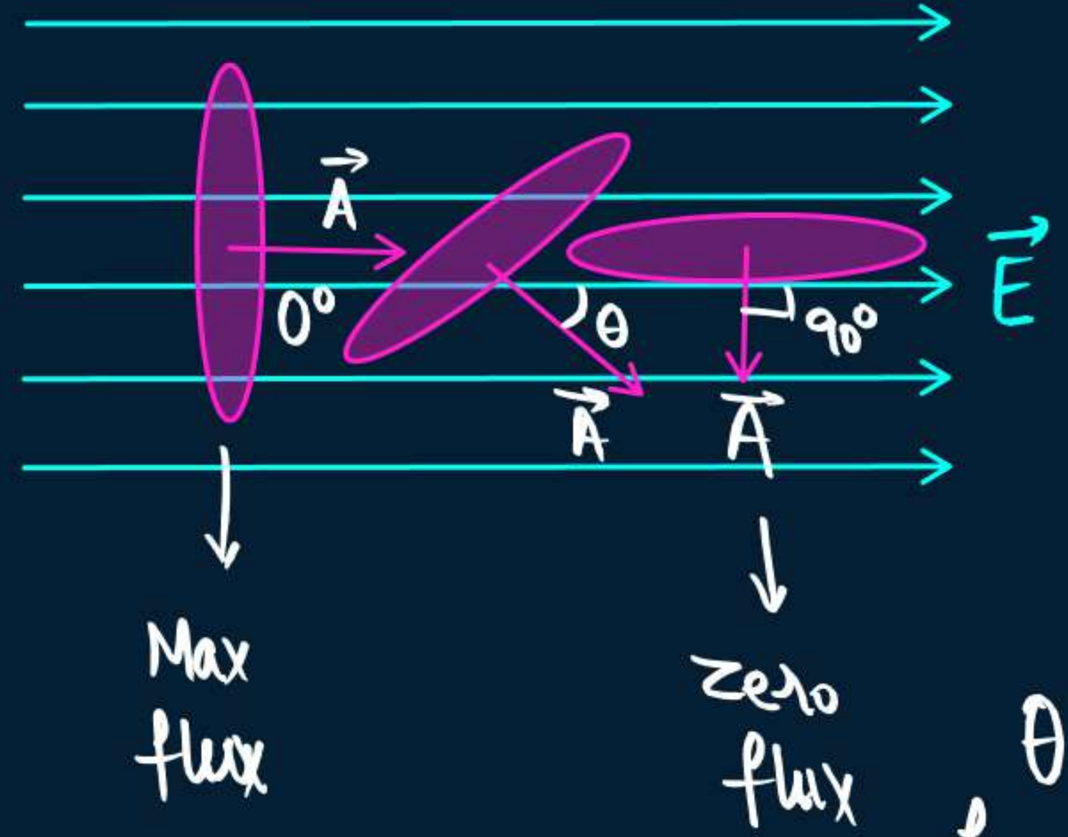


* RDx :- $\vec{A}$ Vo lena hai Jiska $\vec{E}$ ke Saath Angle Acute Bane !!!

Electric Flux $\rightarrow$ $\phi_e = \vec{E}\cdot\vec{A} = EA\cos\theta$

$\Rightarrow$ The No. of Electric field lines passing through an area Normally ($\perp$).

$$\phi_e = \int \vec{E}\cdot d\vec{s}$$



$$\phi_e = \vec{E}\cdot\vec{A}$$

$$\phi_e = EA\cos\theta$$

Y.K.B.

$\vec{A}\cdot\vec{B} = |A||B|\cos\theta$

$\theta = 0^\circ$

$\phi_e = EA\cos 0^\circ$

$\boxed{\phi_e = EA} \rightarrow$ Max

$\theta = 90^\circ$

$\phi = EA\cos 90^\circ$

$\boxed{\phi = 0} \rightarrow$ Zero flux

Units of Electric Flux

$(0, +, -)$

- Electric flux is a scalar quantity. ✓
- SI unit of electric flux = Nm^2C^{-1}
- Equivalently, SI unit of electric flux = Vm.

$\phi_e = \vec{E} \cdot \vec{A}$

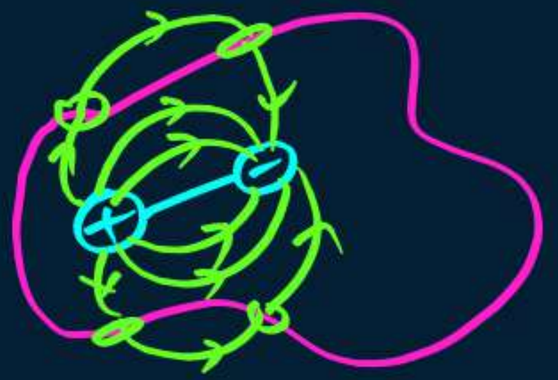
$\phi_e = EA\cos\theta$

$\frac{N}{C} m^2 = Nm^2C^{-1}$ ✓

$\vec{A} \cdot \vec{B} = AB\cos\theta$

↳ 'scalar'

Electric Flux: Imp. Points



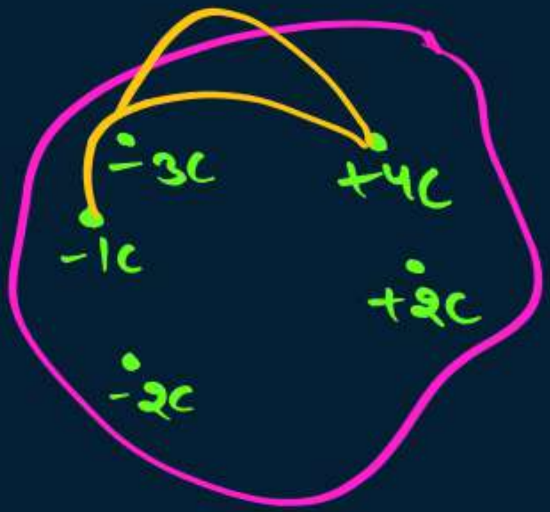
The value of Net $\boxed{\varphi \text{ is zero}}$ in the following circumstances:

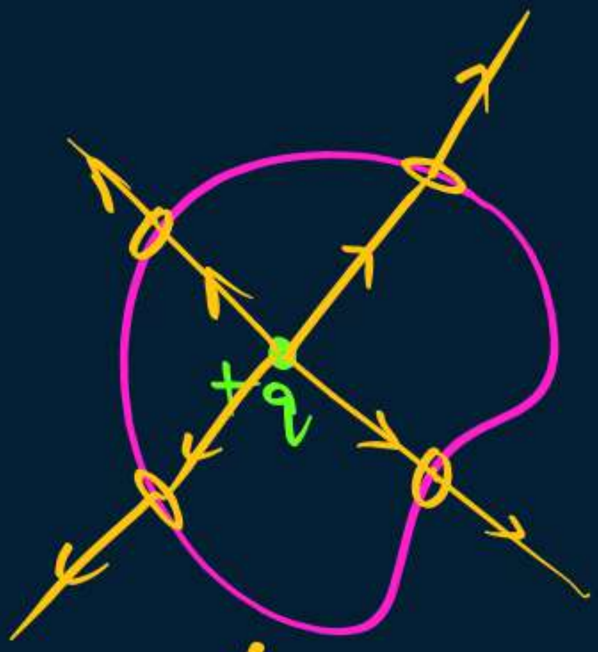
(a) If a dipole is (or many dipoles are) enclosed by a closed surface.

(b) Magnitude of (+ve) and (−ve) charges are equal inside a closed surface.

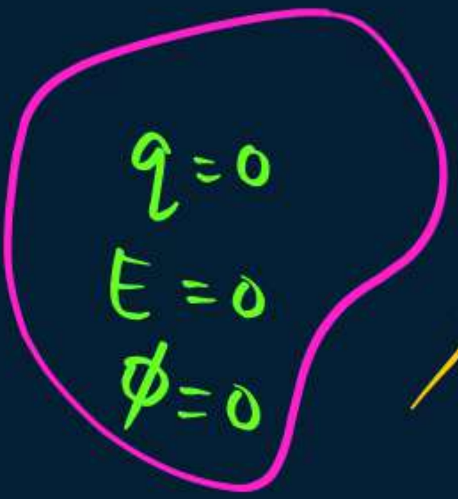
(c) If no charge is enclosed by the closed surface.

(d) Incoming flux (−ve) = outgoing flux (+ve)

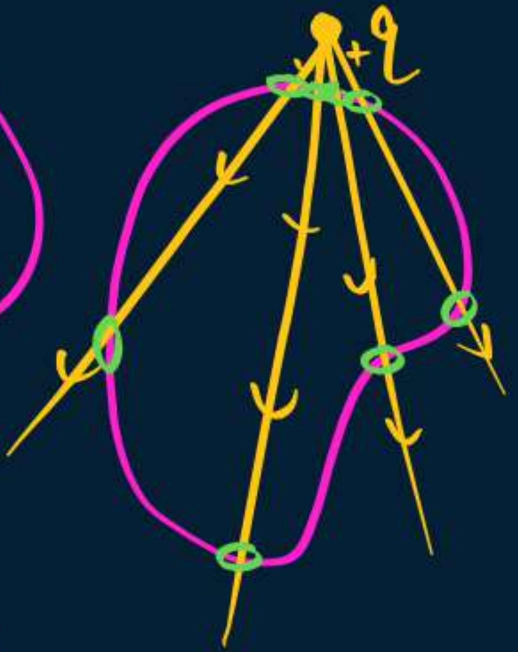


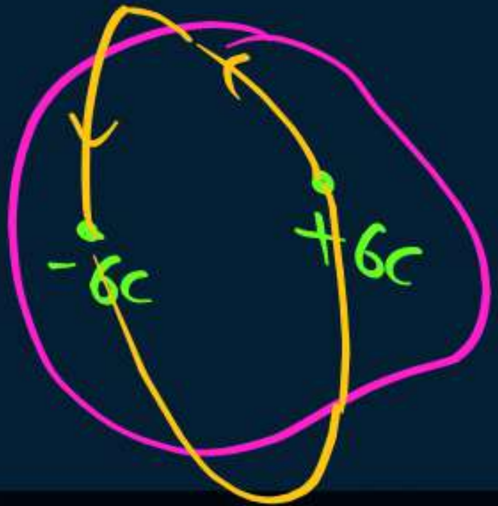


$\phi \neq 0$



$\phi_{net} = 0$





QUESTION

If $\vec{E} = 6\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$, calculate the electric flux through a surface of area 20 units in Y-Z plane.

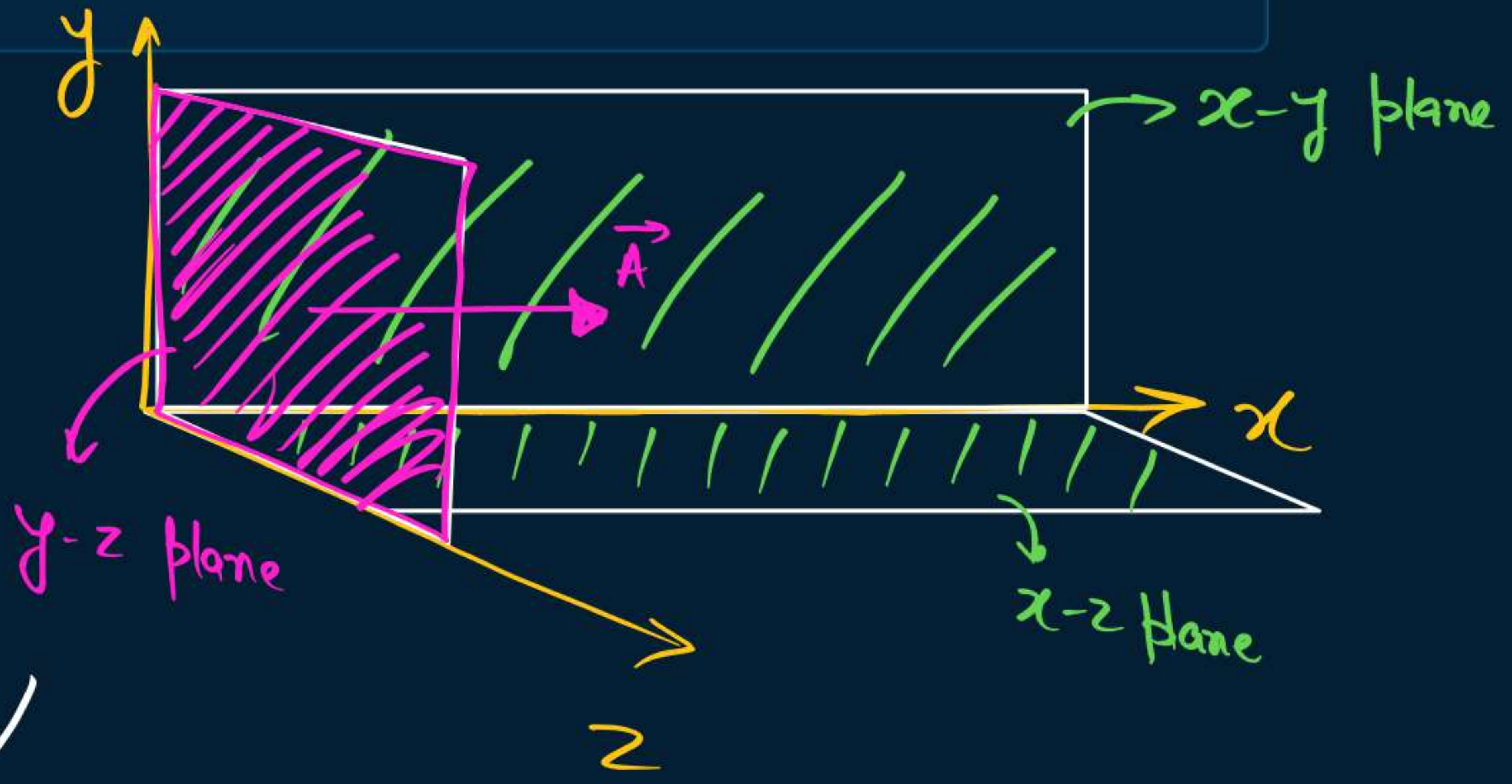
$\vec{A} = 20\hat{i}$

$\vec{E} = 6\hat{i} + 3\hat{j} + 4\hat{k}$

$\phi_e = \vec{E} \cdot \vec{A}$

$= (6\hat{i} + 3\hat{j} + 4\hat{k}) \cdot 20\hat{i}$

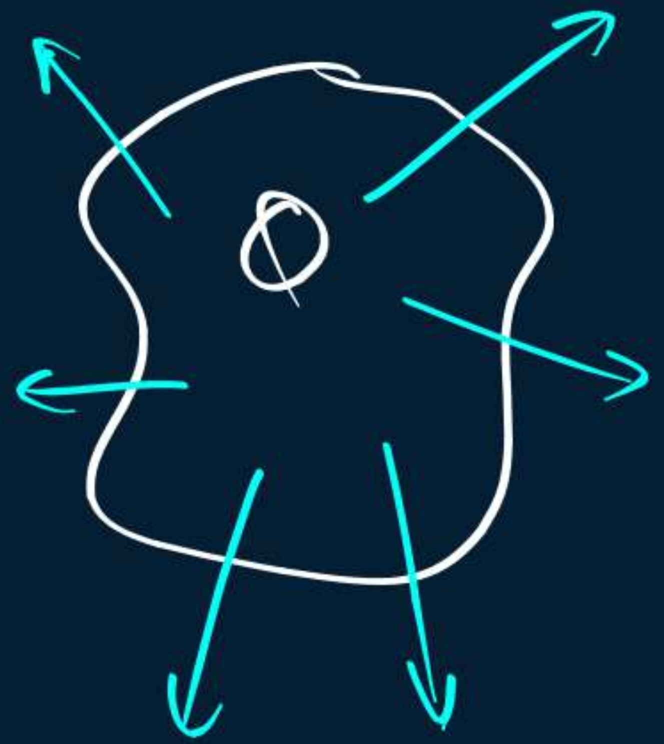
$= 120\ Nm^2C^{-1}$



Gauss's Theorem

$\phi = \vec{E} \cdot \vec{A}$ or $\phi = \int \vec{E} \cdot d\vec{A}$

Gauss Theorem states that the total flux through a closed surface is $1/\varepsilon_0$ times the net charge enclosed by the closed surface. Mathematically.



$$\phi = \frac{Q}{\epsilon_0}$$

$$\phi = \vec{E} \cdot \vec{A} \quad \text{— (I)}$$

$$\phi = \frac{Q}{\epsilon_0} \quad \text{— (II)}$$

$$\vec{E} \vec{A} = \frac{Q}{\epsilon_0}$$

Homework

→ Notes ✓

→ Revision ✓

PARISHRAM

2026

Electric Charges and Fields

PHYSICS **LECTURE-8**

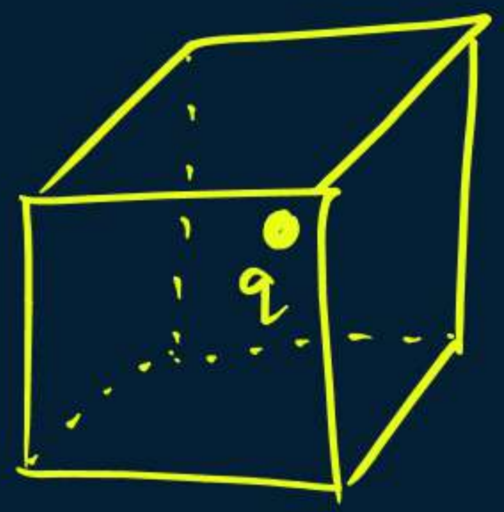
BY - RAKSHAK SIR

Topics *to be covered*

- **A** Gauss Law and Its Applications
- **B**
- **C**
- **D**
- **E**

QUESTION

If a point charge q is placed at the centre of a cube, what is the flux linked (a) with the cube? (b) with each face of the cube?



a) $\phi_{cube} = \frac{Q}{\epsilon_0}$

b) $\phi_{face} = \frac{Q}{6\epsilon_0}$

QUESTION

football / Hollow sphere

S_1 and S_2 are two concentric shells enclosing charges Q and 2Q respectively as shown in figure.

(a) What is the ratio of the electric flux through S_1 and S_2?

(b) How will the electric flux through the sphere S_1 change, if a medium of dielectric constant ε_r is introduced in the space within S_1 in place of air?

'K'

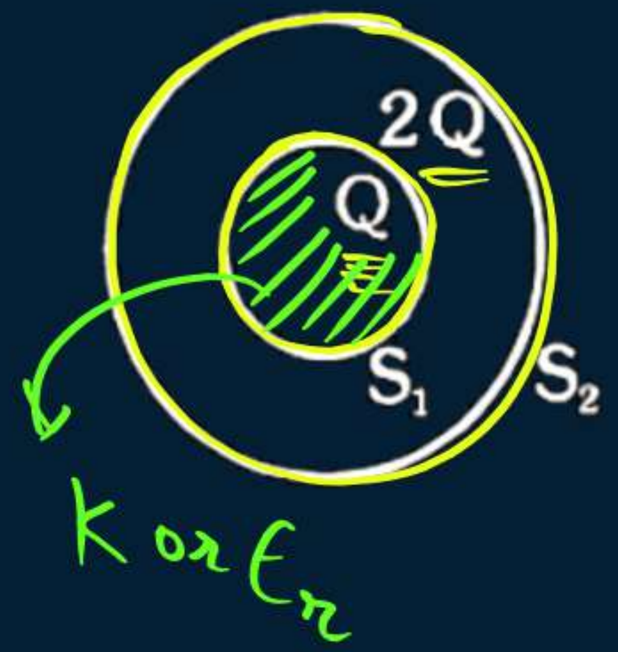
a) $\phi_{s_1} = \frac{Q}{\epsilon_0}$

$\phi_{s_2} = \frac{2Q + Q}{\epsilon_0} = \frac{3Q}{\epsilon_0}$

$\frac{\phi_1}{\phi_2} = \frac{\cancel{Q}/\cancel{\epsilon_0}}{3\cancel{Q}/\cancel{\epsilon_0}} = \frac{1}{3} = 1:3$

b) $\phi_{s_1} = \frac{Q}{K\epsilon_0}$

$\phi_{s_1} = \frac{Q}{\epsilon_r \epsilon_0}$



Gauss's Theorem

Coulomb's law

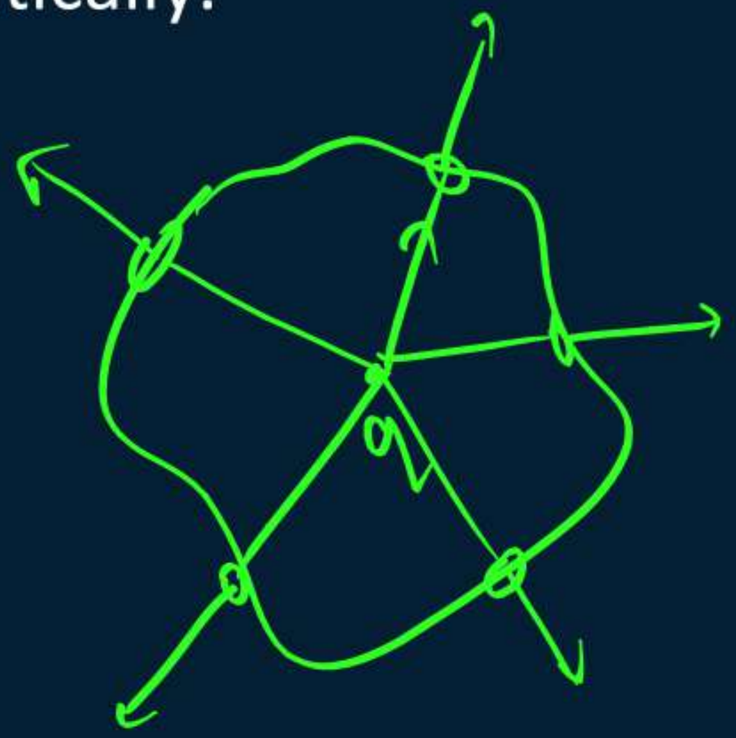
$\phi_e = \vec{E} \cdot \vec{A} = EA\cos\theta$

$\phi_e = \int \vec{E} \cdot \vec{ds} = \int |E||ds|\cos\theta$

Gauss Theorem states that the total flux through a closed surface is $1/\varepsilon_0$ times the net charge enclosed by the closed surface. Mathematically.

$$\phi_e = \frac{q_{enclosed}}{\epsilon_0}$$

$$\boxed{\vec{E} \cdot \vec{A} = \frac{q_{enc}}{\epsilon_0}}$$



Gaussian Surface

Gaussian surface: Any hypothetical closed surface enclosing a charge is called the Gaussian surface of that charge.

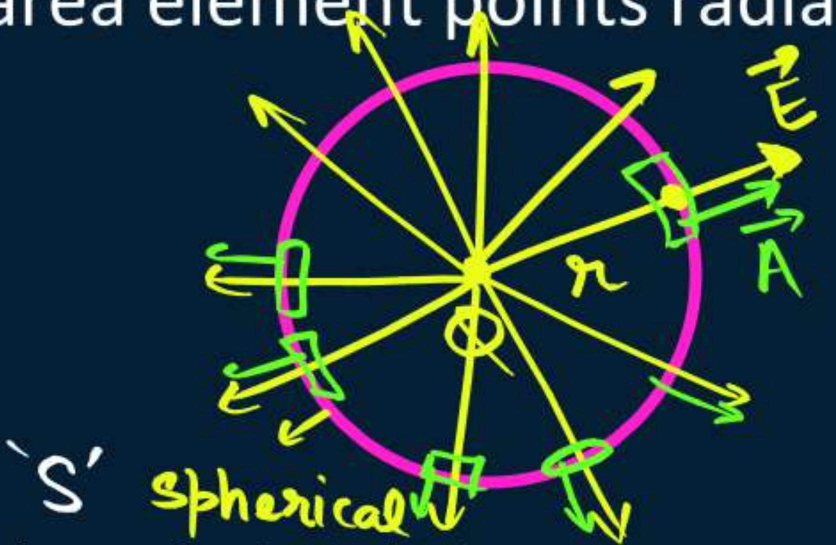
Importance: By a clever choice of Gaussian surface, we can easily find the electric fields produced by certain symmetric charge configurations.

Which are otherwise quite difficult to evaluate by the direct application of Coulomb's law and the principle of superposition.

Proof of Gauss's Theorem

This field points radially outward at all points on S.

Also, any area element points radially outwards, so it is parallel to $\vec{E}$, i.e., θ = 0°.



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

$\phi_e = \vec{E} \cdot \vec{A}$

$\phi_e = |E||A| \cos\theta$

$\phi_e = \frac{kQ}{r^2} \times 4\pi r^2 \times \cos 0° = \frac{1}{\cancel{4\pi}\epsilon_0} \frac{Q}{\cancel{r^2}} \times \cancel{4\pi r^2}$

$= \frac{Q}{\epsilon_0}$

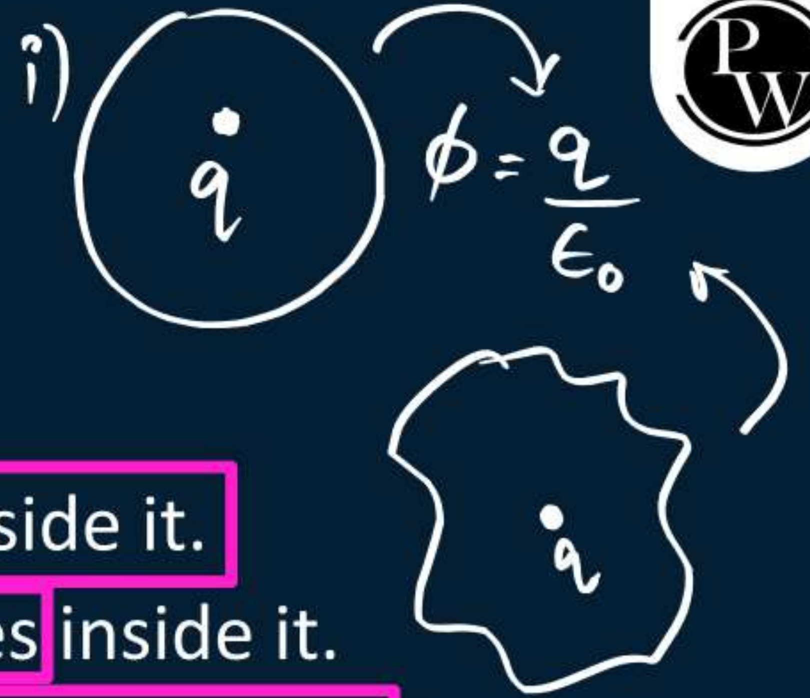
For the sake of simplicity, we approve Gauss's theorem for an isolated positive point charge q.

As shown in fig, suppose the surface S is a sphere of radius r centered on q. Then surface S is a Gaussian surface.

$$\boxed{\phi_e = \frac{Q}{\epsilon_0}}$$

Important Points: Gauss's Theorem

i) $\phi = \frac{q}{\epsilon_0}$



(i) Flux through Gaussian surface is independent of its shape.

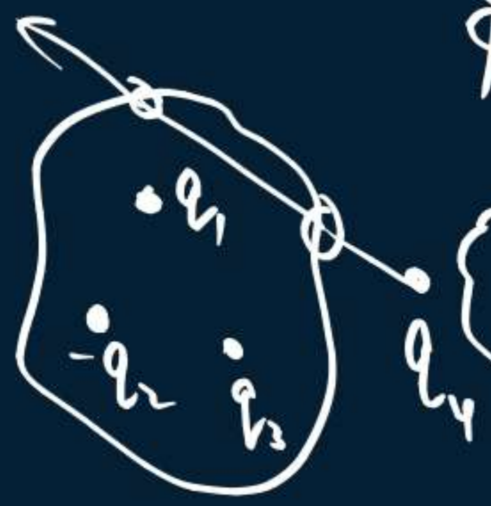
(ii) Flux through Gaussian surface depends only on charges present inside it.

(iii) Flux through Gaussian surface is independent of position of charges inside it.

(iv) Electric field intensity at the Gaussian surface is due to all the charges present (inside as well as outside)

(v) In a closed surface incoming flux is taken negative while outgoing flux is taken positive.

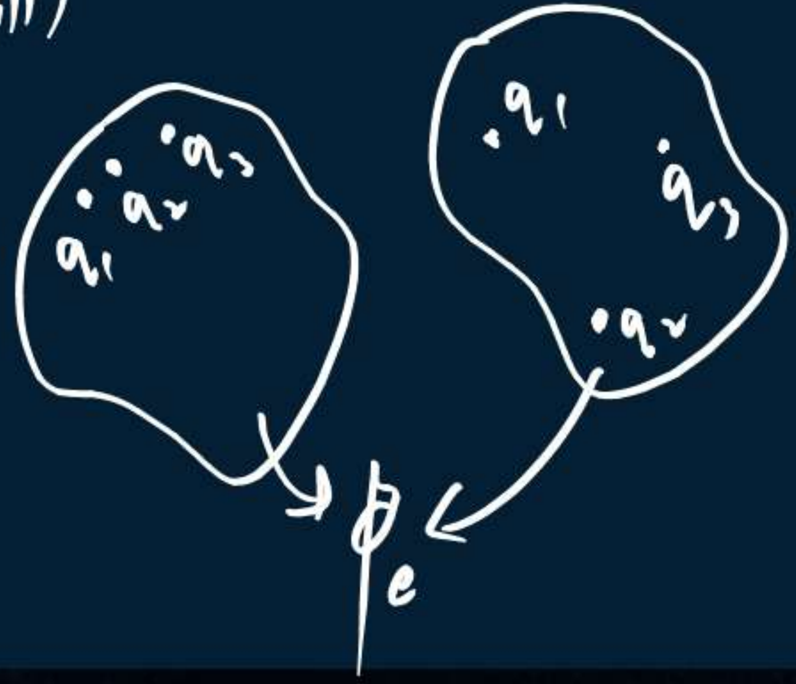
ii)



$\phi_e = \frac{q_{enclosed}}{\epsilon_0}$

$\phi_e = \frac{q_1 - q_2 + q_3}{\epsilon_0}$

iii)



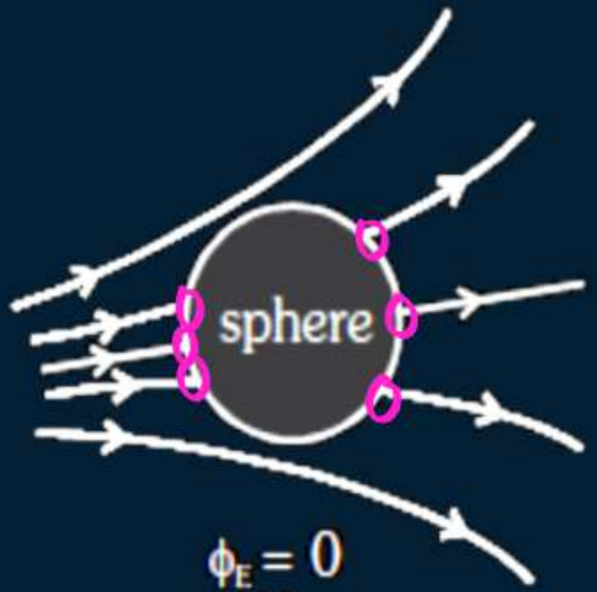
Important Points: Gauss's Theorem

$\phi = 0, E \neq 0$

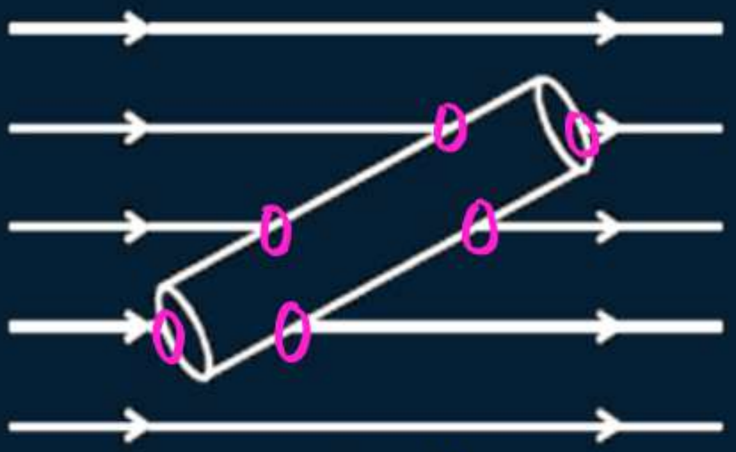
(vi) In a Gaussian surface $\phi = 0$ does not imply $E = 0$ but $E = 0$ implies $\phi = 0$.

(vii) (a) If a closed body (not enclosing any charge) is placed in an electric field (either uniform or non-uniform) total flux lined with it will be zero.

vi)



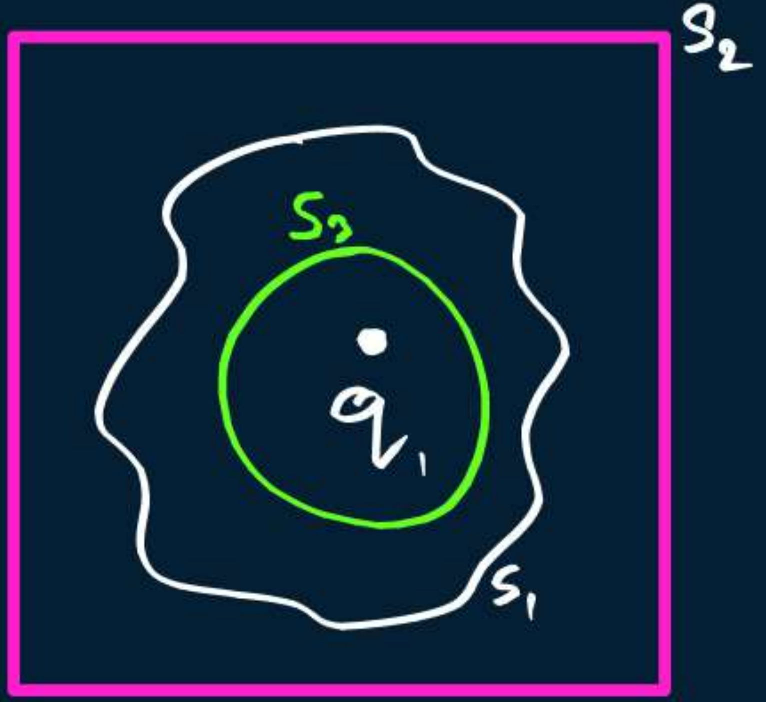
$\phi_E = 0$
(A)



$\phi_E = 0$
(B)

Some Conceptual Questions

Q1



$\phi_{S_1} = \frac{q_1}{\epsilon_0}$, $\phi_{S_2} = \frac{q_1}{\epsilon_0}$

$\phi_{S_3} = \frac{q_1}{\epsilon_0}$

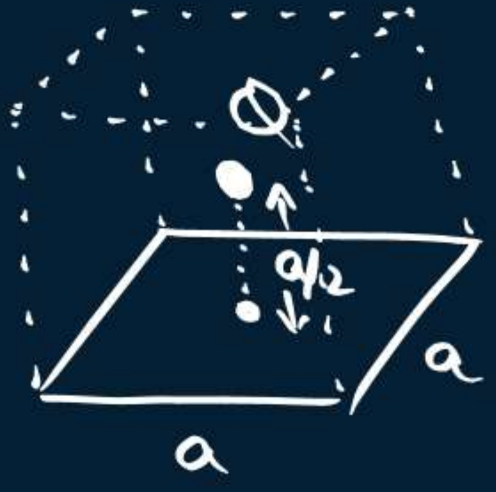
Q2

$\phi_{cube} = \frac{Q}{\epsilon_0}$

$\phi_{cube} = \frac{Q}{\epsilon_0}$

$\phi_{2\,sides} = \frac{Q}{\cancel{6}_3\epsilon_0} \times \cancel{2}^1 = \frac{Q}{3\epsilon_0}$

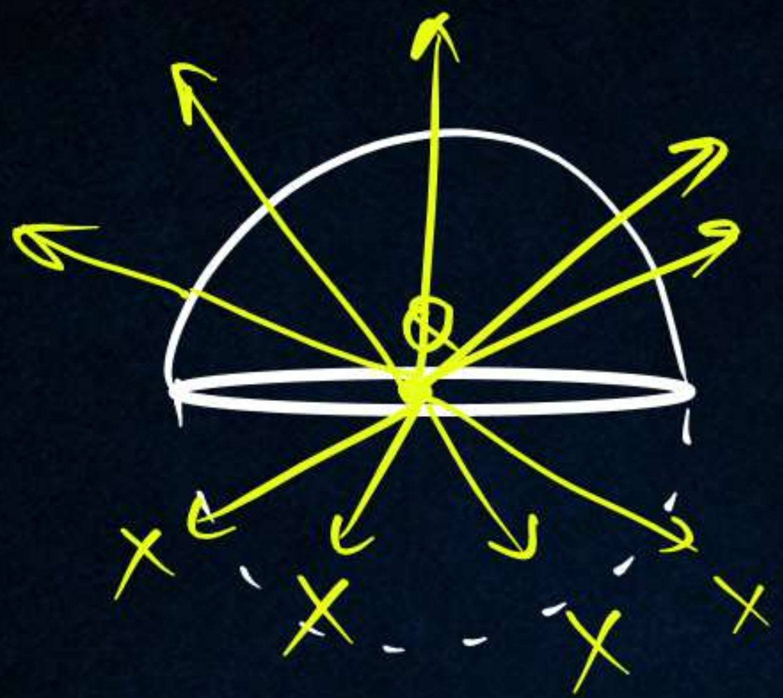
Q3



$\phi_{cube} = \frac{Q}{\epsilon_0}$

$\phi_{\text{side of cube}} = \frac{Q}{6\epsilon_0}$

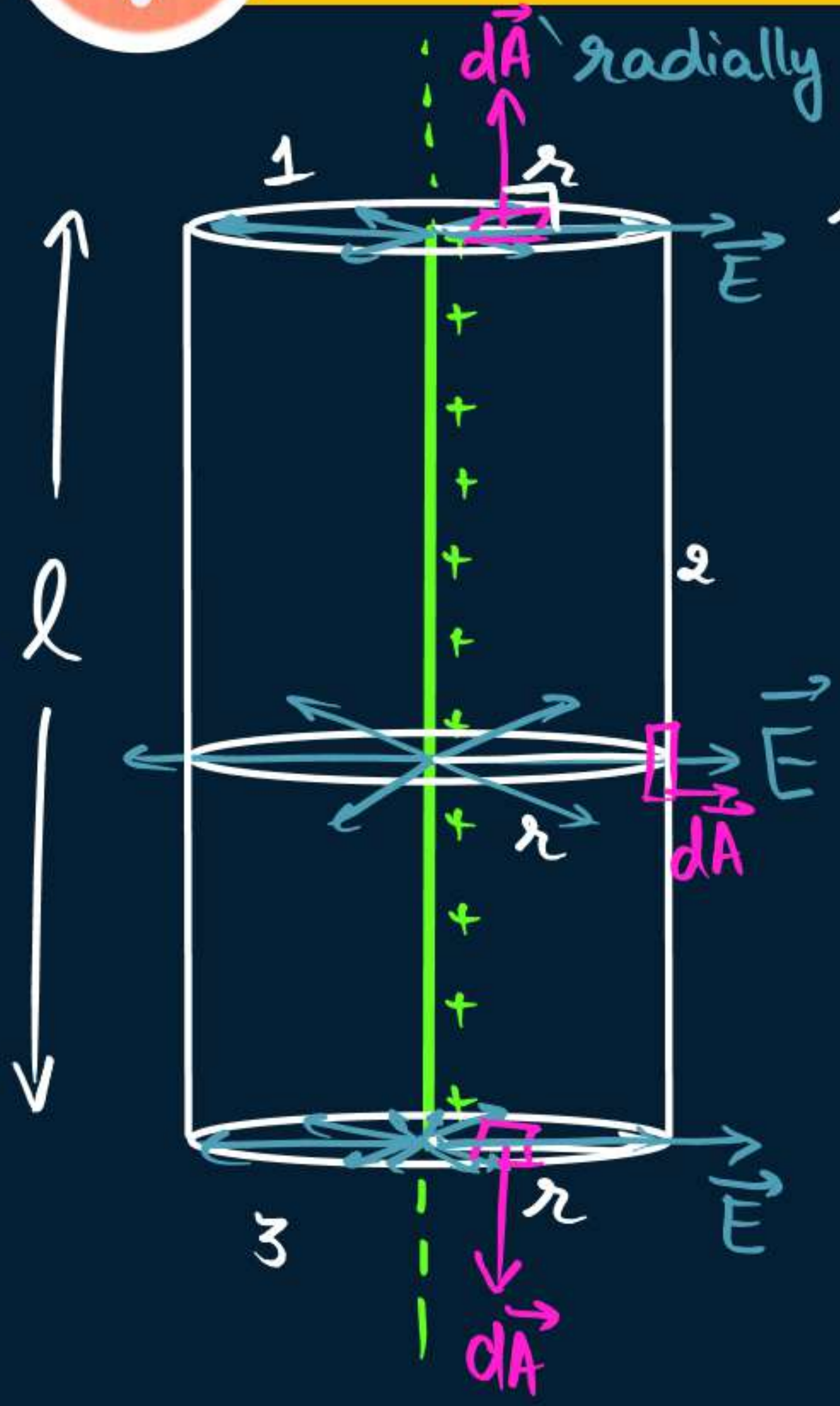
Q



$$\phi_{\text{Hemisphere}} = \frac{Q}{2\epsilon_0}$$

$$\phi_{\text{sphere}} = \frac{Q}{\epsilon_0}$$

E F due to Infinitely Long Charged Wire



let the Gaussian surface be a cylinder of length 'l' and radius 'r'

$$\phi_{net} = \int \vec{E} \cdot d\vec{A}$$

$$\phi_{net} = \phi_1 + \phi_2 + \phi_3$$

$$= |\vec{E}||\vec{A}|\cos 90^\circ + |\vec{E}||\vec{A}|\cos 0^\circ + |\vec{E}||\vec{A}|\cos 90^\circ$$

$$= 0 + E \times 2\pi r l \times 1 + 0$$

$$\phi_{net} = E \times 2\pi r l \quad \text{----} \; (1)$$

let the linear charge density of the charged wire be 'λ'

$$\lambda = \frac{Q}{L}$$

$$Q = \lambda L$$

By <u>Gauss's Theorem</u>

$$\phi_{net} = \frac{q_{enclosed}}{\epsilon_0}$$

$$\phi_{net} = \frac{\lambda L}{\epsilon_0} \quad \text{--- (2)}$$

equating (1) and (2)

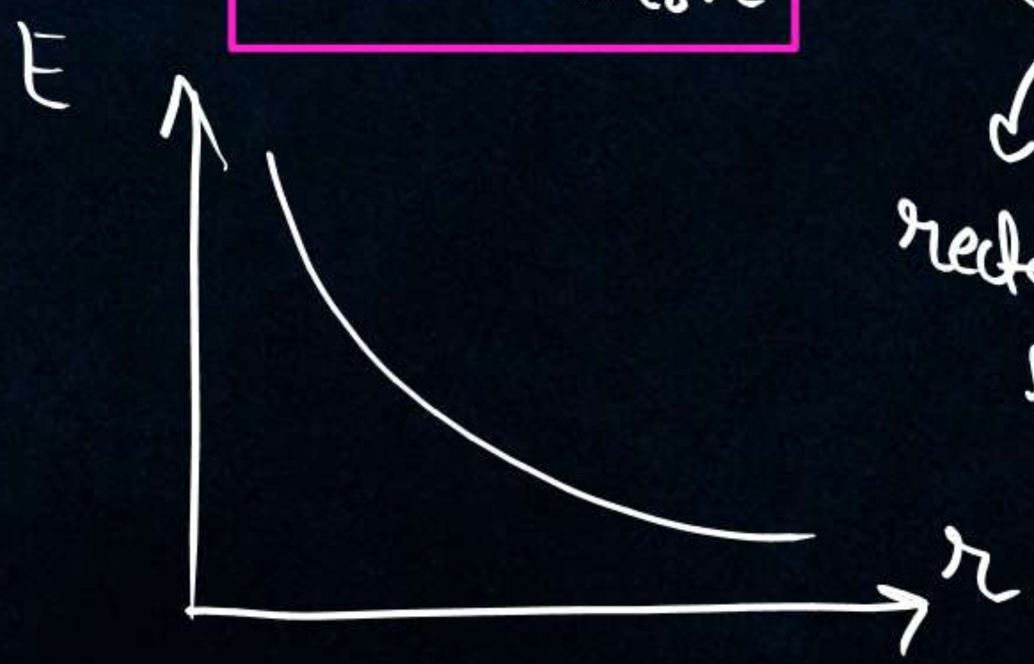
$$E \times 2\pi r \cancel{l} = \frac{\lambda \cancel{l}}{\epsilon_0}$$

याद

$$\boxed{E = \frac{\lambda}{2\pi\epsilon_0 r}}$$

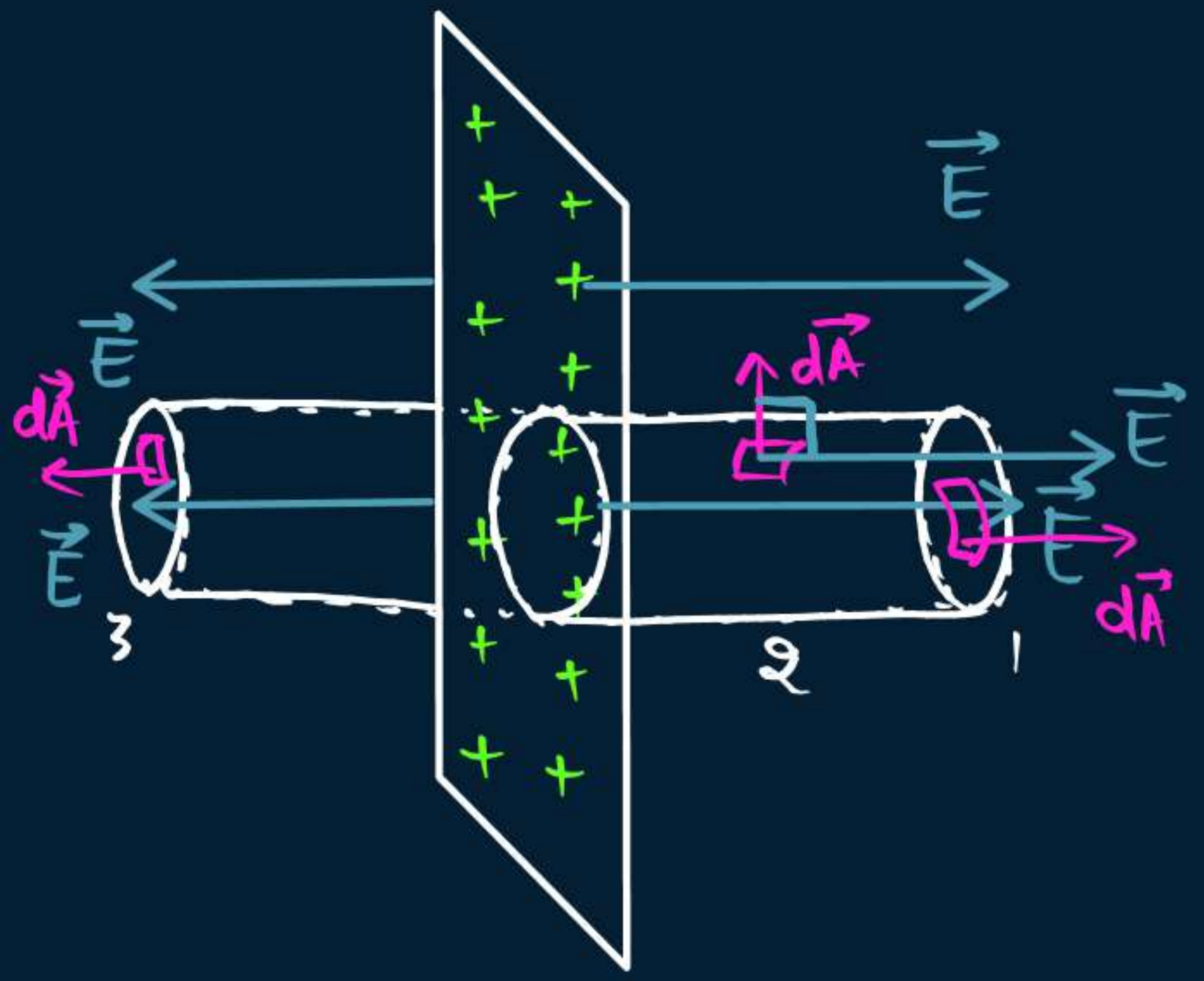
or $E \propto \frac{1}{r}$

rectangular hyperbola



E F due to Infinitely Plane Sheet

Let the Gaussian surface be taken as a cylinder which has two round faces of Area 'A'.



$$\phi_{net} = \int \vec{E} \cdot d\vec{A}$$

$$\phi_{net} = \phi_1 + \phi_2 + \phi_3$$

$$= |\vec{E}||\vec{A}|\cos\theta + |\vec{E}||\vec{A}|\cos\theta + |\vec{E}||\vec{A}|\cos\theta$$

$$= EA\cos 0^\circ + EA'\cos 90^\circ + EA\cos 0^\circ$$

$$= EA + 0 + EA$$

$$\phi_{net} = 2EA \quad \text{---} (1)$$

Suppose the Surface charge density of infinitely " plane charged sheet is 'σ':

$$\sigma = \frac{Q}{A}$$

$$Q = \sigma A$$

<u>By applying Gauss's Law</u> :-

$$\phi_{net} = \frac{q_{enclosed}}{\epsilon_0}$$

$$= \frac{\sigma A}{\epsilon_0} \dots (2)$$

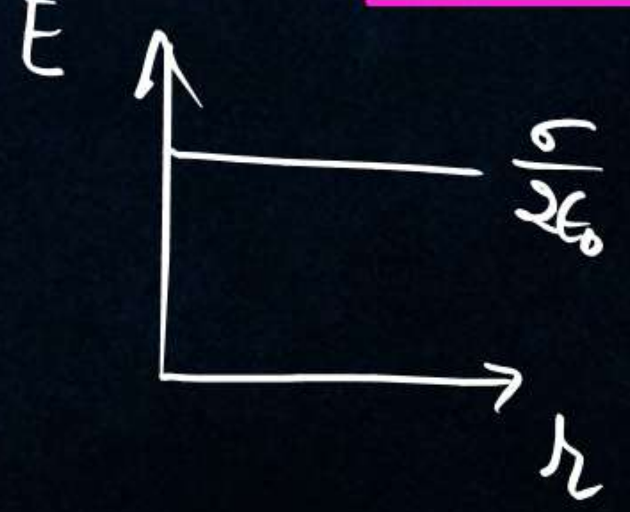
Equating (1) and (II) ...

$$2E\cancel{A} = \frac{\sigma \cancel{A}}{\epsilon_0}$$

यानि

$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$

↳ independent of distance



E F due to Oppositely Charged Parallel Plates

I) $\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$

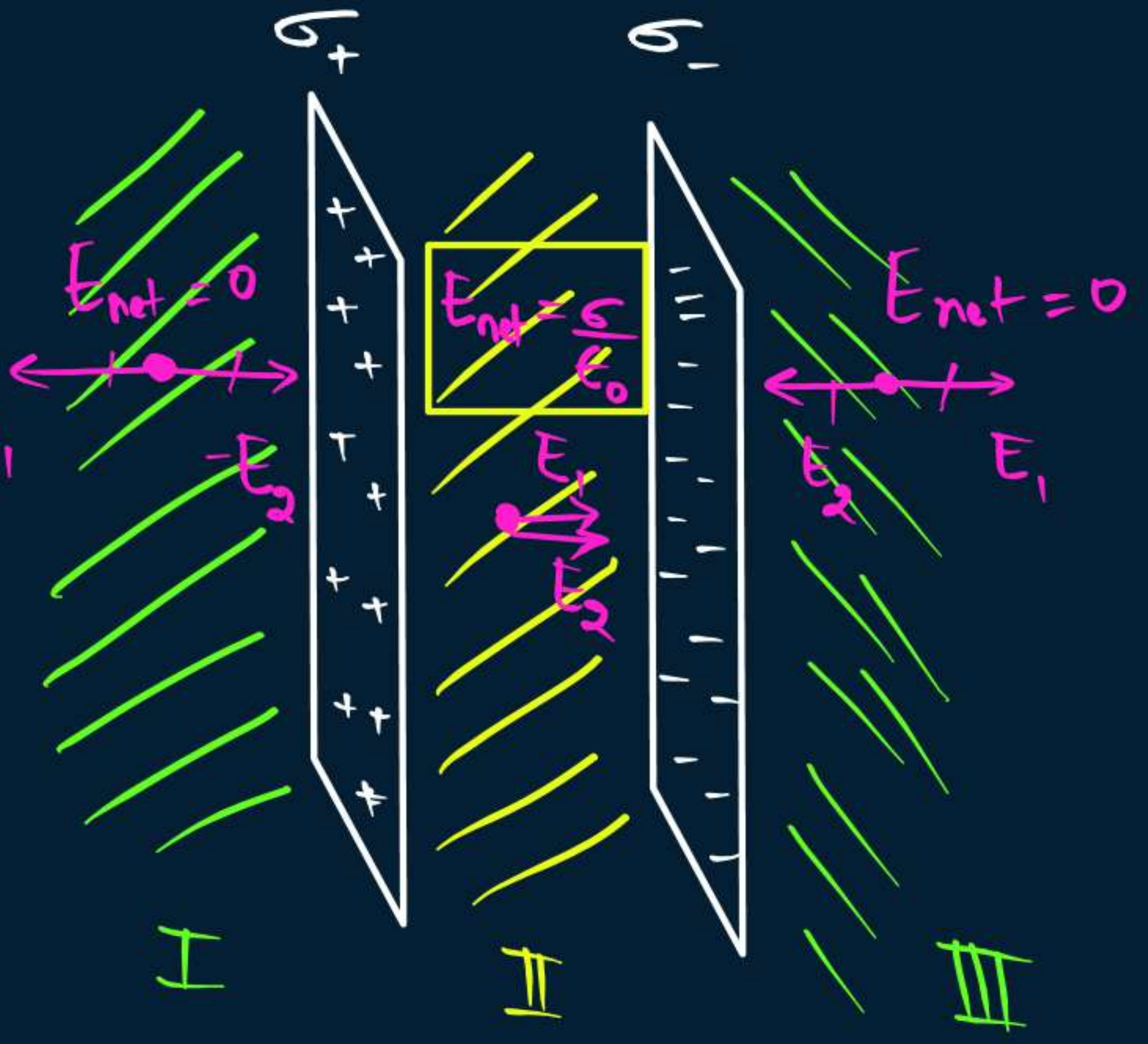
$= \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = 0$

II) $\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$

$|E_{net}| = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0}$

III) $\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$

$= -\frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = 0$



Homework

→ Notes

→ Repeat "Gauss ki Application"

→ Revise


PARISHRAM
2026
Electric Charges and Fields
PHYSICS
LECTURE-9
BY - RAKSHAK SIR
Physics Wallah

Topics *to be covered*

- **A** Bachi kuchi Gauss theorem ki application ✓
- **B** Formula Sheet (Not in Favour)
- **C** PYQ Discussion & Practice ✓
- **D** NCERT Ques are doable ✓
- **E**

Exercises 1.1, 1.2, 1.3

NCERT PUNCH (recorded)

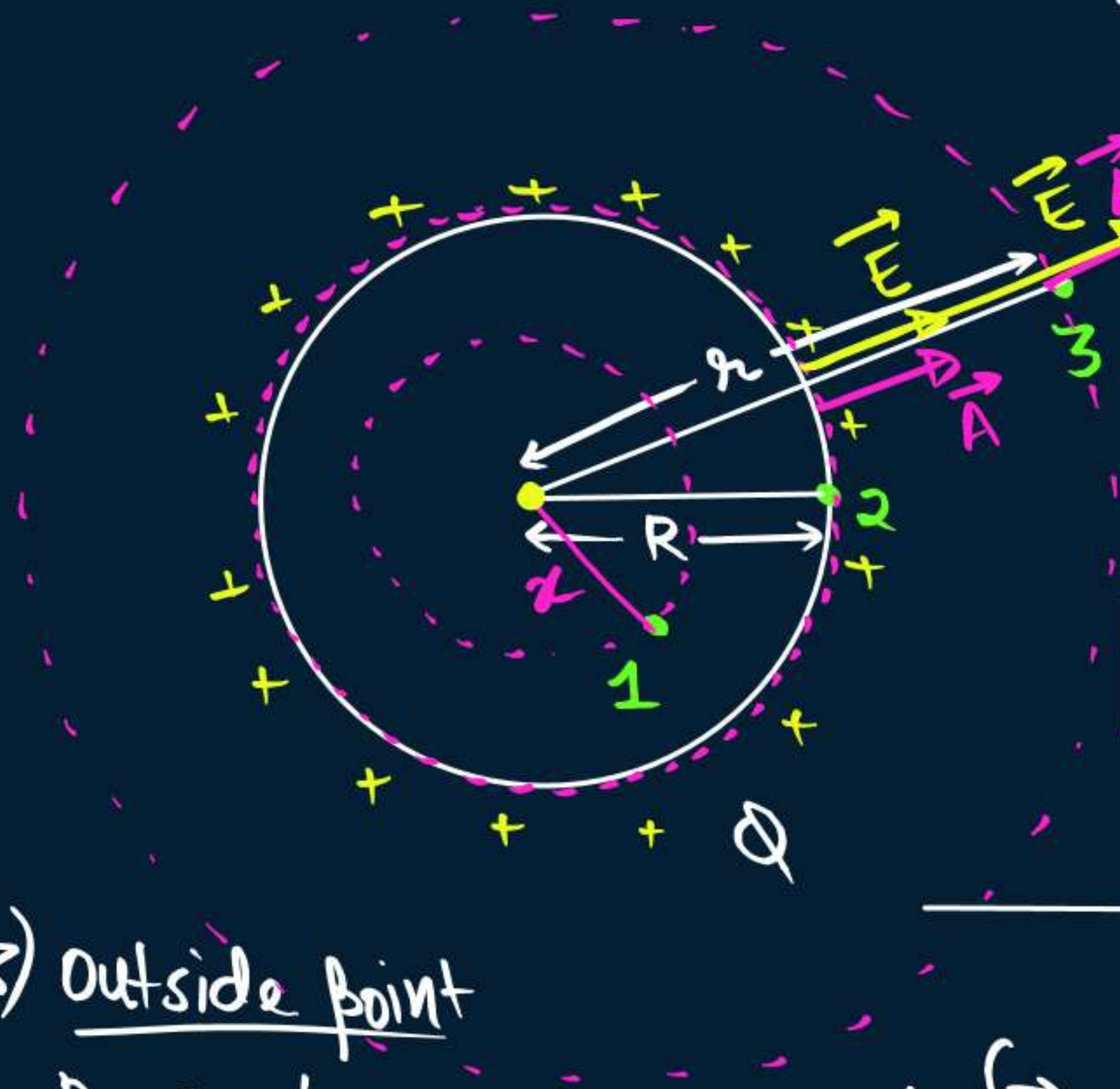
Ch-1 one shot revision

NCERT Exercises Solved.

Practice sheet ✓ (Video soln)

E F due to Conducting Shell

→ Football
⇒ 'Hollow sphere'



1) inside point

By using Gauss

$$\phi = \frac{q_{enc}}{\epsilon_0}$$

$$\phi = 0$$

$$\phi = \int \vec{E} \cdot d\vec{A}$$

$$\boxed{E = 0}$$

2) on the surface

Using Gauss's law

$$\phi = \frac{q_{enc}}{\epsilon_0} = \frac{Q}{\epsilon_0} \quad \ldots (1)$$

$$\phi_e = \int \vec{E} \cdot d\vec{A}$$

$$= \vec{E} \cdot \vec{A}$$

$$= EA\cos\theta$$

$$= E\,4\pi R^2 \cos 0^\circ$$

$$\phi_e = E\,4\pi R^2 \quad \ldots (2)$$

Eq. (1) and (2)

$$E\,4\pi R^2 = \frac{Q}{\epsilon_0}$$

$$E = \frac{Q}{4\pi\epsilon_0 R^2}$$

$$\boxed{E = \frac{KQ}{R^2}}$$

3) Outside point

By Gauss's law

$$\phi_e = \frac{q_{enc}}{\epsilon_0} = \frac{Q}{\epsilon_0} \quad \ldots (1)$$

$$\phi_e = \int \vec{E} \cdot d\vec{A}$$

$$= \vec{E} \cdot \vec{A} = |E||A|\cos\theta$$

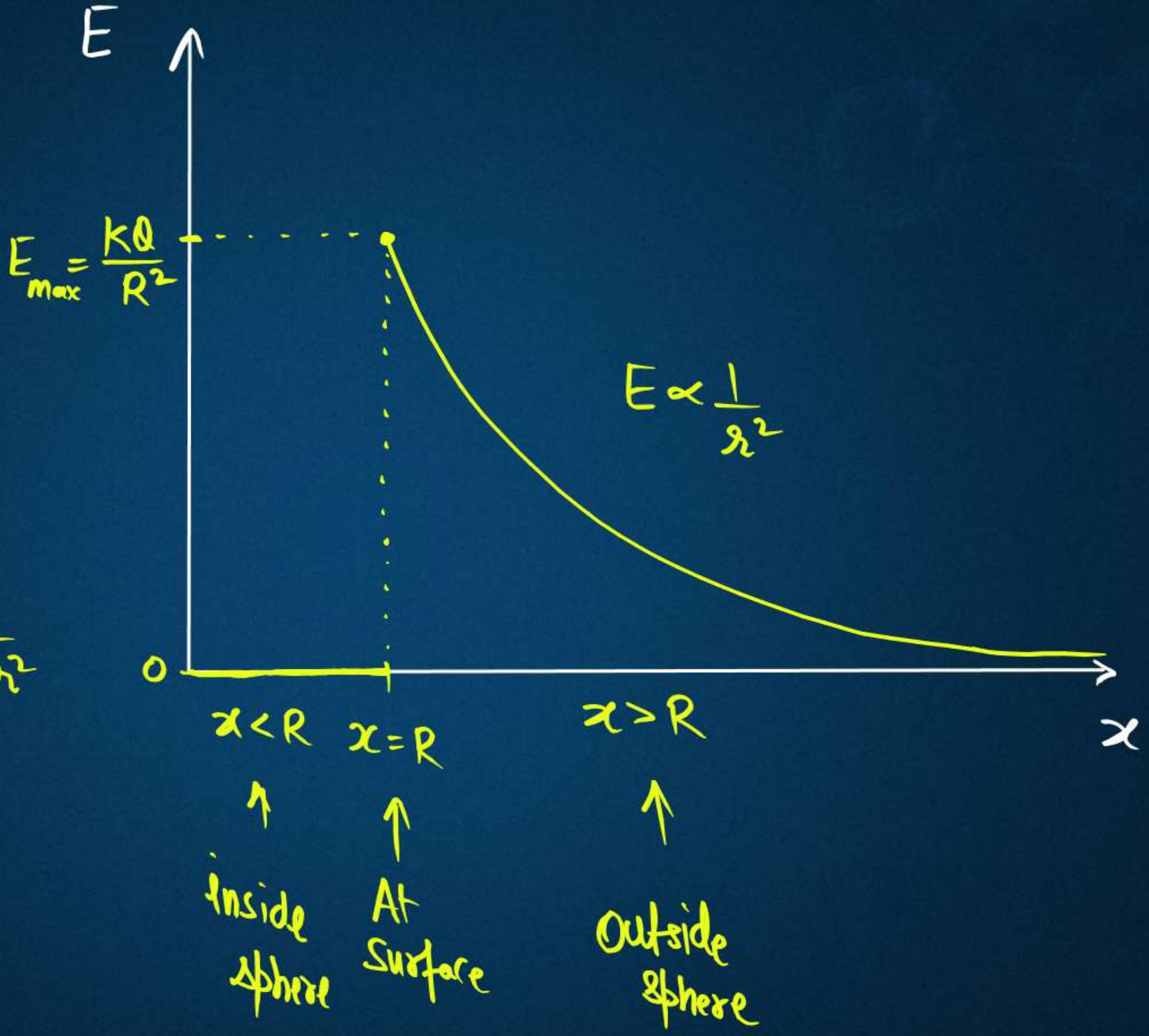
$$= E\,4\pi r^2 \cos 0^\circ \quad \ldots (2)$$

eq ① and ②

$$E\, 4\pi r^2 = \frac{Q}{\epsilon_0}$$

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$\boxed{E = \frac{kQ}{r^2}}$$ or $E \propto \frac{1}{r^2}$



Formula Sheet

$$\boxed{q = \pm Ne}$$

$$\boxed{F = \frac{kq_1q_2}{r^2}}$$

$$\boxed{k = \frac{1}{4\pi\varepsilon_0}}$$

$$\boxed{F' = \frac{F}{k}}$$

$$\boxed{k = \varepsilon_r = \frac{\varepsilon}{\varepsilon_0}}$$

$$\boxed{E = \frac{F}{q} = \frac{kq}{r^2}}$$

$$\boxed{\lambda = \frac{q}{l}}$$

$$\boxed{\sigma = \frac{q}{A}}$$

$$\boxed{\rho = \frac{q}{V}}$$

Infinite Rod /Wire

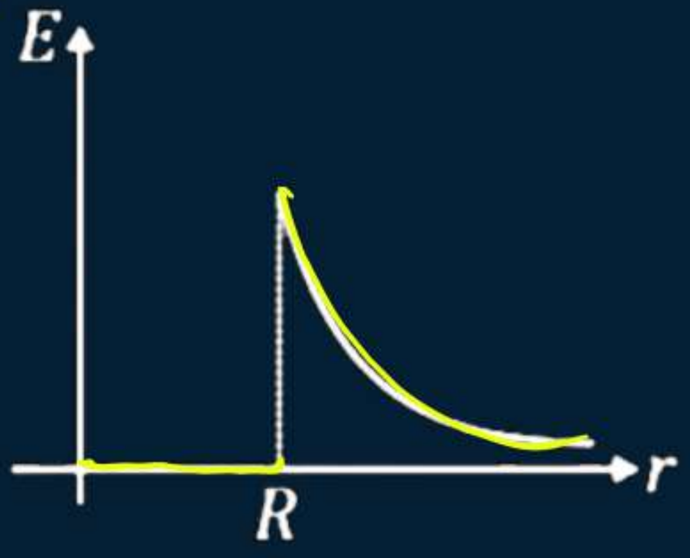
$$\boxed{E = \frac{2k\lambda}{r}} = \frac{\lambda}{2\pi\varepsilon_0 r}$$

Conducting Shell

$E_{in} = 0$

$$\boxed{E_{surface} = \frac{KQ}{R^2}}$$

$$\boxed{E_{out} = \frac{KQ}{r^2}}$$



Uniformly charged sheet

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$

Dipole

$$\boxed{\vec{p} = q2\vec{l}}$$

Short dipole

$$\boxed{E_{ax} = \frac{2kp}{r^3}}$$

$$\boxed{E_{equal} = \frac{kp}{r^3}}$$

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

$$\boxed{\vec{\tau} = \vec{p} \times \vec{E}}$$

$$\boxed{\phi = \vec{E}.\vec{A} = EA\cos\theta}$$

Gauss Law

$$\phi = \oint \vec{E}\,.\,d\vec{s} = \frac{q_{in}}{\varepsilon_0}$$

Practice Session

- Revision done (minimum 1)
- Notes complete
- No Lecture Backlog

QUESTION

Two charged particles P and Q, having the same charge but different masses m_P and m_Q, start form rest and travel equal distances in a uniform electric field E in time t_P and t_Q respectively neglecting the effect of gravity, the ratio $\left(\frac{t_P}{t_Q}\right)$ is **[2024]**

$u = 0$ $\quad$ $s = \text{same}$

A $\frac{m_p}{m_Q}$

B $\frac{m_Q}{m_p}$

C $\sqrt{\frac{m_P}{m_Q}}$

D $\sqrt{\frac{m_Q}{m_p}}$

$F = qE \quad \ldots (1)$

$F = ma \quad \ldots (2)$

$qE = ma$

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

Electric Acceleration

P

$u = 0$

$t_P = ?$

$s = s$

$a_P = \frac{qE}{m_P}$

$s = ut + \frac{1}{2}at^2$

$s = 0 + \frac{1}{2}\frac{q}{m_P}E\,t_P^2 \quad \ldots (1)$

Q

$u = 0$

$t_Q = ?$

$s = s$

$a_Q = \frac{qE}{m_Q}$

$s = ut + \frac{1}{2}at^2$

$s = 0 + \frac{1}{2}\frac{qE}{m_Q}t_Q^2 \quad \ldots (2)$

equate 1 and 2

$$\cancel{\frac{1}{2}}\frac{\cancel{qE}}{m_P}t_P^2 = \cancel{\frac{1}{2}}\frac{\cancel{qE}}{m_Q}t_Q^2$$

$$\frac{t_P^2}{m_P} = \frac{t_Q^2}{m_Q}$$

$$\frac{t_P^2}{t_Q^2} = \frac{m_P}{m_Q}$$

$$\left(\frac{t_P}{t_Q}\right)^2 = \frac{m_P}{m_Q}$$

sq. rooting both sides.

$$\boxed{\frac{t_P}{t_Q} = \sqrt{\frac{m_P}{m_Q}}}$$

QUESTION

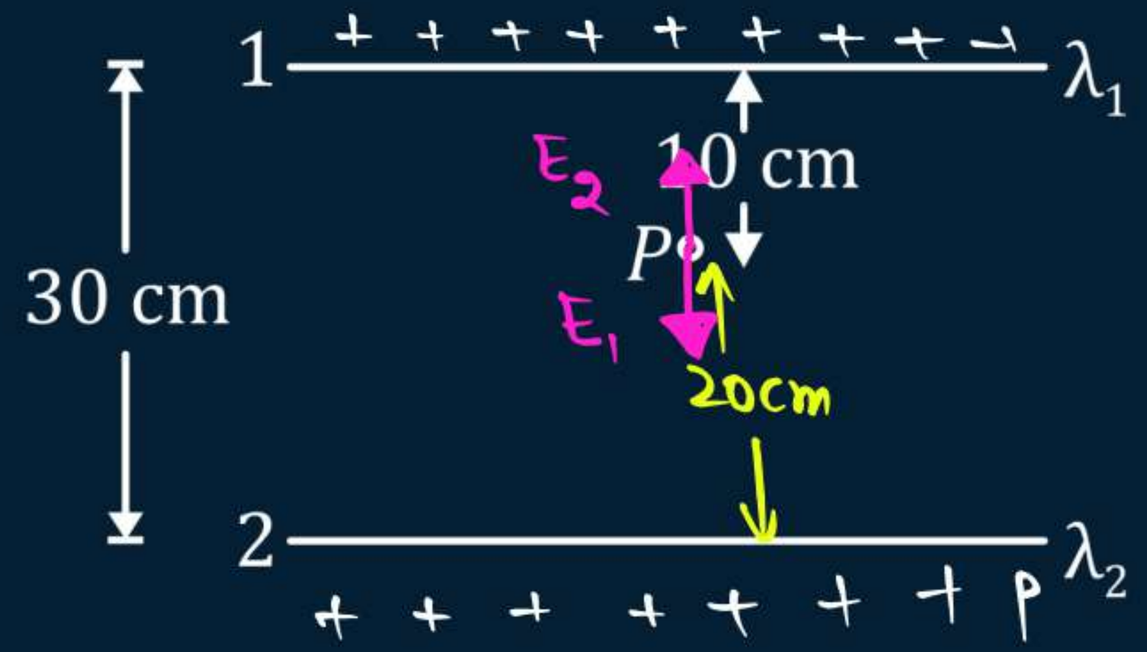
Notes

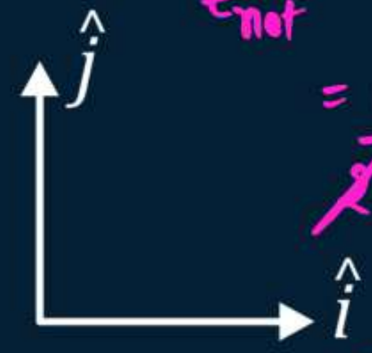
(i) State Gauss's Law in electrostatics. Apply this to obtain the electric field E at a point near a uniformly charged infinite plane sheet.

(ii) Two long straight wires 1 and 2 are kept as shown in the figure. The linear charge density of the two wires are $\lambda_1 = \boxed{10\ \mu C/m}$ and $\lambda_2 = 20 \mu C/m$. Find the net force F experienced by an electron held at point P. **[2024]**

$$E_1 = \frac{\lambda_1}{2\pi\epsilon_0\left(\frac{10}{100}\right)} = \frac{\cancel{10}^{1}\times 10^{-6}}{2\pi\epsilon_0\left(\frac{\cancel{10}^{1}}{100}\right)} = \frac{10^{-6}}{2\pi\epsilon_0 \times \frac{1}{100}}$$

$$E_2 = \frac{\lambda_2}{2\pi\epsilon_0\left(\frac{20}{100}\right)} = \frac{\cancel{20}^{1}\times 10^{-6}}{2\pi\epsilon_0\left(\frac{\cancel{20}^{1}}{100}\right)} = \frac{10^{-6}}{2\pi\epsilon_0\left(\frac{1}{100}\right)}$$





$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2 = \frac{10^{-6}}{2\pi\epsilon_0 \frac{1}{100}} - \frac{10^{-6}}{2\pi\epsilon_0 \frac{1}{100}}$$

$$E_{net} = 0$$

$$F_{net} = 0$$

QUESTION

Two identical point charges are placed at the two vertices A and B of an equilateral triangle of side *l*. The magnitude of the electric field at the third vertex P is E. If a hollow conducting sphere of radius (*l*/4) is placed at P, the magnitude of the electric field at point P now becomes

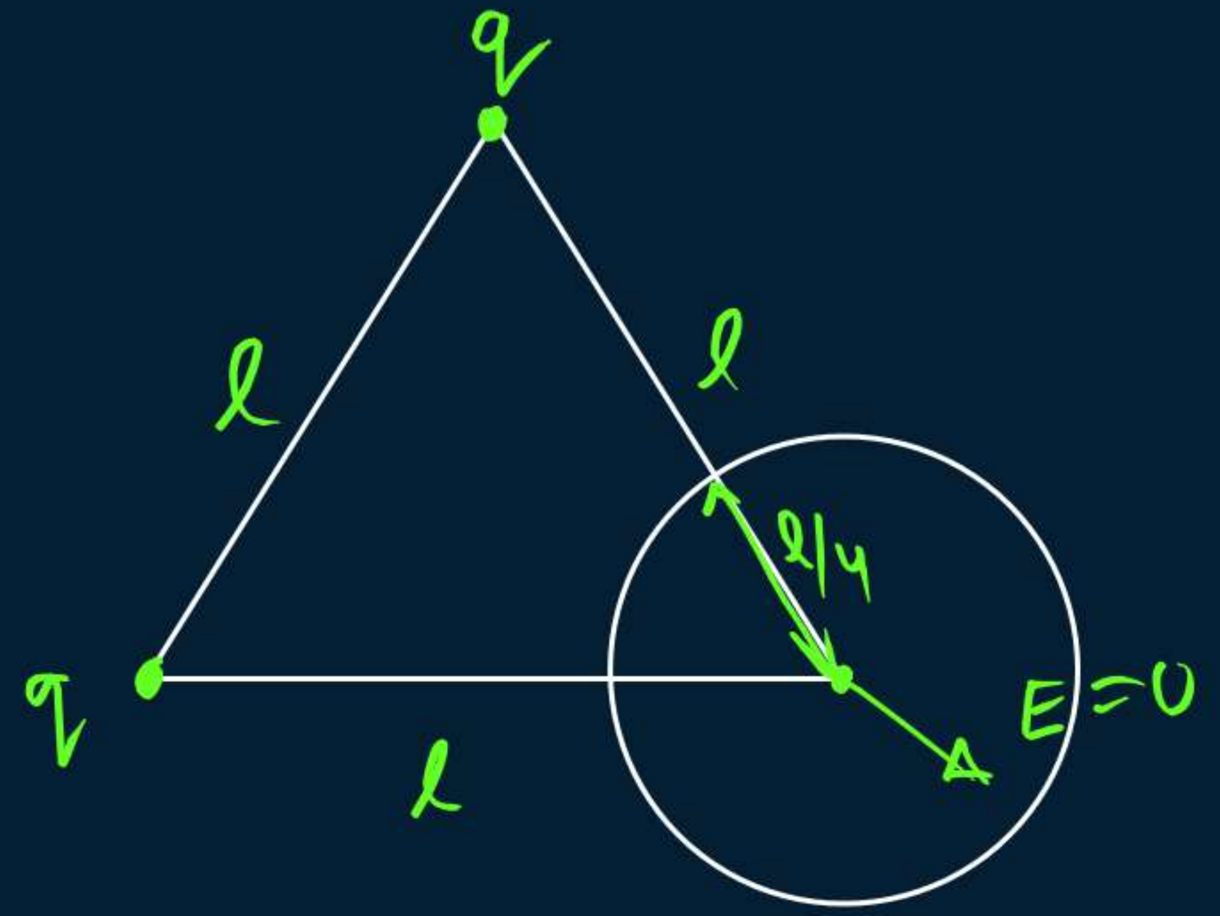
[MCQ, 1 Mark 2025]

(A) >E

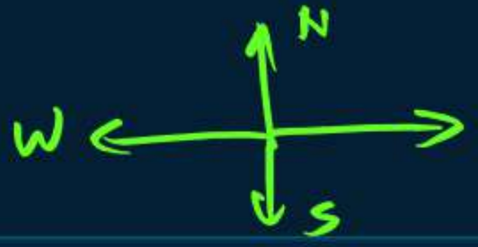
(B) E

(C) E/2

(D) zero



QUESTION



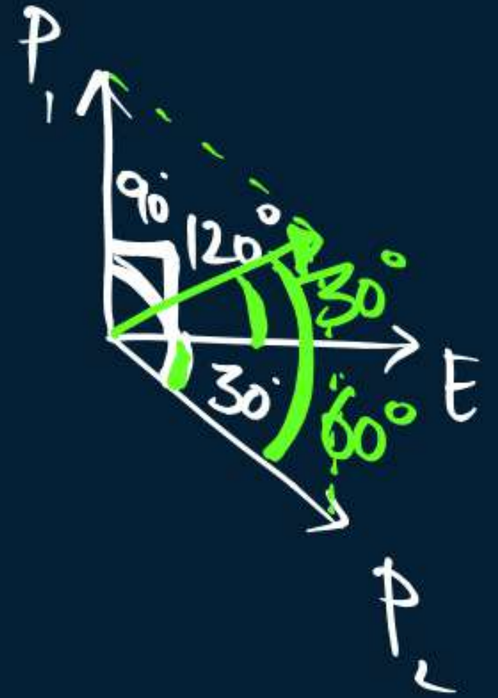
⊙ ⊗

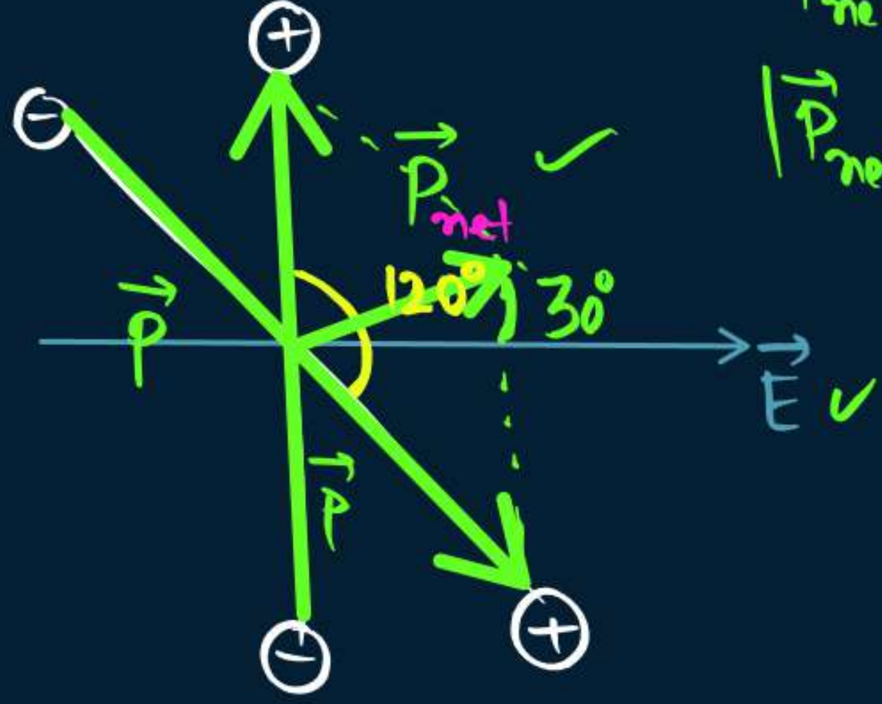
Two small identical electric dipoles AB and CD, each of dipole moment P are kept at an angle of 120° to each other in an external electric field E pointing along the x-axis as shown in the figure. Find the

(a) dipole moment of the arrangement, and $= P$

(b) magnitude and direction of the net torque acting on it **[2020]**

Y.K.B.





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

$= pE\sin\theta$

$= PE\sin 30^\circ = \frac{PE}{2}$ (inwards)

$= \frac{PE}{2}\ \vec{\otimes}$

$\vec{P}_{net} = \vec{P}_1 + \vec{P}_2$

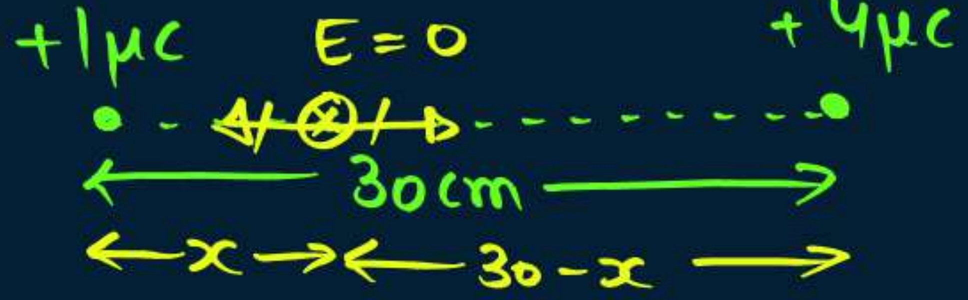
$|\vec{P}_{net}| = \sqrt{|P_1|^2 + |P_2|^2 + 2P_1P_2\cos\theta}$

$= \sqrt{P^2 + P^2 + 2P^2\cos 120^\circ}$

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

QUESTION

Two point charges of +1μC and +4μC are kept 30 cm apart. How far from the +1μC charge on the line joining the two charge, will the net electric field be zero? [2020]



$$\vec{E}_{net} = 0$$

$$|E_1| = |E_2|$$

$$\frac{\cancel{k}(+1\cancel{\mu C})}{x^2} = \frac{\cancel{k}(+4\cancel{\mu C})}{(30-x)^2}$$

$$\frac{1}{x^2} = \frac{4}{(30-x)^2}$$

⋮

QUESTION

An object has charge of 1 C and gains 5.0×10^{18} electrons. The net charge on the object becomes [2021-22]

(A) –0.80 C

(B) +0.80 C

(C) +1.80 C

(D) +0.20 C

$Q = ne$

$= 5 \times 10^{18} \times 1.6 \times 10^{-19}$

$= 8.0 \times 10^{-1}$

$Q = -0.80\ C$

$Q_{net} = Q_1 + Q_2$

$= 1 - 0.80$

$= 0.20$ ✓

QUESTION

Notes

(i) Using Gauss's law, show that the electric field $\vec{E}$ at a point due to a uniformly charged infinite plane sheet is given by $\boxed{\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}}$ where symbols have their usual meanings.

imp.

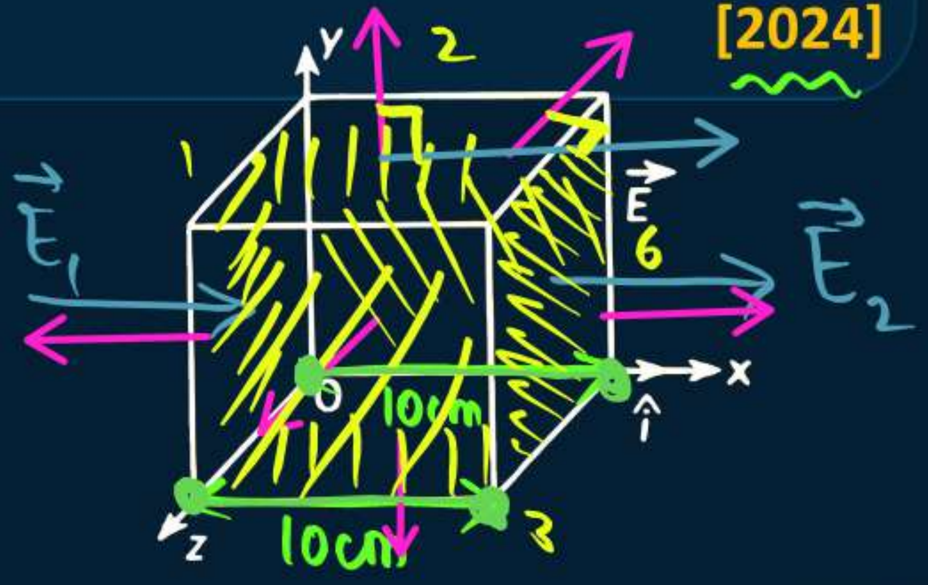
(ii) Electric field $\vec{E}$ in a region is given by

$\vec{E} = (5x^2 + 2)\hat{i}$

where E is in N/C and x is in meters. A cube of side 10 cm is placed in the region as shown in figure.

Calculate (1) the electric flux through the cube, and (2) the net charge enclosed by the cube.

[2024]



1) $\phi_{net} = \phi_1 + \phi_2 + \phi_3 + \phi_4 + \phi_5 + \phi_6$

$= E_1 A \cos 180 + \cancel{E' A \cos 90} + \cancel{E' A \cos 90} + \cancel{E' A \cos 90}$

$+ \cancel{E' A \cos 90^\circ} + E_2 A \cos 0^\circ$

$$\phi_{net} = E_1 A(-1) + E_2 A(+1)$$

$$= -E_1 A + E_2 A$$

$$= -2A + 2.05A$$

$$= A(2.05 - 2)$$

$$\phi_{net} = 0.05A$$

$$= \frac{0.05}{100} \times \frac{1\cancel{0}}{1\cancel{00}} \times \frac{1\cancel{0}}{100}$$

$$\boxed{\phi_{net} = 5 \times 10^{-4}}$$

ii) $\phi = \dfrac{q_{enc}}{\epsilon_0}$

$$q_{enc} = \phi \epsilon_0$$

$$= 5 \times 10^{-4} \times 8.85 \times 10^{-12}$$

$$= \qquad C$$

$$|E| = 5x^2 + 2$$

finding E_1 : $x = 0$

$$E_1 = 5(0)^2 + 2 = 2 \text{ N/C}$$

finding E_2 : $x = \frac{1\cancel{0}\text{cm}}{10\cancel{0}} = 0.1\text{m}$

$$E_2 = 5(0.1)^2 + 2$$

$$= 5 \times 0.01 + 2$$

$$= 0.05 + 2$$

$$= 2.05 \text{ N/C}$$

QUESTION

Notes

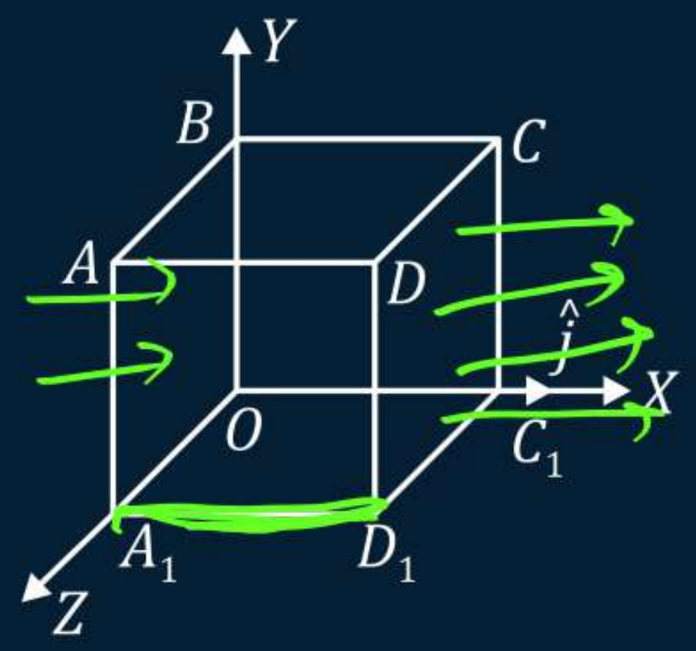
(i) obtain an expression for the electric field $\vec{E}$ due to a dipole of dipole moment $\vec{p}$ at a point on its equatorial plane & specify its direction. Hence, find the value of electric field:

(a) At the centre of dipole $(r = 0)$

(b) At a point $r \gg a$ were 2 a is the length of the Dipole.

H.W. (ii) An electric Field $\boxed{\vec{E} = (10x + 5)\hat{\text{i}}\,\text{N/C}}$ exits in a region in which a cube of side L is kept as shown in figure. Here x and L are in metres. Calculate the net flux through the cube.

[2025]



QUESTION

Which one of the following statements is correct? Electric field due to static charges is

[2025]

A. Conservative and field line do not form closed loops.

B. Conservative and field lines form closed loops.

C. Non-conservative and field lies do not form closed loops.

D. Non-conservative and field lines form closed loops.

QUESTION

(i) What is difference between an open surface and a closed surface? Draw elementary surface vector $d\vec{S}$ for a spherical surface S.

(ii) Define electric flux through a surface. Give the significance of a Gaussian surface. A charge outside a Gaussian surface does not contribute to total electric flux through the surface. Why?

(iii) A small spherical shell S_1 has point charges $q_1 = -3\mu C, q_2 = -3\mu C$ and $q_3 = 9\mu C$ inside it. This shell is enclosed by another big spherical shell S_2. A point charge Q is placed in between the two surfaces S_1 and S_2. If the electric flux through the surface S_2 is four times the flux through surface S_1, find charge Q. **[2025]**

QUESTION

Three point charges, 1 pC each, are kept at the vertices of an equilateral triangle of side 10 cm. Find the net electric field at the centroid of triangle. [2024]

QUESTION

Four point charges of 1 μC, –2 μC , 1 μC and –2 μC are placed at the corners A, B, C and D respectively, of a square of side 30 cm. Find the net force acting on a charge of 4 μC placed at the centre of the square. [2024]

QUESTION

(i) A charge $+Q$ is placed on a thin conducting spherical shell of radius R. Use Gauss's theorem to derive an expression for the electric field at a point lying (i) inside and (ii) outside the shell.

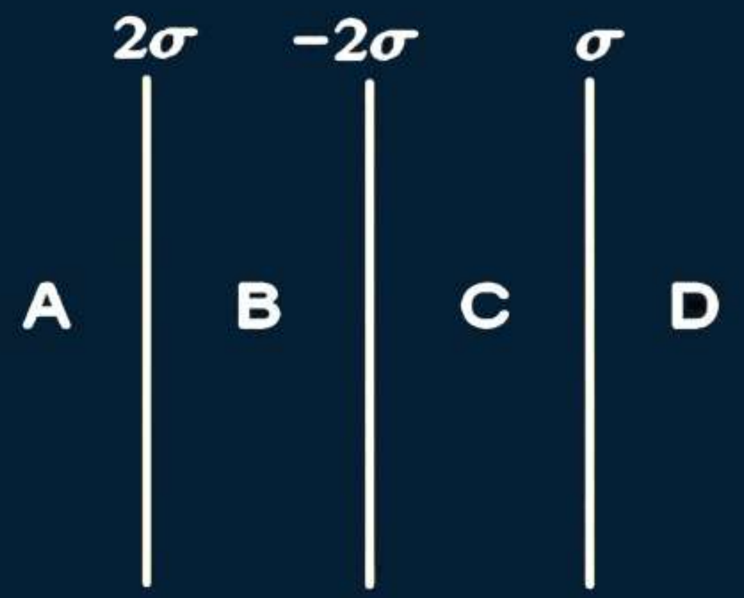
(ii) Show that the electric field for same charge density (σ) is twice in case of a conducting plate or surface than in a nonconducting sheet. **[2024]**

QUESTION

(a) State Gauss's law in electrostatics. Show that with help of suitable figure that outward flux due to a point charge Q. In vacuum within gaussian surface is independent of its size and shape.

(b) In the figure there are three infinite long thin sheets having surface charge density $+2\sigma$, -2σ and $+\sigma$ respectively. Give the magnitude and direction of electric field at a point to the left of sheet of charge density $+2\sigma$ and to the right of sheet of charge density $+\sigma$.

[2020-21]



QUESTION

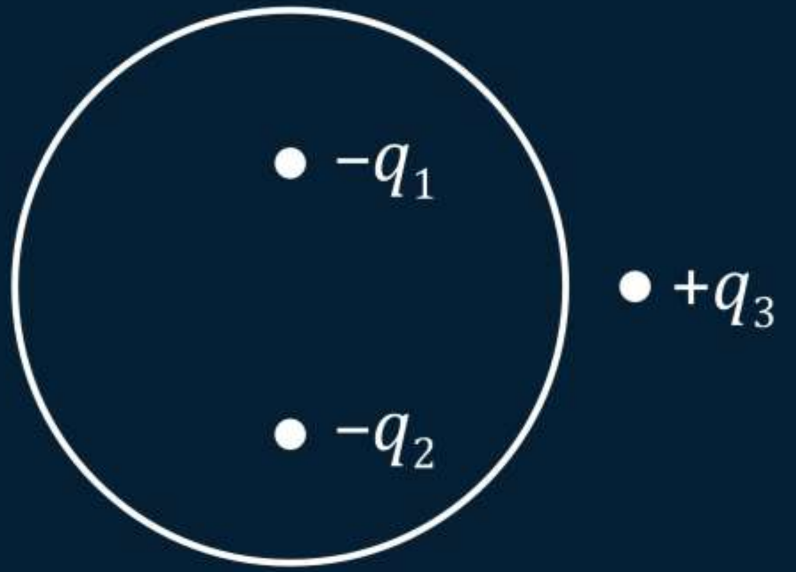
A particle of charge 2 μC and mass 1.6 g is moving with a velocity $4\hat{\imath}$ ms^{-1}. At $t = 0$ the particle enters in a region having an electric field $\vec{E}$ (in NC^{-1}) $= 80\hat{\imath} + 60\hat{\jmath}$. Find the velocity of the particle at $t = 5$ s. [2020]

QUESTION

A point charge is placed at the centre of a hollow conducting sphere of internal radius 'r' and outer radius '$2r$' The ratio of the surface charge density of the Inner surface to that of the outer surface will be ________ . **[2020]**

QUESTION

Electric flux through a spherical surface shown in the figure, is ________ . **[2020]**



QUESTION

Assertion (A): A negative charge in an electric field moves along the direction of the electric field.

Reason (R): On a negative charge a force acts in the direction of the electric field

[2021-22]

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): If the bob of a simple pendulum is kept in a horizontal electric field, its period of oscillation will remain same.

Reason (R): If bob is charged and kept in horizontal electric field, then the time period will be decreased.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): Acceleration of charged particle in non-uniform electric field does not depend on velocity of charged particle.

Reason (R): Charge is an invariant quantity. That is the amount of charge on particle does not depend on frame of reference.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): Net electric field inside a conductor is zero.
Reason (R): Total positive charge equals to total negative charge in a charged conductor.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): All the charge in a conductor gets distributes on whole of its outer surface.
Reason (R): In a dynamic system, charges try to keep their potential energy minimum.

A If both assertion and reason are true and reason is the correct explanation of the assertion.

B If both assertion and reason are true but reason is not the correct explanation of the assertion.

C If assertion is true but reason is false.

D If both assertion and reason are false

QUESTION

Assertion (A): The coulomb force is the dominating force in the universe.
Reason (R): The coulomb force is weaker than the gravitational force.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): The tyres of aircrafts are made slightly conducting.
Reason (R): If a conductor is connected to the ground, the extra charge induced on the conductor will flow to the ground.

A If both assertion and reason are true and reason is the correct explanation of the assertion.

B If both assertion and reason are true but reason is not the correct explanation of the assertion.

C If assertion is true but reason is false.

D If both assertion and reason are false

QUESTION

Assertion (A): In a non-uniform electric field, a dipole will have translator as well as rotatory motion.

Reason (R): In a non-uniform electric field, a dipole experiences a force as well as a torque. [2021-22]

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): The surface densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

Reason (R): Surface density is equal to the charge per unit are.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): Some charge is put at the centre of a conducting sphere. It will move to the surface of the sphere.

Reason (R): Conducting sphere has no free electrons at the centre.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): A point charge is lying at the centre of a cube of each side l. The electric flux emanating from each surface of the cube is $(1/6)^{th}$ of total flux.

Reason (R): According to Gauss' theorem, total electric flux through a closed surface enclosing a charge is equal to $\left(\frac{1}{\varepsilon_0}\right)$ times the magnitude of the charge enclosed.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): Three equal charges are situated on a circle of radius *r* such that they from an equilateral triangle, then the electric field intensity at the centre is zero.

Reason (R): the force on the unit positive charge at the centre, due to the three equal charges is represented by the three sides of a triangle taken in the same order. Therefore, the electric field intensity at the centre is zero.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): On moving a distance two times the initial distance away from an infinitely long straight uniformly charged wire the electric field reduces to one third of the initial value.

Reason (R): The electric field is inversely proportional to the distance from an infinitely long straight uniformly charged wire.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): A deuteron and an α-particle are placed in an electric field. If F_1 and F_2 be the forces acting on them and a_1 and a_2 be their accelerations respectively then, $a_1 = a_2$.
Reason (R): Force will be same in electric field.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): Three equal charges are situated on a circle of radius r such that they form on equilateral triangle, then the electric field intensity at the centre is zero.

Reason (R): The force on unit positive charge at the centre, due to the three equal charges are represented by the three sides of a triangle taken in the same order. Therefore, electric field intensity at the centre is zero.

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B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

QUESTION

Assertion (A): A small metal ball is suspended in a uniform electric field with an insulated thread. If a high-energy X-ray beam falls on the ball, the ball will be deflected in the electric field.

Reason (R): X-rays emit photo-electrons and metal becomes negatively charged.

A. If both assertion and reason are true and reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If both assertion and reason are false

Homework

- Try leftover Ques
- NCERT PUNCH Exercises ✓
- Notes ✓
- Revision