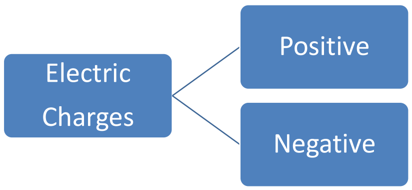
PHYSICS W1: ELECTRIC FIELDS AND CHARGES

JIE YOUNG 2025

Main Objectives

- Understand the concept of Charge
- State Coulomb's Law
- Apply Coulomb's Law for system of point charges

Electric Charges



- Same Charge– Repulsive Force
- Opposite Charge-Attractive Force

$$Q = ne$$

$$n = number\ of\ electron$$

$$e = 1.69 \times 10^{-19} C$$

Unit of charge: Coulomb (C)

Ex: How many electrons are in 1c of charge?

$$1 \ = n \times 1.69 \times 10^{-19} C$$

$$n = \frac{1}{1.69 \times 10^{-19}}$$

$$n = 5.92 \times 10^{18}$$

Coulomb's Law

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

Sign of Charge can be ignored when subbing into the Equation(It is only used to determine the direction)

$k = 8.99 \times 10^9 N (Coulomb's\ Constant)$
$q = Charge\ of\ Particle$
$r = Distance\ between\ Particles$

Problems Involving Triangular

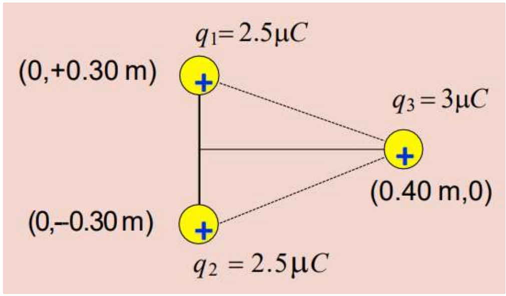
Key Steps:

1. Find all the Forces between Each Particle
2. Identify the angles between Particles
3. Derive into x-component and y-component
4. Perform Vector Addition and Convert back to Magnitude

	F1	F2	TOTAL
X-COMPONENT	F1*cos(theta)		
Y-COMPONENT	F1*sin(theta)		

$$F_{net} = \sqrt{{F_x}^2 + {F_y}^2}$$

Sample Question



Find Charge on q3.

$$F_{13} = \frac{8.99 \times 10^9 (2.5 \times 10^{-6})(3 \times 10^{-6})}{0.4^2 + 0.3^2}$$

$$F_{13} = 0.27N$$

$$F_{23} = F_{13}$$

$$\theta = tan^{-1}\left(\frac{0.3}{0.4}\right)$$

$$\theta = 36.87°, -36.87°$$

	F13	F23	TOTAL
X	0.27cos36.87	0.27cos-36.87	0.432
Y	0.27sin36.87	0.27sin-36.87	0

Ans: 0.432N in +x directions

PHYSICS W1: ELECTRIC FIELDS AND CHARGES

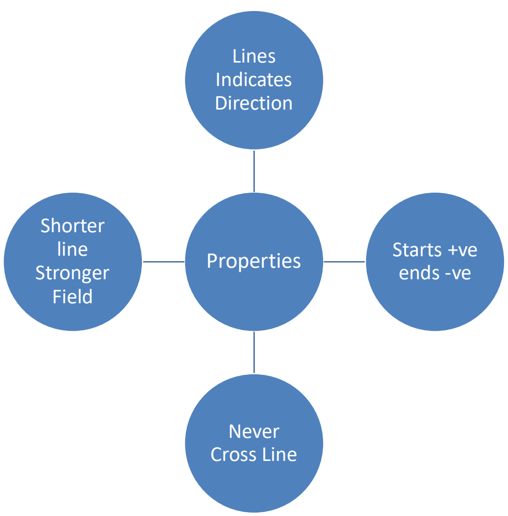
JIE YOUNG 2025

Main Objectives

- Interpret Electric Field Lines and Patterns
- State Electric Field Strength
- Apply Electric Field Strength

Electric Field Lines

- Electric Fields around charges = Electric Field Lines
- Electric Field Strength ∝ Num of Field lines passing through an unit area(Density)
- Pointing Inwards = Negative
- Pointing Outwards = Positive



Electric Field Strength

Electric Force per unit Test Charge

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

$F = Electric\ Force$
$q = Test\ Charge$
$Unit = NC^{-1}/Vm^{-1}$

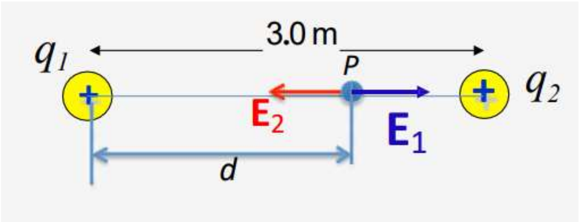
Derivation with Coulomb's Law

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

$$E = \frac{\frac{kq_1q_2}{r^2}}{q}$$

$$E = \frac{kq_1}{r^2}$$

Sample Question



Find d when net Electric field strength is 0.
q1 = +16uc, q2 = +4 uc

$$E_1 = E_2$$

$$k\frac{16\mu C}{d^2} = k\frac{4\mu C}{(3-d)^2}$$

$$\sqrt{\frac{16}{d^2}} = \sqrt{\frac{4}{(3-d)^2}}$$

$$\frac{4}{d} = \frac{2}{3-d}$$

$$d = 2m$$

PHYSICS W1: ELECTROSTASIS

JIE YOUNG 2025

Main Objectives

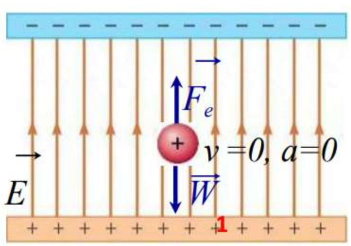
- State Charge in an uniform electric field
- Apply Problems

Definitions

- Plate that has +ve and –ve charge
- Edge of plate is not uniform due to edge effect

Straight Charge Movement

Case 1: Stationary



Electrostatic Force = Weight

Straight Charge Movement

Case 2:Constant Velocity

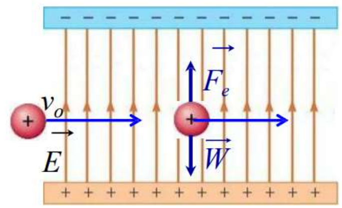
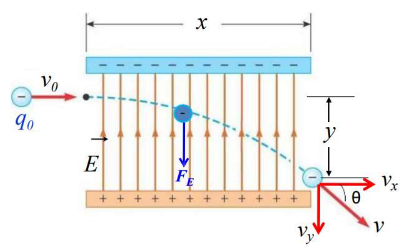


Figure b : Case 2

Electrostatic Force = Weight

$$qE = mg$$

Charge Moving Perpendicularly to the field



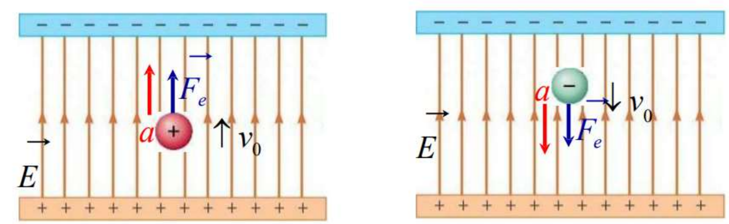
Count with Kinematic Equation

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

$$a_y = \frac{qE}{m}$$

$$t = \frac{x}{v_0}$$

Charge Moving Parallel to the field



Particles will be accelerated towards opposite charge

$$F = qE \qquad a_y = \frac{qE}{m}$$

Working Examples

An electron is released from rest and allowed to accelerate in a straight line
parallel to the uniform electric field of strength 3.0 kV m-1. Determine
a) its acceleration and direction
b) its speed after 3.0 s.

a)

$$E = 3.0\ kV\ m^{-1}$$
$$q = -.1602x10^{-1}\ C$$
$$m = 9.11x10^{-3}\ kg$$
$$a = \frac{qE}{m}$$
$$a = -5.28x10^{14}ms^{-2}(Opposite\ of\ Field)$$

b)

$$v = u + at$$
$$v = 0 + (5.28x10^{14}ms^{-2})(3.0$$
$$v = 1.584x10^{15}ms^{-1}$$