SAFALTA CLASS™

An Initiative by अमर उजाला

# Electricity

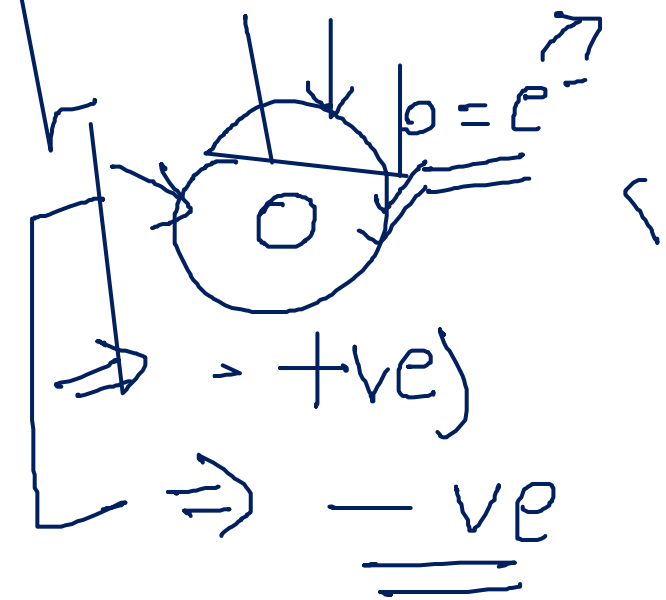
Electrostatics

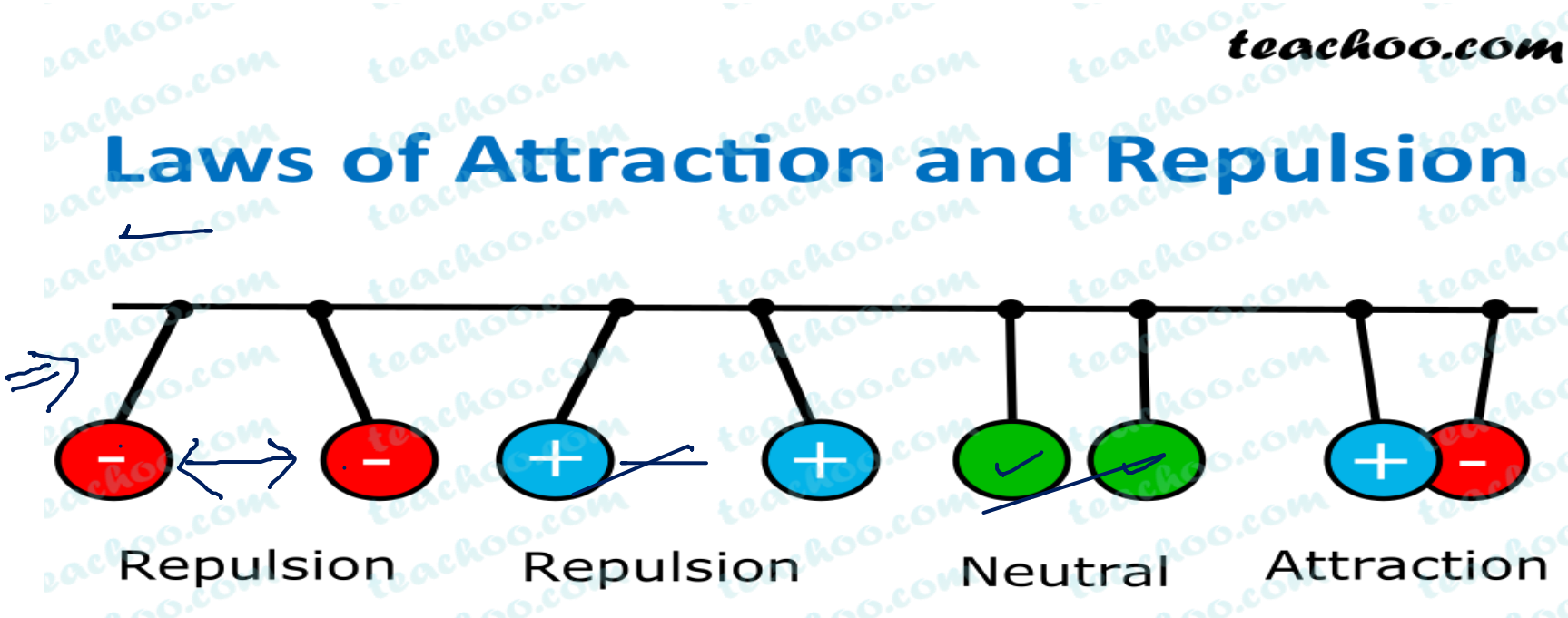
Charge → Stable

**Electric Charge :Electric charge** is the physical property of matter that causes it to experience a force when placed in an electromagnetic field.

इलेक्ट्रिक चार्ज पदार्थ की भौतिक गुण है जो इसे विद्युत चुम्बकीय क्षेत्र में रखे जाने पर बल का अनुभव करने का कारण बनती है।

There are two types of **electric charge:** positive and negative

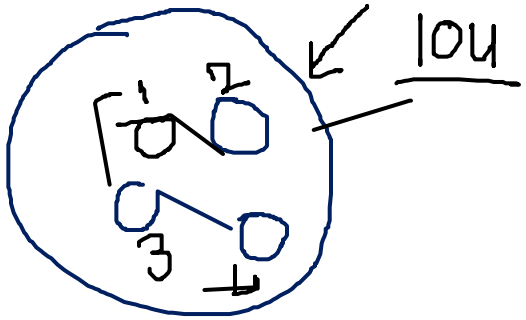


# Properties of an Electric Charge

- Charges are additive in nature


- A charge is a conserved quantity




- Quantization of charge

⇒ ✓ unit → Coulomb (C)

⇒ Smallest unit:- $e^- \rightarrow -1.6 \times 10^{-19} C$ ✓

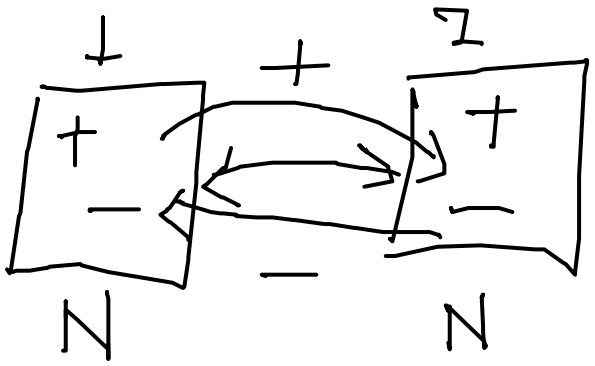
✓ $q = ne$

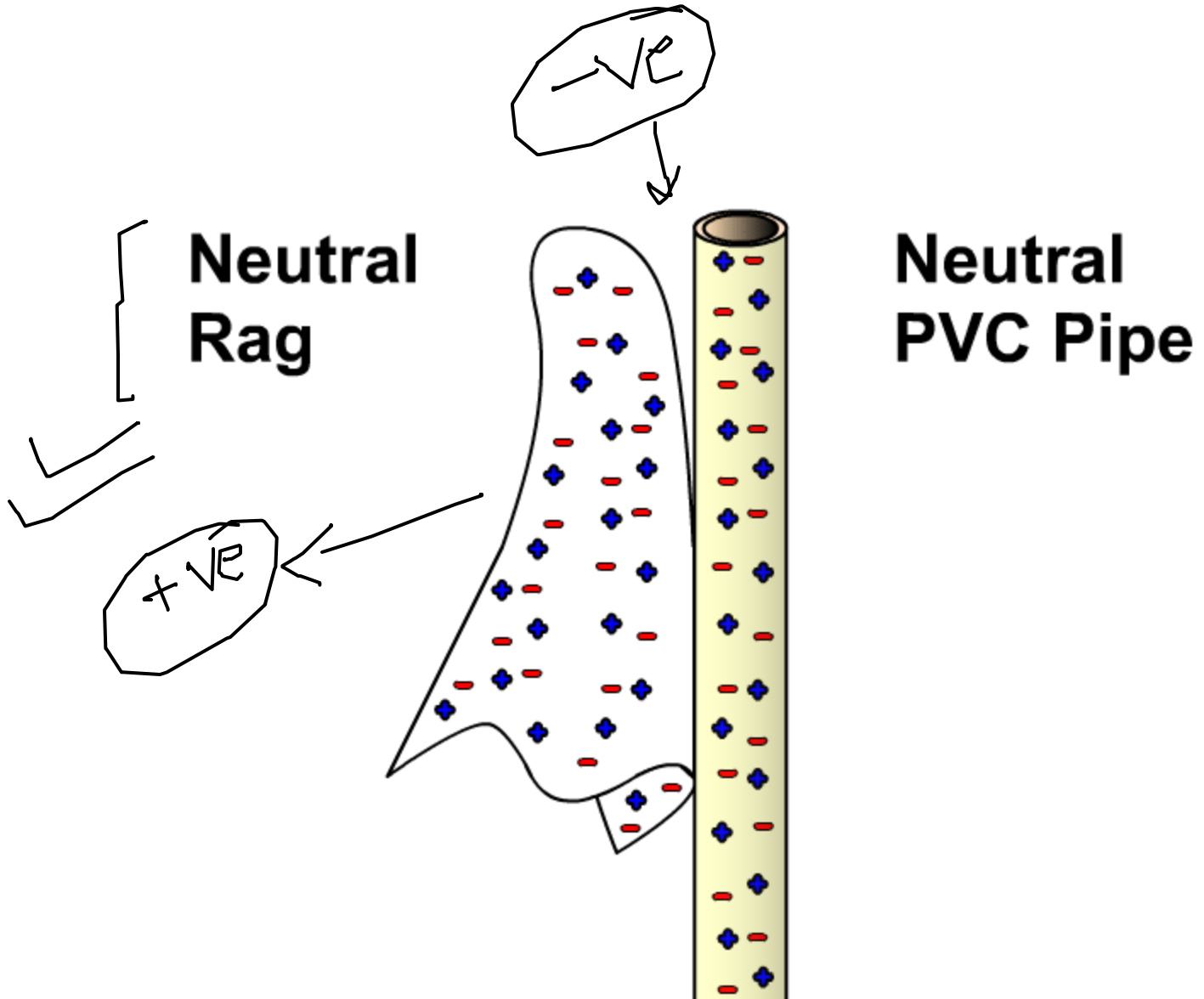
↳ no. of $e^-$

$(n = 1, 2, 3 \ldots)$

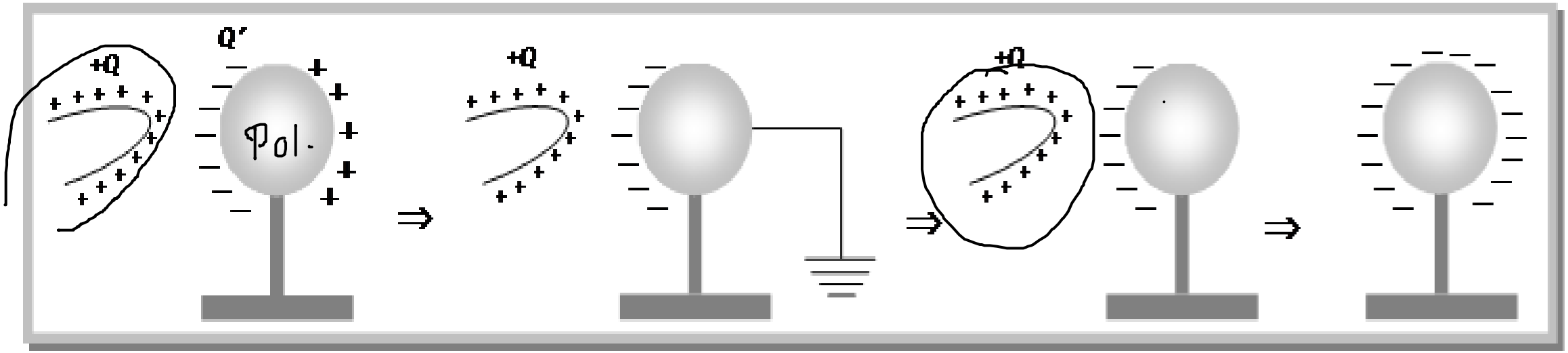
# Methods Of Charging

- (1) Charging By friction :

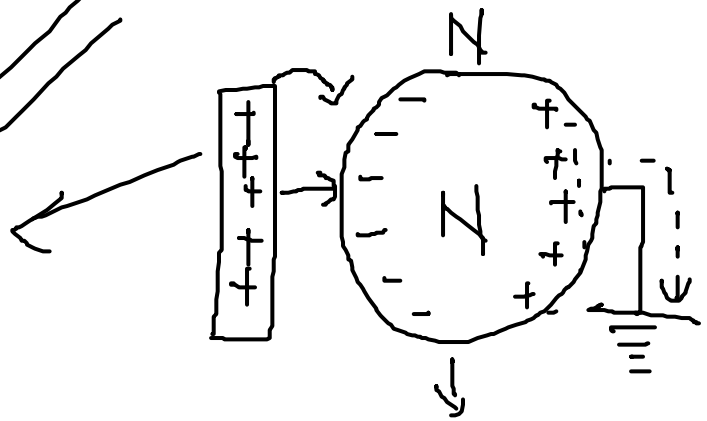


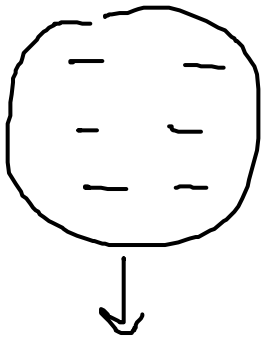
- **(2) Charging By electrostatic induction :** ✓ (प्रेरण)




Without Touch:- ✓✓

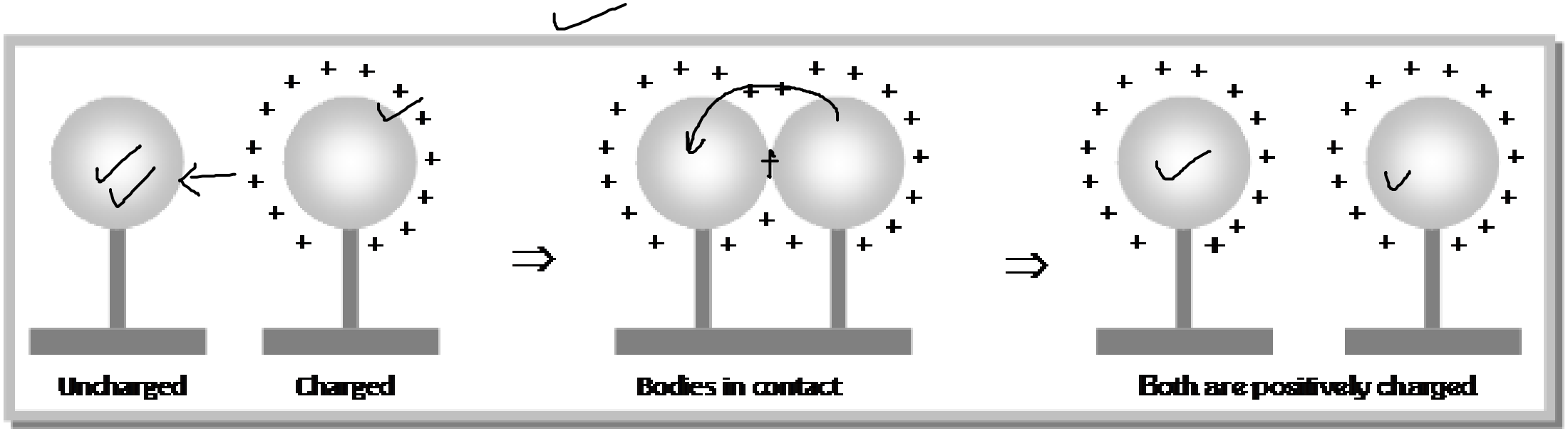



Polarised

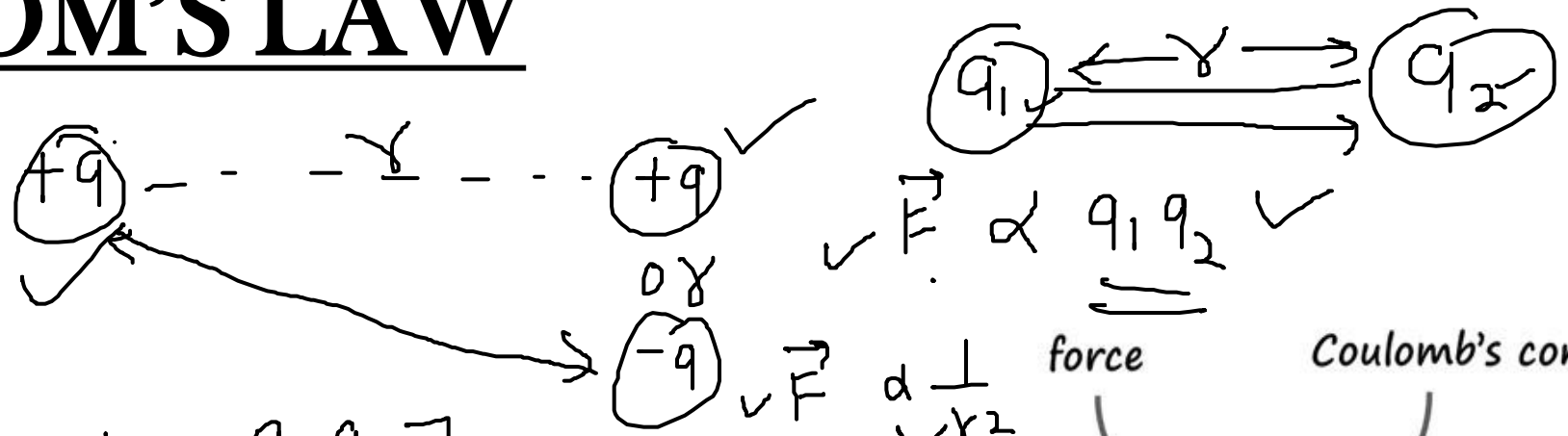


-ve (Charge)

- **(3) Charging by conduction :**



# COULOM'S LAW




$\vec{F} \propto q_1 q_2$

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

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

$$\vec{F} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

$$\left\{ K = \frac{1}{4\pi\varepsilon_0} \right\}$$

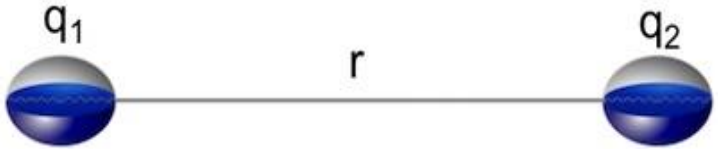
$$\vec{F} = K \frac{q_1 q_2}{r^2}$$

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ \frac{N\text{-}m^2}{C^2}$$

force — Coulomb's constant — particle charge

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

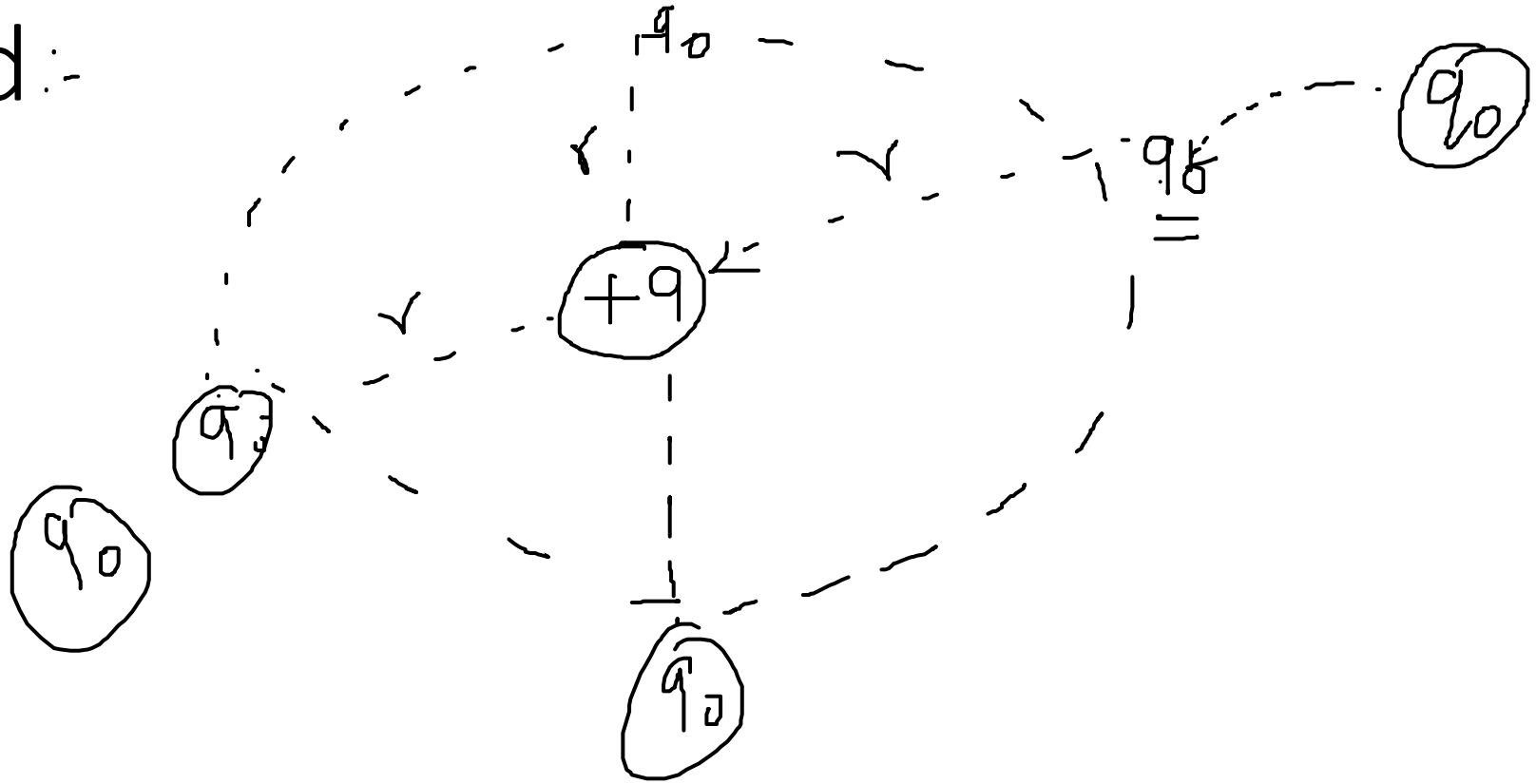
distance




$\varepsilon_0 \rightarrow$ Permittivity of medium

$\varepsilon_0 = 8.85 \times 10^{-12} \ C^2 / N\text{-}m^2$

# Electric field :-



# Electric Field:

$\vec{E}$ → vector

- The space in the surrounding of any charge in which its influence can be experienced by other charge is called electric field.

- Electric field intensity (E) at any point is defined as the electrostatic force acting per unit positive test charge at that point. Its unit is Newton/coulomb.

- E=F/q

$\vec{E} = \frac{F}{q_0}$ → Test charge

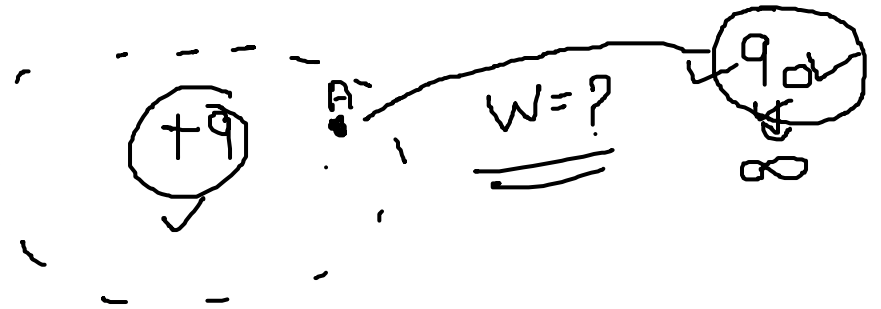
- Electric field intensity is inversely proportional to the square of the distance r from the point charge

$\vec{F} = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$ → Source charge

- **<u>विद्युत क्षेत्र:</u>**
- किसी भी आवेश के आस-पास का स्थान जिसमें इसके प्रभाव को अन्य आवेश द्वारा अनुभव किया जा सकता है, विद्युत क्षेत्र कहलाता है।
- • किसी भी बिंदु पर विद्युत क्षेत्र की तीव्रता (E) को उस बिंदु पर प्रति इकाई सकारात्मक परीक्षण आवेश में इलेक्ट्रोस्टैटिक बल के रूप में परिभाषित किया जाता है। इसकी इकाई न्यूटन / कूलम्ब है।
- • विद्युत क्षेत्र की तीव्रता, बिंदु आवेश से दूरी r के वर्ग के व्युत्क्रमानुपाती होती है

# Electric potential:

(V → Scalar)




- The electric potential at any point in an electric field is equal to the work done per unit charge in carrying at least a test charge from infinity to that point. Its unit is joule/coulomb.

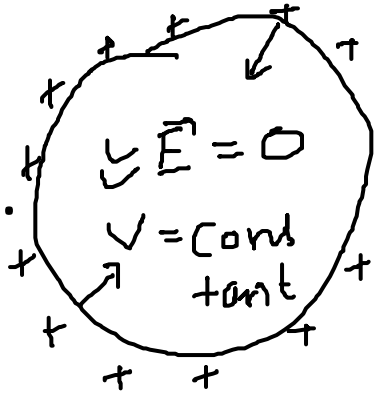
$V = E \cdot d$ → (dist. from source charge)

- Potential difference decides the flow of charge between two points in the electric field.

$$dV = \frac{dW}{q_0}$$

- Positive charge always tends to move from higher potential towards lower potential.

- Inside the closed metallic body, the electric field is zero.



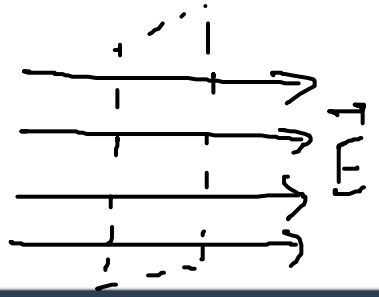
# Electric Potential (**विद्युत विभव**)

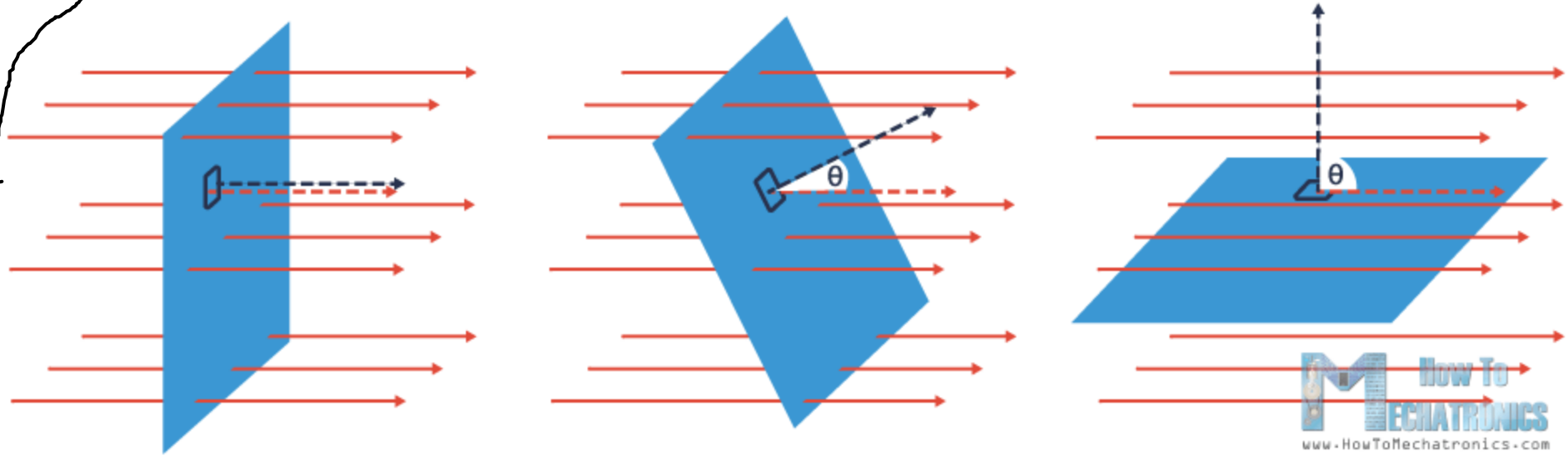
- किसी विद्युत क्षेत्र में किसी भी बिंदु पर विद्युत क्षमता अनंत से उस बिंदु तक कम से कम एक परीक्षण प्रभार ले जाने में प्रति यूनिट चार्ज किए गए कार्य के बराबर है। इसकी इकाई जूल / कूलम्ब है।
- संभावित अंतर विद्युत क्षेत्र में दो बिंदुओं के बीच आवेश के प्रवाह को तय करता है।
- • सकारात्मक चार्ज हमेशा उच्च क्षमता से कम क्षमता की ओर बढ़ने के लिए जाता है।
- • बंद धातु के अंदर, विद्युत क्षेत्र शून्य है।

# Electric Flux (विद्युतीय फ्लक्स)

$$\Phi_E = \oint \vec{E} \cdot d\vec{A}$$

$$\Phi_E = \frac{q}{\varepsilon_0}$$

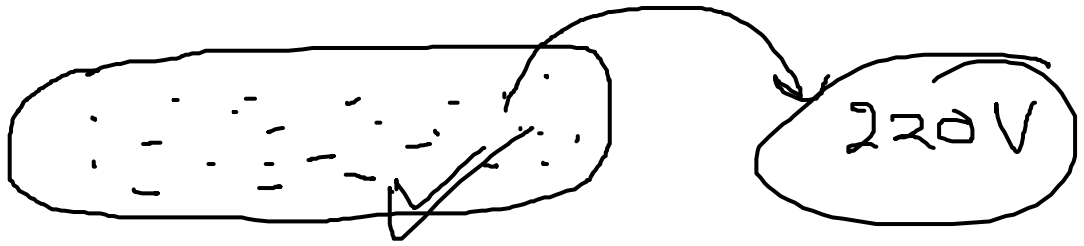


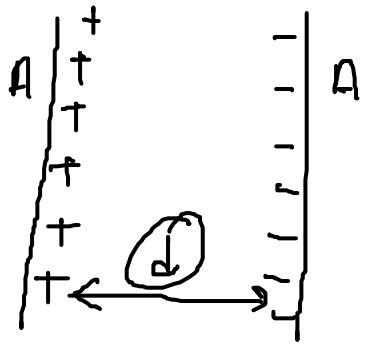



# ELECTRICAL CAPACITANCE

* Capacitor → electrical Device

[Storage of charge or energy.]






C

$V \propto q$

$CV = q$

↓

Capacitance of Cond.

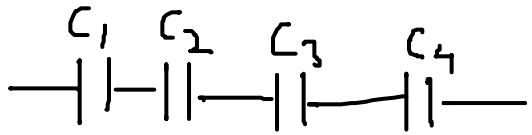
$C \rightarrow \frac{4\pi\varepsilon_0 A}{d}$ (A → Area)

d → distance

Capacitance → unit → Farad

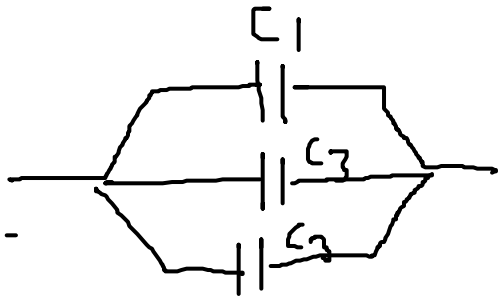
Practical unit ⇒ $\mu F$ ⇒ $1F = 10^{6}\mu F$

* Combination:- (I) In Series:- →

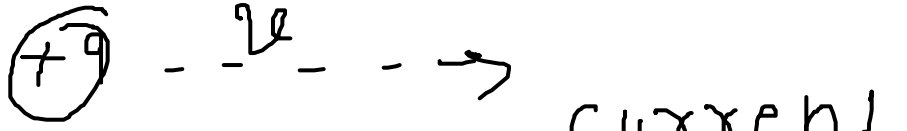



$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \text{- - - - - -}$$

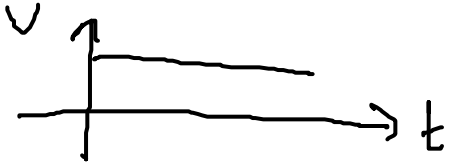
(I) Parallel:- $C = C_1 + C_2 + C_3 + \text{- - - - -}$



# Electric current:

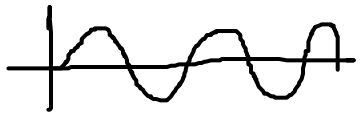



- Electric current is the flow of charge with respect to time.
- Electric current=q/t $i = \frac{q}{t}$ unit → Ampere
- An electric current whose direction does not change with time is called direct current (D.C).



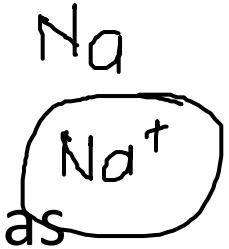

D.C.

- An electric current whose direction changes with time is called alternating current (A.C).



A.C.

- In solids- Current flow due to the flow of electrons ✓




In the liquid- Current flow due to the flow of ions as well as electrons In semiconductors- Current flow due to the flow of electrons and holes.

→ [e⁻ & holes]

$\Rightarrow 1\ \text{Amp} = 1\ \text{C/sec}$

$1\ \text{Amp} = 6.25 \times 10^{18}\ \text{e}^-/\text{sec}$ ✓

- **Resistance:** (प्रतिरोध)

• The resistance offered by any material in the flow of current is called as electrical resistance.

- Its S.I unit is ohm and [ML2T-3A-2 ] is its dimension.


- R=PL/A

$$R = \frac{\rho l}{A}$$

• L=length of conductor • A=cross sectional area • The P= resistivity of the material

$\gamma_1 \downarrow R_1$ $\quad$ $\gamma_2 \downarrow R_2$ $\quad \rightarrow \gamma_2 < \gamma_1$

$R_2 > R_1$

# Ohm's Law

- It states that if physical conditions of any conductor such as temperature, pressure etc. remain unchanged then electric current(I) through it is directly proportional to the potential difference(V) applied across its ends.

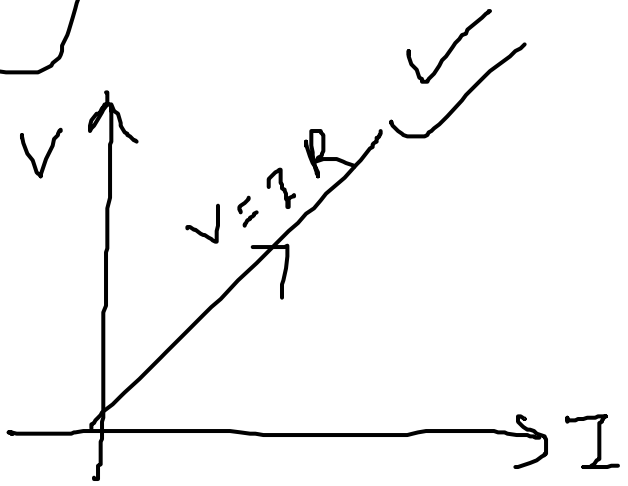
- V=IR

$V \propto I$

$V = KI$

$V = RI$

$R = \frac{V}{I}$



- **Conductance** (चालकता)

• Conductance or conductivity is the reciprocal of resistance and the resistivity of the material respectively.

• Its SI unit is mho.

mho

$\sigma \propto \frac{1}{R}$

$\sigma = \frac{1}{RA}$

- **Resistivity** (प्रति रोधकता)

- The resistivity of a material is equal to the electrical resistance of its wire unit length and of the unit area of cross-section.

- Its unit is ohm-meter.

$$\rho \Rightarrow \frac{RA}{l} = R\,l$$

- The resistivity of a material depends on the temperature and nature of the material.

- It is independent of dimensions of the conductor, i.e. length, area of cross-section.

- The resistivity of metals increases with increase in temperature.

- Resistivity is low for metals, more for semiconductors and very high for alloys.

- **<u>प्रतिरोधकता</u>**

- • किसी सामग्री की प्रतिरोधकता उसके तार इकाई की लंबाई और क्रॉस-सेक्शन के इकाई क्षेत्र के विद्युत प्रतिरोध के बराबर होती है।

- • इसकी इकाई ओम-मीटर है।

- • एक सामग्री की प्रतिरोधकता सामग्री के तापमान और प्रकृति पर निर्भर करती है।

- • यह कंडक्टर के आयामों से स्वतंत्र है, अर्थात् लंबाई, क्रॉस-सेक्शन का क्षेत्र।

- • तापमान में वृद्धि के साथ धातुओं की प्रतिरोधकता बढ़ती है।

- • प्रतिरोधकता धातुओं के लिए कम, अर्धचालकों के लिए अधिक और मिश्र धातुओं के लिए बहुत अधिक है।

# Combination of Resistances

$$R = R_1 + R_2 + R_3$$

- Resistance can be connected in two ways i.e. in parallel and in series.

- (a) Series If resistance R1, R2 and R3 are connected in series their equivalent resistance is given by

R= R1+R2+R3 In series combination equal current flows through each resistor.

- (b) Parallel If resistance R1, R2 and R3 are connected in parallel then equivalent resistance is given by.

$$1/R = 1/R1 + 1/R2 + 1/R3$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

# SUPERCONDOCTORS

# HEATING EFFECT OF CURRENT

- **Electric Power**

- P = V2 /R = I2R Here P= Electric Power, V= Voltage, R= Resistance

# GALVANOMETER

- • यदि हम एक गैल्वेनोमीटर के समानांतर शंट जोड़ते हैं, तो गैल्वेनोमीटर एक एमीटर की तरह काम करता है।

यदि हम गैल्वेनोमीटर के साथ श्रृंखला में उच्च प्रतिरोध जोड़ते हैं, तो गैल्वेनोमीटर वोल्टमीटर की तरह कार्य करता है

- **Electric Cell:**

- An electric cell is a device which converts chemical energy into electrical energy.

- Electric cell is of two types:

(a) Primary cell: cannot be charged. Voltaic, Daniell and Leclanche cells are primary cells.

(b) Secondary Cell: can be charged again & again. Acid and alkali accumulators are secondary cells.

- # Kirchoff’s Law:

- **Kirchoff current law:** states that the net current on a junction in an electrical circuit will be zero. It is based on the conservation of charge.

- **Kirchoff’s Voltage Law:** states that the algebraic sum of all potential difference along a closed loop is Zero. It is based on conservation of energy.

# Electric Fuse

- Used to protect electric appliances from high current.
- Fuse wire made of the alloy of copper, tin and lead.
- The material of fuse wire should be low melting point and high resistance.
- Shunt : It is the wire of very small resistance.
- If we add shunt parallel to a galvanometer, then galvanometer acts like an ammeter.

Note: If we add high resistance in series with the galvanometer, then galvanometer acts like a voltmeter.

- इलेक्ट्रिक फ्यूज
- • बिजली के उपकरणों को उच्च धारा से बचाने के लिए उपयोग किया जाता है।
- • तांबे, टिन और सीसे के मिश्रधातु से बने फ्यूज तार।
- • फ्यूज वायर की सामग्री कम गलनांक और उच्च प्रतिरोध होनी चाहिए।
- • शंट: यह बहुत छोटे प्रतिरोध का तार है।

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