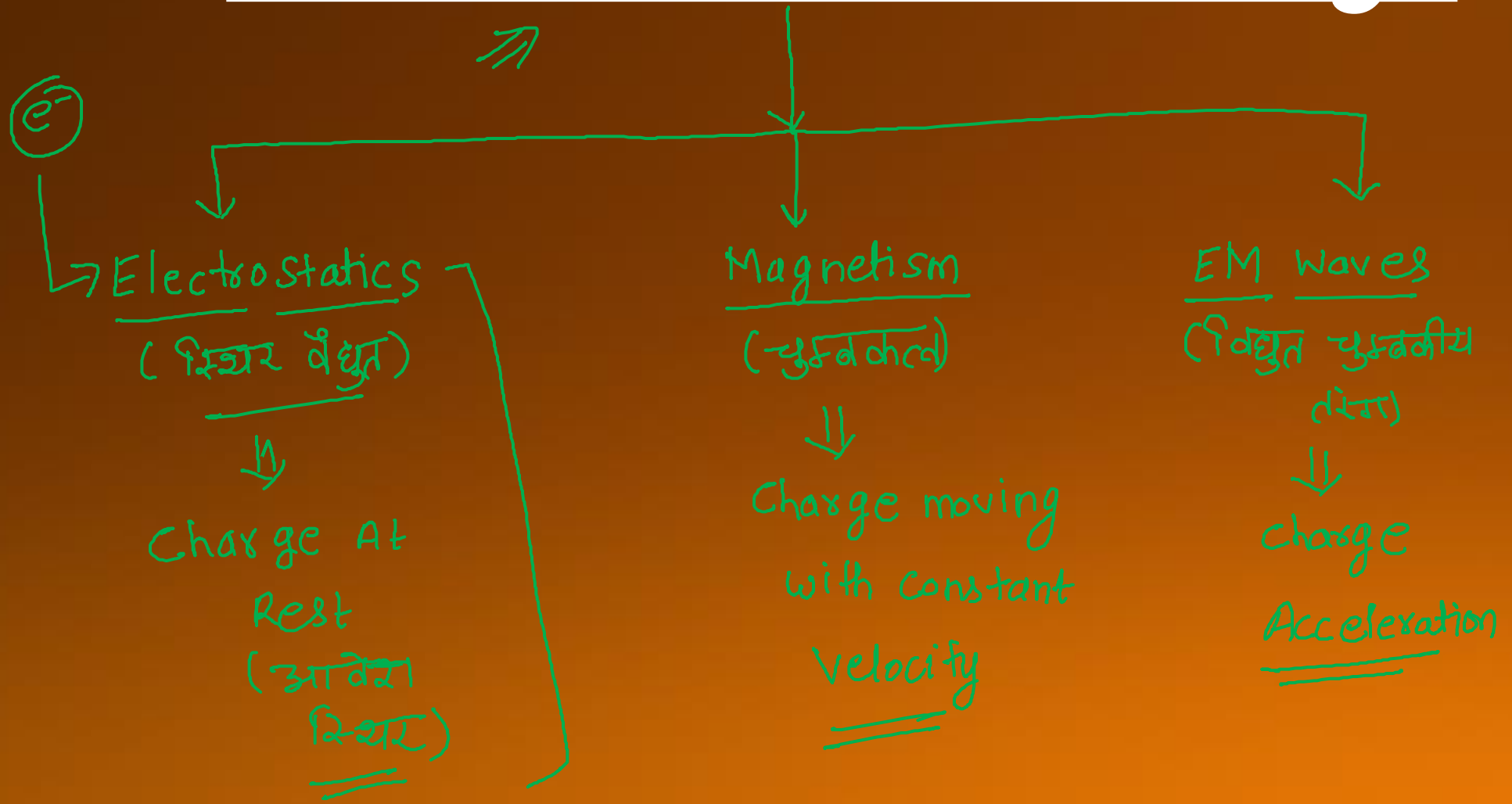
⇒ Electricity & Magnetism

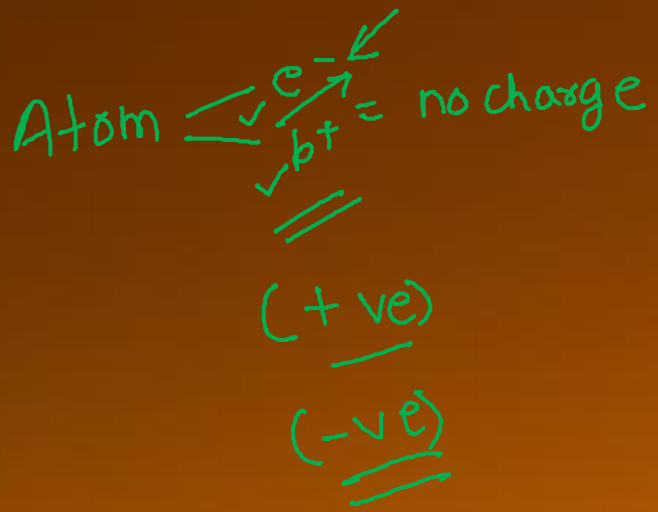
Electricity

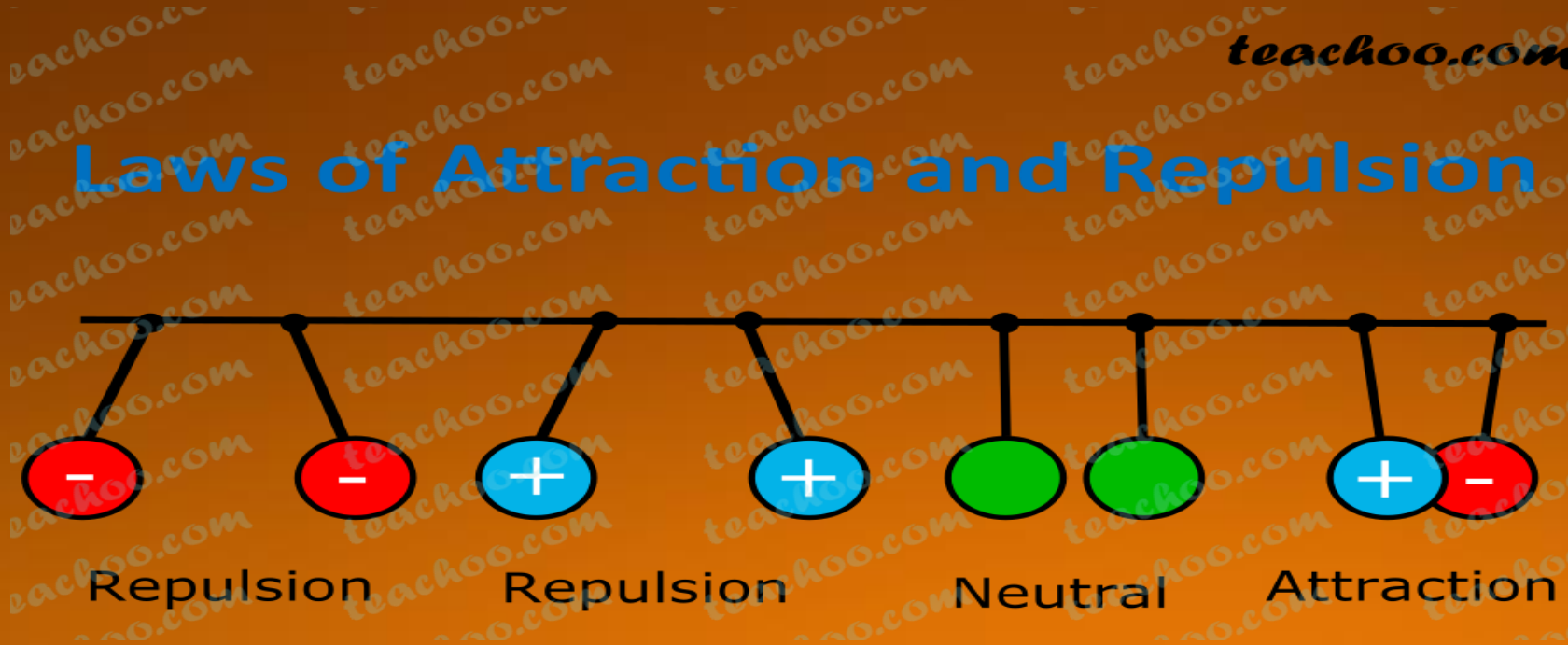


Electric Charge :Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field.

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





* Fundamental unit of charge ⇒ $e^- = 1.6 \times 10^{-19}\ C$

⇒

⇒ $q = \pm ne$

⇒ (+) (+) (प्रतिकर्षण)

(−) (−) ⇒ Repulsion

(+) (−) ⇒ Attraction (आकर्षण)

⇒ Charge ⇒ independent to velocity.

⇒ Charg ⇒ Conservative (संरक्षी)

Properties of an Electric Charge

- Charges are additive in nature
- A charge is a conserved quantity
- Quantization of charge → integer multiple of e^-

$\frac{1}{3}$ $\frac{2}{3}$ $0.7e^-$

$1, 2, 3, 4 \ldots$

3C

$q = \pm ne$

$n = 1, 2, 3, 4 \ldots$

ne

① → $q = 5.4 \times 10^{-19} C$ (1.6)

② → $q = 3.2 \times 10^{-19} C = 2 \times 1.6 \times 10^{-19} C$

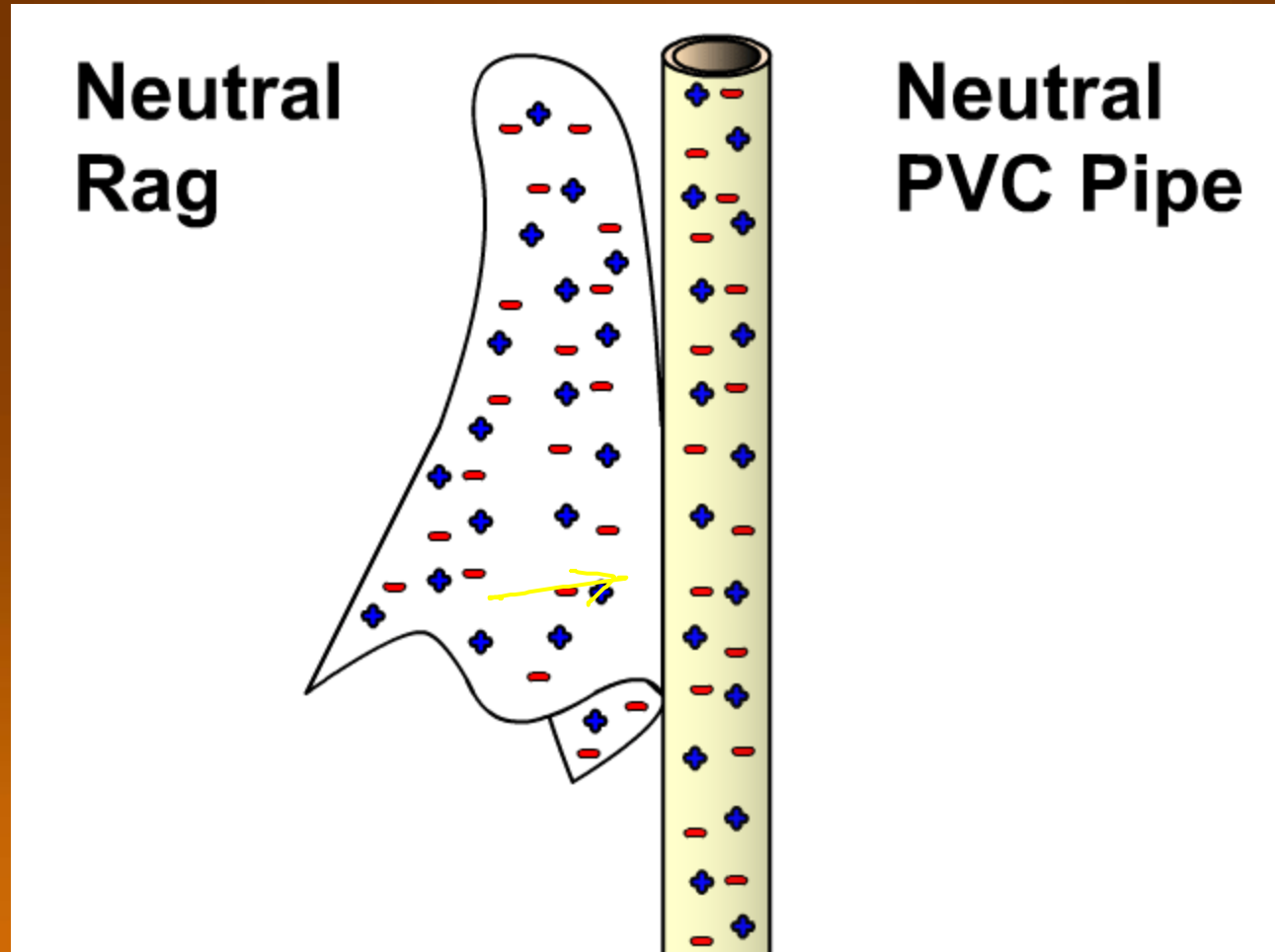
Methods Of Charging

- (1) Charging By friction :

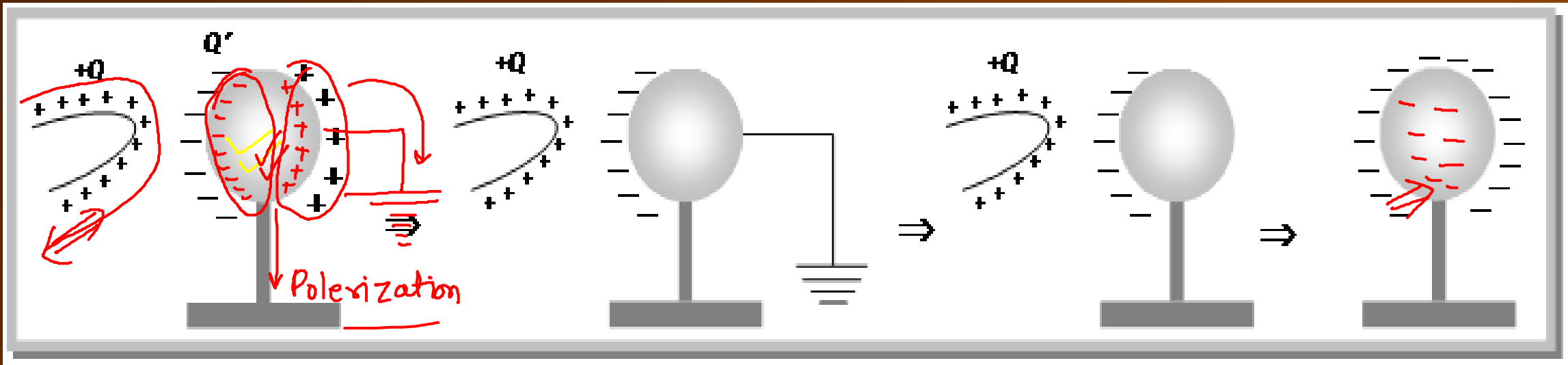
(घर्षण)

Rod → (−ve)

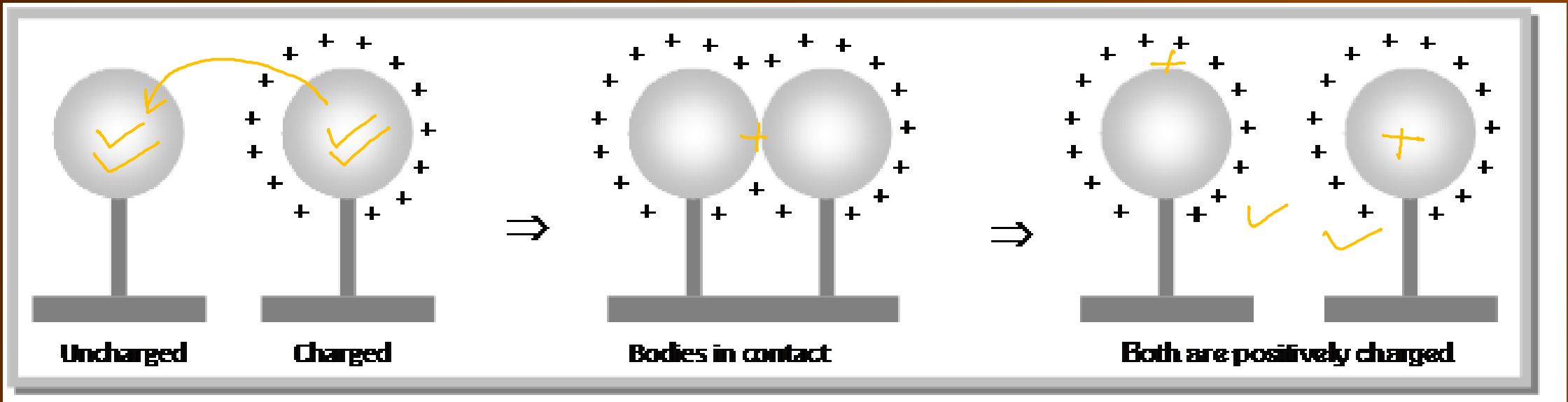
Cloth → (+ve)



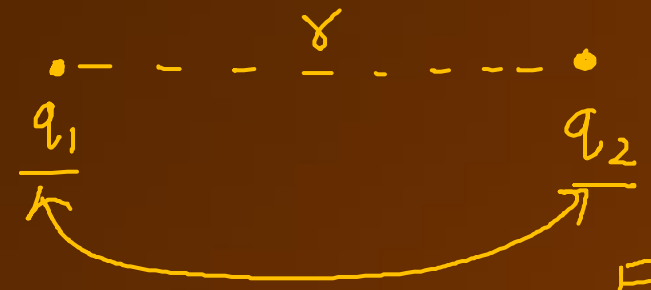
- ## (2) Charging By electrostatic induction : (प्रेरण)



- ## (3) Charging by conduction : (चालन)



COULOM'S LAW (Point charges → बिन्दु आवेश) • q_0



$F \propto q_1 q_2$ ✓

$F \propto \frac{1}{r^2}$ ✓

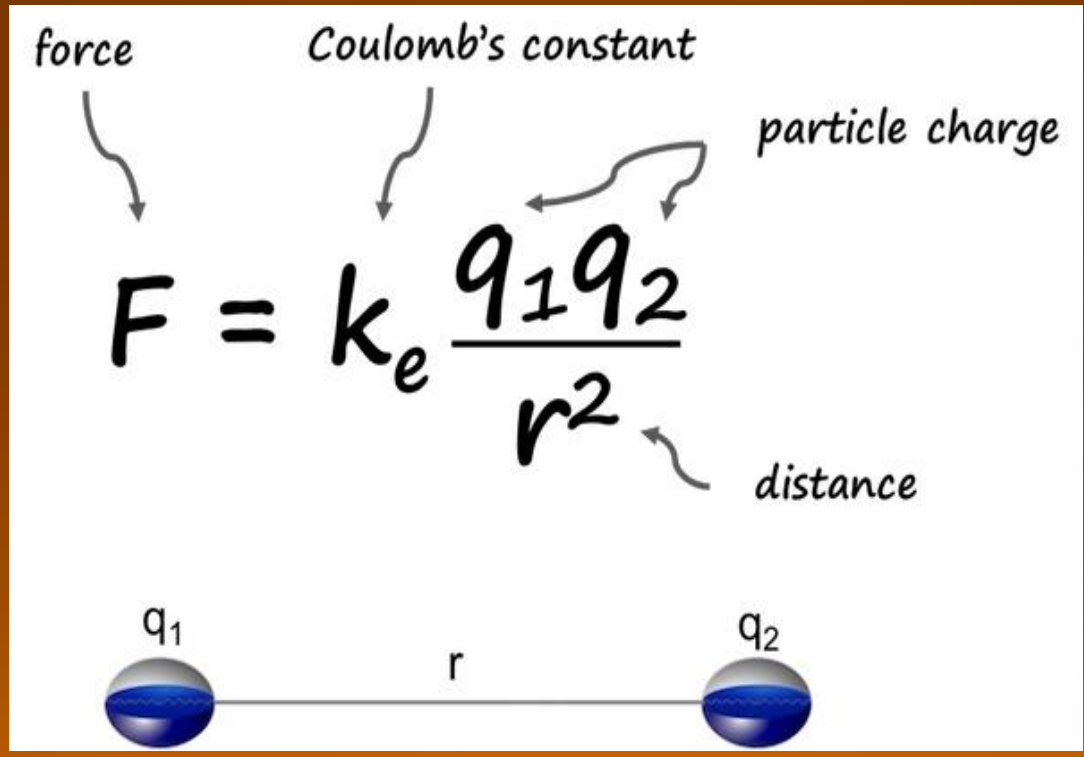
$$F = K \frac{q_1 q_2}{r^2}$$

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

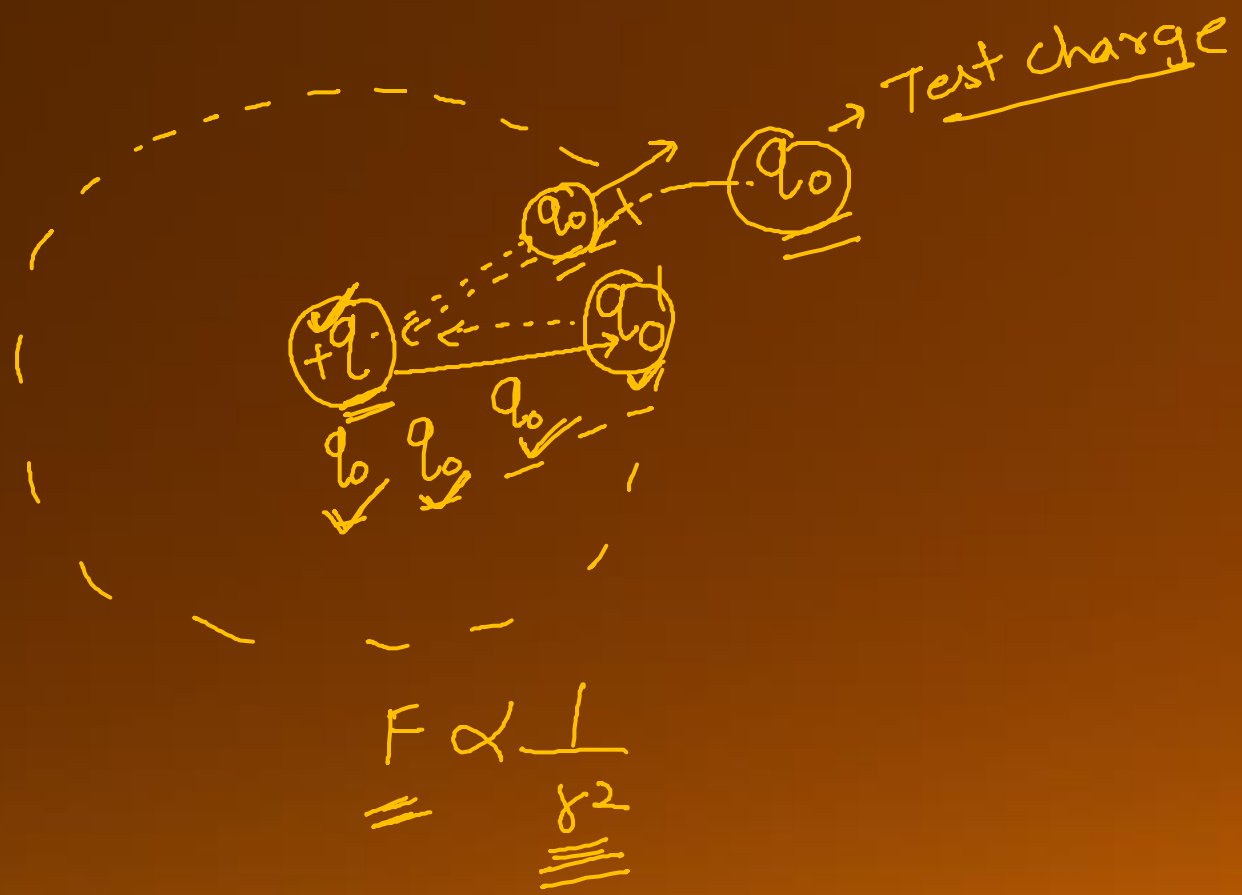
$$K = \frac{1}{4\pi\varepsilon_0}$$

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

ε_0 = Permittivity $= 8.85 \times 10^{-12} \ C^2/N\text{-}m^2$



Electric field:→ वैद्युत क्षेत्र:-



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

Electric Field:

$E = \frac{F}{q_0} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ (vector) सदिश

- 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

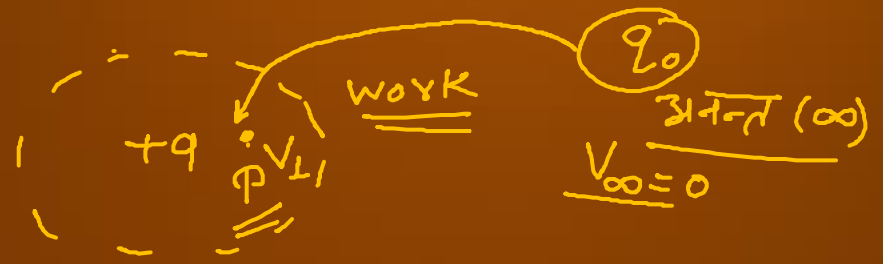
- Electric field intensity is inversely proportional to the square of the distance r from the point charge

- **<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।

$$E = \frac{F}{q_0} = \underline{\underline{N/C}}$$

- • विद्युत क्षेत्र की तीव्रता, बिंदु आवेश से दूरी r के वर्ग के व्युत्क्रमानुपाती होती है

Electric potential: (वैद्युत विभव):-



- 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.

$$V = \frac{W}{q_0}$$

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

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

$$\Delta V = V_1 - V_\infty = V_1 - 0$$

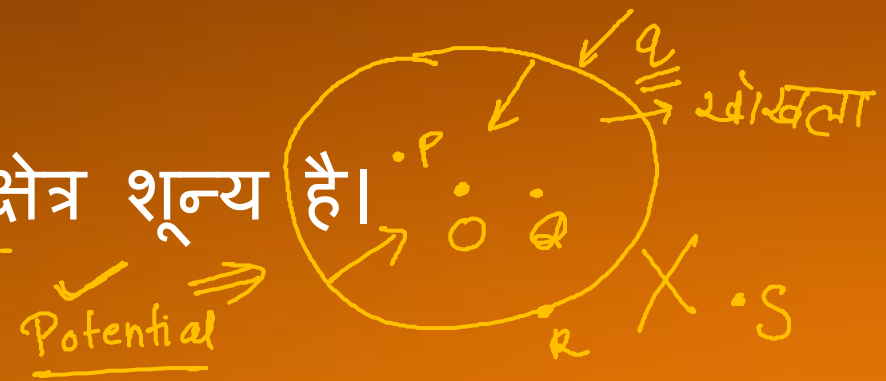
- Inside the closed metallic body, the electric field is zero.

$$\Delta V = V_2 - V_1$$

Electric Potential (विद्युत विभव)

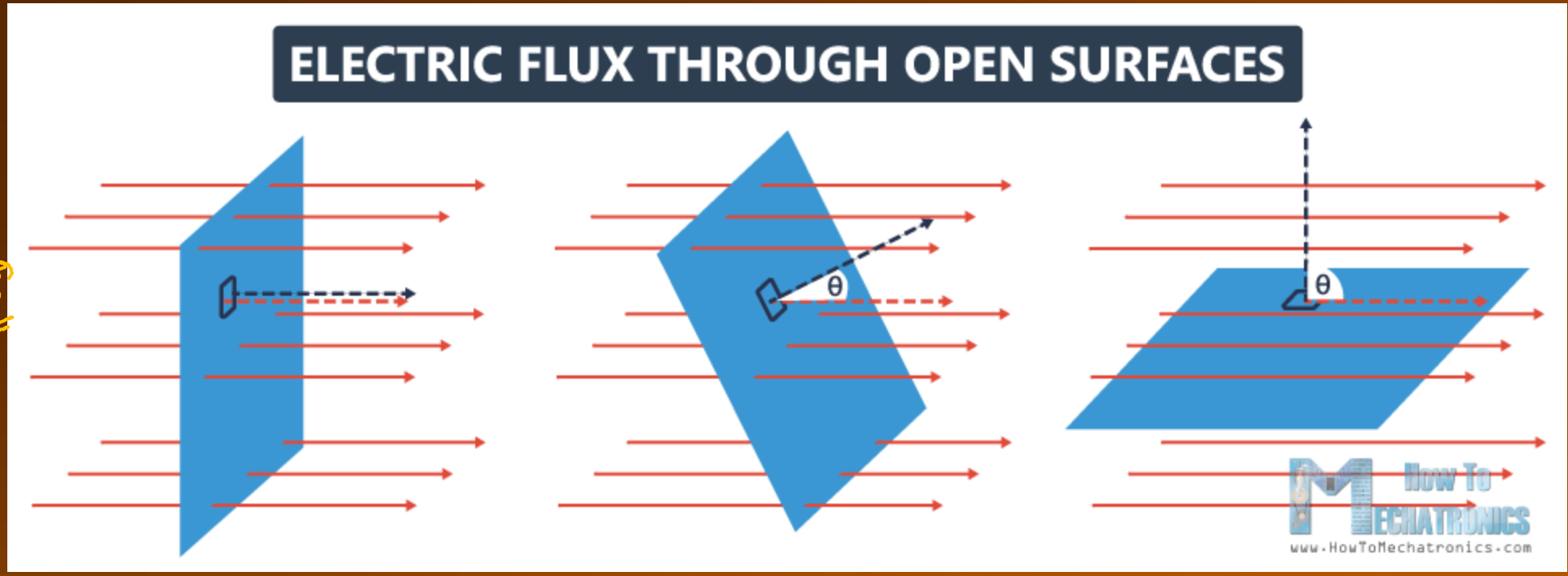
(Scalar → अदिश)

- 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)

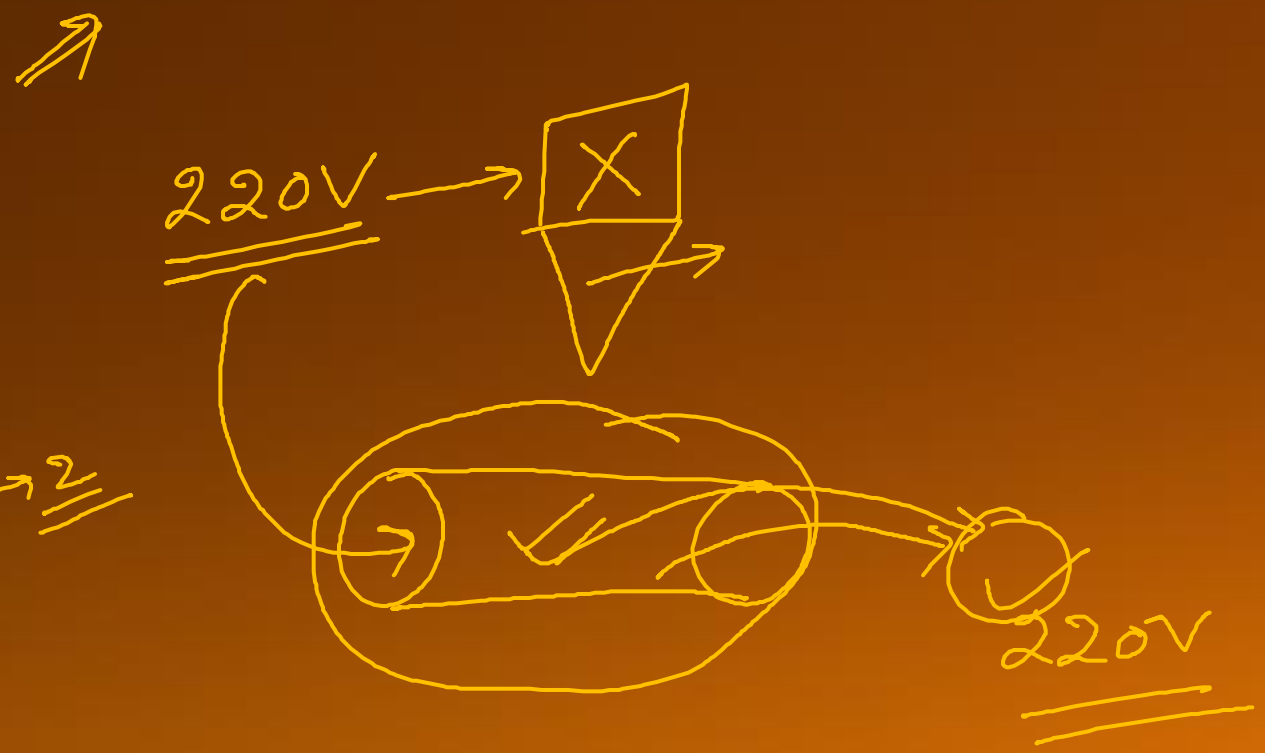
$$\Phi_E = \oint \vec{E} \cdot d\vec{S}$$



ELECTRICAL CAPACITANCE (धारिता) (संधारित)

⇒ Energy storage की → Bucket

Charges store



$\Rightarrow \quad q = CV$

$V \propto q$

$q = CV$

C ↓

Capacitance

$C = \frac{q}{V} = C/\text{Volt}$

$C \Rightarrow$ unit $\Rightarrow$ Farads ($\Rightarrow \mu F$)

$\pm$ $q \cdot V \Rightarrow C = q/V$ X

$\Rightarrow$ material

(Area)

$\Rightarrow$ Distance b/w Plates

$$C = \frac{\varepsilon A}{d}$$

Electric current:

- Electric current is the flow of charge with respect to time.

- Electric current=q/t

- An electric current whose direction does not change with time is called direct current (D.C).

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

Resistance:

• 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

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

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.

- $V=IR$

Conductance

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

• Its SI unit is mho.

Resistivity

- 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.
- 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.

- **प्रतिरोधकता**
- • 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

- 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.

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

SUPERCONDOCTORS

A superconductor is a material that can conduct electricity or transport electrons from one atom to another with no resistance. This means no heat, sound or any other form of energy would be released from the material when it has reached "critical temperature" (T_c), or the temperature at which the material becomes superconductive.

एक अतिचालक एक ऐसा पदार्थ है जो बिना किसी प्रतिरोध के एक परमाणु से दूसरे

में बिजली या परिवहन इलेक्ट्रॉनों का संचालन कर सकती है। इसका मतलब यह है कि

जब कोई सामग्री "महत्वपूर्ण तापमान" (Tc), या जिस तापमान पर पदार्थ अतिचालक

- # Electric Power

- The work done in pushing a charge round an electrical circuit is given by w.d = VIt
- So that power, P = w.d /t = VI

- P = V^2 /R = I^2R Here P= Electric Power, V= Voltage, R= Resistance

- An electrical bulb is labeled 100W, 240V. Calculate:

a)The current through the filament when the bulb works normally

b)The resistance of the filament used in the bulb.

- **Solution**

$I = P/V = 100/240 = 0.4167A$

$R = P/I^2 = 100/ 0.4167^2 = 576.04\Omega$ or $R = V^2/P = 240^2/100 = 576\Omega$

HEATING EFFECT OF CURRENT

When current flows through a conductor, heat energy is generated in the conductor. The heating effect of an electric current depends on three factors:

- The resistance, R of the conductor. A higher resistance produces more heat.
- The time, t for which current flows. The longer the time the larger the amount of heat produced
- The amount of current, I. the higher the current the larger the amount of heat generated.

GALVANOMETER

- A galvanometer is converted into an ammeter by connecting a low resistance in parallel with the galvanometer. This low resistance is called shunt resistance S.

- A galvanometer is converted into a voltmeter by connecting high resistance R_h in series with 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।

Q1. The actual flow of electrons which constitute the current is from:

(a) Negative to positive terminal
(b) Positive to negative terminal
(c) Flow at random
(d) None of the above

Q2. What is the effect of changing the wire in a circuit from a straight thick wire to a longer (coiled) thick wire?

(a) The bulbs become dimmer
(b) The bulbs become brighter
(c) The bulbs stay at the same level of brightness
(d) none of the above

Q6. Nichrome and copper wires of the same length and same radius are connected in series. Current I is passed through them. Which of the two get heated first?

(a) copper wire
(b) Nichrome wire
(c) None of these
(d) Both

Q7. What is the SI unit of electrical conductance?

(a) Volt
(b) Watt
(c) Siemens
(d) Ampere

Q9. What should be present in a substance to make it a conductor of electricity?

(a) Strongly held electrons
(b) Free electrons
(c) Strongly held protons
(d) Free protons

Q10. Which of the following is a conductor of electricity?

(a) Silver
(b) Copper
(c) Aluminium
(d) All of the above

- **Q1. Safety fuse wire used in domestic electrical appliances is made of metal of low**
  घरेलू विद्युत उपकरणों में उपयोग की जाने वाली सुरक्षा फ्यूज तार कम_____ धातु से बना होता है

- (a) resistance/ प्रतिरोध
  (b) melting point/ गलनांक
  (c) specific gravity/ विशिष्ट गुरुत्व
  (d) conductance/ प्रवाहकत्त्व

- **Q8. The metal whose electrical conductivity is more, is**
  वह धातु जिसका विद्युत चालकता अधिक है, है

- (a) copper/ तांबा
  (b) aluminium/ एल्युमीनियम
  (c) silver/ चांदी
  (d) lead/ लेड

- **Q9. Water cannot be used to extinguish fire caused by electric current, because**
  विद्युत प्रवाह के कारण लगी आग बुझाने के लिए पानी का उपयोग नहीं किया जा सकता है, क्योंकि

- (a) it may cause electrocution/ यह विद्युत प्रक्षेपण का कारण बन सकता है
  (b) it may cause hydrolysis/ यह जल-विश्लेषण का कारण बन सकता है
  (c) it may cause electrolysis/ यह विद्युतपघटन का कारण बन सकता है
  (d) it may spoil the wiring/ यह तारों को खराब कर सकता है

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