

Basic Physics and Working of Electricity

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Introduction – What is Electricity?

Electricity is the flow of electric charge.

Almost all electric current in everyday life is the flow of electrons (negative charge) through conductors (usually metals like copper).

Electricity is a form of energy that can be converted into light, heat, motion, sound, etc.

Term	Symbol	Unit	Definition / Meaning
Electric Charge	Q	Coulomb (C)	Property of matter (positive or negative)
Current	I	Ampere (A)	Rate of flow of charge $\rightarrow I = Q/t$
Voltage (Potential Difference)	V	Volt (V)	“Electrical pressure” that pushes charges
Resistance	R	Ohm (Ω)	Opposition to current flow
Power	P	Watt (W)	Rate of energy conversion $\rightarrow P = V$ $\times I$
Energy	E	Joule (J) or kWh	Work done by electricity

Understanding Electric Charge

Definition



A fundamental property causing force in electromagnetic fields

Unit



Measured in Coulombs (C)

Conservation of Charge



Total charge in an isolated system remains constant



Types

Positive and negative charges



Elementary Charge

Smallest unit of free charge, approximately $1.602 \times 10^{-19} \text{ C}$



Quantization of Charge

Exists only in discrete multiples of the elementary charge

Charge and Coulomb's Law

There are two types of charge: positive (protons) and negative (electrons).

Like charges repel, unlike charges attract.

Coulomb's law (magnitude of force between two point charges):

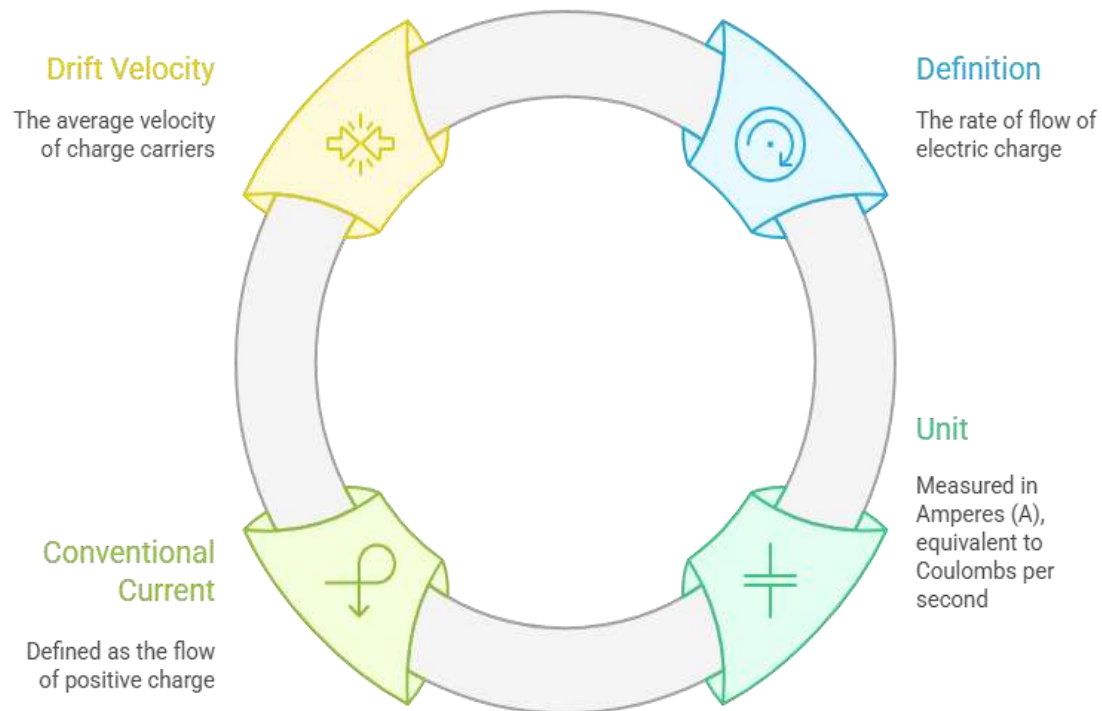
$$F = k \times |q_1 q_2| / r^2 \quad k \approx 9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Electric Current

$I = Q / t$ 1 Ampere = 1 Coulomb of charge passing per second In metals: electrons drift slowly ($\sim \text{mm/s}$) but the electric signal travels near speed of light.

Conventional current direction: positive $\rightarrow$ negative (historical convention) Actual electron flow: negative $\rightarrow$ positive

Understanding Electric Current



Voltage (Potential Difference)

Energy per unit charge.

1 Volt = 1 Joule of energy given to 1 Coulomb of charge.

Batteries and generators create voltage (electromotive force, emf).

Analogy: Voltage = water pressure, Current = water flow rate, Pipe resistance = electrical resistance.

Resistance and Ohm's Law (The Most Important Law)

$$V = I \times R \text{ (or } I = V/R, R = V/I)$$

Good conductors (copper, silver): low R

Insulators (rubber, glass): very high R

Semiconductors (silicon): in-between

Resistivity and Resistance Formula

$R = \rho \times L / A$ ρ = resistivity of material ($\Omega \cdot m$) L = length, A = cross-sectional area

→ Longer wire → more resistance → Thicker wire → less resistance

Electric Power

$P = V \times I$ Also $P = I^2 R$ and $P = V^2/R$

Household electricity (India 230 V, USA 120 V, 50/60 Hz AC)

Example: A 100 W bulb on 230 V draws $I = P/V = 100/230 \approx 0.43 \text{ A}$

Capacitors and Inductors (Brief)

Capacitor: stores charge, blocks DC, passes AC $Q = C \times V$

Inductor (coil): opposes change in current, used in transformers, motors.

Magnetism and Electromagnetism

Current in a wire creates magnetic field (right-hand rule).

Moving magnet near coil → induces voltage (generator principle).

Motor effect: current-carrying wire in magnetic field → force.

**THANK
YOU**