What is Electric Current?

- Flow of charge per unit time
- Flow of electrons per unit time
  - → $1e^- = 1.6 \times 10^{-19}$ Coulomb
    - → S.I unit of charge

Electric Current

$i = \frac{q}{t}$

$q = i \times t$

$q = n \times e^-$

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

$n = 6 \times 10^{18} e^-$

- Electric current is measured by Ammeter
- Current S.I unit: Ampere

Charge → +ve, −ve

Current = $\frac{\text{Charge}}{\text{Time}}$

- Like charges repel each other
- Opposite charges attracts each other

- Conductor: is a material that conducts electricity/allows electron to flow through it

Potential Difference

- The amount of work done in moving a unit positive charge from one point to other in an electric field

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

V → Potential difference

W → Work done to move the charge

- Measured though: Voltmeter
- S.I unit: Volt

1 volt: if one Joule of work is done in moving, one coulomb of charge

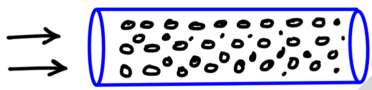
$1V = \frac{1J}{1C}$

Ohm's Law → The current flowing in a conductor is directly proportional to the voltage across the conductor, provided all the physical condition and temperature remain constant

- By George Simon Ohm in 1827
- $V\uparrow \propto I\uparrow$
- $V = IR$

R → Resistance → S.I unit Ohm (Ω)

- **Resistance**: the property of a conductor to resist the flow of charge through it



- **Factors effecting Resistance**

1. Length → Length↑ Resistance↑ (More collision of electrons)
2. Area of cross-section → Area↑ Resistance↓ (Less collision of electrons)
3. Temperature → Temperature↑ Resistance↑
   - Increase movement of e^- and K.E
4. Nature of material

$R \propto L$

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

$R \propto \frac{L}{A}$

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

ρ → Resistivity/Specific resistance

ρ = mho/ohm^{-1}

$\Omega = \frac{1\, m}{m^2}$

$\Omega\, m = \rho$ → S.I unit

Resistivity/Specific resistance → The resistivity of a material is the resistance of a wire of that material

	Material	Resistivity (Ω m)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys	Constantan (alloy of Cu and Ni)	49×10^{-6}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
Insulators	Glass	$10^{10} - 10^{14}$
	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

Alloy has greater resistivity than its constituent metals

Types of Materials

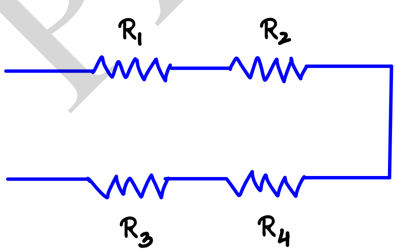
- Conductor: materials that conduct electricity/allow electric flow through them → Has free electrons
  ↓ Seen in metals
- Semi-conductor: they are materials which have conductivity between conductors and non-conductors or insulator. Eg: Silicon (usually Metalloids)
- Insulator: materials that do not allow electricity to pass through them. Eg: Non-metals such as glass, wood

Resistance of a System of Resistance

Types:

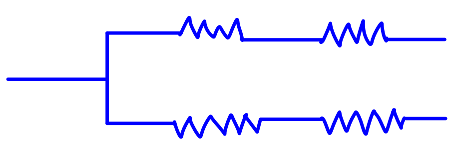
1. Series
2. Parallel

Series



$R_{eq} = R_1 + R_2 + R_3 + R_4$

Parallel



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

- **Series**: same current; different potential difference
- **Parallel**: same potential difference; different current

Q. 2 resistors = 20Ω and 4Ω (Series)
Connected to a 6 volt battery
Current flow?

→ $V = IR$

$R_{eq} = R_1 + R_2$

$20 + 4 = 24\Omega$

$6\ V = I \times 24\Omega$

$\frac{6}{24} = I$ (1/4)

$0.25\ A = I$

Q. $R_1 = 5\Omega$; $R_2 = 10\Omega$; $R_3 = 30\Omega$ → Parallelly connected
P.d = 12 V
Current?

→

$V = IR$	$V = IR$	$V = IR$
$12 = I \times 5$	$12 = I \times 10$	$12 = I \times 30$
$\frac{12}{5} = I$	$1.2\ A = I$	$0.4\ A = I$
$2.4\ A = I$		

→ $2.4 + 1.2 + 0.4 = 4.0\ A$

OR →

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30}$

$\frac{1}{R_{eq}} = \frac{6 + 3 + 1}{30}$

$\frac{1}{R_{eq}} = \frac{10}{30}$

$R = 3\Omega$

$V = IR$

$12 = I \times 3$

$I = 4\ A$

Heating effect of Electric Current

$V = \frac{W}{q}$ Power = $\frac{\text{Work Done}}{\text{Time}}$

Substituting

Electric Power = $\frac{qV}{t}$

Electric Power = VI

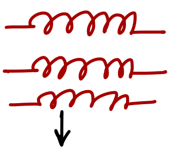
Heat = Power x t

Heat = VIt

IR x IT

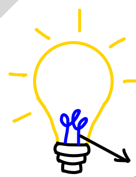
$I^2RT = H$

Practical Applications of Heating Effect of Electric Current

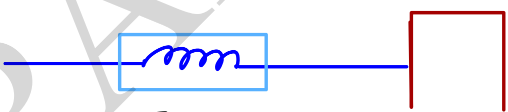


Coils in heater made of Nichrome

Alloy of Ni and Cr



- Filament made of Tungsten (W)
- Has high melting point



Fuse

- Low melting point
- It is used to protect electrical appliances from excessive current and to prevent short circuits or mismatched loads

Electric Power

$P = VI$

$P = I^2R$ ← $V = IR$

$P = \frac{V^2}{R}$ $\frac{V}{R} = I$

Commercial Unit of Energy

1 unit = 1 kWh

$P \times t$ 1 kW = 1000 W

$1000 \times 3600s$

36×10^5 Ws

3.6×10^6 J → 1 unit

1 hr = 60 mins

$60 \times 60 = 3600$ secs

220 V; 50 Hz → In electric appliances

- Live wire: Red
- Neutral: Black
- Ground/Earth: Green/Yellow

} Colour of wire