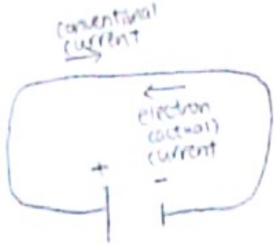
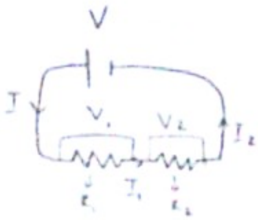
Justin

Electric Circuits:
current, resistance, and power

(A)
↑
$I = \frac{\Delta Q}{\Delta t}$ } rate of flow of charge



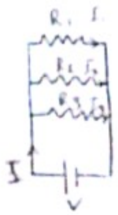
Ohm's
↑
$V = IR$



$I = I_1 = I_2$

$V = V_1 + V_2 + \dots$

$R = R_1 + R_2 + \dots$



$I = I_1 + I_2 + I_3$

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

$V = V_1 = V_2 = V_3$

$\Omega \cdot m$ (resistivity) → constant; depends on material; resistivity ↓, conductivity ↑

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

- L → m (length)
- R → Ω (resistance)
- A → m^2 (cross-sectional area)

higher temperature
↓
higher resistivity
↓
higher resistance

$R_T = R_0 [1 + \alpha_0 (T - T_0)]$

- R_T → resistance at T°C
- R_0 → resistance at 20°C
- α_0 → constant (depends on material)
- T_0 → 20°C

$P = IV$

- P → power (W)
- I → current (A)
- V → voltage (V)

$= I^2 R$ → resistance (Ω)

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

III. ELECTRICITY AND MAGNETISM
C. Electric circuits
1. Current, resistance, power

a) Students should understand the definition of electric current, so they can relate the magnitude and direction of the current to the rate of flow of positive and negative charge.

Electric Current

↳ flow of charge through the wires of a circuit, from one terminal of the power source (battery) to the other.

· the net amount of charge that passes through the wire's full cross section at any point per unit time

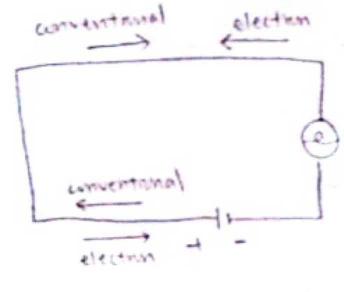
$$I = \frac{\Delta Q}{\Delta t}$$

ΔQ ← change in amt of charge over
Δt ← a given time interval

(C/s) ⇒ ampere

The concept of Current ⇒ Conventional vs Electron

Conventional	Similarities	Electron
· the flow of + charge exiting from the + end into the - terminal (not in reality; but is used to do calculations)	· current's magnitude is the same.	· electrons exit from the - side of the battery & enter the + terminal ↳ this is because electrons flow, protons don't.

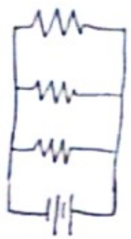


III. ELECTRICITY AND MAGNETISM
C. Electric circuits
1. Current, resistance, power
b) Students should understand conductivity, resistivity and resistance, so they can:
(1) Relate current and voltage for a resistor.

(Ω) resistance = $\frac{\text{voltage (V)}}{\text{current (A)}}$

Resistance in...

Parallel



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

$I = I_1 + I_2 + I_3$

$V_1 = V_2 = V_3$

Series

$\Sigma R = R_1 + R_2 + R_3$

$I_1 = I_2 = I_3$

$\Sigma V = V_1 + V_2 + V_3$

R↑ , I↓

R↑ , V↑

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

R = resistance

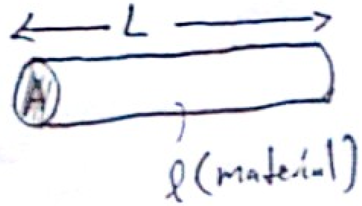
L = length of wire

A = cross-sectional area of wire

ρ = resistivity ($\Omega \cdot m$)

→ - constant of proportionality
- depends on material used
- resistivity ↓, conductivity ↑

III. ELECTRICITY AND MAGNETISM
C. Electric circuits
1. Current, resistance, power
b) Students should understand conductivity, resistivity and resistance, so they can:
(3) Describe how the resistance of a resistor depends upon its length and crosssectional area, and apply this result in comparing current flow in resistors of different material or different geometry.



$R = \rho \frac{L}{A}$ (measured in Ω)

L: length

A: crosssectional area

ρ: coefficient of resistivity (higher for insulators than semiconductors than conductors)

L ↑, R ↑

A ↑, R ↓

ρ ↑, R ↑

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III. ELECTRICITY AND MAGNETISM
C. Electric circuits
1. Current, resistance, power
b) Students should understand conductivity, resistivity and resistance, so they can:
(6) Apply the relationships for the rate of heat production in a resistor.

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

- R → resistance (Ω)
- ρ → resistivity
- L → length (m)
- A → cross-sectional area (m^2)

$P = IV$ (power (W)) → $= IR$

$= I^2R$

↳ the greater the resistance, the greater the rate of heat production (aka. power)

higher temperature → higher resistivity → higher resistance

$R \propto L$

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

$R \propto \rho$