$$\boxed{I = \frac{q}{\Delta t}}$$

q ← amount of charge [C]-

Δt ← time interval [s]

I ← el. current [A]

$1C = 6\times241\times10^{18}\times p^{+}$

C = Coulomb

PHYSICS

ELECTRIC CIRCUITS AND OHM'S LAW

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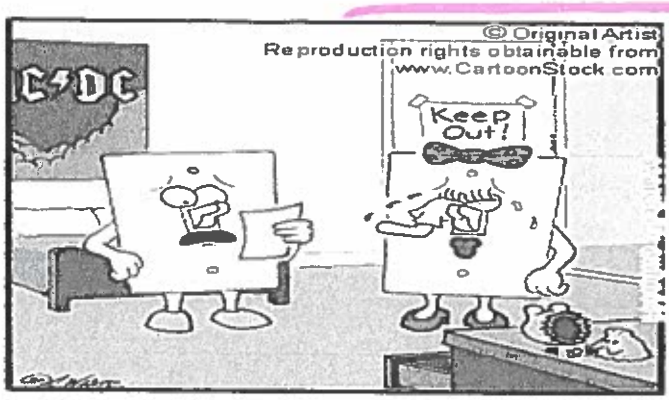

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"Dear Mom and Dad, I'm running away from home to join the circuits."

1. If a battery delivers a current of 0.68mA, how much charge passes through a circuit powered by this battery in 1 hour?

G: $\Delta t = 1hr \rightarrow 3600\,s$

$I = 0.68mA \rightarrow 0.00068\,A$

R: $q = ?\,[C]$

A: $I = \frac{q}{\Delta t} \rightarrow q = I\Delta t$

S: $q = (0.00068)(3600)$

$= 2.448\ C$

S: 2 C of charge passes through the circuit in 1 hour.

2. How much time is needed for 500μC of charge to pass through a current of 0.2mA?

G: $q = 500\mu C = 0.000500C$

$I = 0.2mA = 0.0002\ A$

R: $\Delta t = ?\,[s]$

A: $I = \frac{q}{\Delta t} \rightarrow \Delta t = \frac{q}{I}$

S: $\Delta t = \frac{0.000500}{0.0002} = 2.5\ [s]$

S: 3 s are needed.

3. 10^{10} electrons pass through a wire in 1 minute. What is the current?

G: $N = 10^{10}\,e^{-}$

$\Delta t = 1\,min = 60s$

R: $I = ?\,[A]$

A: $I = q/t$ and $q = N\cdot e$

S: $I = \frac{Ne}{\Delta t} = \frac{10^{10}\cdot(1.60\times10^{-19})}{60} = 2.\overline{6}\times10^{-11}\,A$

S: The current is 3×10^{-11} A.

4. How many electrons per second pass through a wire carrying current of 20A?

G: $I = 20A$

$\Delta t = 1s$

R: $N = ?$

A: $e = 1.6\times10^{-19}\,C$

$I = \frac{q}{\Delta t}$; $q = N\cdot e \rightarrow I = \frac{Ne}{\Delta t} \rightarrow N = \frac{I\Delta t}{e}$

S: $N = \frac{(20)(1)}{1.6\times10^{-19}} = 1.25\times10^{20}$

S: 1 (or 1.3) $\times10^{20}\,e^{-}$ passes through.

Resistance

Resistance is the ratio of the voltage applied to a material to the current that passes through the material.

High Resistance = only a small portion of charge is able to pass through the material

Low Resistance = most of the charge passes through the material

Symbol: R Units: Ohm [Ω]

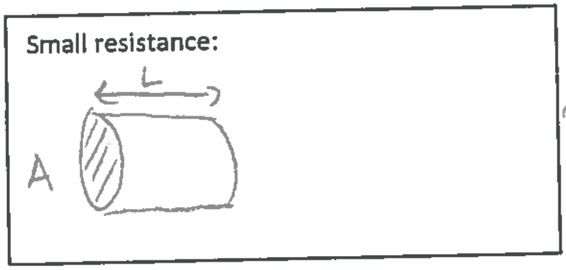
Resistor = material or a device that resist the flow of charges

- Reduces the electric current
- Symbol in an electric circuit:

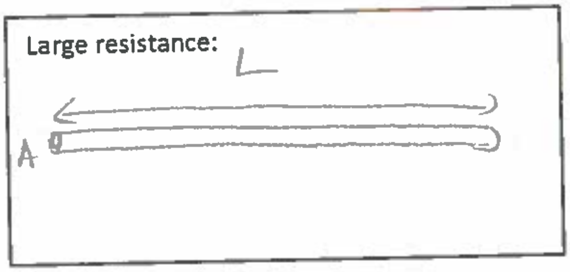
ρ

Resistivity = property unique to every material. Same material will have same resistivity. at the same T.

Resistance = given by resistivity and by the size and shape of the material.


Small resistance:

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


Large resistance:

Equivalent Resistance = **Net Resistance** = $\sum R = R_{eq}$ = total resistance

Ohm's Law

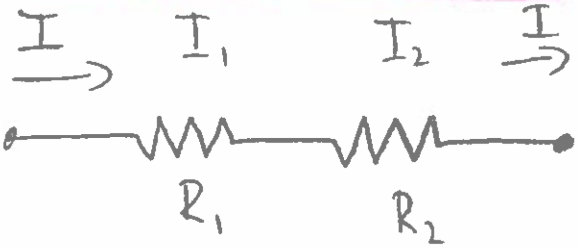
$$V = I \cdot R$$

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

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

Resistors in Series

- If one resistor is disconnected the flow of the current stops to flow to all the other resistors
- Total voltage is equal to the sum of the voltages across each resistor
- Same current flows through each resistor
- **Ammeter must be connected in series**



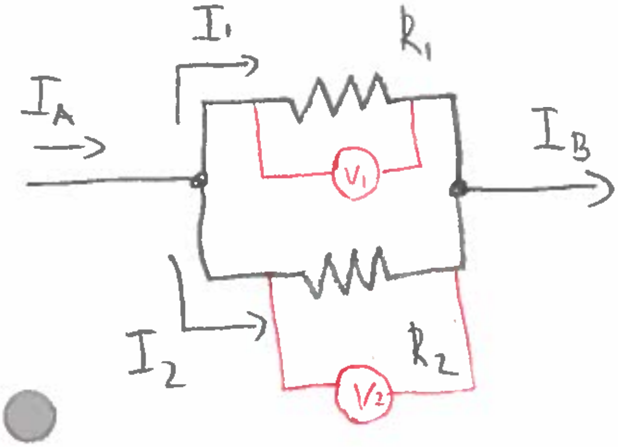
- $I_1 = I_2$
- $V_1 = V_2$ if and only if $R_1 = R_2$

- This circuit is called a voltage divider.

$$\boxed{R_{eq} = R_1 + R_2 + \cdots + R_n}$$

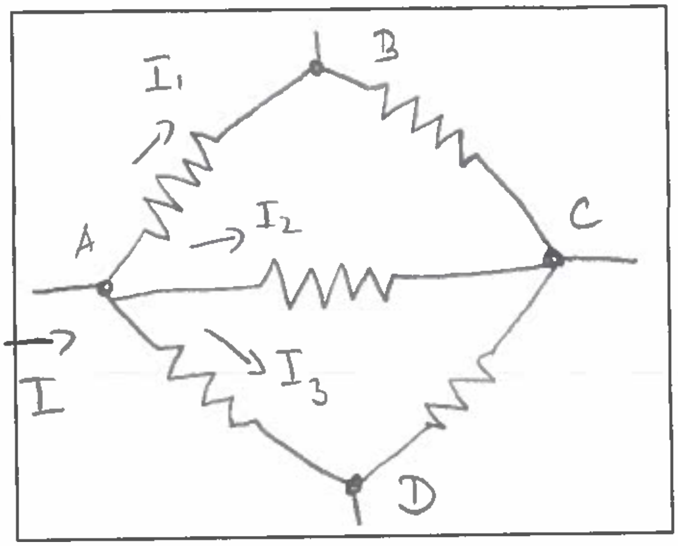
Resistors in Parallel

- The current from a source splits into separate paths
- When one resistor is disconnected the current still flows through the rest of the resistors
- Same voltage is applied across each resistor
- **Voltmeter must be connected in parallel**



- $I_A = I_B$
- $I_1 = I_2$ if and only if $R_1 = R_2$
- $V_1 = V_2$ [illegible]
- R_{eq} in the circuit decreases with more resistors in parallel

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



1. A current I entering A has three possible paths. Hence it divides into I_1 , I_2, and I_3.

2. Points such as A, B, C, and D are called nodes or junctions.

3. A round trip such as

$A \to B \to C \to A$ or $A \to B \to C \to D \to A$

are called loops

Kirchhoff's Rules

1. At any node, sum of incoming current equal the sum of outgoing current.

2. Sum of potential differences (or voltage) across all elements in a loop is zero.

MURPHY'S LAW

What can go wrong, will go wrong.

Essentially, the laws of nature always work, whether we are paying attention or not.

(Equipment blows to protect fuses.)

(Interchangeable parts aren't & fail-safes don't.)

Mrs MURPHY'S COROLLARY

Murphy is too much of an optimist.