KSU

Phys 109

Chapter 22:

Current and Resistance

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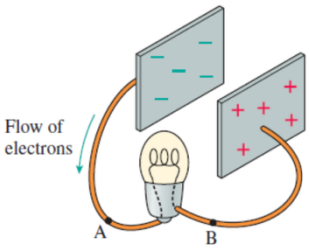
Chapter 22: Current and Resistance

1. Electric Current: *is the flow of electric charge **through a wire or conductor.***

*In metals, the moving charges are usually **electrons**. when electrons flow through a circuit, the current at one point in the wire is equal to the current at another point in the same simple circuit. This means current is **not used up** as it moves through the circuit.*



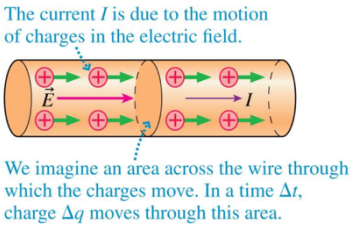
The current at point B equals the current at point A.

So, in a simple single-loop circuit: $I_A = I_B$

> *This is very important because students often think the bulb "uses up" current. That is wrong. The bulb uses **energy**, not current.*

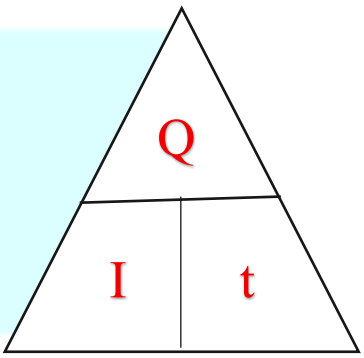
2. Definition of Current

Electric current is defined as: $$I = \frac{\Delta q}{\Delta t}$$



Symbol	Meaning	Unit
I	Electric current	Ampere, A
Δq	Charge passing through a cross section	Coulomb, C
Δt	Time interval	second, s

*The SI unit of current is the **ampere**:* $1\ A = 1\ C/s$



Meaning:

If 1 coulomb of charge passes through a point every second, the current is 1 ampere.

3. Ohm's Law

Ohm's Law connects three important electrical quantities:

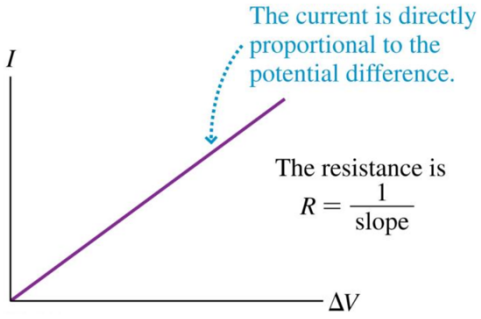
$$I = \frac{\Delta V}{R}$$

Where:

Symbol	Meaning	Unit
I	Current	Ampere, A
ΔV	Potential difference / voltage	Volt, V
R	Resistance	Ohm, Ω

Ohm's Law says:

*The current through an ohmic material is **directly proportional** to the potential difference.*

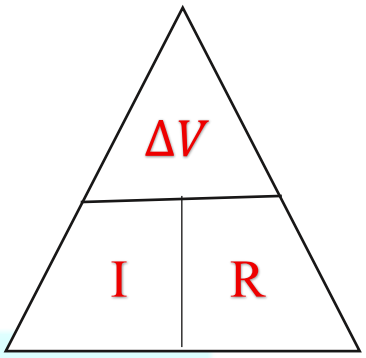


That means:

If voltage increases, current increases.

If resistance increases, current decreases.

4. Important Ohm's Law Relationships



If voltage increases: $\Delta V \uparrow$

Current increases: $I \uparrow$

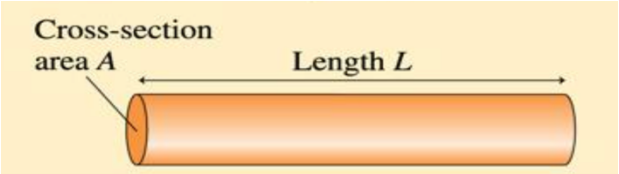
If resistance increases: $R \uparrow$

Current decreases. : $I \downarrow$

If voltage doubles and resistance stays constant: *Current doubles.*

If resistance doubles and voltage stays constant: *Current becomes half.*

5. Resistance. ***is*** *a property of a wire or conductor that opposes the flow of current.*



The resistance of a wire depends on:

1. *The material of the wire*
2. *The length of the wire*
3. *The cross-sectional area of the wire*

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

Symbol	*Meaning*	*Unit*
R	*Resistance*	Ω
ρ	*Resistivity*	$\Omega \cdot m$
L	*Length of conductor*	m
A	*Cross-sectional area*	m^2

6. How Each Factor Affects Resistance

1. Resistivity ρ $R \propto \rho$

- *Higher resistivity* $\Rightarrow$ *higher resistance.*
- *Good conductors have* ***low resistivity****.*
- *Poor conductors have* ***high resistivity****.*
- *Examples from the chapter:*
- *Copper has very low resistivity, so it is a good conductor.*
- *Pure water and cell membranes have very high resistivity, so they are poor conductors.*

2. Length L $R \propto L$

Longer wire $\Rightarrow$ *greater resistance.*

If length ***doubles:*** $\Rightarrow$ *R* ***doubles***

3. Cross-sectional Area A $R \propto \frac{1}{A}$

Larger area $\Rightarrow$ *lower resistance.*

If the wire is thicker, current flows more easily.

If area ***doubles****:* $\Rightarrow$ *R becomes* ***half***

9. Diameter and Area

Sometimes the problem gives the diameter instead of area.

For a circular wire: $A = \pi r^2$

And: $r = \frac{d}{2}$ *So:* $A = \pi \left(\frac{d}{2}\right)^2$

Important exam warning:

If diameter is given in mm, convert it to meters first.

Example: $0.50\ mm = 0.50 \times 10^{-3}\ m$

7. Most Important Exam Formulas

Memorize these:

$I = \frac{q}{t}$	$q = It$	$I = \frac{\Delta V}{R}$	$\Delta V = IR$
$R = \frac{\Delta V}{I}$	$R = \frac{\rho L}{A}$	$A = \pi r^2$	$r = \frac{d}{2}$

8. Units You Must Know

Quantity	Symbol	Unit
Current	I	A
Charge	q	C
Time	t	s
Voltage	ΔV	V
Resistance	R	Ω
Resistivity	ρ	$\Omega.m$
Length	L	m
Area	A	m^2