Electrical Properties

IB PHYSICS | ELECTRICITY

Voltage Current Resistance Power

Remember back…

What is potential energy?

Stored Energy

Voltage

Voltage is the Potential Energy _____Difference_____ between two locations

Voltage = Potential Difference
p.d.

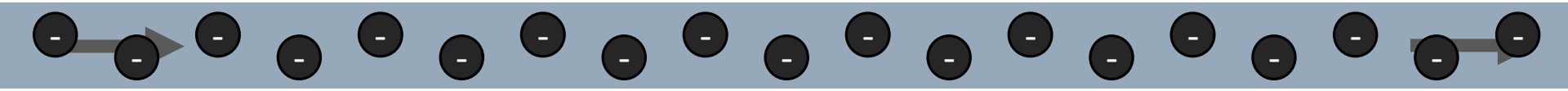
Symbol: V	Unit: Volts [V]

Current

The rate at which charges move through a conductor

Flow of Electrons

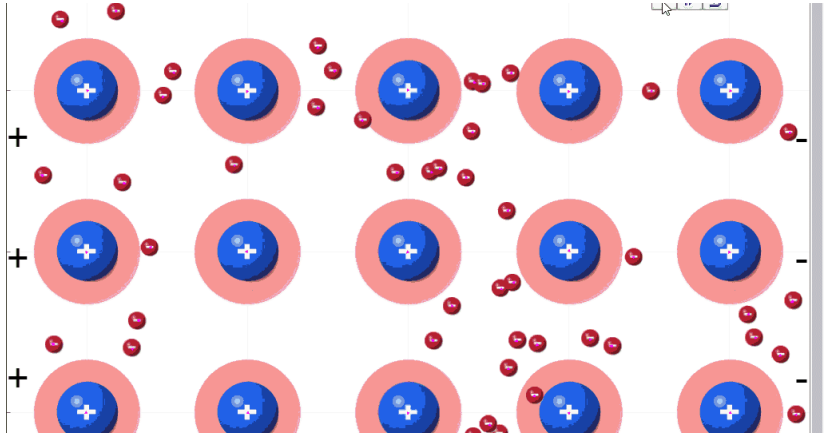
Symbol: I	Unit: Amperes [A]

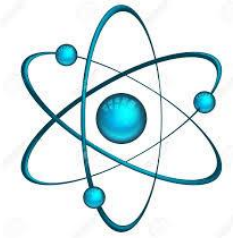


Current

Why do the electrons flow instead of protons or neutrons?

Outside of the atom so they are more easily transferred





Resistance

How difficult it is for electrons to flow

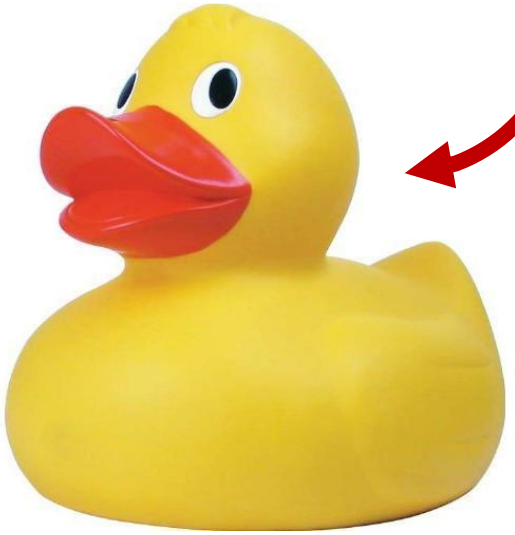
Symbol: R	Unit: Ohms [Ω]

Which one has more resistance for water flow?

Conductors and Insulators

Conductors have a low resistance

Insulators have a high resistance



Electrical Properties

Property	What is it?	Symbol	Unit
Voltage	Potential Difference	V	Volts [V]
Current	The rate at which the charges move through wire	I	Amps [A]
Resistance	How hard it is for current to flow through a conductor	R	Ohms [Ω]

How are they Related?

Voltage

Current

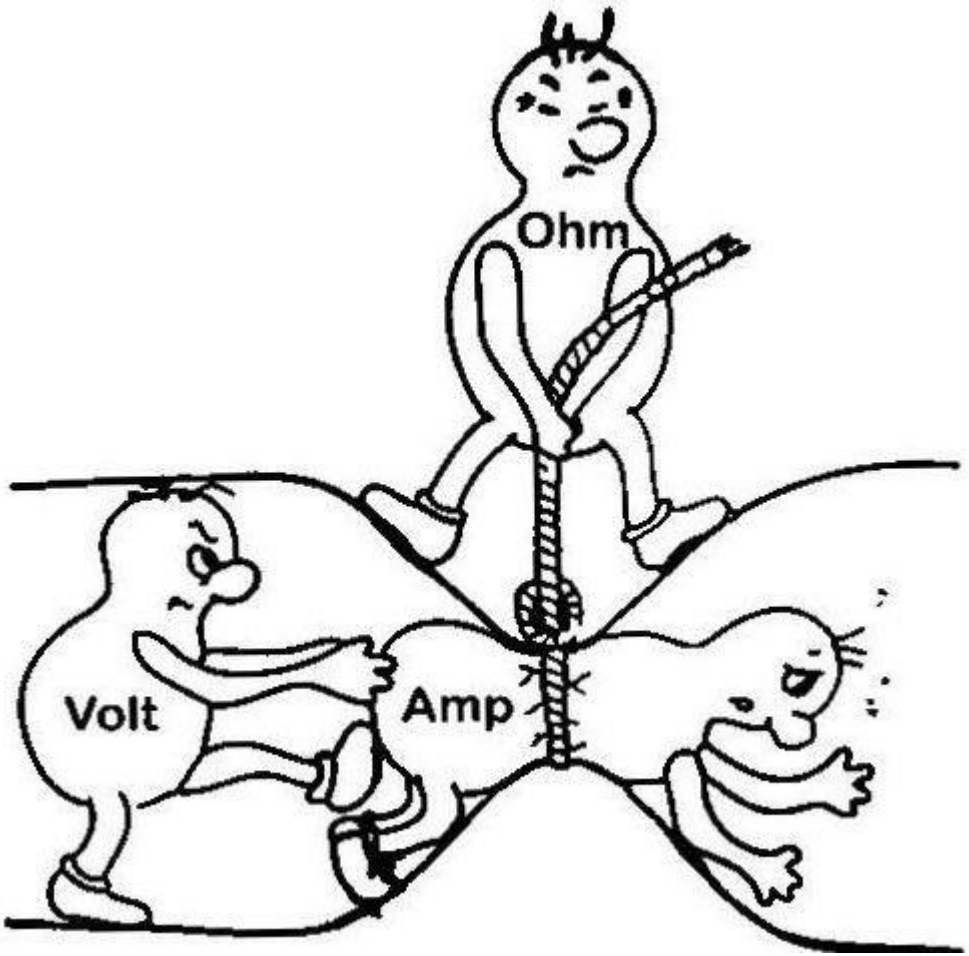
$V \propto I$

Resistance

Current

$R \propto {}^{1}/_{I}$

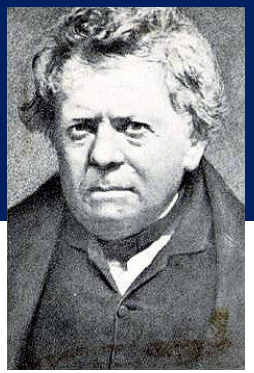
How are they Related?

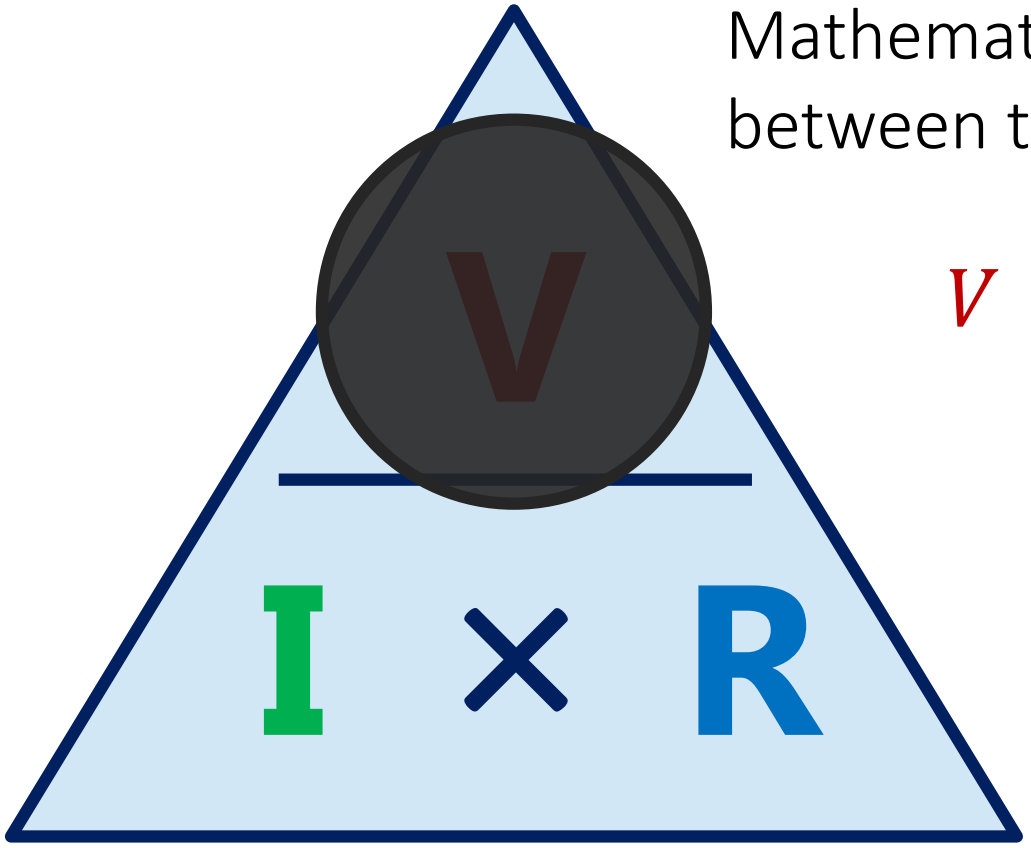


Voltage **Current** **Resistance** Power

Memorize

Ohm's Law





Mathematical relationship between the electrical properties

$$V = I \times R$$

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

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

IB Physics Data Booklet

Sub-topic 5.1 – Electric fields	Sub-topic 5.2 – Heating effect of electric currents
$I = \frac{\Delta q}{\Delta t}$ $F = k\frac{q_1 q_2}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$ $V = \frac{W}{q}$ $E = \frac{F}{q}$ $I = nAvq$	Kirchhoff's circuit laws: $\Sigma V = 0$ (loop) $\Sigma I = 0$ (junction) $R = \frac{V}{I}$ $P = VI = I^2R = \frac{V^2}{R}$ $R_{\text{total}} = R_1 + R_2 + \cdots$ $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ $\rho = \frac{RA}{L}$
Sub-topic 5.3 – Electric cells	**Sub-topic 5.4 – Magnetic effects of electric currents**
$\varepsilon = I(R + r)$	$F = qvB\sin\theta$ $F = BIL\sin\theta$

Try this...

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

What is the voltage of a battery that produces a current of 1.5 amps through a 3 ohm resistor?

$I = 1.5\ \text{A}$

$R = 3\ \Omega$

$V = ??$

$$V = I \times R = 1.5 \times 3 = 4.5\ \text{V}$$

What resistance would produce a current of 5 amps from a 120-volt power source?

$I = 5\ \text{A}$

$V = 120\ \text{V}$

$R = ??$

$$R = \frac{V}{I} = \frac{120}{5} = 24\ \Omega$$

Remember Power?

Symbol: P	Unit: Watts [W]

New Equations:

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

$$V = IR$$

$$P = VI$$

$$P = I^2R$$

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

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Voltage **Current** **Resistance** **Power**

Calculating Power

A blender runs on 5 amps of current on a 120 V. How much power is it drawing?

$I = 5\ \text{A}$

$V = 120\ \text{V}$

$$P = VI = (120)(5) = \mathbf{600\ W}$$

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

Different Devices… Different Power

Common Appliances	Estimated Watts
Blender	300-1000
Microwave	1000-2000
Waffle Iron	800-1500
Toaster	800-1500
Hair Dryer	1000-1875
TV 32" LED/LCD	50
TV 42" Plasma	240
Blu-Ray or DVD Player	15
Video Game Console (Xbox / PS4 / Wii)	40-140

What do you notice?

Heat

Lesson Takeaways

- ❑ I can describe the properties of Voltage, Current, Resistance, and Power
- ❑ I can use Ohm's Law to mathematically relate these electrical properties and solve for an unknown

Voltage **Current** **Resistance** **Power**