Current-Voltage-Resistance Relationship
Lesson Notes

Learning Outcomes

- How are current, resistance, and *voltage* mathematically related?
- How can the relationship be used?

The BIG Equation

The most prevalent equation for electric circuits is …

$$\Delta V = I \cdot R$$

where **ΔV** = electric potential difference (Unit: volt, V)
I = current (Unit: ampere, A)
R = resistance (Unit: ohm, Ω)

The electrical potential difference between any two points on a circuit is equal to the current that flows between those two points multiplied by the total resistance of all elements existing between those two points.

Predicting Current

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

ΔV: encourages charge flow
R: discourages charge flow

The current is …

- directly proportional to the electric potential difference (ΔV)
- inversely proportional to the resistance (R)

ΔV and I

If **ΔV** is doubled, then **I** is doubled.
If **ΔV** is tripled, then **I** is tripled.
If **ΔV** is halved, then **I** is halved.

R and I

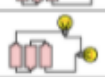
If **R** is doubled, then **I** is halved.
If **R** is tripled, then **I** is 1/3rd as much.
If **R** is halved, then **I** is doubled.

Current Calculations

	Diagram	$\Delta V_{battery}$	R_{total}	I
1.		1.5 V	3.0 Ω	0.5 A
2.		3.0 V	3.0 Ω	1.0 A
3.		4.5 V	3.0 Ω	1.5 A

Rows 1 and 2:
Doubling ΔV ⇒ Doubles I

Rows 1 and 3:
Tripling ΔV ⇒ Triples I

	Diagram	$\Delta V_{battery}$	R_{total}	I
4.		4.5 V	3.0 Ω	1.5 A
5.		4.5 V	6.0 Ω	0.75 A
6.		4.5 V	9.0 Ω	0.5 A

Rows 4 and 5:
Doubling R ⇒ Halves I

Rows 4 and 6:
Tripling R ⇒ I is ⅓-rd original

Equations as a Guide To Thinking

Determine the answers to Parts a. - i. below.

A circuit is wired with a energy supply, a resistor and an ammeter (for measuring **I**). The ammeter reads **I** as 24 mA (milliAmps). Determine the new **I** if the **ΔV** was ...

a. ... increased by a factor of 2 and the **R** was held constant.
b. ... increased by a factor of 3 and the **R** was held constant.
c. ... decreased by a factor of 2 and the **R** was held constant.
d. ... held constant and the **R** was increased by a factor of 2.
e. ... held constant and the **R** was increased by a factor of 4.
f. ... held constant and the **R** was decreased by a factor of 2.
g. ... increased by a factor of 2 and the **R** was increased by a factor of 2.
h. ... increased by a factor of 3 and the **R** was decreased by a factor of 2.
i. ... decreased by a factor of 2 and the **R** was increased by a factor of 2.

Quantities, Symbols, Equations, Units

Quantity	Symbol	Equation(s)	Standard Metric Unit	Other Units
Potential Difference (a.k.a. voltage)	ΔV	$\Delta V = \Delta PE / Q$ $\Delta V = I \cdot R$	Volt (V)	J / C
Current	I	$I = Q / t$ $I = \Delta V / R$	Ampere (A)	Amp or C / s or V / Ω
Power	P	$P = \Delta PE / t$ (more to come)	Watt (W)	J / s
Resistance	R	$R = \rho \cdot L / A$ $R = \Delta V / I$	Ohm (Ω)	V / A
Energy	E or ΔPE	$\Delta PE = \Delta V \cdot Q$ $\Delta PE = P \cdot t$	Joule (J)	V • C or W • s