Technician Class Course

Session 2

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Fundamentals of Electricity

When dealing with electricity, what we are referring to is the flow of electrons through a conductor.

- Electrons are negatively charged atomic particles.
  - The opposite charge is the positive charge
- A conductor is a material that allows electrons to move with relative freedom within the material.

Pop quiz: What is the opposite of a conductor?

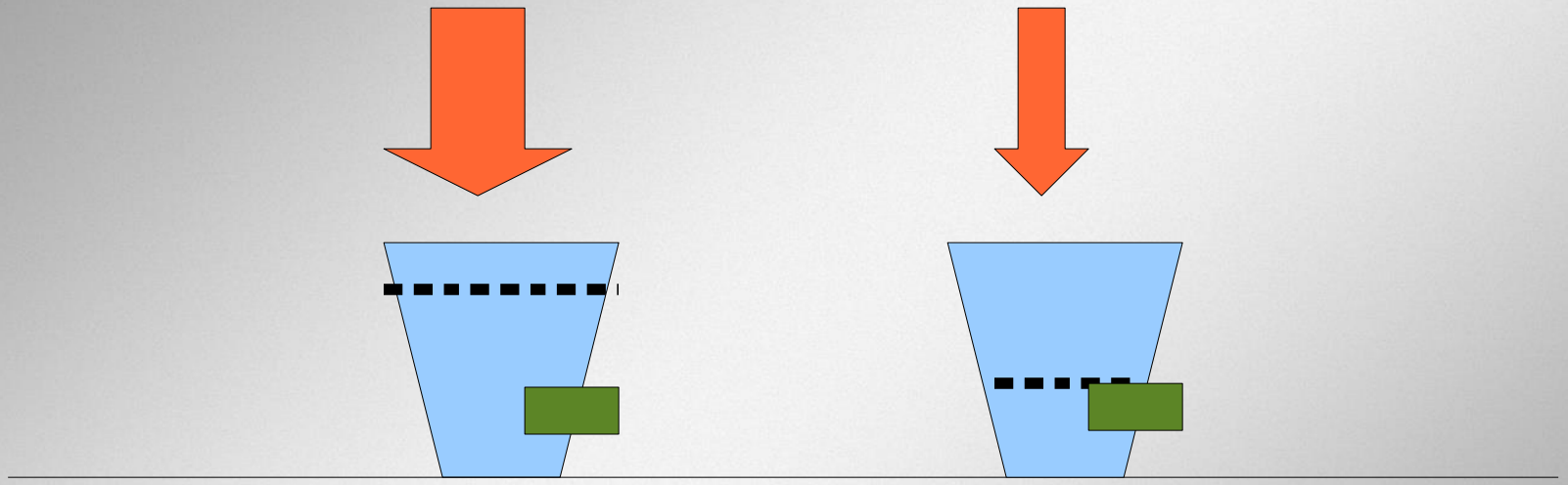
Basic Characteristics of Electricity

There are three characteristics to electricity:

- Voltage
- Current
- Resistance

All three must be present for electrons to flow.

Voltage



- Voltage is like water pressure.
- The higher the water level, the greater the pressure at the bottom of the bucket.
- Voltage is the potential difference in electric charge between two points.
- The unit of voltage is the Volt.

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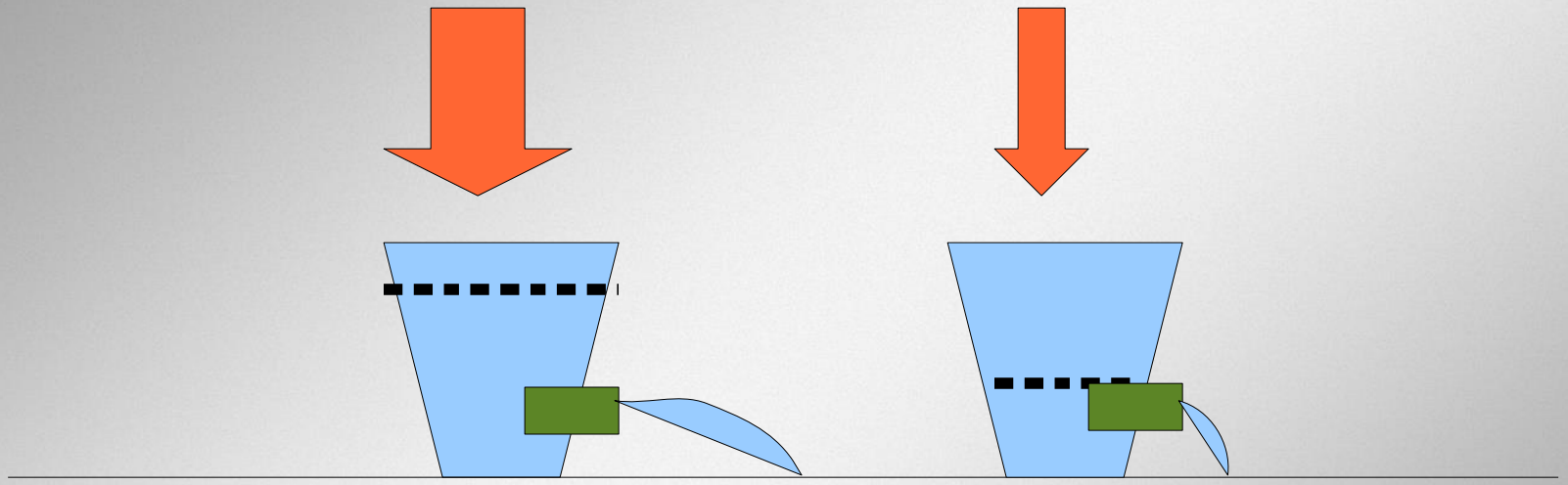
Current



•Current is like the flow of water.
•The higher the water level (the greater the pressure at the bottom of the bucket) the more water will flow out of the tap in the same unit of time.
•Current is the net amount of electric charge flowing past a specific point in a specified unit of time.
•The unit of current is the Ampere (or Amp).

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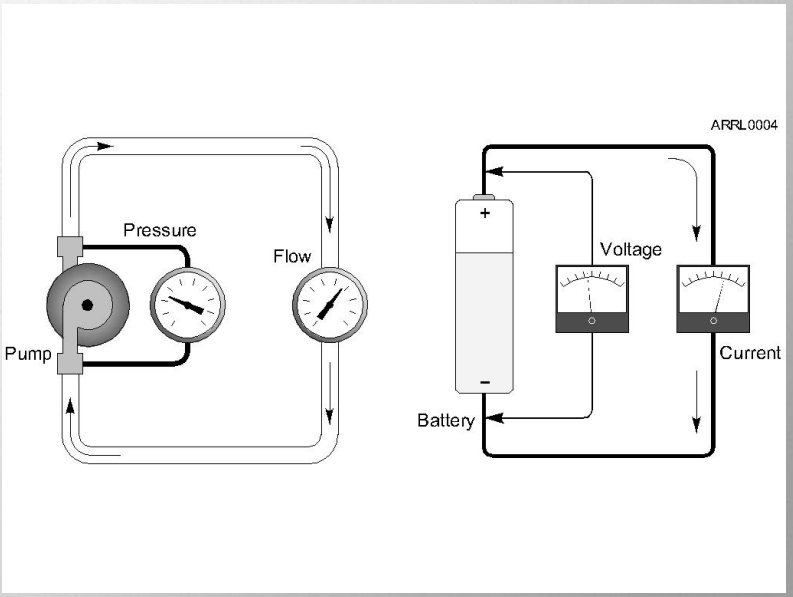
Basic Characteristics of Electricity

- The flow of water through a hose is a good analogy to understand the three characteristics of electricity and how they are related.



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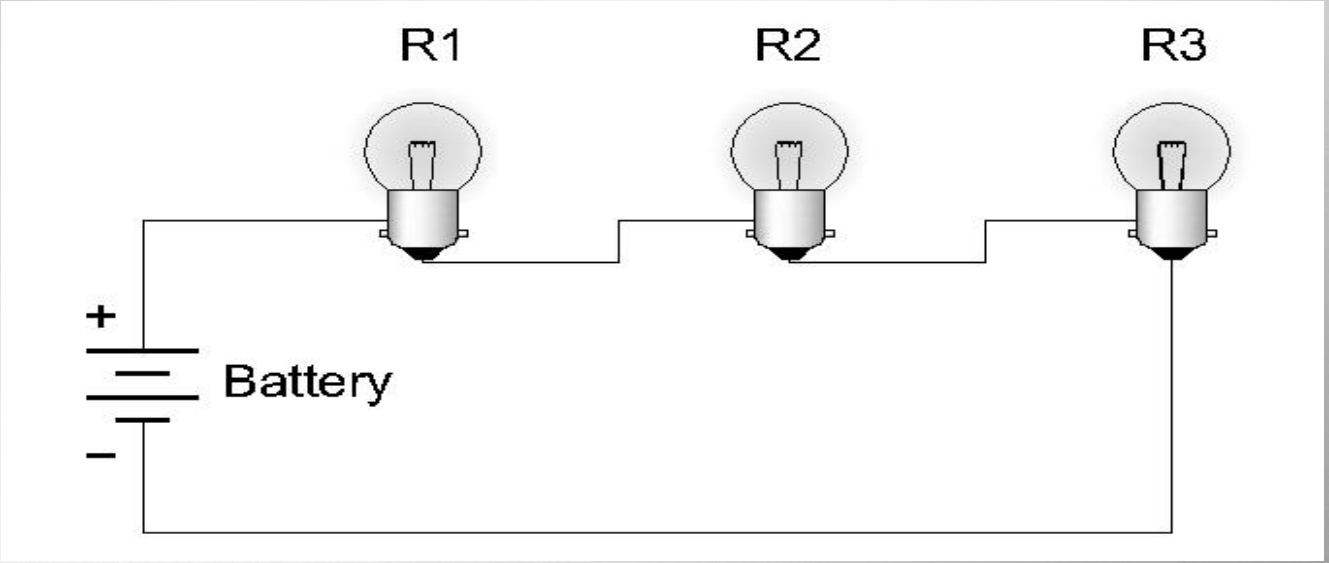
The Electric Circuit: An Electronic Roadmap

- For current to flow, there must be a path from one side of the source of the current to the other side of the source – this path is called a circuit.
  - There must be a hose (conductive path) through which the water (current) can flow.
- The following are some vocabulary words that help describe an electronic circuit.

Series Circuits

•Series circuits provide one and only one path for current flow.



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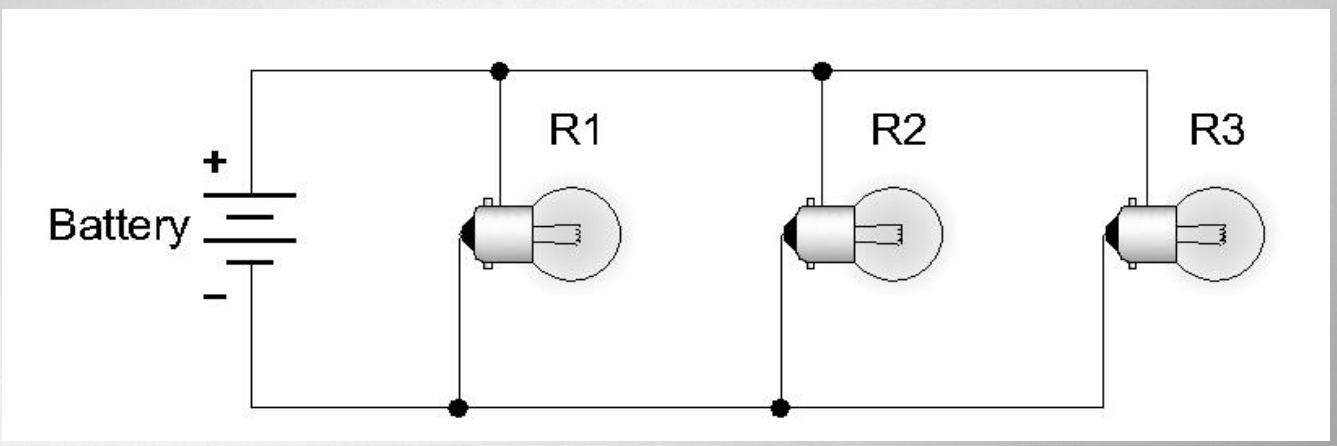
Parallel Circuits

•Parallel circuits provide alternative paths for current flow.



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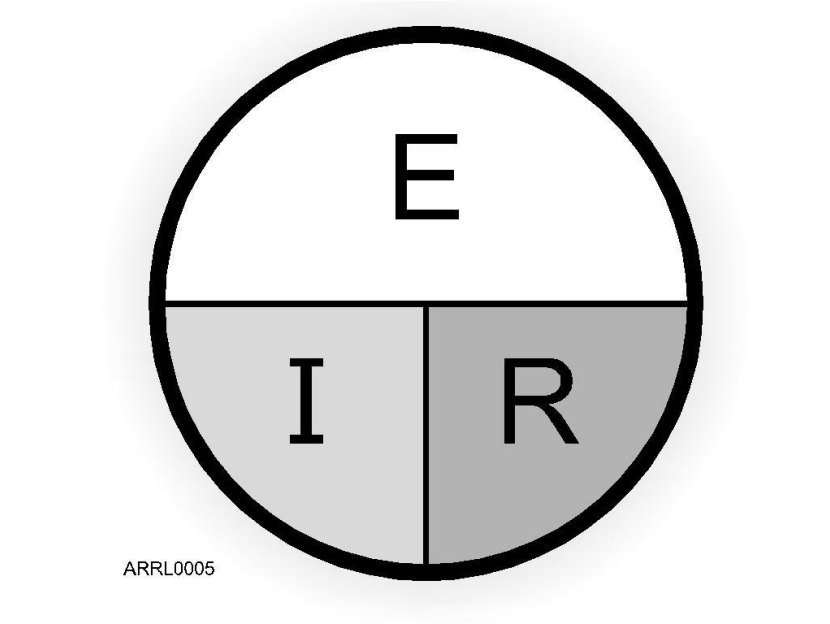
Short and Open Circuits

- When there is an unintentional current path that bypasses areas of the circuit – this is a short circuit condition.
- When the current path is broken so that there is a gap that the electrons cannot jump – this is an open circuit condition.

Ohm's Law



- E is voltage
  - –Units - volts
- I is current
  - –Units - amperes
- R is resistance
  - –Units - ohms

- R = E/I
- I = E/R
- E = I x R

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Moving Electrons - Doing Something Useful

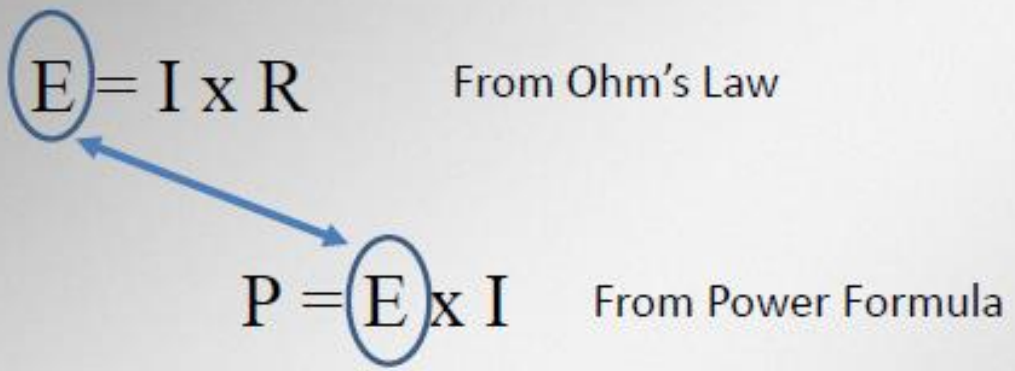
- Any time energy is expended to do something, work is performed.
- When moving electrons do some work, power is consumed.
- Power is measured in the units of Watts.

Power Formula

- Power is defined as the amount of current that is being pushed through a conductor or device to do work.
  - P = E x I
  - E = P/I
  - I = P/E

Power Formula

Power formula and Ohm's Law are interrelated



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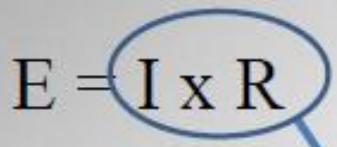
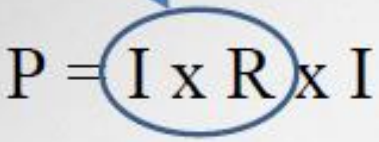
Power Formula

Substitution and some algebra…



From Ohm's Law



From Power Formula

$P = I \times I \times R$ Re-arrange terms

$\mathbf{P = I^2 \times R}$ Remember: I x I = I squared

Power Formula

Substitution and some algebra…

$I = E/R$ From Ohm's Law

$P = E \times E/R$ From Power Formula

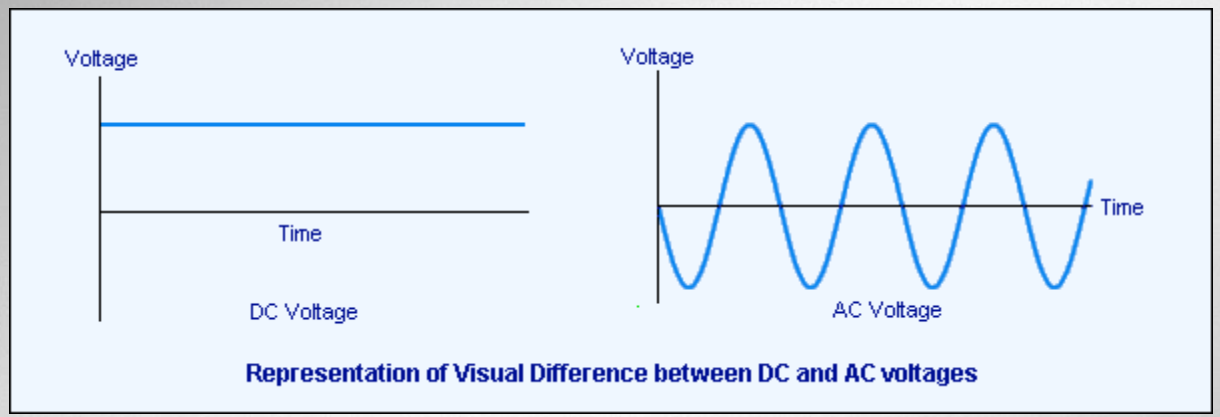
$P = (E \times E) / R$ Group terms together

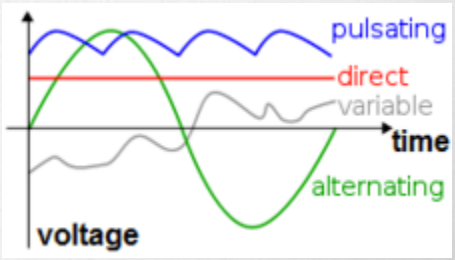
$\mathbf{P = E^2 / R}$ Remember: E x E = E squared

Two Basic Kinds of Current

- When current flows in only one direction, it is called direct current (DC).
  - Batteries are a common source of DC.
  - Most electronic devices are powered by DC.
- When current flows alternatively in one direction then in the opposite direction, it is called alternating current (AC).
  - Your household current is AC.

Two Basic Kinds of Current





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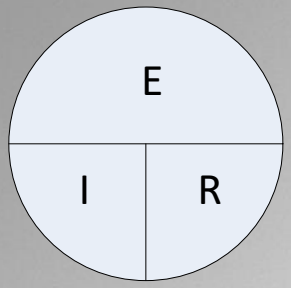
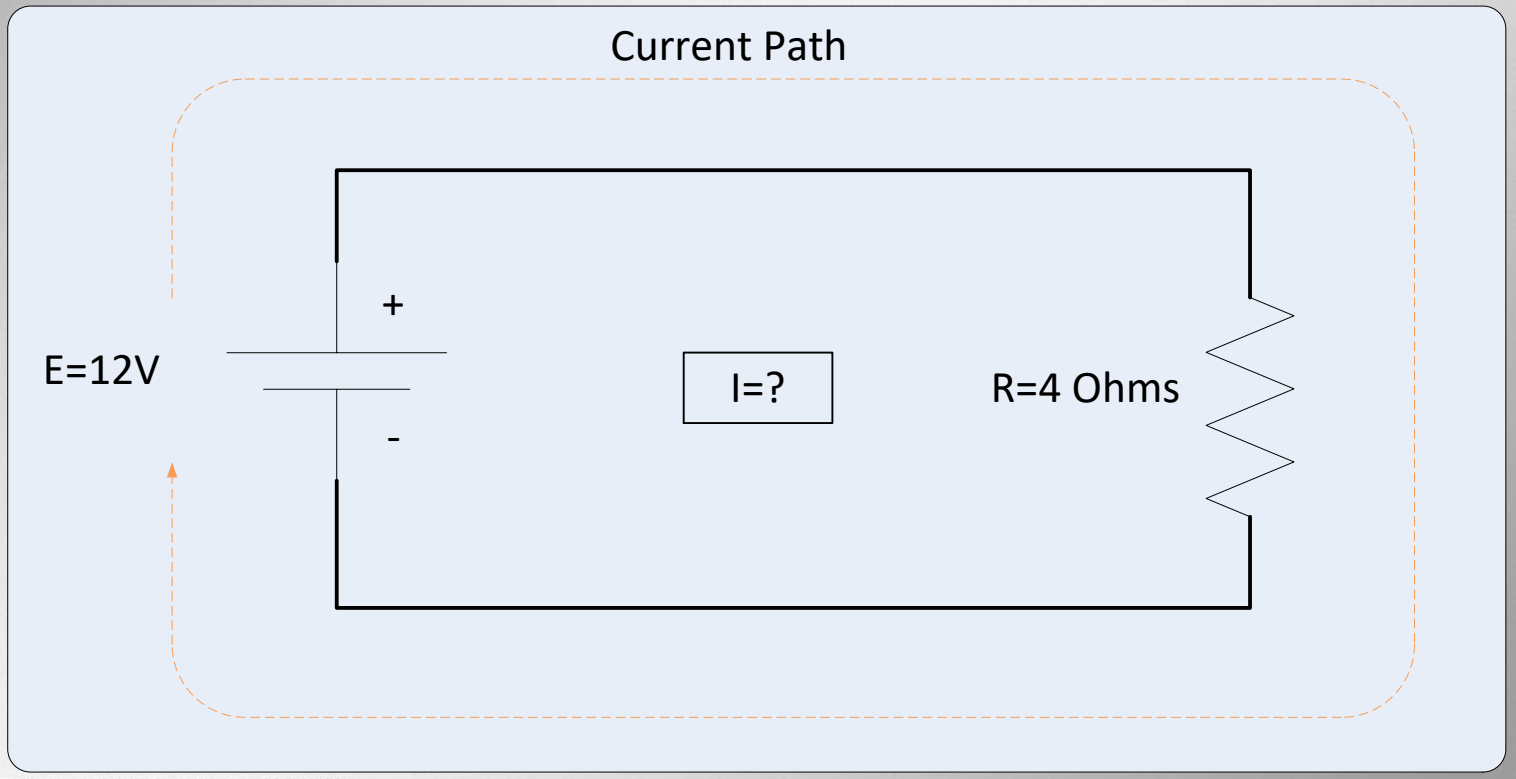
Ohms Law Quiz





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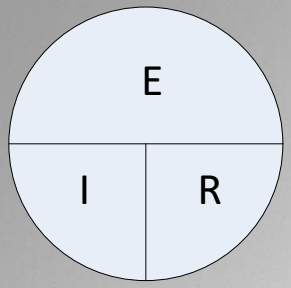

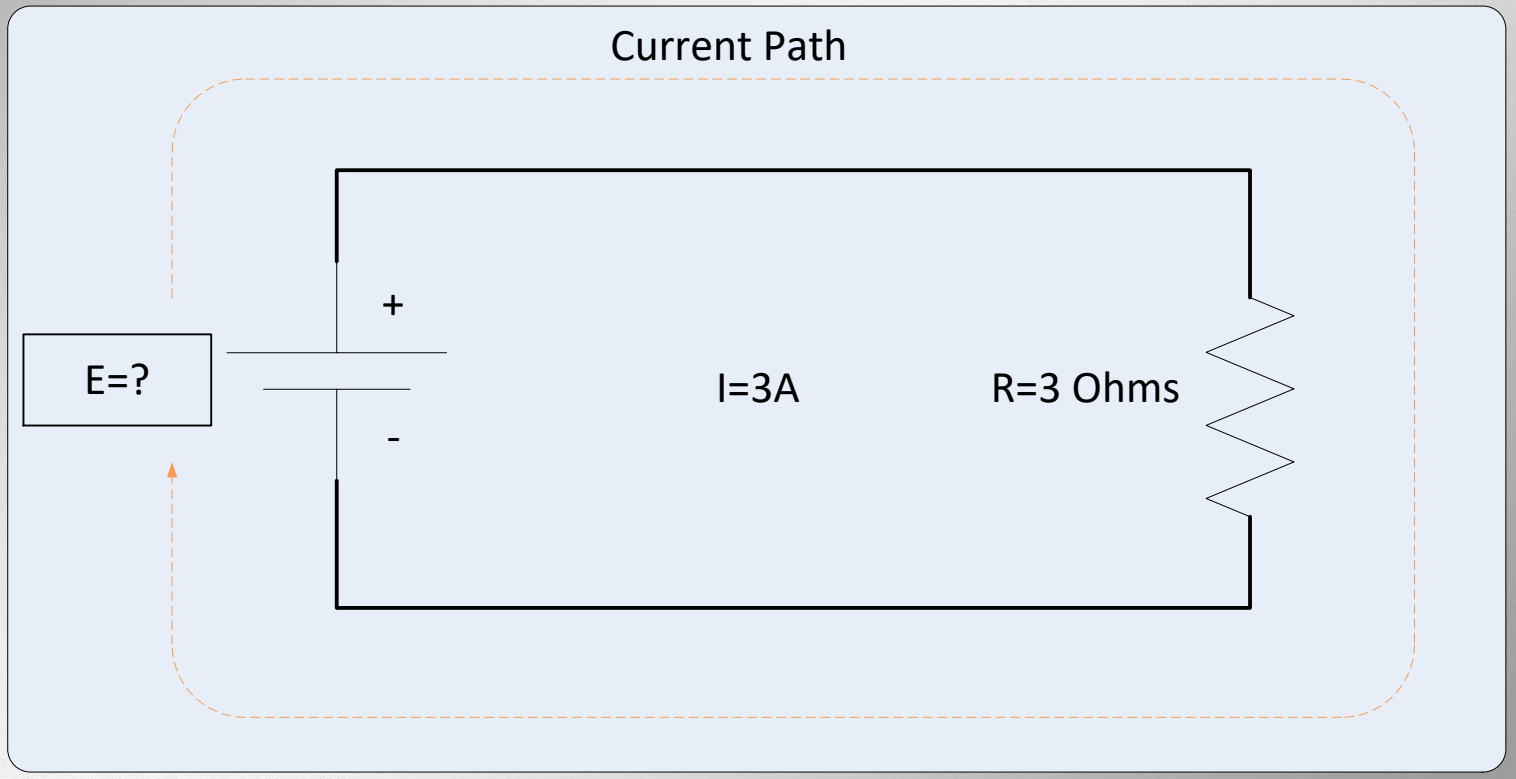

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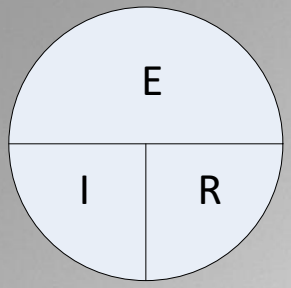

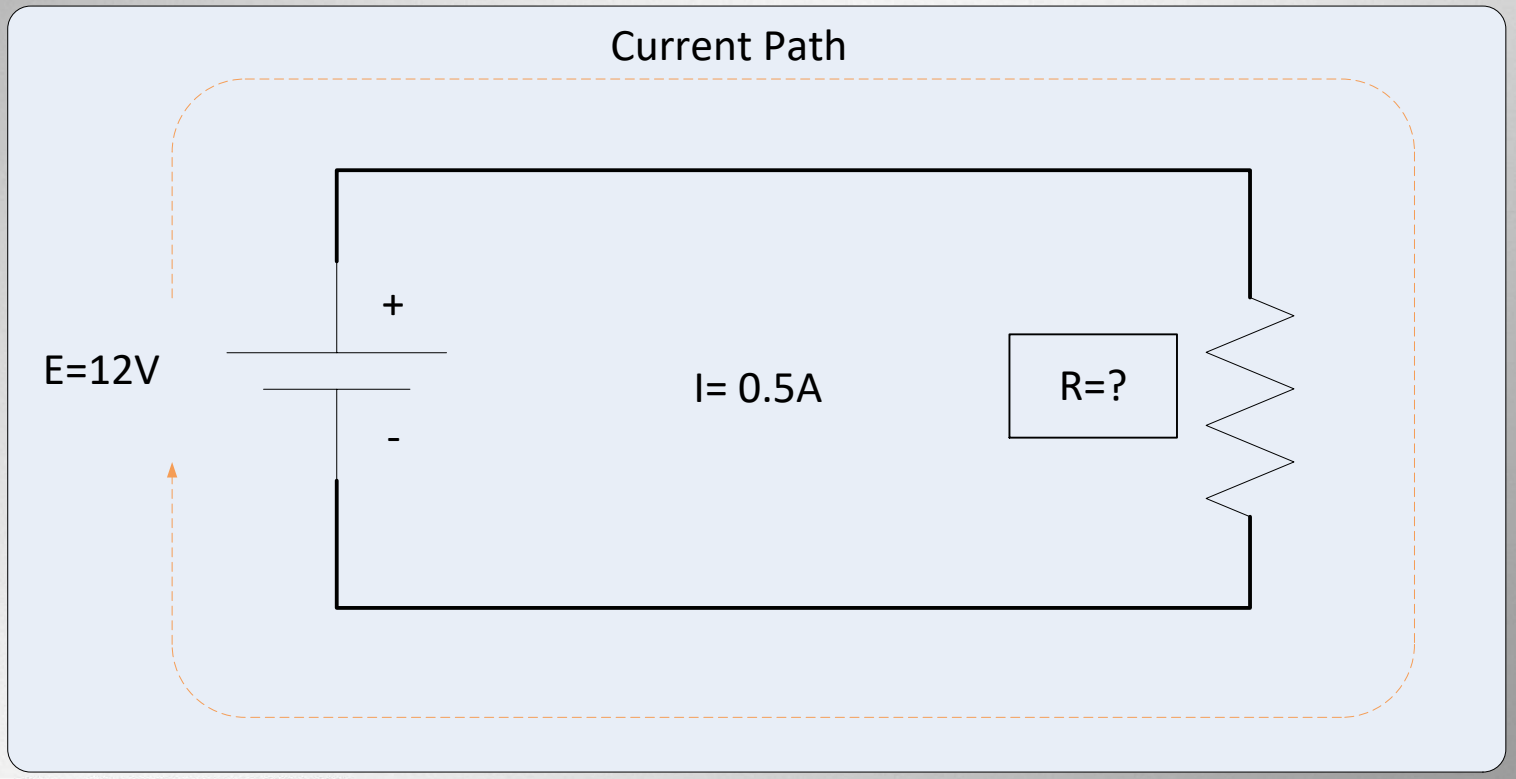

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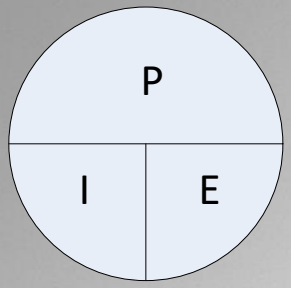
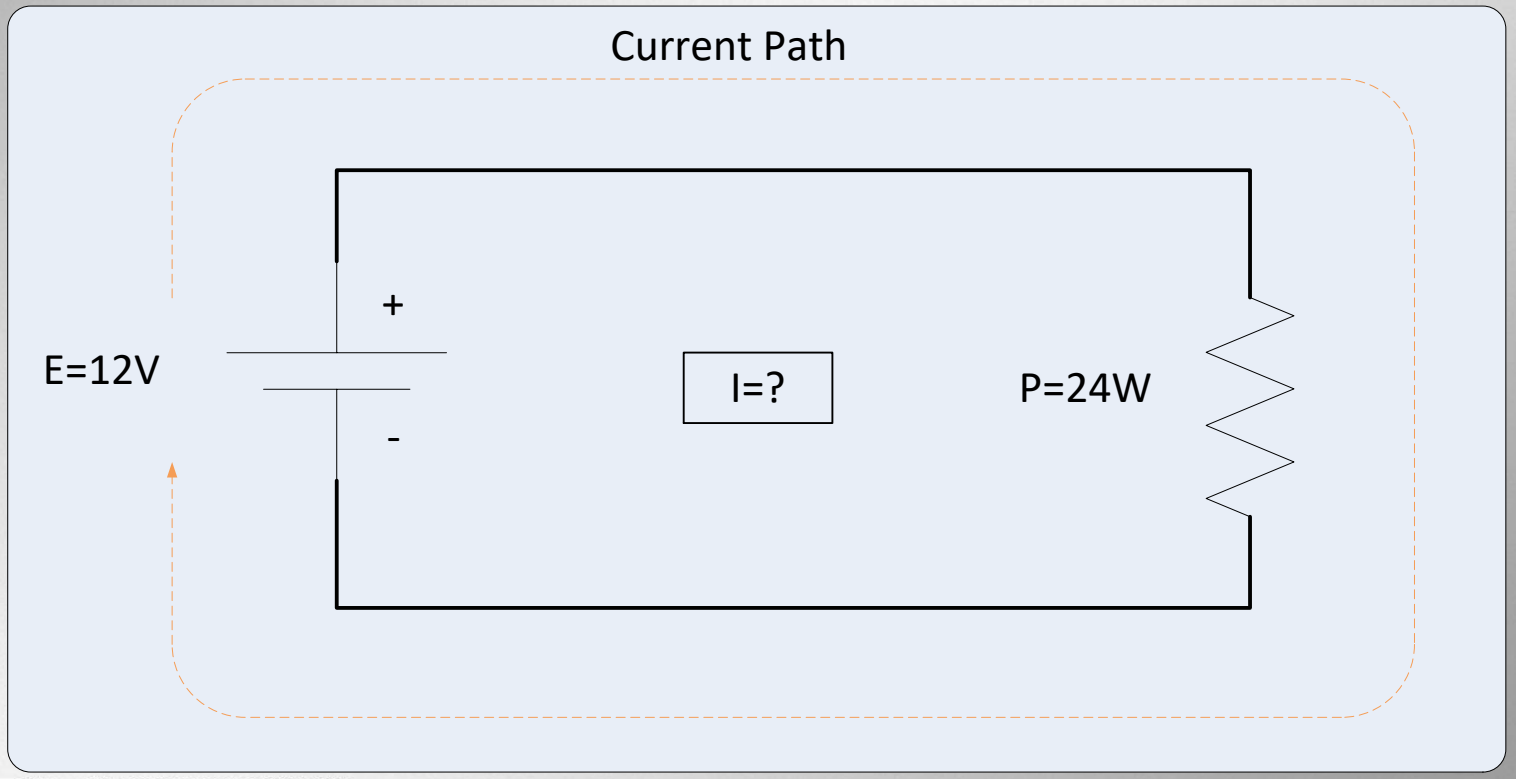
Power Quiz





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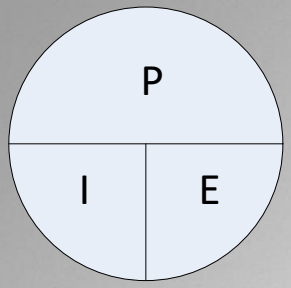

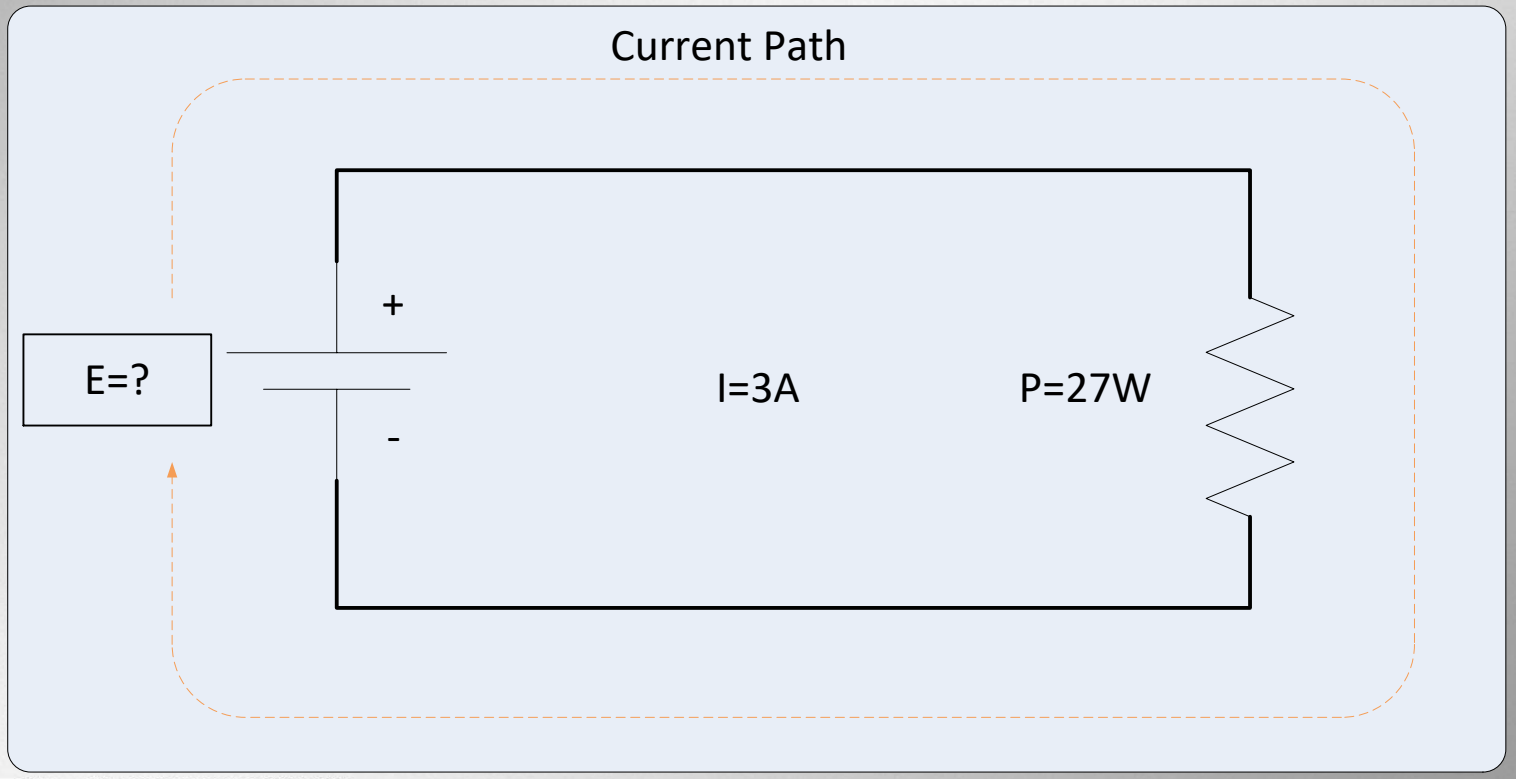

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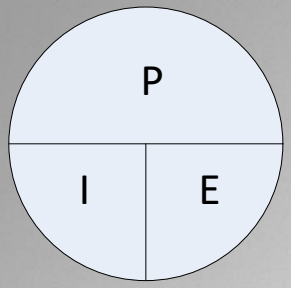

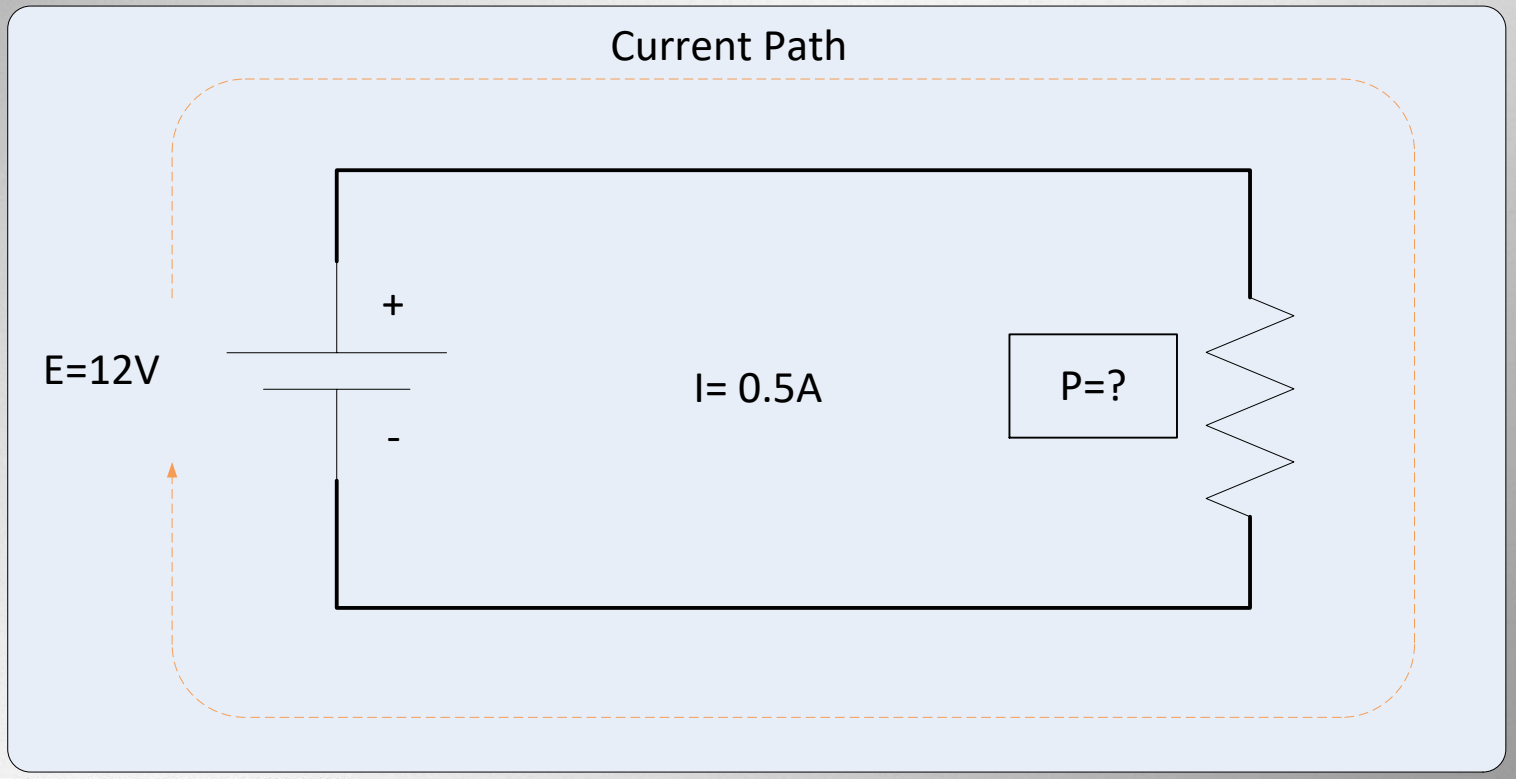

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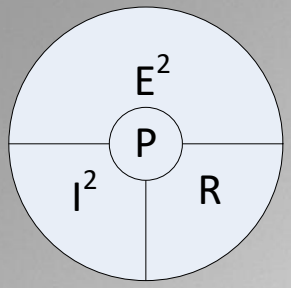
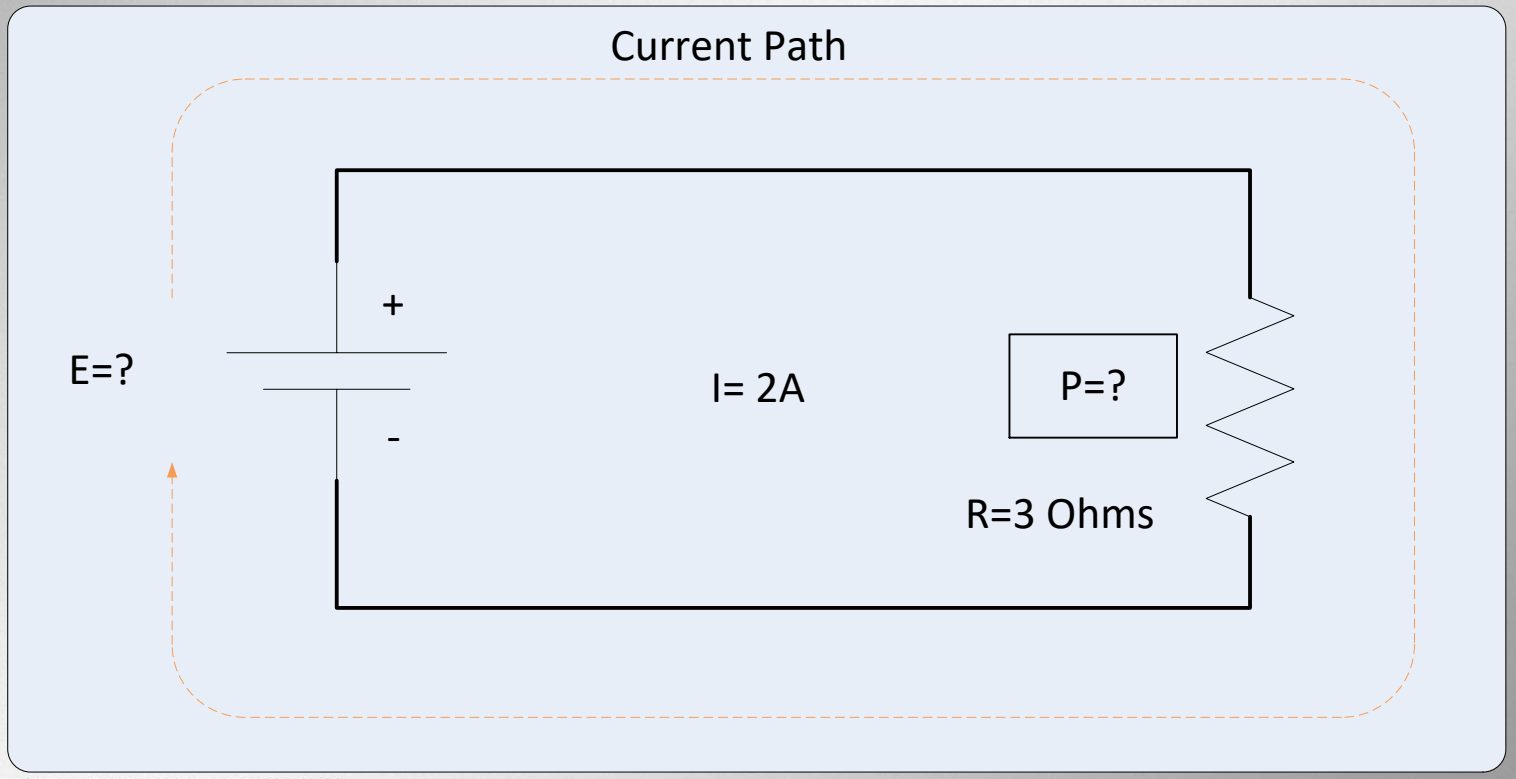


What is the power in the load?



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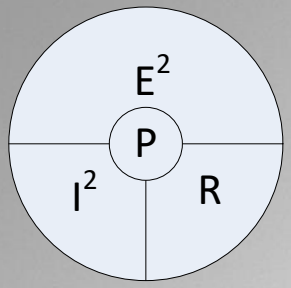

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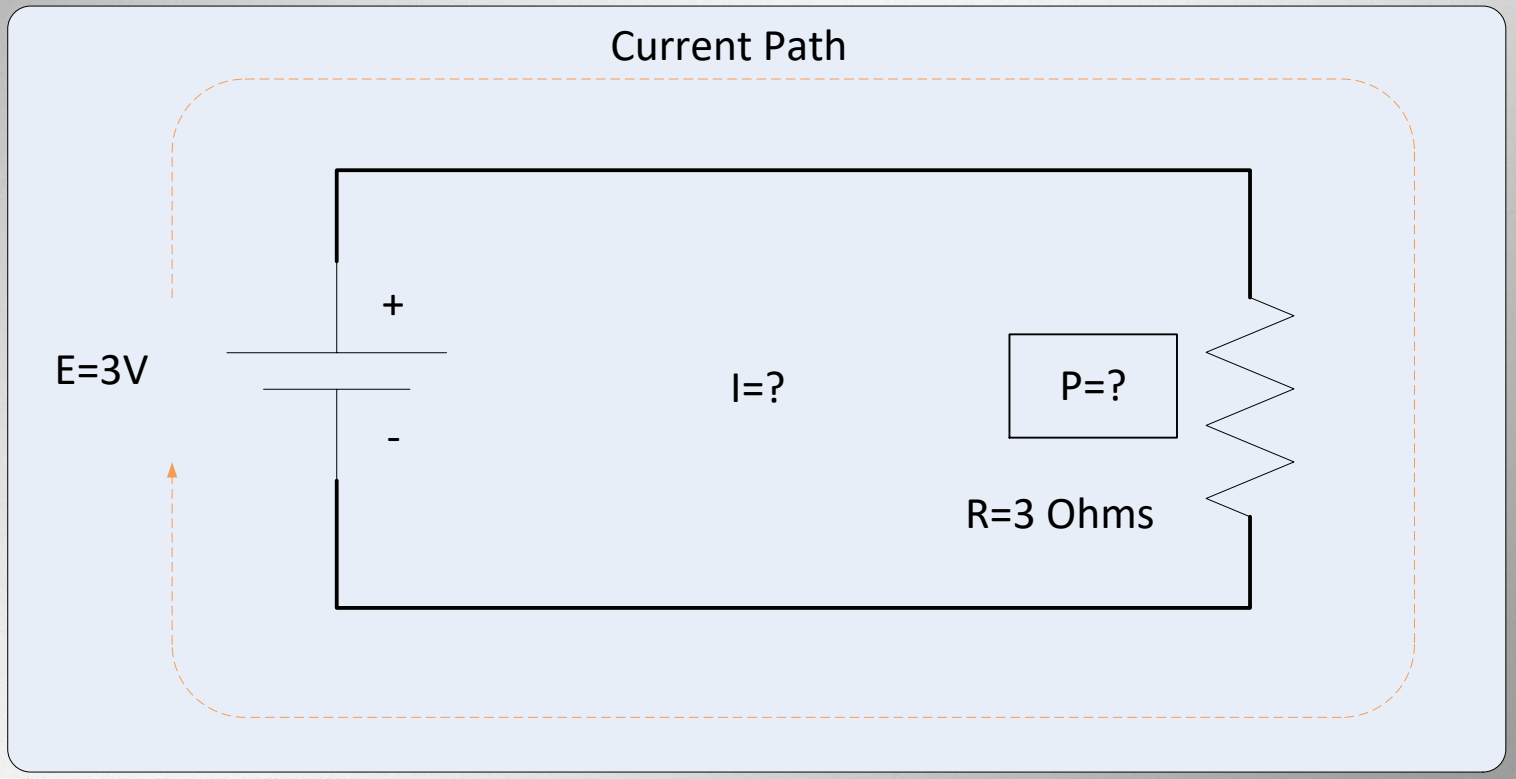

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METRIC UNITS

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Dealing with Very Big and Very Small Numeric Values

- In electronics we deal with incredibly large and incredibly small numbers.
- The international metric system allows for short hand for dealing with the range of values.

Metric Units

Examples:

- Megahertz: MHz
- Kilohertz: kHz
- Microamperes: µA

- 1000kHz=1MHz
- 0.1MHz=100kHz

Table 2-1
International System of Units (SI)—Metric Units

Prefix	*Symbol*	*Multiplication Factor*
Tera	T	10^{12} = 1,000,000,000,000
Giga	G	10^{9} = 1,000,000,000
Mega	M	10^{6} = 1,000,000
Kilo	k	10^{3} = 1000
Hecto	h	10^{2} = 100
Deca	da	10^{1} = 10
Deci	d	10^{-1} = 0.1
Centi	c	10^{-2} = 0.01
Milli	m	10^{-3} = 0.001
Micro	µ	10^{-6} = 0.000001
Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

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Metric Unit Quiz

1000 kHz = ? MHz

0.001 µF = ? pF

1000 ohms = ? k ohms

1 nH = ? µH

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Metric Unit Quiz

k = 1,000 =10^3

1000 x 10^3 = 10^6

M = 1,000,000 = 10^6

So… 1000 kHz = 1 MHz

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Metric Unit Quiz

$\mu = 10^{-6}$

$0.001 \times 10^{-6} = 1000 \times 10^{-12}$

$p = 10^{-12}$

So… $0.001\mu F = 1000pF$

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Metric Unit Quiz

$k = 1000 = 10^3$

So… 1000 ohms = 1k ohms

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Metric Unit Quiz

$n = 10^{-9}$

$\mu = 10^{-6}$

So 1nH = 0.001μH

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