Technician License Course

KE6HEC February 11, 2021

Chapter 3 Part 1

Technician License Course

Chapter 3

Lesson Plan Module - 4

Electricity

Fundamentals of Electricity

- Radios are powered by electricity and radio signals are a form of electrical energy.
- A basic understanding of how we control electricity allows you to better install and operate your radio.

Fundamentals of Electricity

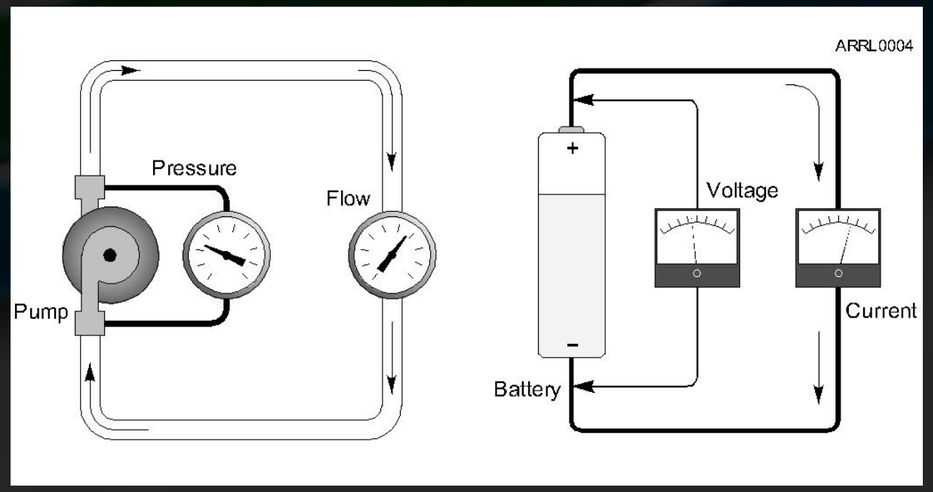
- Electrical charge can be positive or negative.
  - Opposite charges attract each other
- Electrical current is the flow of *electrons*.
  - Electrons are negatively-charged atomic particles, usually surrounding an atom's positively-charged nucleus of protons (positive) and neutrons (neutral – no charge)
  - Electrons move in response to an *electromotive force* and can move independently of atoms

Basic Electrical Concepts

- Resistance: the opposition to the movement of electrons, measured in *ohms* (Ω) by an *ohmmeter* and represented by R in formulas.
- Resistance is like friction and turns electrical energy into heat when current flows.
- *Conductors* permit current flow (low resistance) and *insulators* block current flow (high resistance).

Basic Electrical Concepts

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

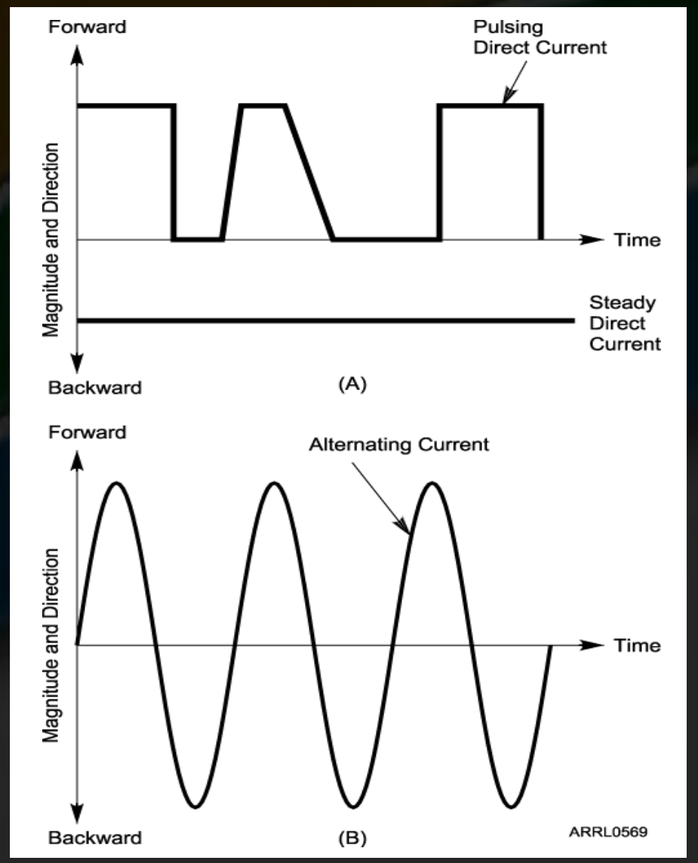


Basic Electrical Concepts

- Voltage from a *source* of electrical energy causes current to flow.
- Resistance is a material's opposition to the flow of current.
- Voltage, current and resistance affect each other. For example, higher voltage (bigger push) causes more current (more flow).

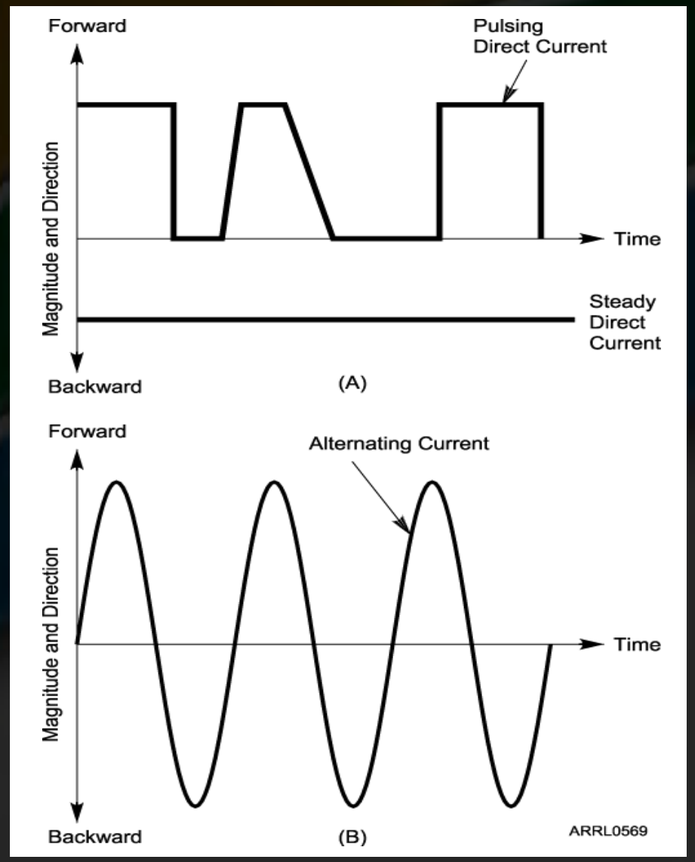
The Two Kinds of Current

- Current that flows in only one direction, is called direct current (dc).
  - –Batteries are a common source of dc.
- Current that flows in one direction then in the opposite direction is called alternating current (ac).
  - –Household current is ac



The Two Kinds of Current

- AC current reverses direction on a regular basis
  - –Each process of reversing is a *cycle*.
  - –The number of cycles per second is *frequency,* measured in hertz (Hz).
- 1 Hz = 1 cycle per second

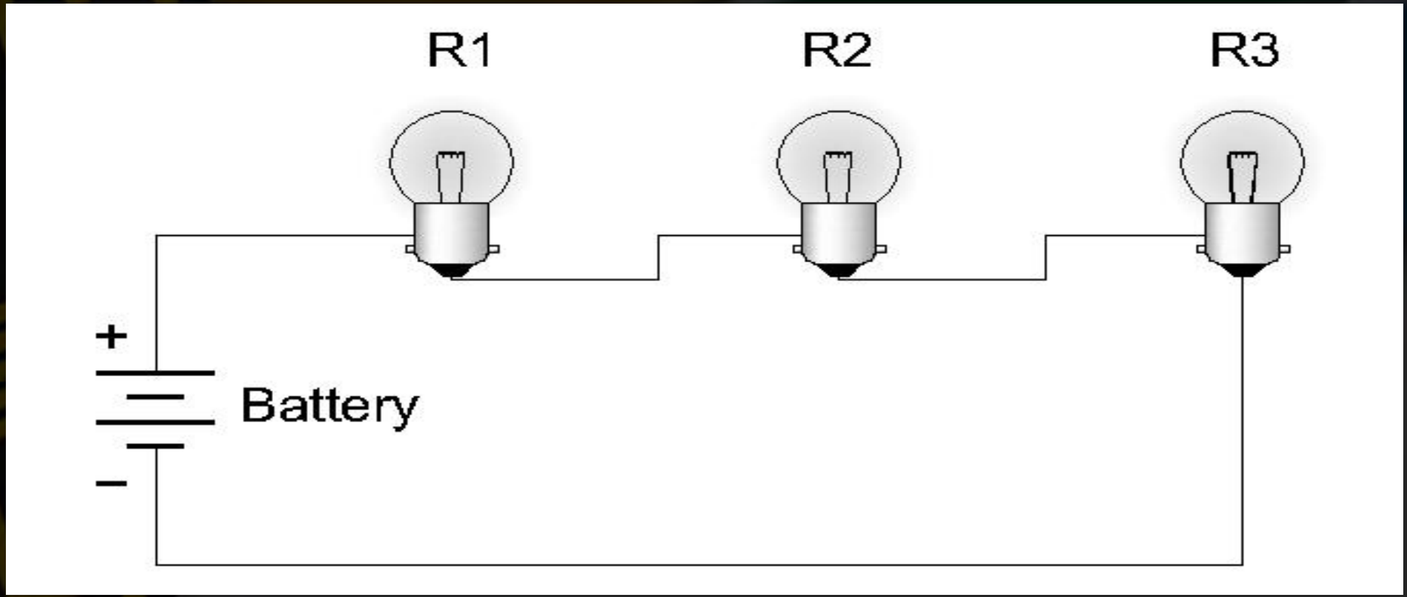


The Electric Circuit: An Electronic Roadmap

- For current to flow, there must be a path from one side of the energy source to the other side of the source – this path is called a *circuit*.
  - There must be a pipe (conductive path) through which the water (current) can flow.
- There are two types of electric circuits.
  - Series and parallel

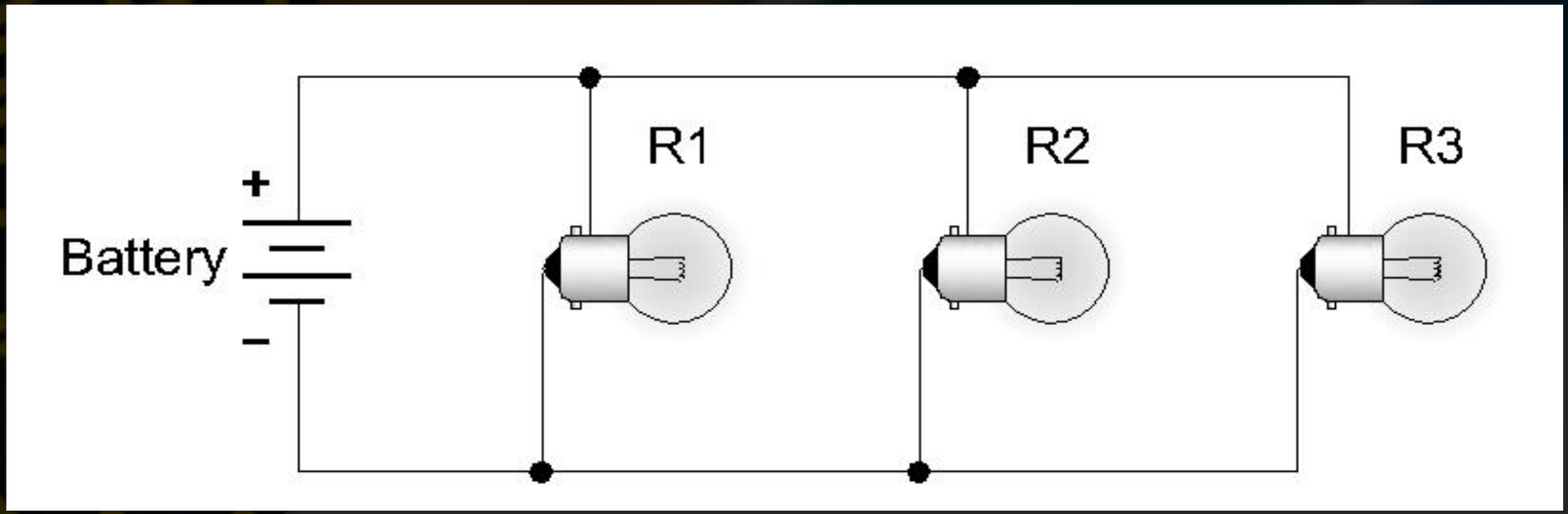
Series Circuits

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



Parallel Circuits

- Parallel circuits provide multiple paths for current flow.



Practice Questions

Electrical current is measured in what unit?

Electrical current is measured in what unit?

Amperes

What is the name for the flow of electrons in an electric circuit?

What is the name for the flow of electrons in an electric circuit

Amperes

What is the name for a current that flows only in one direction?

What is the name for a current that flows only in one direction?

Direct current

What is the electrical term for the electromotive force (EMF) that causes electron flow?

What is the electrical term for the electromotive force (EMF) that causes electron flow?

Voltage

What is a good electrical conductor?

What is a good electrical conductor?

Copper

What is a good electrical insulator?

What is a good electrical insulator?

Glas
s

What is the name for a current that reverses direction on a regular basis?

What is the name for a current that reverses direction on a regular basis?

Alternating current

What is the basic unit of electromotive force?

What is the basic unit of electromotive force?

The volt

What term describes the number of times per second that an alternating current reverses direction?

What term describes the number of times per second that an alternating current reverses direction?

Frequency

Which instrument would you use to measure electric potential or electromotive force?

Which instrument would you use to measure electric potential or electromotive force?

A voltmeter

What is the correct way to connect a voltmeter to a circuit?

What is the correct way to connect a voltmeter to a circuit?

In parallel with the circuit

How is an ammeter usually connected to a circuit?

How is an ammeter usually connected to a circuit?

In series with the circuit

Which instrument is used to measure electric current?

Which instrument is used to measure electric current?

An ammeter

What instrument is used to measure resistance?

What instrument is used to measure resistance?

An ohmmeter

What might damage a multimeter?

What might damage a multimeter?

Attempting to measure voltage when using the resistance setting

What measurements are commonly made using a multimeter?

What measurements are commonly made using a multimeter?

Voltage and resistance

What precautions should be taken when measuring circuit resistance with an ohmmeter?

What precautions should be taken when measuring circuit resistance with an ohmmeter?

Ensure that the circuit is not powered

What precaution should be taken when measuring high voltages with a voltmeter?

What precaution should be taken when measuring high voltages with a voltmeter?

Ensure that the circuit is grounded through the voltmeter

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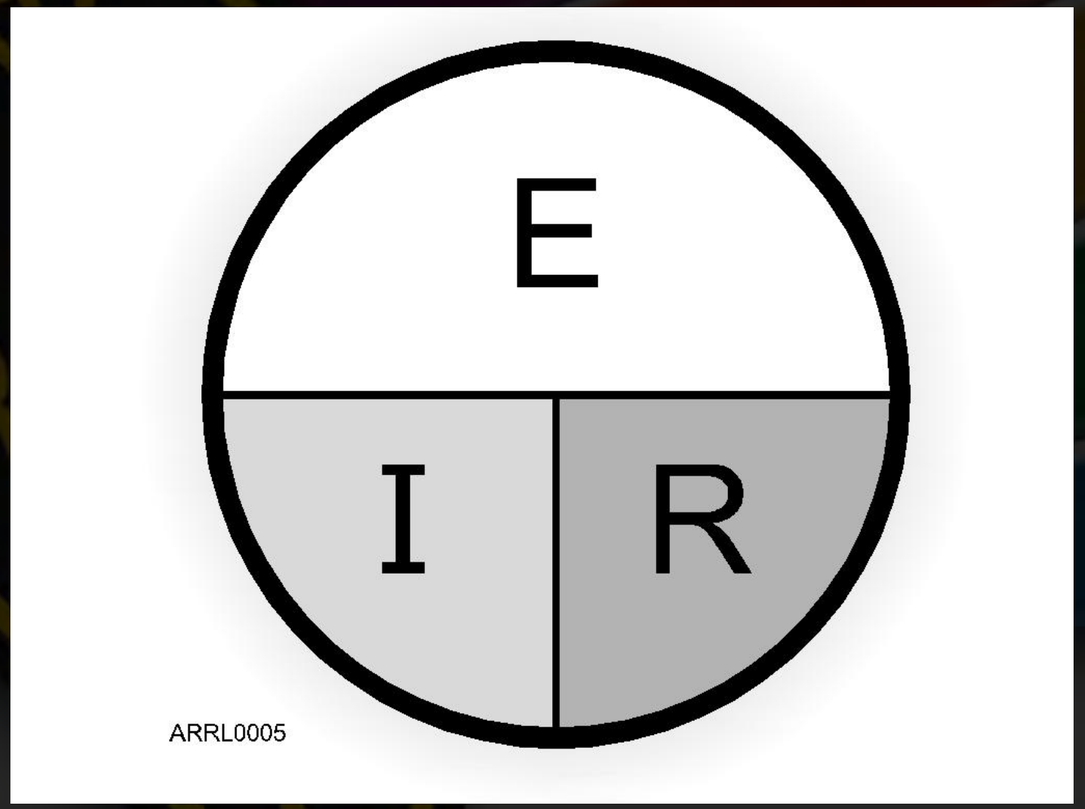
Chapter 3

Lesson Plan Module - 5

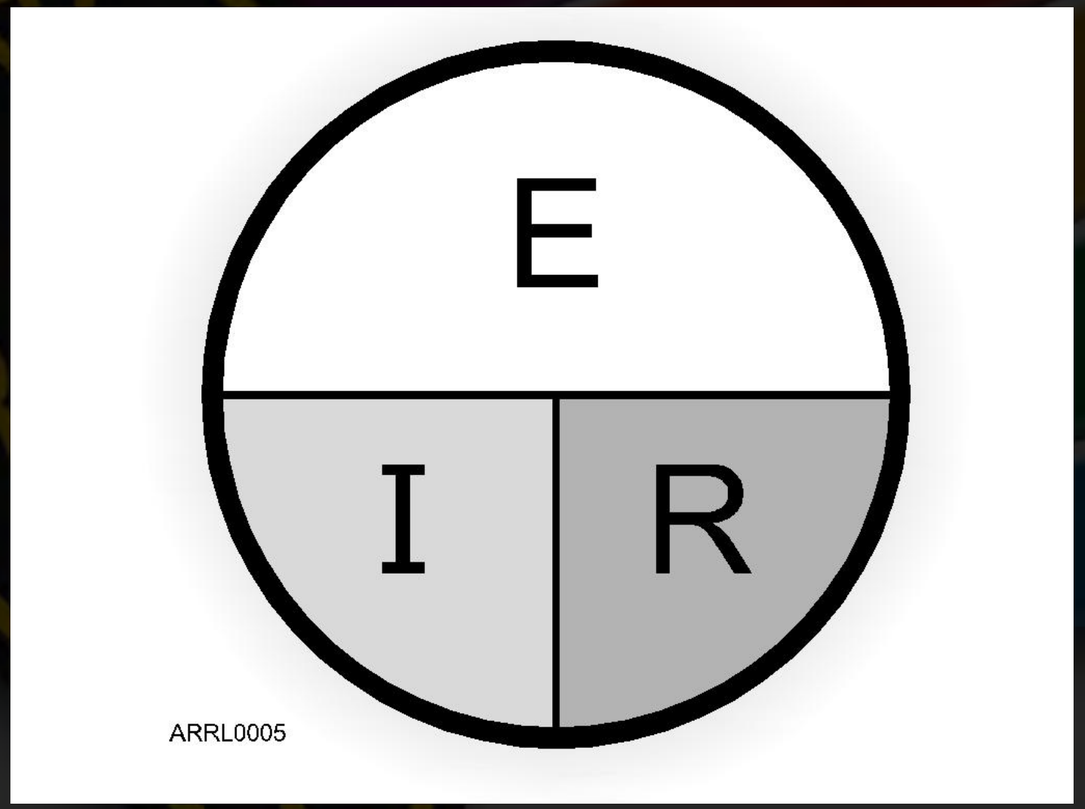
Ohm’s Law, Power and the Metric System

Ohm’s Law

Ohm’s Law

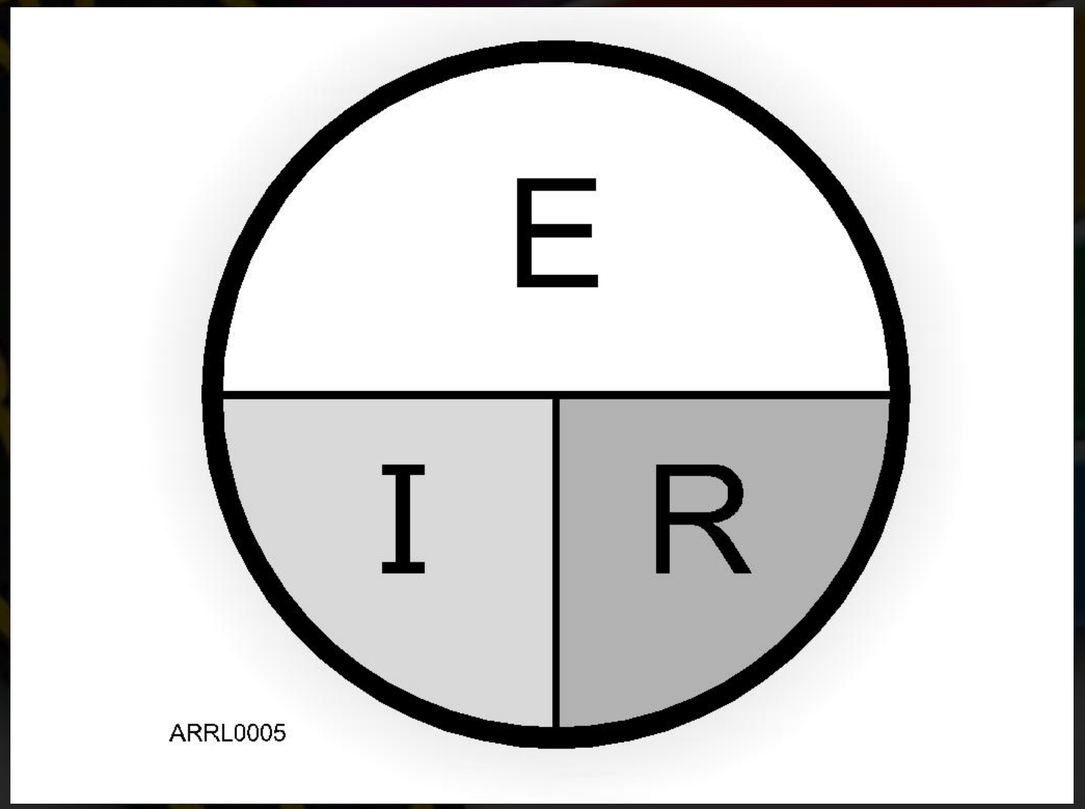


Ohm’s Law



- E represents voltage
  - –Units – volts (V)

Ohm’s Law



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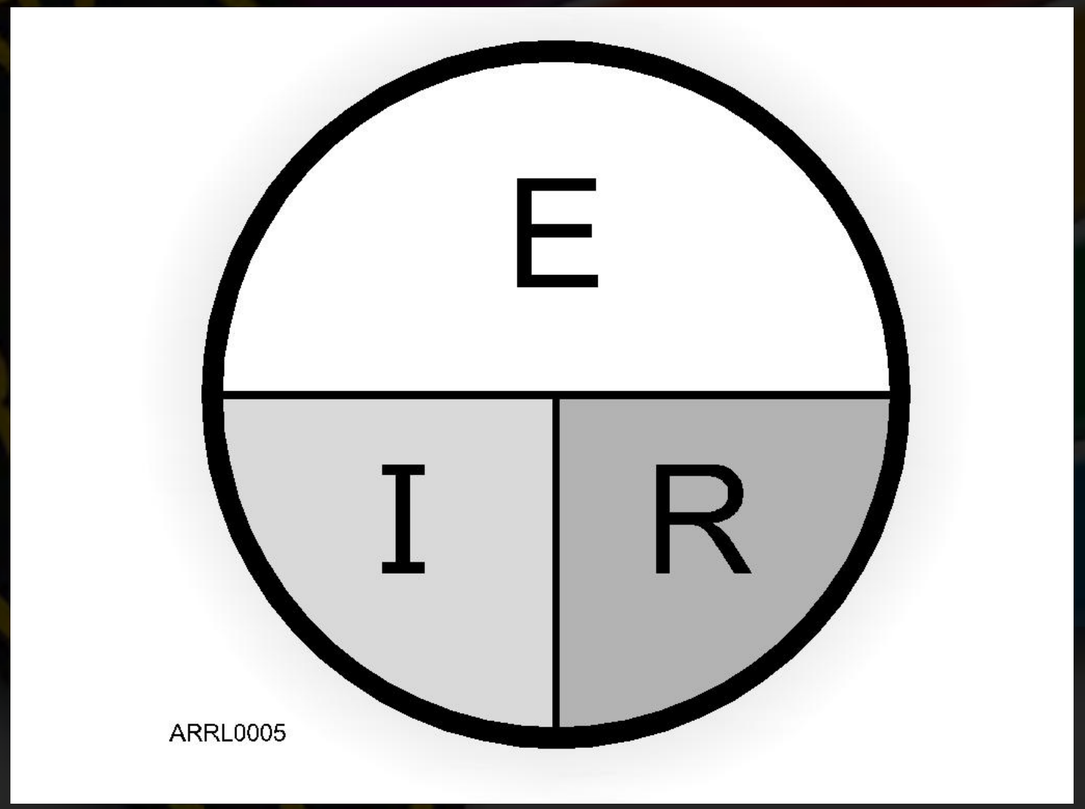
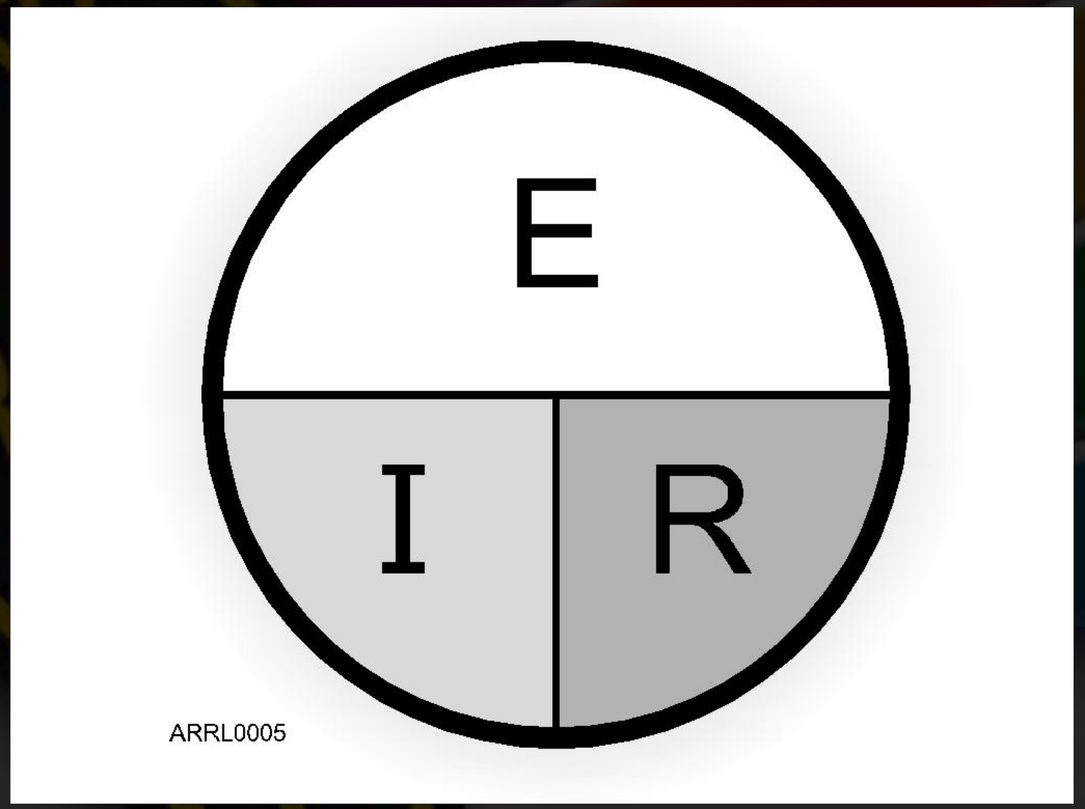
  - –Units – amperes (A)

Ohm’s Law



- E represents voltage
  - –Units – volts (V)
- I represents current
  - –Units – amperes (A)
- R represents resistance
  - –Units – ohms (Ω)

Ohm’s Law



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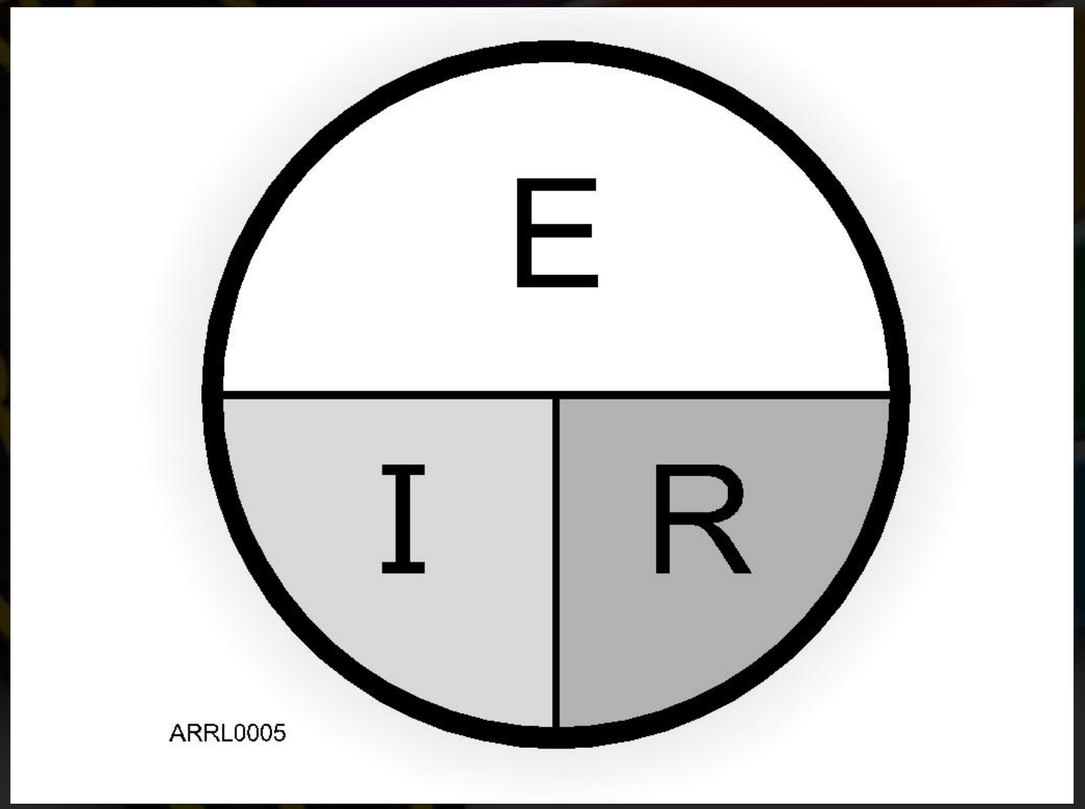
$$R = E / I$$

Ohm's Law



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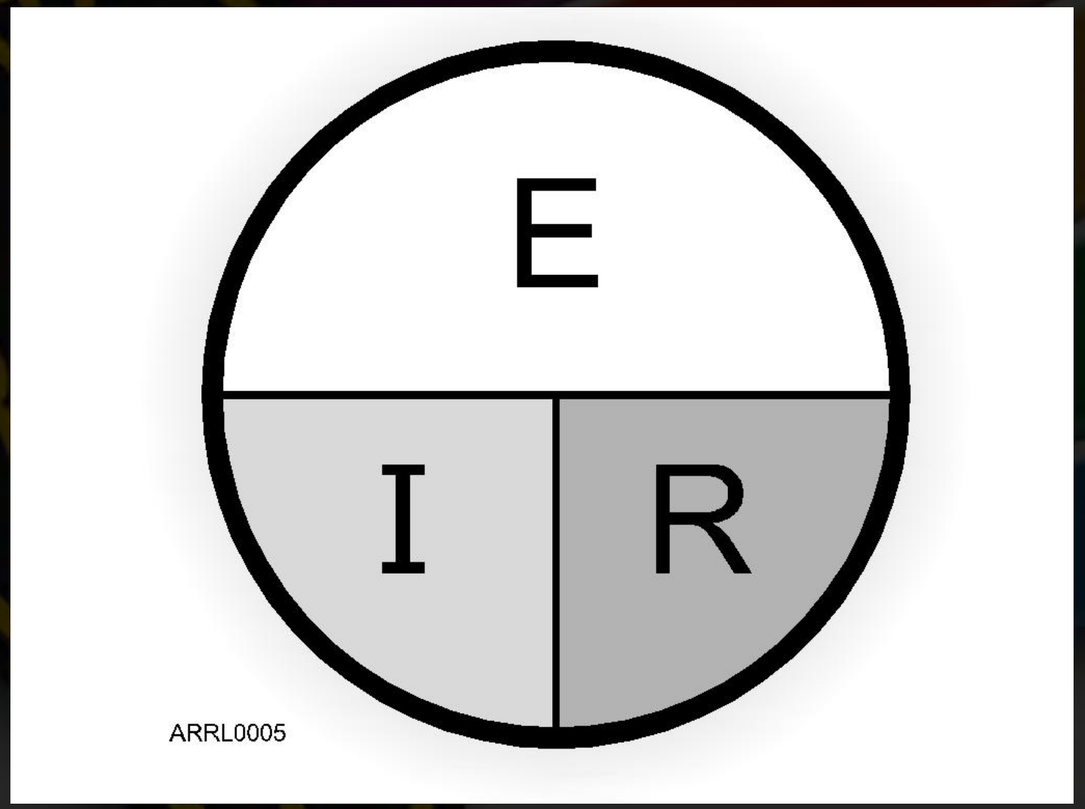
Ohm’s Law



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  - –Units – amperes (A)
- R represents resistance
  - –Units – ohms (Ω)

$$R = E / I$$

$$I = E / R$$

$$E = I \times R$$

Practice Questions

What formula is used to calculate current in a circuit?

What formula is used to calculate current in a circuit?

Current (I) equals voltage (E) divided by resistance (R)

What formula is used to calculate voltage in a circuit?

What formula is used to calculate voltage in a circuit?

Voltage (E) equals current (I) multiplied by resistance (R)

What formula is used to calculate resistance in a circuit?

What formula is used to calculate resistance in a circuit?

Resistance (R) equals voltage (E) divided by current (I)

What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts?

What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts?

30 ohms

What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

8 ohms

What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

3 ohms

What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

1.5 amperes

What is the current flowing through a 100-ohm resistor connected across 200 volts?

What is the current flowing through a 100-ohm resistor connected across 200 volts?

2 amperes

What is the current flowing through a 24-ohm resistor connected across 240 volts?

What is the current flowing through a 24-ohm resistor connected across 240 volts?

10 amperes

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

1 volt

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

10 volts

What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

20 volts

Power - Electrons Doing Work and Expending Energy

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- Any time energy is expended, power is consumed.

Power - Electrons Doing Work and Expending Energy

- Any time energy is expended, power is consumed.
- Electrons moving through resistance expend electrical energy and consume power.

Power - Electrons Doing Work and Expending Energy

- Any time energy is expended, power is consumed.
- Electrons moving through resistance expend electrical energy and consume power.
- Power is the rate at which energy is consumed.

Power - Electrons Doing Work and Expending Energy

- Any time energy is expended, power is consumed.
- Electrons moving through resistance expend electrical energy and consume power.
- Power is the rate at which energy is consumed.
- Power is measured in units of watts (W).

Power Equation

Power Equation

- Power is calculated as the product of voltage and current

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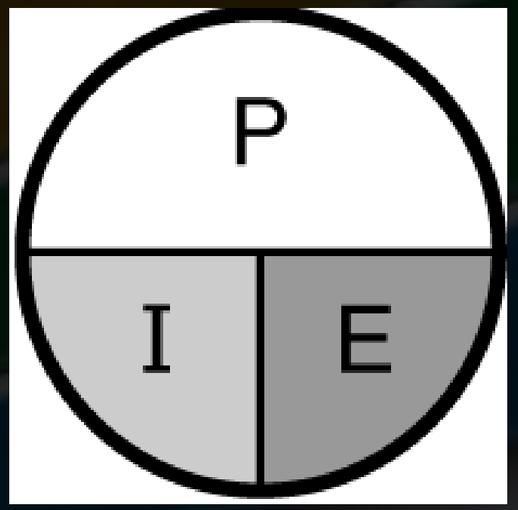
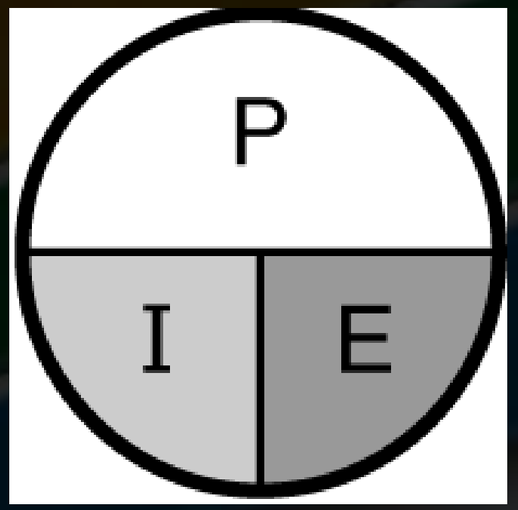
- Power is calculated as the product of voltage and current



Power Equation

- Power is calculated as the product of voltage and current

  P = E x I

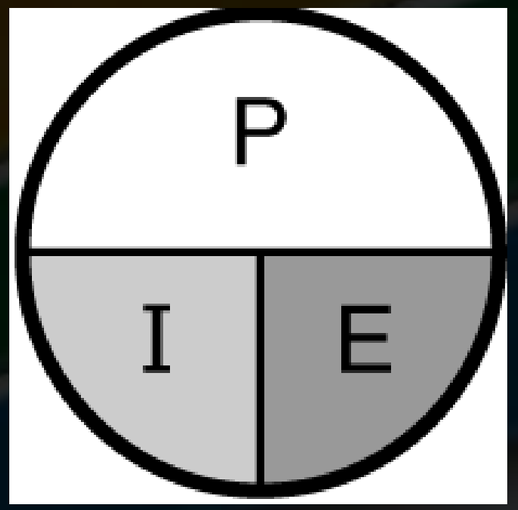


Power Equation

- Power is calculated as the product of voltage and current

  P = E x I

  E = P / I



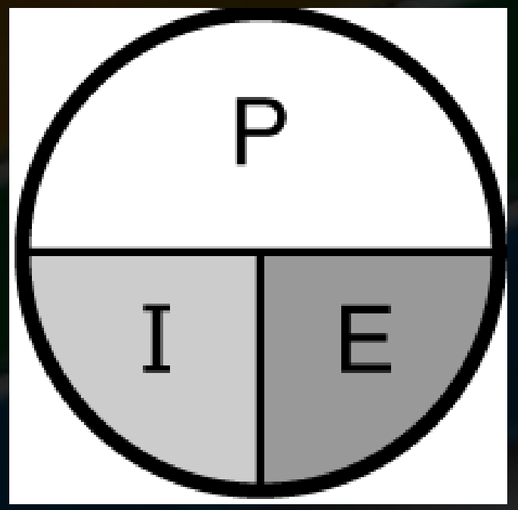
Power Equation

- Power is calculated as the product of voltage and current

  P = E x I

  E = P / I

  I = P / E



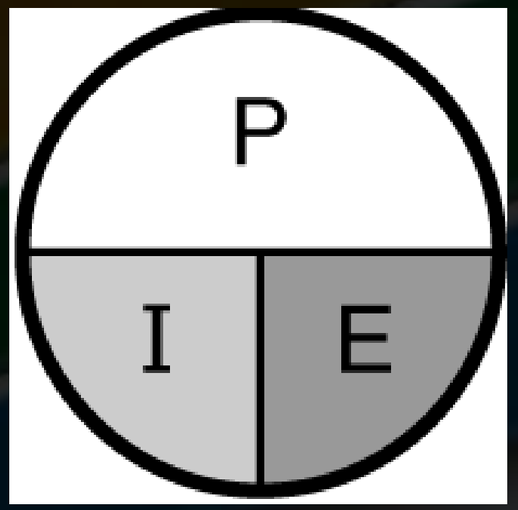
Power Equation

- Power is calculated as the product of voltage and current

  $P = E \times I$

  $E = P / I$

  $I = P / E$



- Like Ohm's Law, if you know two of the values, you can calculate the third.

Practice Questions

Electrical power is measured in what units?

Electrical power is measured in what units?

Watts

What term describes the rate at which electrical energy is used?

What term describes the rate at which electrical energy is used?

Power

What is the formula used to calculate electrical power in a DC circuit?

What is the formula used to calculate electrical power in a DC circuit?

Power (P) equals voltage (E) multiplied by current (I)

How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes?

How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes?

138 watts

How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes?

How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes?

30 watts

How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts?

How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts?

10 amperes

Metric Prefixes

Metric Prefixes

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

Electrical Units

Electrical Units

Electrical Units and Their Namesakes

Unit	*Measures*	*Named for*
Ampere	Current	Andree Marie Ampere (1775 – 1836)
Coulomb	Charge	Charles Augustin Coulomb (1736 – 1806)
Farad	Capacitance	Michael Faraday (1791 – 1867)
Henry	Inductance	Joseph Henry (1797 – 1878)
Hertz	Frequency	Heinrich Hertz (1857 – 1894)
Ohm	Resistance	George Simon Ohm (1787 – 1854)
Watt	Power	James Watt (1736 – 1819)
Volt	Voltage	Alessandro Giuseppe Antonio Anastasio Volta (1745 – 1827)

Practice Questions

How many milliamperes is 1.5 amperes?

How many milliamperes is 1.5 amperes?

1,500 milliamperes

Specify a radio signal frequency of 1,500,000 hertz in kHz?

Specify a radio signal frequency of 1,500,000 hertz in kHz?

1500 kHz

How many volts are equal to one kilovolt?

How many volts are equal to one kilovolt?

One thousand volts

How many volts are equal to one microvolt?

How many volts are equal to one microvolt?

One one-millionth of a volt

If an ammeter calibrated in amperes is used to measure a 3000-milliampere current, what reading would it show?

If an ammeter calibrated in amperes is used to measure a 3000-milliampere current, what reading would it show?

3 amperes

If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?

If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?

3525 kHz

How many microfarads are 1,000,000 picofarads?

How many microfarads are 1,000,000 picofarads?

1 microfarad

If a frequency readout shows a reading of 2425 MHz, what frequency is that in GHz?

If a frequency readout shows a reading of 2425 MHz, what frequency is that in GHz?

2.425 GHz

End Chapter 3 Part 1