FCC Technician License Course

2014-2018 FCC Element 2
Technician Class Question Pool

Presented by:
Tamiami Amateur Radio Club (TARC)

WELCOME

- To the SECOND of 4, 3-hour classes presented by TARC to prepare you for the FCC Technician Class Amateur Radio Service license test.
- Today we will cover Chapter 3 of the ARRL Ham Radio License Manual, 3rd Edition
- Everything you need to know is in this manual

Meet Your Instructors

AndyDurette

KB1HIP

Extra Class

Paul Nienaber

KN4BAR

General Class

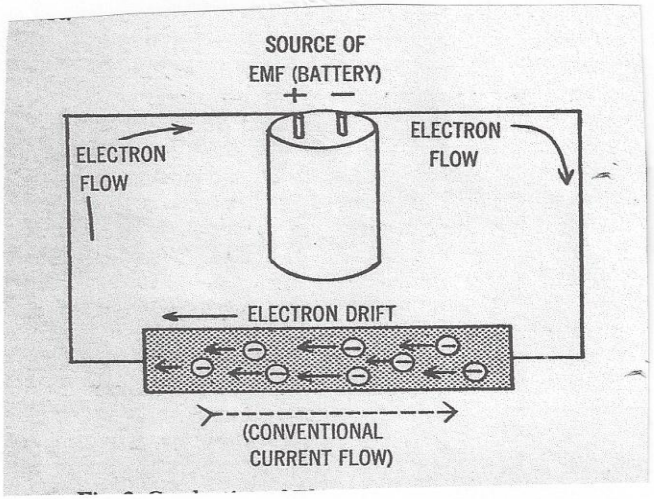
Course Outline

- **Welcome to amateur radio**
- **Radio and Signals Fundamentals**
- **Amateur Radio Equipment (VHF and UHF)**
- **Electricity, Components and Circuits**
- **Amateur Radio Equipment (HF)**
- **Propagation, Antennas and Feedlines**
- **Communicating with other hams**
- **Licensing regulations**
- **Operating regulations**
- **Safety**
- **Test preparation and review**

Electricity, Components and Circuits

- In electronics and radio, we control the flow of electrons to make things happen
- Knowledge of how to control the flow of electrons helps us understand how to operate our radio
- Atoms are the smallest particle that show its chemical and physical properties.
- Atoms consist of a Nucleus (neutron and protons which have a positive charge) and negatively charged particles called electrons that revolve around the Nucleus in fixed orbits.
- The negatively charged electrons balances the positively charged protons so the atom is electrically neutral.
- When a voltage is present across a conductor (ie copper) electrons are dislodged from it's fixed orbit and move in the conductor towards the positive terminal.

Fundamentals of Electricity



Conductors	Insulators
Silver	Mica
Copper	Quartz
Gold	Glass
Aluminium	Ceramics
Brass	Ebonite
Steel	Plastics
Mercury	Air and other gasses
Carbon	Oil
Solutions of salts or acids in water	Pure water

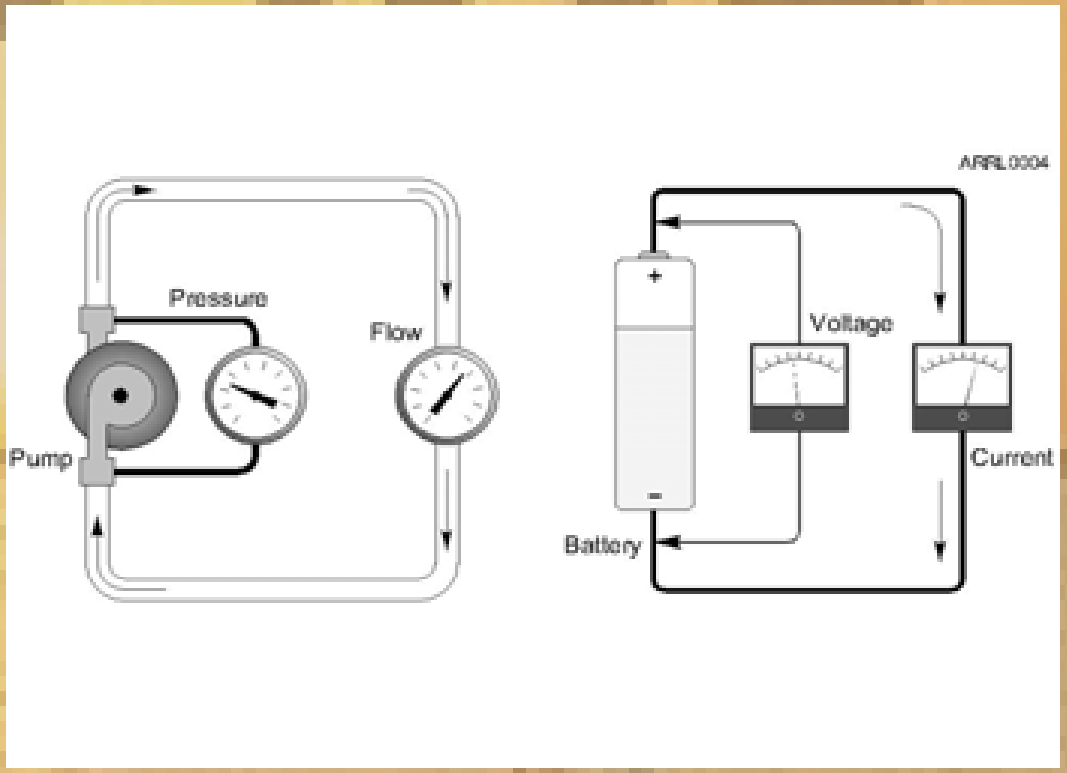
Good Conductors and Insulators

- **A conductor is a material that allows electrons to move with relative freedom**
- **Copper is a good conductor**

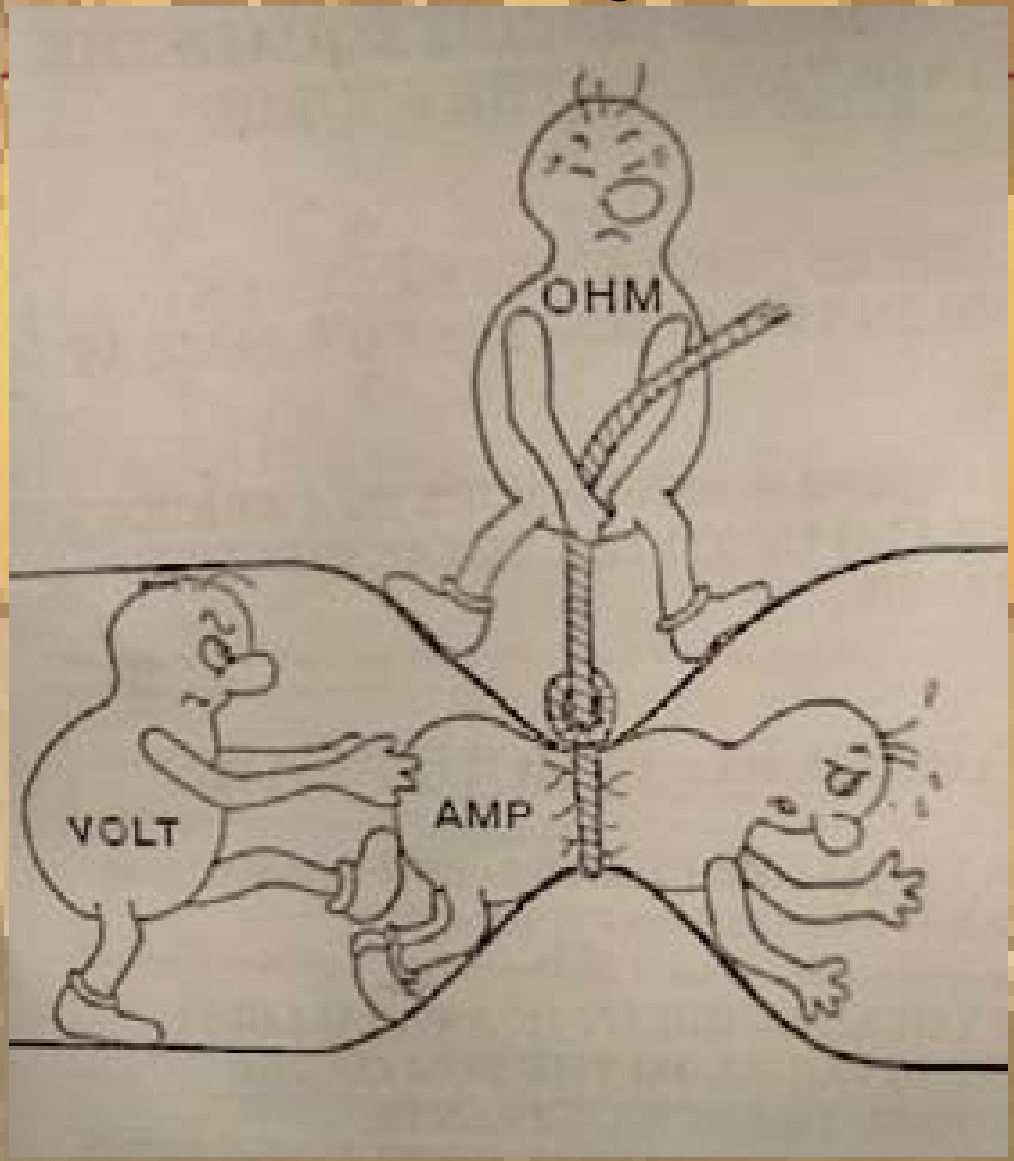
- **The flow of water through a hose is a good analogy to the three characteristics of electricity and how they are related**

Fundamentals of Electricity

- **Voltage and a conductor (resistance/load) must be present to have a current flow**
- **Just like water flowing through a hose, changes in voltage and resistance affect the current flowing**
- **That effect is mathematically expressed by Ohm's Law:**
- **I (current) = E(voltage)/R(resistance)**

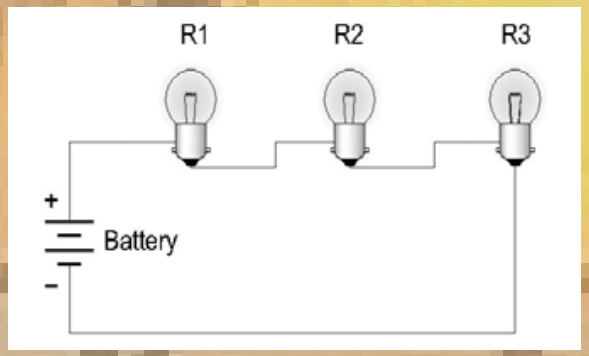


Electricity 101

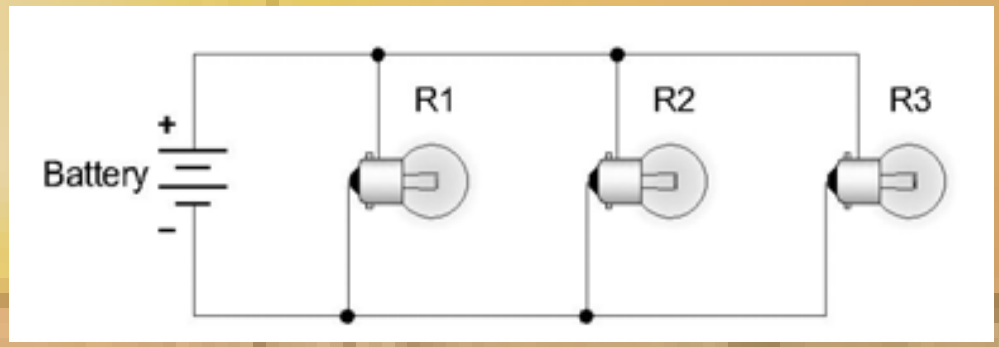


Circuits

- A circuit is a path through which current can flow



Series Circuit



Parallel Circuit

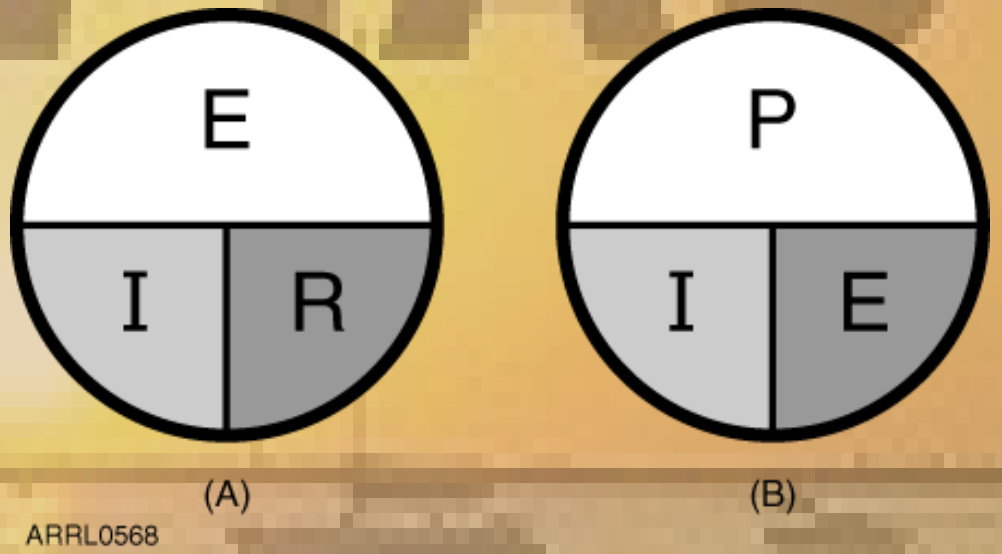
- Short Circuit
- Open Circuit

Resistance

- All materials impede the flow of electrons to some degree
- Measured in Ohms Ω with an ohmmeter
- Insulators resist or prevent the flow of electrons

Characteristics of Electricity

- Three characteristics of Electricity
  - Voltage
  - Current
  - Resistance
- Each can be measured



- I is current, Unit is Ampere
- E is voltage, Unit is Volt
- R is resistance, Unit is Ohm

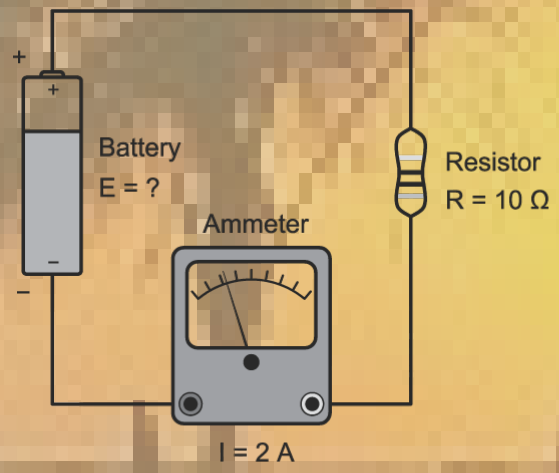
OHM'S LAW

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

$$R = \frac{E}{I}$$ Unit is Ohm

$$E = I \times R$$

Examples of Ohm's Law



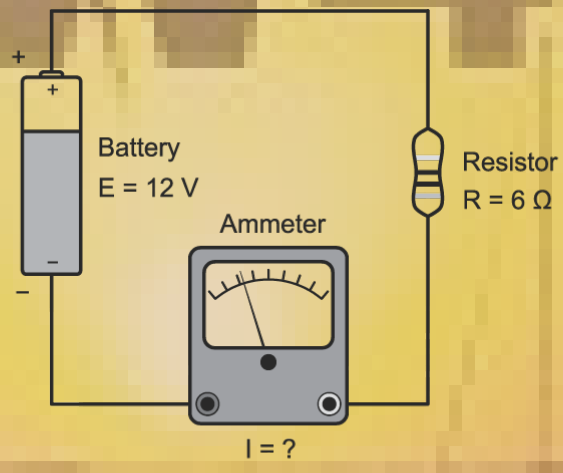
Given: I = 2 Amperes
R = 10 Ohms

Find: E (voltage)

$E = I \times R = 2 \times 10 = 20$ Volts

Voltage Equals 20 Volts

ARRL0006

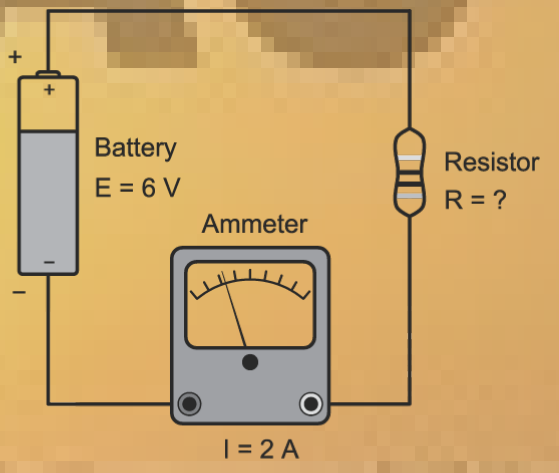


Given: E = 12 Volts
R = 6 Ohms

Find: I (current)

$I = \frac{E}{R} = \frac{12}{6} = 2$ Amps

Current Equals
2 Amperes



Given: E = 6 Volts
I = 2 Amperes

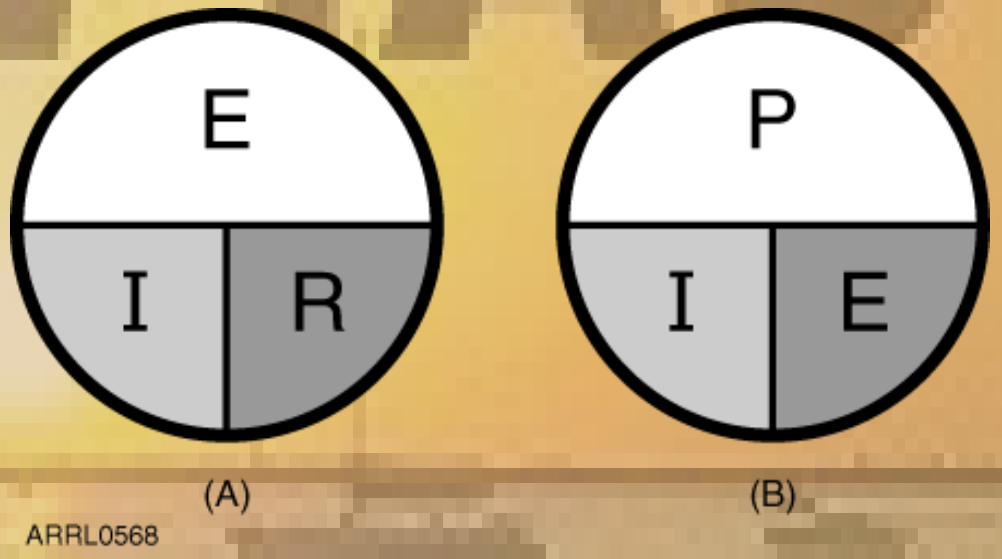
Find: R (resistance)

$R = \frac{E}{I} = \frac{6}{2} = 3$ Ohms

Resistance Equals
3 Ohms

What is Power

- **Anytime energy is expended to do something work is performed**
- **Power is the amount of energy that is pushed through a conductor to a load or device to do that work**



Power

Power is measured in watts

P = I x E, or

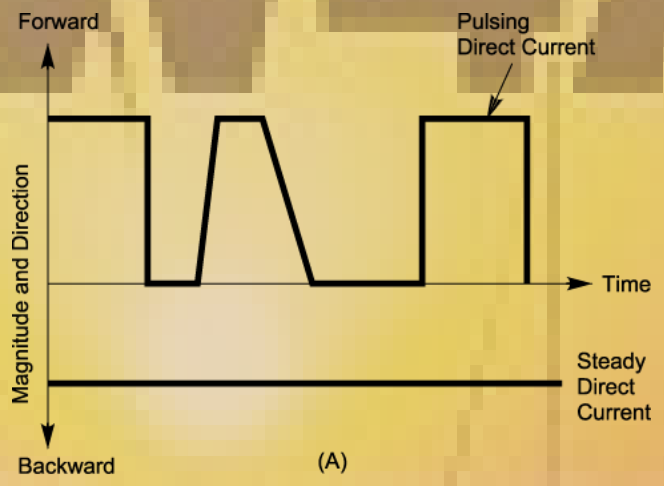
Watts = amps x volts

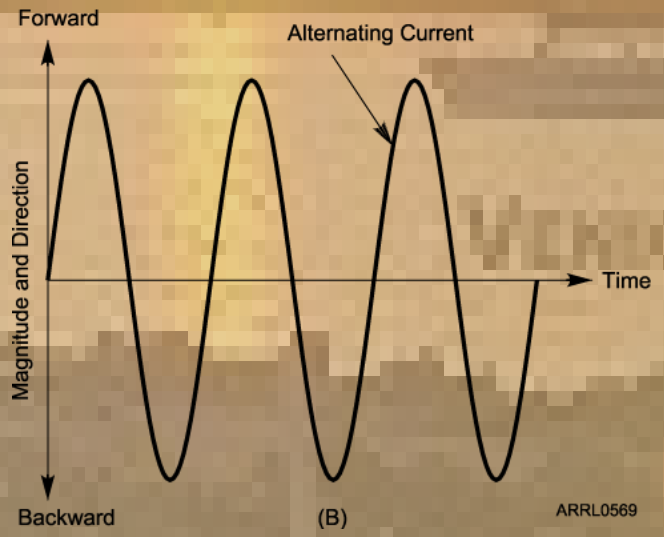
AC and DC Current

- When current flows alternatively in one direction then in the opposite direction, it is called Alternating Current (AC)
- Your household current is AC
- Cross country power lines use AC
- Radio waves are created by AC

- When current flows in only one direction, it is called Direct current (DC)
- Most electronic devices are powered by DC
- Batteries are a source of DC
- Batteries are in flashlights and are used to start your car

AC and DC Current





Test Questions

12 volts (E) at 10 amps (I) produces how much Power (W) ?

12 volts is applied to a 240W motor. How much current is flowing in the conductor?

A 50W motor is drawing 5 amps. What is the applied voltage?

What is the resistance (R) in a circuit drawing 3 amps when 90 volts is applied?

What is the current through a 24 ohm resister connected across 240 volts?

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

Test Questions

12 volts (E) at 10 amps (I) produces how much Power (W) ?

P=EI or 12V x 10A = 120W

12 volts is applied to a 240W motor. How much current is flowing in the conductor?

P=EI or I=P/E = 240W / 12V = 20A

A 50W motor is drawing 5 amps. What is the applied voltage?

E=P/I or 50W / 5A = 10V

What is the resistance (R) in a circuit drawing 3 amps when 90 volts is applied?

E=IR or R=E/I = 90V / 3A = 30Ω

What is the current through a 24 ohm resister connected across 240 volts?

I=E/R or 240V / 24Ω = 10A

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

E=IR or 0.5A x 2Ω = 1V

Electrical Components

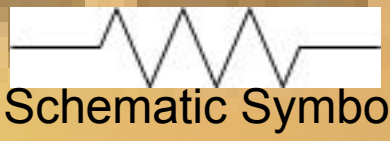
- **Controlling the Flow of Current**
- **To make an electronic device (like a radio) do something useful (like a receiver), we need to control and manipulate the flow of current**
- **There are a number of different electronic components that we use to do this**

Basic Components

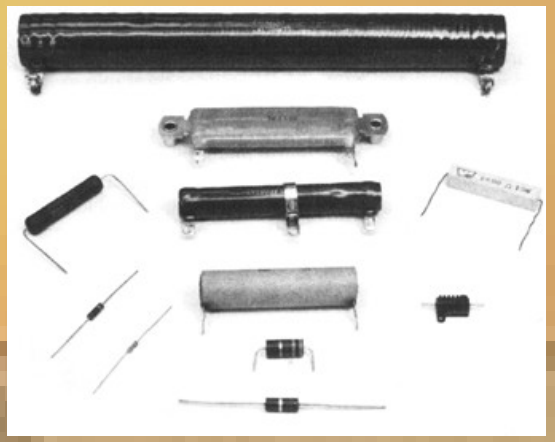
- Resistors
- Capacitors
- Inductors
- Transformers
- Semiconductors
  - Transistors and Integrated Circuits
    - Bipolar junction transistor (BJT)
    - Field-effect transistor (JFET and MOSFET)
  - Diodes
- Switches
- Fuses

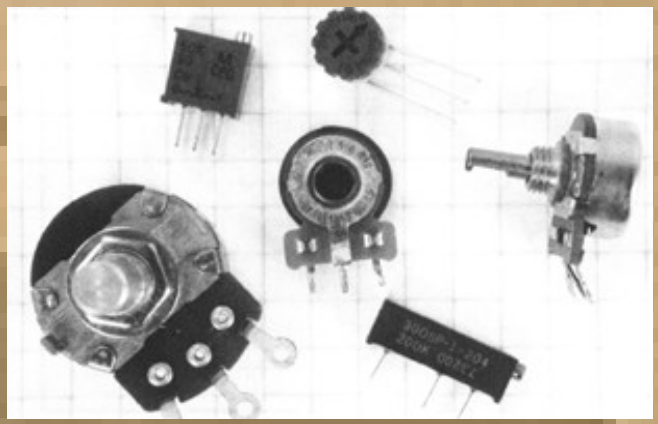
Resistors

- **The function of the resistor is to restrict (limit) the flow of current through it**
- **Measured in Ohms**
- **Can be fixed value or variable**
- **Resistors dissipate energy as heat**



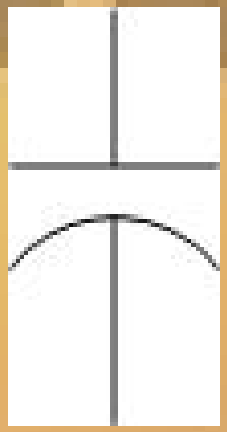
Schematic Symbol





Capacitors

- **The function of the capacitor is to temporarily store electric current**
  - **Like a very temporary storage battery**
  - **Stores energy in an electrostatic field**
- **Measured in pico, nano or micro farads (pF, nF, or µF)**
- **Can be fixed value or variable**
- **Have "electrodes" separated by a "dielectric" material**

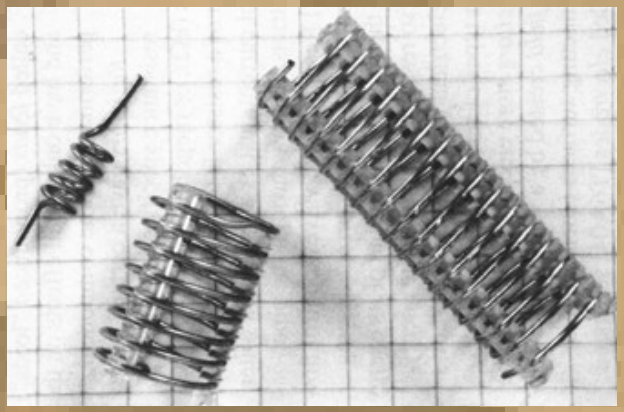


Schematic Symbol

Inductors

- **The function of the inductor is to temporarily store electric current**
- **It is basically a coil of wire that stores or releases energy in a magnetic field**
- **Measured in henrys (H). Can be nano, micro, or millihenrys.**
- **Can be fixed value or variable**

Schematic Symbol



Impedance

- **Impedance** is a measure of a circuits resistance to the AC flow of electricity
- Measured in Ohms as “Z”
- **Reactance** is caused by a phase shift of voltage and current in AC circuits
- Reactance and resistance combine to produce impedance as follows:
  - **Capacitive reactance**
  - **Inductive reactance**
  - **and resistance**

Question

T5C12

What is meant by the term impedance?

A. It is a measure of the opposition to AC current flow in a circuit
B. It is the inverse of resistance
C. It is a measure of the Q or Quality Factor of a component
D. It is a measure of the power handling capability of a component

Question

T5C12

What is meant by the term impedance?

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Question

T5D01

What formula is used to calculate current in a circuit?

A. Current (I) equals voltage (E) multiplied by resistance (R)
B. Current (I) equals voltage (E) divided by resistance (R)
C. Current (I) equals voltage (E) added to resistance (R)
D. Current (I) equals voltage (E) minus resistance (R)

Question

T5D01

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D. Current (I) equals voltage (E) minus resistance (R)

Question

T6C06 (B)
What is component 6?
A. Resistor
B. Capacitor
C. Regulator IC
D. Transistor

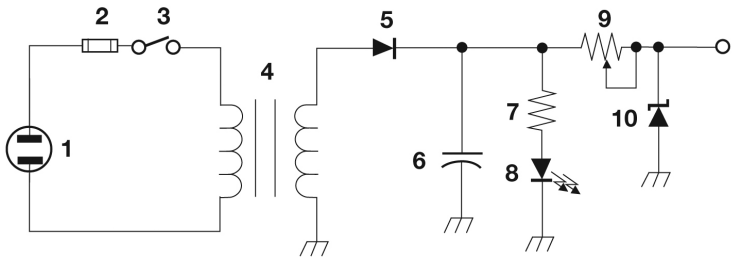


Figure T-2

T6C08 (C)
What is component 9?
A. Variable capacitor
B. Variable inductor
C. Variable resistor
D. Variable transformer

Question

T6C06 (B)
What is component 6?
A. Resistor
B. Capacitor
C. Regulator IC
D. Transistor

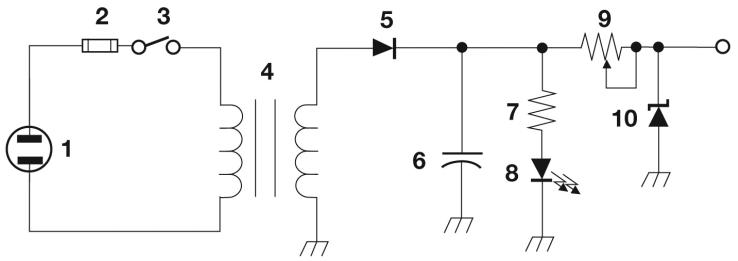


Figure T-2

T6C08 (C)
What is component 9?
A. Variable capacitor
B. Variable inductor
C. Variable resistor
D. Variable transformer

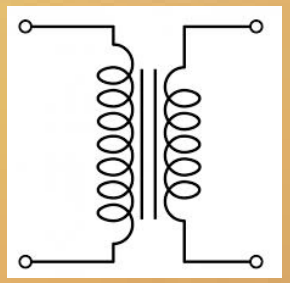
Resonance

- Circuits that contain capacitors and inductors will have one "**resonant frequency**"
- It is the point where inductive reactance and capacitive reactance exactly cancel each other out
- The AC current and voltage are back in phase
- When canceled you have a **resonant or tuned circuit**

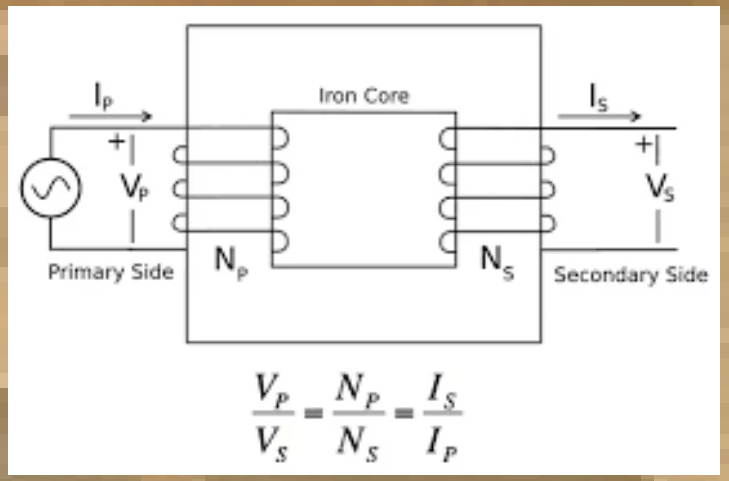
- Acts like a "**filter**" either passing or rejecting signals at its resonant frequency

Transformers

- Made from two or more inductors that share their stored energy
- Changes the combination of voltage and current



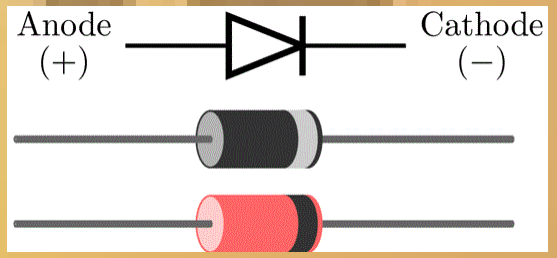
Schematic Symbol



- Example: the wall charger for your cell phone is a transformer

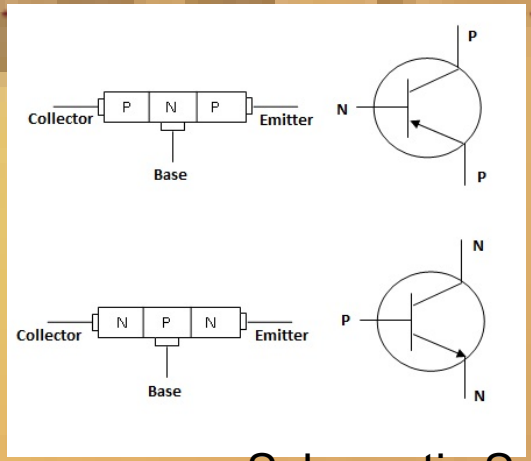
Diodes

- Welcome to the world of semiconductors
- Diodes only allow current to flow in one direction
- Two electrodes: anode and cathode
- Cathode end has a “stripe” to ID it
- Special kind of diode is the LED or light emitting diode
- LEDs require less power than incandescent lights and produce less heat.

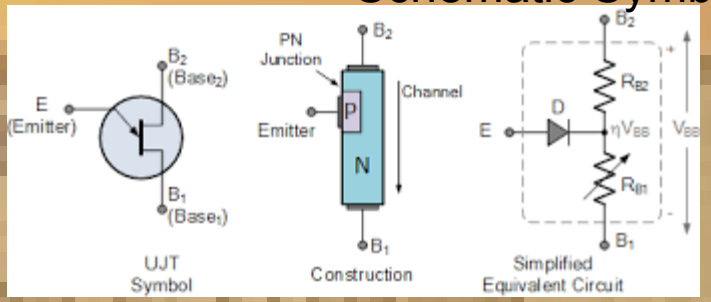


Transistors

- Use to amplify or switch voltages & current
- Made from layers of N and P-type materials
- Two common types of transistor
  - Bipolar junction or BJT has electrode names of: base, emitter, and collector
- Field Effect or FET has electrode names of: gate, source, drain.
- Gate or base electrode controls current flow through the transistor



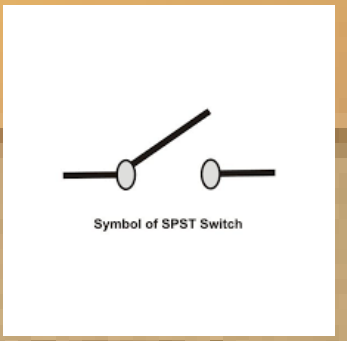
Schematic Symbol



Circuit Gatekeepers

- **Fuses and circuit breakers are designed to interrupt the flow of current if the current becomes uncontrolled**
- **Switches manually open or close a circuit**
- **Relays uses an electromagnet**
- **Described by # or poles & throws**
  - **SPST**
  - **DPDT**

Schematic Symbol



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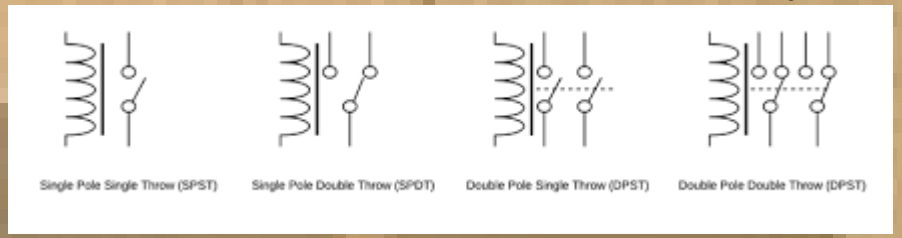
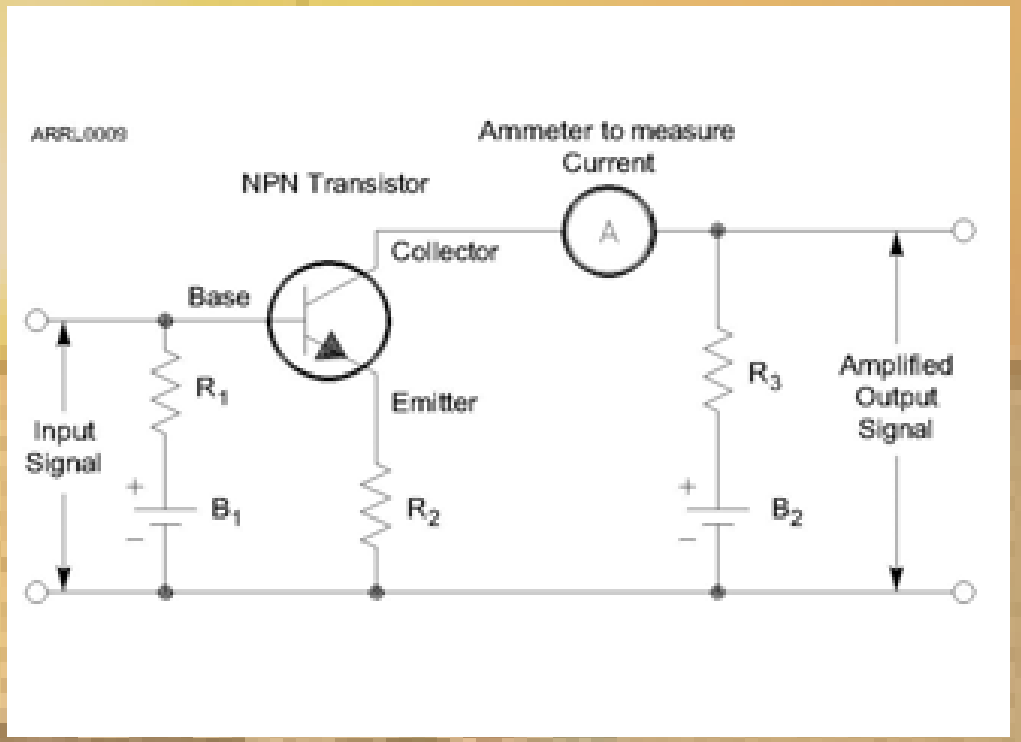


A Circuit Diagram

- Called a "**schematic diagram**"
- Shows the electrical connections of a circuit or device
- Uses industry standard **circuit symbols**
- NOT the physical arrangement of components



Question

T6C11
What is component 4?
A. Antenna
B. Transmitter
C. Dummy load
D. Ground

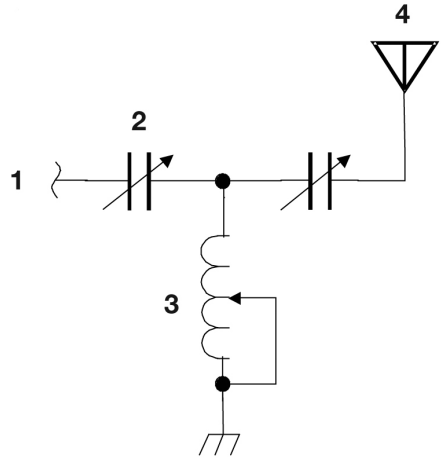


Figure T-3

T6C10
What is component 3?
A. Connector
B. Meter
C. Variable capacitor
D. Variable inductor

Question

T6C11
What is component 4?
A. Antenna
B. Transmitter
C. Dummy load
D. Ground

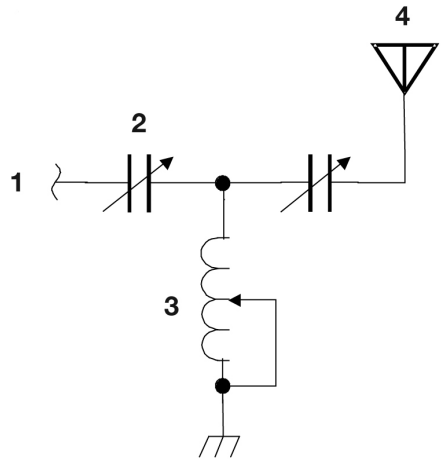
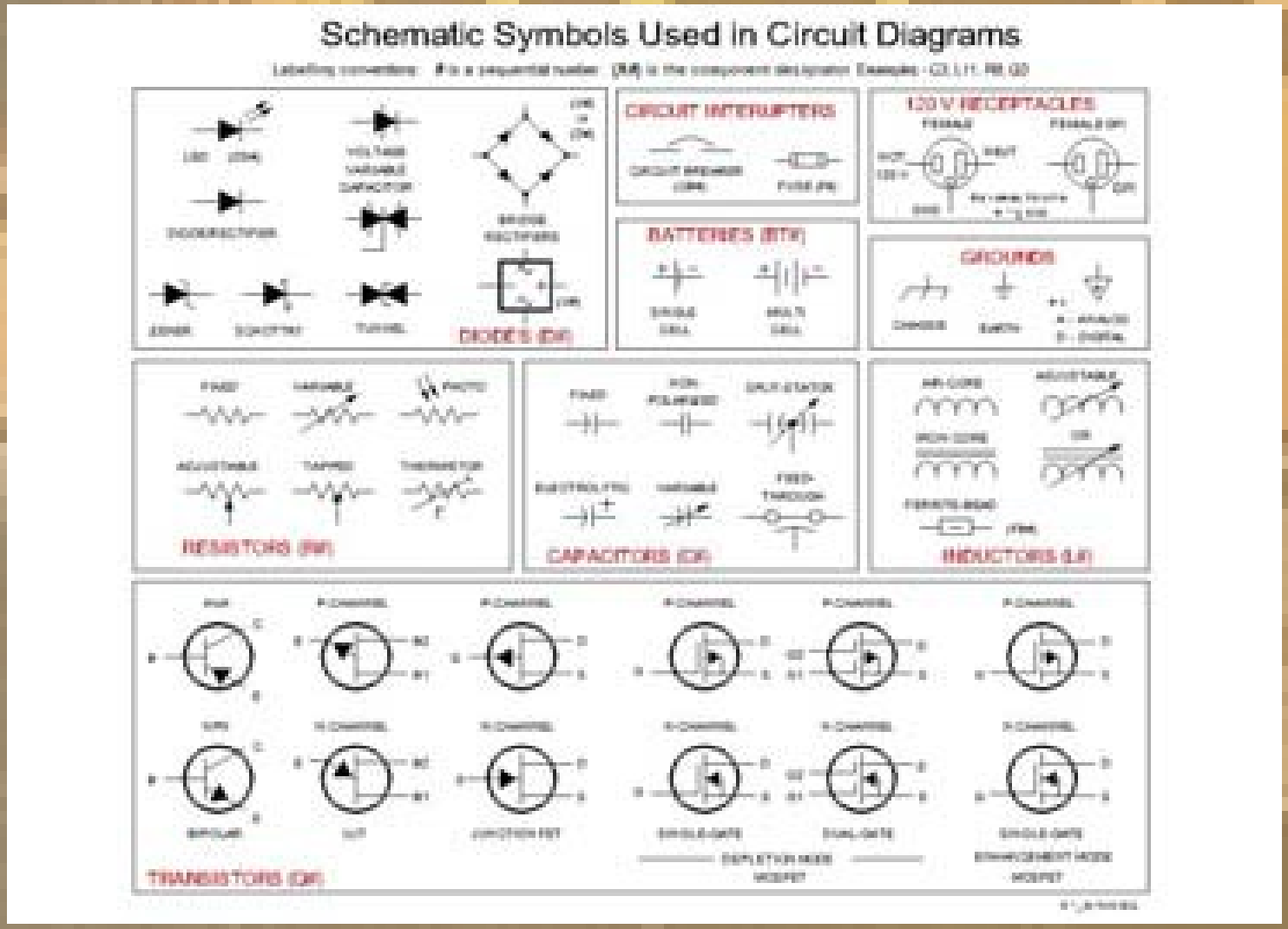


Figure T-3

T6C10
What is component 3?
A. Connector
B. Meter
C. Variable capacitor
D. Variable inductor

Component Symbols



Question

T6D02

What best describes a relay?

A. A switch controlled by an electromagnet
B. A current controlled amplifier
C. An optical sensor
D. A pass transistor

Question

T6D02

What best describes a relay?

A. A switch controlled by an electromagnet
B. A current controlled amplifier
C. An optical sensor
D. A pass transistor

Question

T6D04

Which of the following can be used to display signal strength on a numeric Scale?

A. Potentiometer
B. Transistor
C. Meter
D. Relay

Question

T6D04

Which of the following can be used to display signal strength on a numeric Scale?

A. Potentiometer
B. Transistor
C. Meter
D. Relay

Question

T6D01

Which of the following devices or circuits changes an alternating current into a varying direct current signal?

A. Transformer
B. Rectifier
C. Amplifier
D. Reflector

Question

T6D01

Which of the following devices or circuits changes an alternating current into a varying direct current signal?

A. Transformer
B. Rectifier
C. Amplifier
D. Reflector

Other Components/Circuits

- **Oscillators** produce steady signal at one frequency
- **Filters** are used to pass or reject a signal
- **Modulators** combine voice or data signals with an RF signal (modulation)
- **Mixers** combine to RF signals and shift one of them to a third signal
- **Receivers** convert a modulated signal back to voice or data
  - **Sensitivity** is ability to detect a signal
  - **Selectivity** is ability to retrieve information in presence of strong signals on nearby frequencies

Question

T7A05

What is the name of a circuit that generates a signal of a desired frequency?

A. Reactance modulator
B. Product detector
C. Low-pass filter
D. Oscillator

Question

T7A05

What is the name of a circuit that generates a signal of a desired frequency?

A. Reactance modulator
B. Product detector
C. Low-pass filter
D. Oscillator

Question

T7A03

Which of the following is used to convert a radio signal from one frequency to another?

A. Phase splitter
B. Mixer
C. Inverter
D. Amplifier

Question

T7A03

Which of the following is used to convert a radio signal from one frequency to another?

A. Phase splitter
B. Mixer
C. Inverter
D. Amplifier

End of Introduction

Q U E S T I O N S ?