Electricity & Electronics

Merit Badge

Class 1

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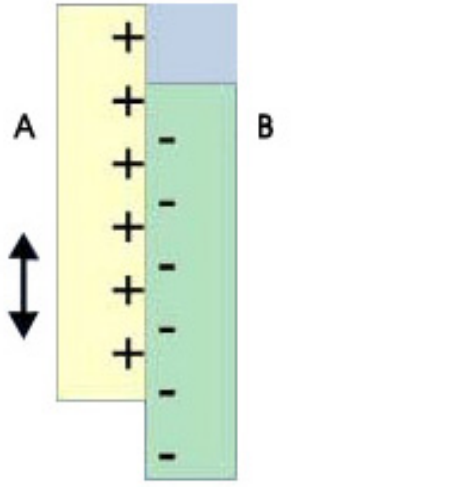
Name _____

IEEE

Types of Electricity

Static Electricity

Static electricity is usually created when materials are pulled apart or rubbed together, causing positive (+) charges to collect on one material and negative (−) charges on the other surface.. Sparks may result!



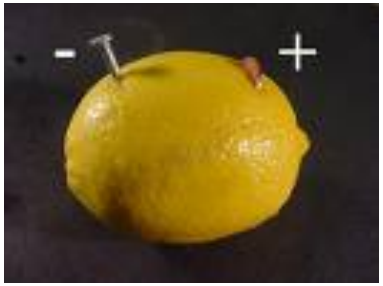
Examples of occurrence of static electricity:

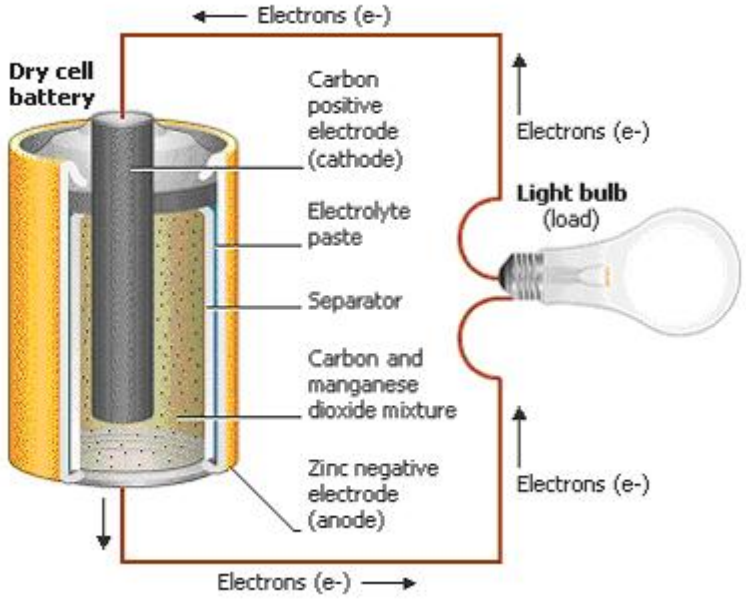
1. Lightning.
2. Combing hair.
3. Walking across carpet and getting shocked.
4. Pulling out scotch tape.

Types of Electricity

Direct Current (DC)

Type of electricity used in most, if not all electronics we have today.
Current only flows in one direction (not both directions, like AC).





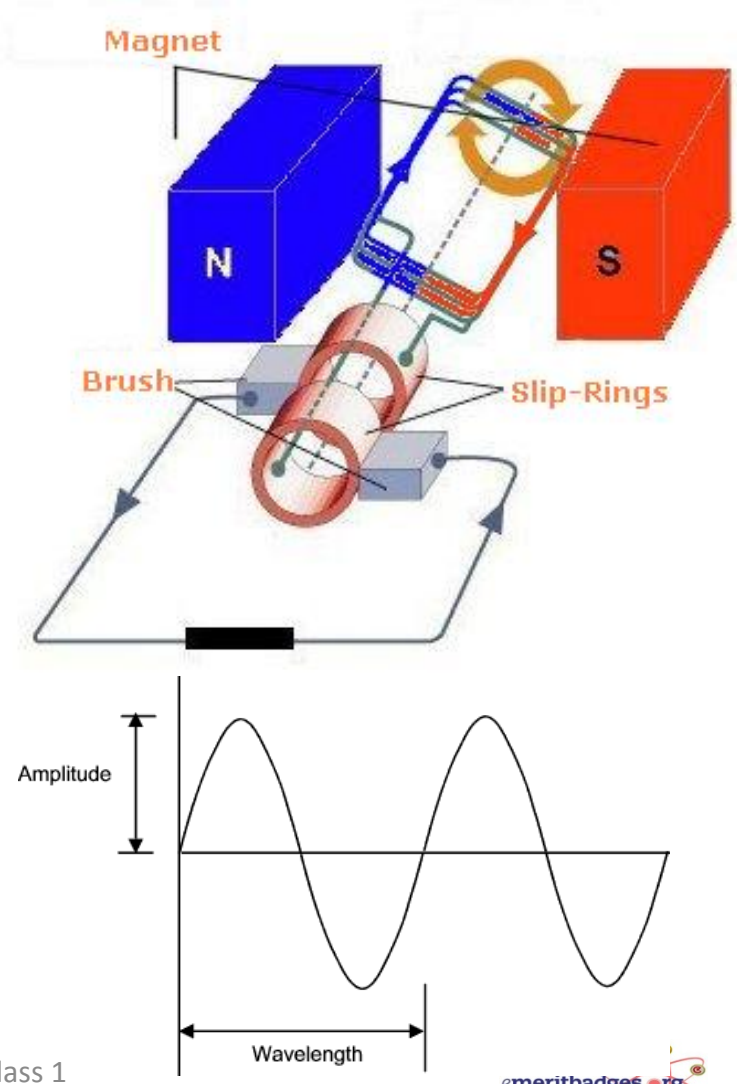
Examples of DC usage:

1. MP3 players
2. Radios
3. Electricity in cars.
4. Anywhere you use a battery for power.

Types of Electricity

Alternating Current (AC)

The common form of electricity from power plant to home/office. Its direction is reversed 60 times per second in the U.S.; 50 times in Europe.

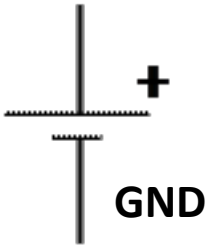


Examples of AC usage:

1. Kitchens: Stoves, ovens, mixer, etc.
2. Computer chargers
3. Lights in house
4. Home air conditioners.

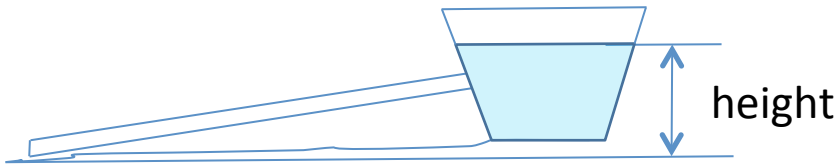
Voltage

- Volts is the electromotive force that causes electrons (current) to flow.
- Voltage can also be thought of as the electrical force that pushes electrons in a wire.
- Units for voltage is VOLTS.
- The symbol for voltage is E.
- The schematic symbol for dc voltage is generally shown as a battery



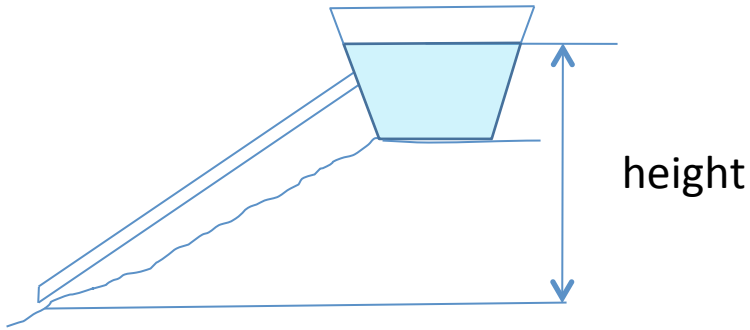
Voltage – Water Analogy

Small height = low voltage



1. Gravity provides the force for water (current) to flow.
2. This illustrates a small voltage, so current flow is small.
3. You can increase water (current) flow by making the pipe larger as well.

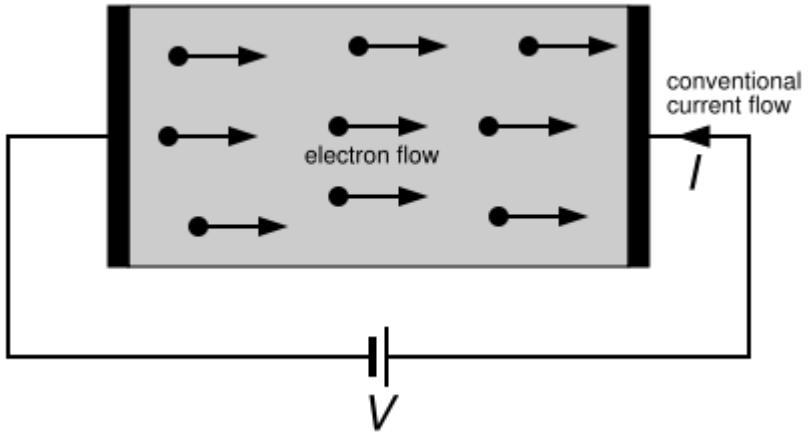
Big height = high voltage



1. Gravity provides the force for water (current) to flow.
2. This illustrates a larger voltage, so current flow is larger.
3. You can increase water (current) flow by making the pipe larger as well.

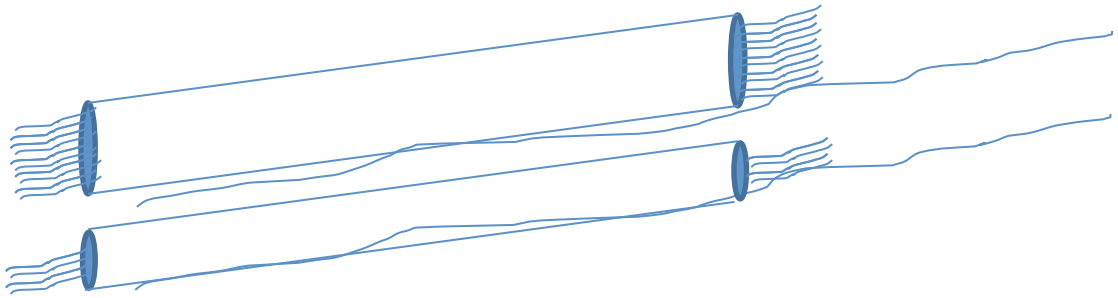
Current

- Current: Defined as "flow(time rate of change) of electrons".



- Current: Units of current is AMPS.
- Current: Electrical symbol for current is I (eye).

Current Flow – Water Analogy



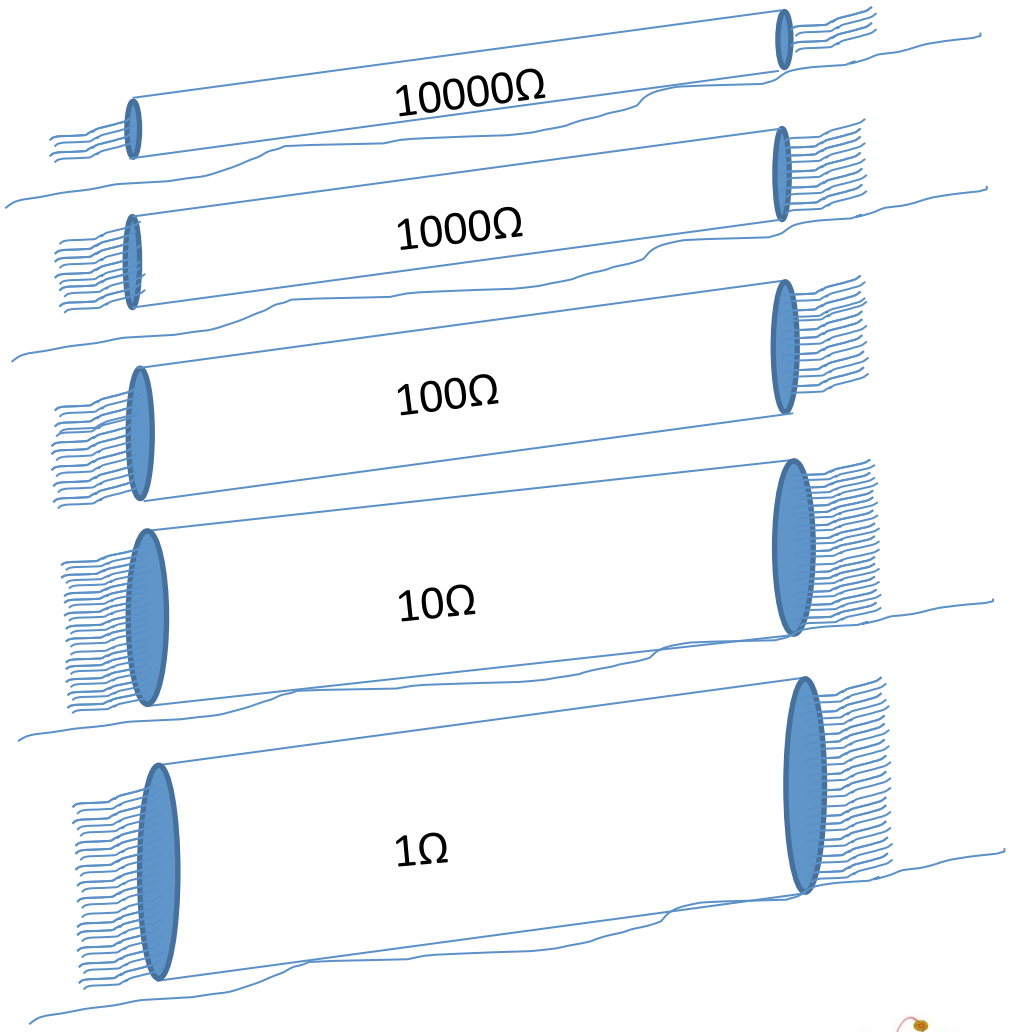
1. Water flows in the hose, entering at the top and exiting the bottom.
2. The water is the "current" ; the flow of electrons.
3. The more water flowing in the pipe, the more current is flowing in the wire.
4. Different pipe diameters illustrates different resistance to water flow, which correlates to different resistor values.

Resistance

- Resistance is the electrical property of a substance to resist the flow of electrons.
- The units of resistance is OHMS (Ω).
- The symbol for resistance is R.
- The schematic symbol is 
- The larger the resistance, the more resistance to current flow.

Resistance – Water Analogy

- Different pipe diameters represents different resistor values.
- The smaller the diameter of the pipe, the larger the resistance.



Electrical Terms

- Circuit-A conductor or system path of electrical elements through which current will flow.
- Potential Difference-The Voltage between two points in a circuit.
- Impedance-The term used in AC Circuits for the resistance to the flow of current.
- Short Circuit-An abnormal connection of low impedance (resistance) between two points of different potential.
- Ground-A point of common connection of zero volts often the earth

Other Electrical Terms

- Watt- Power to do work at 1 joule/sec or W=VxI
- Rectifier-Electronic or Mechanical means to convert AC to DC.
- Rheostat-An adjustable resistance such that resistance can be changed without breaking the circuit(example light dimmer).
- Conductor-Material that will allow current to pass continuously along it (wire).

Other Electrical Terms

- Switch-Electronic or Mechanical means for opening and closing a circuit.
- Fuse-A device that protects a circuit from over-current by melting a link in the device.
- Circuit Breaker-A device that protects a circuit for over-current by opening the circuit with a switch.
- Cycle-One complete reversal of alternating current or voltage.
- Hertz-One cycle per second

Equipment Used To Measure Electrical Quantities and Qualities

Volt/Ohm/Amp Meter

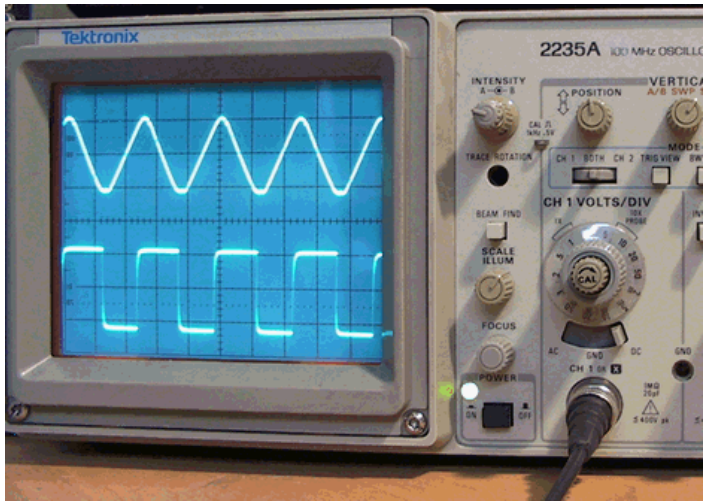
Usually referred to as a multi-meter.

With this we can measure current A, voltage V and resistance R.

Oscilloscope

Usually referred to as a Scope or O-Scope

With this we can ‘see’ voltage wave forms. This is very useful when voltage is changing, as a meter is no good to us when this is happening.



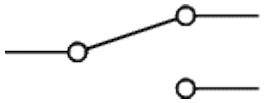
Ohms Law DC Circuits

Volts = Current x Resistance

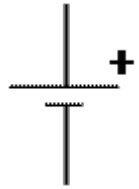
- E = I x R
- Units
  - E is in Volts
  - I the electrical current is in Amps
  - R is Resistance is in Ohms

  Example: If the Voltage E stays the SAME and Resistance R goes UP, then the amount of Current I flowing in the circuit goes DOWN

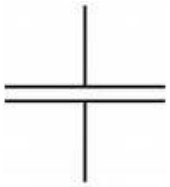
Electricity and Electronic Symbols



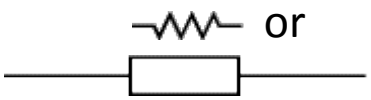
Single Pole, Double Throw Switch (SPDT)



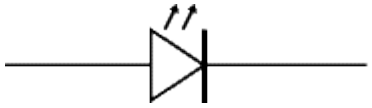
Battery



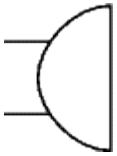
Capacitor



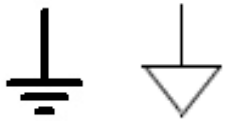
Resistor



Light Emitting Diode (LED)

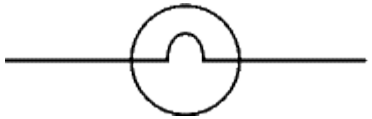


Buzzer



Ground

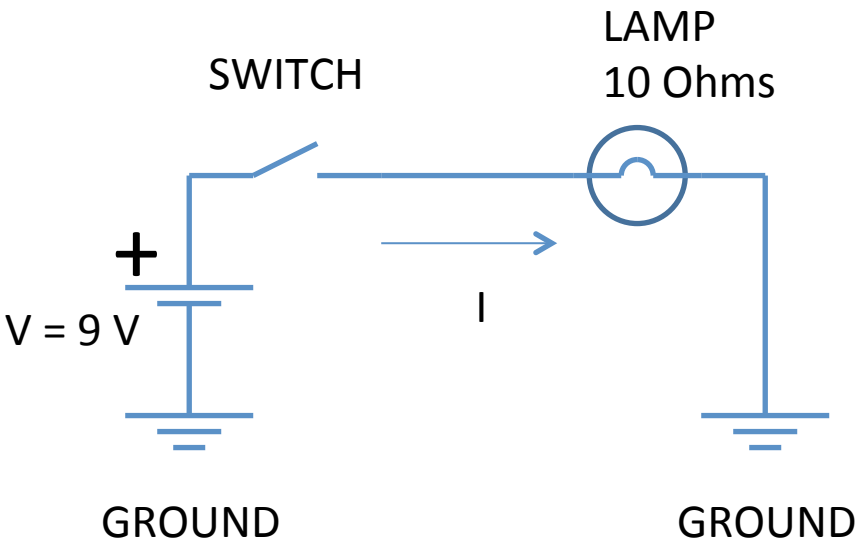
Fuse



Lamp

CIRCUIT DIAGRAM (SCHEMATIC)

FLASHLIGHT



Calculate I

V = I x R

V = 9 Volts

R = 10 Ohms

I = ? Amps

9 V = I A x 10 Ohms

9 V / 10 Ohms = I Amps

0.9 Amps = I

TWO GROUND SYMBOLS IS THE SAME AS CONNECTING WITH A WIRE

GROUND = 0 VOLTS

Electricity Safety

- High Voltage (120V AC or greater) – Safety mainly about not touching the wrong thing.

- Current kills – Only 60 volts can kill when current flows through heart or head for a sufficient length of time.
- Ventricular fibrillation - Current passing through heart causes knocks heart out of synchronization.
- If the shock doesn't kill you, you can still be badly burned from touching the wrong thing.

Electric Shock

- If a person is in contact with an energized (live) circuit do not touch them.
  - Turn off the breaker.
  - If you do not know where the breaker is located push the circuit off of the person with a dry object like a broom, mop handle or wooden chair.
  - Do not use any object that is metal or wet.
  - Water like metal can conduct electricity in amounts that can be dangerous.

Removal of Live Wire

- If you cannot remove the wire with a dry object or turn off the breaker then:
  - Be sure you are on a dry surface and
  - Find a dry shirt, sheet or sweater and loop it around the wire and pull it off
  - Or in case you cannot get to the wire try the same method to pull the person off the wire.
  - Once you have a person away from the wires check to see if they need artificial respiration.

High Power Lines

- If a person is in contact with high power lines:
  - Do not touch them.
  - Stay at least 20 feet away as current can flow through the ground.
  - Call 911.
  - Let the fire and police manage the situation.

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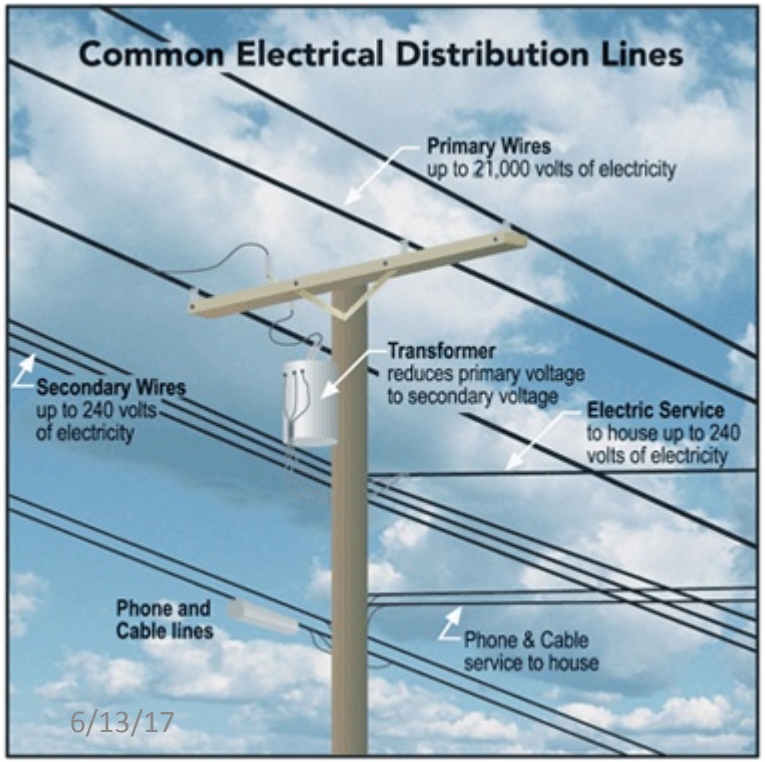
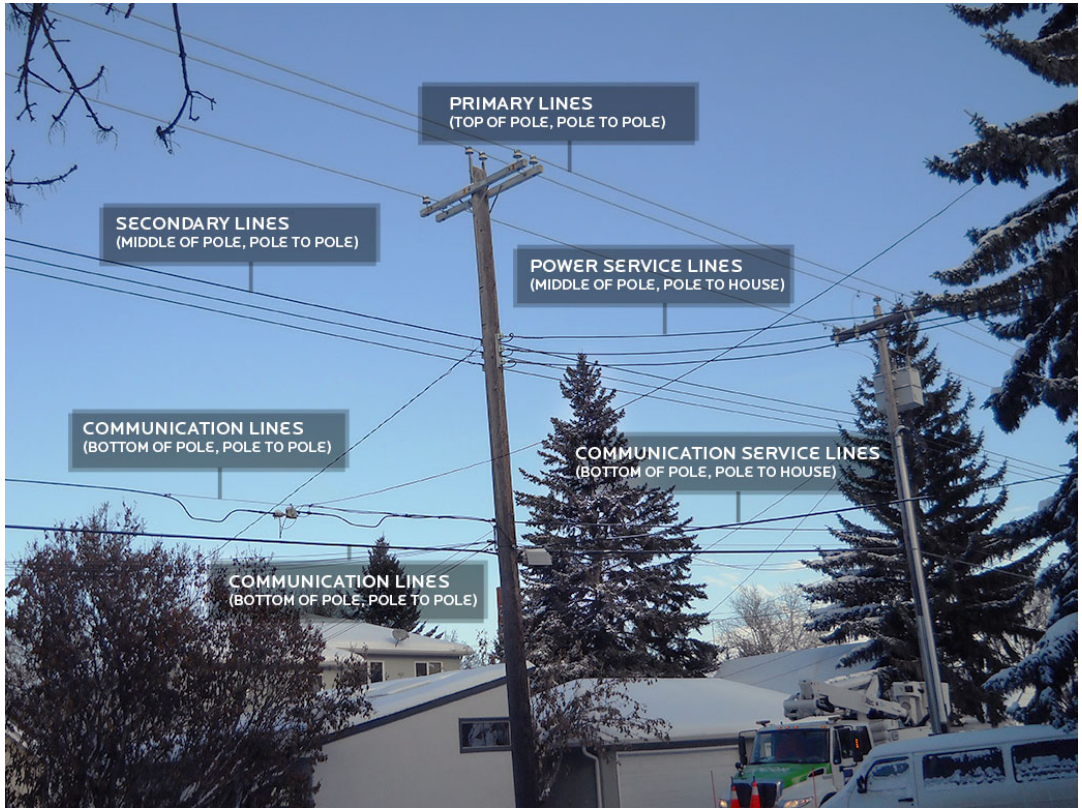
Power Lines


Common Electrical Distribution Lines
Primary Wires
up to 21,000 volts of electricity
Transformer
reduces primary voltage
to secondary voltage
Secondary Wires
up to 240 volts
of electricity
Electric Service
to house up to 240
volts of electricity
Phone and
Cable lines
Phone & Cable
service to house


PRIMARY LINES
(TOP OF POLE, POLE TO POLE)
SECONDARY LINES
(MIDDLE OF POLE, POLE TO POLE)
POWER SERVICE LINES
(MIDDLE OF POLE, POLE TO HOUSE)
COMMUNICATION LINES
(BOTTOM OF POLE, POLE TO POLE)
COMMUNICATION SERVICE LINES
(BOTTOM OF POLE, POLE TO HOUSE)
COMMUNICATION LINES
(BOTTOM OF POLE, POLE TO POLE)

Treating Electrical Burns

- When a person has a severe electrical burn:
  - Do not apply ice, ointment, water, medication, bandages or dressings
  - Do not touch or break boils or blisters
  - Do not attempt to remove clothing

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Electrical Storms

- About 54 people are killed from lightning every year and several hundred are injured.
- Numerous forest and house fires are started by lightning.
- If outdoors avoid tall solitary trees, towers, water, mountain tops and ridge crests, metal fences and any object like a metal tent pole.
- The safest place is a dense forest in a low lying area.
- If caught in the open stay low, spread out, crouch with both feet together and soles on the ground

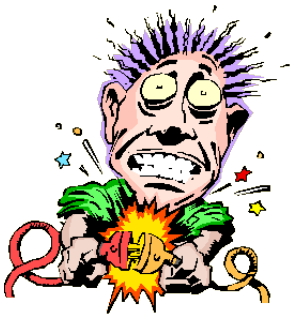
Electrical Fires

- They are different from other fires in that trying to put out a fire:
  - Never use water.
  - Call 911.
  - Turn off main breaker
  - Use only extinguishers rated for fires. **Class C**

    fires involve electrical equipment, such as appliances, wiring, circuit breakers and outlets. Never use water - the risk of electrical shock is far too great! The C classification means the extinguishing agent is non-conductive. Geometric symbol (blue circle)
  - If fire does not go out leave the building.

Personal Safety

- Be aware of what you are doing, and where you are placing equipment and yourself in an electrical circuit.
- Pay attention to energized circuits – Is the power on? Make sure the electricity is turned off especially when working on 120 VAC or higher electrical circuits.
- Pay attention to hot soldering irons. Keep a good distance between you those next to you.
- Know when you are working with high current and/or high voltage circuits.
- THINK before you do something.
- <u>Wear safety glasses when soldering.</u>



How to avoid shock.

- Turn power off before working on equipment.
- Don't touch circuits that could have high voltage on them.
- Do not allow current to flow through heart (or maybe mouth, in this case of an electrified fence).

Sample Home Electrical Inspection Checklist

- **Outlets**
- χ Check for outlets that have loose-fitting plugs, which can overheat and lead to fire.
- χ Replace any missing or broken wall plates.
- χ Make sure there are safety covers on all unused outlets that are accessible to children.
- **Line Cords**
- χ Make sure cords are in good condition-not frayed or cracked.
- χ Make sure they are placed out of traffic areas.
- χ Make sure that cords are not nailed or stapled to the wall, baseboard or to another object.
- χ Make sure that cords are not under carpets or rugs or any furniture rests on them.
- **Extension Cords**
- χ Check to see that extension cords are not overloaded & only be used on a temporary basis, not as permanent wiring.
- χ Make sure extension cords have safety closures to help protect children from shock hazards and mouth burns.
- **Plugs**
- χ Make sure your plugs fit securely into your outlets.
- χ Make sure no plugs have had the ground pin (the third prong) removed in order to make a three-prong fit a two-conductor
- outlet; this could lead to an electrical shock.
- χ Never force a plug into an outlet if it doesn't fit.
- χ Avoid overloading outlets with too many appliances.
- **Ground Fault Circuit Interrupters (GFCIs)**
- GFCIs can help prevent electrocution. When a GFCI senses current leakage in an electrical circuit, it assumes a ground fault has
- occurred. It then interrupts power fast enough to help prevent serious injury from electrical shock. GFCIs can be installed at the
- outlet, or as a replacement for the circuit breaker for an entire circuit at the fuse box.
- χ Kitchen χ Bathrooms χ Garage χ Laundry room χ Outdoors
- χ Test GFCIs according to the manufacturer's instructions monthly and after major electrical storms to make sure they are
- working properly.

Sample Home Electrical Inspection Checklist

- **Light Bulbs**
- χ Check the wattage of all bulbs in light fixtures to make sure they are the correct wattage for the size of the fixture.
- χ Replace bulbs that have higher wattage than recommended; if you don't know the correct wattage, check with the
- manufacturer of the fixture.
- χ Make sure bulbs are screwed in securely; loose bulbs may overheat.
- **Circuit Breakers/Fuses**
- χ Make sure circuit breakers and fuses are the correct size current rating for their circuit. If you do not know the correct size,
- have an electrician identify and label the size to be used. Always replace a fuse with the correctly specified size fuse.
- χ Make sure everyone in your home knows where the main breaker is located and how to shut of power to the entire house.
- **Plug In Appliances**
- χ Make sure there are no plugged-in appliances where they might fall in contact with water. If a plugged-in appliance falls into
- water, NEVER reach in to pull it out—even if it's turned off. First turn off the power source at the panel board and then
- unplug the appliance. If you have an appliance that has gotten wet, don't use it until it has been checked by a qualified repair
- person.
- **Appliances**
- χ If an appliance repeatedly blows a fuse, trips a circuit breaker or if it has given you a shock, unplug it and have it repaired or
- replaced.
- **Entertainment/Computer Equipment**
- χ Check to see that the equipment is in good condition and working properly. Look for cracks or damage in wiring, plugs and
- connectors.
- χ Use a surge protector bearing the seal of a nationally recognized certification agency.

Sample Home Electrical Inspection Checklist

- **Outdoor Safety**
- χ Electric-powered mowers and other electric tools should not be used in the rain, on wet grass or in wet conditions.
- χ Inspect power tools & electric lawn mowers before each use for frayed power cords, broken plugs & cracked or broken
- housings. If any part is damaged, stop using it immediately. Repair it or replace it.
- χ Always use an extension cord marked for outdoor use and rated for the power needs of your tools.
- χ Remember to unplug all portable power tools when not in use.
- χ When using ladders, watch out for overhead wires and power lines. Stay at least 10 feet from all overhead lines.
- **Lightning**
- χ During an electrical storm, do not use appliances (i.e., hairdryers, toasters and radios) or telephones (except in an
- emergency); do not take a bath or shower;
- χ Keep batteries on hand for flashlights and radios in case of a power outage.
- χ Use surge protectors on electronic devices, appliances, phones, fax machines and modems.
- **Space Heaters**
- χ Space heaters are meant to supply supplemental heat. Keep space heaters at least 3 ft. away from any combustible
- materials such as bedding, clothing, draperies, furniture and rugs.
- χ Don't use space heaters in rooms where children are unsupervised and remember to turn off and unplug when not in use.
- χ Do not use space heaters with extension cords; plug directly into an outlet on a relatively unburdened circuit.
- **Halogen Floor Lamps**
- χ Halogen floor lamps operate at much higher temperatures than a standard incandescent light bulb. Never place a halogen
- floor lamp where it could come in contact with draperies, clothing or other combustible materials.
- χ Be sure to turn the lamp off whenever you leave the room for an extended period of time.
- χ Never use torchiere lamps in children's bedrooms or playrooms. Consider using cooler fluorescent floor lamps.

How can we save energy in our homes, schools and scout areas

- Turn off unneeded or unused lights
- Unplug chargers when not in use charging
- When appliances need to be replaced buy energy star appliances
- In the summer set the indoor temperature a degree or two higher and in winter a degree or two lower
- Turn off the TV when leaving the room

How can we save energy in our homes, schools and scout areas

- Plan trips to the store so that one trip can complete several errands
- Don't exceed the speed limit
- Use a bike for short trips rather than a car
- Make sure that the building has adequate insulation
- Stop all air leaks in a building use infrared scanner to find leaks

How can we save energy in our homes, schools and scout areas

- Clean or replace air filters regularly
- Use energy efficient light bulbs
- Keep the doors closed when cooling or heating
- Shade your windows in the summer
- Use ceiling fans
- Close all fireplace flues when not in use
- Wash only full loads
- Set washers on economy load to save water

How can we save energy in our homes, schools and scout areas

- Set water temperature lower
- Take shorter showers
- Don’t let the water run while brushing or shaving
- Look for energy efficient computers and TVs
- Unplug unused appliances and devices as they use power at all times