

# ELECTRICITY NOTES

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# Two kinds of electrical charges

- Positive charge
- Negative charge
  
- Electrons are negatively charged
- Protons are positively charged
  
- The forces from positive charges are canceled by forces from negative charges because ordinary matter has a zero net charge.

- Electric charge is a fundamental property of matter. Important difference is that there are 2 types of charges
- Like charges will repel and unlike charges will attract with electrical charges.
- As far as we know there is only one type of mass and all masses attract each other through gravity.

# Static electricity

- An object with a net charge of zero is describe as being electrically neutral.
- A charged atom does not have a net charge of zero
- An object with more negative charges has a net negative charge
- An object with more positive charges has a net positive charge.
- A tiny imbalance of either positive or negative charges on an object is the cause of static electricity. This is when 2 neutral objects are rubbed together and some electrical charges (electrons) are exchanged

# What causes shocks?

- You get a shock because excess of charge of one sign strongly attracts charge of the other sign and repels the charge of the same sign.
- For example: you are walking on carpet during a dry day, your body will pick up excess negative charges. If you touch a neutral door knob some of your excess negative charges moves to the door.
- Door knob is an conductor, the charge flows quickly. The moving charge make a brief intense electric current between you and the door knob.

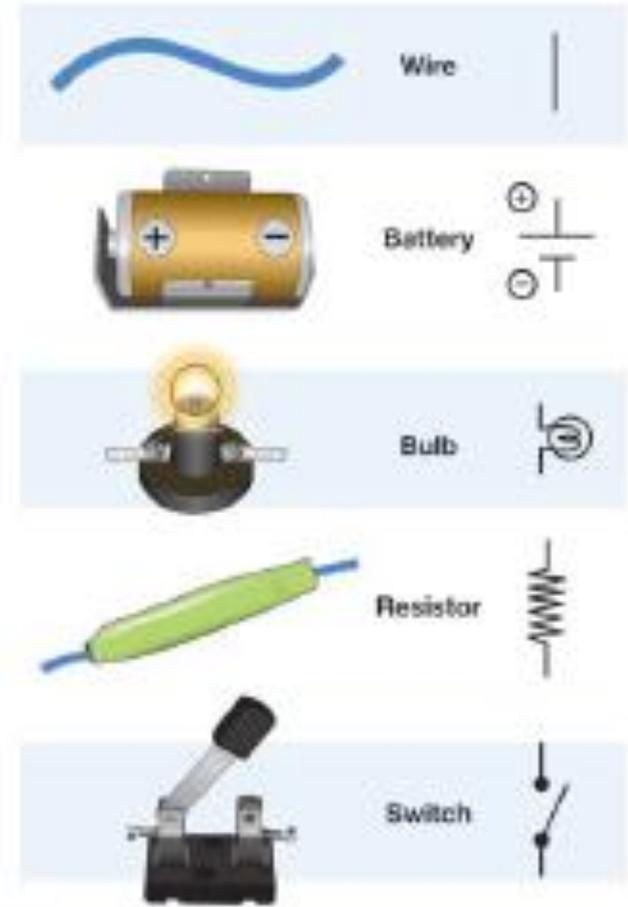
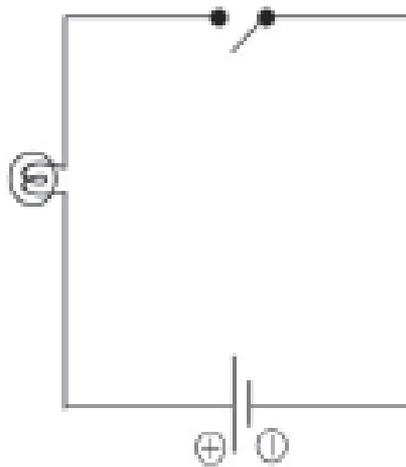
# Storms

- Lightning is caused by a giant build up of static charge
- The forces of gravity and wind cause the particles to separate.
- Positively charged particles accumulate near the top of the cloud and negative charges fall to the bottom
- The negatively charged cloud repels the negatively charged ground causing the ground to become positively charged
- Negative charges are attracted to positive charges
- All the negative charges flow from the cloud to the ground and heats the air as it goes.
- This heating of the air expands the air creating sound waves that we hear as thunder.

# Electric Circuits

- Electricity means the flow of electric current.
- An electric circuit is a complete path through which electricity travels
- Circuits are made up of wires and electrical parts such as batteries, light bulbs, resistors, motors and switches
- A circuit diagram is a shorthand method of describing a working circuit.
- A circuit diagram uses symbols to show the parts that a circuit is made up of.

# Circuit diagram



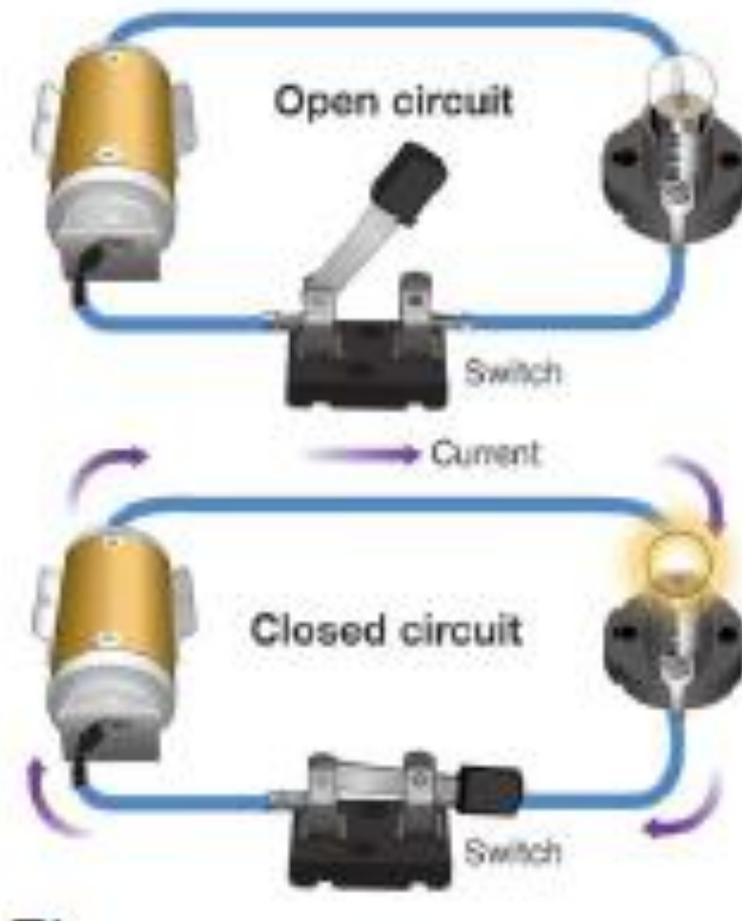
# Resistor

- A resistor is an electrical device that uses the energy carried by the electric current in a specific way.
- In many circuit diagrams any electrical device that uses energy is shown with a resistor symbol such as a light bulb, heating element, speaker, or a motor

# Open and closed circuits

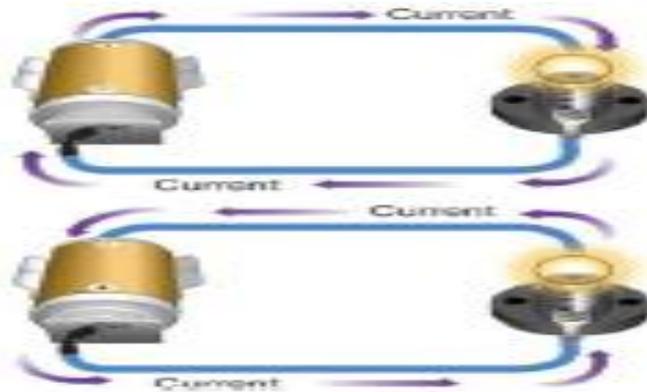
- It is necessary to be able to turn on and off electrical circuits.
- Electric current can only flow if there is a complete and unbroken path. This is called a closed circuit.
- If a switch is opened or disconnecting a wire will cause the current to stop flowing this is called an open circuit
- Switches are used to turn electricity on and off
- Flipping the switch to off will cause an open circuit by making a break in the wire

# Open and closed circuits



# Current

- Electric current is measured in units called amperes or amps
- Electric current from a battery flows out of the positive end and returns back into the negative end. An arrow can be used to show the direction of the current in a circuit diagram

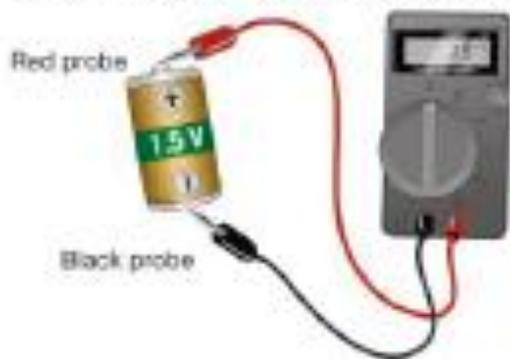


# Voltage

- Voltage is a measure of electric potential energy.
- Voltage is measured in volts
- Voltage difference means there is energy that can be used to do work.
- With electricity, the energy becomes useful when we let the voltage difference cause current to flow through the circuit
- Current is what flows and does the work
- A difference in voltage provides the energy that causes current to flow.

- A voltmeter measures just voltage.
- A more useful meter is a multimeter which can measure voltage or current
- To measure voltage, the meter's probes are touched to two places in a circuit or across a battery. The meter shows the difference in voltage between two places

A multimeter can measure a battery's voltage if one probe touches each end.

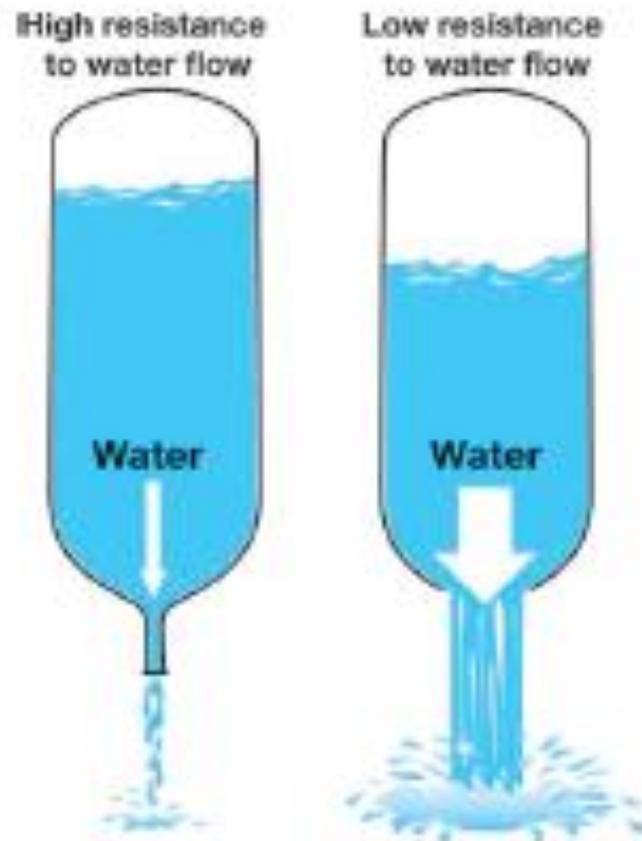


The meter reads zero volts if both probes are connected at the same place.



# Resistance and Ohm's Law

- Resistance is the measure of how strongly a wire or other objects resist current flowing through it.



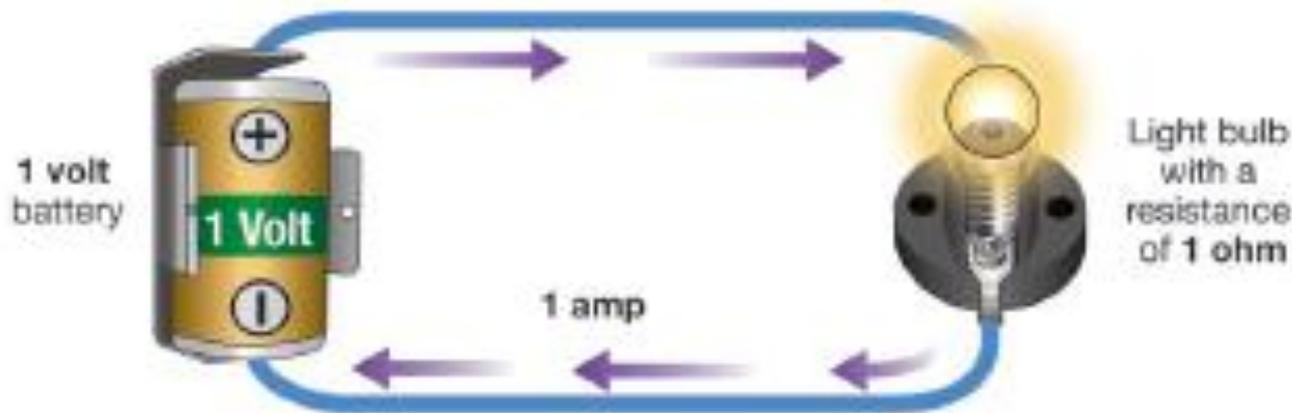
# Circuits

- The total amount of resistance in a circuit determines the amount of current in the circuit for a given voltage.
- Every device that uses electrical energy adds resistance to the circuit
- More resistance a circuit has the less current



- Resistance is measured in units called ohms
- The wires used to connect circuits made of metals have a low resistance so when measuring resistance you can ignore the wires resistance

1 volt creates a current of 1 amp through a resistance of 1 ohm.



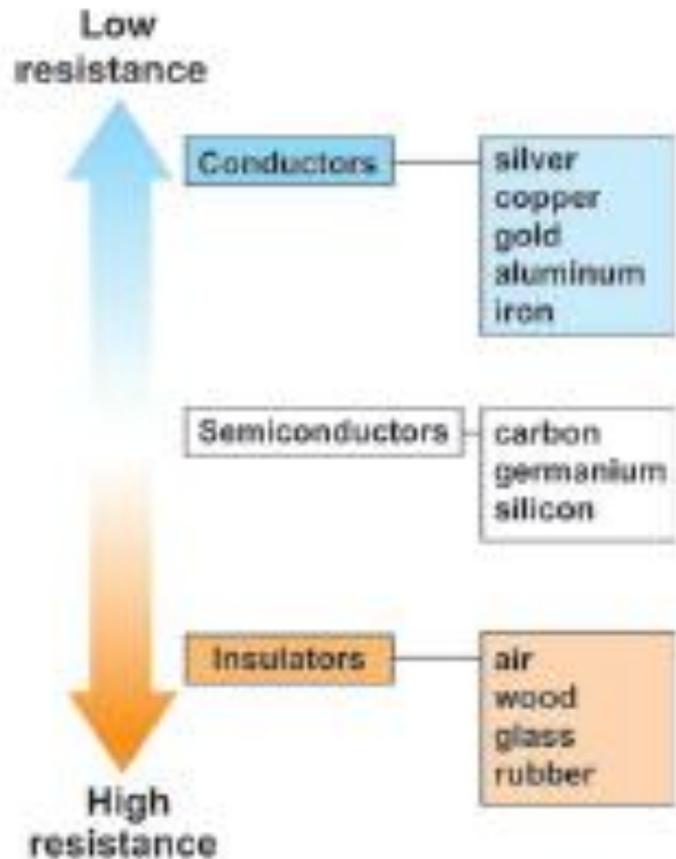
# Ohm's Law

- Ohm's law states that the current is directly related to the voltage and inversely related to the resistance
- $V=IR$

Equation	Gives you...	If you know...
$I = V/R$	current (I)	voltage and resistance
$V = IR$	voltage (V)	current and resistance
$R = V/I$	resistance (R)	voltage and current

# Conductors and insulators

- A conductor can conduct or carry electric current. Most metals are good conductors
- Insulators do not allow current to flow easily. Examples: rubber, glass, and wood.
- Some materials are in between conductors and insulators. These are called semiconductors.

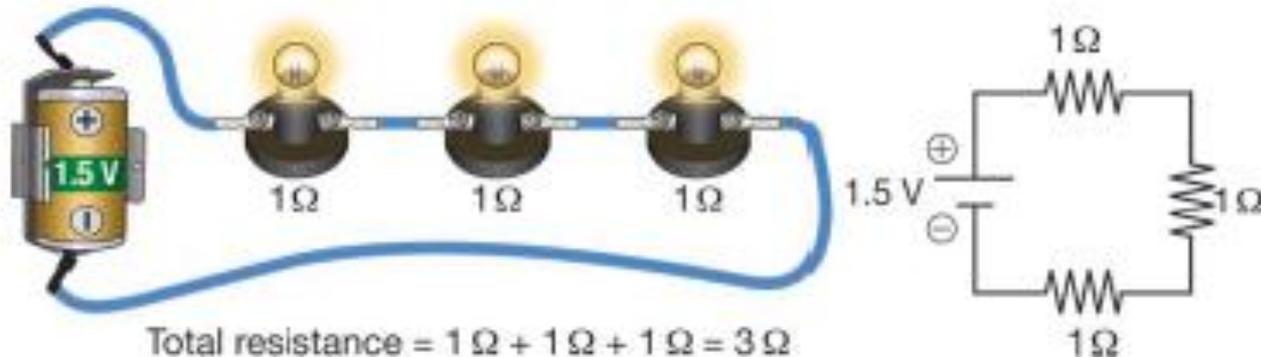


# Series Circuits

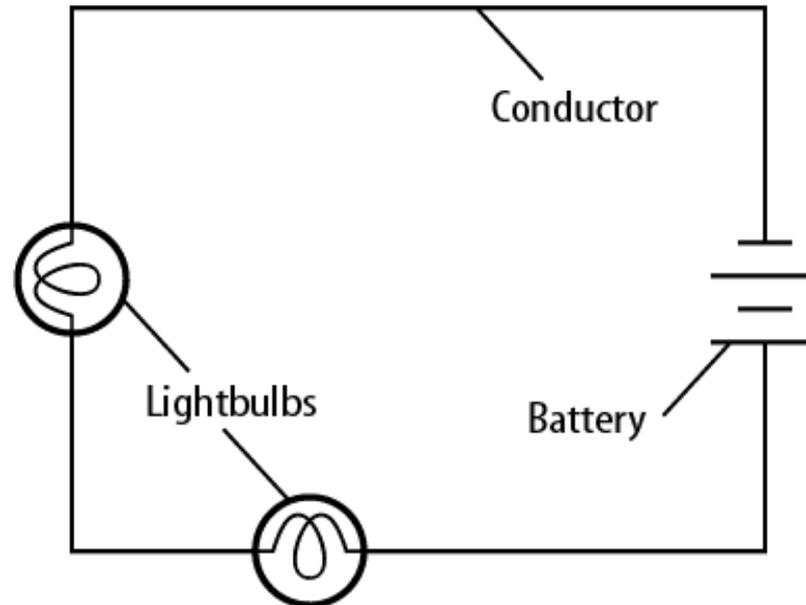


- In a series circuit, the same current flows through each resistor, but a different voltage across each resistor.
- Inexpensive Christmas lights are example. One goes out they all go out. Because the current can no longer flow through.
- $R_T = R_1 + R_2 + R_3 + \dots$

Adding resistances in a series circuit



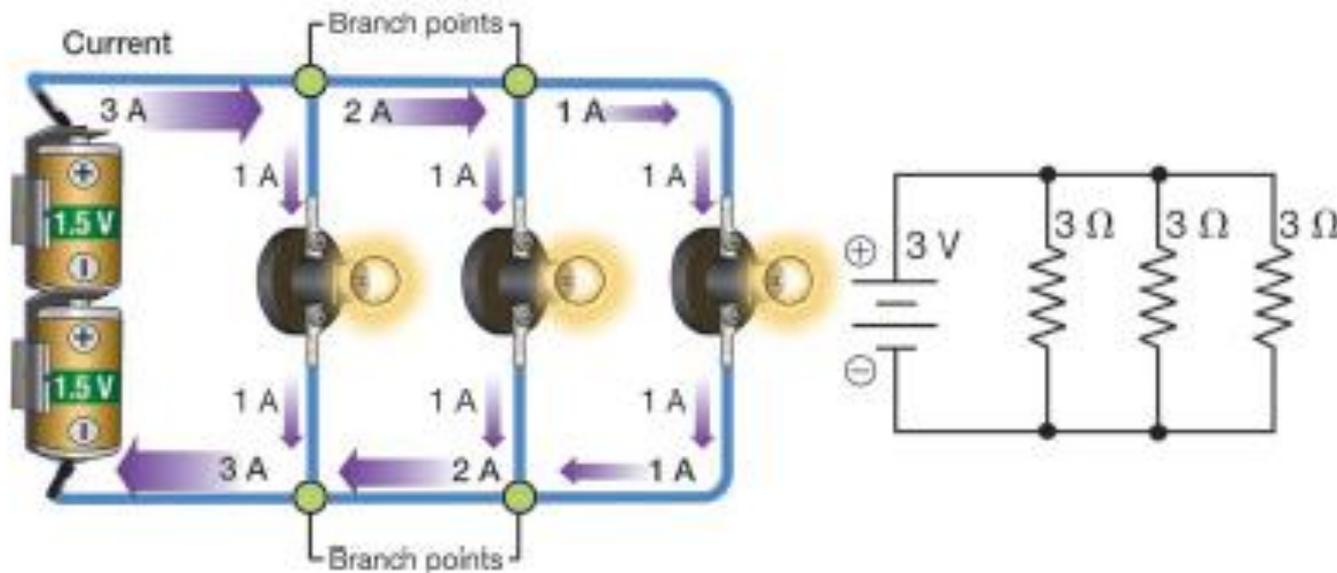
# Series Circuits:



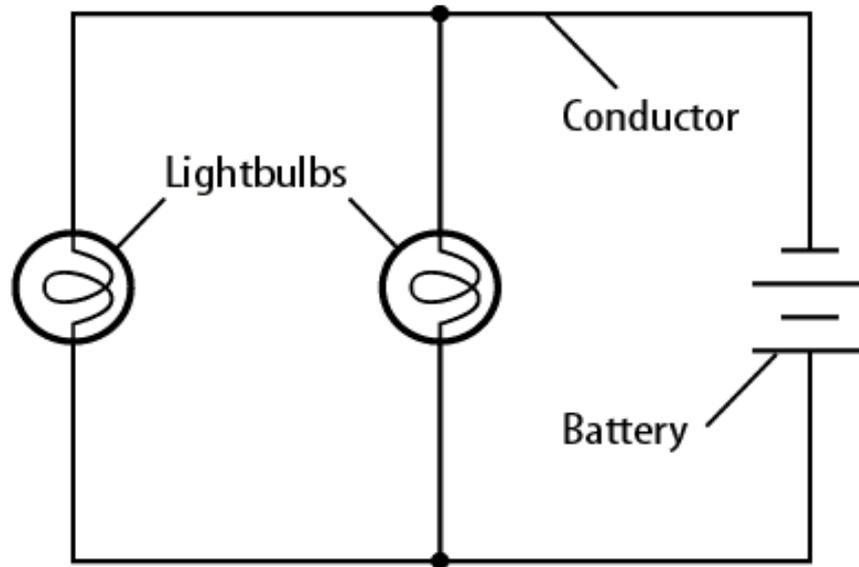
# Parallel Circuits

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$$

- Two or more paths for the current to travel.
- In a parallel circuit, each resistor has the same voltage, but different currents. The current is determined by the branch's resistance



# Parallel Circuits:



	Voltage	Current	Resistance
Series	Resistors must "share" total voltage available	Current is the same everywhere in the circuit	Resistance increases as you add resistors in series
Parallel	Each branch sees the full voltage available	Branch current can vary within the same circuit; add up branch currents to get total current	Resistance decreases as you add resistors in parallel, because current increases