Electricity

- Electrical Energy Production
- Static Electricity
- Electrical quantities in Circuits

Life without Electricity---!!!

- How would you prepare your lunch?
- How would you wash clothes?
- When would you go to bed?

- Think about all the luxuries the discovery of Electricity has brought us!
  - No Television
  - No Computers
  - No Lights

Inventors and Inventions

- 1752 – Lightning Rod
  - Ben Franklin
- 1800 – Electric Battery
  - Count Alessandro Volta
- 1805 – Refrigerator
  - Oliver Evans
- 1876 – Telephone
  - Alexander Graham Bell

1879 – Light Bulb
Thomas Edison
1888 – AC Power
Nikola Tesla
1897 - Electron discovered by J. J. Thomson.
1910 – Flashlight
Conrad Hubert
1920 – Traffic Light
Garrett Morgan

More Inventors and Inventions

- 1927 – Television
  - Philo T. Farnsworth
- 1945 – Computer
  - Mauchley and Presper
- 1954 – Microwave
  - Percy Spencer
  - Polley
- 1955 – TV Remote
  - Eugene

1973 – Internet
Vinton Cerf
1991 - WWW
Tim Berners-Lee
…….

Where does our electricity come from?

- Electricity is made or <u>generated</u> in different ways. Can you think of some?
- Most of our electricity is made using <u>fossil fuels</u>. What do you think these are?

gas

oil

coal

So how do we get electricity from fossil fuels?

- Most electricity is produced by burning fossil fuels in power stations.
- Coal, oil and natural gas are burned in **<u>furnaces</u>** to heat up water. The boiling water makes steam which pushes the gigantic blades of a **<u>turbine</u>** to produce electricity.

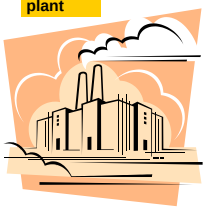
Power stations give off lots of steam which you can see.

Power stations give off **<u>pollution</u>**, which you can't see.

When we burn fossil fuels we put lots of carbon dioxide into the air. This is a cause of **<u>Global Warming</u>**.

Some countries use nuclear power

Nuclear power plant

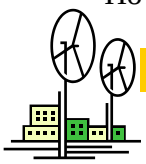


Nuclear power plants use a material called uranium to produce electricity.

Nuclear power plants make electricity by splitting tiny **atoms** of the uranium to release energy.

Nuclear plants also have waste materials that are very dangerous and have to be looked after safely for thousands of years.

How else can we produce electricity?



Wind turbines

PV panels

These are **some** of the ways we can get 'renewable' energy. This means that the source of the energy will not run out.

How is the electricity being generated?

Water wheels

Renewables	Non-renewables

Were you right?

Types of Sources used to make Electricity

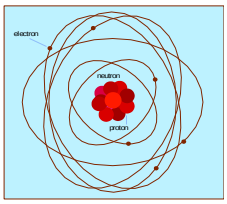
- Thermal
- Geothermal
- Nuclear
- Hydroelectric
- Solar
- Wind

Electricity

Everything in the world is made up of *atoms.* Each atom has smaller parts in it. One of those parts is called *electrons.* Electrons can move from atom to atom. When an electron moves to a different atom, it causes another electron to have to move. When electrons move quickly from one atom to another is it called *Electricity!*

What is Electricity?

- Electricity is generated from the motion of tiny charged atomic particles called electrons and protons!
- Protons = +
- Electrons = -



Inside an atom, electrons have a *negative charge* and protons have a *positive charge.* These particles *attract* each other.

A *charge* is a measure of the extra positive or negative particles that an object has.

Electric Charge

- A basic property of some subatomic particles
  - Protons have **positive** charge
  - Electrons have **negative** charge
  - Neutrons have **no** charge
- Particles that have opposite charges are attracted
- Particles with the same charge repel each other

Kinds of Electricity

Static

- An electric charge that collects or builds up on the surface of an object
- **Examples**
  - Shocking
  - Lightening

Current

- The flow of electric charges carried through a material such as wire or other conductors
- **Examples**
  - Power lines
  - Computers
  - Appliances

Static Electricity

***Static electricity* is the charge that stays on an object.**

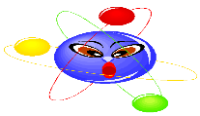
Unlike charges *attract* each other, and like charges *repel* each other.

The steady flow of electricity is called an *electric current.* A current will move along a wire or a path called a *circuit.*

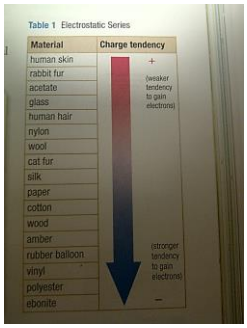
***Circuit* means to "go around."**

How is Electric Energy Produced?

- Atoms are made up of protons, neutrons, and electrons. The electrons have a negative charge and can move freely.
- For example, rubbing two objects together can cause electrons to move from one object to another. This movement of electrons is called ELECTRICITY !



Where and How do the Electrons move?



Draw a diagram of the charges before and after the items are rubbed together. Use the Electrostatic Series.

Balloon with human hair

Paper and wool

Glass and silk

Ebonite and fur

Conductors and Insulators

Conductors

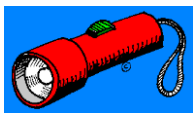
- Any material that allows electric charges to move through it
- **Examples:**
  - Metals (esp. copper)
  - Your body
  - Electric wires

Insulators

- Materials that do not allow electric charges to flow freely through them
- **Examples:**
  - Wood
  - Glass
  - Rubber

Types of Circuits

- The two types of circuits are called open circuit and closed circuit.
- In order for electric current to flow, the circuit must be CLOSED!
- A switch controls the opening and closing of a circuit. Example: flashlight



Circuits

- **A *series circuit* is a circuit that has only *one path* for the current.**
- **A *parallel circuit* has *more than one path* for current to travel.**

- **Lights in our homes are wired in *parallel circuits.***

Conductor

- A conductor is a material that current can pass through easily, like metals.

Resistor

- A resistor is a material that resists, but doesn't stop the flow of current.

Insulator

- An insulator is a material that current cannot pass through easily, like plastic.

Electric Cell

- An *electric cell* supplies energy to move charges through a circuit, like a battery.

Electric Current

- **Newton's Cradle** provides a great analogy
- As soon as the ball you dropped at one end hits the rest of the balls, the ball at the far end moves!
- At a much slower speed, all of the balls move together.
- The invisible transfer of energy is like electric current and the motion of the balls is like the particle drift

Electric Current

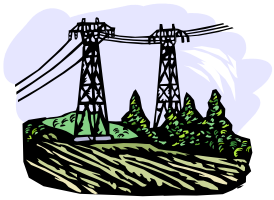
- The SI unit for current is the **ampere, or amp (A).**
- Current is measured with an **ammeter**.
- Note that in order for current to flow, there must be something "pushing" it along.
- This is known as **amperage.**

Voltage

- **Voltage** is the electric potential between two points.
- It describes how much potential there is for current to flow between two points.
- Think of the Newton's Cradle example.
  - Voltage is like the gravity that forces the first ball to fall, thus moving the other balls.

Voltage

- The SI unit for voltage is the **volt (V).**
- Voltage is measured with a **voltmeter.**



Voltage

- How many volts are in…
  - AA battery?
  - The outlet in the wall?
  - The power lines in the street?
  - The large power lines out in the middle of nowhere?
  - Lightning?

Voltage

- How many volts are in…
  - AA battery? **1.5 V**
  - The outlet in the wall? **120 V**
  - The power lines in the street? **13,000 V**
  - The large power lines out in the middle of nowhere? **765,000 V !!**
  - Lightning? **100,000,000 V !!!!!**

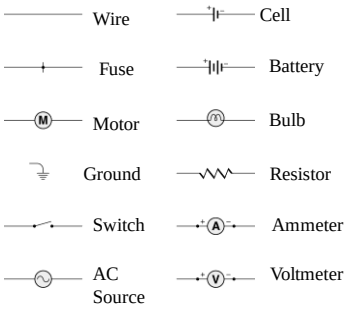
The Electric Circuit

- Electric circuits allow us to harness electricity and have it do something useful
- Electric circuits are connections of two or more electrical devices to form a **closed loop**
- A **closed loop** means you could start at any point the circuit, follow the wires with your finger, and eventually arrive back at the starting point
- They must form a **closed loop** because electric current needs to flow **to** someplace **from** someplace.

The Electric Circuit

- Circuits can either be wired in **series** or **parallel**
- In **series** circuits, the pieces of the circuit are all connected in line.
  - They create only 1 path for the current to flow
- In **parallel** circuits, the pieces are connected side by side, so there are many paths for the current to flow

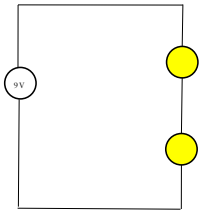
Circuit Symbols



When drawing a schematic of an electric circuit we use symbols to represent the various components of that circuit.

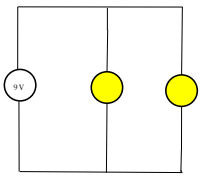
Series Circuit

- Here are 2 lights connected in series with a 9 V battery.
- Notice there is only 1 path for the current to flow
- Notice this forms a closed loop
- If one bulb burns out, will the other stay lit? Why?



Parallel Circuit

- Here are 2 lights connected in parallel with a 9 V battery.
- Notice there are 2 paths for the current to flow
- Notice this forms 3 closed loops
- If one bulb burns out, will the other stay lit? Why?



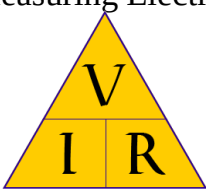
Some notes on series and parallel circuits

- Components in series have
  - The same current
  - Different voltages
- Components in parallel have
  - Different current
  - The same voltages

Examples of Electric Circuits

- Microprocessors
- Computers
- The electric power lines
- Can you think of any more?

Measuring Electricity



All you need to be an inventor is a good imagination and a pile of junk.

-Thomas Edison

Voltage measured in *volts*, symbolized by the letters "V".

Current measured in *amps*, symbolized by the letter "I".

Resistance measured in *ohms*, symbolized by the letter "R".

What is ohms law?

- Ohm's Law explains the relationship between voltage (V), current (I) and resistance (R)
- Used by electricians, automotive technicians, stereo installers

VOLTAGE (V)

- It is the push or pressure behind current flow through a circuit, and is measured in (V) volts.
-

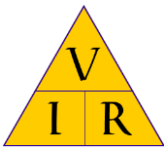
CURRENT

- Current refers to the quantity/volume of electrical flow. Measured in Amps (A)

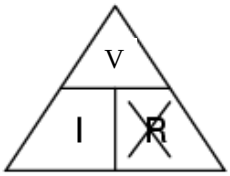
RESISTANCE

- Resistance to the flow of the current. Measured in Ohms Ω

Quantity	Symbol	Unit of Measurement	Unit Abbreviation
Current	I	Ampere ("Amp")	A
Voltage	V	Volt	V
Resistance	R	Ohm	Ω

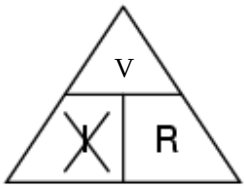


If you know V and I, and wish to determine R, just eliminate R from the picture and see what's left:



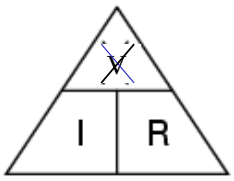
$$R = \frac{V}{I}$$

If you know V and R, and wish to determine I, eliminate I and see what's left:



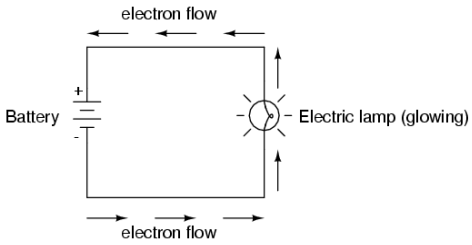
$$I = \frac{V}{R}$$

if you know I and R, and wish to determine V, eliminate V and see what's left:



$$V = I R$$

Let's see how these equations might work to help us analyze simple circuits:



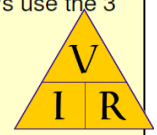
If we know the values of any two of the three quantities (voltage, current, and resistance) in this circuit, we can use Ohm's Law to determine the third.

Ohm's Law

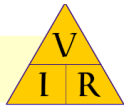
	Resistance	Current	Voltage
Definition	The opposition to the flow of charges	The flow of electrons through a circuit	Potential Difference (the push behind electricity)
Symbol	R	I	V
Equation	$R = \frac{V}{I}$	$I = \frac{V}{R}$	$V = I R$

To obey Ohm's law means a conductor has a constant resistance regardless of the voltage.

- If you know two of the three variables you should be able to solve for the third.
- When using Ohm's law always use the 3 step form
  - 1. Write the equation
  - 2. Replace the known values
  - 3. Solve the problem
  - . Label with the correct unit of measurement.



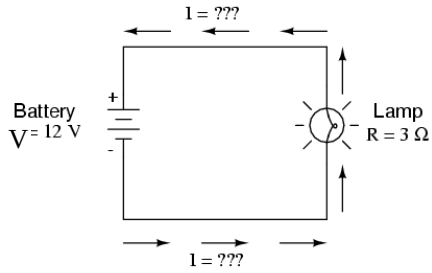
Practice problem



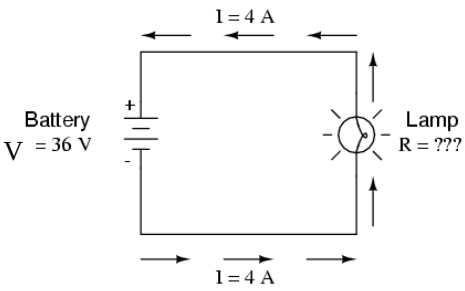
- You light a light bulb with a 1.5 volt battery. If the bulb has a resistance of 10 ohms, how much current is flowing?

1. Write the equation → $I = \frac{V}{R}$
2. Replace the known values → $I = \frac{1.5}{10}$
3. Solve → $I = 0.15$

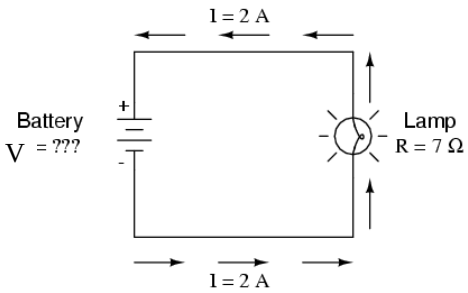
calculate the amount of current (I) in a circuit, given values of voltage (E) and resistance (R):



calculate the amount of resistance (R) in a circuit, given values of voltage (V) and current (I):

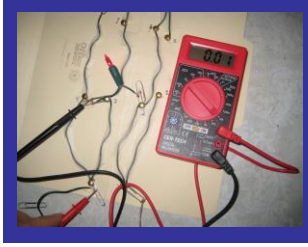


calculate the amount of voltage supplied by a battery, given values of current (I) and resistance (R):



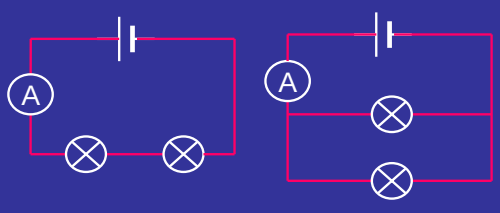
measuring current

Electric current is measured in **amps** (A) using an ammeter connected in series in the circuit.



measuring current

This is how we draw an ammeter in a circuit.



SERIES CIRCUIT

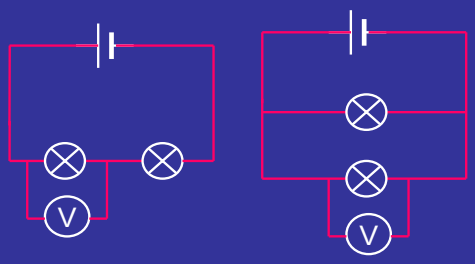
PARALLEL CIRCUIT

measuring voltage

The 'electrical push' which the cell gives to the current is called the **voltage**. It is measured in **volts** (V) on a **voltmeter**

measuring voltage

This is how we draw a voltmeter in a circuit.

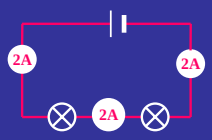


SERIES CIRCUIT PARALLEL CIRCUIT

measuring current

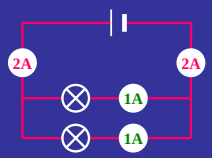
SERIES CIRCUIT

- current is the **same** at all points in the circuit.



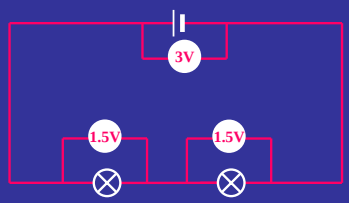
PARALLEL CIRCUIT

- current is **shared** between the components



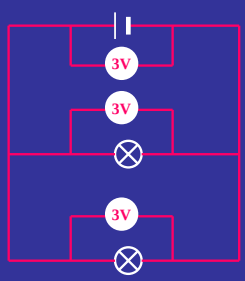
series circuit

- voltage is **shared** between the components



parallel circuit

- voltage is the **same** in all parts of the circuit.



How you can save electricity and money?

- Light bulb - 0.3 to 0.5 cents per hour
- Color TV – 0.8 cents per hour
- Computer – 1.5 cents per hour
- Average Shower – 15 cents per shower
- Freezer – 3.7 cents per hour
- Stereo – 2.5 cents per hour
- Water Heater – 22.5 cents per hour

Always play it safe!

- Safety rules
  - 1 – Never climb trees near power lines
  - 2 – Never go around downed power lines or subst
  - 3 – Never use electrical appliances near the bathtub
  - 4 – Stay away from all electrical equipment (meters, transformers, etc.)
  - 5 – Do not swim or play outside on a stormy day
  - 6 – Never put fingers or other objects near electrical outlets
  - 7 – Obey all safety signs
  - 8 – Never use appliances with cords showing bare wire

Safety in a storm!

- Stay away from tall objects such as trees
- Stay out of open fields or areas where ***YOU*** are the tallest thing
- If your hair stands on end, crouch low to the ground with as little of your body in contact with the ground as possible