SCIENCE 5 STUDY NOTES Name: _____

ELECTRICITY AND MAGNETISM
MECHANISMS USING ELECTRICITY

Humans didn't invent electricity. We discovered it. We invent things that use it.
Electricity already exists in nature

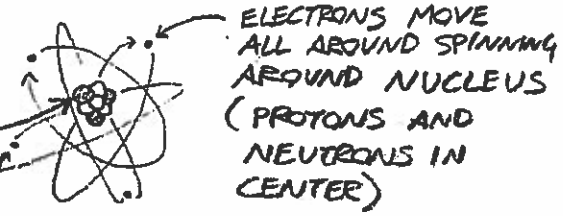
- Lightning
- Static electricity
- Electric eels
- Any animal's nervous system

Everything is made of atoms.

Neutrons have no charge.

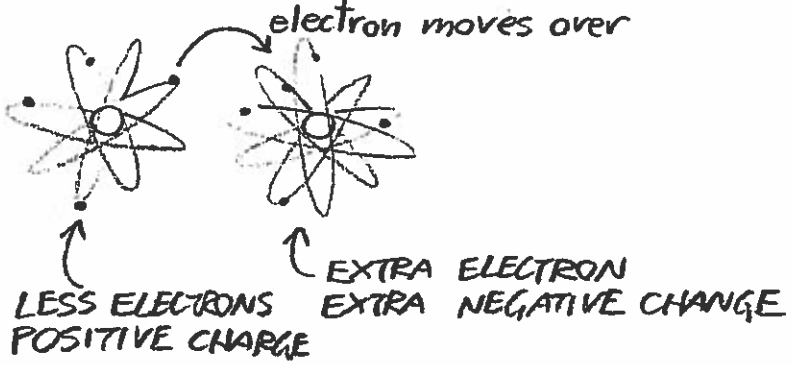
Protons have positive charges. +

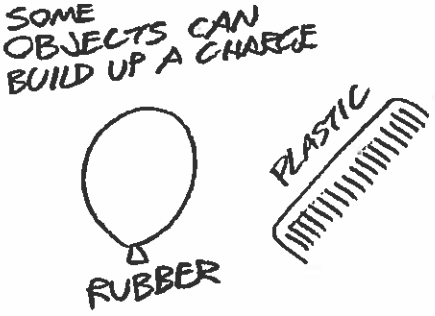
Electrons have negative charges.



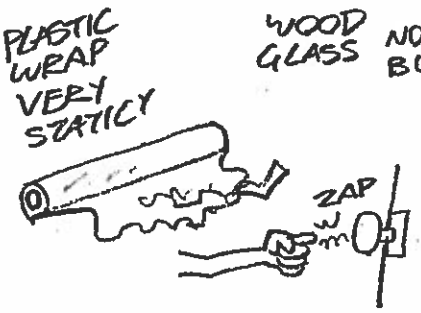
USUALLY THE NUMBER OF PROTONS AND THE NUMBER OF ELECTRONS ARE THE SAME – BALANCED.

Electrons are on the edge and can jump to other nearby atoms (in certain atoms)

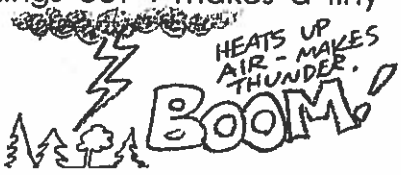




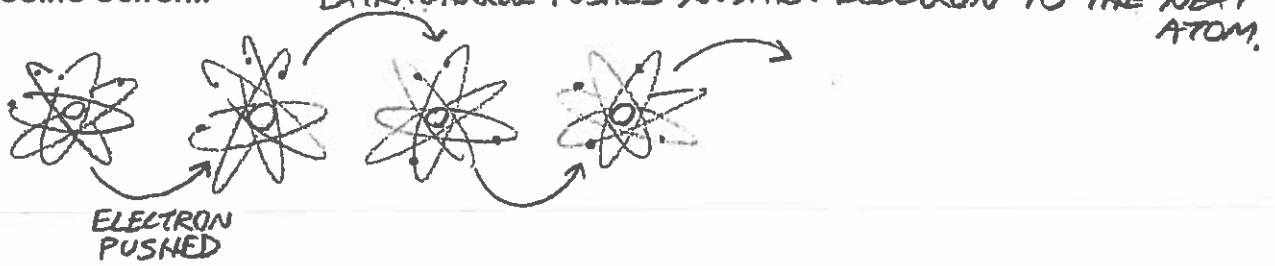
A build-up of extra negative charge makes **static electricity.**
Static electricity attracts things with opposite charges so things may stick to it.
Not every material builds up a static charge.



If enough charge builds up, electrons can jump to even things out → makes a tiny shock.
A BIG example of static charge jumping in nature is lightning.



When electrons bump along a direction (instead of just building up) it is called an **electric current.**



A **load** is anything (device, machine,...) that turns electricity into a purpose.

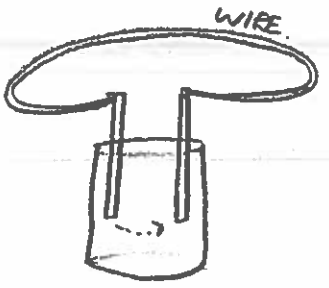
Electricity may be used for several purposes.

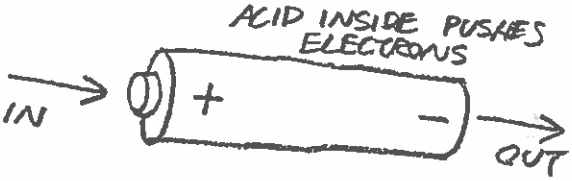
- light (example: a bulb)
- motion (example: an electric motor)
- sound (example: a speaker)
- temperature (example: a heater or a fridge)
- computing (example: calculator)

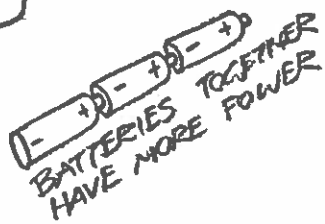
Electricity is very useful but can be very dangerous

- Electricity can kill (**electrocute**).
- Do not fiddle with plugged in machines.
- Do not overload outlets
- Do not touch exposed wires that are plugged in.
- Do not play near power lines.
- Be careful of water when using power tools.
- Household outlets are not safe for experiments

Batteries are a relatively safe source of electricity. Batteries have an electrolyte (an acid or base) that push electrons between electrodes (two metals). They move an electrical charge (a current) out the negative side, through a loop and in the positive side.



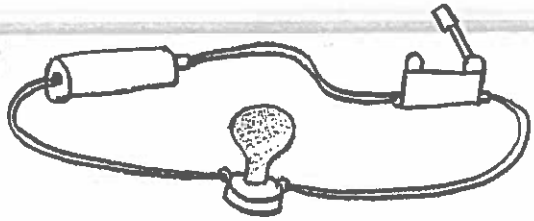




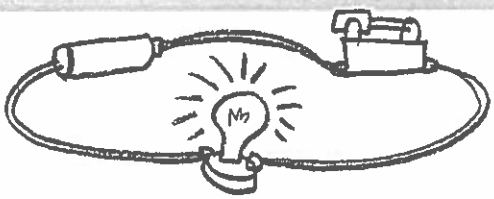
For electricity to move there must be a complete loop. We call the loop a **circuit.**

If there is a break, the electricity stops moving. A **switch** lets you control a circuit.

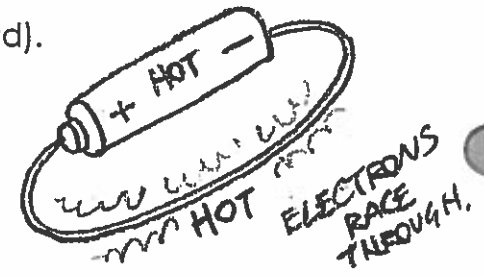
Open switch means off



Closed switch means on



Short circuits have nothing for the electricity to do (no load).



Two problems with short circuits:

1. wire heats up.
2. It wastes the limited amount of energy in batteries.

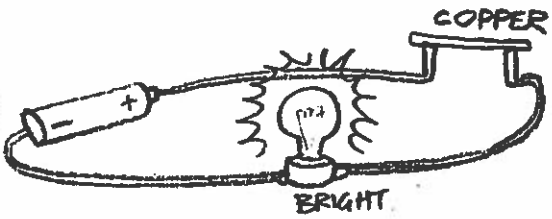
Some materials let their electrons move easily. Some do not.

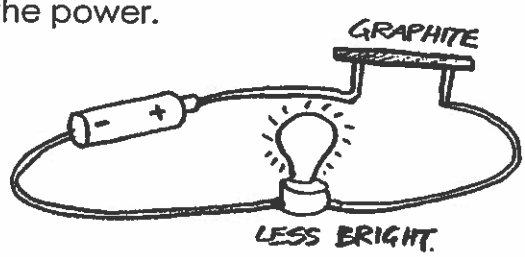
Conductors - materials that allow electricity to flow through them.
Examples: copper, steel, iron, gold, silver, aluminum,

Insulators - materials that **do not** allow electricity to flow through.
Examples: plastic, rubber, wood, glass

Resistors – Also known as semi-conductors. These are materials that **resist** electricity flowing through them. Electricity moves through but it becomes less powerful.
Examples: silicon, graphite (pencil lead)

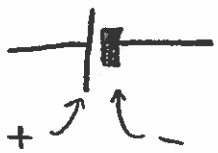
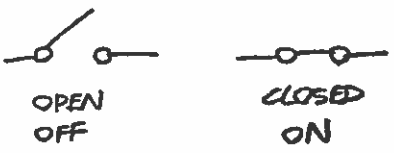
Putting a resistor in a circuit reduces the power.



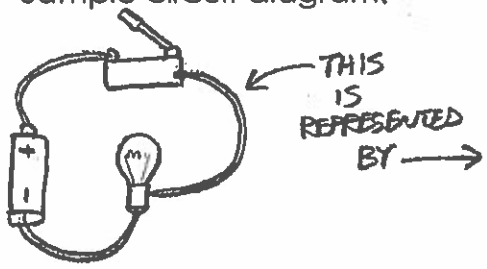


However, if there is enough electricity, it will move through anything. Lightning even jumps through the air and will move through a tree (wood).

Circuit diagrams show common symbols for electrical parts and how they are connected.

Power source (battery)	Conductor (wire)	Switch
		
Light	**Motor**	**Resistor**
		

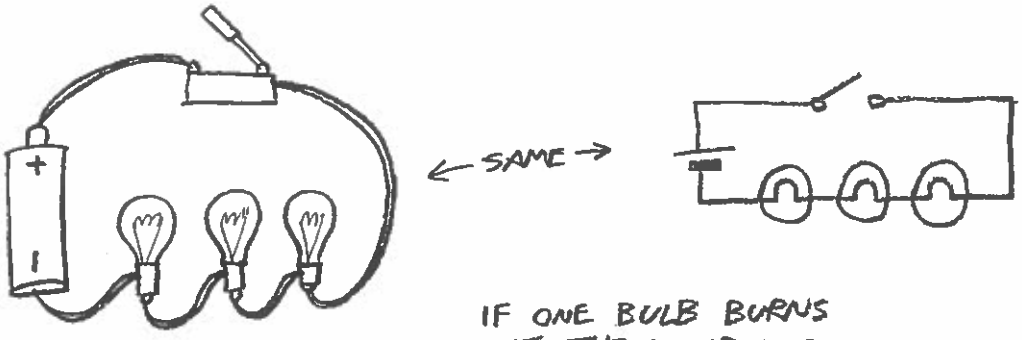
Sample circuit diagram.



USED ON BLUEPRINTS AND PLANNING MUST BE NEAT!

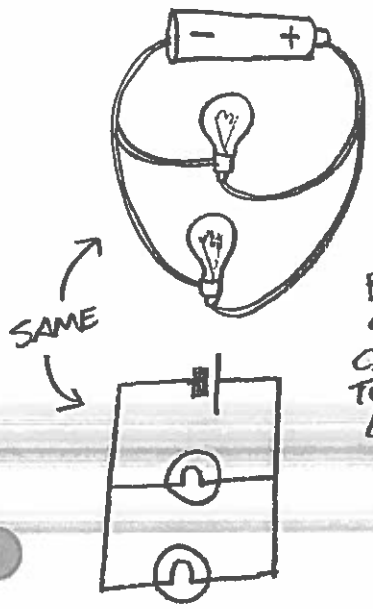
WIRES ARE SHOWN STRAIGHT. ORGANIZED AS A RECTANGLE. VERY NEAT.

This is a **series circuit.**
Loads are along a line.
If one load breaks or burns out, the electrical loop (circuit) is broken and none of the loads along the line will work.

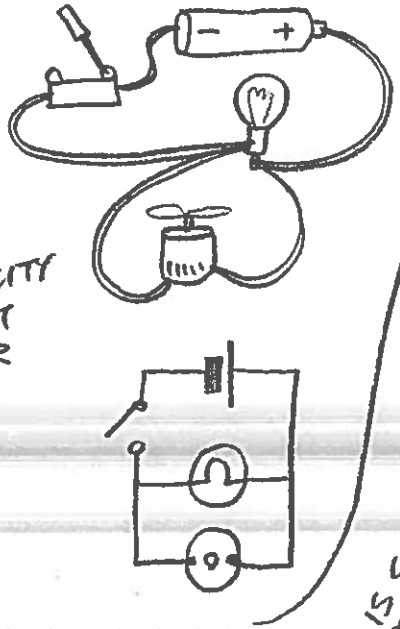


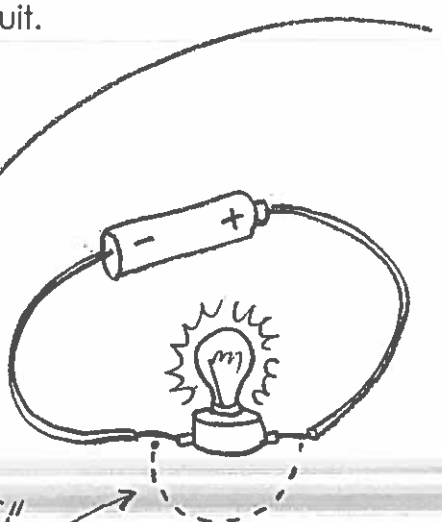
IF ONE BULB BURNS OUT THEN CIRCUIT IS BROKEN AND ALL BULBS TURN OFF.

These are **parallel circuits.** If one load breaks or burns out, other loads can still work because electricity can find another path to complete the circuit.



IF ONE BULB BURNS OUT, ELECTRICITY CAN STILL GET TO THE OTHER LOAD.





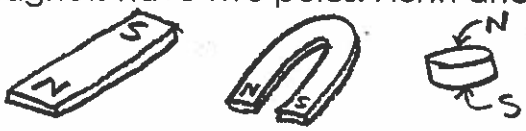
THIS IS CALLED A "SHORT CIRCUIT"

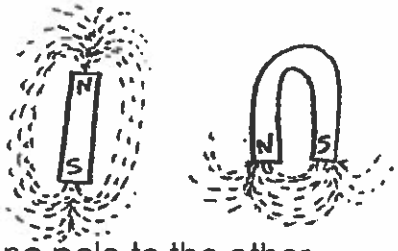
IF YOU PUT A WIRE HERE, THE BULB WILL TURN OFF. IT IS EASIER FOR ELECTRICITY TO RUN THROUGH WIRE THAN THROUGH A LOAD.

Electricity will always find the easiest route to take.

Magnets are attracted to certain metals that contain iron, cobalt and nickel. Magnets do not stick to copper or aluminum.

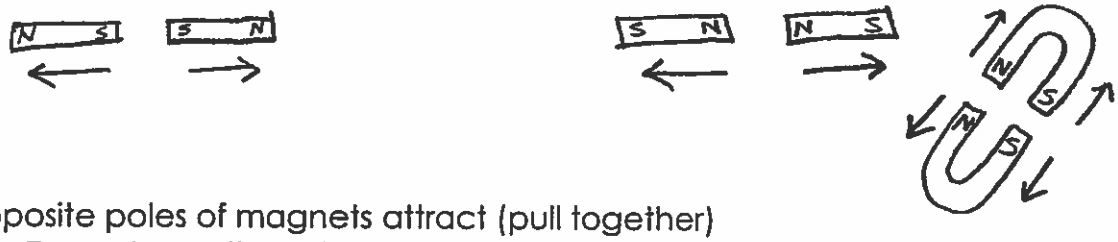
Magnets have two poles: North and South.



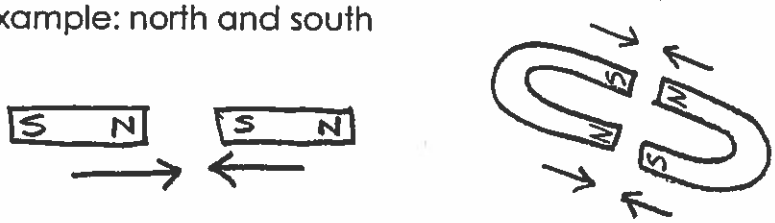


Magnets have a magnetic field that goes from one pole to the other.

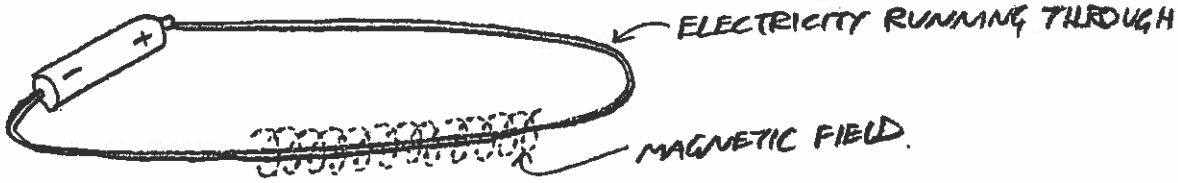
- Like poles of a magnet repel (push away)
  Example: south and south or north and north



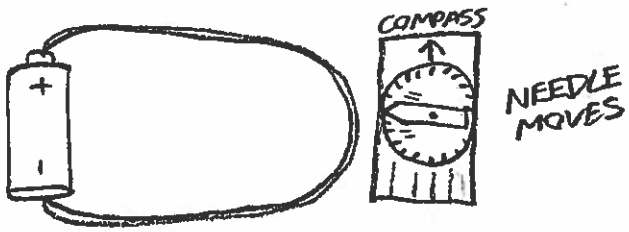
- Opposite poles of magnets attract (pull together)
  Example: north and south



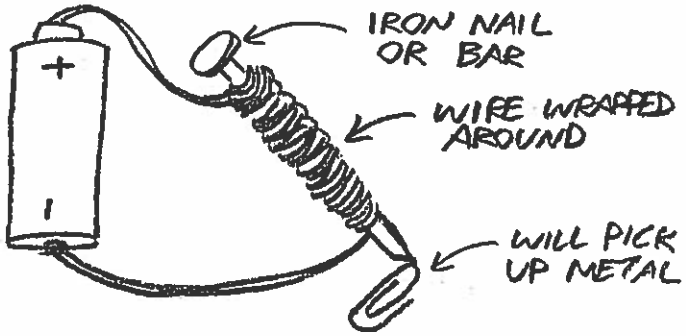
When electricity moves through a wire it creates a tiny magnet field around it.

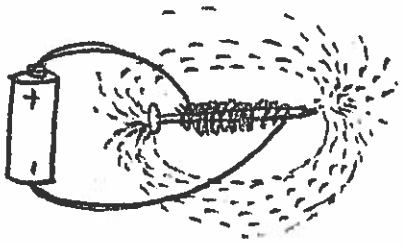


A loop of wire with a current moving through it will move the needle of a magnetic compass.

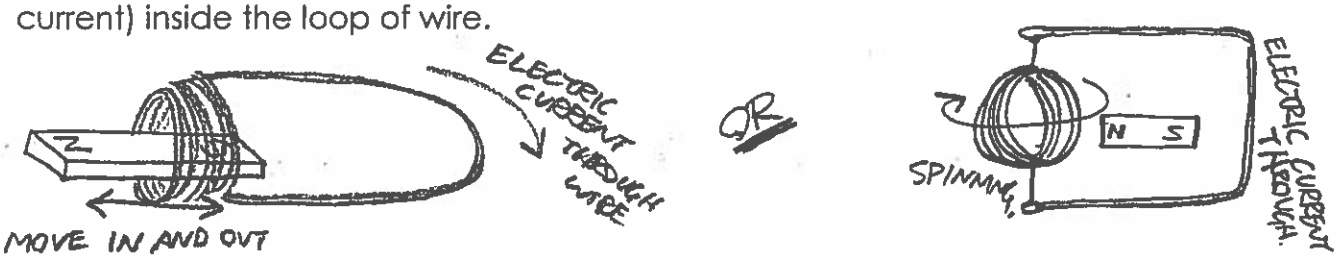


You can group up the tiny magnetic field to make an electromagnet. An electromagnet looks like this. It creates a magnetic field that can pick up metals.





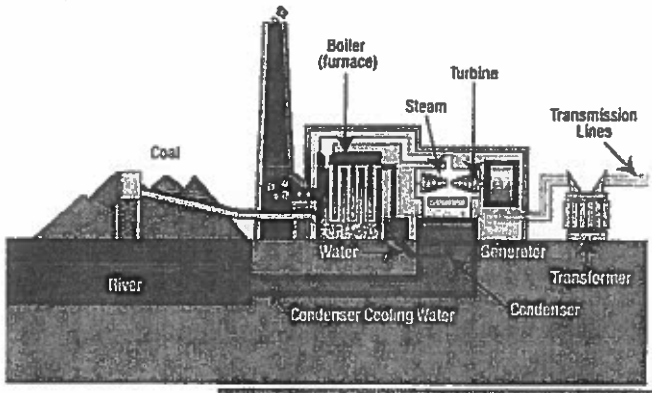
Moving a magnetic field through a loop of wire creates moving electrons (electric current) inside the loop of wire.



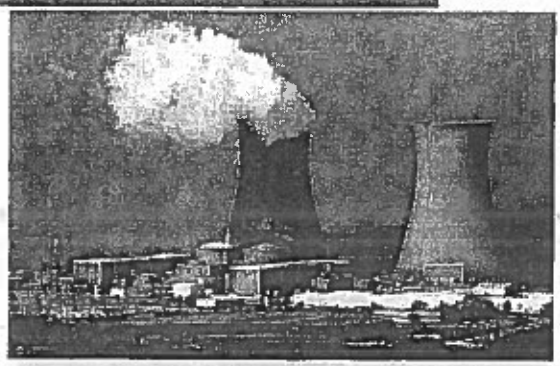
A **generator** is a machine that creates electricity by spinning loops of wire inside a magnetic field OR by spinning a magnet inside a loop of wire.

People have figured out different ways to get the loops of wire to spin.

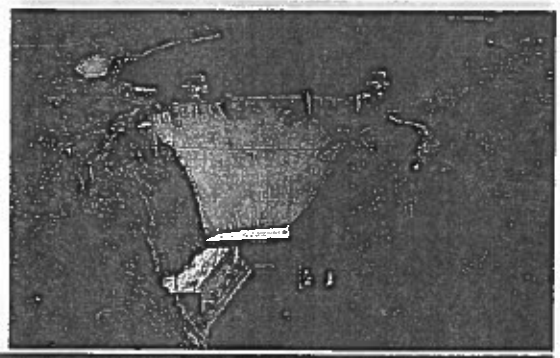
- Power plants burn coal to heat water into steam which turns a turbine (fan blades) which spins a generator to make electricity.



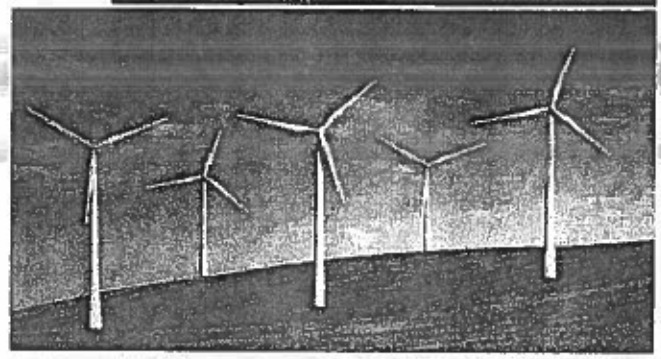
- Nuclear power plants use nuclear reactions to heat water into steam which turns a turbine (fan blades) which spins a generator to make electricity.



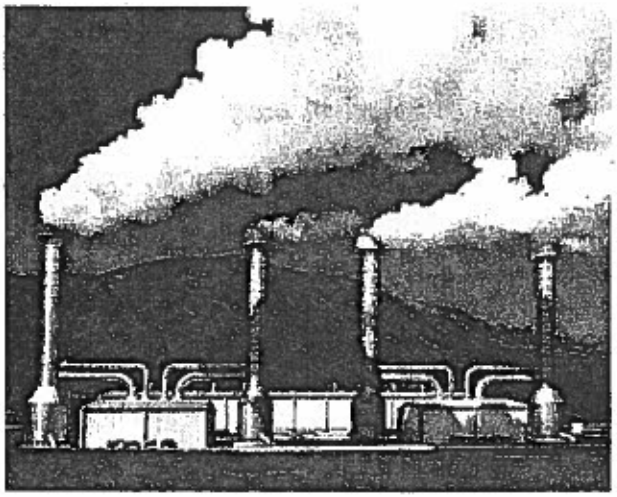
- Some dams hold back large amounts of water and slowly lets gravity pull in down through a turbine (fan blades) which spins a generator to make electricity.



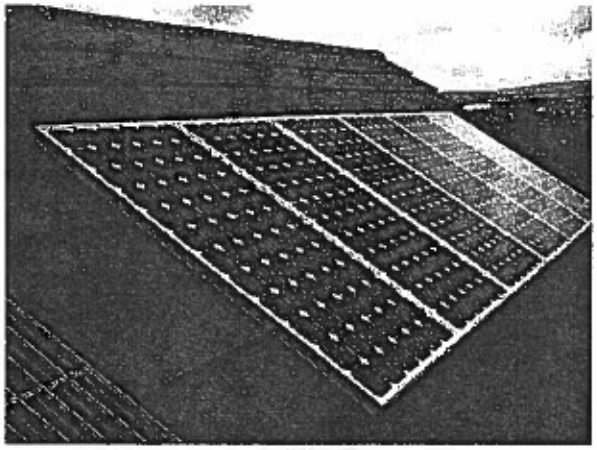
- In windy places, large wind turbines turn a turbine (fan blades) which spins a generator to make electricity.



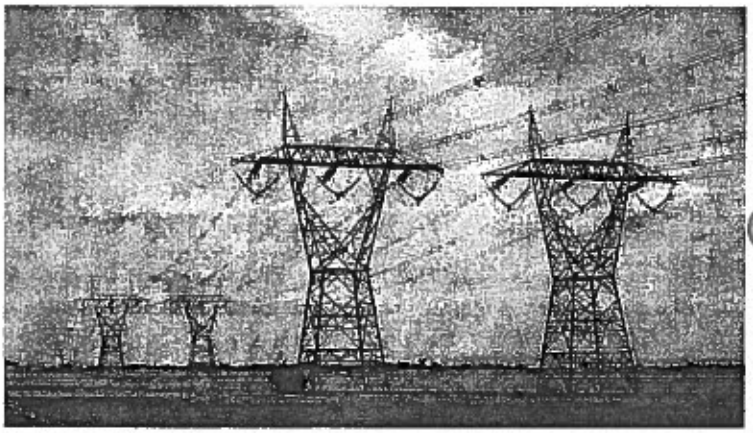
- In certain places, geothermal power plants use the heat inside the Earth (magma) to heat water into steam which turns a turbine (fan blades) which spins a generator to make electricity.



Picture show steam (water vapour) not pollution coming out of stacks.



Solar panels are another way to create electricity from the Sun's energy.

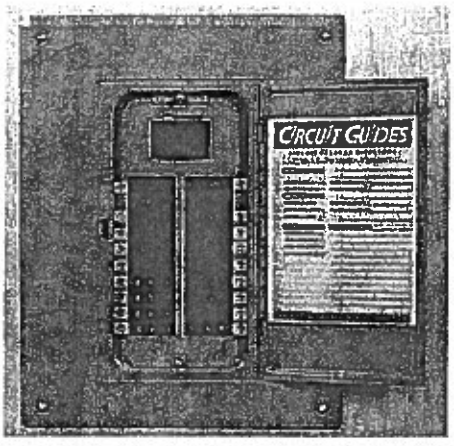


Electricity moves from power plants to cities through large power lines across long distances.

Some **transformers** boost their power up to be able to travel the long distances and then other transformers reduce their power to make the electricity safer for houses and buildings.

Power lines enter our homes either through wires above or through wires buried underground.

Wherever power enters your home there is an electrical meter and a breaker box.

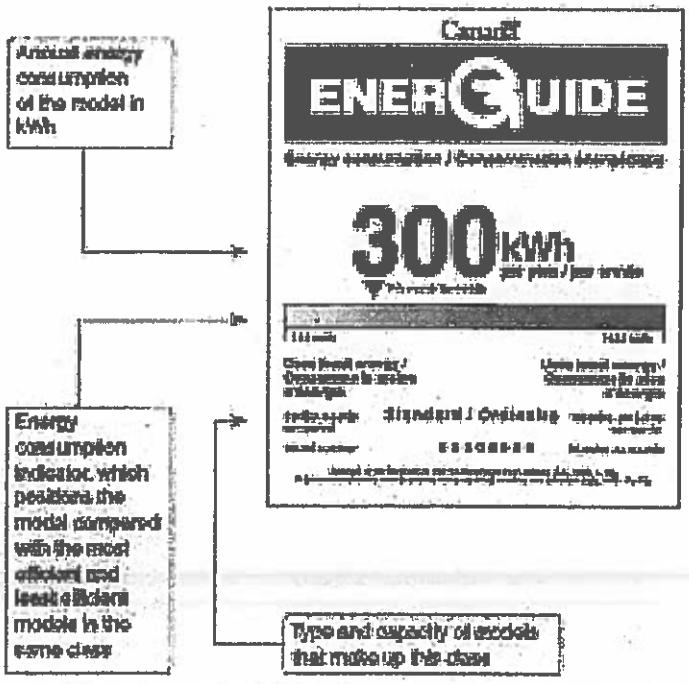


Different appliances (machines) use different amounts of electricity.

The amount of electricity is measured in **kilowatt hours** the symbol is **kWh.**

The amount of power a machine pulls through a wire in measured in amperes and are usually called amps.
Usually the wires in our homes can only handle 15 amps.
If machines pull more power, the wires inside the walls could heat up and cause a fire.
To be safe, if too many amps are happening, fuses or circuit breakers turn off the circuit.

Some appliances have efficiency labels. They show how much electricity is need by the machine.



Keep in mind that electricity has a COST.

If electricity comes through city wires, there is a bill ($$$) to pay for the electricity that is used.
If that electricity is made by a coal burning power plant, then there is pollution that goes into the environment.
Batteries that run out of power and are thrown away also fill landfills and if they crack open, their electrolyte (acid or base) will leak into the environment.

Be responsible with the electricity you use!

There are lots of exciting new inventions to use electricity.

- Longer lasting batteries.
- Rechargeable batteries
- "Green" energy (ecofriendly) – no pollution and no waste.
- Solar panels

Electricity and Magnetism

Electricity occurs naturally and has been observed for thousands of years.

Electricity is made up of microscopic electrons. They move and carry an electrical charge.

An electrical current is when the electrons flow or move.

Electricity is hard to explain because it is something that we cannot see. It is unlikely that anyone will properly see electricity because the electrons, which it is made of, are so small.

What is electricity?

We use electricity every day, in objects all around us. Electricity can produce heat, light, sound and movement.

Naturally Occurring Electricity

In nature, some organisms can produce their own electrical charge.
Electric eels, catfish, fireflies, stingrays
Your brain and nervous system produces electricity.
Lightning is a form of natural electricity.

Static Electricity

This is a buildup of stationary electrons on a surface of an object. For example, electrons from your hair build up on the surface of a balloon as you rub it against your head. This creates an electrostatic negative charge. The balloon can now stick to a surface because the balloon is acting like a magnet.

The positive electrons are trying to move to the negative electrons.

Where is Electricity made?

Electricity is made or produced from power plants. The power plants produce electricity in turbines, using water, heat- from coal or wind.
Electricity flows in a current from the power plant to our homes.

Electrical Current

Electricity flows just like water from a hose. The flowing electricity is called an electrical current. Currents of electricity flow through power lines, transformers and through wires in our homes.

Batteries

Electricity also comes from batteries. There are many different sizes of batteries and they all have different amounts of power. Batteries are storage cells of electricity. Batteries are also called cells. A battery has a positive terminal and a negative terminal. A terminal is where the electricity flows, much like a terminal in a train station.

Light Bulbs

A light bulb provides light. It uses electricity to produce light. A filament is heated by the electricity, which produces light.

Circuits

A circuit is a circular movement of electrons. In a circuit, the electrons flow from the battery to the load and back to the battery. In order for the circuit to work, it must be complete.

A simple circuit

A simple circuit is when one battery is connected to one bulb with wires. A wire is made of copper and covered in a plastic coating. Can you discover how to make light using a battery, bulb and wire?

Complete vs Incomplete Circuits

An Incomplete Circuit has a break or opening in the circuit. The circuit will not work. A Complete Circuit has no openings or breaks. The circuit will work because the electrons can flow in a complete circle.

Switch

Electricity flows as long as a complete circuit is in place. A switch acts like a gate in that circuit. When the switch is turned on, it completes the circuit. The electricity moves across the switch and keeps travelling. When you turn the switch off, it breaks the circuit.

Closed Circuit: A closed circuit is an example of a complete circuit except that a switch has been added. When the switch is closed, the current flows from the battery, through the closed switch, through the light and back to the battery.

Open Circuit: In the case the switch is open and the circuit is incomplete. The electricity will stop and the bulb will not light. Where would using an open and a closed circuit be useful?

Short Circuits

Batteries produce electricity. Electricity flows from the battery through the positive terminal, through the wire, back to the negative terminal. Flowing electricity creates heat, because the electrons are flowing through the wire, back to the battery. This is called a short circuit. There is no job or load for the electrons to perform.

Series Circuit - A Circuit with two or more lights hooked together. The problem is that if one bulb burns out then the circuit is incomplete and the rest will not work.

Parallel Circuit - Have all the bulbs connected directly to the power source. All bulbs will turn on at the same time but if one goes out, the others will stay on.

Adding a battery

If you add a battery, you can make the bulb brighter. Adding a battery, increases the amount of electrons that power the bulb, making more light.

Conductors: A conductor is an object that allows electrons to flow easily through it. Most metals, like copper and aluminum, graphite, water, and people are good conductors.

Insulators

Insulators are objects that do not allow electrons to flow easily through it or at all.
Wood, plastic, rubber are good insulators.

Resistors:

Resistors slow down electrons. When an electron is slowed down, it heats up. Nichrome wire, steel wool, and carbon filament are all examples of
resistors.

Magnets

A magnet is an object that produces a magnetic field. Magnets have a North and South Pole. The North Pole repels the north. The south repels the south. The north and the south are attracted to each other. Magnetic Field A magnetic field can either attract or repel other objects. If you take a bar magnet and break it into two pieces, each piece will again have a North Pole and a South Pole. If you take one of those pieces and break it into two, each of the smaller pieces will have a North Pole and a South Pole. No matter how small the pieces of the magnet become, each piece will have a North Pole and a South Pole. It has not been shown to be possible to end up with a single North Pole or a single South Pole.

Facts about Magnets

1. North poles point north, south poles point south.
2. Like poles repel, unlike poles attract.
3. Magnetic forces attract only magnetic materials.
4. While magnetized, temporary magnets act like permanent magnets.
5. A coil of wire with an electric current flowing through it becomes a magnet.

What types of magnets are there?

There are three main types of magnets:

Permanent Magnets

Permanent magnets are those we are most familiar with, such as the magnets hanging onto our refrigerator doors. They are permanent in the sense that once they are magnetized, they retain a level of magnetism.

Temporary Magnets

Temporary magnets are those which act like a permanent magnet when they are within a strong magnetic field, but lose their magnetism when the magnetic field disappears. Examples would be paperclips and nails and other soft iron items. Electromagnets

An electromagnet is a tightly wound coil of wire, usually with an iron core,
which acts like a permanent magnet when current is flowing in the wire. The strength and polarity of the magnetic field created by the electromagnet are adjustable by changing the current flowing through the wire.

Energy or Electrical Usage

Electricity is measured in your home. The electrical company will keep track of how much energy your homes use. They measure electrical usage in Kilowatts per hour. A watt is a unit of measurement for electricity. 1000 watts is equal 1 kW (kilowatt). Wattage Different devices have different wattages. The amount of wattage or how much energy is requires, is based on what function it performs. To produce heat, that requires more energy so that device who need more wattage. A clock does not require a lot of energy, so it has a lower wattage.

Electrical Meters

The electrical company keeps track of how much energy you use with an electrical meter. It is found outside of your house and they read it once a month.

Daily Energy Consumption

Most devices that require heat, use more electrical energy.
–Clothes Dryers, Dishwashers, Toasters, Ovens, Hair Dryer

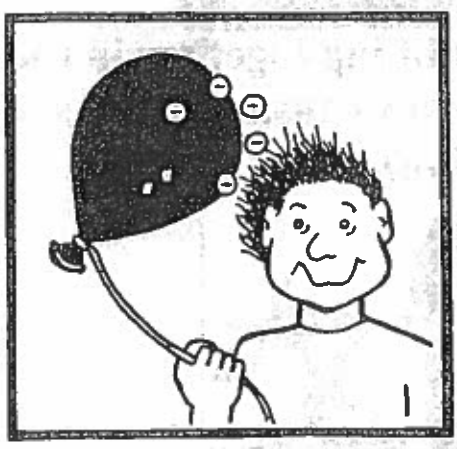
STATIC ELECTRICITY

1. How Does It Work?

When you rub your head with a balloon, the balloon will stick to the wall - why? The reason is that the friction made when two different objects are rubbed together creates static electricity. Three ways to tell if static electricity is present are:

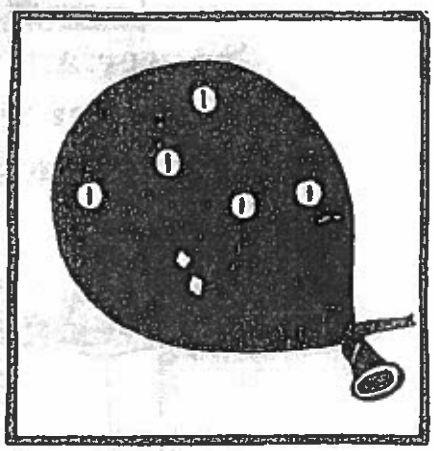
1) **it sparks and can shock you**
2) **it makes a crackling sound**
3) **it causes things to stick together.**

Step 1



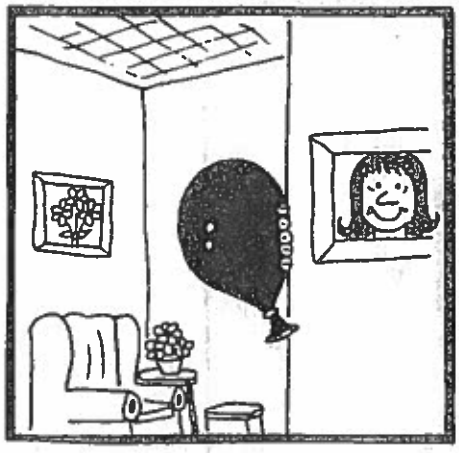
Rubbing causes the balloon to "steal" electrons from your hair.

Step 2



The balloon has a buildup of electrons so it has a negative charge. Your hair has lost electrons so it becomes positively charged.

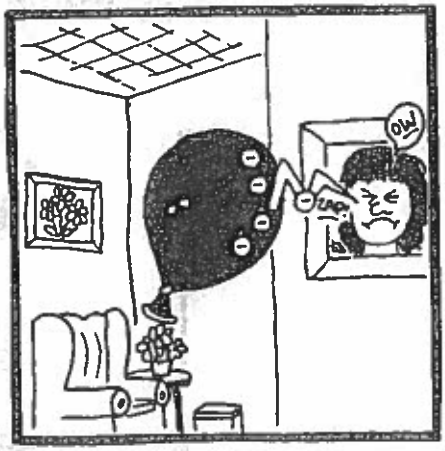
Step 3



Because opposites attract, the negatively charged balloon will stick to the wall.

or

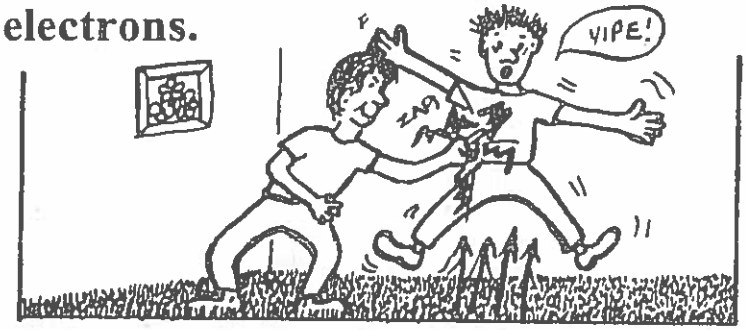
Step 4



If there are enough electrons on the balloon, they will try and "jump" to the wall and will make a small

2. Where Does Static Electricity Occur?
Everyday examples include:

1) **dragging rubber-soled shoes can "steal" electrons from the carpet and you can usually shock someone with your buildup of electrons.**



2) **certain types of cloth rubbing together in the dryer will "steal" electrons causing clothes to stick together (static cling).**

3) **electrons collect on your TV screen and produce static electricity. (This is why there is so much dust on most TV screens)**