

Electricity

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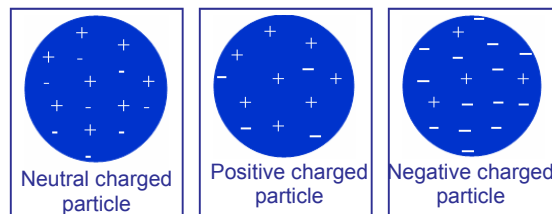
Electricity

Electricity is the movement of electrons from one atom to another.

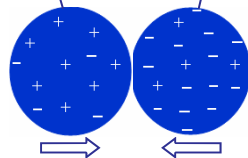
Electricity is a very useful form of energy resulting from the existence of charged particles (electrons and protons). These particles can be charged statically as an accumulation of charge or dynamically as a current. Electricity is easy to transport because it can flow along cables. It can easily be converted to other forms of energy, such as light, heat or movement. It makes all electric appliances and devices work. Electricity is used to power industries and a lot of devices at home. Electricity is kept out of reach because if we touch it, it can give us a very dangerous shock.

Particles and electric charges

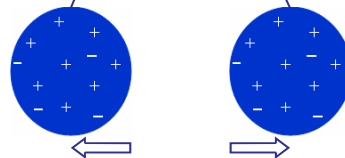
Particles can be neutral charged, positive charged or negative charged.



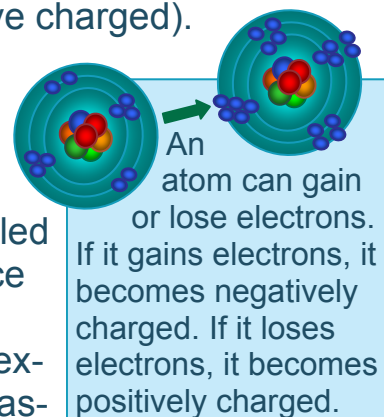
Particles with different charges get attracted.



Particles with the same charge are repelled..



All substances are made of tiny particles called atoms. In the middle of each atom there is a core called *nucleus* (positive charged). Around the nucleus is a cloud of particles called electrons (negative charged). Electricity results from the behaviour of the electrons which have a property called **electric charge**. Electrons are attracted by positive charged particles and repelled by other negative charges. Atoms have a balance of electric charge, but some substances can become electrically charged because they accept extra electrons, while others lose electrons quite easily. This is known as **static electricity**. Charge cannot build up on materials such as metals because they let electrons flow through them. We call a flow of electric charge **current electricity**.²



electricity in nature

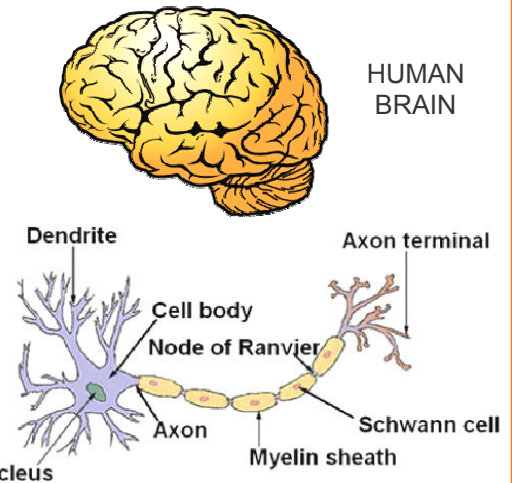
Static electricity

is a form of electricity that builds up in some substances when electrons *jump* to another particle and stay there. They do not have a conductor.

Static electricity is used in laser printers and in photocopiers during the printing process.

1. Drum charged with static electricity.
2. Light shone in the image being copied and reflects on the drum that loses charge in the bright areas.
3. The ink powder sticks only in the charged parts of the drum.
4. This pattern is transferred to paper.
5. Ink is fixed to the paper by two heated rollers.

Our body is full of electricity. The 10 billion nerve cells in our brain work by sending messages one to each other in the form of impulses of electricity.



Our brain is made of a big bundle of millions of cells called neurons. Our brain controls everything that happens in our body. When we think our neurons are passing signals to each other. Neurons link the brain to sense organs and all the other parts of the body. The brain stem links the brain to the spinal cord and so to the rest of the body. Information travels in the form of nerve impulses along the spinal cord to the rest of the body. Brain allows us to make decisions based on stored information. In medicine electrical signals from the brain are observed to find out about certain illnesses.

Lightning is a big spark of electricity in the sky. Lightning is the biggest example of a kind of static electricity caused when water molecules inside clouds rub together during storms. Thunder is the noise that the spark makes. A lightning strike is dangerous, but spectacular.



Lightning strikes somewhere on the surface of the earth about 100 times every second.

The **electric eel**, is a species of fish. It is capable of generating powerful electric shocks, which it uses for both hunting and self-defense. It is a top predator in its South American range. The electric eel may be found in the basins of both the Amazon River and Orinoco River, as well as the surrounding areas. It can grow up to 2.5 m in length and 20 kg in weight, although 1 m specimens are more common. They tend to live on muddy bottoms in calm water and are obligate air-breathers; rising to the surface every 10 minutes or so, the animal will gulp air before returning to the bottom. The Sachs organ, a stack of electroplaques, is the primary source of communication among *E.*



electricus. These signals are used in communication as well as orientation, useful not only to find prey but also thought to play an important role in finding and choosing a mate.

current electricity

Currents are created because of the separation of positive and negative charges. When electrons see a positive charge they move. Batteries use chemicals to create an environment that keeps electrons moving. When the areas of positive charges and negative charges are connected, a circuit is created: it is what you do every time that we switch on lights or other electric devices.



Positive charges pull on negative charges. Electrons are too small to individually pull protons. That's why electrons do the flowing: electric force is stronger when electrons are closer to a positive charge.

Conductors and conductivity

Conductors are materials that gives very little resistance to the flow of an electric current: they have the quality of **conductivity**.

Types of conductors

Metallic conductors

In metallic conductors there are a lot of free electrons. So they are good at carrying the flowing current. We use copper wires, but there are other good metallic conductors like silver and gold.

Ionic conductors

It's a solution, like salt water. They have a lot of free ions floating around and they can carry current very well.

Ion is an atom or molecule with a net electric charge through loss or gain of electrons, either positive (a **cation**) or negative (an **anion**).

Semi-conductors

Silicon is a semi-conductor. In semi-conductors there are free electrons to carry the current, but not as many as in conductors, so they have low conductivity. They are used in electronics, they make our computers possible.

Insulators

Insulators are conductors, but just bad conductors. They allow little or no current to flow through. Materials like glass, plastic, wood, paper, etc. are good insulators because they are very bad conductors.

Michael Faraday

Faraday was a scientist who came up with the idea of electric fields. Positive charges like to move toward negative charges, negative charges like to move toward positive charges. Negative charges move away from positive charges along the line of force (direction that charged particles move to adjust themselves).

Electric fields

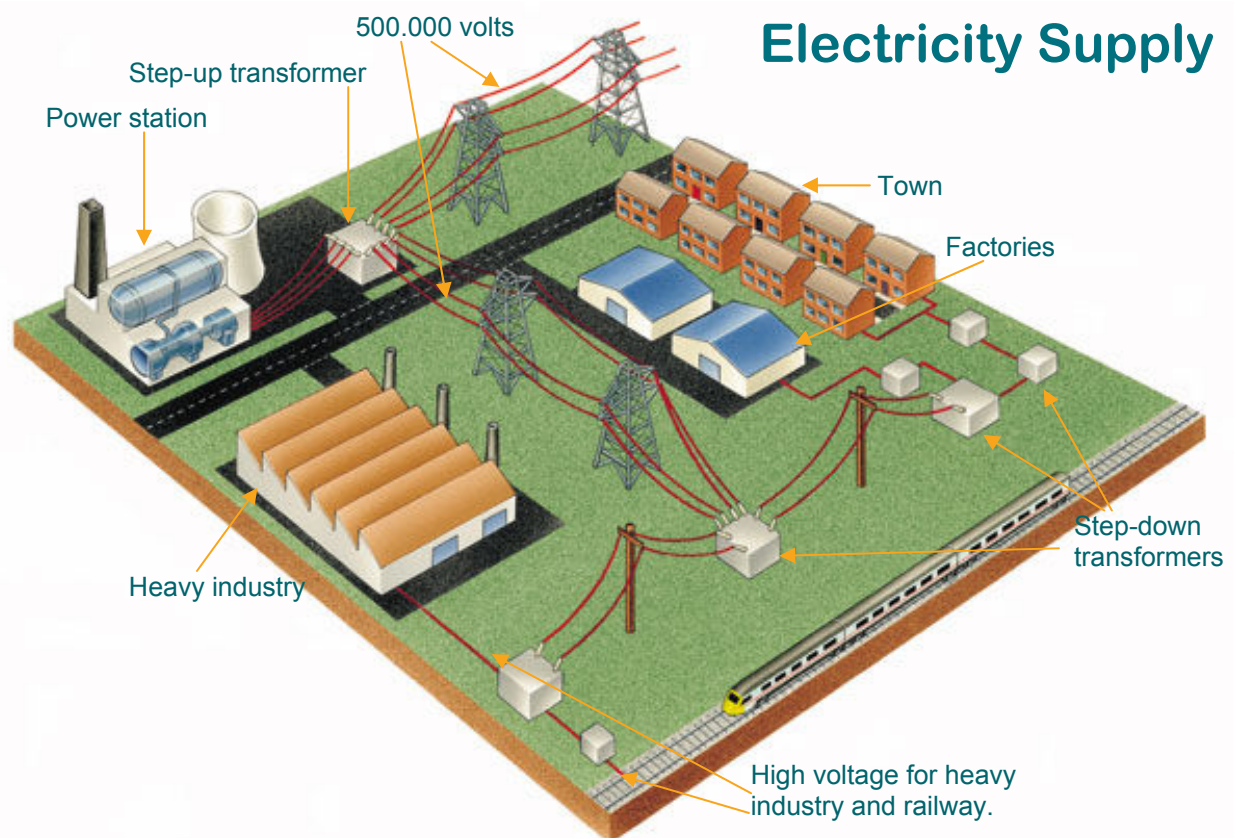
It's the area near any electrically charged object. They can also be created by magnetic fields. They usually happen when two charges are separated: it can be negative charges repelling one to each other or negative and positive charges attracting each other. The strength of the field depends on the distance between the two particles.

Magnetism and electricity are always connected.

Electric current happens when electrons or individual negative charges flow from one place to another like a stream of energy. The speed of the current is measured in *amperes*. The flow of current heats the conductor because when they move they produce a friction and this friction creates heat. The more electrons bumping into the atoms of the conductor, the more heat is created. *Superconductors* let the charges move through very fast without losing energy because there is less friction and they do not heat like normal conductors.

Kinds of current

- There are two main kinds of electric current:
- ⇒ Direct current (DC): it's a steady stream of energy (same direction and constant intensity) where the charges move directly from one point to another. It is the kind of current you can get from batteries, dynamos. It is used for very low and very high voltages.
 - ⇒ Alternating current (AC): energy flips back and forth reversing the direction of the electrons, almost pulsing through the power lines. Used for the domestic and industrial voltage.



Power stations produce electricity (AC) at a voltage of about 20,000 volts. This kind of current changes direction many times per second, so it wouldn't be economic to send this electricity over long distances because too much power would be lost: this electricity is transformed in a step-up transformer to a very high voltage (400,000-500,000 volts) and it travels as DC, so much less power is lost. It is carried across the countries and it is changed again into AC and lower voltages in step-down transformers to be used at home and industries.

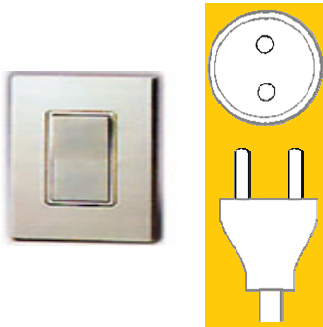
Huge amounts of energy are used to produce electricity. This is why it's so important to save it as much as possible. It is our individual responsibility to do as much as we can.

circuits

A circuit is a system of electrical conductors and components forming a complete path around which an electric current can flow.

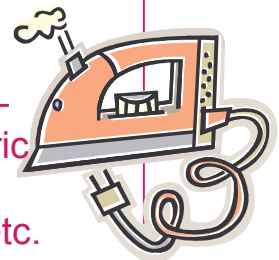
An electric current flows from one place to another because of the **potential difference**, which is measured in volts (voltage). We need a power force to keep current flowing through an unbroken conducting pathway called **electric circuit**. The power source has two ends, called poles or terminals, where the power starts and ends. These poles have opposite charges.

And, of course, you can decide to change or interrupt the flow of circuit: how?



Switches, plugs and commutators help you to do it easily.

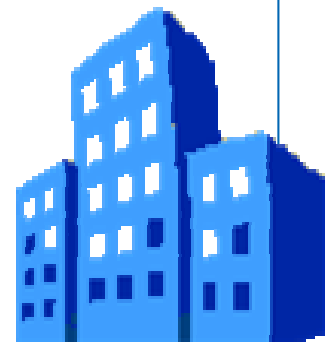
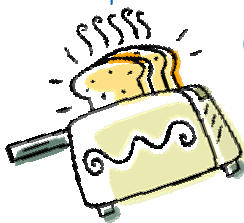
Somewhere in the circuit we can add components such as bulbs, appliances, heaters, radios, etc. and transform electric current in another kind of energy; light, heat, movement, etc.



Two kinds of circuits

Series circuits: the current passes through the all the components from one to another. If one of the components is not working, the circuit is broken and none of the components of the circuit will be working any more. This is what happens with some Christmas lights when a bulb is not working: you need to remove the broken bulb to get the rest of the lights shining again.

Parallel circuits have more than one path for the current, so current always can find a path to continue to other components. These are the kind of circuits used in household. We can interrupt the flow of the current to a part of the circuit (with a switch) but all the rest is working as usual.



If you ever want to experiment with circuits and electricity, you have to make one with batteries. You cannot touch, play or experiment with the electric circuit of a house or building because they work at too high voltage:

You could get electrocuted!!!

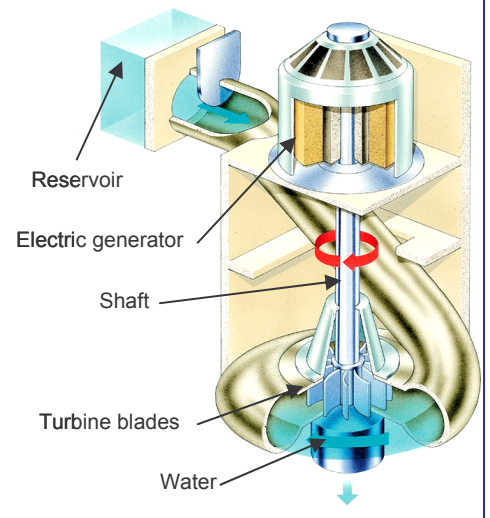
generating electricity

Power stations

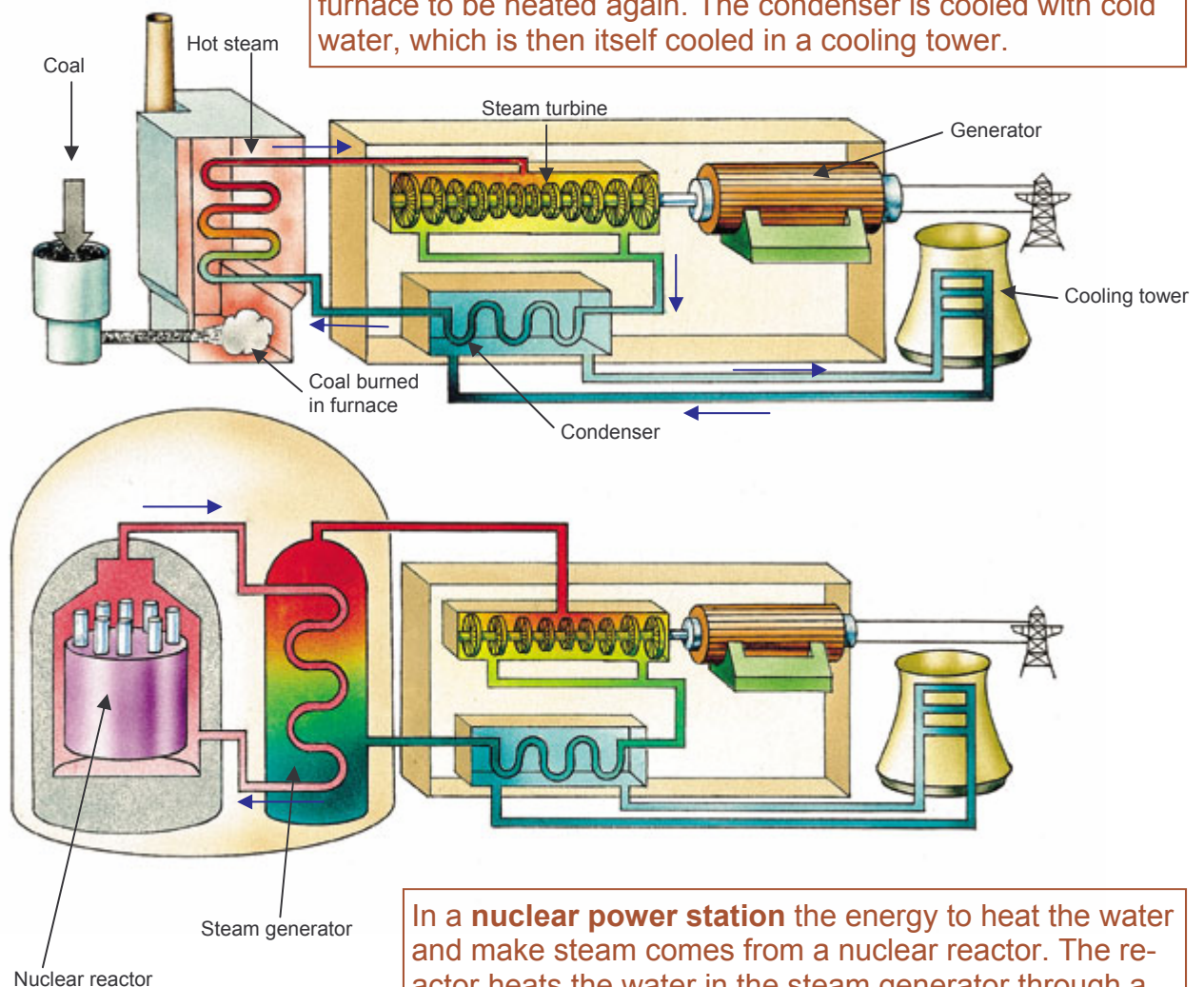
One power station can generate electricity to supply thousands of homes. A huge amount of electricity is used in homes, industries, transports, cities and offices. Power stations use a lot of energy to generate electricity: there are different kinds of power stations according to the fuel they are powered with. Water, wind and geothermal energy are some of those fuels.

In a **hydro-electric power station** the generation of electricity is made using the power of flowing water from a reservoir, river or lake to drive a turbine. Flowing water spins the blades of the turbine and which powers a generator.

A **generator** is a dynamo or similar machine for converting mechanical energy (movement) into electricity.



A **coal or oil-fired power station** contains a furnace, where the fuel is burned to heat water and make steam. The steam drives a turbine attached to an electricity generator. The steam is turned back into water in a condenser, then goes back to the furnace to be heated again. The condenser is cooled with cold water, which is then itself cooled in a cooling tower.



In a **nuclear power station** the energy to heat the water and make steam comes from a nuclear reactor. The reactor heats the water in the steam generator through a heat exchange system, so that no radioactivity can get into the steam powering the turbines.