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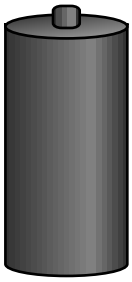
SCIENCE MADE SIMPLE

HOW DO BATTERIES WORK?



Batteries power things like flashlights, toys, radios and watches. There are many kinds of batteries in different shapes and sizes. Some seem to last longer than others before they wear out. Have you ever wondered:

How do batteries work?

What Is Energy?

Batteries provide energy. What is energy?

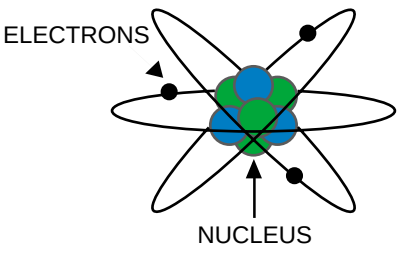
Energy is the ability to do work, or to make something happen.

There are many different kinds of energy. These include heat, light, chemical and electrical energy. Energy can change from one kind to another.

Batteries store chemical energy. When the ends of a battery are connected together, the chemical energy is changed to electrical energy. The electrical energy can be used to do work.

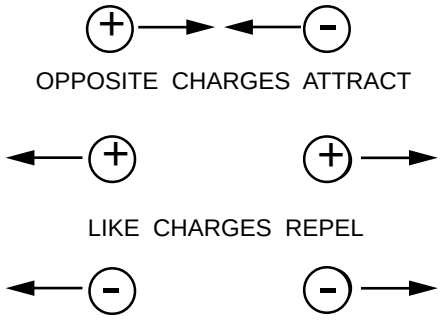
Everything Is Made Of Atoms

Everything in the world around you is made of very tiny particles called atoms. And atoms are made of even smaller particles called protons, neutrons and electrons. The protons and neutrons are packed very tightly together in the center of the atom. This is called the nucleus. Whirling around the nucleus are smaller particles called electrons.



Protons and electrons have what is called an "electric charge." Protons have a "positive" charge. Electrons have a "negative" charge. Neutrons have no charge; they are neutral.

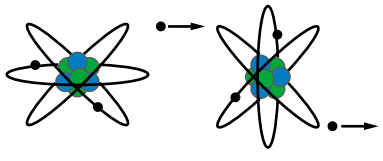
Positive and negative are opposite charges. Things with opposite charges attract, or pull towards each other. Things that have the same kind of charge repel, or push apart from each other.



Electricity

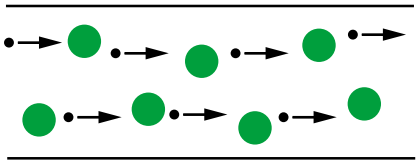
In atoms, negative electrons are attracted to positive protons. So atoms hold most of their electrons very tightly.

But some electrons near the outside of an atom are not held as tightly. They may be able to move from one atom to another. Materials whose electrons move easily from atom to atom are called conductors. (Most metals are good conductors.)



IN A CONDUCTOR, ELECTRONS MOVE EASILY FROM ATOM TO ATOM

Usually the electrons in a conductor move in all different directions. Sometimes, they will all move in the same direction. This flow of electrons is called electricity, or electric current.



Current is the flow of charged particles.

There are two things needed for current to flow. The first is a path it can flow through. This continuous, unbroken path is called a circuit.

The second thing is a force to push the electrons through the circuit. This force is called voltage.

Voltage exists when there is a difference in the electric charge between two places. If there is a path, electrons will move from the place with a negative charge toward the place with a positive charge. Current flows because positive and negative charges attract each other.

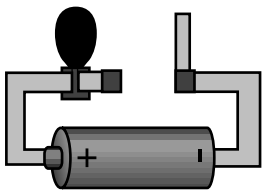
Voltage is measured in volts. A flashlight battery produces about 1.5 volts. The electric lines coming into houses in the U.S. carry about 115 volts. Long-distance power lines can carry hundreds of thousands of volts.

FUN FACTS
HOW FAST DOES CURRENT FLOW?

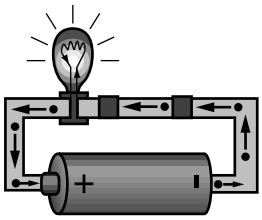
When you flip on a light switch, the light comes on instantly. That is because electric energy travels close to the speed of light. However, the charged particles themselves move much more slowly. The electrons may only travel a few centimeters per minute along the copper wire.

How Does a Battery Work?

Inside a battery are several kinds of chemicals. These chemicals store energy. Chemicals can react with each other and change into different chemicals. Some reactions give off extra electrons. Other reactions require electrons to take place. When the ends of a battery are connected together, there is a path for the movement of electrons. The chemicals react. The stored chemical energy is changed to electrical energy, and current flows.



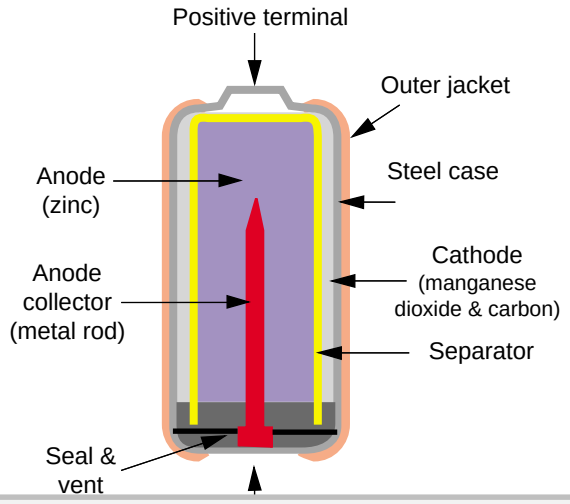
SWITCH IS OPEN.
NO ELECTRICITY FLOWS.



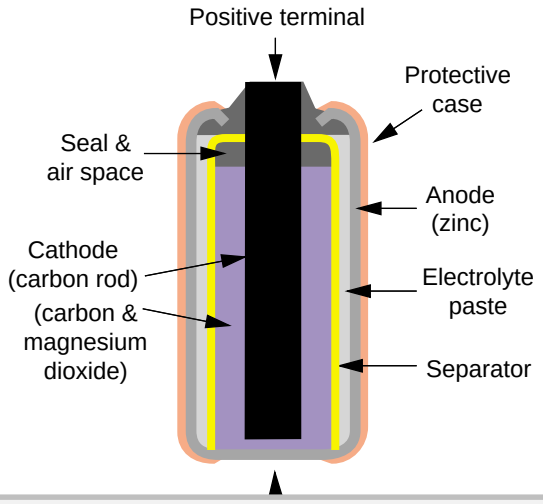
SWITCH IS CLOSED.
ELECTRICITY FLOWS.
THE BULB LIGHTS UP.

BATTERY CROSS-SECTIONS

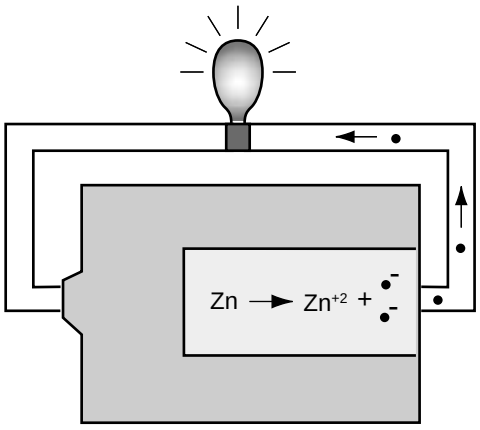
ALKALINE BATTERY



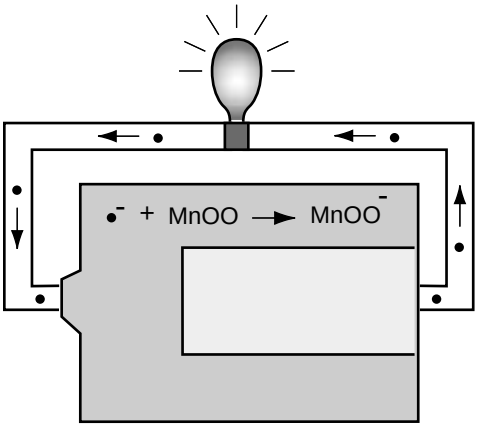
CARBON ZINC (FLASHLIGHT) BATTERY



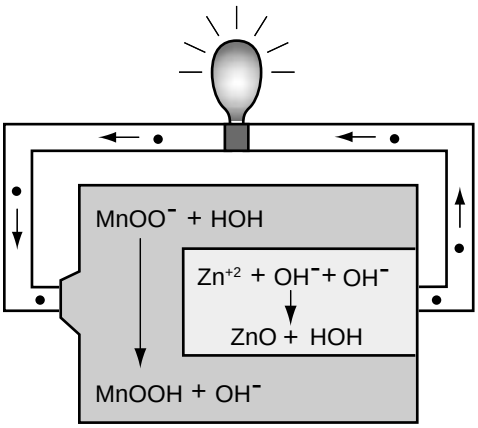
HOW ALKALINE BATTERIES WORK



When the battery terminals are connected together, zinc atoms in the anode give up two electrons. The zinc atoms become positively charged. The electrons flow out of the battery and through the circuit, doing work.



Electrons return to the battery through the cathode. Manganese dioxide molecules take up electrons and become negatively charged.



Electrolyte is located in both the cathode and the anode. The charged manganese dioxide reacts with water in the electrolyte. The water breaks apart into H^+ and OH^-. The H^+ combines with the manganese dioxide. The OH^- moves to the anode. There, it combines with the positively charged zinc

There are three main parts to a battery: the electrolyte, and two electrodes. Working together, these parts make up a "cell."

The negative (-) electrode is called the anode. It is made of a material which gives up electrons easily. Usually, the anode is a metal.

The positive (+) electrode is called the cathode. It is made of a material which can take in (or accept) the returning electrons. The cathode is often made of a metal oxide. (An oxide is a material that has reacted and combined with oxygen.)

When the battery terminals are connected in a complete circuit, a chemical reaction takes place. The metal in the anode gives up electrons. The electrons flow out of the battery and through the circuit. This electric current can be used to do work, like light a bulb or turn a motor. Then electrons flow back into the other end of the battery. The cathode collects those electrons.

To complete the circuit, the electrons have to flow from the cathode back to the anode. That is the job of the electrolyte. The electrolyte can be a liquid, paste or solid material. In some kinds of batteries, the electrolyte is located between the electrodes. In other kinds of batteries the electrolyte is mixed in with the electrodes. Without an electrolyte to carry the electrons, the battery would not work.

Battery Sizes

Batteries come in many shapes and sizes. Some of the most common are the 1.5 volt, cylinder-shaped "D", "C" and "AA" batteries. Why are there different sizes? The bigger batteries contain larger amounts of chemicals and so can provide more energy than smaller batteries.

Primary Batteries

Many batteries use up one of their chemicals to make electricity. They are called primary batteries. When the chemical is gone, the battery stops working. It must be recycled or thrown away.

A common kind of primary battery is the carbon-zinc battery. It is sometimes called a dry cell or flashlight battery. As a zinc-carbon cell

works, zinc is changed into zinc oxide. When the zinc is gone, the battery is dead.

The carbon-zinc battery is often used in toys or flashlights. It is inexpensive, but it wears out quickly. The carbon-zinc battery used today is very similar to a cell invented in the 1860's. There are now many newer, better kinds of batteries.

One of these is the alkaline battery. Alkaline batteries last much longer than carbon-zinc batteries. They use different materials inside. The electrolyte is an alkaline chemical called potassium hydroxide. Instead of being in a separate layer, it is mixed in with both electrodes. These batteries produce more energy for a longer period of time.

Anther common primary battery is the mercury cell. It is often used in things like watches and hearing aids because it can be made as a small flat disk.

Secondary (Rechargeable) Batteries

Secondary batteries are rechargeable. They make electricity by changing one of their chemicals into another form. When all of the chemical has been changed, the battery stops working. But it can be recharged. Sending current through the battery in the opposite direction changes the chemical back to its original form. Rechargeable batteries can be used over and over again.

Lead-acid batteries are a common type of secondary battery. They can produce strong current for a short time. This is useful for starting an engine, and lead-acid batteries are used in automobiles, trucks and airplanes.

Another common rechargeable is the alkaline nickel-cadmium cell, or Ni-Cad. It is light weight and often used for cordless appliances and other portable equipment. Ni-Cad batteries also:

- produce very high current, which is good for starting and turning motors.
- can be rapidly recharged many, many times.

However, Ni-Cad batteries often show a "memory effect." They produce less energy after repeated use. They work better and last longer if they are fully discharged and recharged each time.

Many other kind of batteries are available for special uses. And research into new and improved batteries continues as scientists look for cheaper, smaller, more powerful and longer-life batteries.

WORD PUZZLE
Taking care of batteries

1) _____ dispose of batteries in a fire because they could explode.

N _ _ _ _ _

2) Remove batteries from equipment which will not be used for several _____ to prevent them from leaking or corroding.

M _ _ _ _ _

3) Do not use different kinds of batteries (alkaline & zinc), or mix new and _____ batteries together in the same equipment.

_ _ D _

4) Follow instructions carefully when inserting batteries. Make sure the + and - _____ are lined up correctly.

_ R _ _ _ _ _ _

5) Do not try to _____ a regular battery, because it could explode.

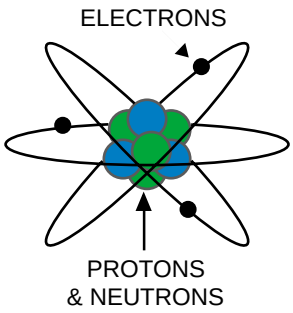
R _ _ _ _ _ _ _

6) Answer the following question using the letters from the squares above: Who invented the battery?

_ _ _ _ _

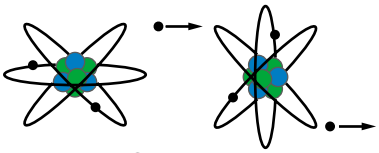
(Answers are on page 8)

I CAN READ
HOW DO BATTERIES WORK?

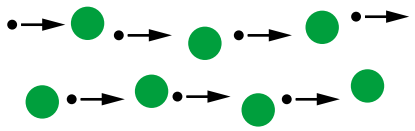


Everything around you is made of very tiny parts called atoms. Atoms are much too small to see. And atoms are made of even smaller parts. These are called protons, neutrons and electrons.

Atoms hold onto most of their electrons very tightly. But some electrons can move from one atom to another.

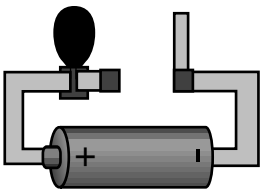


Sometimes the electrons all move in the same direction. This is called electricity, or electric current.



Electricity needs a path to move through. Then it can do work. Electricity can light a light bulb or turn a motor. It can run a watch or a computer.

Batteries make electricity. How? Batteries have chemicals inside. These chemicals hold energy. When you connect the ends of a battery together, there is a path electricity can flow through. The chemicals in the battery start to change. Some of the chemicals give up electrons. The electrons flow out of the battery and along the path, where they can do work. The electrons go back in the other end of the battery. Inside, different chemicals collect the returning electrons. So, as the chemicals change, the battery makes electricity.



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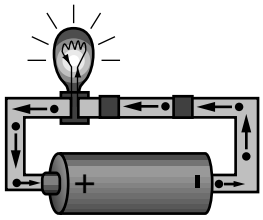

SWITCH IS CLOSED.
ELECTRICITY FLOWS.
THE BULB LIGHTS UP.

Some batteries use up their chemicals. Then they stop working. They must be recycled or thrown away.

Other batteries are rechargeable. They have different chemicals inside. The chemicals change as the battery works. When all the chemicals have changed, the battery stops working. You can recharge the battery by putting electricity through it in the opposite direction. This changes the chemicals back. They are ready to be used again. Rechargeable batteries can be used many times before they must be thrown away.

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