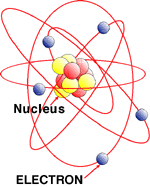
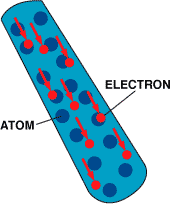
**Chapter 2: What Is Electricity?**

Electricity figures everywhere in our lives. Electricity lights up our homes, cooks our food, powers our computers, television sets, and other electronic devices.

But what is electricity? Where does it come from? How does it work? Before we understand all that, we need to know a little bit about atoms and their structure. All matter is made up of atoms, and atoms are made up of smaller particles. The three main particles making up an atom are the proton, the neutron and the electron. Electrons spin around the center, or nucleus, of atoms, in the same way the moon spins around the earth. The nucleus is made up of neutrons and protons.

Electrons contain a negative charge, protons a positive charge. Neutrons are neutral – they have neither a positive nor a negative charge.

There are many different kinds of atoms, one for each type of element. An atom is a single part that makes up an element. Each atom has a specific number of electrons, protons and neutrons. But no matter how many particles an atom has, the number of electrons usually needs to be the same as the number of protons. If the numbers are the same, the atom is called balanced, and it is very stable.

Electrons can be made to move from one atom to another. When those electrons move between the atoms, a current of electricity is created. The electrons move from one atom to another in a "flow." One electron is attached and another electron is lost.

This chain is similar to the fire fighter's bucket brigades in olden times. But instead of passing one bucket from the start of the line of people to the other end, each person would have a bucket of water to pour from one bucket to another. The result was a lot of spilled water and not enough water to douse the fire. It is a situation that's very similar to electricity passing along a wire and a circuit. The charge is passed from atom to atom when electricity is "passed."

Since all atoms want to be balanced, the atom that has been "unbalanced" will look for a free electron to fill the place of the missing one. We say that this unbalanced atom has a "positive charge" (+) because it has too many protons.

Since it got kicked off, the free electron moves around waiting for an unbalanced atom to give it a home. The free electron charge is negative, and has no proton to balance it out, so we say that it has a "negative charge" (-).

Electricity is conducted through some things better than others do. Its resistance measures how well something conducts electricity. Some things hold their electrons very tightly. Electrons do not move through them very well. These things are called insulators. Rubber, plastic, cloth, glass and dry air are good insulators and have very high resistance.

Other materials have some loosely held electrons, which move through them very easily. These are called conductors. Most metals – like copper, aluminum or steel – are good conductors.

**Hands-on science with squishy circuits Video Transcription**

By: AnnMarie Thomas

0:11I'm a huge believer in hands-on education. But you have to have the right tools. If I'm going to teach my daughter about electronics, I'm not going to give her a soldering iron. And similarly, she finds prototyping boards really frustrating for her little hands. So my wonderful student Sam and Idecided to look at the most tangible thing we could think of: Play-Doh. And so we spent a summer looking at different Play-Doh recipes. And these recipes probably look really familiar to any of you who have made homemade play-dough -- pretty standard ingredients you probably have in your kitchen. We have two favorite recipes -- one that has these ingredients and a second that had sugar instead of salt. And they're great. We can make great little sculptures with these. But the really cool thing about them is when we put them together. You see that really salty Play-Doh? Well, it conducts electricity. And this is nothing new. It turns out that regular Play-Doh that you buy at the store conducts electricity, and high school physics teachers have used that for years. But our homemade play-dough actually has half the resistance of commercial Play-Doh. And that sugar dough? Well it's 150 times more resistant to electric current than that salt dough. So what does that mean? Well it means if you them together you suddenly have circuits -- circuits that the most creative, tiny, little hands can build on their own. And so I want to do a little demo for you. So if I take this salt dough, again, it's like the play-dough you probably made as kids, and I plug it in -- it's a two-lead battery pack, simple battery pack, you can buy them at Radio Shack and pretty much anywhere else -- we can actually then light things up. But if any of you have studied electrical engineering, we can also create a short circuit. If I push these together, the light turns off. Right, the current wants to run through the play-dough, not through that LED. If I separate them again, I have some light. Well now if I take that sugar dough, the sugar dough doesn't want to conduct electricity. It's like a wall to the electricity. If I place that between, now all the dough is touching, but if I stick that light back in, I have light. In fact, I could even add some movement to my sculptures. If I want a spinning tail, let's grab a motor, put some play-dough on it, stick it on and we have spinning. And once you have the basics, we can make a slightly more complicated circuit. We call this our sushi circuit. It's very popular with kids. I plug in again the power to it. And now I can start talking about parallel and series circuits. I can start plugging in lots of lights. And we can start talking about things like *electrical load.* What happens if I put in lots of lights and then add a motor? It'll dim. We can even add microprocessors and have this as an input and create squishy sound music that we've done. You could do parallel and series circuits for kids using this. So this is all in your home kitchen. We've actually tried to turn it into an electrical engineering lab. We have a website, it's all there. These are the home recipes. We've got some videos. You can make them yourselves. And it's been really fun since we put them up to see where these have gone. We've had a mom in Utah who used them with her kids, to a science researcher in the U.K., and curriculum developers in Hawaii. So I would encourage you all to grab some Play-Doh, grab some salt, grab some sugar and start playing. We don't usually think of our kitchen as an electrical engineering lab or little kids as circuit designers, but maybe we should. Have fun. Thank you.

**Conducting Solutions** By Rodney Schreiner at Scifun.og

An electric current is a flow of electrical charge. When a metal conducts electricity, the charge is carried by electrons moving through the metal. Electrons are subatomic particles with a negative electrical charge. When a solution conducts electricity, the charge is carried by ions moving through the solution. Ions are atoms or small groups of atoms that have an electrical charge. Some ions have a negative charge and some have a positive charge.

Pure water contains very few ions, so it does not conduct electricity very well. When table salt dissolves in water, the solution conducts very well, because the solution contains ions. The ions come from the table salt, whose chemical name is sodium chloride. Sodium chloride contains sodium ions, which have a positive charge, and chloride ions, which have a negative charge. Because sodium chloride is made up of ions, it is called an ionic substance. Some substances that are made of molecules form solutions that do conduct electricity. Ammonia is such a substance. When ammonia dissolves in water, it reacts with the water and forms a few ions. This is why laundry ammonia, which is a solution of ammonia in water, conducts electricity, but not very well.

Sometimes, when two different solutions are mixed, the substances they contain react with each other and form ions. This is what happens when ammonia and vinegar are mixed. An ammonia solution contains only a few ions, and it conducts electricity only poorly. A vinegar solution also contains only a few ions and conducts only a little electricity. But when these solutions are mixed, the ammonia reacts with the acid in vinegar (acetic acid), and they form a lot of ions. This is why the mixture of ammonia and vinegar conducts electricity very well.

**Prompt: You have learned about electricity by reading three articles, “Energy Story,” “Short Circuit,” and “Conducting Solutions.” In an essay, analyze how each source uses explanations, examples, and/or descriptions to help accomplish its purpose. Support your response with evidence from each source.**