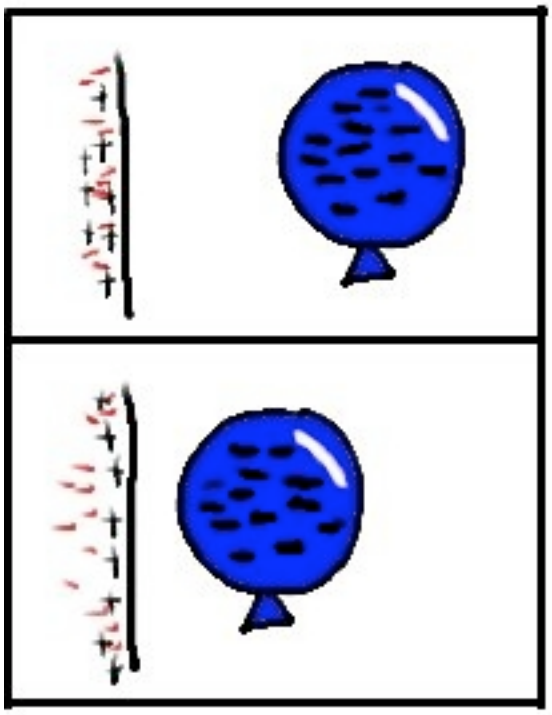
Static Charge

This lesson will be downright shocking! We are going to go deeper into static electricity and we shall create and control lightning! Mwa ha ha ha ha (evil laughter). Well, okay, they are little bitty bits of lightning but lightning none the less.

Temporary Charge

Last lesson I kept talking about this temporary charge thing, where objects that are electrically charged can create a temporary charge on another object. Let's take some time to look at that now. Remember, in static electricity, electrons are negatively charged and they can move from one object to another. This movement of electrons can create a positive charge (if something has too few electrons) or a negative charge (if something has too many electrons). It turns out that electrons will also move around inside an object without necessarily leaving the object. When this happens the object is said to have a temporary charge. Try the following experiment to create a temporary charge on a wall.



As the balloon gets closer to the wall, the negative charges in the balloon repel the negative charges in the wall. Leaving the positive charges behind.

Experiment 1

Back, Back you Electrons!

You need:

A balloon

Hair or a shirt

A wall

1. Blow up the balloon.
2. Rub the balloon on your hair or on your shirt.
3. Hold the balloon up to a wall and see if it will "stick" to the wall.
4. If it doesn't "stick", try rubbing the balloon more on whatever you rubbed it on before. If it still doesn't stick, try rubbing it against something else. This, like all static electricity experiments, works better on dry, non-humid days.

As we learned last lesson, opposite charges attract right? So, is the entire wall now an opposite charge from the balloon? No. In fact, the wall is not charged at all. It is neutral. So why did the balloon stick to it? The balloon is negatively charged. It created a temporary positive charge when it got close to the wall. As the balloon gets closer to the wall, it repels the electrons in the wall. The negatively charged electrons in the wall are repelled from the negatively charged electrons in the balloon. Since the electrons are repelled, what is left behind? Positive charges. The section of wall that has had its electrons repelled is now left positively charged. The negatively charged balloon will now "stick" to the positively charged wall. The wall is temporarily charged because once you move the balloon away, the electrons will go back to where they were and there will no longer be a charge on that part of the wall. This is why plastic wrap, styrofoam packing popcorn, and socks right out of the dryer stick to things. All those things have charges and can create temporary charges on things they get close to. This is also why, in the last lesson,

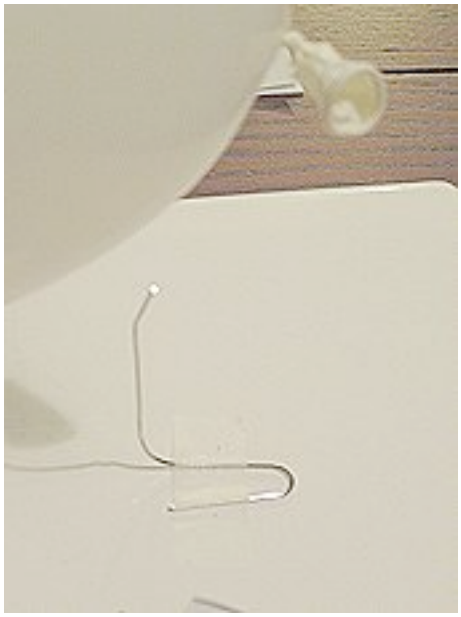
the tape was attracted to your hand. Your hand has no charge, but the tape, being negatively charged, created a temporary charge in your hand.

Charge It Up

So what happens to something if it gets really charged up? You know that things that are charged can attract or repel other things but is that all they can do? Nope, if you can get that charge large enough, you can get a lot of fun things to happen. Let's try something and I'll show you what I mean.

Experiment 2

Make Your Own Lightning



You need:

Inflated balloon

Paper clip

Tape

Hair or shirt

1. Bend an end of the paper clip up so that one end is sticking straight up.
2. Tape the paper clip to a table so that the end is sticking up from the table.
3. Really charge your balloon. Rub it a lot on your shirt or hair.
4. Get your ear fairly close to the paper clip.
5. Now, slowly bring the balloon closer to the paper clip.
6. If all goes well, you should hear a bit of a crackle as you get the balloon fairly close (less then an inch) from the clip.

Believe it or not, you just made…LIGHTNING mwa ha ha ha ha!!! Ok, so like I said before, it's itty bitty lighting but it is lightning! What you heard was tiny little bits of thunder as the static charge that was built up on the balloon zipped through the air and grounded itself on the paper clip.

What's grounding you may ask? Good question. When you built up the charge on the balloon there were millions of electrons just looking for a place to go. Objects like to be neutral, so when there are too many electrons in the same place something eventually has to happen to bring that object back to neutral. This is where grounding comes in to play. The ground in the word grounding is quite literally the ground. The Earth itself is the ultimate ground. Extra electrons can flow fairly freely from the Earth or to the Earth, causing whatever is grounded to become neutral. Lightning is when clouds ground themselves. The molecules in the clouds rub against one another and as they do they build up charges. These charges can get so huge that the grounding spark can jump from the cloud to the ground or from the ground to the cloud, grounding the cloud and unfortunately frying anything that stands in the way. The lightning likes to jump as short a distance as possible and will hit the tallest grounded thing in the area. So, walking around with ten foot metal poles in the middle of fields in a lightning storm is NOT recommended!

In our experiment, the balloon was filled with negative charges. As you got it closer and closer to the metal paper clip, many of the charges were able to "jump" from the balloon to the paper clip in the form of a spark. If you do this experiment in the dark, you may be able to see sparks jump from the balloon to the clip.

Have you ever been zapped by a spark? If you have, then you have been a ground. Some car door, or doorknob, or plastic slide has been charged up some how. Then when you got close to it ZAP, that object used you as a ground. Generally, if it hurts when you get zapped, you were the ground and the electricity flowed into you. If it doesn't hurt, then you were the one with the charge and you used the object (like your friend's ear) to ground yourself.

If you look at the outlets in your house, you'll notice that there are 3 holes in many of them. The roundish hole in the outlet is for the ground. That hole should be connected to metal that eventually goes into the ground. Many appliances use

grounding plugs. The worry is that an appliance, as it's using electricity, can build up a charge. If that appliance is not grounded, that charge will ground itself using you as the connection from the appliance to the ground the next time you touch it. It doesn't feel good to have electricity zap through you! In fact, if the charge gets large enough, it can be quite dangerous.

Here's a great little device for storing charges and then releasing them as a spark. It's called a Leyden jar and has been played with for many, many years. There's a story that Benjamin Franklin invited a bunch of friends over to his house and attempted to cook a turkey using a large Leyden jar. The story goes that he didn't exactly cook the turkey but he did manage to cause the turkey to hurl itself across the room! By the way, the one I'm about to show you how to make is harmless, but Mr. Franklin himself almost caused his own demise with a larger one of these. Be very careful whenever you do experiments with electricity or static electricity. It can be a very dangerous and unpredictable thing.

Experiment 3

The Leyden Jar

You need:

2 styrofoam cups

Tin Foil

Wire Cutters

Copper Wire 10 inches or so in length

Copper Wire 4 inches or so in length (if you don't have Copper feel free to use what wire you have. It will probably still work.)

Nail

Balloon

Hair or preferably wool material

(scarves work great)

Tape

1. Cut two strips of aluminum foil about two inches wide.

2. Wrap one strip of foil all the way around one of your foam cups. Make sure the foil stays at least a half inch below the top of the cup. Try to get the foil as flat and as tight as possible. Wrinkles and air bubbles cause it to be less fun. Tape the foil to the cup and cut off any excess.

3. Do the same thing with your other cup.

4. Take your four inch copper wire and wrap it around your nail. About an inch of the wire should be on one side of the nail and about three inches should be sticking out the other side. Stick the nail through the top lip of the cup. Let it stick out about a half inch. The wire that's wrapped around the nail should be on the outside of the cup.

5. Stick the cup with the nail in it, into the other cup. You want the long end of the wire that is around the nail to be pressed between the inner and the outer cup. The short end should be sticking up from the cup. Make sure the long end of the wire touches as much of the aluminum foil as possible. Don't let the wire poke a hole in the outside cup.

6. You're almost done. Take your ten inch wire and wrap it as tightly as possible around the tin foil of the outside cup. You should have some wire sticking out from the cup. You may want to tape the wire to the cup. Take that wire and

bend it up so that it has a bit of a curl near, but not touching, the nail. The curl should be less than a quarter of an inch away from the nail. Voila, one Leyden Jar! So…now what?

7. Now, charge it up. Take your balloon, or if you have one, a PVC pipe works great, and charge it using your hair or the wool.

8. Once you've charged it, get it close to the wire sticking up from the nail. As you get it close to the wire, be sure to have your other hand touching the aluminum foil. You should hear little sparks jumping from the balloon to the nail. Charge the balloon and then hold it near the wire five or six times. Remember to always touch the outside of the cup when you bring the balloon near.

9. Watch the gap between the nail and the wire that connects to the outside of the cup. You may see a spark jump the gap. If you don't, carefully move the wire closer to the nail. If all goes well you should see and hear a nice white-blue spark jump from the nail to the wire. Taa daa, you have harnessed the power of the electron. I've seen sparks about a quarter inch long with this set up. Have fun with it!

So what's going on here? When you move the balloon to the wire, the extra electrons on the balloon jump to the wire and get stored in the aluminum foil inside the cup. The foam is thin enough to allow the electrons to repel electrons in the foil on the outside cup. The reason you want to touch the foil when you charge the Leyden jar is so that those repelled electrons have somewhere to go. The repelled electrons on the outside foil will travel through you to the ground. Leaving behind the positive protons. The fancy word for this is induction. With each charge you create a stronger negative charge inside the cup and a stronger positive charge outside the cup. Well, this charge build up can't last forever. Eventually something has to happen. What happens is the spark between the nail and the outside wire. ZAP! The extra electrons on the inside zip to the outside where there are missing electrons and the Leyden jar is back to being neutral.

Static electricity is a really fun part of science. Many gadgets have been created over hundreds of years to play with and study this concept. Your library or the internet has bunches of info on how to make your own. Now that you understand how it works, get out there and play with it! Just remember to follow directions and be careful. Static electricity is fun, but it can be quite shocking.

In a Nutshell

- A temporary charge happens when a charged object comes close to an uncharged object. The charged object repels the similarly charged particles in the uncharged object, leaving only opposite charges on the surface. The unlike charges in the two objects can then attract one another.

- A static charge can build up to the point that it will jump through the air to equalize its charge and become neutral. This is often called a static shock.

- Grounding happens when an object releases its charge into the ground, causing the object to be neutral.

- Lightning is a huge electrical charge in the clouds that grounds itself into the Earth.

Did You Get It

1. Why does a charged balloon stick to a wall?
2. What happens when something "grounds" itself?
3. What is lightning?
4. When does something have a negative charge?
5. When does something have a positive charge?

Answers

1. The balloon creates a temporary charge on the wall. The negative charge of the balloon repels the negative charges (electrons) in the wall. This leaves the positive charges toward the surface of the wall allowing the negative balloon to be attracted to the positive section of the wall.
2. Something that is charged (has too many or too few electrons) can neutralize its charge by connecting to the ground. When something connects to the ground it can gain or lose electrons so that it can become electrically neutral.
3. Lighting is a gigantic spark that comes from an electrically charged cloud.
4. When it has too many electrons.
5. When it has too few electrons.