South Florida Science Museum
Exciting Electrons Program Curriculum

PROGRAM DESCRIPTION

This exciting program is a great way to introduce different concepts of magnetism and electricity. Starting with magnetism, students learn the characteristics of magnets and different metals. There are a few demos with big magnets to show the students and last there is an electromagnet that we use to bridge magnetism and electricity.

SUNSHINE STATE STANDARDS

SC.3.P.10.1: Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.
SC.3.P.10.2: Recognize that energy has the ability to cause motion or create change.
SC.3.P.11.2: Investigate, observe, and explain that heat is produced when one object rubs against another, such as rubbing one's hands together.
SC.4.P.8.4: Investigate and describe that magnets can attract magnetic materials and attract and repel other magnets
SC.4.P.10.1: Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.
SC.4.P.10.2: Investigate and describe that energy has the ability to cause motion or create change.
SC.5.P.8.4: Explore the scientific theory of atoms (also called atomic theory) by recognizing that all matter is composed of parts that are too small to be seen without magnification.
SC.5.P.10.1: Investigate and describe some basic forms of energy, including light, heat, sound, electrical, chemical, and mechanical.
SC.5.P.10.3: Investigate and explain that an electrically-charged object can attract an uncharged object and can either attract or repel another charged object without any contact between the objects.
SC.5.P.10.4: Investigate and explain that electrical energy can be transformed into heat, light, and sound energy, as well as the energy of motion
SC.5.P.11.1: Investigate and illustrate the fact that the flow of electricity requires a closed circuit (a complete loop).

MATERIALS

<u>Demo</u>
Horseshoe magnets with paperclips
Big magnet with metal rods
Electromagnet
Plasma Ball
Light Bulbs
Van der Graaf Generator
Aluminum Pie Plates
Plastic Crate

Extension Cord
D Batteries

VOCABULARY
Atoms – Building block of matter
Electricity – energy generated from the movement of electric charges
Electromagnet – magnet made by passing electricity through a wire wrapped around an iron rod
Ion – an atom with unequal numbers of protons and electrons that leads to its having charge

SCRIPT

Atoms:
Today we're going to talk about electricity and magnets, but before we do that, we need to talk about the smallest thing that exists. Who can tell me something that is really small? What about smaller than that? What's even smaller than that? The smallest thing that exists is an atom. Everything is made up of atoms. The chairs you are sitting in, the food you eat, even your own body! Now I need three volunteers to help me demonstrate what an atom has to do with electricity. *Have one volunteer be a neutron, one is a proton, and one it an electron.* Here we have the proton. The proton is very positive (say something positive). He's always smiling and loves life.The neutron is very neutral. He doesn't really care too much about anything. He's not happy all the time, but he's not really mad either. He's neutral. The proton and the neutron make up the nucleus of an atom. Then there's the electron. The electron is smaller than the proton and neutron and he is very negative (say something negative). Now what the electron does is he is constantly moving around the nucleus, the proton and neutron. *Have the volunteer run around the nucleus.* Now occasionally the electron is plucked out of the atom and creates electricity. Electron = Electricity. Electrons have an electrical charge. And whenever electricity moves, a magnetic field is created.

Magnetism:
To start what do you all know about magnets? *Get answers and answer questions if any.* Magnets have a north and south poles or + and – poles. North and south poles are attracted and negative and positive poles are attracted. Everyone say opposites attract. Magnets are also attracted to metals containing iron. Where might we find magnets? On your fridge, so rocks are magnetite, and our earth is a giant magnet!

Small Horseshoe Magnet:
Here I have a smaller horseshow magnet. I also have an entire container of paper clips. Do you think paper clips are magnetic? I'll give you a hint: paper clips are made out of steel wires and steel is one of the magnetic metals. So how many paper clips do you think I can hang from this magnet? (Only the first one touches the actual magnet, the rest touch the magnet above it. This shows that the force can be transferred though metal objects.) Now do you think I could pick up all of these paper clips at one time with this magnet?

(Depending on the number of students you can pass this around to them. This is a big heavy magnet so tell them to take care while passing them around.)

Big Horseshoe:
What types of things do you think are magnetic? *Metals.* Are all metals magnetic? *Use the magnet and 2 types of metal – steel and aluminum.* Here I have a giant magnet. This first tube is made of aluminum. Raise your hand if you think the aluminum will be attracted to the magnet. Raise your hand if you don't think it will be. *Try it.* Aluminum isn't magnetic (soda cans won't stick to your fridge). This next tube is made out of steel. Raise your hand is you think steel is magnetic. Raise your hand if you don't think it is. *Try it.* I can't even get it all the way between the two magnetic sides because it's so strong. *Call up a volunteer to try and pass the metal bar through the bigger magnet bolted to the board.* (It's hard to do, but with practice it gets easier.) SO metals are magnetic but not all metals.

Electromagnet:
Does anyone know what this might be called? (Hold up the electromagnet).(If they don't know right away).What do you think it would be called since it combines electricity and magnetism? Right, this is called an electromagnet. Can everyone say electromagnet?
I need two volunteers to help me with this next experiment. Place them together. Right now there is no electricity going through the magnets. If I connect the two magnets do you think you two can pull them apart? *They will pull it apart.* So the magnet is not very strong before the batteries are hooked up.
I'm going to connect the wires so that the batteries are hooked up to the magnet. Now try and separate them. *They won't be able to.* Once the wires are connected, the magnet gets very strong! Electromagnets are very useful in junkyards. If you need to move a car from one side to the other, you would need a really really big regular magnet. If you use an electromagnet though, it could be relatively small. You would set it on the car, turn on the electricity, and move the car. Then just turn off the electricity when you want to set the car down again. We can make electromagnets very strong.

Electricity –
What do you all know about electricity? Where does it come from? (Get answers and ask more questions about it)

Tesla Coil:
There was this man named Nikola Tesla. Raise your hand if you have heard the name Nikola Tesla?
He was an inventor a long time ago from Croatia. He introduced the idea of alternating current. Direct current flows continuously in one direction; alternating current changes direction 50 or 60 times per second and can be stepped up to vary high voltage levels, minimizing power loss across great distances. So he invented AC generators and motors (polyphase AC)Tesla thought it would be a good idea to send electricity through the air so he built this. This is called a Tesla Coil. Can you say Tesla Coil?

Widely used today in radio and television sets and other electronic equipment. The Tesla Coil can transform ordinary power into high frequencies at tremendous voltages. Voltages can get to be well above 1,000,000 volts and are discharged in the form of electrical arcs. Tesla coils are unique in the fact that they create extremely powerful electrical fields. Large coils have been known to wirelessly light up florescent lights up to 50 feet away, and because of the fact that it is an electric field that goes directly into the light and doesn't use the electrodes, even burned-out florescent lights will glow.

Inside this device is a coil. When you plug the Tesla Coil in and give it some energy in the form of electricity, it sends electricity from the metal tip into the air. If you hold it near a long cylinder light bulb, it will light up. Now we can light up all of the lights. Most of these lights here have different gases in them like nitrogen, oxygen, argon and some others that will all light up a different color. *Light up the different light bulbs to see the different colors of the gases. Can connect a few of them and light them all up.*

Plasma ball:
This is a plasma ball. We have one on the floor in the electricity exhibit. Does anyone know what plasma is? It's the fourth state of matter. When gas gets really hot it becomes plasma. When gas gets that hot, the electrons in those molecules break away from the atom creating electricity. Lightning is made out of plasma. Our sun is actually a great big ball of plasma.

This plasma ball is a miniature Tesla coil. Inside the ball is a coil of wires that have electrons going through them, moving back and forth at a very high frequency. This shakes the atoms around the wires so hard that their electrons start to fall off! Inside the glass globe is a partial vacuum. This just means that some of the air has been sucked out. Because there is not as much air in there, it is easier to make electric sparks that can be seen.

The electrons then travel out into the air from the glass ball. We know this because the plasma ball can
light up the light bulb. If you touch the plasma ball, all of the electrons will go through you to the ground. Electricity always takes the easiest path through something. If it's going into a person, it usually goes through their hands, if they are touching something, up their arm, and out their feet. We are not able to feel this happening though because it isn't strong enough.

In this plasma ball, the little strands of light follow your hand because you are made mostly of water and electricity is attracted to water, water is a good conductor. What kinds of things shouldn't you do in a lightning storm? *Swim (water is a conductor), play golf with metal clubs, etc.* If you stand on a stool, you are insulated from the ground and get filled with electrons. This means you can light up a fluorescent light bulb!

This is a good place to talk about lighting rods on top of tall buildings. They are put there to draw the lighting to it. There is a thick wire that runs from the bottom of the lightning rod the entire way to the ground, where it can't hurt anything. The wire is insulated so if

it ever does get hit, the electricity stays away from the electronics of the building. Otherwise, there would be a huge electrical surge. You can find good pics of this online. There's one of the space shuttle getting almost struck too online. If you need help finding them, let me know.

Van de Graaf generator:
This is called a Van Der Graaf Generator. Can you say Van Der Graaf Generator? The top is a metal ball that acts like a conductor. The tall part leading up to the ball is a plastic tube (insulator) with a rubbery belt inside that spins when you turn it on. The belt rubs against the inside of the ball, so a charge builds up. It's the same principle as your socks on the carpet.

The excited electrons like to move from charged objects to uncharged. The charge that is generated from the ball will move to the person. You have to stand on an insulator (plastic crate), and touching the ball before you turn it on. This makes the static electricity stay in your body and that's why your hair stands up! That way you are all the same charge. If they wait to touch it until it's already on, the ball will be charged, but they won't be… and ZAP!

If I call you to come up you have to take all jewelry off your hands, stand on the crate and touch the metal ball with either one hand or two. You just always want to make sure that you are touching it while it's on. If you take your hand away you could get shocked. If you want to stop just let me know and I'll turn it off for you. (Turn on the van de graf and slowly increase the speed of the rubber tube.) Wow you're hair is standing up want to see? (Hold a mirror up to show them what they look like. Do this as many times as you want as long as there's enough time.)

So everyone, that was the show did you all have fun? I hope you did, thanks for being so good and hopefully I'll see you all again