OMAHA children's MUSEUM

Museum in a Box Instructions

Activity 1

What is a Circuit?

Circuit: a complete circular path that electricity flows through.

Background science knowledge

Electricity is created by electrons flowing through an object. These electrons are negatively charged subatomic particles and act as the primary carrier of electricity. Electrons must have a complete path through which to flow as it is the movement of the electrons that creates electricity. This path is called a circuit. A circuit starts at one end of a power source like a battery. When both ends of the battery are connected, this allows a path for the electrons to continuously travel and move in thus creating electrical charges. If the path is not complete then no movement will occur from the electrons. Breaking a circuit is as simple as turning on and off a switch. The switch moves some kind of conductor on and off of the connecting wires resulting in opening and closing a circuit.

Objective

Students will learn that the path electricity flows is called a circuit and that without a complete circuit, objects that use electricity cannot operate.

Guiding questions to start

1. What is electricity?
2. What do you already know about it?
3. What objects use electricity?
4. How do we get electricity in this room?

Lesson

Objects powered by electricity are powered through the movement of particles called electrons. Electrons are particles that carry electrical charges. In order for the electrons to power something they have to be moving through what is called a circuit.

What word does circuit sound like to you? Circuit sounds a little like circle because that is sort of what a circuit is. A circuit must start and end at the same spot and be complete. This allows for the electrons to flow through an object and continue moving. Think about if there was a road or circular race track. Cars could drive on that road without needing to stop, they would continue to go around and around since there is no stopping point. Now imagine a road that had a dead end. Cars would have nowhere to go and they would get all backed up and be stopped. If a circuit is not complete, then the electrons are like the cars at the dead end. They made it to the end of the wire or battery but then cannot move any further.

Demonstration / Activity

Use the energy stick to demonstrate how a circuit needs to be complete. Hold one end of the stick in each hand. Lights and sounds should occur. YOU just completed a circuit.

Now demonstrate that when you remove your hand the circuit is broken. You can talk about how removing and placing your hand is similar to a light switch turning on and off a light.

Allow time for students to experiment with the energy sticks. Let them see how many people can link up to complete a circuit. Can the whole class link up? What happens if one person lets go in the middle of the chain?

Activity 2

Conductor or Insulator

Conductor: a material which electrons can move through easily and thus, can be used to complete a circuit.

Insulator: A material with high resistivity or high resistance, which prevents electric current from flowing.

Objective

Students will be able to identify and group objects into insulators and conductors. Students can also conclude what type of materials are conductors or insulators.

Lesson

This lesson begins by building off of the previous activity about what a circuit is. A circuit is a complete path for electrons to flow thereby creating electricity. However, the materials that a circuit can be created from are not limited to simply copper wires. A circuit can be created using any material that is considered a conductor and can be stopped with any material that is an insulator. This lesson aims to discover what materials work as a conductor or insulator.After explaining what an insulator or conductor is, begin to give examples about why we would use different material. For example, an insulator like rubber helps protect us from being shocked by electricity. This is why we put rubber around wires. A material like copper works really well as a conductor, this is why we use that material for wires in the wall.

Students will use the energy stick to test out materials and determine what can be an insulator and what can be a conductor.

Execution notes. For best results, the test object needs to be held by the student and touch the contact on the energy stick while holding the other contact. The student is a part of the circuit. If they are not in contact with the object, then the circuit is not complete. The activity can be executed at varying levels of complexity.

Basic Activity

With students in groups, separate the various objects into containers and allow students to investigate which objects conduct and which do not. Students will take turns testing objects. A suggestion may be to allow each students to pick two or three objects he or she would like to test for the group and then pass out the energy sticks. This ensures each students tests the same number of objects. Students could physically put objects into groups or boxes that identify which worked. Or a whole class list could be created. A discussion at the end of the activity about which materials worked and what type of materials they are (plastics, metals, etc.) Students could also chart the findings by drawing pictures or writing down the object and/material they test.

More Advanced Activity

Take students through the scientific method of discovery with this activity.

Posing the question
What material is able to conduct electricity and what materials insulate?

Hypothesis
Students generate a hypothesis to test. Ex: If it conducts electricity, then the energy stick will light up.

Conduct experiment and track data: Students will conduct the experiment in the same way mentioned above in the basic activity but as a group or individually, they will also track the data. Using the provided charts, students can list or draw which items from the group’s materials and from around the classroom allowed for conduction. This is the data collection portion of the experiment.
Drawing a conclusion: students can make a conclusion based on their findings or after a whole class discussion. The conclusion should be something like “metallic objects worked as conductors where plastics and wooden ones did not.”

Activity 3

Static Electricity

Static electricity: an imbalance between positive and negative charges. Positive and negative charges attract one another. When there is a buildup of one type of charge on an object and it is placed near another object with opposite charges, they will be attracted. This can be seen by rubbing a balloon on a shirt or hair and then sticking it to a wall. The negative charges build up on a balloon and they attract the positive charges in the wall there by sticking to it. Another result of static electricity is static shock. A static shock occurs when the imbalanced charges are discharged. This is like when you rub socks against carpet and then touch a metal doorknob. The metal acts as a ground and discharges the unbalanced negative charges resulting in a shock.

Objective

Students will be able to understand how static electricity is formed.

Guiding questions

1. What is static electricity?
2. How is it formed?
3. How does it react with certain objects?

Lesson

Start with a demonstration. Rub a balloon against the fur or felt provided in the box. Then, try to stick it to a wall, the ceiling, or a student. Ask students "How is this balloon being stuck to the ____?" The balloon is being attracted to the object because of something called static electricity. Static electricity is a type of electricity caused by unbalanced electrical charges. Electricity is made up of positive electrical charges and negative charges. Really this just means that they are opposites and not that one is better or worse than the other. These opposite charges like to sit in pairs. However, the amount of each charge can be changed. In the balloon, when it is rubbed against something like the fur, the fur attracts positive charges removing them from the balloon resulting in more negative charges. When the negatively charged balloon is against the wall, it pushes the negative charges on the wall away because like charges repel. This leaves positive charges from the pairs in the wall available and seeking to link to the negative charges in the balloon. Due to this, the balloon sticks to the wall! Static electricity works to attract and repel materials. Showcase the following examples to the class to demonstrate how static electricity attracts and repels.

1. Start by rubbing the balloon against felt or fur and then move to a student's head. Watch as their hair becomes attracted to the balloon.

2. Now, starting a small steady stream of water from a sink, place the charged balloon near the water but not touching it. It should result in slightly repelling the stream of water.

3. Try moving a ping-pong ball across a table by placing the charged balloon by it. Watch it be repelled and move.

The repelling occurs because the objects either do not have enough of the opposite charge to be attracted to the balloon or because there is too much of the same charge and like charges repel.

Activity: Moving Butterfly

Students can create a butterfly whose wings flap with static electricity. Using the provided template, cut out of construction paper a body for the butterfly. Also, cut out wings from tissue paper. Attach the wings to the body with either tape or glue. Students can color the butterfly and design it how they like. When a charged balloon is brought close to the butterfly, one can see its wings be attracted to the balloon. Move the balloon closer and further from the butterfly and see the wings flap up and fall back down.

Activity 4
Playdough to make a circuit

Objective: Students will run an experiment to find out which type of clay is conductive and can complete a circuit.

Continue discussing conductors and insulators as well as circuits. This activity allows students to manipulate and create their very own circuits. Students will explore to find out what happens when a circuit is created with a conductor vs with an insulator and be able to answer the question of the experiment: which dough conducts?

Activity

Students will receive a ball of clay and a ball of playdough for the group. Students will also need a battery and two alligator clip wires. Students should break the ball of clay in half and roll out two small balls. Then, attach the wires to the battery and place them each into one of the balls. Connect the balls with the small LED light. Repeat the steps with the playdough. The playdough is conductive and the LED should light up.

Steps for the activity:

1. Break one color of clay/dough into two balls
2. Connect the wires to each terminal (+/-) on the battery
3. Stick the alligator end of the cable into the dough/clay
4. Keeping space between the clay balls, place a lead wire from the LED into each piece of clay.
5. Trouble shoot. If you are using the playdough, then it should conduct. Make sure the two balls are not touching. Check battery connections. Try flipping the leads of the LED to be in whichever ball it is not in already. Try the set up in a different battery.
6. Repeat for which ever piece of clay was not already used. Remember circuits need to have no breaks in them.

Activity 5
Snap Circuits

Snap circuits are a great and safe way for your students to explore making a circuit. Use the different accessories like buzzers, lights, and switches to practice making and changing a circuit! Included for you are three complete sets of snap circuits as well as the activity booklets.

Activity 6
Van de Graaff Generator

PLEASE READ SETUP AND SAFETY INTRUCTIONS ON PAGES 5 & 6 BEFORE USING THE VAN DE GRAAFF GENERATOR

The Van de Graaff (VDG) is made up of a metal dome under which lies a rotating belt. As the belt moves it creates a static charge in the ball. The static charge can then be used to perform demonstrations described below.

Demonstrations

Flying hair

Place the Barbie doll on top of the VDG and turn it on. As the generator charges, the hair on Barbie should began to spread out and fly in different directions. This is due to the buildup of charges in the generator being greater than the opposite charge on Barbie. Because of the buildup, like charges in the hair will repel each other.

Tart pans

Similar to Barbie, with the generator off, place the pans open side down, on top of the VDG. Turn it on and the pans will fly off of the top of the generator as like charges repel. As charges buildup in the ball of the VDG, so will charges transfer from that to the pans. When the pans have built enough charge, the charges will begin to repel one another making the pans separate.

Person

You or a student can stand on a non-metal and non-grounded surface (wood stool or plastic stool/chair would work well... if you stand on a metal chair the experiment will not work). Have person place one hand on dome while off. (Remind them that if they let go while it is on they should not touch it again (while running). Start the generator and after some time have them shake their head slightly. Their hair should start to stick up like it did on the Barbie. This works best with hair between 4-12 inches (longer short hair or shoulder length).

It is important to properly discharge a person who has been charged by the VDG. While a person is touching the device NEVER bring anything that will discharge quickly near the device.

- The goal is to avoid a quick discharge. Instead of turning it off with your hands, use the included wooden dowel to turn off the machine. The student should not remove their hand until after it discharge has happened.

- Have the student then, with their other hand, grab the wooden dowel. You will know they are slowly discharging because the previously static hair will start to fall. When they are no longer showing static hair they can hop down to the ground and let go of the dome.

- This process will help avoid any unnecessary shocking.

Grounding ball

Turn lights off and watch as sparks of light can be seen when the grounding ball is brought near the VDG.

Setting up the Van de Graaff Generator

Set the device upright on a wooden or plastic table. Attach the top of the dome by setting it in its grooves. Attach the grounding ball to the device by placing the contact around the pin and tighten it down (this is the nut and bolt near the switch). Plug in the included power strip into an outlet. Make sure the power strip is off before plugging in the VDG cord. The switch on the VDG is actually just for a light in the unit and not to turn on and off the unit itself. The unit will turn on when plugged in. The switch on the included power strip will act as the on/off switch for the VDG.

⚠ Van de Graaff Safety ⚠

It is important to understand what is happening in the machine before operating. The VDG is a device in which a rubber belt rotates around and passes two metal combs. These combs catch and release charges from the rotating belt. Positive charges are then collected on the metal dome. This creates a conductive dome full of unbalanced positive charges.

WHAT THIS MEANS.... This means that anything that is conductive that comes near the generator when running will cause the positive charges to want to discharge on to that object. That discharge feels like a shock. While this shock is not severely harmful it can be surprising and painful to different individuals. Think rubbing socked feet on carpet then touching someone. The rubber belt are the socks, the dome is the person, and your body is who the VDG will shock.

While not permanently damaging, there are safe procedures to use when operating the generator. Most of these procedures come from how you discharge and ground both the VDG and any individual that touches it. Shocking occurs when it is discharged quickly.

The following safety procedures apply for when there is not a person touching the VDG.

- When the VDG is on and running, do not touch it with a bare hand. Human bodies are very conductive and it will shock you. This includes touching any part of the apparatus as well (base, neck, switches).

- To turn off the generator, discharge it first using the grounding wand. You will most likely hear a shock sound. This means it has discharged and can be safely touched to turn it off.

- Always discharge the dome before touching it.

Special instructions for the hair rising experiment

- It is important to properly discharge a person who has been charged by the VDG. While a person is touching the device NEVER bring anything that will discharge quickly near the device.

- The goal is to avoid a quick discharge. Instead of turning it off with your hands, use the included wooden dowel to turn off the machine. The student should not remove their hand until after the machine is turned off and they themselves have discharged following the next step.

- Have the student then, with their other hand, grab the wooden dowel. You will know they are slowly discharging because the previously static hair will start to fall. When they are no longer showing static hair they can hop down to the ground and let go of the dome.

- This process will help avoid any unnecessary shocking.

General Safety notes:

Do not use a Van de Graaff generator near water, grounded water faucets, or other grounded objects such as doors or walls. Also, do not operate near electrical equipment such as computers, televisions, or magnetic recordable devices (VCR tapes or floppy disks). Make sure no flammable gases are present. **People with pacemakers, insulin pumps, cochlear implants, or other critical devices should not come near the VDG.**

Instructions for the SAFE and PROPER use of lab materials

It is important to understand that with any lab materials included in this kit, safety should be the first concern. In general, proper usage of the included materials pose little to no risk of injury to persons and supplies. However, to ensure the safest execution review these instructions and inform students when relevant.

Wires, batteries, and circuits: everything included in manipulatives that students will touch are very low voltages. Still, proper usage is important. When making circuits with wires and batteries, make sure your wires are not damaged. Avoid making a "short circuit" in which wires are connected to each terminal of a battery but there is nothing else connected in the circuit. This will damage the battery as there will be little resistance for the electrons causing it to overheat.

Warning: Small parts are associated with many of the materials. Do not place objects in or near the mouth to avoid choking hazards. Adhere to warning labels on products.

Name:___________________________________

Insulator	Conductor

Describe the characteristics of materials that were conductive:

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