BUILDING A BASIC CIRCUIT

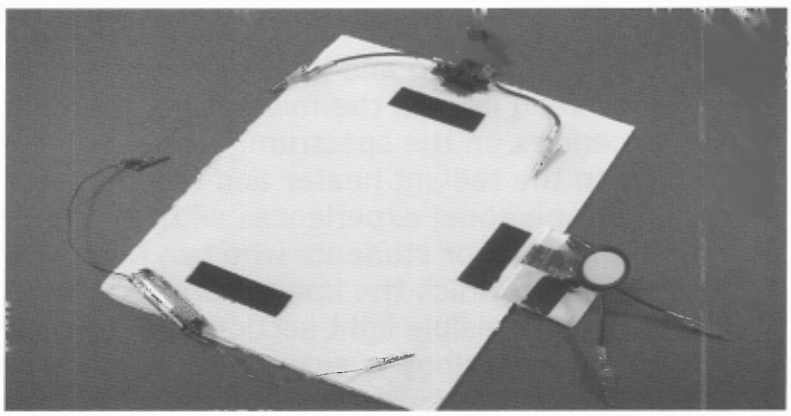
Teacher Information

NSES9-12.2 Physical Science: Interactions of Energy and Matter

Adaptations

Some adaptations and modifications that may assist a student with visual and/or other impairments to build a circuit include using Velcro to stabilize each component atop a template board with Velcro patches where the components go; traditional single blade switches where the open/close action is more readily observed tactually than other forms of switches; Magna lead wires where the connections at the end of the wires are magnetized and thus easier to connect than standard alligator clips.

If you do attach wings or paper blades to the motor, students must wear goggles incase the wings come off when you switch the motor on. Standard electric motors and batteries are generally safe for any student to use.



Black Velcro patches provide a good contrast for low vision and tactile location.

Our students enjoyed making fans out of Braille paper and taping them to a wheel which fits on the motor. The air movement created by the fan added another sensory dimension to the activity.

STUDENT HANDOUT

Building a Series Circuit

Vocabulary

Electric circuit – path that an electric current follows
Series circuit – circuit in which electric current follows only one path

Background Information

Circuits

An electric circuit is the path that an electric current follows. All electric circuits have three parts; a source of electric energy, a load or device that uses the electric energy and wires. The source of electric energy can be a battery or a wall outlet. The load can be a light bulb, an appliance or some other electric device. Wires connect the source to the load.

Open and Closed Circuits

What would happen if the only bridge over a river was closed for repair? Vehicles using that bridge would not be able to cross the river. The path that connects both sides of the river would no longer be complete. The same situation occurs in an electric circuit. If the circuit is not complete, then the electric charges cannot flow. An electric circuit that is incomplete or broken in any way is called an open circuit. Electric charges cannot flow through an open circuit. Electric charges can only flow through a complete or closed circuit. In a closed circuit, there are no breaks in the path.

A switch is used to control (open or close) an electric circuit. When a switch is in the "off" position the circuit is open. Electric charges cannot flow when a switch is in the off position. When a switch is in the "on" position the circuit is closed. Electric charges will flow when a switch is in the on position.

Series Circuit

The simplest type of electric circuit is called a series circuit. In a series circuit the electric charges follow only one path through all elements of the circuit.

Activity

Purpose

To provide a hands-on opportunity to build and examine a basic electrical circuit

Materials

Safety goggles
11" x 9" white cardboard template
4 black Velcro patches
Basic circuit components with lead wires attached to each with alligator clips on ends, or Magna leads, and Velcro on underside of each component
Motor
1.5v AA battery
Battery holder
Single-knife switch

The motor will need to be fastened to a sturdy base of some sort and then Velcro placed on underside of the base.

Procedure

1. Examine and identify each component.
2. Practice attaching the leads to each other.
3. With the switch in the open (off) position, place components on the template and attach the wires.
4. Observe that the circuit looks like a circle.
5. Close the switch and listen for the sound of the motor.
6. If the motor does not activate, open the switch to stop the electricity flow and check the connections. Retry.

Questions and Conclusions

1. An electron has a __ charge.
2. A __ object has neither a positive nor a negative charge.
3. Static electricity is a buildup of __ on an object.
4. Two electrons will __ each other.
5. How do two like charges behave? Do they attract or repel each other?

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 438 to 439.

INSULATORS AND CONDUCTORS

Teacher Information

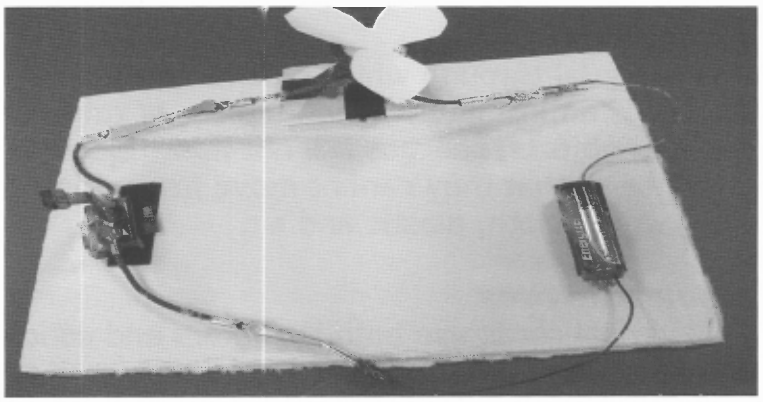
NSES9-12.2 Physical Science: Interactions of Energy and Matter

The circuit can be used to examine conductors and insulators. After opening the switch to turn off the flow of electricity, disconnect the circuit at any point. Add an item to the circuit using the alligator clips, close the switch to reestablish the electric city flow, and observe whether the motor runs or not. Insulators will not allow the passage of electricity, conductors will. Try metal objects such as empty soda cans, strips of copper, as well as insulators like wood blocks and plastic and glass containers.

Please Note: When doing this activity keep the circuit closed (on) for only a few seconds, as insulators will cause a build-up of heat in the power source.

Adaptations

The activity included in the student section requires no adaptations, except for those mentioned above. Most setups use a light bulb, but we substitute a motor.



STUDENT HANDOUT

Conductors and Insulators

Vocabulary

Conductor - material that electric charge can flow through easily
Insulator - material that electric charge does not flow through easily

Background Information

Conductors

A material through which electric charge can flow easily is called a conductor. Most metals are good conductors of electricity.

If a metal wire is placed between the positive and negative poles of a battery, a path is created so that electrons can flow. Suppose metal wires are used to attach a light source to the positive and negative poles of the battery. Electrons will flow through the wire and the light bulb will light up. If a piece of rubber is used instead of metal wires, electrons will not flow. The light bulb will not light up.

Some conductors are better than others. Wire made of copper is one of the best conductors of electricity. Wire made of aluminum is lighter and is less expensive than wire made of copper. However, aluminum is not as good a conductor of electricity.

Insulators

A material through which electric charge does not flow easily is called an insulator. Rubber is an insulator. When a piece of rubber is placed between two oppositely charged objects, charges will not flow. Electrons in the atoms of rubber are held tightly together so that they cannot move freely throughout the material. Other insulators are cork, wood, cloth, plastic and air.

Insulated Wires

Electrical cords use both insulators and conductors. The conductor is usually made of copper. The copper wire is covered with an insulator, such as rubber. Rubber prevents the electric charges from leaving the bare wire.

The rubber insulation of electric cords may become cracked or worn out. Such electric cords are dangerous because they can cause a short circuit. A short circuit happens when two un-insulated wires touch. When they touch, a large amount of electric charge jumps between the wires. Wires carrying too much charge can become hot and even cause a fire.

Activity

Purpose

To observe properties of conductors and insulators

Materials

A circuit board (see Building an Electric Circuit)
Assorted metal and nonmetal objects (aluminum soda can, paper clips, magnets, sponges, paper clips, paper, pencils)

Procedure

1. Using a circuit board, test the conductivity of common materials.
2. Build a closed circuit to show the students how electricity can only flow through a complete circuit.
3. Place the aluminum can between two of the wires to show that aluminum allows the electrons to flow through and make the motor turn.
4. Use each object to test its conductivity.

Questions and Conclusions

1. A ___ allows current to flow easily through it.
2. Rubber is an ___ because it does not allow an electric charge to flow easily through it.
3. In an insulated electrical wire, the conductor is often ___.
4. An electric cord is safe to touch because it is covered with ___.
5. If two conducting wires in an electric cord touch, a ___ will result.
6. Cork is a good ___.
7. A copper wire is one of the best ___.

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 434 to 435.

MEASURING ELECTRICITY

Teacher Information

NSES9-12.2 Physical Science: Interactions of Energy and Matter

Electricity is the flow of electrons from atom to atom. This is something that no one can directly observe. Many of the activities used to teach about electricity can be easily adapted for the student with a visual impairment. Diagrams of circuits from textbooks can be produced in a tactual form.

Students with a visual impairment may be unaware that there are wires attached to poles outside of buildings and that there are wires traveling from the poles to every building. In some locations the wires are underground and no one can see them!

The following background information may be presented before the classroom activity. The strong electric current from a power plant travels to get where it is needed. Electricity loses some of its voltage as it travels, so we use transformers to boost its power.

Electricity also needs to be slowed down when it approaches where it needs to be. We use different kinds of transformers to slow the flow of electrons. Other transformers change the amount of voltage to fit whatever they need to power like appliances, lights, and other things that run on electricity. A cable carries the electricity from the distribution wires to the house through a meter box. The meter measures how much electricity the house uses.

Electrons travel in a circuit. When you switch on a light, you complete the circuit and the electrons can flow. Electricity flows along power lines to the outlet, through the power cord into the appliance, then back through the cord to the outlet and out to the power lines again.

Adaptations

A large print and/or tactual diagram of the route electricity travels from the power plant to a home

STUDENT HANDOUT

How Is Electricity Measured?

Vocabulary

Voltage - energy available to move charges through a circuit.
Volt - unit used to measure voltage.
Ampere - unit used to measure electric current.
Resistance - opposition to the flow of electric current.
Ohm - unit used to measure resistance.

Background Information

Voltage

Energy is needed to make something move, even something as tiny as an electron. The energy available to move charges through a circuit is called voltage. Voltage is measured with an instrument called a voltmeter.

Current

The amount of electric current depends on the number of charges flowing through a wire. The unit for measuring electric current is the ampere, or amp. An ampere is a measure of the number of charges flowing past a point in a circuit in one second. A device used to measure the amount of electric current is called an ammeter.

Resistance

Resistance is the tendency for materials to oppose the flow of electric charges. Some insulating materials, such as rubber and plastic, have very high resistance. Other materials that are good conductors, especially metals, have lower resistance. The unit for measuring resistance is the ohm.

Four things affect the resistance of a wire:

1. Length-The longer a wire is, the more resistance it has.
2. Diameter-The thinner a wire is, the more resistance it has.
3. Material-Wires made of poor conductors have more resistance than wires made of good conductors.
4. Temperature-As a wire gets hotter, its resistance increases.

The resistance of a material to the flow of electricity can be useful. For example, a light bulb lights up because of the resistance of the wire inside the bulb. As electric current passes through a light bulb, the wire inside the bulb resists the electric current. Its resistance to the electric current heats up the wire so that it glows.

Superconductors

When a conductor such as a wire carries an electric current, the conductor becomes hot. This causes the resistance of the conductor to increase. However, there are materials that show no resistance to the flow of electrons at temperature close to absolute zero. Absolute zero is –237 degrees Celsius. Scientists are working to develop materials that have near-zero resistance at temperatures well above absolute zero. Such materials are called superconductors.

Some materials become superconductors at temperature below –250 degrees Celsius. Liquid helium has been used to cool materials to this temperature. However, liquid helium is very expensive. Scientists have found that some materials become superconductors when cooled with liquid nitrogen. So researchers are looking to use liquid nitrogen as a coolant. Liquid nitrogen does not reach temperatures as low as liquid helium, but it is much less expensive. However, much research is needed before such "warm" superconductors become part of our daily lives.

Activity

Purpose

Observe how materials and components affect the flow and allow us to measure voltage, current, and resistance.

Materials

Batteries of various voltage
Resistance in the form of light bulbs or buzzers
Lengths of wire -The longer a wire is, the more resistance it has.
Various diameters of wire -The thinner a wire is, the more resistance it has.
Various types of wires made

Procedure

1. Using the initial circuit setup, you can test the effects that materials have on the amount of electricity that flows through wires.
2. Assemble the circuit using short wires and then longer wires. Observe the intensity of the buzzer, light bulb, or spinning fan. The longer the wires, the less intensely the buzzer will buzz.
3. Assemble the circuit using wires with varying diameters and observe the intensity of the buzzer, light bulb, or spinning fan. The wider the wires, the less intensely the buzzer will buzz.
4. Assemble the circuit using wires made of different materials. Observe the intensity of the buzzer, light bulb, or spinning fan. Wires made of strong copper are good conductors and will buzz louder.

Questions and Conclusions

1. What do we call the energy available to move charges through a circuit?
2. What do we measure a current in?
3. What is the unit for measuring resistance?
4. What does resistance mean?
5. What are the four things that affect resistance?
6. Which has more resistance, a conductor or an insulator? Explain.
7. If a wire is short and fat, will it have high or low resistance?
8. If a wire is hot and skinny, will it have high or low resistance?
9. Why do you think finding materials that are superconductors at room temperature can be useful?

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 442-443.