ACTIVITY 2

HOW DO YOU BUILD AN ELECTRIC GAME?

EXPERIMENT OBJECTIVES AND CONTENT

The primary goals of this activity are to teach students about the concept of electrical circuits connected in series and to give them a chance to design and build an operational electrical circuit.

ESSENTIAL KNOWLEDGE

Energy:
- Forms of energy: Sources of energy (chemical reaction in a battery)
- Transmission of energy: Electrical conductivity and Simple electric circuits

Systems and interaction:
- How manufactured objects work

Techniques and instrumentation:
- Use of tools
- Design and manufacture of simple circuits

Appropriate language:
- Terminology related to an understanding of the material world
- Conventions and types of representations specific to the concepts studied

SUGGESTED MATERIALS

Scientific equipment:
- Electrical wire or aluminum foil
- Conductive metallic wires
- 1.5 V batteries
- 3.5 or 5 V LED light bulbs
- Bulb holders
- Audio signal devices (e.g., buzzer)
- Wire strippers
- Electrical tape
- Conductive foil
- Adaptors to connect two batteries in series

Household materials:
- Shoe boxes

School supplies:
- Paper, cardboard
- Scissors
- Colored pencils
- Brass paper fasteners, paper clips

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

One of your friends' birthdays is coming up and you want to give them a really special present that you made yourself. Your friend likes challenges, so you decide to build an electric game that will call upon your friend's logic skills or dexterity. How will you go about creating this game?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher leads a brainstorming session to let the students get an idea about how electricity works. The students should know the main elements used to build an electrical circuit connected in series (e.g., electrical wires, resistance, etc.). The teacher suggests that the students carry out conductivity tests and dismantle an electric game (such as Operation) in order to examine it and understand how it is built.

INITIAL IDEAS AND HYPOTHESES

Here are a few examples of hypotheses the students might formulate based on their initial ideas:

Example 1
I predict that I can build an electrical game using split-shank fasteners and electrical wire. I believe this because I know metal conducts electricity and that I can connect the fasteners using electrical wire.

Example 2
I predict that I can design an association game using paper clips to conduct the electricity. I believe this because they are made of metal, and metal allows electricity to flow through it.

Example 3
I predict that I can build a dexterity game by creating a circuit that connects a buzzer to a battery adaptor through piece of metal foil. I believe this because I have seen games like this before.

WORK PLAN AND EXPERIMENTATION

Here are a few examples of experiments the students can carry out to verify their hypotheses:

Example A
The students create an electrical game in a shoe box. On the shoe-box cover, they write a series of questions and answers in two columns and insert a split-shank fastener beside each one; on the underside of the box, they connect the correct answers to the questions with electrical wire. Next, they connect one end of a piece of electrical wire to one terminal of a battery placed inside the box; the other end of this wire comes out the top of the box through a hole. They do the same thing at the other end of the box, but using a light bulb instead of a battery. Finally, inside the box they connect the light bulb to the other battery terminal. In this way, by touching the end of one free wire to a question, and, at the same time, touching the end of the other free wire to the correct answer, a closed circuit is created and the light bulb illuminates.

Note: You can replace the light bulb with a buzzer. In this case, the goal of the game is to avoid setting off the buzzer with an incorrect answer.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example B

You can use the same principal as in example A but instead of two columns, the students make a drawing on the shoe-box lid and create a list of terms identifying different parts of the drawing (e.g., a map and a list of countries, an anatomical drawing of the human body and names of the body parts), The students use paperclips rather than electrical wires to connect the fasteners.

Note: This type of assembly requires numerous connections between the contact points (12 connections for 4 questions/answers).

Example C

The students make a dexterity game, the goal of which is to pick up various objects through an opening in a box without touching the edge of the opening. They cut a slot in a shoe box and affix a slotted piece of metal foil underneath it. The metal foil is connected to one of the terminals of a battery. The students next make a rod with a hook at one end used to pick up the objects in the box. The rod must be made of metallic wire, and its handle covered with plastic or electrical tape to prevent shocks. An electrical wire connects the rod to a buzzer and inside the box, another wire connects the buzzer to the battery. Holes should be punched in the sides of the box to let light in so the students can see the inside the box.

Note: To connect the components of an electrical circuit, you must always strip the insulation off the ends of the electrical wire so the current can flow.

EXPERIMENTAL FACTORS

To ensure scientific rigor, the students should evaluate the experimental factors that might influence the experimental results.

- Open circuit (does not allow electricity to flow)
- Lack of resistance element that prevents short circuits (e.g., light bulb, buzzer)
- Presence of non-conductive material in the circuit
- Wire ends not stripped
- Bad connection
- Light bulb burned out
- Dead battery
- Length of wire

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The teacher suggests that the students compare the results of their experiment to their starting hypothesis: were they able to design a game that worked or not? What changes could they make to improve their prototype? Next, the teacher asks the students to explain what they learned from the activity, then reviews the basic concepts about electricity in order to consolidate learning.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher suggests that the students create a diagram or blueprint of the game they designed, using symbols employed in the field of electricity. To access lists of symbols in electricity, visit the *Éclairs de sciences* website.

SCIENTIFIC CONCEPTUAL CONTENT

Atom
An atom is the smallest particle characterizing an element. All matter in the universe is made up of a combination of different atoms. Atoms are made up of protons, neutrons and electrons.

Electrical charge
An electrical charge is produced when an atom loses or gains an electron. When there are more electrons than protons, the charge is negative. When there are fewer electrons than protons, the charge is positive. The unit of electrical charge is the coulomb (symbol: C).

Electrical current
An electrical current is the movement of negative electrical charges (electrons) through a conductor (electrical wire, metal foil, etc.). In an electrical circuit, the current flows from the point where the electrical potential is highest to the point where it is lowest.

Electrical circuit
An electrical circuit is the complete loop through which an electrical current flows. It is made up of a series of electrical components and conductors (e.g., batteries, electrical wires, light bulbs, etc.). The current only flows in an electrical circuit when the path is completely closed, forming a loop.

Types of electrical circuit
There are two types of electrical circuit, parallel circuits and series circuits. Parallel circuits provide several different paths for the electrical current. Series circuits force the current through a single path; in other words, the electricity flows through all the electrical components of a series circuit one after the other.

Conductors of electricity
Conductors are bodies or materials that allow an electrical current to pass through them. Copper, aluminum, brass, zinc, iron and pewter are examples of metal that conduct electricity well. Salt water is also a good conductor.

Resistance
Resistance is the part of an electrical circuit that resists the flow of electricity (for example, by transforming it into heat or light, as in a light bulb or a buzzer). In an electrical circuit, the presence of a resistor limits the current and prevents damage related to short circuits. The unit used to measure resistance is the ohm (symbol: Ω).

Ampere
The ampere (symbol: A) is the unit used to measure current intensity.

Voltage
Voltage (symbol: V) is the unit used to measure electrical tension, also called "difference of electrical potential."

Short circuit
A short circuit occurs when two live (i.e., carrying current) conductors accidentally come into contact, either directly or through a conducting object (e.g., when the blade of an electric lawn mower cuts the electrical wire). When this happens, the current can flow with very little restriction because the resistance of the loop formed by the two conductors is very weak. The high amount of current heats up the wires and can cause a fire. Fuses and circuit breakers detect unusually high currents and break the circuit, which helps to prevent fires.

Battery
Batteries are reserves of chemical energy that can be transformed into electrical energy. Small electric cells (commonly called batteries, as in AA batteries) are examples of simple batteries for everyday use.

Insulator
Insulators, such as wood and plastic, are materials that do not easily transmit heat, cold or electricity. Electrical wires are covered with an insulator to prevent electrical shocks and short circuits that could cause fires.

CULTURAL REFERENCES

Heritage
Québec, thanks to its great many rivers, has developed a very large hydroelectricity network.

People
Thomas Alva Edison (1847-1931), a U.S. inventor who designed the first electric light bulb. He also invented many other devices, including the phonograph, ancestor of the gramophone.
Alessandro Volta (1745-1827), an Italian physicist, invented the first electric battery.

FOR MORE CULTURAL REFERENCES, VISIT THE ÉCLAIRS DE SCIENCES WEBSITE:
www.eclairsdesciences.qc.ca

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PROCESS OF ACTIVE DISCOVERY

GENERAL LEARNING PROCESS IN SCIENCE AND TECHNOLOGY (IN ELEMENTARY SCHOOL)

Context related to everyday life

- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

Initial ideas and hypothesis

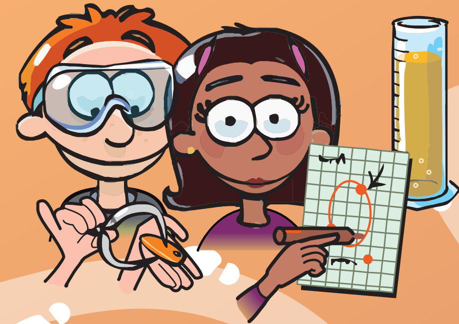
My initial ideas:

- I share my own ideas.

My hypothesis:

- I predict that...
  I think that because…
- I imagine my prototype.
- I think it works like this…

Planning and carrying out



My equipment:

- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

Carrying out my process:

- What will the steps be?
- What precautions should I take?

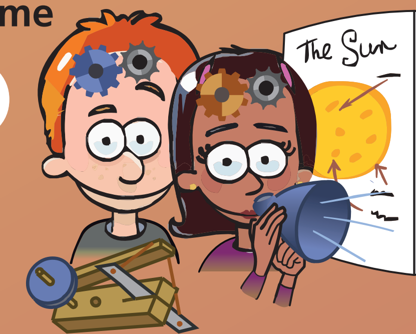
My actions:

- I carry out the steps of my protocol.
- I note or draw what I observe, what I do and what I discover.

My results:

- What is my answer to the problem, question or need?

Outcome



My outcome:

- Do my results confirm my hypothesis or not?
- Are my results similar to those of the other teams?
- Can the other teams' results help me to find answers to my problem, my question or my initial need?
- What could I communicate concerning my discoveries?

New question?

What I learned:

- What do I retain from this activity?
- What could I communicate concerning my results or my discoveries?

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