ACTIVITY 2

HOW DOES WATER CIRCULATE ON THE EARTH?

EXPERIMENT OBJECTIVES AND CONTENT

The goal of this activity is to teach students about the different stages of the water cycle.

ESSENTIAL KNOWLEDGE

MATERIAL WORLD

Matter:
- Properties and characteristics of matter in different states (solid, liquid, gas): shape, texture
- Changes in matter: physical changes (phase changes)

EARTH AND SPACE

Matter:
- Transformation of matter: water cycle

Systems and interaction:
- Meteorological systems (clouds, precipitation)

Techniques and instrumentation:
- Use of simple measuring instruments
- Design and manufacture of measuring instruments and prototypes

Appropriate language:
- Terminology related to an understanding of the Earth and the universe
- Drawing, sketches

SUGGESTED MATERIALS

Scientific equipment:
- Eye dropper
- Graduated cylinders
- Stopwatches

Perishable non-scientific materials:
- Water
- Ice cubes
- Substrata (sand, gravel, clay, dead leaves)

Household materials:
- Plastic plates and containers
- Glass jars and glasses
- Plastic wrap, coffee filters
- Sieve/strainer, grill (e.g., cake rack)
- Measuring cups, water sprayer
- Plastic tubs
- Hair dryer, lamp

School supplies:
- Elastics
- Clocks
- Brown paper towels

School equipment:
- Window ledge

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

One day, while stomping in puddles, a question crosses your mind: Where does the water that falls as rain come from? Does the water in lakes, rivers and oceans rise into the sky and fall back to Earth? How does water circulate around the Earth?

Note: A context inspired by a snow storm may be more appropriate if the activity takes place in winter.

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher begins a discussion, supplemented with photos or images, on where precipitation comes from: Where do rain and snow come from? How do clouds form? Students share their own ideas and are then invited to design a model, or part of one, that represents the water cycle. They should reproduce conditions that favor evaporation, condensation, the formation of precipitation, and infiltration of water into the ground.

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 water evaporates faster when it's warm and windy out. I believe this because when I use a hair dryer, my hair dries faster.

Example 2
I predict that water vapor condenses to form rain when it gets cold. I believe this because when we cook pasta at home in winter, the kitchen window (which is cold) gets all fogged up.

Example 3
I predict that rain water will infiltrate into different types of materials (sand, clay, gravel, mulch, etc.) at the same speed. I believe this because when it rains, the rain water is completely absorbed by the ground.

Example 4
I predict that I can make rain drops in a jar. I believe this because when my parents put hot soup in a container with a lid, the inside of the lid becomes covered with droplets of water.

WORK PLAN AND EXPERIMENTATION

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

Example A
Students compare the effect of temperature and wind strength on the evaporation of a small amount of water (several drops). They place the same amount of water on brown paper towels and place them in different conditions: in the sun (or under a lamp), crumpled up in a ball, in the shade, in a warm wind (hair dryer), etc. The students make note of the time it takes for each paper to dry.

Note: The conditions that favor evaporation can be discovered by placing the same quantity of water in three identical containers and subjecting them to different conditions: beneath a lamp (sun), beneath a fan (wind), and in a closet (shade and no wind).

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example B
Students evaluate the conditions that allow water vapor to condense. They put ice cubes in a glass of water, fill another glass with water but no ice, and place the two in a humid environment (large plastic tub in which water has been sprayed, or a tub of warm water with a cake tray in the bottom on which to place the glasses). The students compare the sides of the two glasses and record their observations for about 10 minutes, then redo the experiment in a dry environment.

Example C
Students compare how water infiltrates through different materials. They choose substrata that mimic the Earth's surface: rocks, sand, clay, top soil, mulch or dead leaves (to represent vegetation), etc. Students line coffee filters with an equal amount of each material then place the filters on strainers above collection containers. They use graduated cylinders to pour water into the filters, making sure no water goes above the lined section. The students then measure how much water has flowed through the filter and substrata, along with the time it took.

Note: Have students think about all the asphalt in cities. Asphalt makes water runoff into sewers rather than infiltrating into the ground.

Example D
Students try to make "rain" by having it condense from water in a glass jar (ideally with a wide opening). They fill a jar three-quarters full of hot water then seal it with plastic wrap and an elastic such that the wrap forms a depression into which they place one or two ice cubes. The students observe what happens inside the jar and record their observations.

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

- Amount of water
- Water temperature
- Relative humidity of air
- Number of ice cubes used
- Precision of measurements
- Moisture content of soil samples
- Compactness of soil samples
- How water is poured over soil samples

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The teacher has the students give oral presentations of their results. Students can enrich their presentations by drawing the portion of the water cycle they studied. Then, the teacher goes over the key concepts by filling in a summary chart with the students.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher discusses the importance of drinking water for human survival. Teachers can suggest that students conduct a study of how water is used at home. The students can compare their results and try to find ways to reduce their water consumption. They could also conduct a study of access to drinking water in the world, which would raise their awareness of the harsh reality experienced by many people around the world. To conclude, the teacher could reuse vocabulary related to the water cycle in the context of writing a story or poem.

SCIENTIFIC CONCEPTUAL CONTENT

The water cycle

It's a series of phenomena that repeat to form a continuous loop. The water cycle illustrates the various ways water circulates around our planet. The stages of the water cycle are:

1) Evaporation (from a body of water) and transpiration (from plants),
2) Condensation (cloud formation),
3) Precipitation (snow, rain, hail),
4) Flow (run off, infiltration and subterranean flow).

Evaporation

Evaporation is the transformation of a liquid into a vapor. The Sun plays a crucial role in the phenomenon of water evaporation. It provides the energy needed for ground moisture and the water in bodies of water to evaporate. At the same time, plants also contribute to the formation of water vapor through a process called *evapotranspiration* (evaporation of water from plants).

Condensation

Condensation is the transformation of a vapor into a liquid. Droplets form around a condensation nucleus such as a speck of dust floating in the atmosphere. Condensation occurs when the temperature reaches the dew point (temperature at which air becomes saturated by humidity). The warmer the air, the more humidity, or moisture, it can hold. Warm, moist air that rises will eventually cool and reach its dew point, which causes clouds to form. In the same way, when warm, moist air comes into contact with a cold surface, water droplets (dew, condensation, mist or fog) or ice (frost) will condense out of it.

Precipitation
Miniscule water droplets and ice crystals that form in clouds clump together and fall when they are large enough. Precipitation can fall as a solid (snow, ice pellets, hail) or a liquid (rain, drizzle, freezing rain).

Infiltration (or seepage)
Water that infiltrates into the ground forms reserves of groundwater (water table). It hydrates soil and allows vegetation to grow. The soil's seepage velocity (speed at which water infiltrates), is related to its composition and level of saturation.

Runoff
When it rains, some of the water runs off on the surface into waterways and oceans. The water flowing on the surface is the excess water that the soil cannot absorb.

Cloud
Clouds form when water vapor rises into the sky and condenses into tiny droplets that float in the air. There are many different types of clouds: cirrus, "altos," stratus, and cumulus.

CULTURAL REFERENCES

Drinking water
Drinking water is an essential resource for humans. And yet one in six people does not have access to clean drinking water. Fresh water is distributed over the planet very unevenly. Some countries, such as Canada, have huge reserves of fresh water, while other states, such as Libya and Namibia, in Africa, have highly arid climates and therefore very few drinking water reserves. Because of water's great value, it is sometimes called "blue gold," just as oil is sometimes called "black gold."

Changes in the water cycle
18,000 years ago, at the height of a glacial period, huge quantities of water became trapped in glaciers. On the other hand, today we are undergoing climate warming that is melting ice caps and sending fresh water trapped in glaciers into seas and oceans. The planet's water cycle is influenced by natural cycles, but also by human activities such as deforestation, urban sprawl and soil depletion. These activities contribute to the reduction of drinking water quantity and quality in some countries. The situation is, or will soon become, a major issue for the survival of people in such countries.

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

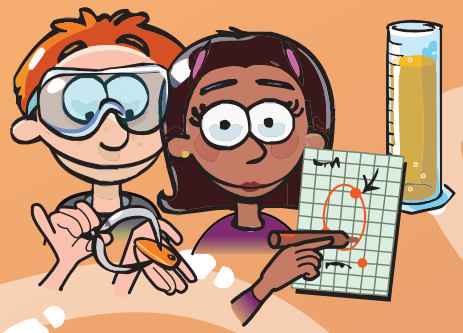
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

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



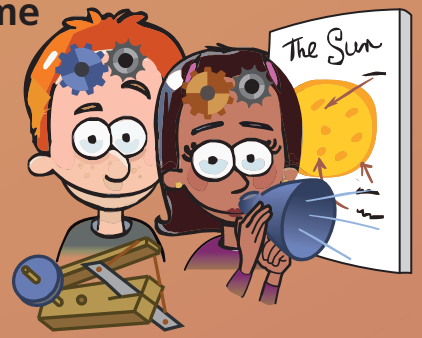
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

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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