ACTIVITY 2

IS IT THE SAME TEMPERATURE AT THE WATER'S SURFACE AS AT THE BOTTOM?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students learn about the phenomenon of convection in water.

ESSENTIAL KNOWLEDGE

Matter:
- Properties and characteristics of matter in different states (solid, liquid, gas)

Energy:
- Forms of energy (heat)
- Transmission of energy: convection

Forces and motion:
- Effects of a force on the direction of an object
- Characteristics of motion (direction)

Techniques and instrumentation:
- Use of simple measuring instruments (thermometer)

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

SUGGESTED MATERIALS

Scientific equipment:
- Thermometers
- Hot plate

Perishable non-scientific materials:
- Cold water
- Hot water

Household materials:
- Pot (transparent, if possible)
- Spray bottles
- Large containers

School supplies:
- Sheets of paper
- Scissors

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

When you take a bath or swim in a pool, lake or the sea, is the water temperature the same at the bottom (where your feet are) as at the surface? Have you ever felt currents of cold or warm water?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

Before starting this activity, it would be interesting to visit the cafeteria kitchen on a day when the cook is preparing pasta or rice. The students could observe how the pasta or grains of rice move in the boiling water.

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 if I place a thermometer in a container of cold water, the temperature will be the same everywhere. I predict this because when I wash my hands in cold water, the water is the same temperature.

Example 2
I predict that if I pour hot water in a container of cold water and then place a thermometer in it, the water will be warm where I poured it in. I predict this because the water in my bathtub is warmer below the tap.

Example 3
I predict that if I heat water in a pot and place a thermometer in it, the water will be warmer near the heating element than at the surface. I predict this because the bottom of the pot is very hot.

WORK PLAN AND EXPERIMENTATION

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

Example A
The students fill a large container with cold tap water and use thermometers to check whether the temperature is the same everywhere.

Example B
The students fill a large container with cold tap water and place thermometers in different locations (at the bottom of the container, in the middle, at the surface, near the edges, etc.). Then they gently pour in a small amount of hot water and take readings from all the thermometers at regular intervals (e.g., every 10 seconds for the first minute and every minute for five minutes).

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

BE CAREFUL WHEN HANDLING THE HOT PLATE OR THE POT OF BOILING WATER TO AVOID SPILLING HOT WATER.

Example C
The students fill a pot with cold water and place it on a hot plate to bring it to boiling. They take the water's temperature at different places.

Example D
The students fill a pot with cold water and place it on a hot plate to bring it to boiling. They then carefully add small pieces of paper to the boiling water and observe what happens.

EXPERIMENTAL FACTORS

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

- Time elapsed between when the hot water is added and when the temperature is taken
- Stillness of water in container
- How the hot water is poured

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The students compile their results into a table and then create a graph from the data (e.g., change in temperature over time). Teams can discuss their results with other teams to see whether they were able to find answers to the initial question. Were they able to verify their hypothesis? Do they have an explanation to support their response? As a group, they should try to identify problems or experimental errors and find ways to improve their experiments.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The students could do further research on the ocean currents that affect climate, such as El Niño, the Gulf Stream, etc. They could also find out about the different currents at the confluence of the St. Lawrence and Saguenay rivers near Tadoussac.

SCIENTIFIC CONCEPTUAL CONTENT

Convection

In gasses and liquids, temperature differences cause an exchange of heat (and therefore a transfer of energy) that goes along with motion of the molecules within the gas or liquid. This motion, called convection, occurs because the temperature of the gas or liquid seeks equilibrium. Once the temperature is the same everywhere, the movement of the gas or liquid stops. Hence, when cold water is heated, currents of warm water form and rise in the cold water. These convection currents occur because warm water is lighter than cold water.

Daily life

When you cook pasta, water at the bottom of the pot heats, expands and becomes lighter, and begins moving to the surface. This motion also moves the pasta. Once it reaches the surface, the water cools, becomes more dense and falls back down, taking the pasta with it. When water boils, some of it changes from a liquid state to a gaseous state (water vapor) and escapes from the pot. The vapor rises because it is warmer (and thus lighter) than the air in the room. The same phenomenon occurs in Earth's atmosphere. Warm and cold air masses move through the process of convection, creating currents that we call wind.

Hot-air balloons
To inflate and keep hot-air balloons in the air requires warm air that is lighter than the surrounding air. Balloons do not fly, they float!

Geysers
Geysers at the bottom of the ocean spit out boiling water that has been heated in the Earth's crust.

Diving
Water in the depths of lakes and oceans is very cold, and diving in these waters requires a dry suit. However, near the surface, water is heated by the Sun and therefore protective garments are not always necessary.

CULTURAL REFERENCES

Meteorology
Why do clouds often form on beautiful summer afternoons? Because the Sun's rays heat up the Earth's surface. This heat is then radiated into the air, which becomes lighter and starts to rise. As it rises, it reaches colder regions of the atmosphere, loses its heat and the water vapor contained within it condenses into clouds. These clouds, called convection clouds, appear even more easily when there is cold air aloft (masses of unstable air). They are fairly flat at the base, which can be considered the boundary between the mass of warm air and the mass of cold air. At the top, these clouds bulge to a greater or lesser degree depending on the temperature and altitude. Convection clouds sometimes cause thunderstorms.

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

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Conception
L'île du savoir inc. (CRÉ de Montréal)

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PROCESS OF ACTIVE DISCOVERY

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

Context related to everyday life

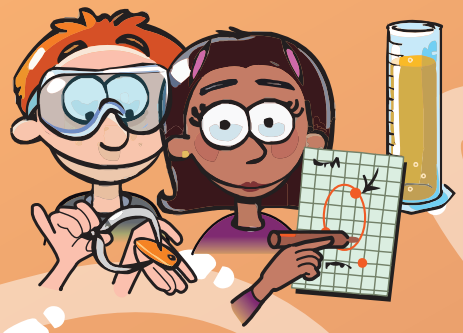
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

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



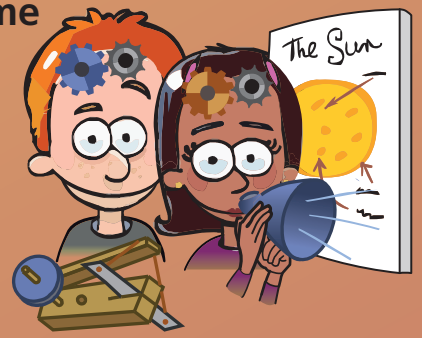
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

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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