ACTIVITY 6

HOW CAN I KNOW IF SOMETHING IS ACIDIC OR ALKALINE?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students explore multiple facets of acids and bases, from identifying them with a pH scale to their various uses. The activity also deals with everyday realities such as the pH of pool water, heartburn, acidification of the oceans, and the pH of soaps and detergents.

ESSENTIAL KNOWLEDGE

MATERIAL WORLD

Matter:
- Changes in matter: chemical changes (acid-base)

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

EARTH AND SPACE

Matter:
- Properties and characteristics of matter on Earth: water

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

LIVING THINGS

Systems and interaction:
- Interaction between living organisms and their environment: living things and their habitats

SUGGESTED MATERIALS

Scientific equipment:
- Small clear containers with a volume of about 100 ml (e.g., beakers or graduated cylinders)
- Syringe or eye dropper
- Hot plate
- pH test paper (litmus paper)
- Electronic pH sensor (e.g., for LEGO® RCX robot or other commercial sensor)
- Safety glasses (for students who do not already wear corrective lenses)

Perishable non-scientific materials
- Water
- Red cabbage
- Acids: vitamin C (ascorbic acid), lemon juice, vinegar, soft drinks, apple juice
- Bases: powdered laundry detergent, sodium bicarbonate (i.e., baking soda), liquid hand soap
- Other powders that dissolve in water or that are translucent in a liquid state

Household materials:
- Large saucepan
- Strainer (sieve)
- Large container with lid

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

At your last birthday party, your grandmother said that the soft drink you were drinking was really acidic and would cause cavities. You wondered how a so-called acidic drink could cause cavities when everyone knows that it's sugary foods like candy that causes tooth decay. You also wondered if there were other acidic products? Above all, you would have liked to know how to find out whether something is acidic or not.

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

Start by drawing a table on the board with two columns (acids and bases) and add to it as the students provide responses. Next, ask the students to name any acidic and basic (or alkaline) products they know. For acids, they will likely mention vinegar, lemons and other citrus fruits. Bases might be more difficult. Point out that soaps and other cleaning products are generally alkaline. Finally, ask them if something can be acidic and alkaline and the same time, or be neither acidic nor alkaline.

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 will be able to identify an acid by taste, because I know how to recognize the taste.

Example 2
I predict that I will be able to identify an acid or a base with red cabbage juice. I predict this because when my mother makes red cabbage soup and she cleans out the pot, the cabbage juice turns green.

Example 3
I predict that I will be able to identify an acid or a base with a commercial pH indicator. I predict this because my parents use one to measure the pH of our pool water.

Example 4
I predict that I will be able to determine an substance's pH with an electronic pH sensor. I predict this because my big brother has used one with his robotic equipment.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

CAUTION! NEVER TASTE PRODUCTS THAT HAVE BEEN USED IN EXPERIMENTS; THEY COULD MAKE YOU SICK.

WORK PLAN AND EXPERIMENTATION

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

Example A

Students must not use this method and will have to find another way to identify acids and bases. But this is an excellent occasion to convey an important message about safety during scientific experiments.

Example B

For this experiment, teachers must first prepare some red cabbage juice with the following recipe: Cut a red cabbage into several pieces and place it in a large pot of boiling water (preferably distilled water). Cook for about two minutes, turn off heat and let steep for 15 minutes. Strain cabbage juice and allow to cool. Juice can be stored in a sealed container in the refrigerator until the day of the experiment.

Students prepare six to eight different test solutions in small, clear containers. For powdered products, they add a pinch of the powder into about 50 ml of water and stir. For liquid products, they dilute a small amount in about 50 ml of water and stir.

They then fill an eye dropper with red cabbage juice and drop a few droplets into each solution being tested. If the color change is not marked enough, add juice (or prepare stronger solutions during the previous step).

Students refer to a color code to identify acids and bases (see Scientific Conceptual Content).

Example C

After preparing test solutions (see Example B), students dip litmus paper in each sample and compare its color with the color scale provided by the manufacturer. They record the pHs in a results table. They can also use commercial pH solutions (e.g., products for testing pool water), which they mix with the test solutions and compare with the color scale provided with the product.

Example D

After preparing test solutions (see Example B), students follow the manufacturer's instructions for using the sensor (see product instruction manual).

EXPERIMENTAL FACTORS

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

- Color of solution (if the test solution is dark, you will not see the cabbage juice react)
- Amount of product in test solution (if not enough, the reaction will be difficult to see)
- Amount of cabbage juice (if not enough is used, the color will be too light)
- Quality of water used to make the cabbage juice (if its pH is unbalanced to start with, results will be affected)
- Differences in color perception between students.

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

Lead a discussion with the whole class to pool the observations and results of all students. Were students able to distinguish between acids and bases? How? How were they able to describe them? If their results were not conclusive, can they determine why? Each team could share their results and processes with the rest of the class.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

What happens when you mix an acid and a base? In this case, use vinegar as the acid and sodium bicarbonate as the base. When the two are mixed, a gas immediately begins to escape from the liquid: carbon dioxide (CO_2). Ask the students what they think just happened. Check the pH of the resulting solution. Is it lower or higher than that of vinegar? Teams could also try to neutralize all the solutions they used in the experiments, remembering that an acid neutralizes a base, and vice versa.

SCIENTIFIC CONCEPTUAL CONTENT

pH scale

The pH scale goes from 0 to 14, with 0 being the most acidic and 14 being the most basic (or alkaline); 7 indicates pH neutrality. The scale is logarithmic, meaning that each pH unit is 10 times more acidic (or alkaline) than the next (or previous) unit. For example, a product with a pH of 4 is 10 times more acidic than a product with a pH of 5). "pH" stands for "potential of hydrogen."

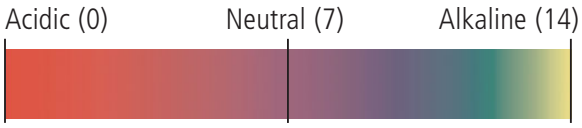
Acids and bases

A few examples of acidic products commonly found in the home are: soft drinks (pH = 2.5), vinegar (pH = 3), tomatoes (pH = 4.5), coffee (pH = 5), milk (pH = 6.5). You will also find many alkaline products at home: baking powder (pH = 8.3), laundry detergent (pH varies depending on brand, but generally above 10), toothpaste (pH varies but generally between 7 and 10), bleach (pH = 12).

pH indicators

There are two common types of commercial pH indicator available, one for pools and the other for school laboratories. Pool indicators are usually phenolphthalein-based and come with a color code for analysis. School labs generally use litmus paper, which also comes with a color code analysis guide and instructions.

Red cabbage juice
As long as it has been prepared using water with a pH of 7, red cabbage juice is neutral (pH = 7). It changes color when it comes into contact with substances whose pH are higher or lower than 7. Below is a scale of the colors it takes on depending on the surrounding pH.



Every indicator reacts in its own way, so this color scale is only valid with red cabbage juice, and the colors obtained will vary depending on the substance's initial color.

Acid-base reaction
A chemical reaction between an acid and a base. The resulting substance is different from the two initial substances because a transformation at the molecular level occurs. One acid cannot neutralize another acid, nor can one base neutralize another.

Soaps and detergents
Soaps are bases with variable pH. The pH of skin is slightly acidic, and some soaps can irritate certain skin types. This is why some soap brands are advertised as being pH neutral.

CULTURAL REFERENCES

Food and health
Heartburn is caused by excess acid in the stomach. People suffering from this condition sometimes use commercial products to ease the symptoms. These products are made up of alkaline substances (e.g., calcium carbonate) that neutralize the acid and therefore reduce the burning sensation.

Dental erosion
Cases of dental erosion are increasing in the industrialized world, especially among teens. Dental erosion occurs when the teeth's enamel wears away due to contact with acidic substances. Regularly eating and drinking acidic foods such as soft drinks, juices, coffee, energy drinks, etc., can cause dental erosion.

Environment
Normal rain (i.e., unpolluted) is slightly acidic because the CO_2 present naturally in the atmosphere dissolves into raindrops and forms carbonic acid. Increasing amounts of atmospheric CO_2 is causing an acidification of the oceans because the seawater absorbs CO_2 from the air. This increased oceanic acidity degrades corals because they are made up of calcium carbonate.

History
The concept of pH was developed by the Danish chemist Søren Sørenson (1868-1939); this allowed the acidity or alkalinity of chemicals to be accurately determined. He also developed the pH scale that we still used to day.

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

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Conception
Les Neurones Atomiques

Find out more about the educational activities and other resources offered by this organization on their website: **www.lesneuronesatomiques.com**

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PROCESS OF ACTIVE DISCOVERY

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

Context related to everyday life

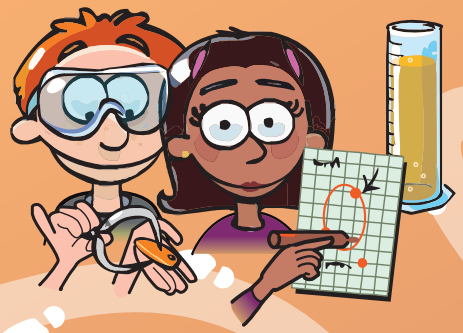
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

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



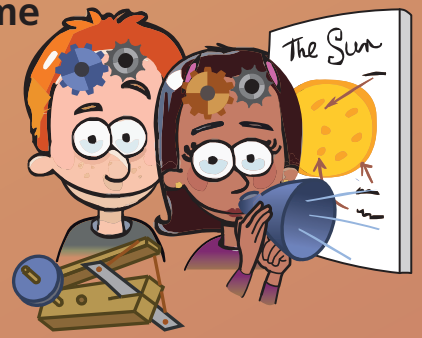
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

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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