ACTIVITY 2

HOW ARE SHADOWS FORMED?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students are introduced to the concept of shadow and experiment with different ways of creating and changing a shadow.

THE STUDENTS MAY BELIEVE THAT ONLY VERY THICK MATERIALS AND LARGE LIGHT SOURCES, SUCH AS THE SUN, CAN CREATE A SHADOW.

ESSENTIAL KNOWLEDGE

MATERIAL WORLD
- Transparence

EARTH AND SPACE
- Light and shadow

SUGGESTED MATERIALS

Perishable non-scientific materials:
- Powder (flour or some other powdery substance)

Household materials:
- Table lamps
- Flashlights
- Lamp shade
- Opaque plastic glasses
- Transparent plastic glasses
- Various colors of plastic soft drink bottles
- Facial tissues
- Tissue paper
- Aluminum foil

School supplies:
- Pencils
- Adhesive tape
- Glue
- White cardboard
- Books
- Stir sticks

School equipment:
- Sunny window ledge and curtains

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

Have you ever noticed that as you move away from a streetlight at night, a dark impression forms on the ground at your feet, and that as the distance between you and the streetlight increases, the shadow gets longer and eventually disappears? Why does the shadow disappear? Is it possible to create shadows or play with them? If so, how might you go about it?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher leads the students in a brainstorming session and allows them to express what they know about the concepts of shadow and transparence. After the discussion, the students handle the materials and think about how they can go about creating shadows.

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 make a shadow by blocking light from a flashlight with a barrier made from stir sticks. I predict this because when I walk near the wall of the school, I block light from the sun and make a shadow.

Example 2
I predict that I can make shadows by moving a piece of cardboard in front of a light, like clouds passing in front of the sun. I predict this because when I place something between a light source and the ground, a black impression appears on the floor.

Example 3
I predict that I can make more than one shadow appear for the same light source. I predict this because when I walk in the street and I pass beneath streetlights, I see several shadows on the ground.

Example 4
I predict that not all objects can produce shadows; objects I can see through do not produce a shadow. I predict this because the glass in windows does not make a shadow.

Example 5
I predict that if I sprinkle flour in front of a flashlight, I will see a shadow form. I predict this because I cannot see through flour, and as a result, light cannot pass through it.

WORK PLAN AND EXPERIMENTATION

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

Example A
The students build a wall using stir sticks, using white glue to stick them together. They place the wall a certain distance from a flashlight and observe the shadow created. They can also make the shadow move by changing the angle of the wall or the light source.

Example B
The students pass shapes cut out of cardboard and mounted on stir sticks in front of a lamp. They verify what distance from the lamp they must pass the forms in order to create crisp shadows.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example C
The students place an object over a piece of white cardboard, shine several flashlights on it and count the number of shadows created.

Example D
In front of a bright window, the students make predictions about the likelihood that various objects will cast a shadow on a piece of white cardboard when they move that object between the window and the cardboard. The students use different containers (transparent, translucent and opaque), for example soft drink bottles of different colors, or plastic glasses. They also compare different types of paper (facial tissue, wax paper, aluminum foil, etc.).

Note: Take the opportunity to have the students observe the intensity of the shadows; some will be light grey, while others will be black.

Example E
In a dark room, the students illuminate a wall and sprinkle flour in front of the light source into a tub on the floor. They verify what happens when they blow on the flour. They could also test different sources of light.

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

- Thickness of screen
  (paper, cardboard or stir sticks)
- Intensity of light
- Size of light source
- Position of light source
- Number of light sources
- Ambient light

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

After the experiments, the teacher invites the students to share their discoveries with the rest of the class in the form of an oral presentation. The teacher takes the opportunity to review the important concepts: shadow, transparence, translucence, and opacity.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher can suggest an activity to make a simplified sundial (the construction of a true sundial made from a semi-circle divided into degrees is for cycle 3 students). It is also possible to build a small Chinese shadow theatre: some students tell a story or fable while others are in charge of illuminating and manipulating cut-out figures.

SCIENTIFIC CONCEPTUAL CONTENT

Shadow
An area of darkness created when an opaque body intercepts light. There are two types of shadow: 1) shade and 2) cast or projected shadow (umbra). Shade is the non-illuminated portion of an object, for example the dark side of the Earth when it is night. The projected shadow, or umbra, is the shadow cast by an object onto another surface. For example, during a solar eclipse, the sun's light is blocked out by the moon, casting the moon's shadow onto the Earth. A shadow can vary in shape and size depending on where the light source is located with respect to the illuminated body. In addition, when there is only one light source, the shadow cast will gain contrast as the light source becomes more intense. The number of shadows produced by a single object is related to the number of light sources illuminating it.

Penumbra
A lighter area of shadow around the shadow cast or projected by an object (umbra).

Opaque materials
Materials that do not let light pass through them. Hence, one cannot see through such materials. Wood and metals are examples of opaque materials.

Transparent materials
Materials that allow light to pass through them easily. Hence, one can look through such materials and see objects on the other side. Glass and clear plastic bottles are examples of transparent materials.

Translucent materials
Materials that allow some light to pass through them but which do not allow objects on the other side to be clearly distinguished. Frosted glass or very thick glass are examples.

CULTURAL REFERENCES

History

Sundials have long been used to tell local time when the sun is not hidden. The oldest known sundial is in Egypt and dates from 1,500 years BCE. The first sundials were made of a flat surface onto which an upright rod was placed. The direction of the shadow cast by the rod indicated the time. Such sundials were not very precise. It was not until the 14th century that the Arabs invented a more accurate sundial with a rod that was inclined according to the location's latitude.

Culture

Shadows have long been used in the world of art. Chinese shadow plays are an excellent example. As its name suggests, this type of play originated in China over 2,000 years ago. Legend has it that shadow plays originated out of a military strategy dating back to the Qin dynasty (221 years BCE to 206 BCE). The leader of a besieged army ordered his soldiers to make and place small puppets on top of the town's walls then shine lights on them to create numerous shadows, to make the enemy think that the fortress was impregnable and cause them to retreat.

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

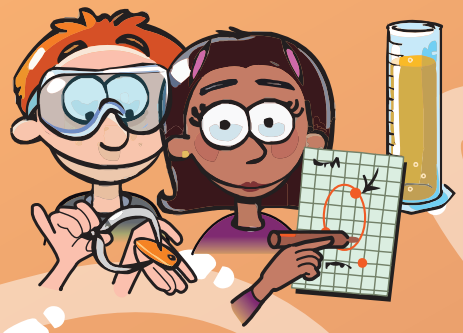
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

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



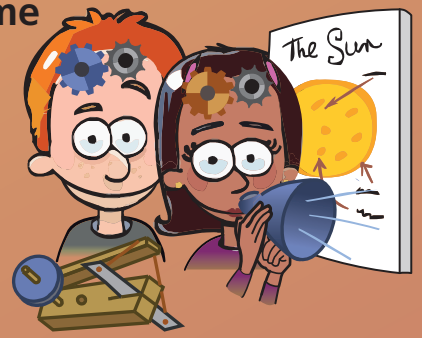
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

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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