ACTIVITY 3

WHY DOES THE MOON CHANGE SHAPE?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students observe the different phases of the Moon using a miniature Earth-Moon-Sun model they have built themselves.

ESSENTIAL KNOWLEDGE

- Light and shadow
- System involving the Earth, the Moon and the Sun

SUGGESTED MATERIALS

Scientific equipment:

- Lunar calendar showing the Moon's phases every day (some ordinary calendars show this too.)
- Globe

Household materials:

- Opaque party balloons

School supplies:

- Opaque sports balls
- Styrofoam or tennis balls
- Flashlights
- Projector
- Stir sticks
- Felt markers

School equipment:

- Darkened classroom with curtained windows

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

During an arts and crafts period, you notice that your friends did not all draw the Moon like you did. Some made it totally round while others made a crescent shape, and you wonder who is correct. Is it possible that the Moon changes shape? You decide to observe the Moon one night in the car with your parents and when you see it in the sky you notice that it is perfectly round. But you remember that last week it had a crescent shape. So you decide to solve this mystery with your friends. How might you go about it?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher reads a story aloud that describes the phases of the Moon and that mentions the full Moon and werewolves (see suggested websites). The teacher can present the basic concepts of the interaction between the Earth, Moon and Sun using a simple model. Another idea would be to make a model of the system using three students, each representing one of the three heavenly bodies. The teacher could ask the other students to infer hypotheses about how these "bodies" interact with each other. He or she then invites them to verify their hypotheses by trying to explain why the Moon changes shape.

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 we cannot always see the entire Moon because the Sun only lights a part of it. I predict this because when I shine light on an object with a flashlight, part of the object remains in shadow.

Example 2
I predict that it is Earth's shadow that hides a part of the Moon and prevents us from seeing it all. I predict this because when I cast my shadow on a white wall, it gets darker.

Example 3
I predict that we do not always see the whole Moon because it revolves around the Earth. I predict this because when I revolve an object around me, I can't see it at certain times.

WORK PLAN AND EXPERIMENTATION

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

Example A
The students revolve a ball of Styrofoam with a stir stick in it, representing the Moon, around a globe. They illuminate their miniature Earth-Moon system with a lamp, which represents the Sun. They record their observations using drawings and sketches and determine if the play of shadow and light created by the Sun might be the cause of the Moon changing its shape.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example B
The students hang an opaque party balloon, representing Earth, in front of a projector and revolve a tennis ball around it, symbolizing the Moon. They record their observations with drawings and sketches and determine if the Earth's shadow projected on the Moon might be what causes the Moon to change shape.

Note: This experiment demonstrates what happens during a lunar eclipse. To help the students look into this matter more deeply, draw their attention to the shape of the shadow created by the light on the tennis ball.

Example C
The students examine how the Moon's phases occur from the observation point of Earth. One after the other, a student (Earth) stands in front of a projector (the Sun) and another takes a sports ball and holds it in his or her outstretched arms (the Moon). The student holding the ball revolves around the student representing Earth, who follows how the shadows fall on the ball and makes oral observations to the other team members, who record them by drawing sketches. The students then change places and notice if they observe the same thing. They next determine whether the Moon's revolution around the Earth is what causes it to change shape.

EXPERIMENTAL FACTORS

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

- Intensity of ambient lighting
- Number of light sources
- Size and intensity of light sources
- Position and distance between the models of the Earth, Moon and Sun

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The teacher leads a class discussion to review the activity's key concepts. Which teams were able to observe changes in the Moon's shape? Which hypotheses were valid? What roles do the Earth and Sun play in the Moon's changing shape? The teacher has the students draw the shadows observed on the miniature Moons and compare them to the illustrations on a lunar calendar. Are there any similarities? The teacher helps the students identify the different phases of the Moon.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher suggests that the students find English expressions containing the word "Moon" and explain their meaning (e.g., moonstruck, honeymoon, over the moon, once in a blue moon, many moons ago, etc.) The class could also write a story that features the different phases of the Moon. The class could also visit a museum or centre with astronomy activities or exhibitions.

SCIENTIFIC CONCEPTUAL CONTENT

The Moon

The Moon is Earth's only natural satellite and the largest heavenly body visible in the night sky. It is four times smaller than Earth and is about 385,000 km away (a distance that varies depending on its orbit around Earth). It is therefore the celestial object that is closest to us. While the Moon is the brightest object in the night sky, it only reflects the Sun's light, like a reflector on a bicycle. In addition to rotating slowly on its axis, the Moon orbits the Earth. It takes 27 days, 7 hours, 43 minutes and 11 seconds (sidereal revolution) to orbit the Earth once. Because this is exactly the same time it takes to rotate once on its axis, the Moon always has the same side facing Earth.

Earth

Earth is the third planet from the Sun of our solar system. It takes 24 hours to rotate once on its axis and one year to revolve around the Sun.

The Sun

The Sun is the only star in our solar system and is located at its centre. Its extreme brightness is explained by its close proximity to Earth.

Phases of the Moon

These are the different shapes of the Moon as seen from Earth. Since the Moon reflects the Sun's light and revolves around the Earth, the illuminated portion we can see changes every night. We can observe eight phases. The new Moon occurs when the Moon is located between Earth and the Sun. It is not visible because the Sun lights its hidden side. Then the Moon appears as an increasingly thick crescent, passing through the following phases: first crescent, first quarter, and waxing gibbous. During these phases, the Moon is said to be "waxing." It finally reaches the full Moon phase 14 days later, which is when its visible face is completely lit by the Sun. Then, for the next 14 days, the Sun is said to be "waning," i.e., the illuminated portion lessens, passing through the following phases: waning gibbous, last quarter and last crescent, before finally disappearing completely again into the new Moon.

Lunar eclipse
A lunar eclipse occurs when the Moon passes into Earth's shadow. During lunar eclipses, Earth passes between the Moon and the Sun, projecting its shadow onto the Moon and preventing the Sun from illuminating it. Eclipses may be partial or total. Lunar eclipses are rare but may be observed with the naked eye without danger, unlike solar eclipses. Recent and upcoming lunar eclipses visible in North America are on February 20, 2008, December 21, 2010 and April 15, 2015.

CULTURAL REFERENCES

Origin of the Moon
Astronomers do not know exactly how the Moon formed, and there are several theories, one of which is widely accepted because it explains the differences and similarities between Earth and the Moon. According to this theory, in the early history of the solar system, there was a collision between Earth and a Mars-sized object. This collision projected a large amount of material into space, which coalesced to form the Moon.

Walking on the Moon
In 1969, U.S. astronauts Neil Armstrong and Edwin Aldrin, of the Apollo 11 mission, were the first humans to walk on the Moon. Do you know which of the two said the famous phrase "That's one small step for a man, one giant leap for mankind," as he stepped onto the Moon's surface? The answer is Neil Armstrong. Since then, we have returned to our satellite five times; the astronaut Eugene Cerdan was the last person to walk on the Moon, in 1972. The astronauts took many photographs of the Moon during these missions, and they also brought samples of Moon rock and dust back to Earth. They also left a flag of the United States, vehicles, lunar modules, footprints–and a golf ball!

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

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Montréal Science Centre

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PROCESS OF ACTIVE DISCOVERY

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

Context related to everyday life

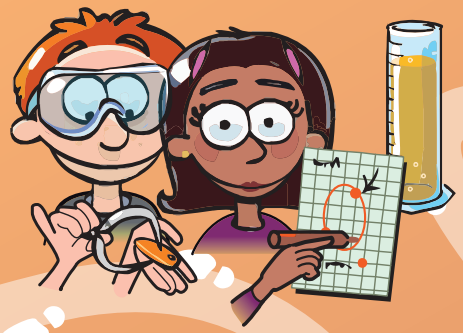
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

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



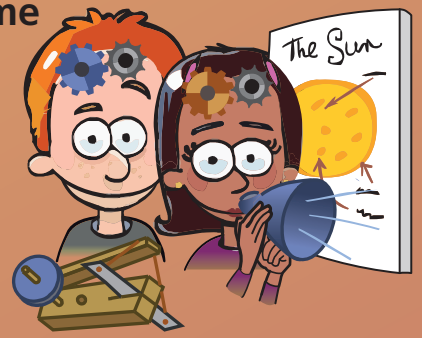
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

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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