TRB^3

Elementary Science Teacher Resource Book

A PROFESSIONAL DEVELOPMENT RESOURCE FOR TEACHING CORE CURRICULUM

GRADE 6

LITERACY -- STRATEGIES – ASSESSMENT

Utah State Office of Education

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The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the Sun.

8. Standard I

STANDARD I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.
Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

1.1 Student Reading
1.2 Investigations
1.3 Assessment

6th Grade Science

STANDARD I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Desired Results

Benchmark/Enduring Understandings

The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the sun.

Essential Questions (Things Students need to know)	Skills (Things students need to be able to do)
A. How does the appearance of the moon change during a month? B. Why does the moon appear to move across the sky? C. How can data be collected to show change in the moon phases? D. What is the difference between the motion of an object rotating on its axis and an object revolving in orbit? E. How do objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night?	A. Identify the pattern of change in the moon's appearance. B. Describe scientific evidence explaining the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky. C. Design an investigation, construct a chart, and collect data depicting the phases of the moon. D. Model revolution and rotation of planets. F. Model the movement and relative positions of Earth, the moon, and the sun.

Assessment Evidence

- Pre-Assessment and Invitation to Learn
- Multiple Choice/Constructed Response Test
- Performance Test 1-Moon Watching
- Performance Test 2-Modeling the Moon

Instructional Activities (Investigations)

1. It's Just A Phase (A, B)
2. Tracking the Moon (B)
3. Phases of the Moon (C)
4. Wobbling in Circles (D, E)

Science Benchmark:
The appearance of the lighted portion of the moon changes in a predictable cycle as the result of the relative positions of Earth, the moon, and the sun.

STANDARD 1
Students will understand that the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

STANDARD I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.
b. Identify the pattern of change in the moon's appearance.
c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.
c. Model the movement and relative positions of Earth, the moon, and the sun.

Science language students should use:
Axis of rotation, orbits, phases of the moon, revolution, reflection

Intended Learning Outcomes
For Sixth Grade Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

- **Instruction should include significant science experiences that lead to student understanding using ILOs.**

By the end of sixth grade students will be able to:

1. Use Science Process and Thinking Skills

a. Observe simple objects, patterns, and events, and report their observations.
b. Sort and sequence data according to criteria given.
c. Given the appropriate instrument, measure length, temperature volume, and mass in metric units as specified.
d. Compare things, processes, and events
e. Use classification systems.
f. Plan and conduct simple experiments.
g. Formulate simple research questions.
h. Predict results of investigations based on prior data.
i. Use data to construct a reasonable conclusion.

2. Manifest Science Attitudes and Interests

a. Demonstrate a sense of curiosity about nature.
b. Voluntarily read or look at books and other materials about science.
c. Pose questions about objects, events, and processes.
d. Maintain an open and questioning mind toward new ideas and alternative points of view.
e. Seek and weigh evidence before drawing conclusions.
f. Accept and use scientific evidence to help resolve ecological Problems.

3. Understand Science Concepts and Principles

a. Know and explain science information specified for the grade level.
b. Distinguish between examples and non-examples of concepts that have been taught.
c. Solve problems appropriate to grade level by applying science principles and procedures.

4. Communicate Effectively Using Science Language and Reasoning

a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
b. Describe or explain observations carefully and report with pictures, sentences, and models.
c. Use scientific language in oral and written communication.
d. Use reference sources to obtain information and cite the source.
e. Use mathematical reasoning to communicate information.

5. Demonstrate Awareness of Social and Historical Aspects of Science

a. Cite examples of how science affects life.
b. Understand the cumulative nature of science knowledge.

6. Understand the Nature of Science

a. Science is a way of knowing that is used by many people, not just scientists.
b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
c. Science findings are based upon evidence.

- **Instruction should include significant science experiences that lead to student understanding using ILOs.**

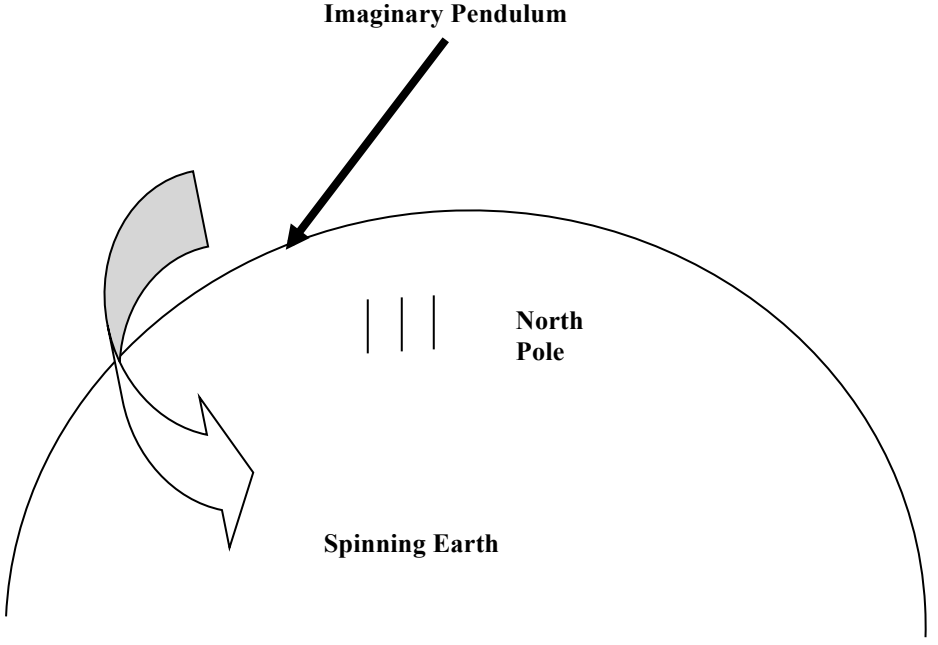
8.1 Student Reading

Science Benchmark: 06 : 01 The appearance of the lighted portion of the moon changes in a predictable cycle as a result of The relative positions of Earth, the moon, and the sun.
Standard 01: Students will understand that the appearance of the moon changes in a predictable cycle as it Orbits Earth and as Earth rotates on its axis.

Shared Reading
THE MYSTICAL MOON

When we look up into the sky, we see the sun, moon, planets and stars going across the sky. We may think Earth is standing still and everything is going around us. Hundreds of years ago people saw the same thing and believed Earth was center of the universe. It seemed Earth stood still and everything in the sky circled Earth.

In 1852, a French scientist, Jean Bernard Foucault, did an experiment to show that Earth spins. He built a pendulum by attaching an iron ball with a pointer on it to a 200-foot wire hanging from a dome ceiling. After putting the ball into motion, it scratched a mark in sand spread out below it, each time it swung across. Throughout the day the scratch lines slowly and evenly shifted to the right. Foucault's swinging iron ball offered proof of the Earth's *axis of rotation*. Since a pendulum does not change course, it had to be Earth that was rotating beneath the pendulum. The North and South Poles mark Earth's axis. It is easiest to understand a pendulum at the North Pole. The pendulum would swing in the same path all day scratching marks in a complete circle as Earth rotated under it.



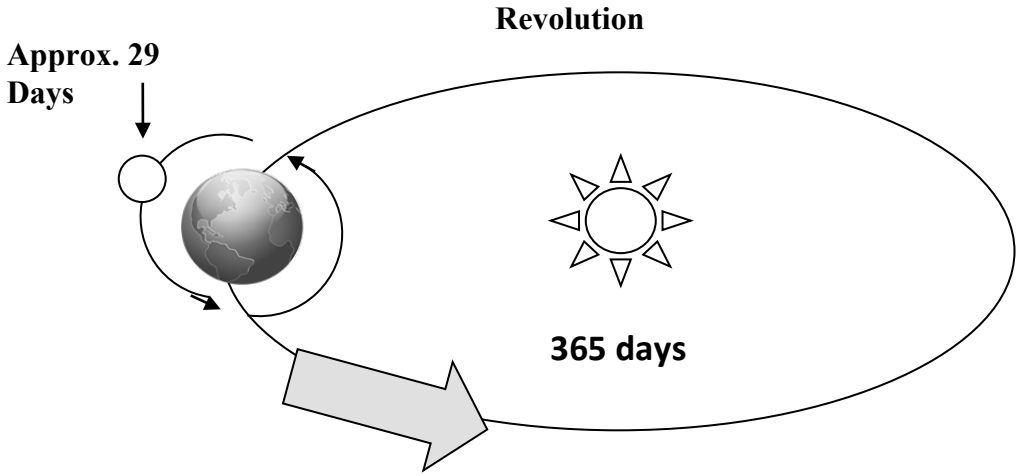
Axis of rotation – The spinning of objects around an imaginary center line.

Grade	Benchmark	Standard	Page
06	06 : 01	01	8.1.1

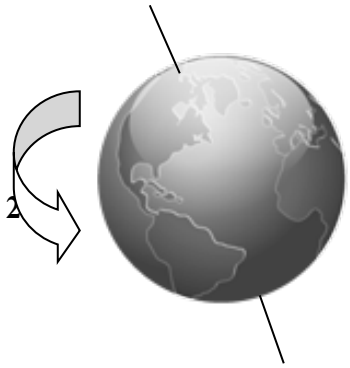
When we see the sun move across the sky, it is the rotation of Earth that gives the sun this appearance. The sun is actually in the same place in the sky. As Earth rotates on its axis every 24 hours, it brings the sun in and out of view giving us daylight and darkness. Like the sun, the stars stay in the same place. As Earth rotates, all stars, except the North Star, appear to change their positions. Some stars will come into view or go out of view. Others will follow a circular pattern in the sky. Some night, pick a star in the eastern horizon to observe. During the night, it will appear to be moving across the sky just like the sun. It is the rotation of Earth that changes the star's positions during the night. On another night, pick a star near the North Star. It will appear to be circling around the North Star. Earth's axis is pointing directly at the North Star, so the star doesn't appear to move. The stars near the North Star seem to be circling it because of the rotation of Earth.

Another major movement of planets and moons is their *revolution* in space around another object in space. It takes one year for Earth to revolve around the sun. It takes the moon approximately 29 days to revolve around Earth. The path a planet or a moon takes during its revolution is called an *orbit.*

Movements of the Earth and Moon (not to scale)



Side view of Earth's and moon's orbits make the circular orbits look oval



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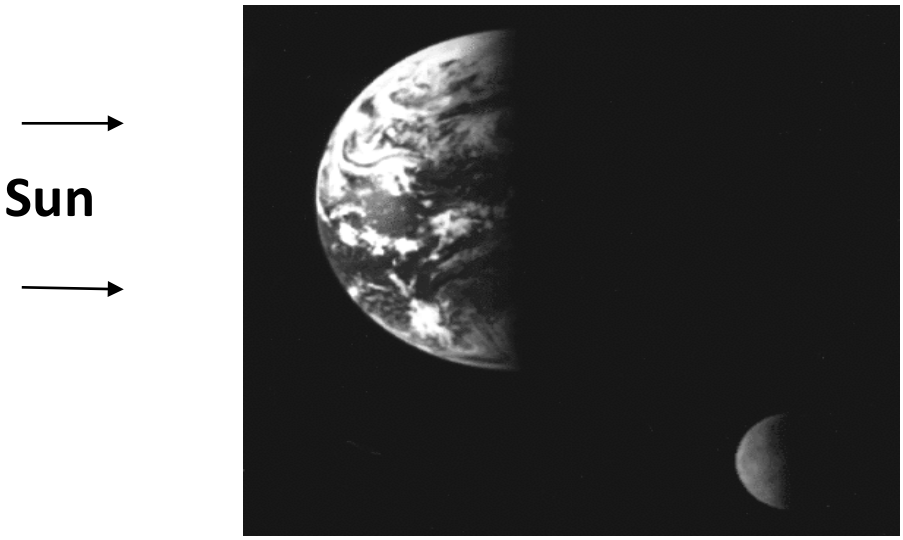
orbit – the path a planet or a moon takes during its revolution
revolution – the circling of an object in space around another object in space

Not only were early astronomers very interested in the sun and stars in the sky, they were also fascinated by the changing moon. It appeared to change size from day to day. This strange occurrence captivated people's imaginations for hundreds of years. There have been many stories, legends, and myths written to explain why the moon changes shape. One story claims the moon is a cookie that is nibbled on each night by some mysterious creature, then magically reappears whole in a few days. Another story tells that Earth's shadow falls on the moon causing the light to gradually reappear. Today we know these ideas are incorrect. In the next few pages, you will ready why the moon appears to change by increasing and decreasing in the sky each month.

Changes in the Moon

To understand the changes in the moon's appearance we need to know where the moon gets its light. The moon does not produce its own light. As the sun's rays shine on the moon, they are *reflected* or bounced off. This reflection lets us see the moon. Just like Earth, half of the moon is always exposed to light, and the other half is dark. But, why don't we see the full reflection of the moon each time we see the moon?



Light Reflected from Earth and Moon

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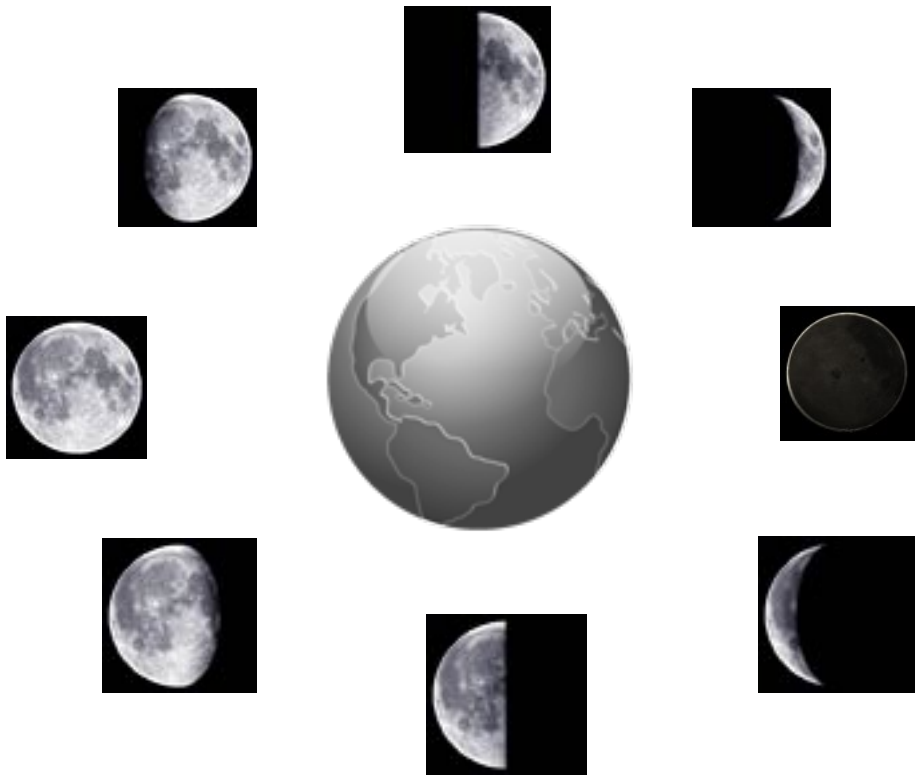
reflection – the process of light bouncing off an object

Remember it takes the moon about twenty-nine days to revolve around Earth. The lunar cycle takes place during the revolution. During the lunar cycle the sun rises about twenty-nine times. You have probably noticed that the moon doesn't always rise and set at the same time each day. Sometimes it rises with the sun, after the sun has been up a while, or when the sun is setting. Sometimes it rises after the sun has gone down or in the middle of the night. The moon doesn't revolve around Earth as fast as the Earth rotates. Because of Earth's faster rotation, the moon rises about forty minutes later each day.

You have probably noticed that each time the moon rises it appear to have a different shape. The shape of the moon seems to grow for a while and then shrink for a while. These changes we see are called *phases of the moon.* The phases of the moon are the different shapes of the moon seen during a lunar cycle. So, not only is the moon rising at different times each day, it also has a different shape each day.

Some views of the moon from Earth during one month



The lunar cycle begins with the New Moon – one that is not visible to our eyes. During this phase the moon is between the sun and Earth. The moon and sun rise and move across the sky together. (Remember, the sun is not moving. It is the rotation of Earth that brings the sun into view.) Since sunlight is hitting the part of the moon that is facing away from Earth, we see only the dark side of the moon. We cannot see any part of the moon's lighted reflection, so the moon seems invisible. We call it a New Moon. The New Moon phase only takes place during daylight hours. As Earth rotates to nighttime, the New Moon is no longer in view, having disappeared behind the horizon.

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phases of the moon – the different shapes of the moon during a lunar cycle

Since the moon rises later each day during the lunar cycle, we see more of the lighted side of the moon each time it rises. On the seventh or eighth day, the moon is in the First Quarter phase. It has traveled one-quarter of the way through its orbit. From Earth we can now see one-half of the lighted side.

New Moon to First Quarter

New Moon

First Quarter

On the fourteenth or fifteenth day of the lunar cycle, the moon has orbited behind Earth, putting Earth between the sun and moon. The moon has traveled half way in its orbit. Each night we see more of the lighted side appear. The positioning of these three bodies lets us see the complete lighted side of the moon called the Full Moon.

First Quarter to New Moon

First Quarter

Full Moon

On the twenty-first or twenty-second day of the lunar cycle, the moon has orbited to the other side of the Earth, opposite the First Quarter Moon's position. The moon now looks similar as we see less and less of the lighted side. It appears as a half moon just as it did at the First Quarter Moon. But what is different about the Last Quarter Moon compared to the First Quarter Moon? You are right if you guessed that the lighted side is on the left or east side instead of the right or west side of the moon. This is called the Last Quarter Moon because the moon has traveled three-quarters of the way through its orbit.

Full Moon to Last Quarter

Full Moon

Last Quarter

Finally on about the twenty-ninth day, the moon approaches the last phase of the lunar cycle. The moon and sun are rising at about the same time. The reflected light we see from the moon has shrunk to a small sliver. The next day the moon will be positioned between the sun and Earth creating a New Moon which begins a new lunar cycle.

Last Quarter to New Moon

Last Quarter **New Moon**

Scientists can predict very accurately where the moon will be and what phase the moon will be in on any given day in the future. Because the sun, Earth, and moon are so reliable, we have based calendars and measured time on their motions. We also have the beautiful phases of the moon for our enjoyment and curiosity.

Science Language Students Need to Understand and Use

1. **axis of rotation:** the spinning of objects around an imaginary center line
2. **orbit:** the path a planet or moon takes during its revolution
3. **phases of the moon:** the different shapes of the moon during a lunar cycle
4. **reflection:** the process of light bouncing off an object
5. **revolution:** the circling of an object in space around another object in space

8.2 Investigations

Investigation One – It's just a Phase

Standard I
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Standard I

Objective 1
Explain patterns of changes in the appearance of the moon as it orbits Earth

Objective 1

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest scientific attitudes and interests
3. Understand science concepts and principles
4. Communicate Effectively Using Science Language Reasoning

Background Information

The moon rotates on its axis at the same pace as it revolves around Earth. As a result, the moon always keeps the same side pointed toward us throughout its orbit. Astronomers call the side we see from Earth the "nearside of the moon," and the side we never see from Earth, the "farside of the moon."

During the moon's cycle, the actual shape of the moon never changes. It is always a sphere. We only see the moon because sunlight reflects back to us from its surface; it has no light source of its own. What changes is the portion of the moon that can be seen from Earth. Half of the moon is always illuminated by the sun. The half of the moon facing the Sun is always lighted; but the lighted side does NOT always face Earth. As the moon circles Earth, the amount of the side facing us that is lighted by the sun changes, altering how much of the lunar surface appears bright and how much is in darkness. The changes are known as phases, and repeat in a specific cycle. These are the primary phases: New Moon, First Quarter, Full Moon, Last Quarter. (It takes 28-30 days to go from one New Moon to the next.)

During the time it takes to move from one phase to another, the amount of the moon's surface lighted by the sun changes gradually; it's not an abrupt change from one phase to the next. (Many times students get the impression that changes are abrupt because they are only shown diagrams of the primary phases.)

There are times during the cycle when the moon can be seen during the day. These times are predictable. The following chart gives the times when each phase rises and sets.

PHASE	RISES	HIGHEST IN SKY	SETS
New Moon	Sunrise	Noon	Sunset
First Quarter	Noon	Sunset	Midnight
Full Moon	Sunset	Midnight	Sunrise
Last Quarter	Midnight	Sunrise	Noon

Earth's shadow plays no role in the moon's phases, but the shadow of Earth does darken the moon during a lunar eclipse. Earth revolves around the sun once every year. The moon circles Earth about once per month. The plane of the moon's orbit is tilted a little (5°) from the plane of Earth's orbit. When the moon is on the side of Earth away from the sun (Full Moon), it passes very close to Earth's shadow; however, because its orbit is tilted, the moon usually passes just above or below Earth's shadow. About once every six months the moon goes right through the shadow of Earth, creating a lunar eclipse.

Materials
- ☐ Phases of the moon cards (see) directions at the end of this activity.

Pre-Assessment/Invitation to Learn

Ask the students what they see when they look at the moon. As the students describe the various phases, give the appropriate phase card to the student. Teach the correct term for each phase; New, First Quarter, last Quarter, and Full Moon. Include all the phases of the moon but do not name intermediary phases (waxing, waning, gibbons and crescent are not vocabulary words students need to learn). Have the students with the phase cards come to the front of the room. Assign the student to arrange the cards in the order they would see them during the moon's cycle. Start at New Moon and end with New Moon to emphasize that it is a cycle. Have the students tape the cards to the board in the order they have determined. Do not comment or evaluate the order at this time. Students will discover the correct sequence for themselves in the next activity.

Materials
- ☐ 1 bright lamp without the shade (at least 75 watts)
- ☐ Styrofoam ball for each student craft (Popsicle)
- ☐ Stick, tongue depressor, or sharpened pencil for each "Moon
- ☐ Observation Chart" for each student
- ☐ lunar diagrams chart
- ☐ scissors
- ☐ glue or tape

Instructional Procedures

This activity works best in a dark room with a bright light at student eye level.

1. Place the lamp in the middle of the room. Arrange furniture so there is enough room for the students to stand with arms extended in a circle around the lamp.
2. Distribute a Styrofoam ball moon model to each student. Stick a pencil, craft stick or tongue depressor into the ball to make it easier to hold.

3. Explain to students that the light represents the sun and their heads will represent Earth. They also need to imagine that all observations are being made by a person standing on the top of "Mt. Nose." Have all the students stand so that it is noon for the observer on Mt. Nose. (This can also be called "noses at noon" position.) Have the students rotate to the position where it is midnight on Mt. Nose (noses) at midnight). Have the students rotate in the correct counterclockwise direction. (To help students remember how to rotate, it is helpful to have them put their right hand over their hearts as if saying the Pledge of Allegiance and then use that hand to push themselves around.) Have the students extend their arms to represent the horizons for the observer on Mr. Nose. Allow the students to determine which hand represents the western horizon where the sun sets and which hand represents the eastern sky where the sun rises.
4. The students should hold the Styrofoam ball slightly above their heads to keep it out of their bodies' shadows. Have the students observe the moon in different positions as it rotates around their heads or Earth. Ask them how much of the moon is illuminated as it rotates. Make sure that the students understand that half the moon is always illuminated.
5. Start at New Moon position. Have the students observe that the illuminated side is away from them and the farside is visible. Have the students rotate 1/8 of the way around the circle. They should now be able to see a small crescent of the illuminated side. Have the students rotate another 1/8 of the way around the circle to the point where they see the First Quarter. Continue through the lunar cycle and back to New Moon.
6. Have the students go through the sequence again, this time saying the name of the phases, New, First Quarter, Full, and Last Quarter as they pass through each phase.
7. Call out moon phases and have students move to that position. (Make sure that the students move in a counterclockwise direction to correctly model the moon's orbit.)
8. Distribute the Moon observation Chart to the students. Assign them to observe the moon in the sky each day/night. Students should color the part of the visible circle that is illuminated yellow, and the part that is not illuminated black. students should describe the appearance of the sky in their journals.

Curriculum Extensions

Science –

- Have the students work in pairs with one student holding the moon in the different phases. The other student should extend his/her arms and rotate to determine the time of day when each phase rises and sets. (ILO 1)
- This activity can be done using an overhead projector to represent the sun. Have all the students stand opposite the projector. (ILO 1)

Language Arts –

- Read and discuss legends about the phases of the moon. Have them write their own legends. (Standard VII, Objective 3)
- Share poetry about the moon and have the students write a moon poem. (Standard VII, Objectives 3, 6)

Assessment Suggestions

- Distribute Oreo Cookies and a plastic knife to the students. Have the students separate the cookies and use the white frosting to represent the illuminated portion of the moon that we see during each phase. The chocolate cookie represents the portion of the moon that is not illuminated. The cookies could be placed on a calendar on the appropriate days to demonstrate understanding of the cycle. (Teacher will need to provide information on the phase for the day the activity is conducted.)
- Given a specific phase, the students will determine what phase they will be able to see in 24 hours, in 72 hours, in 1 week, or in 2 weeks.
- Have the students complete the worksheet to show level of individual understanding.

Reference to Assessment Section

	Multiple Choice	Constructive Response	Performance Test
Unit Test	2, 3, 5, 6	1, 2, 5, 6, 7	Moon Watching

Resources

Book s -

- Branley, Franklyn M. *The Moon Seems to Change.* 1987
  Simple text, but good photos and drawings about the phases and movement of the moon. $4.50

- Estalella, Roberts. *Our Satellite: The Moon.* 1994
  General text about the moon, includes phases. Two page chapters, photo on one Side, text opposite. 32 pages. $6.95

- Smith, P. Sean. *Project Earth Science Astronomy.* NSTA, Arlington, VA, 1998. ISBN 0-87355-108-7

- Sneider, C. I. *Earth, moon, and Stars.* Lawrence Hall of Science, Berkeley, CA., 1986. *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook.*

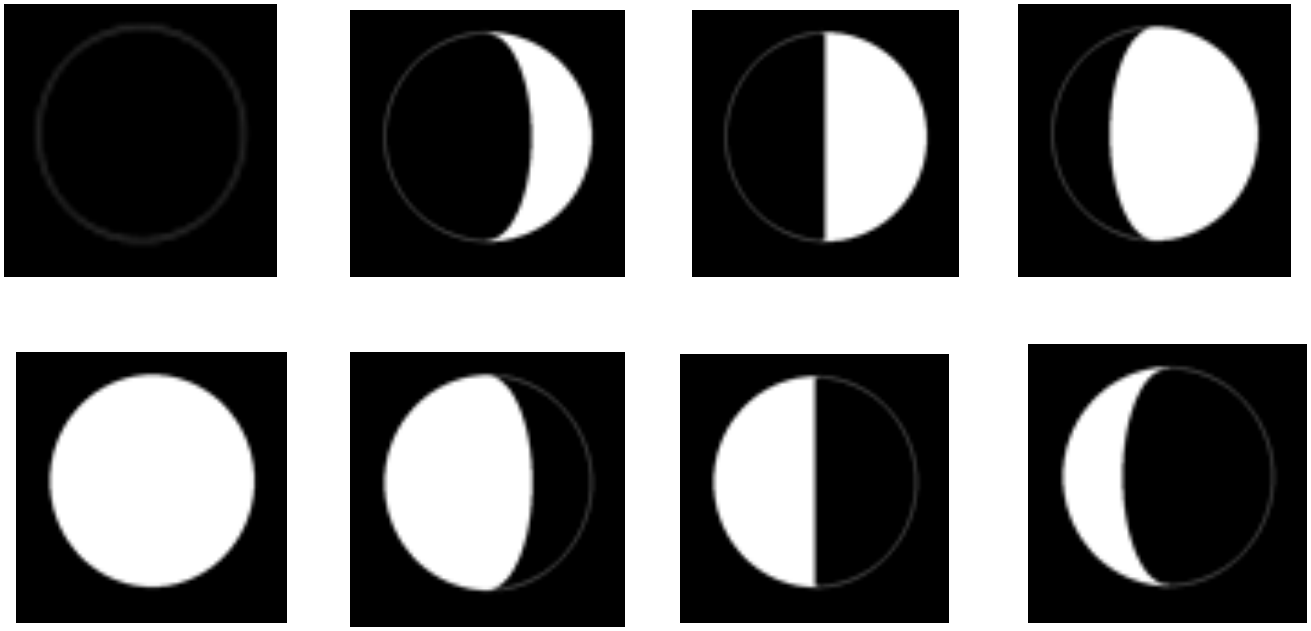
Websites –

- Exploration (allows students to view moon phase for any day of their choosing)
  http://liftoff.msfc.nasa.gov/Academy/UNIVERSE/MOON.HTML

Videos –

- The Moon, Disney Educational, 1995 (Bill Nye)

Directions for Moon Phase Cards



Enlarge the drawings above to fit on 9” by 9” construction paper to make moon phase cards. Laminating will increase their life span.

Moon Observation Chart

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____
Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____
Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____
Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____	Date ____ Time ____

Investigation Two – Tracking the Moon

Standard 01:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Standard I

Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits Earth.

Objective 1

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest scientific attitudes and interests
4. Communicate effectively using science language reasoning

Background Information

Each day (or night) when the moon comes up, the moon seems to be moving across the sky as the day progresses. When we see the moon move across the sky, it is the rotation of Earth on its axis that gives the moon this appearance. As Earth rotates on its axis every twenty-four hours, it brings the moon in and out of view. Students learn that the moon revolves around Earth. But they need to know that it doesn't revolve as fast we see it move across the sky each day. It takes about twenty-nine Earth rotations (days) for the moon to revolve one time around Earth. However, when the moon comes up each day, it has revolved about 13 degrees more around Earth. Because of this the moon comes up about forty minutes later each day and we see more or less reflected light off the moon each day.

This lesson is to help students understand that it's the turning of Earth on its axis that gives the appearance that the moon is moving across the sky. They need to know that the moon revolves slowly around Earth. This makes the moon rise later each day.

Pre-Assessment/Invitation to Learn

Ask the students, "What time of the day or night have you see the moon in the sky?" Some may say they have seen it up during all parts of the day or night on different days. Others may say they have seen it occasionally during the day, but mostly at night. Some may say that they have only seen it at night. Some may say they see it occasionally.

Ask the students, "When it is up, what does it seem to be doing during the day?" Most of the students will say that the moon moves across the sky. Ask, "Why does it seem to move across the sky?" Get into a discussion of Earth's rotation on its axis that changes the position of the moon in the sky during the day (or night) just like the sun changes position in the sky during the day. Make sure they understand that it is not the revolution of the moon around Earth that makes it seem to move across the sky. Even though the moon revolves around Earth, it doesn't move that fast.

Ask the students, "How often does the moon come up?" Some may say once a month, others may say once a week, and others may say about once a day.

After you have established that the moon comes up once a day, ask them, "Does the moon come up at the same time each day?" Some won't know, some will say yes, and some may know that it comes up at a different time each day.

Ask the students, "Why does the moon come up later each day?" Come to the conclusion that the moon revolves slowly around Earth. Each day they see the moon it has revolved about 13 degrees more around Earth. This extra 13 degrees makes it come up about 40 minutes later each day.

Instructional Procedure

Activity One

Materials
- ☐ 4-inch Styrofoam Ball
- ☐ 2 foot wooden dowel
- ☐ tape

1. Put a large Styrofoam ball on a stick and hold it up so all can see.
2. Have all the students stand and face the ball.
3. Explain to them that this is a simulation of why the moon seems to be moving across the sky each time it comes up. Their heads are Earth and they will be turning counter clockwise, watching the moon in their vision.
4. Have them turn clockwise a fourth of a turn to be in a starting position. Looking forward (not at the moon) the moon should be seen in their peripheral vision in their left eyes.
5. With their eyes fixed forward, staring straight all the time, have them turn counter clockwise (rotating on an axis) by shuffling their feet in one spot so they turn as slowly as they can at a constant move until they have rotated 180 degrees. (The moon is now seen with their right eyes in their peripheral vision.) Not at anytime should they have looked directly at the moon, only viewing it in their peripheral vision.
6. Have the students keep rotating another 180 degrees (the moon is now out of view during this time) until the moon comes into sight in their left eyes.
7. Have them repeat this two or three times until they can do it better each time.
8. Ask them, "What does the moon seem to be doing each time you rotate?" (Moving from left (east) to right (west) each time.)
9. Ask "Is the moon really moving in the sky?" (No, it is in one spot all the time.)
10. Ask, "Why does it seem to be moving?" (We are moving (rotating) all the time, which makes it seem that the moon is moving across the sky.)
11. Ask, "But, doesn't the moon revolve around Earth? So isn't the moon moving?" (Yes, but it isn't the revolution of moon that makes it seem like the moon is moving across the sky. It is the rotation of Earth that makes it seem the moon is moving across the sky.)
12. Tell the students, "To understand this we are going to continue with our simulation."
13. Tell the students to stand again in the starting position. (Students are one-quarter turn from the moon with the sight of the moon in their left eyes in their peripheral vision.)
14. Tell the students that you want them to rotate exactly 360 degrees as they have done before. Have the students rotate slowly with their eyes fixed forward being able to see the simulation of the "moon moving across the sky". When they are at the position that they can't see the moon in their vision, move the moon about 13 degrees to the left, simulating the revolution of the moon around Earth. Have them stop when they have gone exactly 360 degrees.

15. Ask, "With your eyes still looking forward, can you see the moon out of your left eye in your peripheral vision?" (No, it is not in sight.) Ask, "Why do you think it isn't in sight?" (You must have moved the moon.) Ask, "Why do you think I moved it?" (Because the moon revolved more around Earth as we were rotating.)
16. Tell the students to keep rotating slowly until they see the moon in their peripheral vision. Ask, "What did you notice you had to do to see the moon again?" (We had to move a little farther.) Ask, "What does this mean when we see the moon rise each day?" (Each day the moon revolves more around Earth. Each day Earth has to rotate a little more before we can see the moon. Because of this, the moon will rise later each day.)

Activity Two

In a succession of three to five days when you can see the moon the sky most of the day do the following activity. (Look on the calendar and see when there will be a New Moon. Three or four days after that you should be able to see the moon most of the day. The moon will be waxing at this time.)

Materials
- ☐ Moon in the sky all day
- ☐ Standard ruler
- ☐ Journal or "Moon's Daily Position

1. Tell the students that for the next three to five days we are going to be tracking the moon. We will be looking at the positions of the moon during the day and the phase it is in each day. (At the beginning of each day, note the time the moon came up.)
2. Tell the students what time the sun came up. Have them record it in their data sheets.
3. Starting on the earliest hour possible, have the students go outside with journals or data sheets and rulers in hand. At this first observation have them draw what the moon looks like.
4. With their rulers stretched out at arms' length and the end of the ruler on eastern horizon, measure in inches how far the moon is up over the horizon. (Not everyone's will be the same because of different length of arms and accuracy, but as they do the measurements all day the measurements will be relative to their outcomes in their own situations.) Have them record their data.
5. Each hour, have them go out and measure how far the sun is up over the eastern horizon.
6. At the end of the day, they should have 5 or 6 readings. Ask them at the end of the day, "What did they notice about the moon's position after each hour?" (The moon's position is farther over the eastern horizon each day.) Ask, "Why is it farther each hour?" (Because Earth is rotating on its axis making it seem the moon is moving across the sky.")
7. Tell them that we are going to do this for the next couple of days and see if there are any changes.
8. On the beginning of the next day, tell the students the time the moon came up. (It should have come up about 40 minutes later.)
9. With rulers and data sheets in hand, have the students go out at the same times they went out on the previous day. Have them draw what the moon looks like during the first observation. Have them record all the data on their data sheets for each hour they went out.
10. At the end of the second day, ask them if they see any changes from the first day in their data charts. (The moon came up later. We can see more of the lighted side of the moon. The moon wasn't as high up beyond the eastern horizon compared to the same times as the previous day.)

11. With this data, ask them to predict what will happen tomorrow as we observe the moon. (We will see more of the lighted side of the moon. The moon will come up later tomorrow. The moon won't be as high over the eastern horizon on each hour as the day before.
12. You can continue to make observations for as many days as you need and ask questions about their observations.

Make sure they understand that the moon changes its position in the sky during the day because of the rotation of Earth on its axis. The moon does revolve around Earth but this is not the reason for the changing of its position during the day. With the revolution of the moon around Earth, it does make the moon come up later each day, and it isn't in the same position each hour of every day. The phases of the moon change slightly each day.

Curriculum Extension

Math –

- Have the students graph the results of their three to five-day moon tracking Observations. (Standard V, Objective 1)

Technology –

- Have the students go to www.askjeeves.com (moon phases) and look up the chart that tells the moonrises of the moon on the different days of the moon. Have them make graphs of the moonrises for any given month. (Standard VI)

Language Arts –

- Have the students read some books about the moon that apply to its movement and phases. Have them make illustrations of what they read about and report it to the class. (Standard VII, Objectives 2.3)

Assessment Suggestions

- Review the students' notes and/or journals for accuracy and completion.
- Ask the students:
  - Why does the moon seem to move across the sky when it is in our view?
  - How can you prove this?
  - Why does the moon rise later each day?
  - Is the moon in the same position the same hour each day? Why or why not?
  - What else changes in our sight when we look at the moon each day?

Reference to Assessment Section

	Multiple Choice	Constructive Response	Performance Test
Unit Test	1, 2, 4, 6, 8, 10	1	Moon Watching

Resources

See Resources in Investigation One (p. 8.2.4)

Name _____

Moon Tracking Data Sheet

Day 1 Time	Observations	Moon Phase Drawing

Day 2 Time	Observations	Moon Phase Drawing

Day 3 Time	Observations	Moon Phase Drawing

Day 4 Time	Observations	Moon Phase Drawing

Investigation Three – Phases of the Moon

Standard 01:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Standard I

Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits Earth.

Objective 1

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles
4. Communicate effectively using science language and reasoning
6. Understand the nature of science

Background Information

The moon orbits around Earth once every 28-30 days. During this time, the moon moves eastward about 13° per day (just bigger than a fist at arm's length), making the time of moonrise later each day. From Earth, we see it as the moon changing position in the sky and changing the percent of the illuminated side we are able to see (called phases). At any given time, half of the moon has sunlight hitting it (the day side of the moon) and the half not facing the sun is dark. How much of the illuminated side of the sun we can see from Earth determines the phase of the moon. The basic phases are New Moon, First Quarter, Full Moon, Last Quarter, and back to New Moon. First Quarter occurs and we continue to see more of the moon until we can see the entire illuminated side at Full Moon. The phases move to Last Quarter, and then the New Moon and we begin the cycle all over again. As the moon orbits around Earth, it also rotates on its axis. We only see one side of the moon because it keeps the same side facing Earth. If it didn't rotate as it orbited Earth, we would see both sides of the moon. The side we see from Earth is the "nearside of the moon" and the side we never see from Earth is the "farside of the moon."

Materials

- ☐ Phase sheet for each student (2 are included- teacher select)
- ☐ glue
- ☐ paper
- ☐ the moon as seen from Earth model

Pre-Assessment/Invitation to Learn

Give the students a phase sheet and have them cut out the moons pictured along the bottom. Next they should glue the pictures into the boxes in the location they think is correct.

Instructional Procedures

This activity will take at least two weeks and must begin in the evenings beginning a day or so after the New Moon.

1. Have the students pick a spot in their backyards or near their houses where they can observe the moon at the *same time* each evening.

2. Students will draw the foreground objects they see from their observation spot on a piece of paper.
3. A quick sketch of what the moon looks like and where it is each night will be drawn in comparison to the foreground objects (house, garage, tall tree, power pole, etc.) on the same paper. Students can use their fists to estimate angles and aid in their placement of the moon.
4. Following the 2-week evening observations, teachers can also do one week of day time observing with the entire class a few days after the New Moon or Full Moon. this will help reinforce the fact that the moon is not always seen in the evening and is orbiting around the Earth.

Curriculum Extensions

Technology-

- Have the students go to the NASA web site www.nasa.org to learn different facts about the moon. Have them share these facts with each other on a poster or a PowerPoint presentation. (Standard VIII)

Assessment Suggestions

- Have students draw a particular moon phase, as seen from Earth, to test their understanding.

Reference to Assessment Section:

	Multiple Choice	Constructive Response	Performance Test
Unit Test	2, 3, 5, 6	1, 2, 5, 6, 7	Modeling the Moon

Resources

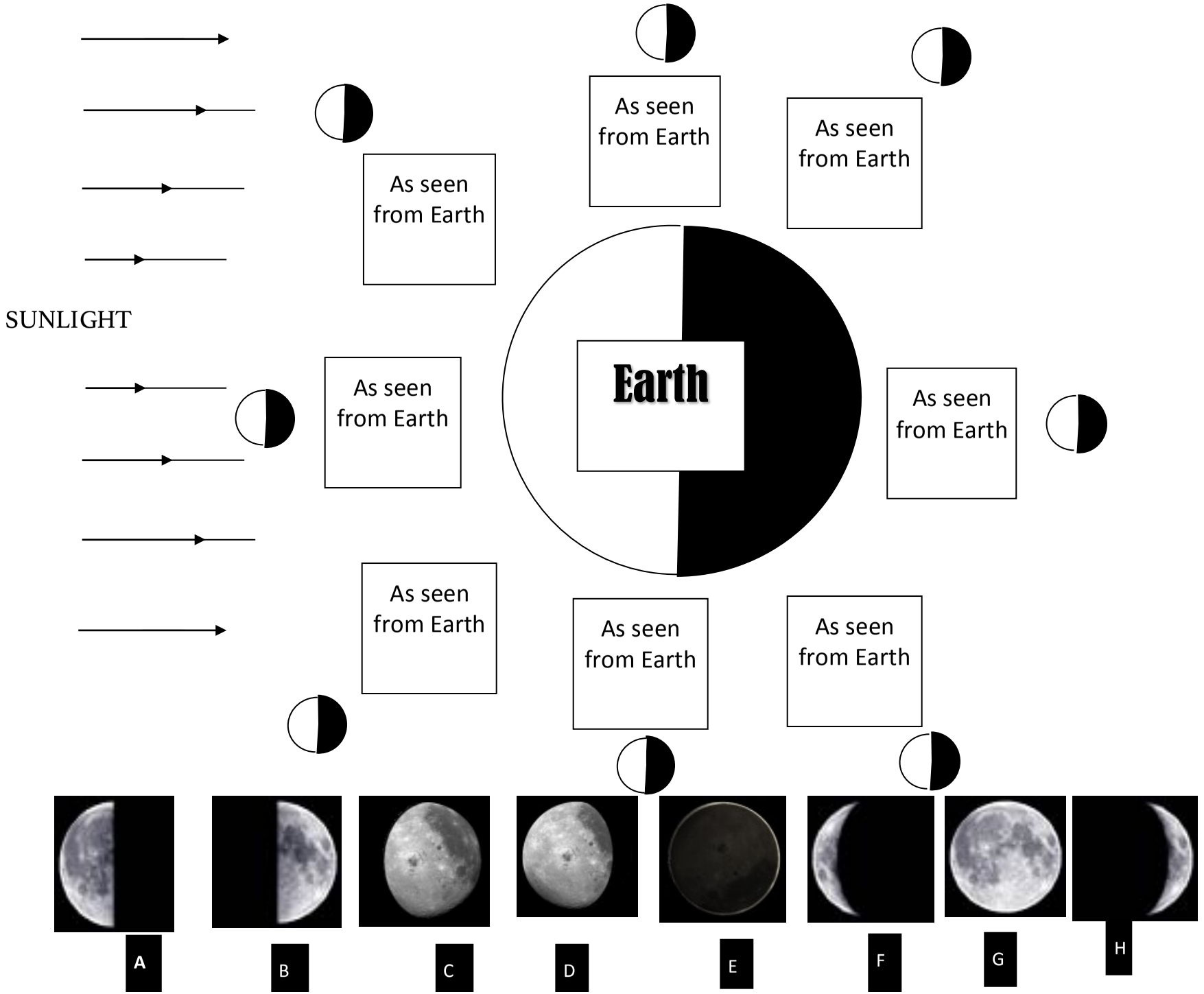
Web sites –

- To find when the next New Moon will occur, go to the Clark Planetarium web site: http://www.clarkplanetarium.org education page.

- www.askjeeves/phasesofthemoon
  This site will show you what the moon looks like presently and on any given date in the past and future. There are also schedules of the dates and times the moon rises in any certain city around the world.

Videos-

- Reflecting on the Moon, National Geographic
- Take a Look I, Moon, ITV Express 1990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Earth
As seen from Earth
As seen from Earth
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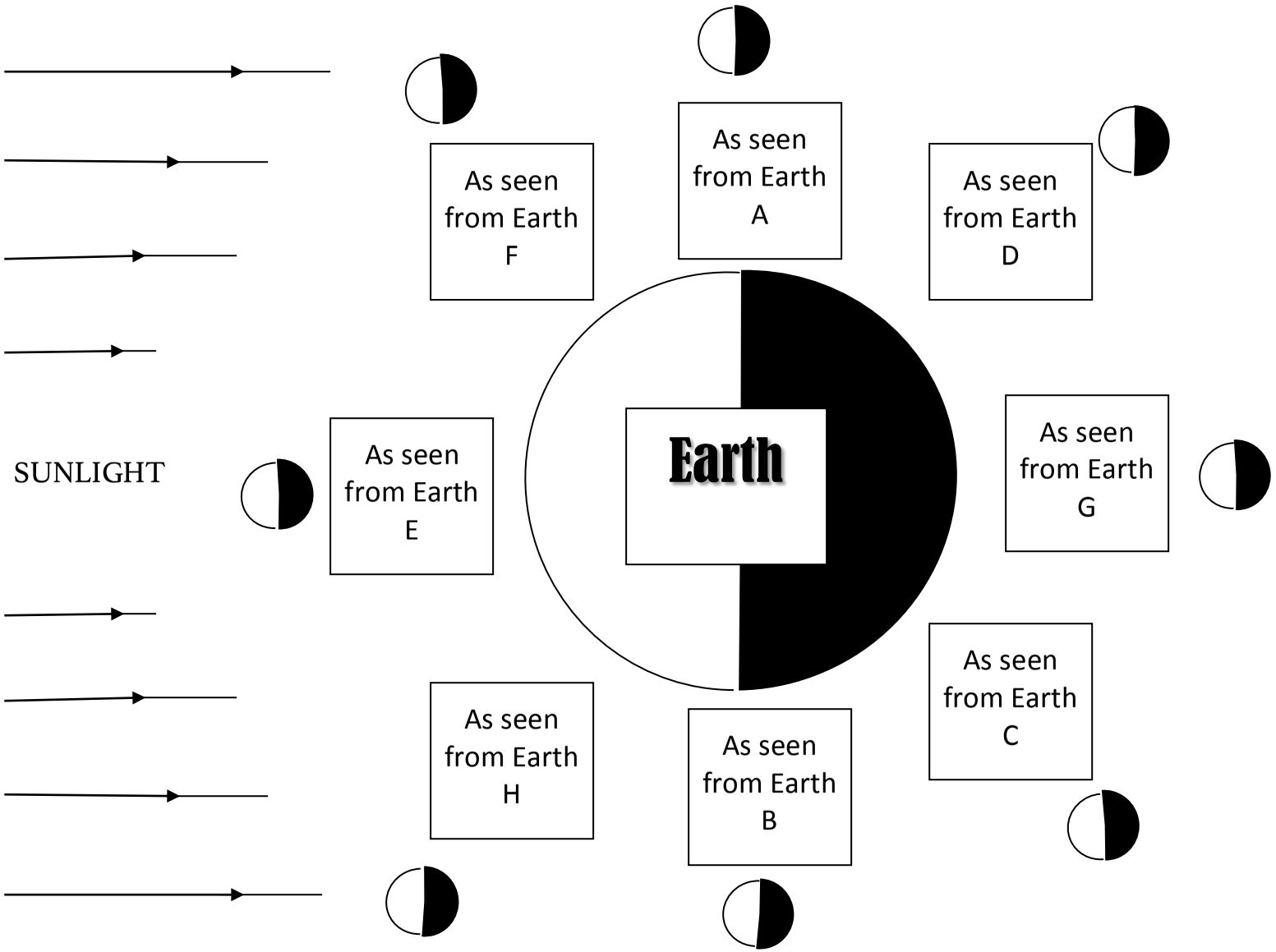
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As seen from Earth C
As seen from Earth D
As seen from Earth E
As seen from Earth F
As seen from Earth G
As seen from Earth H
Earth
SUNLIGHT

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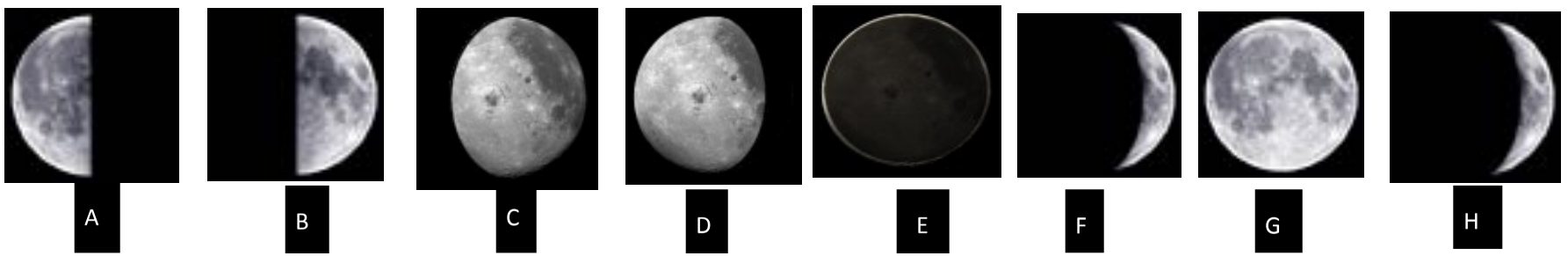
A
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Investigation Four – Wobbling in Circles

Standard 01: Students ill understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.	**Standard I**
Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.	Objective 2
Intended Learning Outcomes: 1. Use science process and thinking skills 3. Understand science concepts and principles 6. Understand the nature of science	

Background Information

The rotation of an object is when it spins on its axis. The revolution of an object is when it circles around another object. Earth takes about 24 hours to complete one rotation. Earth takes 365 ¼ days to make a complete revolution. It takes the moon about 28-30 days to make one revolution, and the same amount of time to make one complete rotation. Therefore, the same side of the moon is always facing Earth. The revolution of the moon around Earth is the reason we have moon phases.

Pre-Assessment/Invitation to Learn

1. Ask students if they know the difference between a rotation and a revolution.
2. Have another student demonstrate the counter clockwise rotation of Earth.
3. Have another student demonstrate the counter clockwise rotation of the moon while it revolves around Earth. The first student (Earth) should still be rotating. Make sure the moon is only rotating once for every revolution. The same side of the moon should always be facing Earth. Explain to students that the revolution of the moon around Earth is why we have moon phases.

Materials
- ☐ Word cards for Earth, Moon, Sun, planet, and 2 stars (for each group.
- ☐ Large open area

Instructional Procedure

1. Explain to the students that Earth revolves around the sun, just as the Moon revolves around Earth.
2. Remind students that Earth and the moon rotate counter clockwise as they orbit the sun. The moon revolves around Earth as Earth is revolving around the sun.
3. Assign three students to represent Earth, the moon, and the sun. They should hold the right word cards.
4. Have students demonstrate the rotation and revolution of Earth and the moon around the sun for the class. Make sure they rotate as they revolve.
5. Put students into groups to repeat this activity. Have students play the different roles of the sun, the moon, and Earth.

6. Bring the students back together as a class.
7. Assign students again to be the sun, the moon, and Earth, but this time add two stars and one planet out in the distance.
8. Have Earth slowly turn from day to night. Have them pay special attention to the planet and stars. What do they appear to do? Earth should notice that the planet and stars appear to move across the sky as they are rotating. Point out that although the other planets are revolving around the sun, it is because of Earth's rotation that the planets appear to move across the sky. The same is true with the stars in the sky. They appear to move because of Earth's rotation.
9. Again, break students into groups to repeat the activity so all can understand that stars and planets appear to move across the sky based on Earth's rotation. Each student should have the opportunity to play Earth.

Assessment Suggestions

- Observe groups demonstrating the activity to make sure the concepts are understood.
- Journal Activity: Have students write a paragraph comparing a revolution and a rotation. Have them explain the movement of Earth and the moon in space, in addition to the apparent change in position of the planets and stars.

Reference to Assessment Section:

	Multiple Choice	Constructive Response	Performance Test
Unit Test	1, 7, 8, 9, 10, 11	3, 4	

Resources

Videos –

- The Moon, Lucern Media, 1994
- The Moon, Staton Films, 1983

8.3 Assessment

Grade 6 **Standard 1** **Unit Test**
The Moon

Multiple Choice

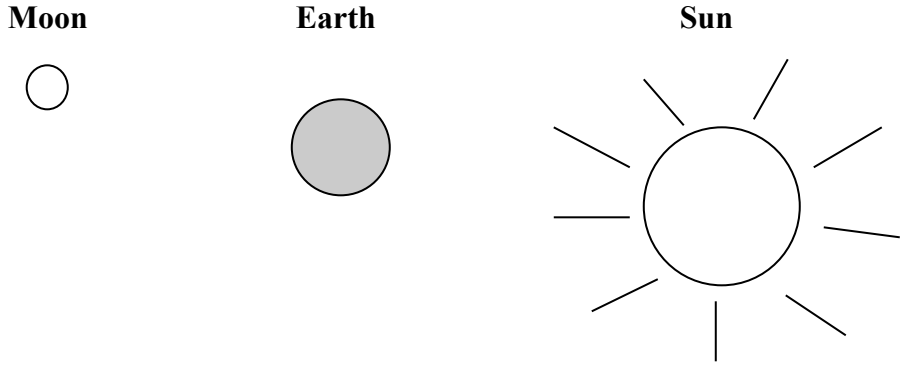
1. Why does the moon appear to move across the sky during the night?

   A. It Travels around Earth every day.
   B. Earth rotates on its axis
   C. It is extremely far away.
   D. All objects in space are moving.

2. What happens when you see the moon's "phases" change? The moon appears to change.

   A. Color
   B. Location
   C. Shape
   D. Distance

Use this diagram to answer the next two questions.



3. What phase of the moon would you see on this night?

   A. First quarter moon
   B. Last moon
   C. New moon
   D. Full moon

4. How many days would pass before the moon was on the other side of Earth?

   A. 7
   B. 14
   C. 21
   D. 28

5. Why do we see phases of the moon during a month?

    A. We see only the lighted part of the moon as it moves around Earth.
    B. Parts of the moon are covered by Earth's shadow.
    C. Volcanoes on the moon change its shape.
    D. The moon is smaller when it is father from us.

6. Which of the following would be a way to investigate the phases of the moon?

    A. Watch it all night.
    B. Draw it every night for a month.
    C. Measure the moon with a ruler.
    D. Make measurements every Wednesday for a year.

7. Which of the following correctly describes the movement of Earth, moon, and sun?

    A. Moon revolves around Sun, Earth revolves around moon
    B. Sun revolves around moon, moon revolves around Earth.
    C. Moon revolves around Earth, Earth revolves around Sun.
    D. Sun and moon revolve around Earth.

8. What is the movement of Earth on its axis called?

    A. Phases
    B. Flotation
    C. Revolution
    D. Rotation

9. What is the movement of Earth around the sun called?

    A. Precipitation
    B. Random movement
    C. Revolution
    D. Rotation

10. What causes the apparent movement of objects across the sky during a day or night on Earth?

    A. Revolution of Earth in its orbit.
    B. Rotation of Earth on its axis.
    C. Location of Earth in space.
    D. Objects are moving around Earth.

11. If you watched the night sky for several hours, how would the stars appear to be Moving? Around

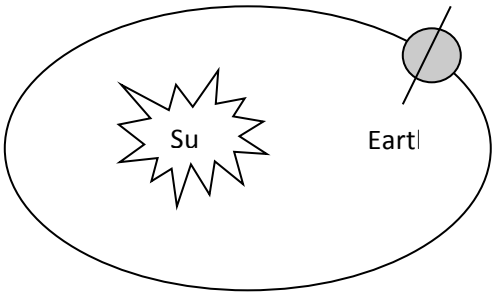
    A. The North Star
    B. The Big Dipper
    C. The moon
    D. You

Constructed Response

1. Describe how the moon would change if you observed it every night for a month. Assume it starts as a new moon.

2. What are you seeing when you see a half moon?

Use this diagram to answer the next two questions



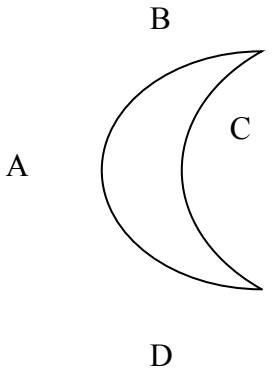
Side view of Earth's orbit

3. Label Earth's orbit.

4. Label Earth's axis.

5. Draw the moon on this diagram, showing where it would be in a New Moon phase.

Use this picture of the moon to answer the next two questions:



6. Which letter shows the direction of the sun in relation to the moon?

7. Make a drawing showing where the moon, sun, and Earth would be for this phase of the moon.

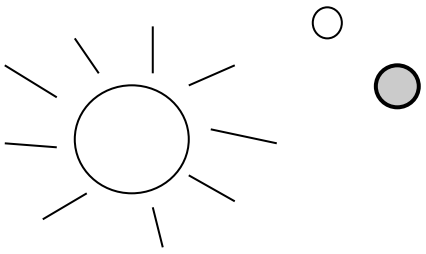
Answers Standard 1:

Multiple Choice

1. B
2. C
3. D
4. B
5. A
6. B
7. C
8. D
9. C
10. B
11. A

Constructed Response

1. The moon would go from new moon to first quarter to full to last quarter. It would seem to get bigger until the full moon then smaller as it reaches the new moon.
2. One half of the moon is light and bright, the other half is shadowed and dark but not always invisible.
3. The large circle.
4. The line extending from Earth
5. In between Earth and sun
6. A
7. Something like this:



Grade 6 **Standard 1** **Performance Test 1**

Moon Watching

Activity Description: Students will watch the moon over several days to help explain its phases and movement.

Materials Needed: Paper and Pencil

Prior to Assessment

The teacher will need to plan this activity so that it corresponds to several days when the moon rises at a time when 6th graders can be awake and the moon visible. Some daytime hours will work and early evening or morning hours as also OK. When the sun is high in the sky, the moon becomes hard to see and students should not be looking at the sun. A calendar with moon phases will be helpful to planning this activity. Internet sites such as NASA or weather stations also have moon charts.

Time Needed

If done as homework, 30 minutes of explanation, 30 minutes of summary. The same if done in class but an additional 15 minutes per observation will have to be added.

Procedure

1. Explain to students that they will be observing the moon for the length of time you desire (at least a week). You may want to send a note to parents asking them to remind students of this homework assignment, or have parents sign the students' observations every time they make them.
2. Have students develop a chart on which to collect data. It doesn't need to be the same for each student. Tell students the chart needs to be complete and accurate. They might make drawings, note the time, write a journal entry or draw other objects (in the landscape or sky).
3. Remind students each day about the assignment or take them outdoors and write observations.
4. Summarize the assignment on the final day. Give students summary questions to answer such as:
    A. What were the names of the phases we saw this week?
    B. Was the moon waxing (getting bigger) or waning (getting smaller)?
    C. What kinds of features could you see on the moon?
    D. What did you notice about the time the moon came up each day?

Scoring Guide

1. Student makes data chart…….. 5 pts
2. Student makes daily observations ……20 pts
3. Students records accurate and complete observations …….20 pts
4. Student correctly answer questions ……5 pts

Grade 6 **Standard 1** **Performance Test 2**

Modeling the Moon

Activity Description: Students will develop and use a model of the Earth, sun and moon system.

Materials Needed: Light source (a light bulb in a socket able to stand alone) several white, Styrofoam balls or light-colored play balls, student worksheet.

Prior to Assessment: Students should know that the moon revolves around Earth and Earth revolves around the sun. They should be familiar with the fact that we see the moon best at night but we can see it during the day. They should also know that it is always half lighted by the sun but we cannot see the entire lighted half except during a full moon.

Time Needed for Assessment: One hour

Procedure

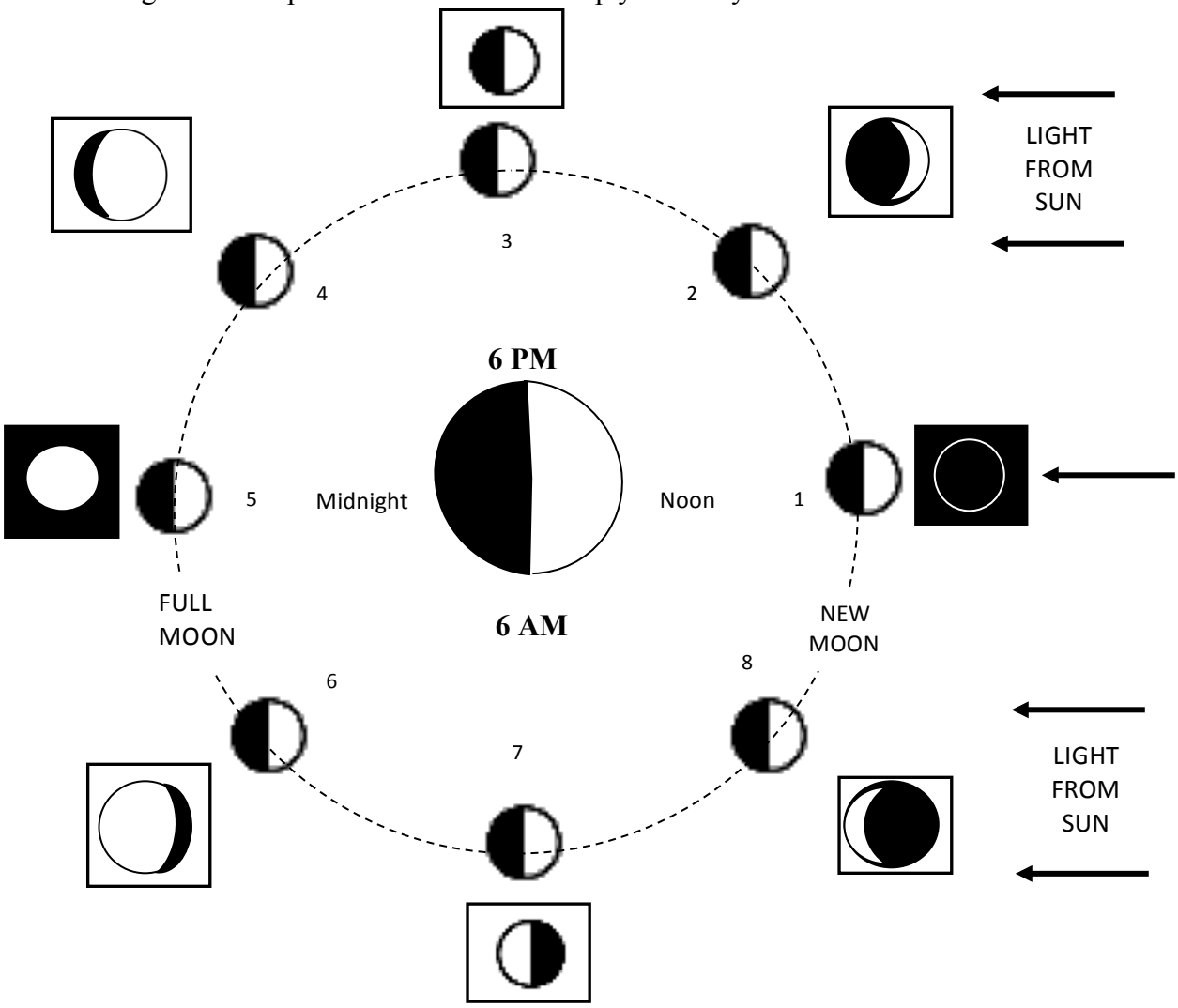
1. Divide the class into groups of four or five students. Each group needs a moon (ball).
2. Explain to students that the light source represents the sun, the ball is the moon. Ask a student to volunteer his/her head to represent the Earth. The student's head can rotate just as Earth does.
3. One student from each group should volunteer to be Earth and one will hold the moon ball.
4. Darken the room as much as possible and turn on the "sun".
5. Start with "Earth" facing away from the "sun" and the moon ball on the side farthest from the light source. This would be a full moon to the Earth observer.
6. Other students in the group need to follow the directions on the worksheet and ask their Earth and moon to move around. At each position the questions should be answered.
7. When the students have had time to learn from their model, ask each group to position themselves in a particular phase of the moon.

Scoring guide:

1. Students model the phases and work in their groups …….5 pts
2. Students accurately fill out worksheet and answer questions…….5 pts
3. Students are able to correctly model phases when asked ……..3 pts

Student Worksheet:

Use this diagram of the phases of the moon to help you with your model.



1. Start with the moon on the far side of Earth from the sun. Have the person who is "Earth" describe what the moon looks like. Draw it here:

   What is the name of this phase?

2. Have the person holding the moon to move around the Earth a little ways. Draw the moon as it is described by "Earth."

   What is the name of this phase?

3. As the moon continues around Earth, make a drawing and label the phase below:

4. Your teacher will ask you to model a phase of the moon. Be ready to show how that phase will look.