Moon Phases Investigation

GRADE LEVEL 5th-8th, Supporting PE MS-ESS1-1
SUBJECTS Earth & Space Science, Developing and Using Models
DURATION Preparation: Varies Activity: At least 5 class periods
SETTING Outside, Classroom, Completely dark room

OBJECTIVES

Students will be able to:
1. use models of Earth, the Sun, and the Moon to discover why moon phases occur.
2. understand and describe the order of the moon phases from one full moon to the next.

Essential Question:
Why does the moon look different on different days?

MATERIALS

For every student:
- ☐ Moon Journals Instructions
- ☐ Science Notebook
- ☐ "Earth or Moon Shadow" probe

For every group of 3-4 students:
- ☐ 1 pencil
- ☐ 1 orange
- ☐ 1 white balloon
- ☐ 1 inflatable globe
- ☐ 1 flashlight

For the class:
- ☐ Post-it notes
- ☐ 4 large posters or wall space

SCIENTIFIC TERMS FOR STUDENTS

(wait until the end of the investigation to introduce this conceptual vocabulary)
- » **lunar phase:** one of the cyclically recurring apparent forms of the moon
- » **gibbous:** the figure of the moon that is more than half full, looking swollen on one side
- » **crescent:** the figure of the moon that appears as a curve with pointy ends
- » **waxing:** growing; describes the moon when the illuminated portion is increasing.
- » **waning:** shrinking; describes the moon when the illuminated portion is decreasing.

BACKGROUND FOR EDUCATORS

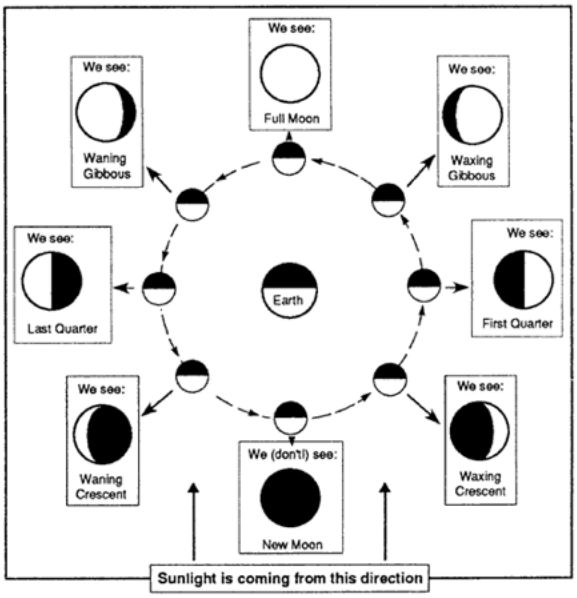
Although everyone is familiar with a few predictable shapes that our moon can take in the sky, misconceptions regarding the cause of these phases abound. Stahly, Krockover and Shepardson (1999), included a list of "five frequently occurring notions featured by children aged 9-16 regarding the phases of the moon":
1.) Clouds cover the part of the moon that we cannot see.
2.) Planets cast shadows on the part of the moon that we cannot see.
3.) The shadow of the sun falls on the moon, blocking our view of it all.
4.) The shadow of the earth falls on the moon, blocking our view.
5.) The phases are explained in terms of the portion of the illuminated side of the moon visible from the earth (scientific viewpoint).

So what causes the moon's phases? Let's begin with the basics. The Moon is a natural satellite of planet Earth, taking about a month to revolve all the way around our planet. Its orbit is very nearly circular; it stays about 380,000 kilometers away from us as it moves counterclockwise (as viewed from a northern hemisphere perspective). It also stays fairly close to the Earth's equatorial plane (an imaginary extension of Earth's equator out into space).

Moon Phases Investigation

As you may expect, the Moon doesn't just revolve around the earth, it also rotates about its own axis – but in quite an interesting fashion. Over the millennia, the Moon has become "locked" into a special kind of motion around the Earth. It rotates on its axis at the same pace as it revolves around the Earth. As a result, the Moon keeps the same face toward us throughout its orbit. (Watching a video is perhaps the best illustration of this: http://www.youtube.com/watch?v=OZIB_leg75Q). So, you may often hear astronomers talk of the "near side" and "far side" of the moon. While Earthlings can only view the near side, astronauts and spacecraft have successfully taken images of the far side. Note that there is not actually a "dark side" of the Moon – with this demonstration, you'll see how the sun's rays will strike the entire surface!

Figure 1: The pictures are shown from a northern hemisphere perspective.



Those of us who live in the northern hemisphere generally look south to see the Moon when it's highest in the sky, and we see the right-hand side illuminated at first quarter phase, for example. People who live in temperate or high latitudes south of the equator must look toward the north; to them the first quarter moon has its left side illuminated.
Note: the diagram is not to scale; in reality, the Moon is 1/4 the diameter of the Earth and its orbit's width is about 60 times the Earth's diameter.
Illustration credit: Astronomical Society of the Pacific

For more information, see:
A Private Universe Project: http://www.learner.org/teacherslab/pup/act_moonphase.html Moon Phases Diagrams: http://www.astrosociety.org/education/publications/tnl/12/12.html
Parts of this lesson are adapted from the Kinesthetic Astronomy program developed by the Space Science Institute, 2004.

TEACHER PREP

1. Pay attention to the phases of the moon and your local weather forecast to select an optimal time to start this unit. It's best to start with a whole-class observation of the moon during the school day, so select a date to start when the moon will be visible during the day and not obscured by fog or cloud-cover.
2. Before launching moon journals, make sure you've taught your students the basics of scientific sketching (see lesson plan on Academy website).
3. Make copies of "Moon Journal Instructions," 1 per student
4. When it comes time for the kinesthetic modeling, find a way to make your room (or another room in the building) as dark as possible.
5. Prepare all materials for modeling activity: wrap the oranges in white balloons and skewer them onto the pencils.
6. When it comes time for question sorting, make four posters for the four types of questions: Questions to Test, Questions to Ponder, Questions to Research, and Questions Already Answered.

PART 1: MOON JOURNALS (1 MONTH OF HOMEWORK, 3 IN-SCHOOL SESSIONS OF ~20 MINUTES)

Moon Phases Investigation

1. Bring your students, with their notebooks, outside at a time when you can see the moon. Guide them through their first moon journal entry. Make sure they record the date and time, make a sketch of the moon, and add labels of all details they observe about the sky at this time. They should also annotate their entry with any questions that come to mind as they observe the sky, using the stem "I wonder.."
2. Distribute "Moon Journal Instructions" and tell students they will be observing the moon every day/night for the next month. If they go outside and can't see the moon, that's okay! They should still record what they notice about the sky, and any questions they have.
3. After 1 week of keeping moon journals, have students bring their journals to class. Conduct a gallery walk so that students can see how their classmates are choosing to record their observations. Give students post-it notes and allow them to comment on each other's journals using the stems, "I value.." and "Another scientist might want to know.." Encourage students to incorporate this feedback into their next entries.
4. After 2 weeks of keeping moon journals, conduct a second gallery walk. Afterwards, have students reflect in their notebooks, listing two techniques they saw that they'd like to incorporate into their own moon journal.
5. Introduce the Essential Question for the unit: *Why does the moon look different on different days?*

Teacher Tip: *Make sure students bring their moon journals back to class during the modeling portion of the unit, as they will want to refer back to their observations and questions.*

NGSS CROSSCUTTING CONCEPTS CONNECTION:
NGSS CROSSCUTTING CONCEPTS CONNECTION: This portion of the lesson connects to the Crosscutting Concept of Patterns because over the course of a month, students are observing the changing appearance of the moon.

PART 2: DRAWING ON PRIOR KNOWLEDGE (30 MINUTES)

1. Pass out a copy of the "Earth or Moon Shadow" probe to each student.
2. Instruct students to select the answer with which they most agree, and to explain their reasoning in writing. Put them at ease by saying this exercise is just a chance to elicit their current ideas. They'll have a chance to come back to this question and revise their answer later. All ideas are welcome!
3. Give students a chance to share their initial ideas with one or two other students.
4. Have students paste the probes with their current thinking into their notebooks, so that they can return to them later.

Teacher Tip: *Do not open this question up into a whole-class discussion at this point, as one knowledgeable student could answer the question for everyone and make the rest of the investigation moot.*

PART 3: MODELING MOON PHASES (90 MINUTES)

1. Bring students to a room that can be made dark. Sort students into groups of 3-4, and give each group an inflatable globe, a flashlight, and an orange (covered in white balloon), positioned on a pencil.
2. Remind students of the investigation's essential question: Why does the moon look different on different days?
3. Instruct groups to see what they can figure out about the phases of the moon, using these materials. Give them at least 30 minutes to explore the model. If they get stuck, encourage them to try things they see other groups doing.
4. Hold a whole-class discussion, using some or all of these prompts:

- How did you set up your model?
- What did each item represent?

- What did you figure out?
- What are you thinking now?
- What are some of the limitations of this model?

5. Have students record their current answer to the focus question in their notebooks. Encourage them to use words and drawings to explain their thinking.

NGSS SCIENCE AND ENGINEERING PRACTICES CONNECTION: This portion of the lesson connects to the Practice of Developing and Using Models because students are asked to develop a model of the earth-moon-sun system. They use the model to better understand why the appearance of the moon changes, from the perspective of earth, over the course of a month.

PART 4: QUESTION SORTING (60+ MINUTES)

1. Have students read through their moon journals and copy each question they recorded on a separate post-it note.
2. Explain to students that it can be useful to sort our questions, in order to decide how we might answer them. Introduce the four categories:

- Questions to Test are questions we can use our model to answer. An example of a testable question would be, "Why do we sometimes see a crescent moon?"
- Questions to Research are questions we can look up in a book or online, such as, "How many moons does Jupiter have?"
- Questions to Ponder are questions that we think nobody knows the answer to, such as "Will earth ever lose its moon?"
- Questions already answered are any questions the group feels they answered with the first round of modeling.

3. Instruct students to place their post-it notes on the appropriate posters, according to the type of question on each. Give students a chance to look over their classmates' questions as well.
4. Have each group select a "Question to Test" from the poster and give them a chance to return to the model to answer that question. If they answer it successfully, they can move it to the "Questions Already Answered" poster.
5. Give students time to record their final answer to the focus question, explaining everything they understand now about what causes the moon to look different on different days.
6. You have several options for handling the remaining questions on the posters:

- Give students an opportunity to research the "Questions to Research."
- Make a class picture book out of the "Questions to Ponder"
- Invite an astronomy expert to visit the class to help answer some of the remaining questions.

NGSS SCIENCE AND ENGINEERING PRACTICES CONNECTION: This portion of the lesson connects to the Practice of Asking Questions and Defining Problems because students ask questions that can be investigated within the scope of the classroom, and distinguish testable questions from non-testable questions.

WRAP UP: TRACKING OUR LEARNING (25 MINUTES)

1. Introduce any scientific terms you'd like students to learn, such as gibbous, crescent, waxing, waning.
2. Ask students to reflect on their learning in their notebooks, guided by the prompt: "How have the activities we've done helped you to understand the phases of the moon?"

Moon Phases Investigation

STANDARDS ADDRESSED

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems **6-8:** Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. **Developing and Using Models** **6-8:** Develop a model to predict and/or describe phenomena.	**ESS1.A: The Universe and Its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	**Patterns** **6-8:** Patterns can be used to identify cause-and-effect relationships.

RELATED PERFORMANCE EXPECTATIONS

Remember, performance expectations are not a set of instructional or assessment tasks. They are statements of what students should be able to do after instruction. This activity or unit is just one of many that could help prepare your students to perform the following hypothetical tasks that demonstrate their understanding:

MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]