



Phases of the Moon

By Pam Blanchard, Revised by Heather Miller

Focus on Inquiry

The student will create and use a model of an Earth-Moon-Sun model system to observe and describe the phases of the Moon.

Lesson Content Overview

This activity asks students to use models of Earth, the Sun, and the Moon system to discover why Moon phases occur. Students use a Styrofoam ball to represent the Moon, which will be lit by a single light source in the classroom, to observe how different portions of the ball are illuminated as they hold it in various positions. They create a complete series of phases matching the appearance of the Moon. And they relate Moon phases to the positions of Earth and the Sun.

Duration 75 minutes	Setting Classroom	Grouping Whole class	PTI Inquiry Subskills 3.3, 4.3, 5.2, 5.8, 5.9, 7.2
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Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	5 min	None	None	2	Students will complete a Moon phases probe and will engage in a discussion on the Moon.
Explore	30 min	3.3, 4.3, 5.8	None	3	Students create a model of the Moon phases and go through each phase.
Explain	25 min	5.2	None	3	Students go through the lunar phases describing the illumination and identifying the name of the phases. Students answer reflection questions about Moon phases.
Expand	10 min	5.2, 7.2	Internet/TV hook-up	3	Students view a video of the lunar phases and identify which phase is shown. Students will engage in a Test-Test-Swap Game that will allow them to apply their knowledge of Moon phases.
Evaluate	5 min	3.3, 5.9	None	3	Students organize Moon phase cards in the correct order. Moon Phase Assessment

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

Next Generation Science Standards – Inquiry

NGSS Practice 2:Developing and Using Models

Next Generation Science Standards – Earth Science

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.

Florida Science Standards – Nature of Science

SC.8.N.3.1 Select models useful in relating the results of their own investigations

Florida Science Standards – Earth and Space Science

SC.8.E.5.9 Explain the impact of objects in space on each other, including: 1. the Sun on the Earth, including seasons and gravitational attraction; 2. the Moon on the Earth, including *phases*, tides, and eclipses, and the relative position of each body.

Materials and Advance Preparation Materials List**Class set:**

- Overhead projector (1 or 2) (or bright light source)
- Test-Test Swap Review Cards

Student materials (1 per student):

- Moon Phases Student Worksheet (**Blackline Master #1**)
- Sticky note or dot sticker
- Styrofoam balls (1" – 2" in diameter)
- Moon Phase Calendar for current month (Blackline Master #2; see Advance Preparation, Step 1)
- Moon index cards (see Advance Preparation, Step 2. 1 set per student (8 index cards per student)).
- Evaluation (**Blackline Master #3**)

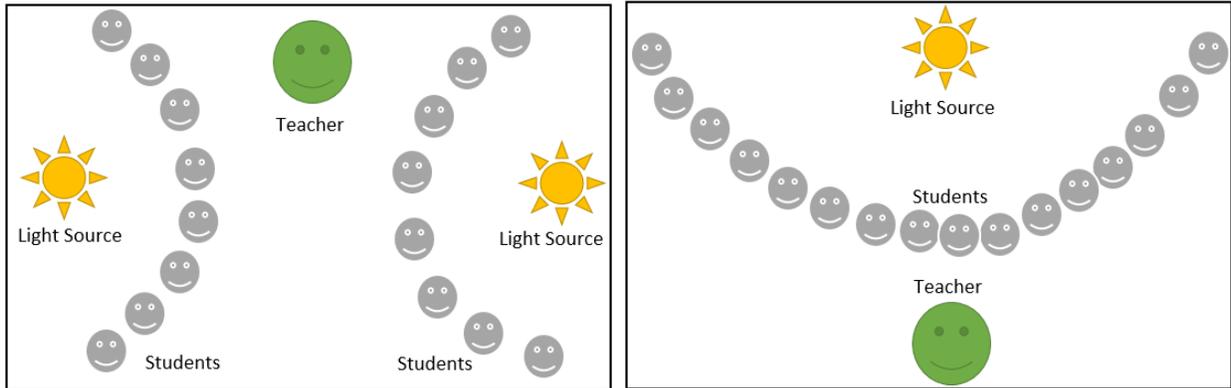
Blackline Masters

1. **Moon Phases Student Worksheet**
2. **Moon Phases** (to be cut in half; see Advance Preparation)
3. **Check for Understanding: Moon Phases**
4. **Common Uses of Moon-related Words in the English Language**
5. **Test-Test Swap Review Cards**

Advance Preparation

1. Make enough copies of the Moon phases student worksheet (**Blackline Master #1**), one for each student.
2. Label a piece of chart paper with the 8 different student names at the top.
3. Obtain sticky notes or dot stickers of two different colors (one pre and one post) for student use.
4. Download the Lunar Calendar for the month that you will be teaching the lesson. This can be downloaded from StarDate Online, <http://stardate.org/nightsky/Moon/>. This can be placed on the top half of a sheet of paper, while the 8 phases of the Moon can be placed on the lower half of the sheet. Cut the sheet in half to prepare for the lesson. See **Blackline Master #2** for an example.
5. Obtain small pictures of the 8 phases of the Moon (see **Blackline Master #2** – the lower half of the sheet). Cut out each phase and glue/tape it to an unlabeled index card. Be sure to mark to the "top" of each card.
6. Obtain Styrofoam balls (1-2)" in diameter for each student.
7. You will need an open area and access to a bright light source in order to complete this lesson as written.
8. Make a class set of Quiz-Quiz Trade cards and cut them out.

9. Possible Classroom Set-up options for Explore Activity:



Lesson Information

Learning Objectives

1. The students will correctly use an Earth-Moon-Sun model to explain why the Moon goes through phases during the lunar month.
2. The students will use, from memory, correct vocabulary for each phases of the Moon, including the terms, gibbous, waning, crescent, and quarter Moon.

Prior Knowledge Needed by the Students

- Students should have a general understanding that the Moon revolves around the Earth and the Earth revolves around the Sun.

Background Information

Moon phases occur because as the Moon travels around the Earth, we see different amounts of the surface of the Moon that faces the Earth illuminated. At the *New Moon* phase, the Sun is on the far side of the Moon and so the entire side of the Moon facing the Earth is in shadow. At the *Full Moon* phase, the Moon is now on the far side of the Earth from the Sun and the side facing the Earth is completely illuminated. As the Moon's position relative to the Sun changes from in between the Sun and the Earth (a New Moon) to the opposite side, with the Earth in between the Moon and the Sun, more and more of the side facing the Earth is illuminated, which is referred to as the *waxing* phases, with the right side always illuminated. Once past the Full Moon, the side facing the Earth begins to fall more and more into the shadow, which is referred to as the *waning* phases and the illuminated side is always the left side.

For the teacher: when completing this activity, be sure that the students' Moons do not fall into any shadows created by themselves or by other students. This would introduce the concept of eclipses and you do not want students to have the misconception that Moon phases are caused by shadows cast from the Earth. Pay close attention to the height and angle with which students are holding their Moons.

Lesson Procedure

Engage

1. Have students complete the Moon phases probe (on their student handout) by choosing which student they agree with and why.
2. Have students cast their "vote" for which student is correct by using a sticky note or dot sticker (in one particular color) and placing it on a piece of chart paper at the front of the room under which student they agree with. (probing and assessing prior knowledge and misconceptions)

3. Let students know that by the end of class they will have a better understanding of WHO is really correct.
4. Give students the Moon phase index cards (in mixed order). Ask them to try to put them in the correct order. Use this activity as a means to assess prior knowledge and any misconceptions students will be bringing to the lesson. Have the students set the cards aside (in order) on their desks. You will return to these cards at the end of the lesson.

Explore

1. Distribute the Styrofoam balls to students (1 per student) and have students push a pencil or pen about halfway through their ball.
2. Have students stand up and move into the light of the projector (or bright light source). Everyone should face the projector, but not look directly into the light.
3. Ask students, "We are modeling the Sun-Earth-Moon system, so in our system, what will represent the Sun? (*the projector*). What about this Styrofoam ball on your pencil? (*the Moon*). What do we represent? (*the Earth*).
4. As students move through the phases of the Moon in their Moon model system, have students concentrate on describing what they see in terms of what portion of the Moon's surface is illuminated. The first time through the lunar phases, begin with $\frac{1}{4}$ turns (new, first quarter, full, third quarter). At this point, do not worry about vocabulary, but the descriptive process. Go through the lunar phases at least twice, focusing on description. Make sure that you remind students not to allow their Moon to fall into their shadow or the shadow of anyone else.
 - a. Everyone face the projector and hold your Moon in the light of our Sun so that you can see the glow around the edge of your Moon. How much of the Moon's surface that is facing you is illuminated? (*none of side facing me is illuminated*)
 - b. Everyone turn 90° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*half of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the right side is illuminated*)
 - c. Everyone turn another 90° to your left. Make sure your Moon is still in the light of our "Sun." Looking at your Moon, how much of your Moon is now illuminated? (*all of the side facing me is illuminated*)
 - d. Everyone turn 90° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*half of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the left side is illuminated*)
 - e. Everyone turn 90° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*none of side facing me is illuminated; we are back to where we started!*)
5. Now we are going to do 45° turns.
 - a. Everyone face the projector and hold your Moon model in the light of our Sun model so that you can see the glow around the edge of your Moon. How much of the Moon's surface that is facing you is illuminated? (*none of side facing me is illuminated*)
 - b. Everyone turn 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*a little bit of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the right side is illuminated*)
 - c. Everyone turn another 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*half of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the right side is illuminated*)
 - d. Everyone turn 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*almost all of the side*)

- facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the right side is illuminated*)
- e. Say to the students, “Okay, who sees a pattern here? Can you put this pattern into words?”
 - i. *Student responses could include that the moon gradually lights all the way up following the pattern crescent, quarter, gibbous, full and then goes through the reverse phases back to dark.*
 - f. Everyone turn 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*all of the side facing me is illuminated*)
 - g. Let’s finish our Moon cycle. Everyone turn 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*almost all of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the left side is illuminated*)
 - h. Everyone turn another 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*half of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the left side is illuminated*)
 - i. Everyone turn 45° to your left. Make sure your Moon is still in the light of our Sun. Looking at your Moon, how much of your Moon is now illuminated? (*a little bit of the side facing me is illuminated*) Which side of your Moon is illuminated, the right side or the left side? (*the left side is illuminated*)
 - j. Everyone turn 45° to your left. You should be facing the projector again. Looking at your Moon, how much of your Moon is now illuminated? (*none of the side facing me is illuminated*).
 - k. Ask students, “Are we back to where we began? (*Yes*) What will happen next? (*The moon will continue to revolve in the same direction going through the phases again*).

Explain

1. Go through the phases of the Moon, this time asking for students to (1) describe the illumination of the Moons’ face that is seen from the Earth (like in Step 5), and (2) to supply the correct vocabulary for the lunar phase. As you move through the lunar cycle, ask students to give their own explanations for what is happening at each phase of the lunar month.
 - a. *A call and answer or choral response format would work best for this activity.*
 - a. – **New Moon**
 - b. – **Waxing crescent**
 - c. – **1st Quarter**
 - d. – **Waxing gibbous**
 - e. – **Full Moon**
 - f. – **Waning gibbous**
 - g. – **3rd Quarter**
 - h. – **Waning crescent**
 - i. – **New Moon**
2. Students will work in pairs to complete the reflection questions on their student handouts.
3. Ask students, “Why might we need to use a model to study and learn about the Moon phases?”
 - a. *Possible responses may include the distances between the Sun, Earth, and Moon are too difficult to directly observe, the positions of the Sun, Earth, and Moon are too difficult to directly observe, the moon revolves around the Earth too slow to observe all of the phases at once.*
 - b. Help students recognize the importance of the use of models in science.
4. Ask students, “Are all models the same? Do they show the same things and do the same job?”

- a. Possible responses could be Yes or No (the correct answer is NO, models are not all the same and do not show the same things or do the same jobs).
5. Ask students, "What type of model would NOT be helpful in learning about moon phases?"
 - a. Possible response could include a mathematical model (equation), a graph, or a clay model.

Expand

View the Phases of the Moon Animation Video (<https://youtu.be/l1g2gCAc3BQ>)

1.). As the video progresses through the phases of the moon, ask students to give the correct terminology to each phases and explain why that part of the Moon's surface is illuminated.
2. Give students the Lunar Month calendar for the month that you are teaching the lesson (top portion of Blackline Master #2). Discuss with the students what phase the Moon is currently in and what they can apply to this calendar from what they learned in today's lesson. Sample questions can include? *Answers will vary based on when the lesson is taught.*
 - a. What phase of the lunar cycle is the Moon in today?
 - b. On what day is the Moon a New Moon?
 - c. When does the 3rd Quarter occur?
 - d. When do the waxing phases of the lunar cycle occur?
3. Give each student a Test-Test Swap Review Card (**Blackline Master #5**) and have them use the stand-up, hand-up, pair-up strategy to collaborate with different people in the room, applying and reviewing their understanding of the Moon phases.
 - a. Students will meet up with someone in the room, indicating they are available by having their hand raised.
 - b. Each student will take turns showing their card to their partner, having their partner respond (answer on the back), coaching their partner if they need help, and then swapping cards before they move on to find a new partner.
 - c. Allow students as long as you'd like for this review and extension.
4. Ask students "Has anyone ever heard the statement "Once in a blue Moon"? What does this statement mean when it is used? (*It refers to something that rarely happens.*) What is a blue Moon? (From EarthSky.org: Blue Moon can be second of two full Moons in a month. Or it can be third of four full Moons in a season.
 - a. For more information about "blue Moons," refer to a very interesting discussion at <http://Earthsky.org/space/when-is-the-next-blue-Moon.>)
5. Ask students, "Are there any other statements that you have heard about the Moon?" Let students share this they know about common Moon/lunar mythology. [Example: Crazy things happen around a full Moon. See **Blackline Master #4** for examples.]

WRAP UP.

Bring the lesson to a conclusion by having the students re-evaluate the probe from the beginning of class. Have them use the other color sticky note or dot sticker to cast their "vote" for who they now believe is correct.

Have students check their card stack from the beginning of the lesson. Ask students, "Did you have your cards in the correct order? If not, then put them in the correct order. Have the person sitting next to you check your card stack. With your neighbor listening, touch each card and name the phase it represents."

Evaluate

FORMAL EVALUTION

1. **Checking for Understanding: Moon Phases (Blackline Master #3).**

INFORMAL or OPTIONAL EVALUTIONS

1. The two Expand activities can serve as informal evaluations of student understanding.

Supplementary Resources

Teachers

Henes, Donna. (2004). *The Moon Watcher's Companion: Everything You Ever Wanted to Know About the Moon and More*. Marlowe & Company. 144 pp. ISBN-10: 1569244669
Bringing together a wide range of writings about the Moon, from Mother Goose to Joseph Campbell, Galileo to Audre Lorde, Sappho to Black Elk, as well as providing a comprehensive encyclopedia of lunar terminology, a timeline of lunar explorations, and three sections that detail the Moon's faces, phases, and known facts, author Henes has created a fascinating compendium of lunar science, myth, folklore, poetry, curious facts, and old wives' wisdom culled from cultures throughout the ages.

Students

Fowler, Allan. (1992). *So That's How the Moon Changes Shape* (Rookie Read-About Science Series) Chicago: Children's Press. 31 pp. ISBN: 0516449176
A simple explanation of the Moon and why it changes shape throughout the month. Ages 4-8.

Olson, Gillia M. (2006). *Phases of the Moon*. Pebble Plus. 24 pp. ISBN-10: 0736863400
Brilliant and interesting photographs, easily understood diagrams, and a short, informative text. This book explains that the Moon only appears to change shape. A clear diagram names each phase, including less familiar words like "gibbous" and "crescent," included in a short glossary at the end and illustrated with a photograph. There are photos of the tiniest sliver which appear after the new Moon, which is really no visible Moon at all. Ages 9-12.

Gibbons, Gail. (1998). *The Moon Book*. Holiday House, Inc. ISBN: 0823413640
Identifies the Moon as our only natural satellite, describes its movement and phases, and discusses how we have observed and explored it over the years. Ages 6-8.

Miscellaneous

Moon in My Room by Uncle Milton. ISBN: 1400641527
You can hang this light up Moon that is authentically sculpted and detailed on your wall. It is internally lit to realistically illuminate a darkened room. Using an automatic or manual function, the 12 main phases of the Moon can be shown. Included are a Moon discovery guide with calendar, Moon phase charts, instructions, a 15 minute CD tour and IR remote control. The built-in light sensor illuminates the Moon when it gets dark and the unit has an automatic shut-off. Cost: ~\$30 (in 2007). Ages 6+

CITATION OF SOURCES.

Gaherty, G. (2012). *How the Moon Phases Work*. Retrieved from <http://www.space.com/6650-moon-phases-work.html>

Moon Connection. (2015). *Understanding the Moon Phases*. Retrieved from http://www.moonconnection.com/moon_phases.phtml.

StarDate. (2016). Moon Phase Calendar. Retrieved from <http://stardate.org/nightsky/Moon/>.

All black and white moon phase images are available through Creative Commons:
www.creativecommons.org

Moon Phase Diagram in Test-Test-Swap Review Cards retrieved from <https://pixabay.com/en/phases-of-the-moon-moon-diagram-150852/>

Yes, I cited all materials and resources used in this lesson.

Pam Blanchard

Lesson author signature

Moon Phases Student Worksheet



Photo Credit: <https://pixabay.com/en/lunar-phase-moon-lunar-phase-cycle-25451/>

Engage - Moon Phases Probe

Mrs. Miller asks her class what causes the different phases of the Moon. Below is some of their responses:

Diana: The Moon lights up in different parts at different times of the month.

Drew: The phases of the Moon change according to the season of the year.

Kristi: Parts of the Moon reflect light depending on the position of the Earth in relation to the Sun and the Moon.

Amanda: The Earth casts a shadow that causes a monthly pattern in how much of the Moon we can see from Earth.

Nick: Different planets cast a shadow on the Moon as they revolve around the Sun.

Leah: the shadow of the Sun blocks part of the Moon each night causing a pattern of different Moon phases.

Sarah: The clouds cover the parts of the Moon that we can't see.

Brian: The Moon grows a little bit bigger each day until it is full and then it gets smaller again. It repeats this cycle every month.

Which student do you agree with and why? Explain your thinking. _____

Explain – Moon Phase Reflection Questions

Where does the light come from that lights up the Moon?

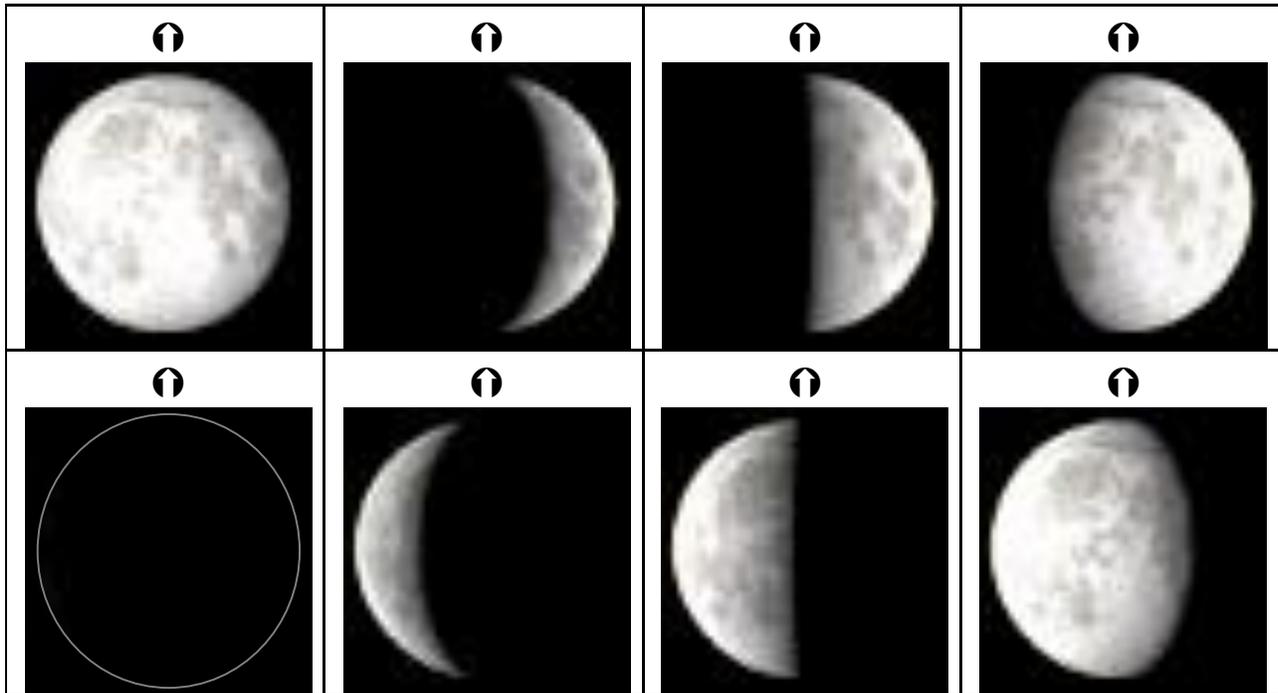
Draw a diagram and explain what causes the Moon phases.

Moon Phases for October 2015

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1 	2 	3 
4 	5 	6 	7 	8 	9 	10 
11 	12 	13 	14 	15 	16 	17 
18 	19 	20 	21 	22 	23 	24 
25 	26 	27 	28 	29 	30 	31 

Moon Phase Calendar Retrieved from: <http://stardate.org/nightsky/Moon/>
Used by permission of The University of Texas McDonald Observatory

Moon Phases (cut into 8 squares and glue to index cards)



Moon phase images available through Creative Commons.

Blackline Master #3

Name _____ Date _____ Student No. _____

Checking for Understanding: Moon Phases



- ___ 1. In the picture to the right, what phase of the Moon is shown? (SC.8.E.5.9)
- A. waxing gibbous
 - B. waxing crescent
 - C. waning gibbous
 - D. waning crescent

- ___ 2. In our Sun-Earth-Moon model, what represented the Sun? (SC.8.N.3.1)
- A. The light source
 - B. Myself.
 - C. The Styrofoam ball.
 - D. The pencil.



- ___ 3. Sometimes the Moon looks like this: . And sometimes the Moon looks like this: . What causes the Moon to change its appearance this way? (SC.8.E.5.9)
- A. Clouds block part of the Moon from our view.
 - B. As the Moon orbits Earth, Earth's shadow covers the Moon.
 - C. The Moon lights up in different parts at different times of the month
 - D. As the Moon orbits around Earth, we see different views of the Moon's Sunlit side.

- ___ 4. Which of the following has the Moon phases in the correct order? (SC.8.E.5.9)

A.        

B.        

C.        

B. none of the above

- ___ 5. Why is using a model useful when studying phases of the moon? (SC.8.N.3.1, PT1 5.9)
- a. The distances between the Sun, Earth, and Moon are too difficult to directly observe.
 - b. The positions of the Sun, Earth, and Moon are too difficult to directly observe.
 - c. The moon revolves around the Earth too slow to observe all of the phases at once.
 - d. All of the above.

Answer Key

Checking for Understanding: Moon Phases



- ___ 1. In the picture to the right, what phase of the Moon is shown? (SC.8.E.5.9)
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C.        

- D. none of the above
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 - D. All of the above.

Blackline Master #4**Common Uses of Moon-related Words in the English Language**

Harvest Moon - this is the full Moon that occurs closest to the autumn equinox, which usually occurs in September or October. The name comes because farmers are able to work in their fields into the night because of the Moon's bright light in the night sky. See <http://stardate.org/nightsky/Moon>.

Lunatic – A lunatic is a person with irrational behavior. The word comes from the Middle English word that meant “Moonstruck.” In many Latin languages, the word for moon is “Luna.” The name is associated with the Moon because a superstition held that heavenly bodies directly affected peoples’ behavior on Earth. In 2012, President Obama signed a law banning the word from legislative language. See <http://dictionary.reference.com/browse/lunatic>.



Photo Credit:
https://commons.wikimedia.org/wiki/File:Moon_Phase_%283920172639%29.jpg

Superstitions

“Crazy people come out on the night of a Full Moon.”

(See <http://mentalfloss.com/article/31608/does-full-moon-really-make-people-act-crazy>)

“Women go into labor around the time of a Full Moon.”

(See <https://www.dukemedicine.org/blog/myth-or-fact-more-women-go-labor-during-full-moon>)

“Cutting your hair or fingernails on a Full Moon will cause them to grow fast.”

(See <http://www.livestrong.com/article/279219-hair-growth-moon-phases/>)

10 other superstitions about the Moon Phases

(See <http://impressivemagazine.com/2014/06/11/10superstitions-about-the-Moon/>)

Nursery Rhyme

Hey diddle diddle,
 The cat and the fiddle,
 The cow jumped over the Moon.
 The little dog laughed,
 To see such sport,
 And the dish ran away with the spoon.

Famous Songs featuring the “Moon”

(<http://Moon.nasa.gov/Moonsongs.cfm> and <http://www.axs.com/top-40-songs-about-the-moon-57595>)

Moonlight Sonata (Ludwig van Beethoven, 1801)

Moon River (Audrey Hepburn, 1961)

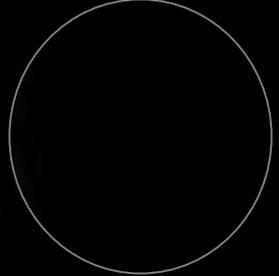
By the Light of the Silvery Moon (Lillian Lorraine, 1909)

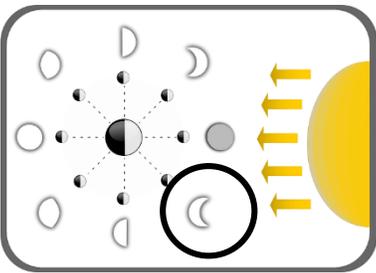
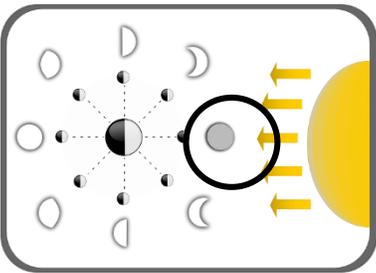
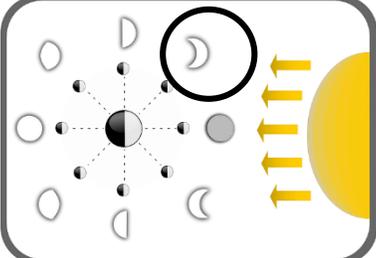
It's Only a Paper Moon (Jim Reeves, 1964)

Blackline Master #5

Test-Test Swap Review Cards

Cut out the cards on the dotted lines, fold them in half along the solid line, and tape/glue the two sides together.

			<p>Full Moon</p>
			<p>Waxing Crescent</p>
			<p>First Quarter</p>
			<p>Waxing Gibbous</p>
			<p>New Moon</p>

		<p>Waning Crescent</p>
		<p>Third Quarter</p>
		<p>Waning Gibbous</p>
		<p>Waning Crescent</p>
		<p>New Moon</p>
		<p>Waxing Crescent</p>

	<p>First Quarter</p>
	<p>Waxing Gibbous</p>
	<p>Full Moon</p>
	<p>Waning Gibbous</p>
	<p>Third Quarter</p>