Adapted to STEMAZing ECE Format by
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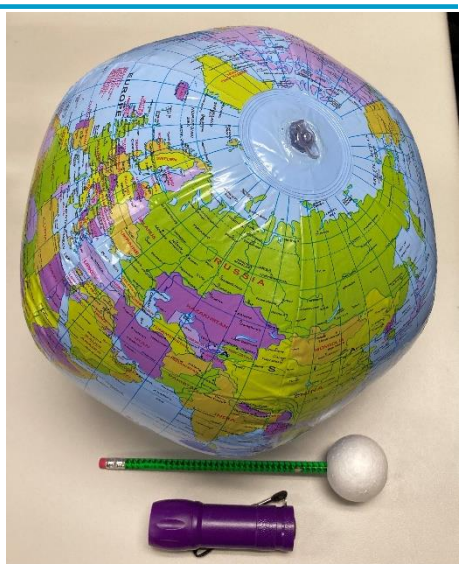
Phases of the Moon



NOTE: Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.

Always engage children with our two favorite questions:

What do you notice?
What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with them how they might design a test to help answer their question. As much as possible and within reason, let them test their questions by trying the experiments they propose.

Learning Objectives

Children will…

- become part of a model to demonstrate the phases of the moon.
- match the phase of the moon they see using the model to phase of the moon cards.

Key Questions

What are the phases of the Moon and what causes them?

What causes day and night on Earth?

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

Sun	Moon	Revolution	Day	Model
Earth	Orbit	Rotation	Week	

Materials

sharpened pencil

1.75” Styrofoam ball

16” beach ball globe

LED flashlight or lamp with shade off

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Advanced Teacher Preparation

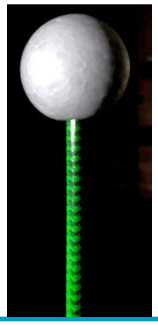
If possible, have children make moon observations for one month prior to and after this exercise.

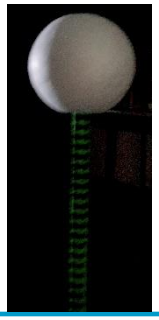
Sharpen a pencil and stick it into the Styrofoam ball as the image on the first page shows. **NOTE:** Multiple children or even all the children in your class, can do this activity at the same time. Each child will need a Styrofoam ball with a sharpened pencil pushed into it.

Notice and Wonder Developmentally Appropriate Practice

1. In a dark room, set up the flashlight on one side of the room and clear space on the opposite side of the room.
2. Explain to the children that in this model, the flashlight is the Sun, their head is Earth, and the Styrofoam ball is the Moon.
3. At first, they should just slowly rotate counterclockwise (to their left) and watch the Moon.
    - Ask them what they notice.

    NOTE: The children will need to make sure Earth's shadow (the shadow from their head) does not cause a Lunar Eclipse (occurs when the Moon enters the Earth's shadow). To avoid this, they can simply hold the Moon up a bit so it still gets light from the Sun when their back are turned toward the Sun.
4. After they have had some time to make observations, you can have them go through the phases of the moon one at a time, in order, starting with the full moon.
5. The Moon Phases cards can be used in a few ways.
    - You can give one to a student and see if they can figure out how to replicate that phase using their model.
    - You can have them memorize the phases by showing them the picture and asking which phase it is. (Be sure the card is right side up with the words Moon Phases at the top.)
    - You can have them put the Moon Phases cards in order from full moon to new moon. (For younger students, they can simply match the pictures on the cards to the images on the Phases of the Moon page.)



New moon not shown.



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Children should notice…

- the phases of the Moon as seen from Earth change as the Moon orbits Earth.
- the Moon repeats these phases as it orbits around and around Earth.
- there are unique names for each phase of the Moon.

Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them test their questions by trying new experiments.

See below for examples of what they might wonder and experiments they might do to test their wonderings. NOTE: Some of their questions may be answered in the What the Heck? Explanation at the end.

- I wonder how long it takes the Moon to orbit Earth?
- I wonder if the Moon will ever go away forever?
- I wonder what would happen if the Moon orbited around Earth in a different way?
    - Let them try it or look it up on the internet!
        - Many of the questions they have will be things you can look up on the internet – time it takes for the Moon to orbit Earth – about 29½ days. This is called a lunar month.
        - Let them experiment with different ways to make the Moon orbit Earth.

Differentiating Developmentally Appropriate Practice

For younger children, you can use a much larger Styrofoam ball to represent the Moon – a 4” diameter or larger. This will make the phases more noticeable.

For older children, you can have them look up additional phases of the moon to model. You can also quiz them on how they would have to be oriented when they are using the model to replicate specific phases of the moon.

For older children, you can help them notice the umbra (full dark shadow) and penumbra (partial shadow – grayish area around the edge of a shadow) of the Moon’s shadow on Earth.

Older students can play with this PhET simulation. It is a digital model of the Sun, Earth, and Moon system: http://bit.ly/PhETGravityAndOrbitsModel

They can do lots of noticing and wondering using the simulation.

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#STEMAZingPictureBook Recommendations:

Moon! Earth's Best Friend by Stacy McAnulty

Sun! One in a Billion by Stacy McAnulty

Earth! My First 4.54 Billion Years by Stacy McAnulty

Connections to the activity:

Children can use a large ball for the Sun, a smaller ball for the Earth, and an even smaller ball for the Moon. They can then physically move around each other to demonstrate the Earth revolving around the Sun while rotating on its axis while the Moon revolves around Earth.

This PhET simulation is a digital model of the Sun, Earth, and Moon system: http://bit.ly/PhETGravityAndOrbitsModel

#STEMAZingVideo Recommendations:

Moon Phases: Crash Course Astronomy #4 http://bit.ly/MoonPhasesCrashCourse

Phases of the Moon: Astronomy and Space for Kids http://bit.ly/MoonPhasesFreeSchool

Tidal Locking: Why Do We Only See One Side of the Moon http://bit.ly/MinuteEarthTidalLock

References

Adapted from: https://www.jpl.nasa.gov/edu/teach/activity/moon-phases/

SAFETY CONCERNS

As always, a choking hazard with small objects and a poking hazard with sharpened pencils.

AZ Early Learning Standards

Science Standard - Strand 1: Inquiry & Application - Concept 1: Exploration, Observation & Hypotheses
The child observes, explore, and interacts with materials, others, and the environment.

Science Standard - Strand 1: Inquiry & Application - Concept 2: Investigation
The child researches their own predictions and the ideas of others through active exploration and experimentation.

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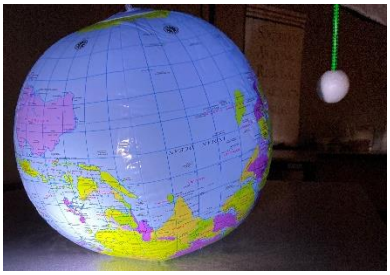
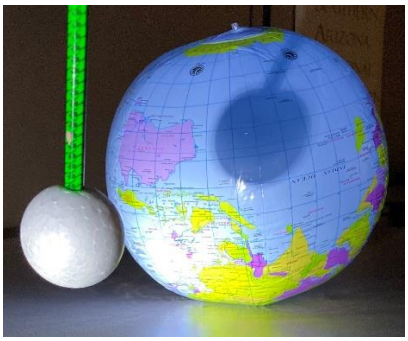
BONUS DEMONSTRATIONS – Lunar and Solar Eclipses: As mentioned above, if the moon goes into Earth's shadow when it is full, this is called a lunar eclipse. This can be demonstrated, and seen by children, if they let the Moon dip into their head's shadow (their head representing Earth still). This might be difficult for some students so it can also be setup using the inflatable globe as shown in the picture below as the moon enter Earth's shadow, is about half way covered, and then complete in Earth's shadow.



To demonstrate a solar eclipse (below except the globe would be a child's face), have one child use the model while another observes from a short distance away. A solar eclipse happens when the Moon's shadow moves across the surface of Earth during the day. When the shadow of the Moon moves across the child's face as they are facing the Sun, they are modeling a solar eclipse. It can also just be demonstrated with the inflatable globe as shown below.

Ask children what they notice and wonder as you have them demonstrate the different kinds of eclipses. They should note that a lunar eclipse is visible to nearly half of Earth. A solar eclipse is only visible to people who happen to be in the exact right spot on Earth's surface in the path of the Moon's shadow as it moves over Earth's surface. Because Earth's surface is 71% water, solar eclipses often pass over the ocean where no one see them.




As with all models, they are never 100% accurate. In the first example of modeling a solar eclipse, the shadow of the moon on Earth's surface is WAY too big. In the second example on the right, the pom pom is getting closer to the actual size of the Moon's shadow but is still WAY too big. The moon's shadow would be less than $^{1}/_{8}$" on this 16" inflatable globe. This, again, demonstrates why you are very unlikely to see a solar eclipse and much more likely to see a lunar eclipse even though about two to five of each kind of eclipse happen each year.

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Phases of the Moon

What the heck? Explanation of the Science (Vocabulary in bold.)

FIRST, A NOTE ABOUT MODELS: The 1.75" Styrofoam ball is close to the right scale for the size of the Moon if your head was really representing Earth. The moon is less than $^1/_3$ the size of Earth. It should also be noted that while the scale is close for the size of the Earth and Moon, the scale for the distance between them, and between the Earth-Moon system and the Sun, is way off in this model. If the distances apart were to scale with their size, the Moon would need to be more than 25 feet from Earth. The Sun, at this scale would need to be more than 1.75 miles away. It would be hard to hold the Moon 25 feet from your head and have a flashlight representing the sun almost 2 miles away. This is the whole purpose of models though. We use them to model phenomenon but they will always be inaccurate in some ways. They are still an important tool for understanding and demonstrating how things work in the universe!

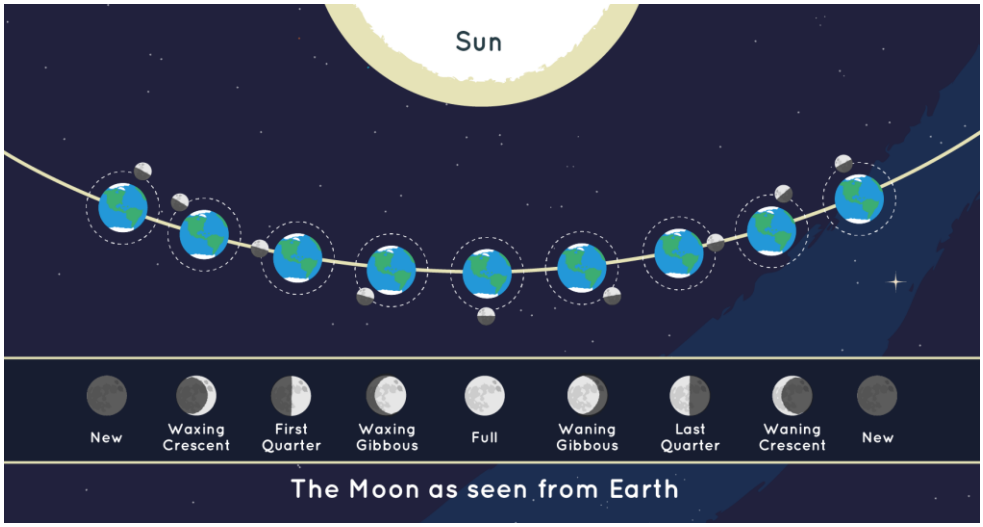
(The remainder of this explanation is taken directly from: https://spaceplace.nasa.gov/moon-phases/en/)

If you have looked into the night sky, you may have noticed the Moon appears to change shape each night. Some nights, the Moon might look like a narrow crescent. Other nights, the Moon might look like a bright circle. And on other nights, you might not be able to see the Moon at all. The different shapes of the Moon that we see at different times of the month are called the Moon's **phases**.

Why does this happen? The shape of the Moon isn't changing throughout the month. However, our view of the Moon does change.

The Moon does not produce its own light. There is only one source of light in our solar system, and that is the Sun. Without the Sun, our Moon would be completely dark. What you may have heard referred to as "moonlight" is actually just sunlight reflecting off the Moon's surface.

The Sun's light comes from one direction, and it always illuminates, or lights up, one-half of the Moon – the side of the Moon that is facing the Sun. The other side of the Moon is dark.



The position of the Moon and the Sun during Each of the Moon's phases and the Moon as it appears from Earth during each phase. Credit: NASA/JPL-Caltech

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On Earth, our view of the illuminated part of the Moon changes each night, depending on where the Moon is in its orbit, or path, around Earth. When we have a full view of the completely illuminated side of the Moon, that phase is known as a full moon.

But following the night of each full moon, as the Moon orbits around Earth, we start to see less of the Moon lit by the Sun. Eventually, the Moon reaches a point in its orbit when we don't see any of the Moon illuminated. At that point, the far side of the Moon is facing the Sun. This phase is called a new moon. During the new moon, the side facing Earth is dark.

The eight Moon phases:

● **New**: We cannot see the Moon when it is a new moon.

◐ **Waxing Crescent**: We see the waxing crescent phase as a thin crescent opening to the left.

◐ **First Quarter**: We see the first quarter phase as a half moon.

◐ **Waxing Gibbous**: The waxing gibbous phase is between a half moon and full moon. Waxing means it is getting bigger.

○ **Full**: We can see the Moon completely illuminated during full moons.

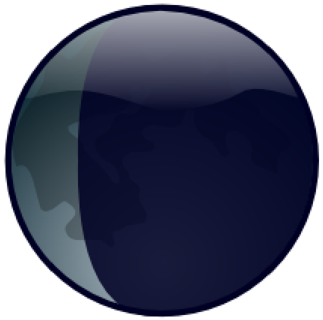
◑ **Waning Gibbous**: The waning gibbous phase is between a half moon and full moon. Waning means it is getting smaller.

◑ **Third Quarter**: We see the third quarter moon as a half moon, too. It is the opposite half as illuminated in the first quarter moon.

◑ **Waning Crescent**: We see the waning crescent phase as a thin crescent opening to the right.

The Moon displays these eight phases one after the other as it moves through its cycle each month. It takes 27 days for the Moon to orbit Earth. That means the Moon's cycle is 27 days long.

Moon Phases



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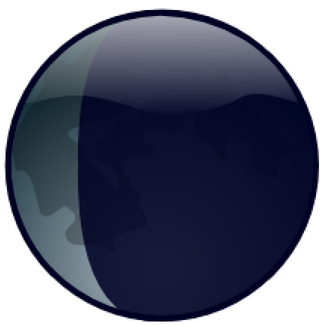

Moon Phases

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Moon Phases

Full Moon	Waning Gibbous	Third Quarter	Waning Crescent
New Moon	Waxing Crescent	First Quarter	Waxing Gibbous
Full Moon	Waning Gibbous	Third Quarter	Waning Crescent
New Moon	Waxing Crescent	First Quarter	Waxing Gibbous

Phases of the Moon