

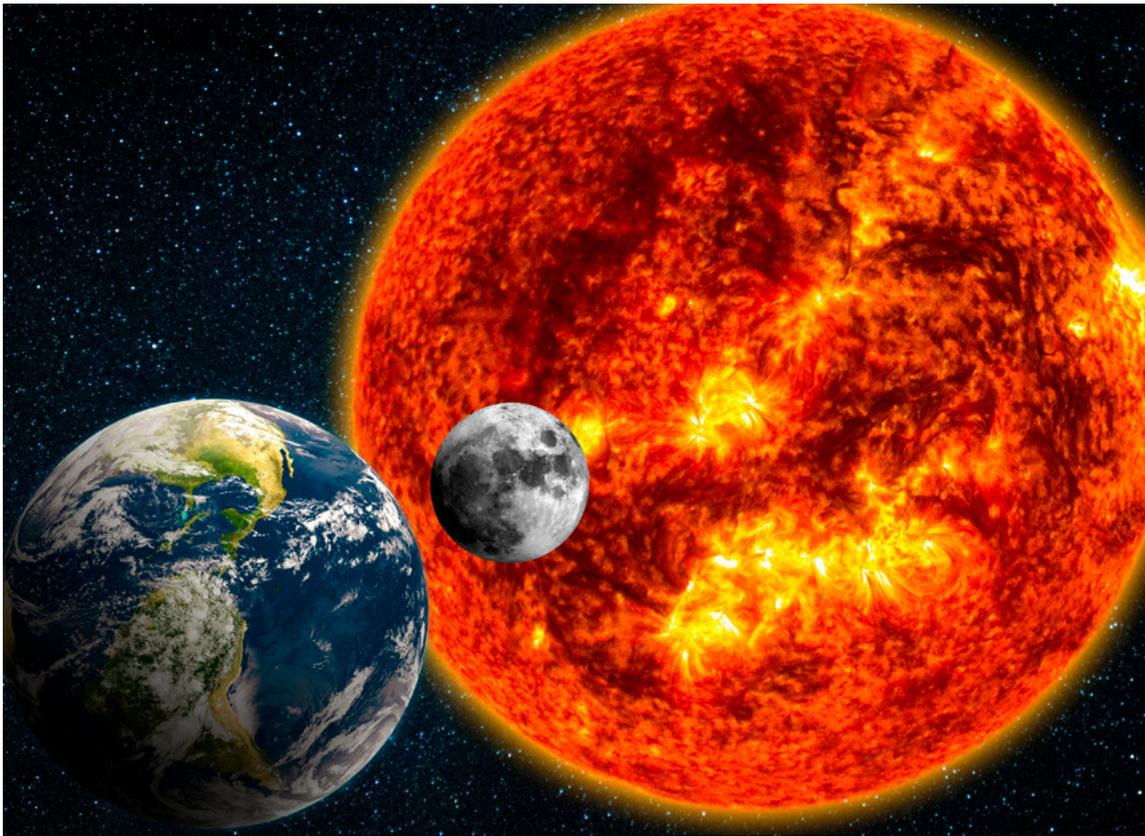


Developed with Laura Beres

Earth-moon-sun system

Volume 7 | Gr. 9-12

Time: 60+ mins.



Objective

Students will be able to construct and use a model of the Earth, sun, and moon in order to describe the phases of the moon and eclipses

Materials list

- Modeling clay ([9731115](#))
- Styrofoam balls (Different sizes available ([0500479-0500482](#) and [9714794-9714797](#)))
- Dowels ([9734598](#) or [0300921](#))
- Building materials: glue ([9742856](#) or [9702899](#)), dowel cutter ([SB31425](#)), paint ([9735753](#) or [8100362](#))
- Printed materials for students

Notes for teachers

- Part 1: Introduction to content (slideshow with content).
- Part 2: Develop a model and use it to demonstrate lunar events.

STEAM connections

Science: Students will analyze the relationships between the sun, moon, and Earth to determine the moon phase and if an eclipse will happen.

Technology: An orrery is a piece of technology used to model the sun, moon, and Earth.

Engineering: Students will build an orrery to use in modeling different lunar events.

Art: Students will create a model of the sun, moon, and Earth.

Math: Students will use calendars and dates to help predict moon phases.

Essential questions

What causes the different phases of the moon? What is the relationship between the position of the sun, Earth, and moon? What causes an eclipse?

Learning Standards

HS-ESS1.A — The Universe and Its Stars. The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. The Big Bang Theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

HS-ESS1.B — Earth and the Solar System. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from or collisions with other objects in the solar system.

Modifications



For a fun, in-person activity: Use 8 chocolate sandwich cookies per student to model the moon phases. Students will twist open the cookie and use the inside frosting to create the shape of the moon on the dark background of the cookie. Plastic knives or toothpicks work well for this.

Common misconceptions

- Phases of the moon are caused by a shadow from the Earth.
- Different countries see different phases of the moon on the same day.
- The moon goes around the Earth in a single day.
- The moon makes light the same way the sun does.
- Lunar and solar eclipses occur every month somewhere on Earth.

Extension Questions



How do seasons occur?



How does the moon impact tides?

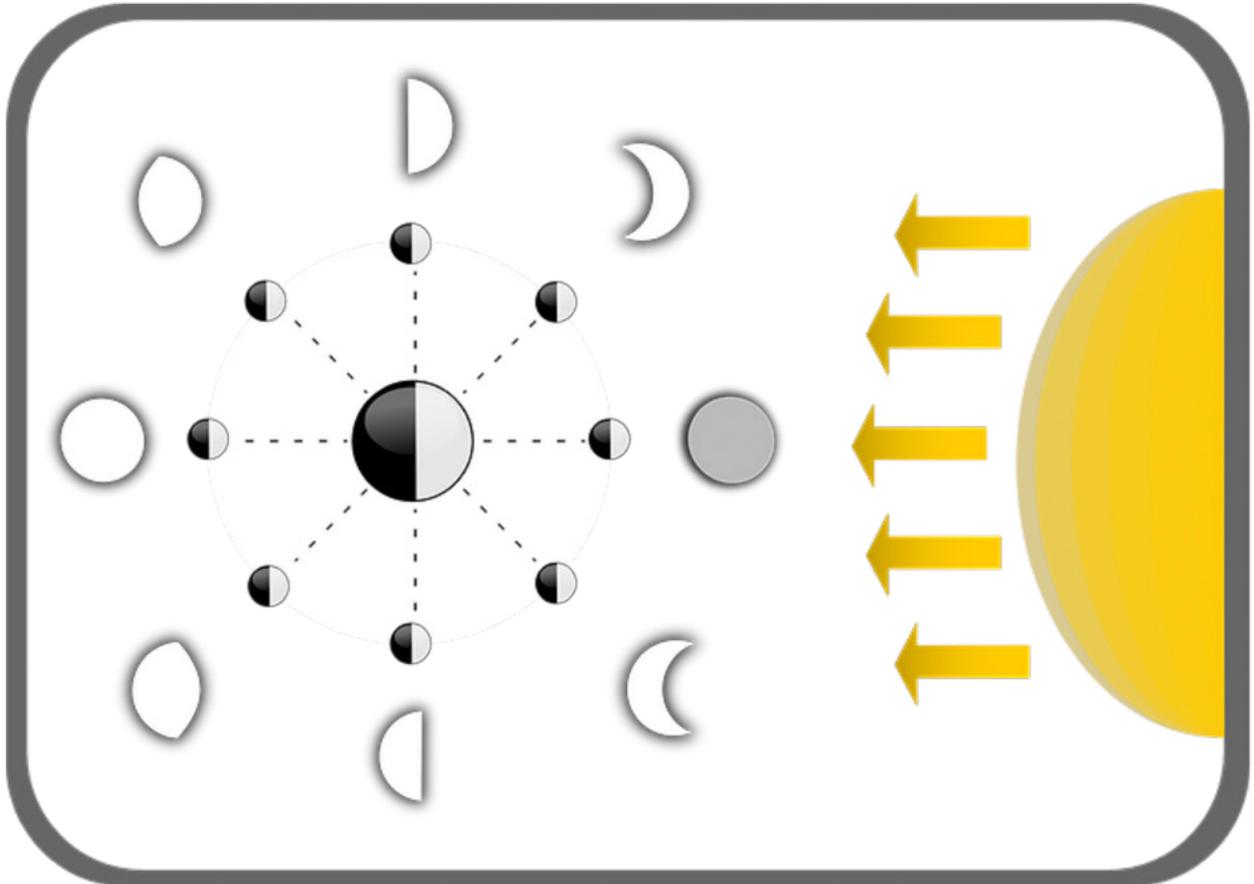


What role does the sun play in the entire solar system?

Earth, moon, and sun

Name: _____ Period: _____ Date: _____

Label the following image based on the class notes:



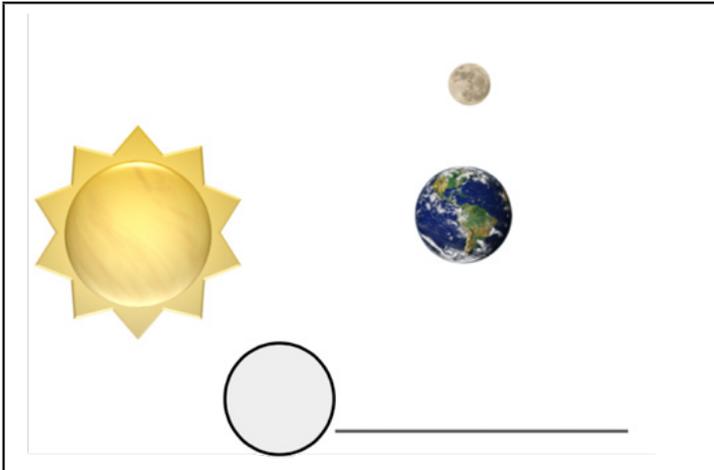
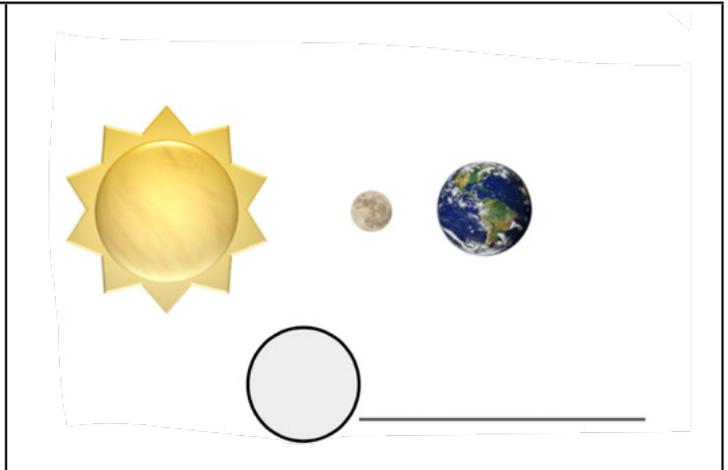
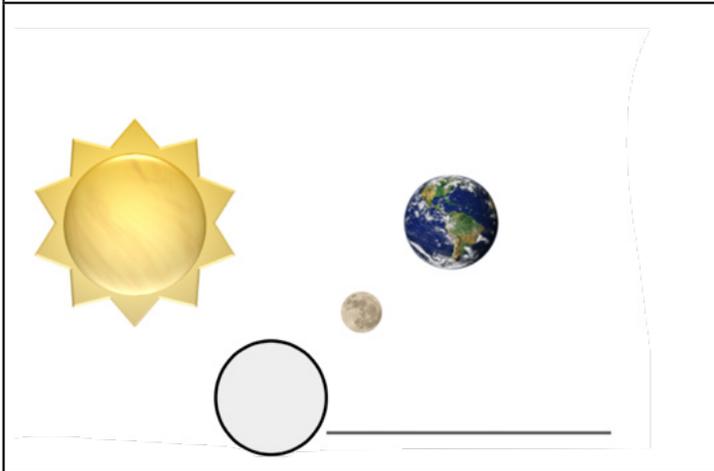
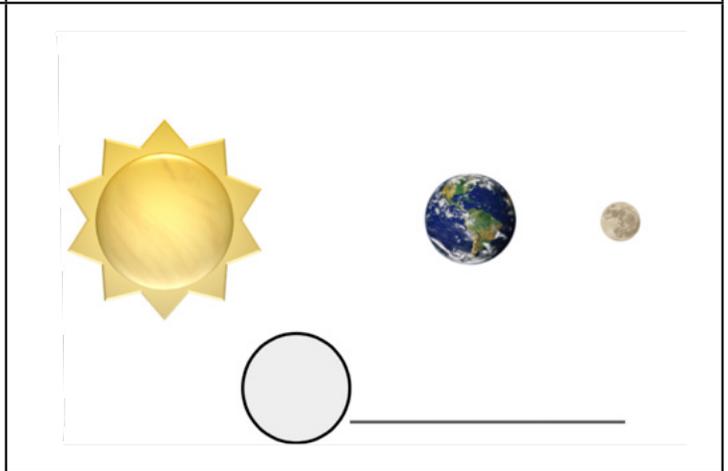
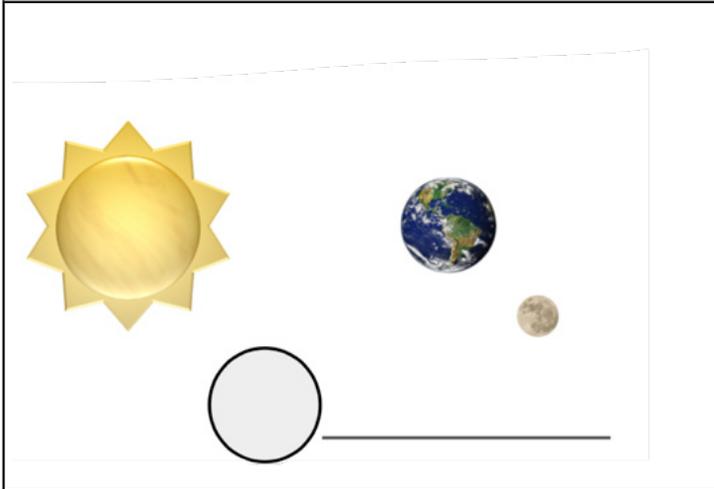
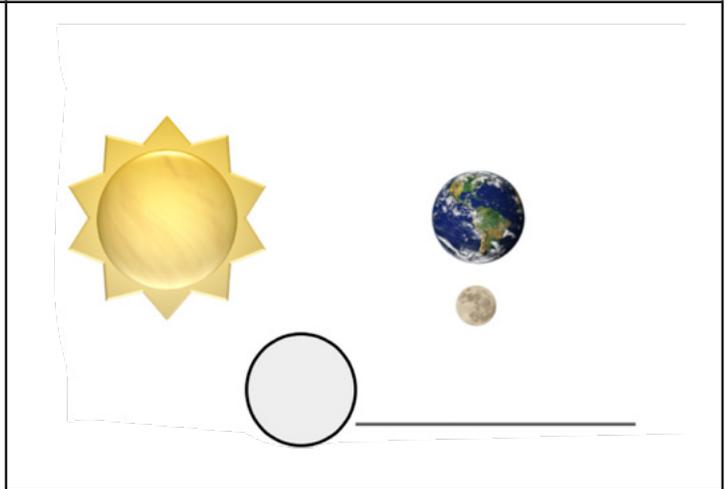
Sarah and Malik love Halloween. They can't wait to dress up in scary costumes and tell ghost stories. What they want the most is a full moon on the night of October 31. They remember having a full moon on July 4, because it wasn't totally dark for the fireworks. Based on what you know about the length of the moon phase cycle, will there be a full moon on October 31? Explain your answer.

CREATE A 3D ORRERY BEFORE CONTINUING! Ideas for materials include modeling clay, foam balls, LEGO® pieces, dowels, balls, or balloons.

Moon phases

Name: _____ Period: _____ Date: _____

With the following diagrams, create the sun-moon-Earth relationship with your orrery. In the blank circle, draw the moon phase as it would be seen from Earth. Write the name of the moon phase on the line provided.

 <p>_____</p>	 <p>_____</p>
 <p>_____</p>	 <p>_____</p>
 <p>_____</p>	 <p>_____</p>

Which two phases are not represented? _____ and _____

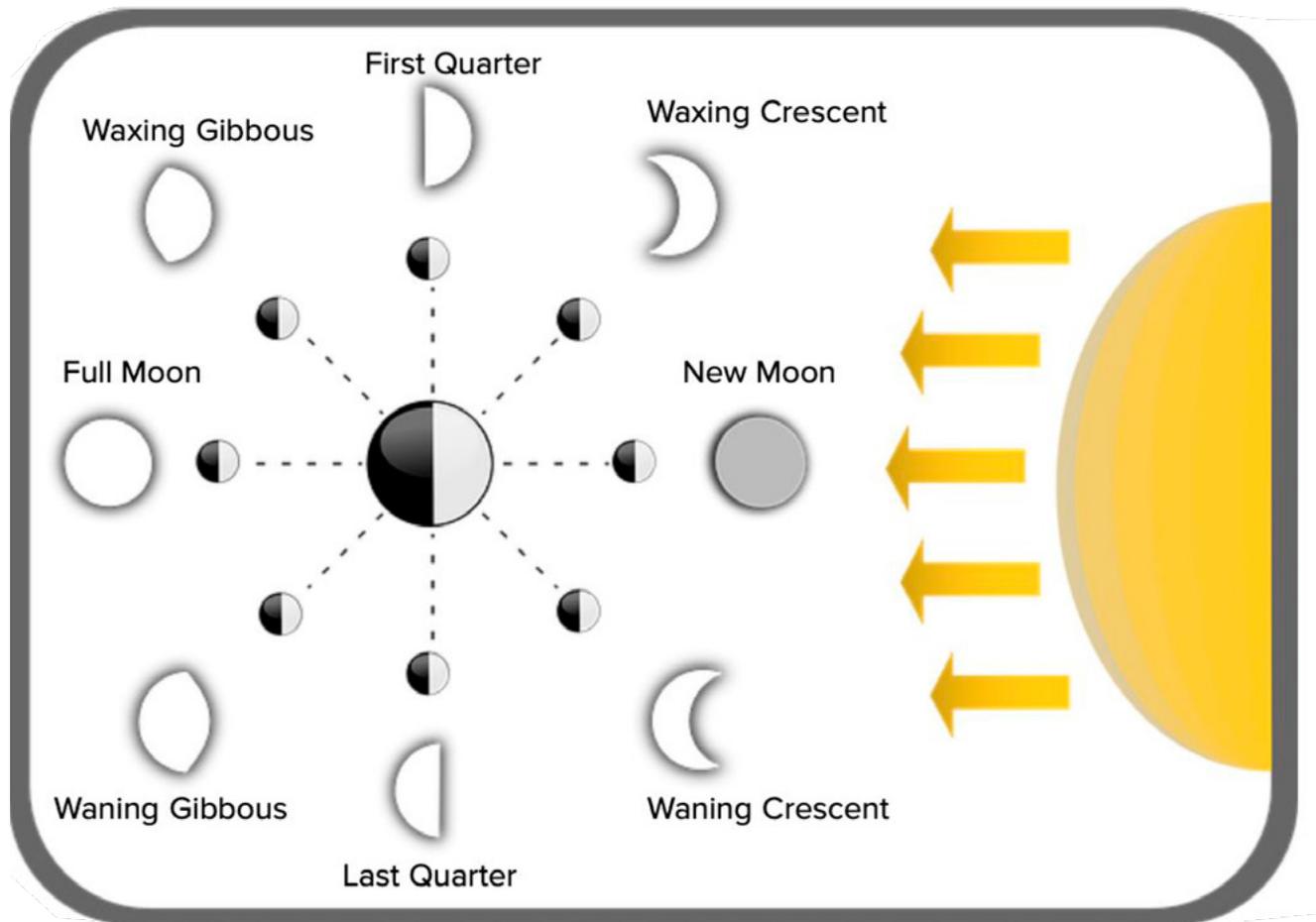
What are Kepler's Laws of Planetary Motion? Use class materials or online sources to help you.

Using Kepler's Laws of Planetary Motion and other science knowledge, explain why an orrery is not an entirely accurate model to use.

Draw a model that will more accurately represent the paths of the Earth and moon as they move in the solar system:

Earth, moon, and sun – Answer key

Label the following image based on the class notes:

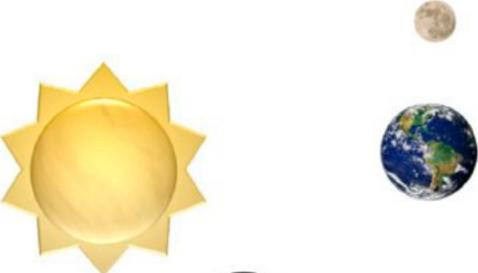
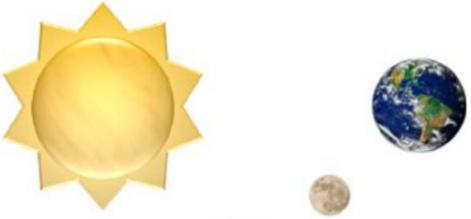
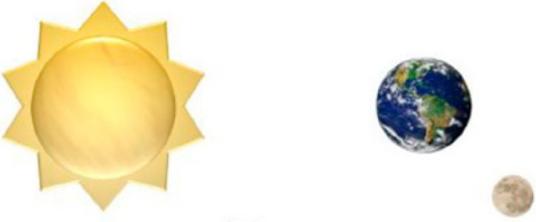


Sarah and Malik love Halloween. They can't wait to dress up in scary costumes and tell ghost stories. What they want the most is a full moon on the night of October 31. They remember having a full moon on July 4 because it wasn't totally dark for the fireworks. Based on what you know about the length of the moon phase cycle, will there be a full moon on October 31? Explain your answer. **There are 119 days between July 4 and October 31. A full moon happens every 29.5 days. It is very likely that there will be a full moon because that is almost exactly 4 cycles.**

CREATE A 3D ORRERY BEFORE CONTINUING! Ideas for materials include modeling clay, styrofoam balls, LEGO® pieces, dowels, balls, or balloons.

Moon phases – Answer key

With the following diagrams, create the sun-moon-Earth relationship with your orrery. In the blank circle, draw the moon phase as it would be seen from Earth. Write the name of the moon phase on the line provided.

 <input type="text"/> Third quarter	 <input type="text"/> New Moon
 <input type="text"/> Waxing Crescent	 <input type="text"/> Full Moon
 <input type="text"/> Waxing gibbous	 <input type="text"/> First Quarter

** use Earth, Moon, and Sun PDF or labeled diagram above to grade drawings.

Which two phases are not represented? **Waning Crescent** and **Waning Gibbous**

Moon phases – Answer key

What are Kepler's Laws of Planetary Motion? Use class materials or online sources to help you.

- 1. All planets move around the sun in elliptical orbits, having the sun as one of the foci.**
- 2. A radius vector joining any planet to the sun sweeps out equal areas in equal lengths of time.**
- 3. The squares of the sidereal periods (of revolution) of the planets are directly proportional to the cubes of their mean distances from the sun.**

Using Kepler's Laws of Planetary Motion and other science knowledge, explain why an orrery is not an entirely accurate model to use.

The orrery that was made uses circular orbits, but planets orbit in ellipses. The orrery also does not accurately represent the distances between or the size of the sun, moon, and Earth.

Draw a model that will more accurately represent the paths of the Earth and moon as they move in the solar system:

Drawings will vary. Orbit paths should NOT be circular, but rather ellipses.



Earth, Moon, and Sun

Motion of the Moon

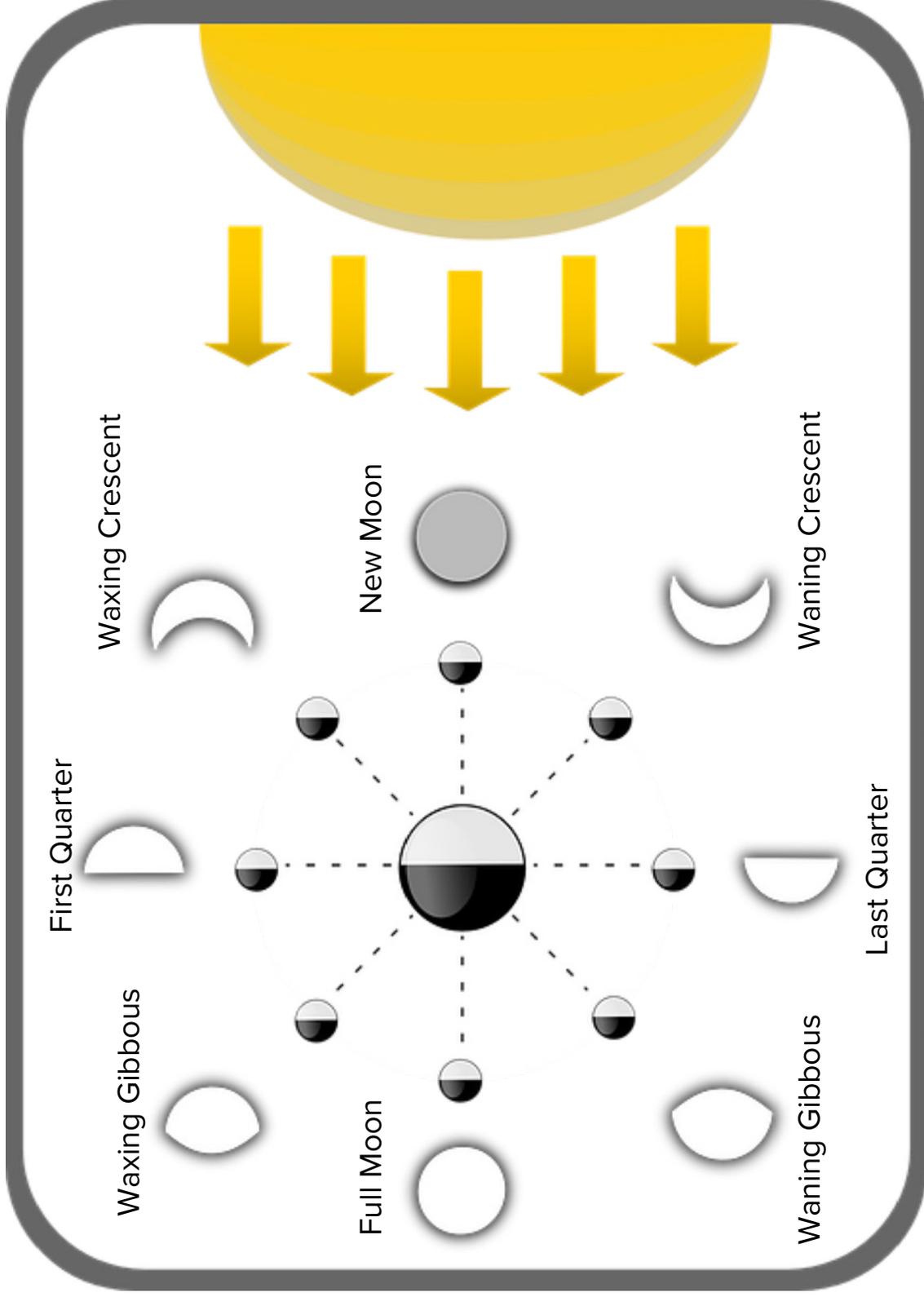


- Moon rotates (spins) on its axis as it revolves around (circles) the Earth
- The time it takes to rotate is the same as the time it takes to complete one full revolution
- Moon does not produce its own light — it reflects the light of the Sun

Phases of the Moon

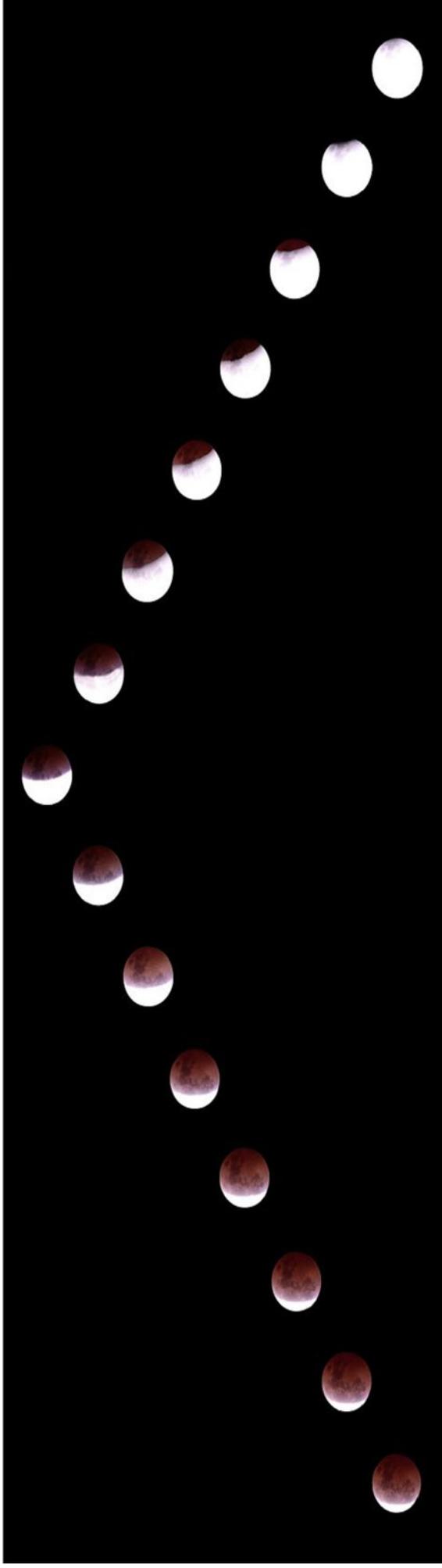
- Complete lunar cycle takes 29.5 days
- “Waxing” refers to the amount of lit surface seen becoming larger
- “Waning” refers to the amount of lit surface seen becoming smaller





Lunar Eclipse

- Occurs when a full moon moves through the shadow cast by the Earth
- Also known as a blood moon
- This can only happen when the sun, moon, and Earth align just right, which is only 1–2 times per year



Solar Eclipse

- Occurs when the new moon passes directly between the Earth and Sun
- The shadow of the Moon falls on the Earth's surface
- There are 1–2 total solar eclipses per year and several more partial ones

