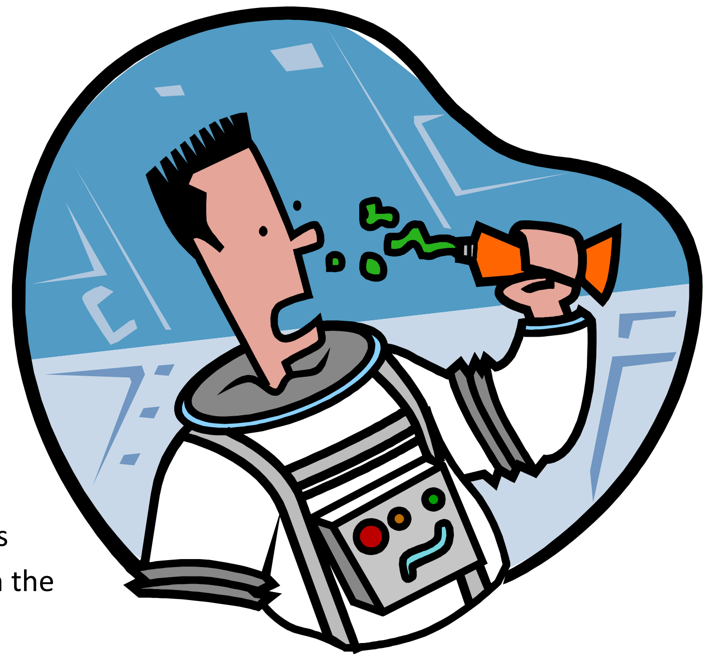
Moonstruck

Grade Level Modification Tips:



Remember throughout each lesson we need to provide opportunities to have all of our students Read, Listen and Comprehend, Write, and Speak. The standards provide a guide on what each grade level needs to know. The moon is stressed through most grade levels from Kindergarten all the way through high school. Use the following standards to guide you in your modifications for each grade level. With younger students, emphasize the basic concepts and ideas. With older students go more in depth with the scientific terminology and concepts.

Examples of Possible Academic Science Standards to Incorporate:

Kindergarten:

- 7.6.1 Know the different objects that are visible in the day and night sky.
- 7.6.2 Observe, discuss, and draw objects found in the day and night sky.

1st Grade:

- 7.6.2 Realize that the sun can only be seen during the day, while the moon can be seen at night and sometimes during the day.
- 7.6.2 Identify objects in the sky and describe their observable similarities and differences.
- 7.6.1 Compare and describe features of the day and night sky.
- 7.6.1 Create a chart of things that can be observed in the day and night sky.

2nd Grade:

- 7.6.1 Realize that the sun is our nearest star and that its position in the sky appears to change.
- 7.6.2 Make observations of changes in the moon's appearance over time.
- 7.6.2 Draw and record changes in the moon over a period of time.

3rd Grade:

- 7.6.1 Identify and compare the major components of the solar system.
- 7.6.1 Identify the major components of the solar system, i.e., sun, planets and moons.
- 7.6.2 Compare and contrast major solar system components.
- 7.6.1 Create a model of the solar system depicting major components and their relative positions and sizes.
- 7.7.2Describe how rocks can be classified according to their physical characteristics.

4th Grade:

- 7.6.1 Analyze patterns, relative movements, and relationships among the sun, moon, and earth.
- 7.6.1 Chart the movements of the sun, moon, and earth to develop an explanation for the phases of the moon and solar and lunar eclipses.
- 7.6.1 Organize the phases of the moon in the correct sequence.
- 7.6.2 Sequence the major phases of the moon during a lunar cycle.
- 7.6.2 Infer that the moon's phases are caused by the revolution of the moon and earth around the sun.
- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.3 Determine the relationship between speed and distance traveled over time.

5th Grade:

- 7.6.1 Compare planets (and bodies in the solar system) based on their known characteristics.
- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.12.1 Recognize that the earth attracts objects without directly touching them.
- 7.12.3 Design and explain an investigation exploring the earth's pull on objects.
- 7.12.1 Explain and give examples of how forces act at a distance.

6th Grade:

- 7.6.2 Describe the relative distance of objects in the solar system from earth.

- 7.6.3 Explain how the positional relationships among the earth, moon, and sun control the length of the day, lunar cycle, and year.
- 7.6.4 Describe the different stages in the lunar cycle.
- 7.6.5 Produce a model to demonstrate how the moon produces tides.
- 7.6.3 Investigate how the earth, sun, and moon are responsible for a day, lunar cycle, and year.
- 7.6.4 Explain why the positions of the earth, moon, and sun were used to develop calendars and clocks.
- 7.6.7 Model the positions of the earth, moon, and sun during solar and lunar eclipses.
- 7.6.7 Explain the difference between a solar and a lunar eclipse.
- 7.6.4 Explain the different phases of the moon using a model of the earth, moon, and sun.
- 7.6.2 Explain how the relative distance of objects from the earth affects how they appear.
- 7.6.3 Distinguish among a day, lunar cycle, and year based on the movements of the earth, sun, and moon.

7th Grade:

- T/E.1 Explore how technology responds to social, political, and economic needs.
- Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.
- Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- Inq.3 Interpret and translate data in a table, graph, or diagram.
- Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.
- Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.
- 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.
- 7.11.4 Recognize how a net force impacts an object's motion.

8th Grade:

- CU 7.12.5 Explain the difference between mass and weight.
- CU 7.12.6 Identify factors that influence the amount of gravitational force between objects.
- CU 7.12.7 Explain how the motion of objects in the solar system is affected by gravity.

- SPI 7.12.4 Distinguish between mass and weight using appropriate measuring instruments and units.
- SPI 7.12.5 Determine the relationship among the mass of objects, the distance between these objects, and the amount of gravitational attraction.
- SPI 7.12.6 Illustrate how gravity controls the motion of objects in the solar system.

High School: Earth Science

- 4.1.2 Examine the components of the solar system.
- 4.1.3 Explore the sun, earth, and moon relationships and their gravitational effects.
- 4.1.4 Investigate the history of space exploration.
- 4.1.6 Explore the role of astronomical events in the earth's history: asteroid/meteor impacts, solar flares, and comets.
- 4.1.9 Describe the position of the sun, earth, and moon during eclipses and different lunar phases.
- 4.1.10 Predict tidal conditions based upon the position of the earth, moon, and sun.
- 4.1.14 Investigate the history of space exploration.
- 4.1.11 Describe the relationship between the mass of an object and its gravitational force.

Examples of Possible Academic Vocabulary to Incorporate:

For the Academic Vocabulary we encourage you to use as many of these words as possible, not simply pick one or two. The more words we can introduce in a setting that makes sense to our students, the better.

Kindergarten:

- air
- animal
- change
- color
- day/night
- food
- growth
- moon
- natural
- observe
- ocean
- parts
- senses
- shape
- size
- star
- sun
- temperature
- thermometer
- tools
- weather

1st Grade:

- adult
- balance
- classify

- environment
- freezing
- heat
- invent
- investigate
- light
- location
- matter
- mixed
- planet
- prediction
- property
- push/pull
- texture

2nd Grade:

- Celsius/Fahrenheit
- compare/contrast
- depend
- dissolve
- distance
- energy
- habitat
- infer
- investigate
- observation
- reasoning
- renewable/non-renewable
- scientific inquiry
- scientist
- similarities/differences
- sound
- universe

3rd Grade:

- atmosphere
- cross section
- force
- orbit
- revolution
- rotation
- solar system

4th Grade:

- eclipse (solar/lunar)
- electricity
- friction
- lunar cycle
- mass
- reflection
- refraction

5th Grade:

- conduction
- constellation
- core
- crust
- dissipate
- earthquake
- faulting
- gravity
- plane
- plate movement

6th Grade:

- atmospheric convection
- asteroid
- bias
- cause and effect
- control
- criteria
- ocean current
- protocol
- prototype
- tides
- variable

7th Grade:

- acceleration
- momentum
- phenomenon
- speed
- velocity

8th Grade:

- base
- density
- gravitation (universal law)
- magnetic field
- variation
- gravitational effects

High School:

High school students are responsible to be familiar with and understand all of the above vocabulary mentioned K-8 as well as the technical terms used within the lesson itself. Look at the words above and choose as many as possible that your students may not be familiar with, which naturally fit within your lesson.

Moonstruck

“Magnificent Desolation”

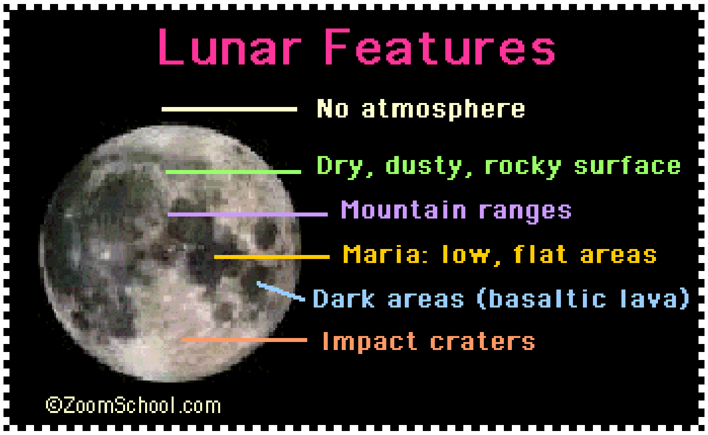
Read a book such as, *The Boy and the Moon* by James Christopher Carrol, or *Long Night Moon* by Cynthia Rylant. “Long ago Native Americans gave names to the full moons they watched throughout the year. Each month had a moon. And each moon had a name...." or *No Moon, No Milk!* by Chris Babcock to introduce this section.

Unit 1: The Man on the Moon

Tip: There are some great videos on YouTube of the Lunar Landing in 1969. If you have internet access it would be an excellent idea to show the students the actual CBS Broadcast from 1969.

Ask any student, the moon is a bright, silvery disk. When you go for a car ride, it glides alongside you, matching your speed no matter how fast you’re driving. As it inches its way up from the horizon to the top of the sky’s dome, it shrinks to nearly half its original size. Actually the moon is tricking your eyes. The farther away something is, the harder it seems to be to get past it. This is because the angle of your direction from distant objects changes much more slowly than the angle of nearby objects. The moon is very far away (about 238,000 miles or 384,000 km), though it looks closer.

Test it out! Tell students, hold both of your forefingers in front of your face, with your left forefinger three inches in front of your face and your right forefinger at arm’s length. Now move your head from side to side. Notice that the closer finger moves past your face much faster than finger at arm’s length. Ask students how this might apply to the moon.



The Moon has fascinated people throughout history and people such as farmers, sailors and other common folk down through history have depended on it's movements to guide them in their daily lives. The moon, the Earth's only natural satellite,*(A satellite can be defined as any object, either manmade or naturally occurring, that orbits around something else. For example, the moon orbits around Earth and is thus a satellite. The Earth orbits around the sun and is a satellite of the sun. Other examples of naturally occurring satellites include comets, stars, asteroids, and other planets. Note: About 5000 manmade satellites currently orbit earth, and on clear dark nights, it's often possible to see one in the night sky. Of course, viewing a planet, the stars, or comets is also viewing a satellite. We also must remember, we live on a satellite, and are not stationary in the sky.)* is about 238,900 miles away from Earth. It is the brightest light in the night sky, but what people sometimes call "moonlight" is really sunlight reflecting off the Moon's surface. The Moon itself puts out no light at all, but instead reflects the sun's light. The moon is about one quarter the size of Earth and it has about one-sixth of the Earth's gravity, which isn't very much. Weight is a measure of how much gravity pulls on an object. Mass is the amount of matter an object has. On the Moon, gravity's pull isn't as strong as it is on Earth. So a child who weighs about sixty-five pounds on Earth would only weigh about ten pounds on the Moon, about the weight of a small dog. **Help children understand that weight changes with gravity, but mass always stays the same. The amount of matter in an object doesn't change depending on where the object is in the universe.** The moon is made up of rock and dust. There is no air or life on the moon that we know of. There is no wind or weather on the moon. The footprints left there by astronauts will remain there for many years because of this. The surface of the moon has many things on it such as craters, lava plains,

mountains, and valleys. Scientists believe the craters were formed around 3.5 to 4.5 billion years ago by meteors hitting the moon's surface.

Why were people so eager to get a man on the moon?

The space race began in 1957 when the Soviet Union launched the world's first satellite, *Sputnik*. At that time the United States and the Soviet Union were great rivals and enemies, they were even at war, the Col War. After *Sputnik*, Americans were afraid that the Soviet Union had gained military control of space. Suddenly, they realized that they were in a race to space, and that the Soviets were winning. In early 1961, the Soviets sent the first human into space. President John F. Kennedy responded with a new challenge to America's young space program, NASA. He wanted to land an American on the moon before 1970! It was a huge challenge but millions of people from the government, universities, and private businesses worked to make it happen. On July 20, 1969, all the years of hard work paid off. After an 8 day trip through space, with no gravity holding anything in place, not able to talk to friends or family, with the mission almost being aborted at the very end due to alarms and computer problems, and heading straight for a crash while running out of fuel, and landing in the wrong place, *Apollo 11* astronauts Neil Armstrong and Buzz Aldrin became the first humans to set foot on the Moon. It was a very close call but President Kennedy's goal was finally realized, and America had achieved one of the greatest feats of all time!

After their historic landing on the Moon, Neil Armstrong and Buzz Aldrin rejoined their fellow astronaut on the command ship and they headed back to Earth. They traveled several days before they re-entered Earth's atmosphere at speeds up to 25,000 miles per hour. The exterior of their ship, the "Columbia" reached a temperature of 5,000F. The heatshield covering the spacecraft prevented it from burning up and killing all aboard. On July 24, 1969 the Columbia splashed down safely in the Pacific Ocean. Navy divers helped the astronauts out of the capsule and brought them aboard a nearby aircraft carrier. Once aboard they were put into quarantine until scientists were sure that they hadn't carried any alien germs back to Earth.

Ask the students what they think it would be like on the moon? What would they think as they walked around?

Share the following quotes of how the astronauts felt.

Astronauts have said of their experiences being on the moon:

Buzz Aldryn, the second man to step on the moon said, "Beautiful! Beautiful! Magnificent desolation." Edwin E. Aldrin, Jr. quotes.

December 1968.

It suddenly struck me that that tiny pea, pretty and blue, was the Earth. I put up my thumb and shut one eye, and my thumb blotted out the planet Earth. I didn't feel like a giant. I felt very, very small.

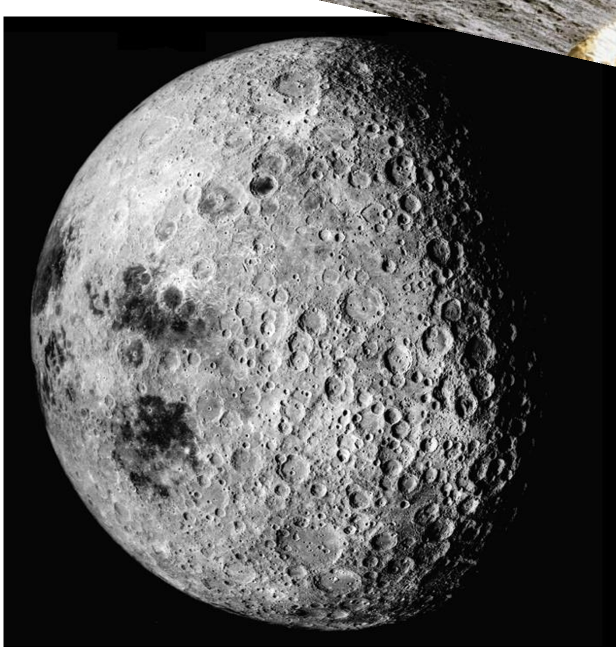
Frequently on the lunar surface I said to myself, "This is the Moon, that is the Earth. I'm really here, I'm really here!

— *Alan Bean*

If somebody'd said before the flight, "Are you going to get carried away looking at the earth from the moon?" I would have say, "No, no way." But yet when I first looked back at the earth, standing on the moon, I cried.

— Alan Shepard

It takes about one month for the moon to travel or orbit around the Earth. The moon makes one complete rotation for each trip it takes around the Earth. The same side of the moon faces the Earth the whole time. The same side of the moon always faces the Earth humans were very curious about what might be on the far side of the moon imagining aliens watching us or mysterious creatures living there.



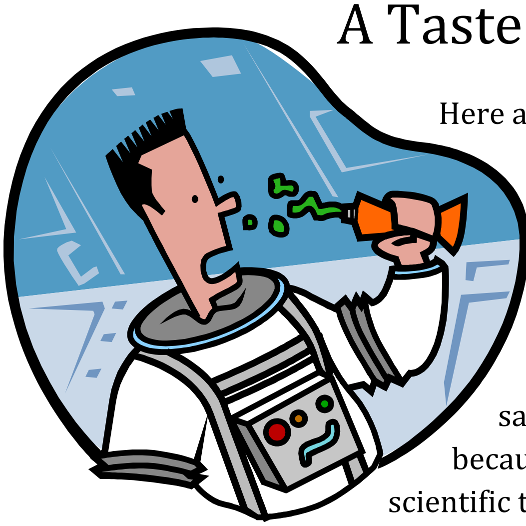
The far side of the moon was first actually observed by humans in 1959 when the unmanned Soviet Luna 3 mission orbited the moon and photographed it, finding out it looked a lot like the side we see every night. Neil Armstrong and Buzz Aldrin (on NASA's Apollo 11 mission, which also included Michael Collins) were the first people to walk on the moon, on July 20, 1969. And remember because there is no weather on the Moon

Aldrin's footprint will remain crisp for millions of years until eroded by micrometeorite impacts. In total 12 men have left their footprints on the Moon's surface. The last moonwalk was in 1972.

If anyone actually did live on the moon, or for anyone visiting, the sky always appears dark, even during the daytime. Also, from any spot on the moon (except on the far side of the moon where you cannot see the Earth), the Earth would always be in the same place in the sky; only the phase of the Earth would change and the Earth rotates, displaying various continents.

You would also need a really good coat, and some sunscreen, all for the same day. The temperature on the Moon ranges from daytime highs of about 130°C = 265°F to nighttime lows of about -110°C = -170°F

A Taste of Space:



Here are several experiments that illustrates why it is harder to drink in outer space and why astronauts have to have special food containers. The kids get a goofy kind of satisfaction at the end of this because they've learned a scientific truth while at the same time having fun. Drinking in space requires special equipment to stop the drink going everywhere. Drinks are usually kept in pouches, with a built in straw. Some missions even carry soft drinks, with special nozzles that dispense the drink straight into the astronaut's mouth. Coca Cola has even designed a special Coke dispenser so that space shuttle crews can get a cold soda whenever they want one! Pillsbury used its role as a food supplier on Apollo 11 as a launching pad for a spin-off named Space Food Sticks, which were added to the menu for the Skylab astronauts. Three different flavors, three sticks a day. The long, chewy sticks could slide into an airtight port located in an astronaut's helmet.

Materials:

Glass of water
Drinking straw
Straight-back chair

Directions:
1. Put the glass of water on the floor near the side of the chair.
2. Have a student lie across the chair so that their stomach is higher than your mouth. Their stomach will be on the seat of the chair with their feet and head hanging off either side.
3. Have students lift the glass and try to take a drink (without the straw). What happens?
4. Now put the straw in the glass and try to take a sip. What happens?

What happens? It is almost too difficult to get a drink from the glass while lying on the chair.

Why? Gravity!! Gravity makes it easy to feed ourselves her on Earth because it automatically “forces” the food down your throat and helps it through the digestive tract. There is no gravity in space. When you lie on the chair you are effectively changing your center of gravity and imitating conditions in space. However, when you use a straw it is a little easier because you are able to use pressure on the drink to force it into your mouth (sucking). Once the drink is in your mouth, your muscles in your throat do the rest. How do you think this affected the astronauts?

The main problem with eating and drinking in space is that there is no gravity. If you let go of a piece of food in a space craft, it will drift around, not fall to the floor. Water won't stay in a cup, it will float out and hang in the air. Food crumbs and drops of water could float around the spacecraft, make a mess or even damage the space craft itself. Bread is the number one enemy in space. You do not want crumbs floating around in microgravity getting into the electronics.

The first space missions only lasted for a few minutes, so of course there was no need for the crews to eat, but as missions became longer, like the ones to the Moon, astronauts had to be fed. The first American astronaut to eat in space dined on bite-sized cubes, freeze-dried foods, and semi-liquids squeezed from an aluminum toothpaste-like tube. Years later, astronaut John Glenn requested Tang for his return to space, but now astronauts can choose from an ever-expanding list of meals that the food scientists at NASA keeps cooking up.

Special ways of packaging and eating foods had to be invented for space meals. Scientists spend lots of time working on foods for space travel, to make sure astronauts stay fit, happy and healthy, so they can be at their best while they are in space.

How did they do it? Rehydration

Rehydration is an essential part of eating in space . If astronauts were to transport foods in their full form, the water and packaging materials would add weight and require more storage space. Water, of course, is limited aboard a spacecraft. Consequently, astronauts are allowed only a certain amount of H2O for rehydrating food items. The NASA Apollo missions, which took men to the moon, lasted several days, so the astronauts had the luxury of hot water to mix into their food to make hot

The Truth about Tang

http://theopenend.com/2009/01/19/tang-the-drink-of-choice-among-gemini-astronauts/

The "Tang :: The Drink of Choice Among Gemini Astronauts" TV commercial [available on YouTube] became so wide spread in the 1960's that some people started to believe the citrusy powder was invented by NASA's space program. But this is a myth. The most convincing evidence is that Tang was invented in 1957 by General Foods and wasn't used by NASA until 1962.

Of course, heavily-circulated, full-color magazine ads showing astronauts drinking Tang didn't help dispel this myth. The truth is that Tang was adopted by the space program in an effort to make the water that was produced as a natural byproduct of the Gemini life-support system more drinkable. Here's a quote from a NASA engineer who knows the inside scoop: "There was a particular component of the Gemini life support-system module which produced H2O (water) among other things. This was a byproduct of a recurring chemical reaction of one of the mechanical devices on the life-support module. The astronauts would use this water to drink during their space flight. The problem was, the astronauts did not like the taste of the water because of some of the byproducts produced, which were not harmful of course. So, they added Tang to make the water taste better."

Tang is still Kraft Foods most popular powdered drink today and is available in more than 30 countries in a wide variety of flavors, based on local taste buds and preferences.

meals! They were able to enjoy hot soup, chicken and rice, spaghetti, beef sandwiches, and even chocolate pudding!

In the Future: Space Farms!

A mission to Mars is likely to last at least 24 months, six to go, six to return and 12 months on the planet. As we go on to longer-duration missions, it makes sense to become a little more self-sufficient with our food. The ultimate way of doing that is growing crops and processing them into food.

On the outpost of the moon as well as Mars, it is very likely we will grow vegetables and fruits, and then we'll have a real galley because you've got 1/6th gravity for the moon or 3/8th gravity for Mars, so you can actually prepare foods and not be eating out of packages all the time. NASA continues to collaborate with scientists, students, inventors and innovators around the world as it works toward its goal of a manned flight to Mars.

Now you get to try! Space Pudding

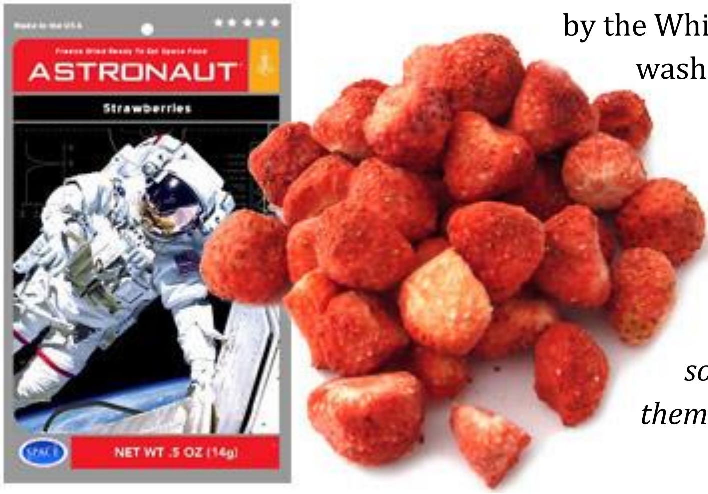
Materials:

- Ziploc sandwich bags
- Straws
- Instant pudding
- Powdered coffee creamer
- syringe

For this experiment, you'll need a Ziploc sandwich bag, a straw, a package of instant pudding, powdered coffee creamer, and a syringe. First, put approximately 1/3 of the bag of pudding mix and 1 tablespoon of coffee creamer into the sandwich bag. The creamer makes this concoction sweeter since pudding is made normally with milk instead of water.

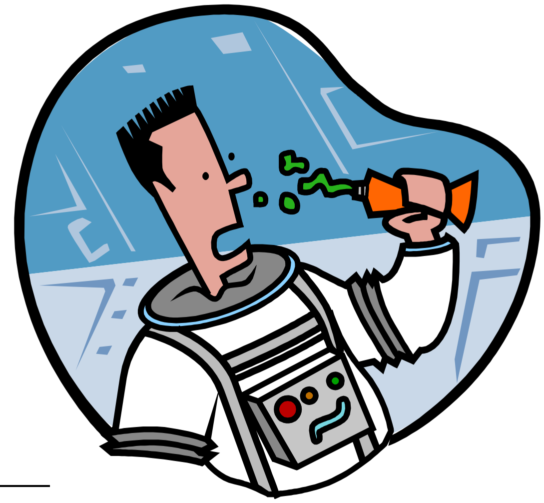
Cut a small slit in one side of the sandwich bag, approximately ¼ of the way down from the top. Now insert the straw into the slit seal it in place with tape and zip-seal the bag. Give the bag to your junior astronaut and have the student use the syringe to add water through the straw. To mix the water into the powder, the child must grasp the outside of the bag and knead the two ingredients together. Continue to add water through the syringe and straw until the mixture is completely hydrated. Finally, have your junior astronaut eat the pudding through the straw – just like astronauts do.

What kinds of foods would your students want in space? Do they ever eat astronaut food? Actually, they do!



The process of freeze drying food was invented for space travel, [First made by the Whirlpool Corporation (yup, the washer/dryer people) for the Apollo missions, freeze dried ice cream has been a favorite of geeks ever since] but is now used for everyday foods as well. Some breakfast cereals now contain freeze dried fruit, similar to these strawberries. *Have students try some freeze dried foods. Do they like them?*

A Taste of Space



1. The main problem with eating and drinking in space is that there is no what? ________________________
2. If you let go of a piece of food or drink in a space craft what will happen?

   ____

   ____
3. Do you think gravity helps you eat on Earth? _________ Why or why not?

   ____

   ____.
4. What kinds of foods would you want to eat in space?

   ____

   ____.

   How would you get them there? ____

   How would you keep them from going bad? _______________________________________

   ____.
5. Do you ever eat astronaut food? _______________. What kinds?

   ____
6. Inventions for astronauts have helped people on Earth, ex. the process of freeze drying food was invented for space travel, but is now used for everyday foods as well. What other things used in space might be used to help people on Earth?

   ____
7. Do you like freeze dried foods? Why or why not?

   ____

   ____

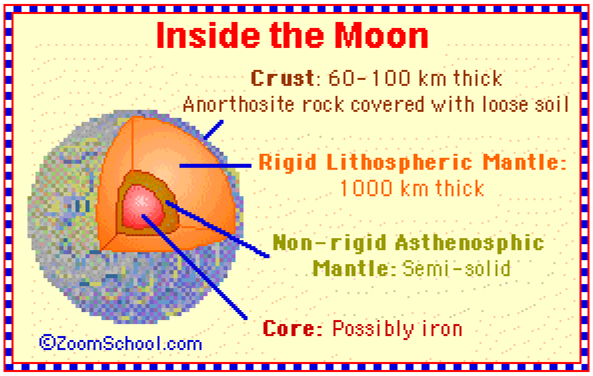
A Man on the Moon

1. The space race began in ___________ when the Soviet Union launched the world's first satellite, ___________________.
2. The process of was _________________ invented for space travel, but is now used for everyday foods too.
3. ___________________________ was the first man to step on the moon.
4. The last moonwalk was in ____________________.
5. In total, ____________ men have left their footprints on the Moon's surface.
6. It takes about one ___________ for the moon to travel or orbit around the Earth.
7. President _______________ wanted to land an American on the moon before _________!
8. The ______________ of the moon was first actually observed by humans in __________.
9. What people sometimes call _____________ is really sunlight reflecting off the Moon's surface.
10. The moon orbits around Earth and is thus a ___________________.
11. The Moon is about ________________ miles away from Earth.

1. 238,900
2. Neil Armstrong
3. 1970
4. Twelve
5. John F. Kennedy
6. *Sputnik*
7. Satellite
8. month
9. 1972
10. Far side
11. Twelve
12. Freeze drying food
13. Moonlight
14. 1959

Unit 2: A Many Layered Moon

Inside The Moon



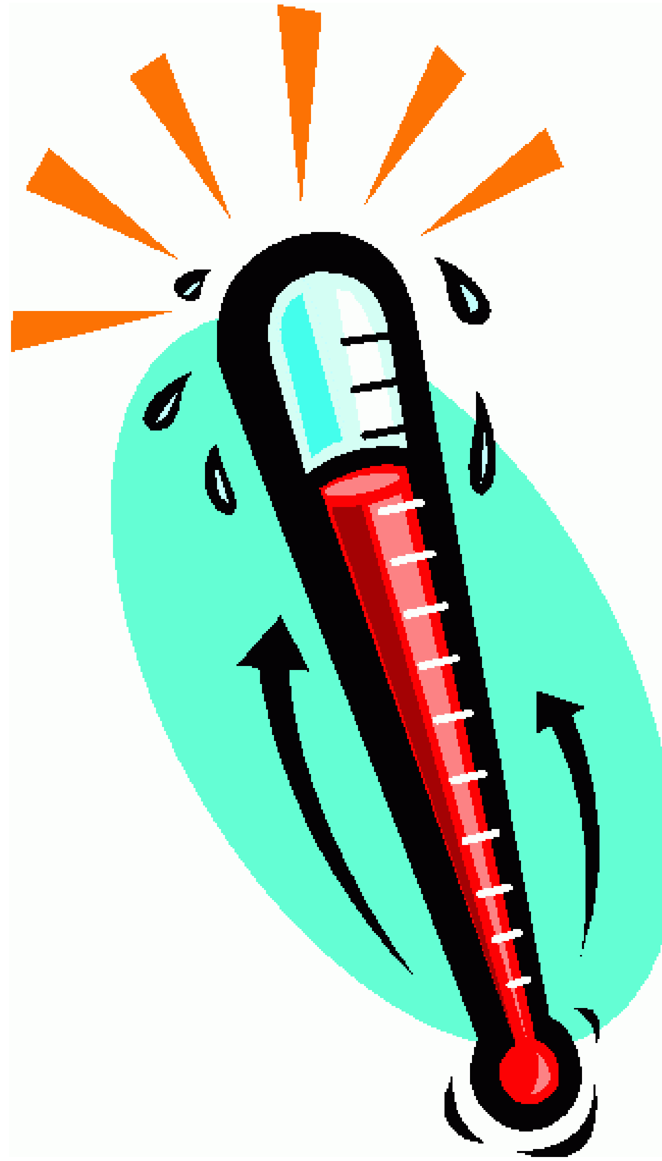
Our Earth has layers, and the interior of the moon is layered too, it's not just one big chunk of the same kind of rock. Knowledge of the Moon's interior is limited; however, scientists have developed a model based on available data. The moon is divided into a hard, outer crust, a rigid outer mantle, a semi-rigid inner mantle, and a core. The inside of the moon is colder than the inside of the Earth. Since the moon is so small, and its surface area is large compared to that of the Earth, more of its body is surface, and since so much of it is exposed it loses its heat quickly into space. Since the Earth and the moon formed, the moon has cooled down much more than the Earth. The Earth has less surface for its size and so it has held its heat inside better. Another example: An elephant is much bigger than a mouse, therefore its surface area: volume is smaller than the mouse's. That means the elephant loses less heat than the mouse for its size and therefore it has to eat less than the mouse for its size. The mouse has to eat food equivalent to a 100% of its body weight and the elephant only 5%.

Hot, or Not?: Making Predictions

Materials:

- Beakers or similar containers, different sizes, but preferably with the same wall thickness. Ex. Measuring cups
- Thermometers
- Student Sheets
- Pencils
- Graph Paper

To demonstrate this concept and help it make sense to students take three beakers (500ml, 200ml and 75ml), or other similar containers, all of different sizes, but preferably with the same wall thickness, ex. measuring cups, plastic cups. Explain that you are going to test how well large and small objects retain or lose heat over time. What do students predict will happen? Have them **write** down their predictions. Do they predict that in the smallest beaker the heat-loss will be the greatest and in the largest beaker the heat-loss will be the smallest? Fill them with very hot water, be cautious when working with any hot liquid, have an adult pour the water in the beakers. Then put a thermometer in the beaker and have students **record** the initial temperature of each beaker. Then start the stop clock. Have students **record** on a chart the temperature every minute for twenty minutes for each beaker. For accuracy, repeat so you can use the two results to get an average. Were the student's predictions correct? Do the results support their hypothesis?



Option: Have older students measure the radius of each beaker and the depth for calculations. On the back of their sheets, have students draw one graph with each beaker's results on it, so they can compare each beaker's heat-loss with another. First, have them draw a time/temperature graph, then using that graph they can draw a surface area: volume/heat-loss graph. This graph will show the relationship between surface area: volume and heat-loss if there is one at all. To calculate the surface area: volume have students first work out the surface area using the formulae $2\pi r^2 + 2\pi rd$, d being the depth. Then students can calculate the volume using the formulae $\pi r^2 d$. Then, students will put the surface area over the volume to calculate the ratio of heat loss. To calculate the rate of heat loss have students determine the number of degrees lost and divide that by the time it took to lose them, ex: 500ml Beaker - 16^0C/9min = 1.77^0C/min

Sample calculations with three beakers:

500ml Beaker

Surface Area = $2 x \pi x 4^2 + 2 x \pi x 4 x 9.1$

= 100.53+228.71

= $329.24 cm^2$

Volume = $\pi x 4^2 x 9.1$

= $457.42 cm^3$

Surface Area/Volume = 329.24:457.42

= 0.72

200ml Beaker

Surface Area = $2\times\pi\times3.1^2+2\times\pi3.1\times6$

= 60.38+116.87

= $177.25cm^2$

Volume = $\pi\times3.1^2\times6$

= $181.14cm^3$

Surface Area/Volume = 177.25:181.14

= 0.98

75ml Beaker

Surface Area = $2\times\pi\times2.25^2+2\times\pi\times2.25\times4$

= 31.81+56.55

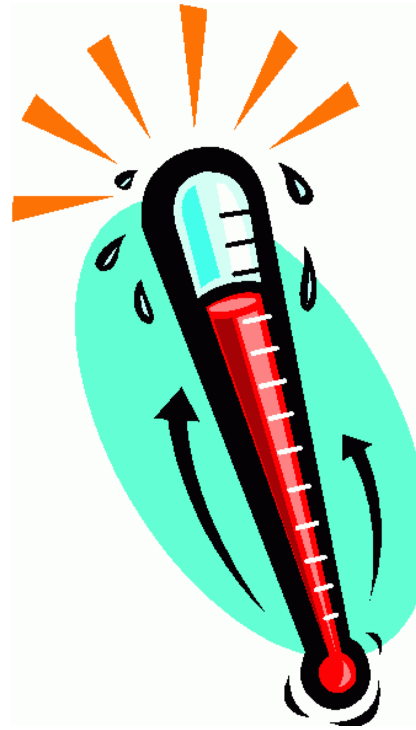
= $88.36cm^2$

Volume = $\pi\times2.25^2\times4$

= $63.62cm^3$

Surface Area/Volume = 88.36:63.62

= 1.39



Hot or Not?

How well do large and small objects retain [keep] or lose heat over time?

What do you think will happen?

Which beaker will keep heat the longest? ________________________

Explain your reasoning:

____

Which beaker will cool off the most quickly?

____

Explain your reasoning:

____

Record the initial temperature of each beaker:

A: _____°C_______°F B. _____°C_______°F C: _____°C_______°F

Record below the temperature every minute for twenty minutes for each beaker.

Time:	Beaker A	Beaker B	Beaker C
2 minutes			
3 minutes			
4 minutes			
5 minutes			
6 minutes			
7 minutes			
8 minutes			
9minutes			
10 minutes			
11 minutes			
12 minutes			
13 minutes			
14 minutes			
15 minutes			
16 minutes			

17 minutes			
18 minutes			
19 minutes			
20 minutes			

Which beaker lost heat the fastest? ___________________________

Which beaker kept the most heat? ____________________________

At what time, if any, did temperatures start to drop more quickly? ________________________

Were your predictions correct? _______________ Explain: _____________________________________

____.

Do the results support your hypothesis? _______________ Explain: ____________________________

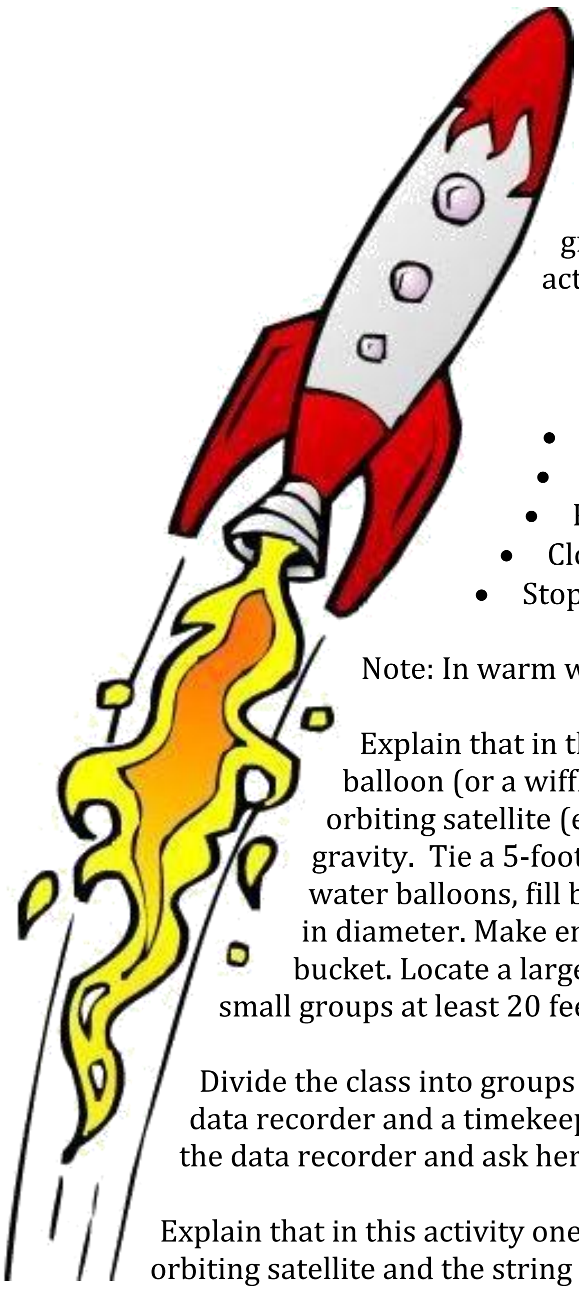
____.

Crusty Dusty Skin

Regolith: A layer of shattered rock due to meteor impacts. What are meteors? Though some can come from Mars or other planets most meteorites are fragments that have come away as two asteroids collide. Asteroids are irregular-shaped rocks that orbit the sun. There are thousands of asteroids in our solar system. Meteorites can measure anything from a fraction of a millimeter to the size of a soccer field and bigger. These tiny or huge pieces of metal and rock are constantly flying through space and sometimes they hit the moon, or the Earth, or even your house. It's true. Your house has probably been bombarded with hundreds, maybe thousands, of meteorites and you survived the impact. Granted, the meteorites that hit your house were small in size… very small… so small you'd need a microscope to see them, but the house was hit. Chances are your house has been hit by a few thousand micrometeorites, and you'll be able to find a few if you know the secret place to look. This layer of broken meteorites and meteorite dust is called regolith, and it covers the surface of the Moon. This depth varies and can be up to 100 meters thick. Under this layer lies the crust.

Crust: The moon's surface is dry, dusty and rocky. The rocky crust is about 37 miles (60 km) thick on the side of the moon that faces Earth and about 62 miles (100 km) thick on the opposite side of the Moon. The reason for this is probably related to the Earth's gravitational pull. Heavy and dense moon material, inside the moon, was attracted by the Earth's gravitational pull. So it pulled closer to the side of the Moon facing the Earth. Because the heavy material shifted towards the Earth, this made the mantle (lithospheric and asthenospheric mantle) a little off center, and the crust was pushed slightly out of the way, leaving the crust thicker on the side of the Moon facing away from the Earth. The moon formed about 4.3 billion years ago (about 60 million years after the formation of the Earth).

Breaking free of Gravity!



To demonstrate the gravitational pull of orbiting bodies in space, and to guide students in discovering how satellites stay in orbit and how spacecraft break free of gravitational orbit to reach the moon, do the following activity:

Materials:

- String/twine
- Waterballoons or wiffleballs
- Pencils
- Clothespins
- Stopwatches (optional)

Note: In warm weather you can use water balloons in an outdoor space

Explain that in this activity one student represents a planet, the water balloon (or a wiffle, or sponge ball that weighs around 100 grams/3.5 oz) an orbiting satellite (ex. the moon), or a rocket, and the string the force of gravity. Tie a 5-foot length of twine securely onto the clothes pins. If using water balloons, fill balloons with water until they are approximately 2 inches in diameter. Make enough for each group and spares. Place them in a plastic bucket. Locate a large, open, outdoor area where students can spread out in small groups at least 20 feet apart.

Divide the class into groups of three to five. Assign or allow each group to choose a data recorder and a timekeeper. Give the data collection worksheet and clipboard to the data recorder and ask her to bring pencils. Give the timekeeper a stopwatch.

Explain that in this activity one student represents a planet, the water balloon (or ball) an orbiting satellite and the string the force of gravity. They will each have a turn being the planet.

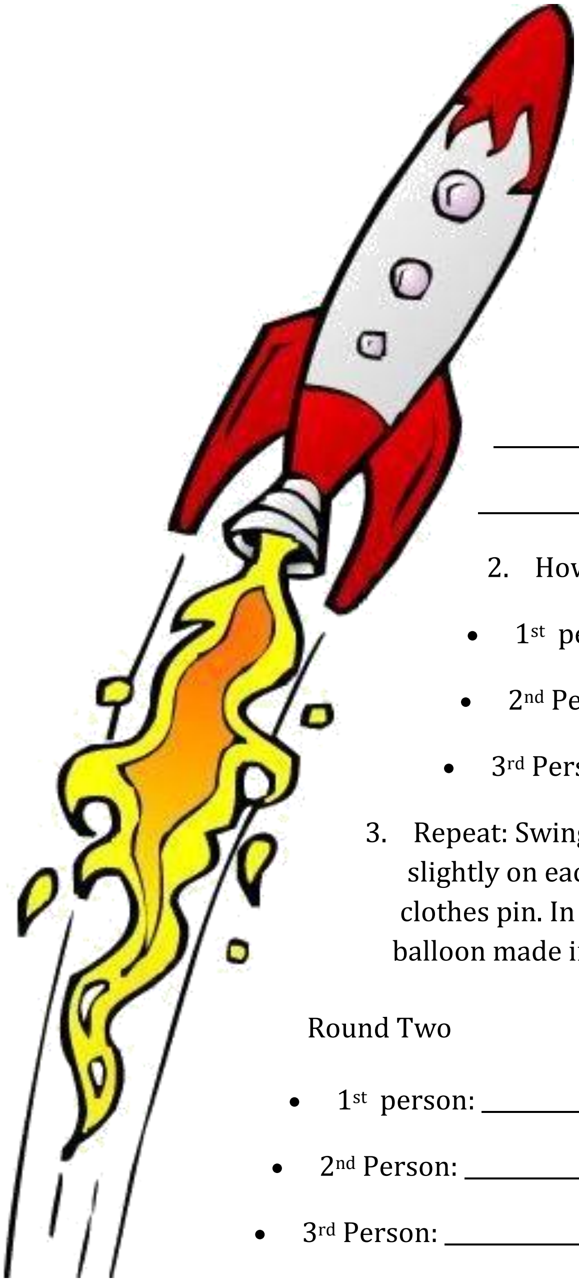
Give each group a water balloon or ball and tell them to clip it securely onto the clothes pin. Remind them not to start swinging it yet. Ask students to predict what they think will happen if they swing the water balloon in a circular motion, slowly, and then faster and faster and to write their predictions down on their sheets.

Tell other students to stand well back while the timekeeper starts the stopwatch and the first student slowly swings the balloon around his body so the balloon is moving just fast enough to keep the balloon a few feet above the ground. Count how many complete orbits the balloon makes in 10 seconds. The data recorder writes this number on the data collection sheet. Allow each student to repeat the experiment at this speed and record the data.

Repeat the swinging procedure three or more times, speeding up slightly on each round, until the balloon breaks loose from the clothes pin.

Calculate the escape velocity of each student's satellite planet or rocket using the following formula: Divide the number of orbits at the final speed by 10 seconds. Then multiply the result times 10 feet (orbital diameter) times pi (3.14). the minimum velocity that a moving body (as a rocket) must have to escape from the gravitational field of a celestial body (as the earth) and move outward into space. Discuss how the space shuttle or rocket must achieve escape velocity in order to break free of earth orbit to reach the moon.

Tip: Turning the whole body while swinging the balloon or ball can result in dizziness and falls. You may want to have students swing the satellite object with an overhead lasso motion.



Breaking Free of Gravity

1. Predict what you think will happen if you swing the water balloon in a circular motion, slowly, and then faster and faster.

____

____.

2. How many complete orbits did the balloon make in 10 seconds?

- 1st person: ______________
- 2nd Person: ______________
- 3rd Person: ______________

3. Repeat: Swing the ball/balloon again three or more times, speeding up slightly on each round, until the balloon or ball breaks loose from the clothes pin. In each round, write down how many complete orbits did the balloon made in 10 seconds.

	Round Two	Round Three	Round Four
1st person:	______________	______________	______________
2nd Person:	______________	______________	______________
3rd Person:	______________	______________	______________

4. Calculate the escape velocity of each person's satellite planet or rocket using the following formula: Divide the number of orbits at the final speed (round 4) by 10 seconds. Then multiply the result times 10 feet (orbital diameter) times pi (3.14).

   Sample: 25 orbits ÷ 10 = 2.5 orbits per second 2.5 x 10ft = 25 25 ft x 3.14 = 78.5 feet per second is the escape velocity.

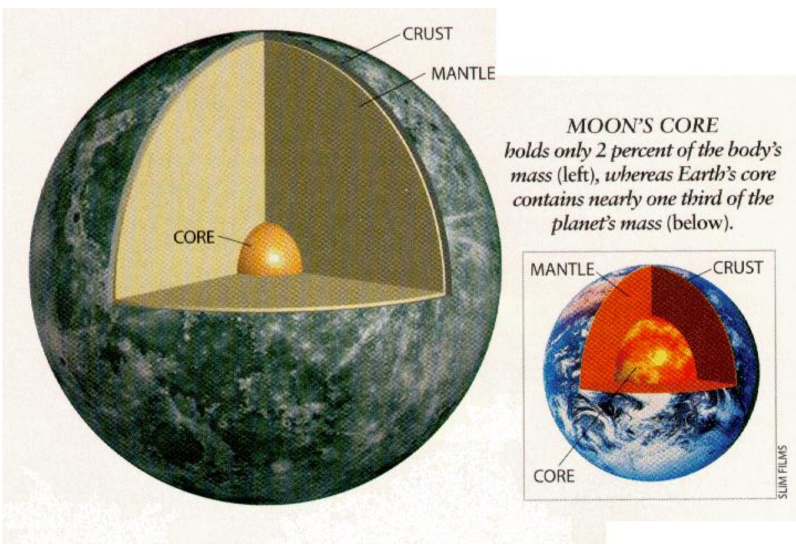
- 1st person: ______________
- 2nd Person: ______________
- 3rd Person: ______________

Layers Upon Layers

Rigid lithospheric mantle:
This rocky layer is not hot enough to flow like batter, or move, like some of Earth's layers do. This hard shell is about 620 miles (1,000 km) thick.

Non-rigid mantle:
Only the deepest parts of this asthenospheric layer (rock which is less rigid (stiff and hard) than in a lithosphere, the layer right on top, but is still rigid enough to transmit seismic waves, what we call earthquakes, but would be moonquakes there) are hot enough to flow, the rest of it can't move. It's semi-solid, rather like very thick jello.

Core:
The non-fluid core may be composed of iron-rich rock, scientists aren't sure. The moon's core is really small, it contains only about 2-4 percent of the Moon's total mass; but even so, this tiny core is probably about 225 miles (360 km) in diameter).



This small, non-fluid core does not create much of a magnetic field; the moon's magnetic field is about one ten-millionth of the Earth's magnetic field. A compass wouldn't work on the moon, (show students a compass and how the needle always points north) since there isn't any magnetic north for the magnet in the compass to point to, but since the sky is always dark (because there is no atmosphere), you could navigate by looking at the stars.

Moon rocks brought back by astronauts show that things haven't always been this way though. When scientists study the layers of the rocks they can see, from how the rocks formed and the different layers in them, that the moon used to have a hot, molten core that made a magnetic field. The moon's magnetic field was probably about one-fiftieth as strong as Earth's current field, but that's still a lot stronger than it is now! The discovery is consistent with the theory that our moon was born when a giant asteroid (remember the huge rocks that move throughout our solar system?) barreled into Earth and broke off chunks that clustered together to become an orbiting satellite. The finding also supports the argument that it's important to send trained humans, and not just robots, to visit alien worlds. It was astronaut Harrison "Jack" Schmitt, the only geologist ever to walk on the moon, who hand-selected the specimen that led to this discovery.

Peeling Back the Layers Activity

Materials: per group

- 4 pack of Play Doh
- Rulers
- Plastic knives
- Silver glitter

1. Divide the students into groups of four and give each group a 4 pack of Play Doh. *For the following layers have the students press the clay into their hands to the proper depth and then wrap the clay around the previous layer.*
2. When students make the initial ball of green clay it is only .2" to represent the core.
3. Flatten a piece of blue clay .5" thick to represent the asthenosphere and surround the green clay core with the .5" thickness of blue clay.
4. Flatten a piece of red clay 1" thick, this will represent the lithosphere. Surround the blue clay with the 1" thickness of red clay.
5. Flatten a piece of yellow clay .1" thick, this represents the crust. Surround the red clay with the .1" thickness of yellow clay.
6. Add some silver glitter to represent the regolith, not too thick as it is only 100 meters thick, which would be .01"
7. Create some lowlands (maria), highlands, and craters.
8. Students will use the plastic knife to cut a triangle into the clay to remove a 1/8 section of the Moon to see the layers.

The Surface of the Moon

We all know that the moon has craters, we can all see some of them, even from Earth. But, did you ever stop to think how those craters were formed or that there are craters right here on Earth. Impact craters are geologic structures formed when a meteorite, asteroid or comet smashes into a planet or other solid body. All the terrestrial planets and satellites have been bombarded throughout their history. To us the most obvious examples of these impacts are the craters on the Moon. If the Moon is visible, craters are visible. You can only see the very large craters or basins with the naked eye. Lunar craters were not described until after Galileo used one of the first telescopes to look at the Moon. Modern binoculars help to make the craters on the Moon very obvious.

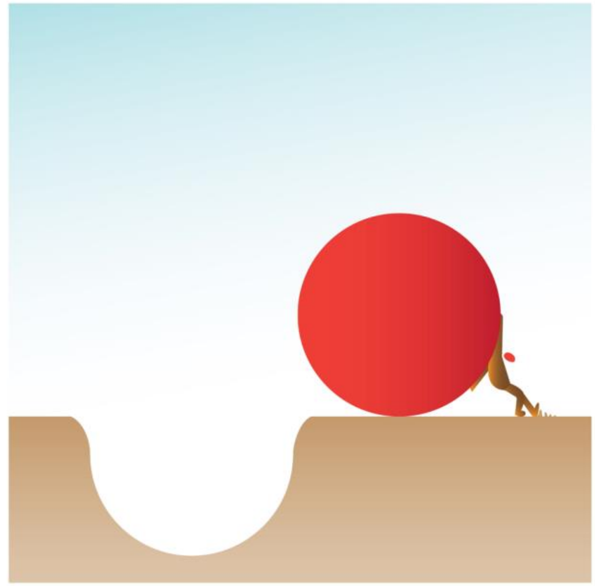
Most of this material is very small compared to the asteroid- sized objects that hit the Earth and Moon billions of years ago. On the Earth, dynamic geologic forces have erased most of the evidence of its impact history. Weathering, erosion, deposition, volcanism, and tectonic activity have left only a small number of impacts identifiable. Approximately 140 terrestrial impact craters have been identified. These impact craters range from about 1 to over 200 kilometers in diameter and from recent to about two billion years in age.

Most of the material which hits Earth burns up in the atmosphere before it ever reaches the ground. However, once in a while a piece of this outer space material makes it all the way to the ground and forms a crater. Meteor Crater in northern Arizona is a good example of an impact crater *(see photos)*

The Moon however, is literally covered with craters. Why isn't Earth? Most of the craters on Earth and the Moon were made billions of years ago. Since that time water and wind on Earth have eroded the craters, wiped them away. Only those craters that were formed a few thousand years ago can be seen today. The Moon however, doesn't have an atmosphere and therefore no wind or water. So, the craters from billions of years ago have remained essentially undisturbed and the Moon looks the same today as it did millions of years ago.

- Impact craters are caused when an impactor collides with a planet or moon.
- A crater's size and features depend on the mass, velocity, and incoming angle of the impactor.

- Impact craters provide insights into the age and geology of a planet's surface.
- Models — such as those the children are using here — can be tools for understanding the natural world.



Tell students they will making their own craters in much the same fashion as real craters are formed (except their craters will be very small compared to the ones you can see on the moon). Note: There is one feature of a crater that can't be reproduced in this exercise the central peak of some larger craters. This is caused by the heated, molten material from the impact splashing up and hardening before it has a chance to settle in the bottom of the crater.

Materials

For each team of 3 to 5 children:

- A large pan or box such as a dish pan, aluminum baking pan, or copy paper box lid (larger pans allow children to drop more impactors before having to re-smooth or resurface)
- Enough sand, sugar, rice, or oatmeal to fill the pan about 4 inches
- Enough flour to make a 1"- to 2"-deep layer
- 1 heaping cup of powdered cocoa
- A large trash bag or piece of cloth or plastic to place under the crater box
- Several objects that can be used as impactors, such as large and small marbles, golf balls, rocks, bouncy balls, and ball bearings. Use your imagination! *(Option: use steel marbles or ball bearings, small pebbles, pellets or BB's that can be removed with a magnet so that your craters remain undisturbed)*
- Ruler
- Paper and pencil
- Images of lunar craters (http://www.lpi.usra.edu/education/explore/LRO/activities/craterCreations/Lunar_Crater_Images.pdf)
- Safety glasses

Preparation

- Print out the images of lunar craters.
- Prepare an area large enough to accommodate the crater boxes for the number of teams participating. Allow several feet between each box.
- Prepare the appropriate number of crater boxes:
- Fill a pan 4 inches deep with sand, sugar, rice, or oatmeal.
- Add a 1- to 2-inch layer of flour.
- Sprinkle a thin layer of powdered cocoa on top of the flour (just enough to cover the flour, you do not have to cover the entire top thickly with this powder. You just need a light dusting). *(This represents the Moon's layers with its lighter material beneath a thin layer of darker volcanic remains.)*
- Provide several impactors, a ruler, and images of craters beside each box.

1. Show the images of lunar craters to the children and invite them to describe what they see.

- What shape are they?
- How can they use the light and shadow to determine the shape and features of the craters?
- Can they find some craters on top of each other? Which were formed first? Which were formed later? Do the edges of the more recent craters look different than those of the older ones?

2. Divide the children into groups of 3 to 5 and have each group stand by a box after discussing proper experiment behavior (This lab can get a little messy if not properly supervised.) Invite them to begin experimenting by having them each select one impactor to drop and determining from what heights they will drop them (remind them to not throw their impactors). What do they think will happen when an impactor — a heavy object — is dropped into one of the boxes? Have each team drop their impactors one at a time.

- What do they observe?
- Does the feature that was created look like any of the features they observed on the surface of the Moon? *They look like craters — roughly circular depressions on the surface of a planet or moon.*

- How are they similar? Different? *Some similarities include the circular shape and depression, and the material that is excavated from the crater and forms a rim — the ejecta. Long bright streaks — rays — probably extend out from the crater they created. Some differences include the fact that the impactor is still present in the model.*

After each crater creation, ask them to carefully remove their impactors to make the craters clearly visible. (In reality, impactors are completely — or almost completely — obliterated upon impact; any remains of the impactor are called "meteorites.")

3. Now, taking turns, let the children experiment with creating craters! Have each group conduct an experiment by changing one variable to see how it affects impact crater size. Experiments could explore different impactor sizes, weights, distances dropped, or angles of impact. For example, one group could drop the same impactor from different heights (modeling different velocities of the incoming impactors), and another group could experiment by dropping different-sized impactors from the same height. If the children want to experiment with angles of impact they will need to throw (but not too hard) the impactors at the box; caution should be used to make sure no one is standing on the opposite side of the box in case the impactors miss. Invite the children to predict what will happen in their experiments. Have the children measure and note the width and depth of each impact crater formed in their experiments, identifying the parts of the craters using the following terms: rim, ejecta, impact crater.

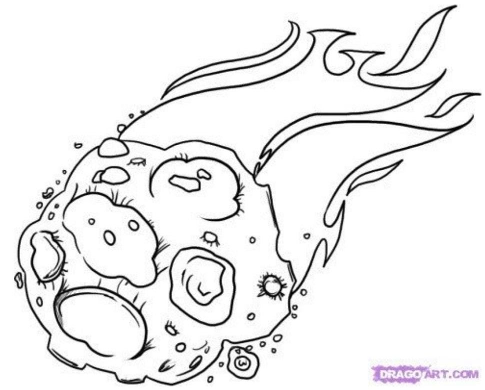
4. Have students compare the crater from an object dropped from a low point with the crater from a fast moving object. After students practice a bit, have the students leave the room and make several craters. Then have the students come back and see how much they can figure out by looking at the patterns. Trade jobs and have the students make craters for you to observe. Then, as a group, look at some of the photos of the moon craters and see what they can figure out from them.

- What did the groups observe?
- How did the weight of objects affect the size and depth of the crater you created?
- How did the size of the object affect the size and depth of the crater?
- How did dropping or throwing the impactors from different heights affect the sizes and depths of the craters they formed?
- The powder represents the planet's surface. Any material beneath the top layer must have formed at an earlier time (making it physically older).
- If you were to examine a crater on the Moon, where would you find the older material?
- Where would you find the younger material? Why?
- What effect did the time intervals have on crater formation? Why?

Conclusion

Have the children reflect on what they observed and the images of lunar craters.

- What features did the children create in their models? *Impact craters.*
- Where do you find the thickest ejecta?
- How do they think the crater rim formed?
- How do the children think the craters on the Moon formed? *By large impactors — asteroids or comets — striking its surface.*
- Scientists have not actually seen any large asteroids or comets hit the Moon, but they think the large craters on the Moon — and on other planets and moons — were created by them. Scientists have observed very small asteroids hitting the Moon and Earth.



Creating Craters!

1. How do you think the craters on the Moon were formed?

   ____

2. Why doesn't Earth's surface have lots of visible craters? _______________

   ____.

3. Describe each crater after you test the following. Note the width and depth of each impact below. How are they similar? Different?

   Low height: from _________ (inches/cm)

   Crater Width: ___________(inches/cm) Depth: _____________(inches/cm)

   Description: ____

   Higher height: from _________ (inches/cm)

   Crater Width: ___________(inches/cm) Depth: _____________(inches/cm)

   Description: ____

   Rapid impactor:

   Crater Width: ___________(inches/cm) Depth: _____________(inches/cm)

   Crater Description:____

   Heavy impactor: weight _________ (grams/oz)

   Crater Width: ___________(inches/cm) Depth: _____________(inches/cm)

   Crater Description: ____

   Light impactor: weight _________ (grams/oz)

Crater Width: ___________(inches/cm) Depth: _____________(inches/cm)

Crater Description: ____

4. Compare the crater from an object dropped from a low point with the crater from a fast moving object. What is the difference?

   ____

   ____

5. How did the weight of objects/impactors affect the size and depth of the craters you created?

   ____.

6. How did the size of the object/impactors affect the size and depth of the craters?

   ____.

7. How did dropping or throwing the impactors from different heights affect the sizes and depths of the craters that were formed? ________________

   ____.

8. Does changing the angle you throw at change the way a crater forms? __________ Explain: ____

Test your teammates!

Have several of your teammates leave the area and make several craters while they are gone. Then have the students come back and see how much they can figure out by looking at the patterns. Which were made first? Which are the "youngest"? Which were made by heavy or light impactors? Trade jobs and have your teammates make craters for you to observe.

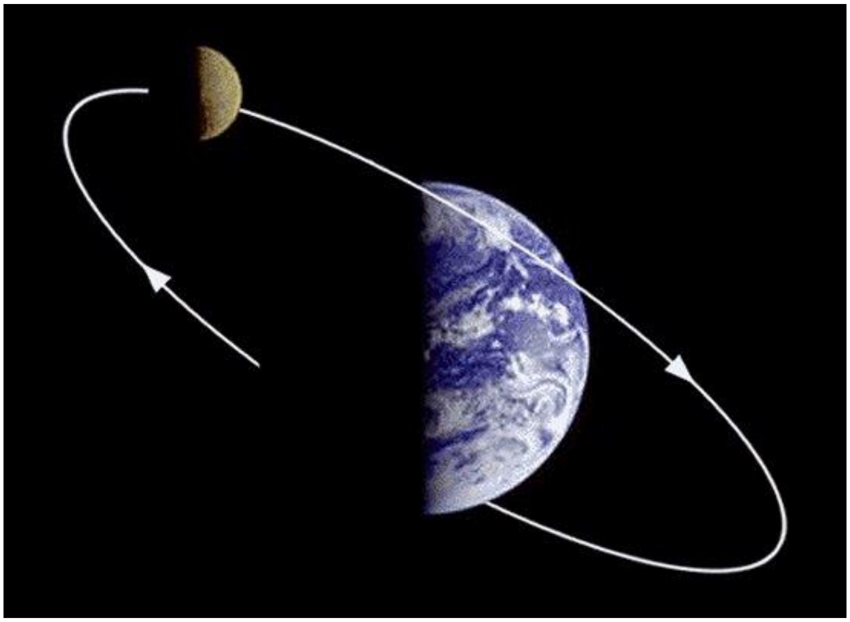
9. How can scientists tell the age of a crater?

   ____

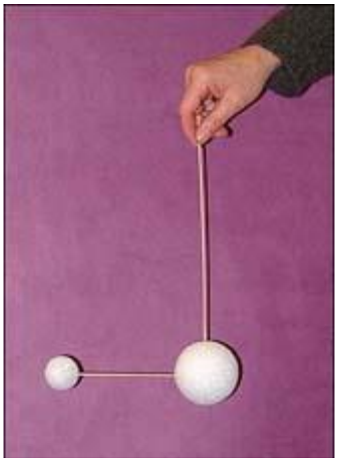
   ____.

Unit 3: Round and Round She Goes

The Moon's Orbit



The moon is about 238,900 miles (384,000 km) from Earth on average. At its closest approach (the lunar perigee) the moon is 221,460 miles (356,410 km) from the Earth. At its farthest approach (its apogee) the moon is 252,700 miles (406,700 km) from the Earth.
The Moon's orbit is expanding over time as it slows down (the Earth is also slowing down as it loses energy). For example, a billion years ago, the Moon was much closer to the Earth (roughly 200,000 kilometers) and took only 20 days to orbit the Earth. Also, one Earth 'day' was about 18 hours long (instead of our 24 hour day). The tides on Earth were also much stronger since the moon was closer to the Earth and had a stronger pull.
Saros- The saros is the roughly 18-year periodic cycle of the Earth-Moon-Sun system. Every 6,585 days, the Earth, Moon and Sun are in exactly the same position. When there is a lunar eclipse, there will also be one exactly 6,585 days later.



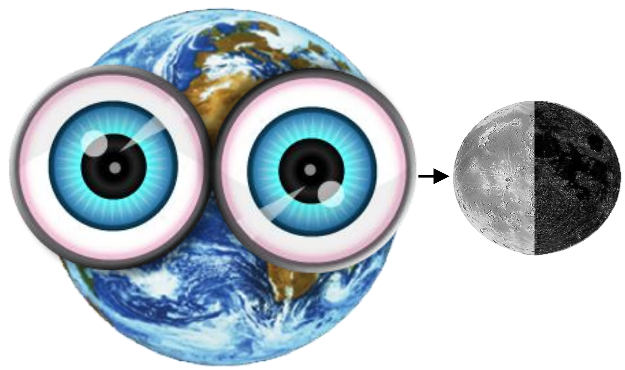
Demonstrate orbits:

Cut or break a 12-inch skewer in half and place a 1 1/4-inch styrofoam ball on a 6-inch skewer. Insert the other end of the skewer in a 3" styrofoam ball (representing the Earth) at the approximate "equator" (i.e. perpendicular to the longer skewer). Rotate the long skewer counterclockwise to demonstrate the spin of the Earth and the Moon orbiting the Earth. Note: Remind your students that the model is not to correct scale or distance. Extension: While turning the Earth/Moon model, walk counterclockwise around the Sun to demonstrate that the Earth is rotating, that the Moon is revolving around the Earth, and that both are revolving around the Sun.

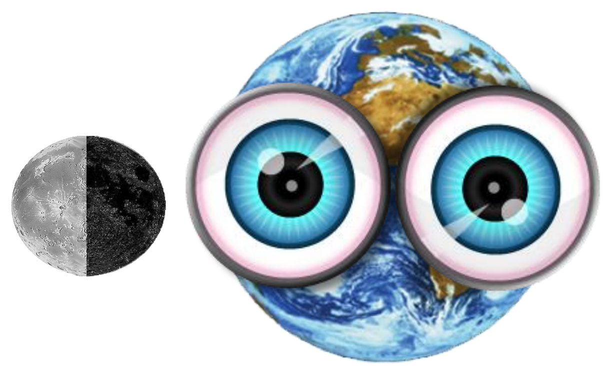
Explain to students that the motions they see demonstrated happen as a cycle and that the rotating and revolving never stop! Explain again that it takes a day and a night for the Earth to make one entire rotation and that it takes a whole year for the Earth to complete its long orbit around the Sun.

Why do we always see the same side of the moon?

Because the Moon is also orbiting around the Earth and rotating on its axis, [a straight line down the middle of an object, about which the object rotates] it's called a synchronous rotation with the Earth, that means the Moon spins on its axis in the same time it takes it to orbit Earth. The moon takes approximately 27.322 days to orbit all the way around the Earth. It takes the same amount of time for it rotate on its axis. So, by the time we see the Moon again, after the New Moon, it has spun all the way around, so we see the same side we saw last. If the Moon didn't rotate [spin] about its axis, here's what would happen. One side would be facing us right now; two weeks later, when the Moon has gone halfway in its orbit around the Earth, the opposite side of the Moon would be facing us. Here's a picture: *(Draw the following illustrations on the board for students)*

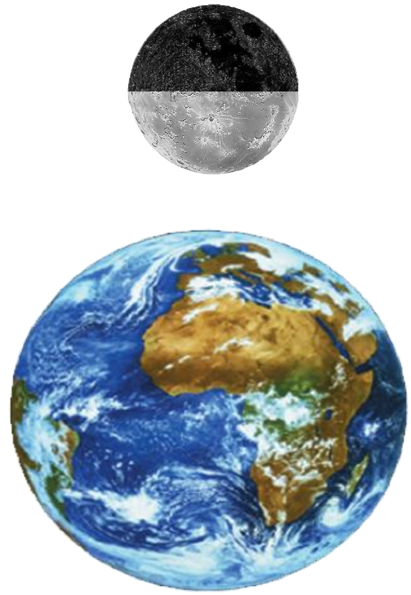


After the Moon has gone halfway in its orbit around the Earth, if the Moon didn't spin on its axis, the picture would look like this:



Notice that we on the Earth would now see the opposite side of the Moon (the Earth sees the lightly colored side, but it sees the darkly colored far side in the second picture).

What really happens is that the Moon is rotating on its axis; it spins all the way around once a month, exactly the same length of time as it takes to orbit the Earth. So, after half an orbit around the Earth, the Moon has also spun one-half of a revolution about its axis. The correct second picture looks like this:



Now the Moon has rotated 180 degrees, so the Earth still sees the light side of the moon.

Here's another picture. After one-quarter of an orbit (about one week after the original picture), the Moon has rotated 90 degrees on its axis, and it looks something like this:

Once again, the light side of the moon is facing the Earth, but it took an appropriate amount of rotation of the Moon about its axis to keep the near side facing the Earth.

So the Moon rotates about its own axis in the same length of time that it takes to orbit the Earth. That's what keeps the same side of the Moon always facing the Earth.

It's All About Perspective

Materials:

- Basketballs (or other equivalent)
- Tape
- Pencils
- Flashlights
- Journals

1. Divide the class into groups of 3s.
2. Put a piece of tape on the basketball and try to make the room as dark as possible.
3. One student will be the Earth. This person will stand in place.
4. A second student will be the Moon. This person will hold the basketball and stand about 2 meters from the Earth. This person must make sure that the piece of tape is always facing the Earth.
5. The third student will be the Sun. This person will stand about 4 meters from the Earth and shine the flashlight on the Moon.
6. The Moon will then slowly orbit the Earth taking care to keep the piece of tape always facing the Earth.
7. The Earth will make a note of the pattern of the shadow on the Moon. Making a brief sketch of the Moon every quarter revolution on the included student sheet.
8. The person representing the Sun should make note that he/she sees all sides of the Moon while the Earth only sees the side with the piece of tape on it.

9. The students should realize that from the Earth's perspective, the Moon doesn't appear to rotate.
10. However, from the Sun's perspective the Moon does rotate once each month.
11. Have groups compare findings and connect findings to the phases of the moon.
12. Using the included sheet, have students create a chart showing where the moon and sun are in relation to each other at different phases.

It's All about Perspective

1. In the circles below, sketch what the shadow on the moon looks like every quarter revolution:

2. The Sun sees how many sides of the moon? ____________________ side(s)

   Explain: ____

3. From the Earth, we see how many sides of the Moon? ____________________ side(s).

   Explain: ____

4. From the Earth's perspective, the Moon ________________ appear to rotate.

   Doesn't Does

   Explain: ____

   ____.

5. From the Sun's perspective, the Moon _________________ appear to rotate.

   Doesn't Does

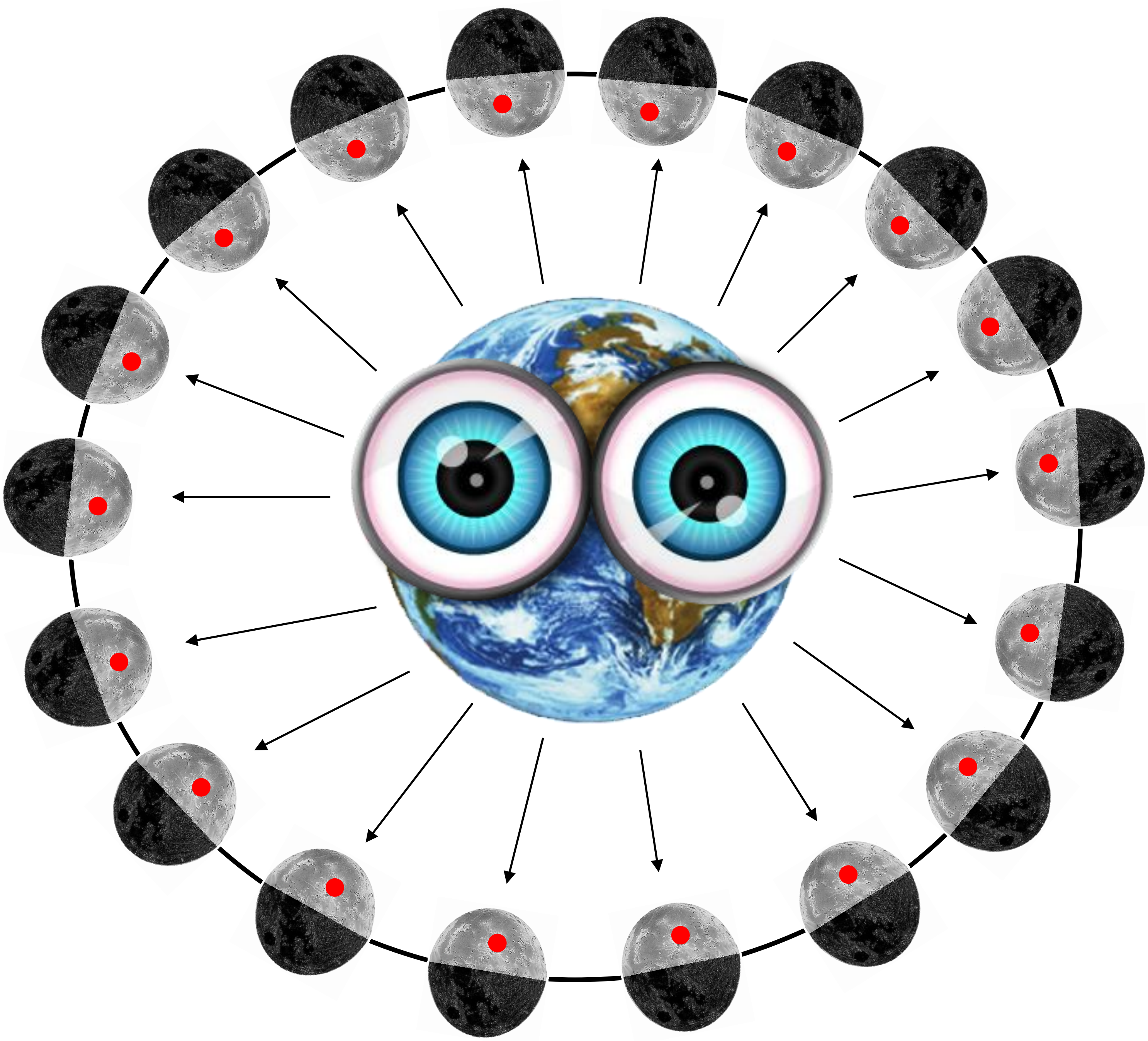
   Explain: ____

   ____.

6. On the back of this sheet, create a chart showing where the moon and sun are in relation to each other at different phases.

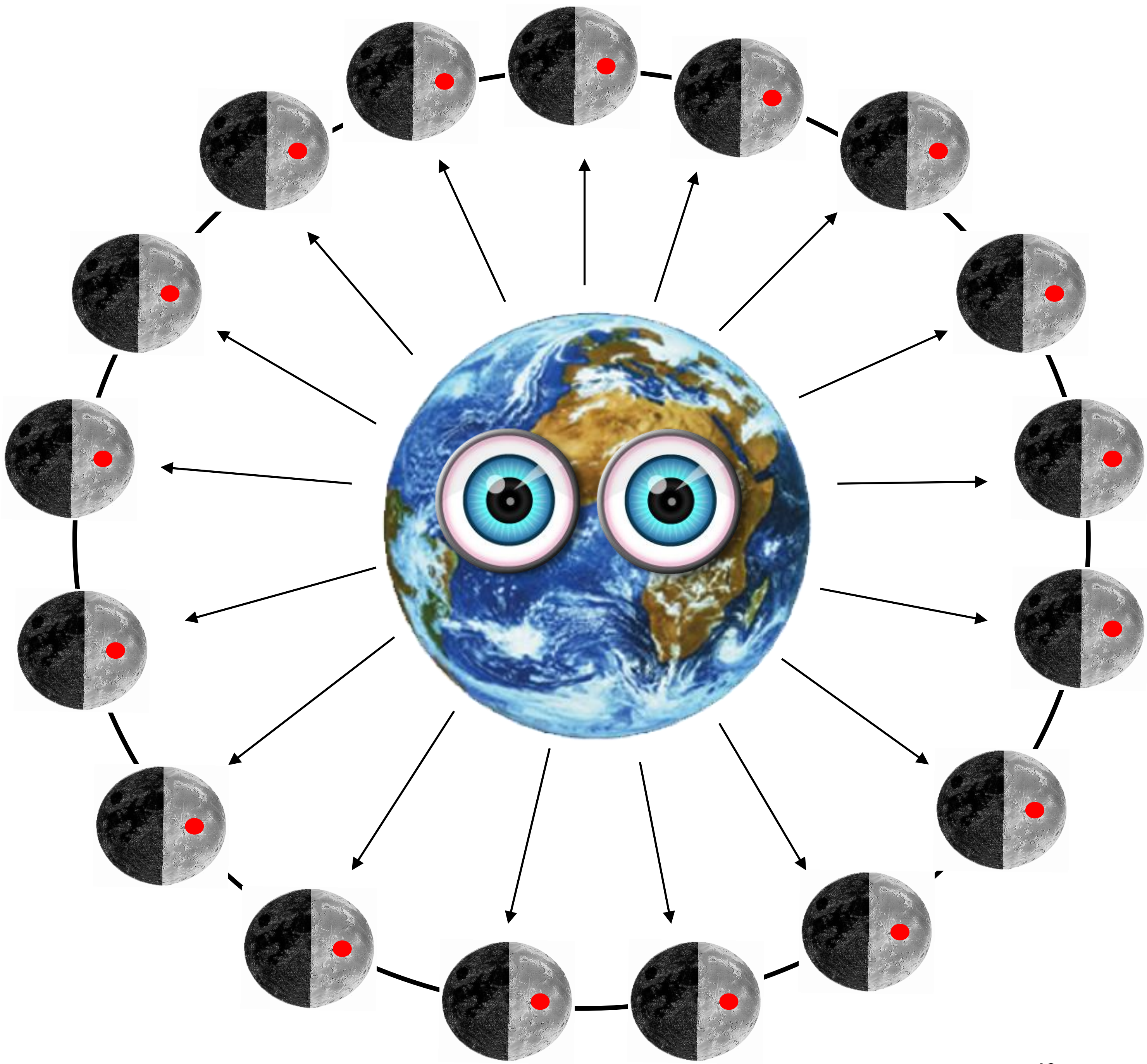
Moon Orbit: With Rotation

Because Earth and the Moon both rotate, we only see one side of the Moon.



Moon Orbit: Without Rotation

If Earth spun and the Moon held still, we would see all sides of our Moon.



What if we didn't have the Moon?

Sometimes you might hear stories or rumors about scientists thinking about deliberately blowing up the moon with an eye towards stabilizing the Earth's climate and giving everyone on the planet really nice weather all year long, or for some other reason. In case you're thinking that might be a good idea, let's see what the world would really be like without that Moon.

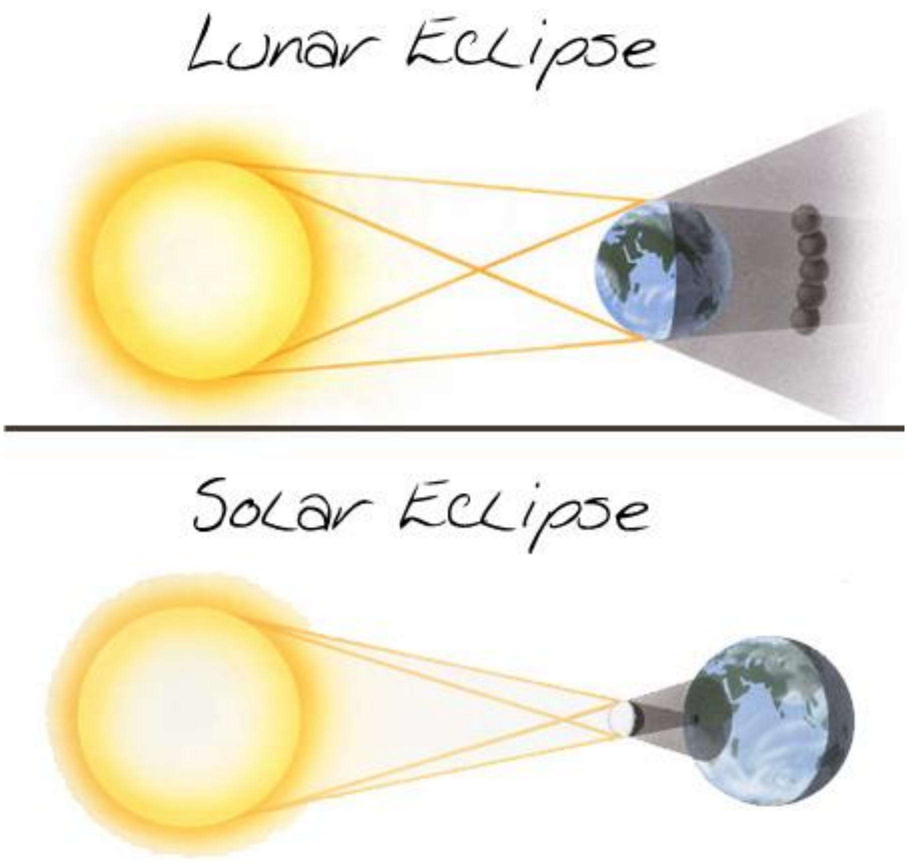
We often take the Moon for granted. We assume it will always be there. Circling the Earth month after month with regular precision. But what would our world be like if we didn't have a moon? No Moon. And here's the bad answer… No Earth as we know it! The length of the day, the tilt of the planet, the number of meteors impacting the surface are just a few of the things that would all be vastly different if the Moon did not exist.

Yes that is correct. Without the Moon, life on Earth would not be life as we know it.
The first thing that would be different are eclipses. They would be no more. No more solar eclipses, no more lunar eclipses In fact there would be no more solar eclipses anywhere in the solar system. The earth is the only planet where, from the surface of the planet, one of the planet's moons seems exactly the same size as the Sun and can just cover it, causing an eclipse. Lunar eclipses occur when the Earth is between the Sun and the Moon and the Moon is in the shadow of the Earth. Is this what the children are demonstrating? A solar eclipse occurs when the Moon is between the Sun and Earth.

Ask the children how they think a lunar eclipse happens. What has to happen? (The Moon, Earth, and Sun have to be in a line so that the shadow of the Earth "covers" the Moon)

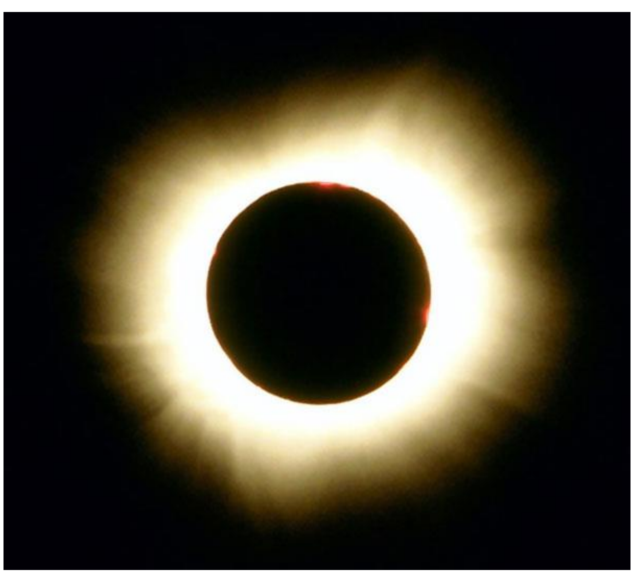
Remind the children that Earth goes around our Sun. Likewise, our Moon goes around Earth. However, the Moon's orbit is tilted a little to Earth's plane (by about 5 degrees) and is a bit elongated, making an oval-shape — an ellipse.

Every month the Moon moves around its inclined plane. As the Moon orbits Earth, it only intersects Earth's orbital path at two points — or twice each month (think of two crossed Hula Hoops; there are two places they touch). These two times are the only times when Earth, the Moon, and the Sun are in the same plane.



In order for an eclipse to occur, the Earth, Moon, and Sun must be in the same plane, lined up, and the Moon must be in the position of a full Moon (lunar eclipse) or a new Moon (solar eclipse). Most of the time during the full Moon — when a lunar eclipse is possible, the Moon is a little above or a little below Earth's shadow — it misses the shadow and we see the full Moon. Occasionally, the Earth and Moon and Sun are aligned so that the Moon is in Earth's shadow, and then we see a lunar eclipse.

The Moon's plane of orbit stays oriented in nearly the same direction in space as it moves with Earth around the Sun once a year. With this orientation, the geometry is correct for the Sun, Earth, and Moon to be in the same plane at the same time the Moon is in full or new phase twice a year.



However, eclipses vary in timing from year to year. This is because the Moon's elliptical plane of orbit shifts or turns a little each year, moving the timing of eclipses.

Do –It-Yourself Solar Eclipse

Your young astronomers can create a solar eclipse in just a few seconds using easily found materials (including their own faces)! This experiment demonstrates how a small celestial body like the moon, can obscure the light from a much larger one, such as the sun. Invite your students to recreate this fantastic phenomenon by using a flashlight to represent the sun, a quarter as the moon, and their face as Earth!

What You Need:

- Flashlight
- Quarter

What You Do:

1. Either hold the flashlight for your student, or have him place it on a surface at his eye level.
2. Aim the flashlight at the right side of her face.
3. Have your student hold out the quarter in front of her face.
4. Turn the flashlight on.
5. Have your student position herself so that the quarter is directly between the light and her face. She may have to adjust the position of any of either of the instruments involved.
6. Eclipse time! Experiment with both full and partial solar eclipses, where the moon comes between Earth and the sun, and either fully or partially obscures the light from the sun.

Did You Know?

The last total eclipse, which took place in July 2009, was visible from China. Although it only lasted six minutes, Chinese astronomers used 17 observation locations to photograph the corona (the sun's extended outer atmosphere) for over 40 minutes. Normally, the corona is difficult to see because the sun is so bright.

In order to see two total eclipses from the same spot on earth, you'd have to wait about 375 years. Because of their rare and dramatic nature, eclipses are still often greeted with fear and superstition.

There would be more consistently dark skies for astronomical observing if there was no moon. Astronomers would still have to compete with human created light pollution. Plus, it would be a lot harder to see at night! Starlight wouldn't be very bright in comparison.

If we had no moon there would be no tides. Well not exactly. There would still be tides; they would just be smaller. Both the Sun and the Moon create tides on the Earth. There are two high tides and two low tides each day.

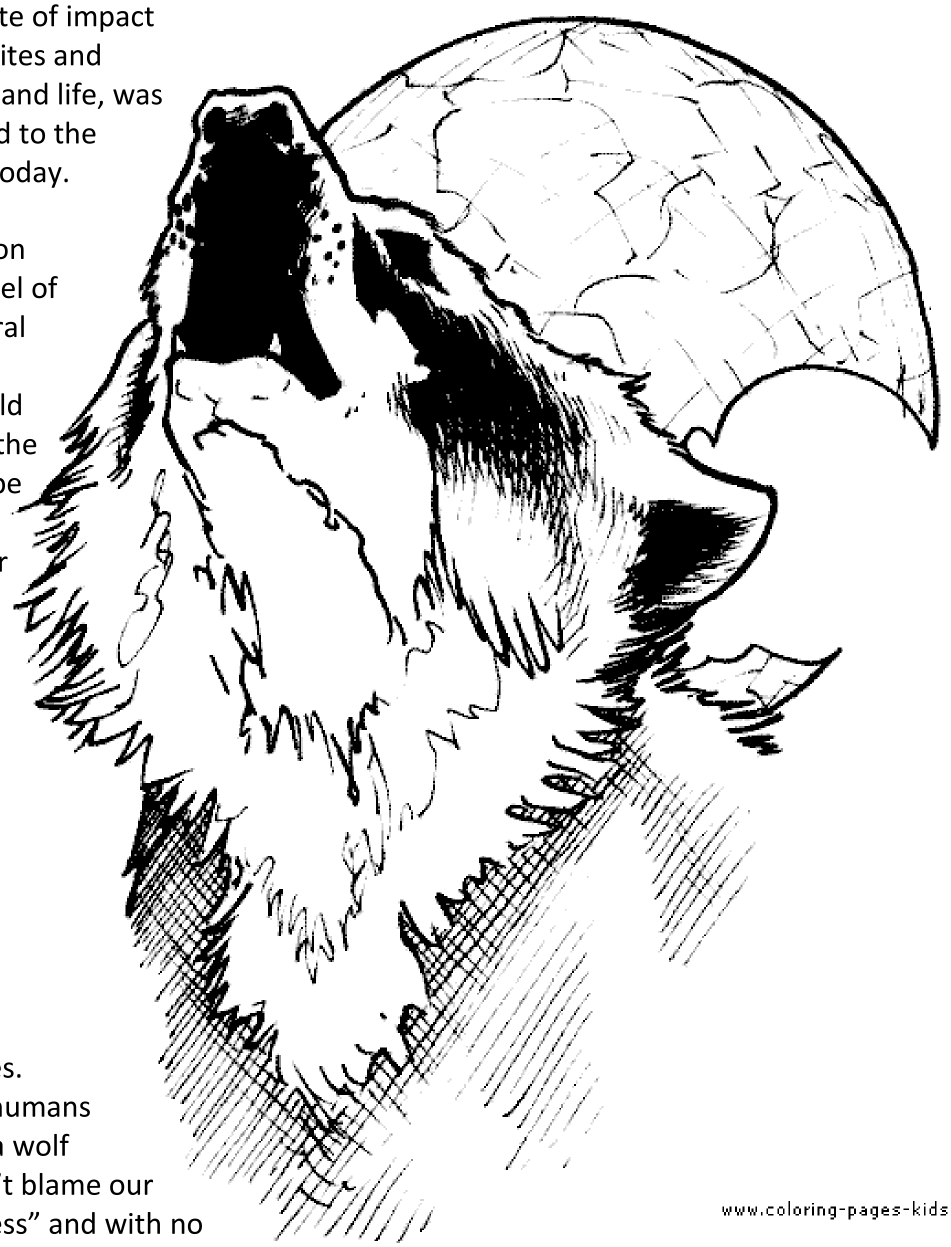
Tides occur because the gravitational force between two bodies decreases with distance. Gravity tugs on nearby objects more strongly than on distant objects. The oceans on the side of the Earth closest to the Moon feel the greatest attraction to the Moon (and to the Sun). Being fluid, the nearby oceans move upward in response to the Moon's pull, until there is a balance between the upward force from the Moon and the downward force from the Earth. The high tide on the far side of the Earth occurs because the oceans on the side of the Earth farthest from the Moon feel less gravitational attraction to the Moon. They are left behind as the Moon pulls the other parts of the Earth toward itself with greater force.

Thus, if we had no moon we would still have tides thanks to the smaller pull from the sun. But, they would be simpler. And they would not be as strong. So less nutrients would land on our shores and less food washed in for fish. The movements of the tide have always created special environments on Earth. Many life forms have developed in these tidal pools and basins. Without tides, the kinds of plants and animals on Earth would be quite different than those we know today. So we can safely say that life forms would have been different at all times of Earth's history.

The tidal effects of the Moon and, to a much lesser degree, the Sun have lengthened the day from six hours to 24 hours, they slow down how fast the Earth spins. So if no Moon, the Earth would be spinning a lot faster, instead of a 24 hour day, we would have an eight-hour day at present time with no Moon. Not good for life on Earth! The faster a planet rotates, the faster its winds blow. The Earth would be rotating once every eight hours, so 100 mile per hour wind speeds would not be unreasonable to expect. Hurricanes would have even higher wind speeds.

Have students try to imagine what life would be like with only three to four hours of very windy sunlight each day. Of course life would have evolved to fit the conditions of a shorter day. It just might not have included humans. There are so many things we don't get done during a 24 hour day, let's not even speculate how little could be accomplished in an 8 hour day.

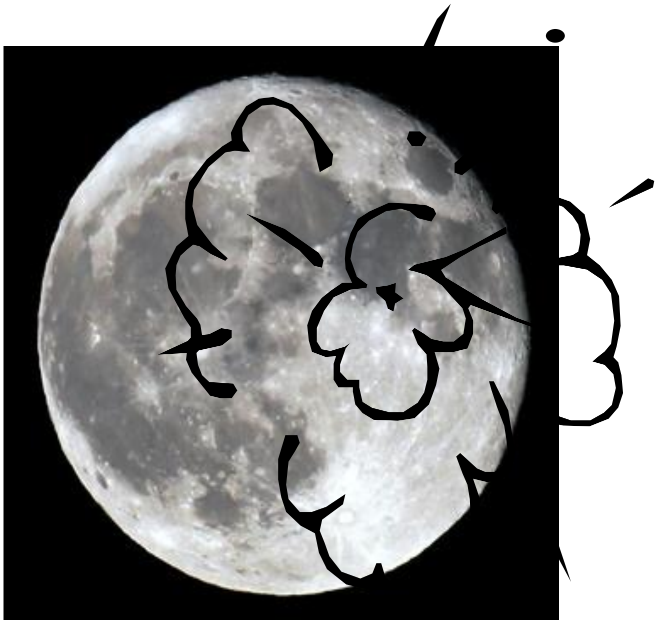
Let's not forget that the mere presence of the Moon caused less life ending impacts to occur on the Earth. Without the Moon's helpful goal keeping, keeping harmful things away, by letting them hit it instead of us, the Earth would have experienced a much higher rate of impact from space debris like meteorites and asteroids as the solar system, and life, was forming. Which might have led to the absence of humans on Earth today.



And even if humans did exist on this wildly rotating, wind tunnel of a planet, think of all the cultural references to the Moon that would not exist. The cow would have nothing to jump over in the poem and we wouldn't even be able to call things the same names. The word month, after all, comes from a word that means moon – because many calendars are based on the changing phases of the moon. So, the word "month" would not exist. With no Moon as a reference, there could be no lunar calendar. Time keeping would be more difficult. The Sun would be the next best reference point.

There would be no lunar fables. Gone would be werewolves, humans who change into the form of a wolf during full moons. We couldn't blame our restlessness on "mood madness" and with no moon to travel to, our first foray off the Earth to a distant world would not have occurred. Mars would be the nearest destination. A trip to Mars is a much more complicated three year journey compared to the, although difficult, but much shorter, two week trip to the Moon.

The Moon is good for a whole lot more than simply lighting up the night sky. If students wonder what your life would be like without it, the surprising answer is that you might not be here to wonder at all! So while we often forget it is around, we should take time out every now and again to reflect on how different the Earth would be without our nearest neighbor.



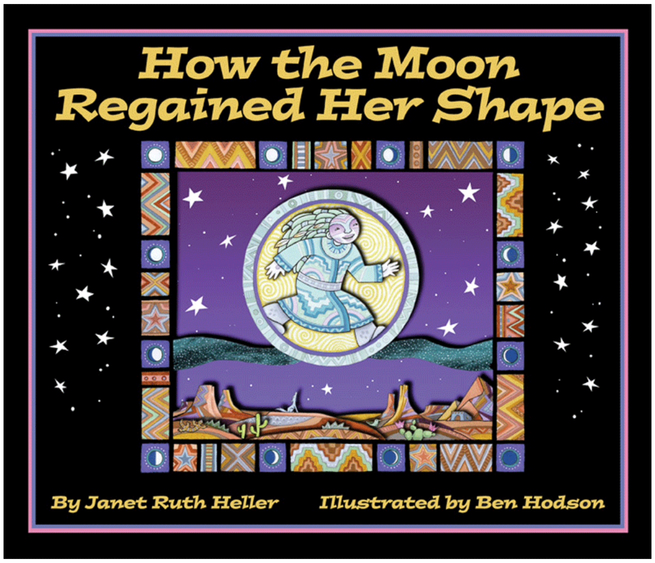
A Moonless Life

1. Without the moon our day would be _______ hours long.
2. Without the Moon's help the Earth would have been hit by many more _____________ and _________________.
3. The ________________ and ___________ slow down how fast the Earth spins.
4. The ________________ is the sun's extended outer atmosphere.
5. Both the Sun and the Moon create ___________________ on the Earth.
6. In order for an _____________ to occur, the Earth, Moon, and Sun must be lined up exactly.
7. ______________ eclipses occur when the Earth is between the Sun and the Moon and the Moon is in the ______________ of the Earth.
8. A solar eclipse occurs when the Moon is _____________ the Sun and Earth.

Word Bank

- Asteroids
- Between
- Meteorites
- Corona
- Shadows
- Eight
- Solar
- Moon
- Lunar
- Eclipse

Unit 4: The Phases of the Moon

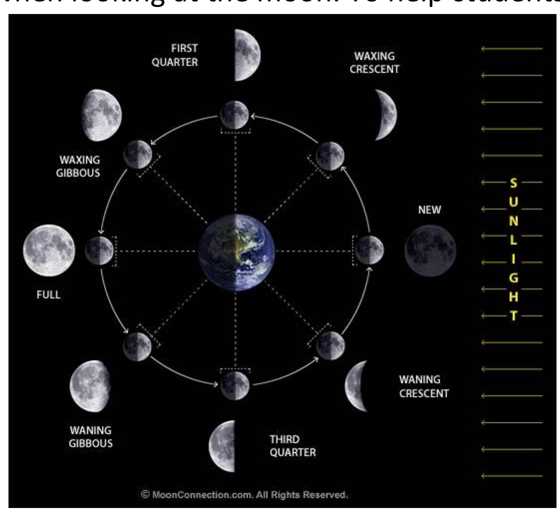


Read a story such as How the Moon Regained Her Shape *by Janet Ruth Heller to introduce the topic of Moon Phases.*

Why does the moon look different on different days? Is it actually changing shape?

A full sheet size is included in the following pages, pass out copies to students and discuss the following. The illustration may look a little complex at first, but it's easy to explain.

Sunlight is shown coming in from the right. The earth, of course, is at the center of the diagram. The moon is shown at 8 key stages during its revolution around the earth. The dotted line from the earth to the moon represents your line of sight when looking at the moon. To help students visualize how the moon would appear at that point in the cycle, you can look at the larger moon image. The moon phase name is shown alongside the image.



One important thing for students to notice, and for you to point out, is that exactly one half of the moon is *always* illuminated by the sun. Of course that is perfectly logical, but students need to visualize it in order to understand the phases. At certain times we see *both* the sunlit portion and the shadowed portion -- and that creates the various moon phase shapes we are all familiar with. Also note that the shadowed part of the moon is invisible to the naked eye; in the diagram, it is only shown for clarification purposes.

So the basic explanation is that the lunar phases are created by changing angles (relative positions) of the earth, the moon and the sun, as the moon orbits the earth. The phases are named after how much of the moon we can see, and whether the amount visible is increasing, or decreasing each day.

It's probably easiest to understand the moon cycle in this order: new moon and full moon, first quarter and third quarter, and the phases in between.

As shown in the above diagram, the **new moon** occurs when the moon is positioned *between* the earth and sun. The three objects are in approximate alignment (why "approximate" is explained below). The entire illuminated portion of the moon is on the back side of the moon, the half that we cannot see.

At a **full moon**, the earth, moon, and sun are in approximate alignment, just as the new moon, but the moon is on the opposite side of the earth, so the entire sunlit part of the moon is facing us. The shadowed portion is entirely hidden from view.

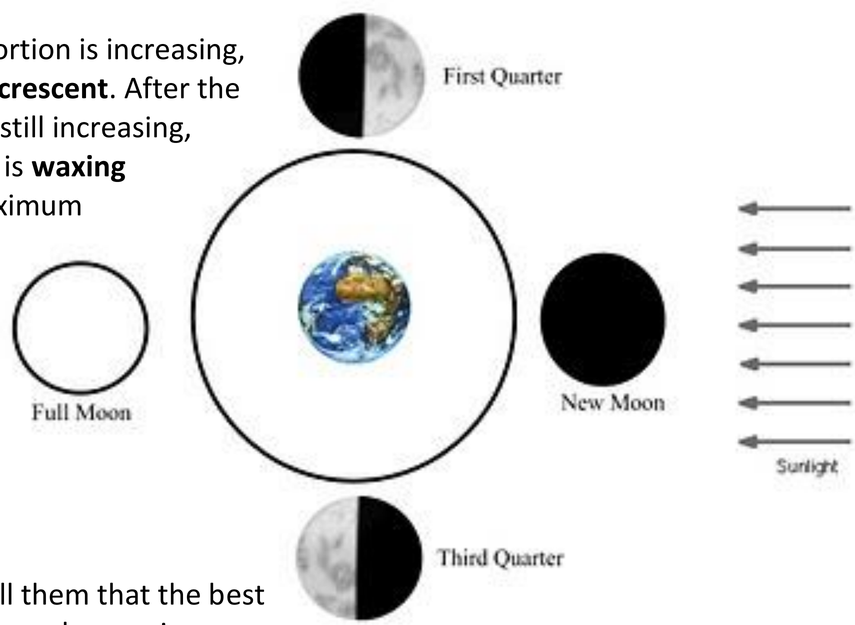
The **first quarter** and **third quarter** moons (both often called a "**half moon**"), happen when the moon is at a 90 degree angle with respect to the earth and sun. So we are seeing exactly half of the moon illuminated and half in shadow.

Once you understand those four key moon phases, the phases between should be fairly easy to visualize, as the illuminated portion gradually transitions between them.

An easy way to remember and understand those "between" lunar phase names is by breaking out and defining 4 words: crescent, gibbous, waxing, and waning. The word *crescent* refers to the phases where the moon is *less* that half illuminated. The word *gibbous* refers to phases where the moon is *more* than half illuminated. *Waxing* essentially means "growing" or expanding in illumination, and *waning* means "shrinking" or decreasing in illumination.

Thus you can simply combine the two words to create the phase name, as follows:

After the new moon, the sunlit portion is increasing, but less than half, so it is **waxing crescent**. After the first quarter, the sunlit portion is still increasing, but now it is *more* than half, so it is **waxing gibbous**. After the full moon (maximum illumination), the light continually decreases. So the **waning gibbous** phase occurs next. Following the third quarter is the **waning crescent**, which wanes until the light is completely gone -- a new moon.



After you finish with the chart, tell them that the best way for them to really see the phases happening, without watching the moon every night, which you don't have time for during class, is with a demonstration.

Materials:

- Lamp (with a single bright light bulb and no shade)
- Tennis Balls (one for each student)
- Slides or pictures showing the different phases of the Moon (optional, but preferred)
- Calendar showing the phase of the Moon when New, First Quarter, Full, and Third Quarter (optional)

Tip: You may be able to get all the tennis balls you need by calling a local tennis or athletic club. Tennis balls wear out and places like this are always throwing old ones away. Tell them who you are and why you need them and you might be able get as many as you can use.

Option: Drill a finger-sized hole in the tennis balls. This will make it easier to hold up for the demonstration. It will also make them less bouncy, in case the children want to play.

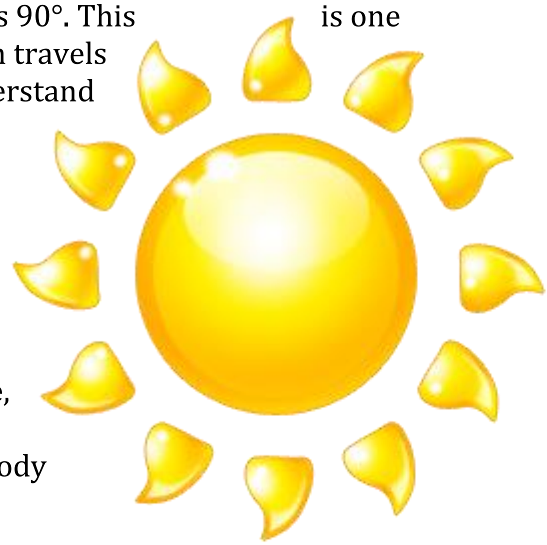
Pass out the tennis balls, one per student. Of course, admonish the class to not bounce, throw, or otherwise play with them. Explain that the tennis ball is the Moon, and your head is the Earth. Set up the lamp at the front of the room and turn it on. This will be the Sun. Finally, turn off all other lights in the room. you are now ready to begin.

NOTE: Your room might not be able to be darkened because it has outside windows or some other reason. If so, you will need to find another place to do this demonstration. It really will not work unless the lamp is the only source of light.

Have all the students look carefully at their Moons. Note how half of the Moon is always lit by the Sun, and half of it is always dark, no matter where it is. Explain that when we see different phases, we are just looking at the lit portion from different angles.

You and your students should do this next part together. Stand and hold up your Moon so that it is between the "Earth" and the "Sun." This is the new moon phase. We see the side of the moon that is currently dark, while the far side of the moon experiences daylight.

Slowly move your arm so that the moon orbits to the left. This is the actual direction that the real Moon travels in as it moves around the Earth. You should see a thin crescent of lit tennis ball appear. This is the waxing (growing) crescent phase. Continue moving the moon to the left, and you will see it change from waxing crescent to first quarter. At this point, the angle between the Sun and the moon, as seen from Earth, is 90°. This is one quarter of a circle, the first quarter of the orbit as the moon travels through its cycle. Make sure that the students see and understand this.



Keep moving your arm to the left. You will go from first quarter through waxing gibbous, to full. You will need to hold the moon up a bit to prevent an eclipse. The moon has now moved through two quarters of a circle. Therefore, you could call this the second quarter moon. Of course, nobody does.

Move on around the orbit. the lit portion of the moon begins to shrink. It will pass through waning (shrinking) gibbous phase to third quarter. Point out that the moon has now traveled through three quarters of its orbit. Finally, orbit your moon through the last part of its orbit. You will see it pass from third quarter through waning crescent phase, and back to new once again.

An Oreo Moon

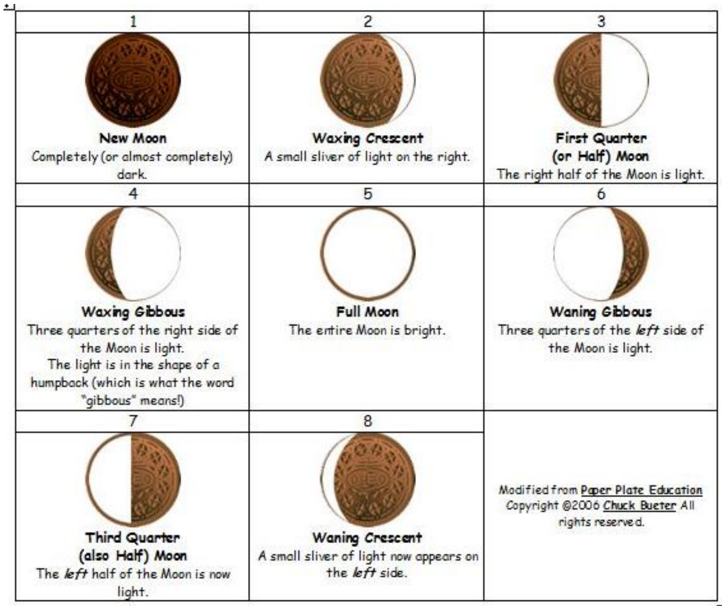
Never has the moon been so immediate, hands on, or delicious as this! Over the course of a month, the Moon passes through different phases, making the part of it we see change shape. The amount of the Moon we see illuminated by the Sun grows from New Moon, to Crescent, to First Quarter, to Gibbous, to Full Moon and then decreases back to New Moon. This activity uses Oreo® cookies to demonstrate the Moon's phases. Reference the charts below.

Materials for each child:

- 8 Oreo Cookies (4 for younger children)
- Paper Towels
- A plastic spoon and/or plastic knife

- Marker (optional)

Halve and scrape the cookies to illustrate Moon phases. Then arrange the cookies on the sheets in linear fashion, beginning with the New Moon and ending with the Waning Crescent Moon, have older students use the blank sheets and fill them in, younger students can use the pre-labeled charts, but must write and describe each phase in the space on the bottom, or on the back of the sheet. You may be familiar with other activities that place the phases in circular formation. This could confuse young children if they attempt to conceptualize the location of the Sun or Earth in relation to the Moon's orbit. Therefore children should first simply learn to match the correct names of the phases with the proper appearance for each phase. With students younger than 8, you may want to model only 4 moon phases, i.e. New Moon (completely dark), Crescent Moon, first Quarter (or Half), and Full Moon. Older students should be able to model all 8 phases, as shown in the chart, or see below.



1	2	3
New Moon Completely (or almost completely) dark.	**Waxing Crescent** A small sliver of light on the right.	**First Quarter (or Half) Moon** The right half of the Moon is light.
4	5	6
Waxing Gibbous Three quarters of the right side of the Moon is light. The light is in the shape of a humpback (which is what the word "gibbous" means!)	**Full Moon** The entire Moon is bright.	**Waning Gibbous** Three quarters of the *left* side of the Moon is light.
7	8	
Third Quarter (also Half) Moon The *left* half of the Moon is now light.	**Waning Crescent** A small sliver of light now appears on the *left* side.	Modified from Paper Plate Education Copyright ©2006 Chuck Bueter All rights reserved.

1

New Moon

Completely (or almost completely) dark.

2

Waxing Crescent

A small sliver of light on the right.

3

First Quarter (or Half) Moon

The right half of the Moon is light.

4

Waxing Gibbous

Three quarters of the right side of the Moon is light. The light is in the shape of a humpback (which is what the word "gibbous" means!)

5

Full Moon

The entire Moon is bright.

6

Waning Gibbous

Three quarters of the left side of the Moon is light.

7

Third Quarter (also Half) Moon

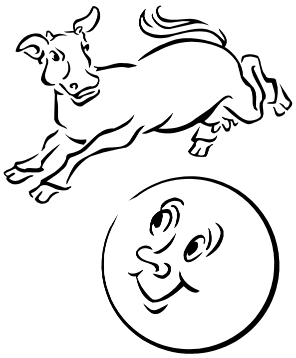
The left half of the Moon is now light.

8

Waning Crescent

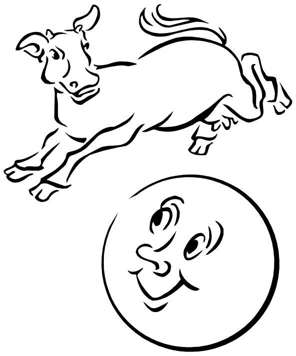
A small sliver of light now appears on the left side.

The Phases of the Moon!



	1: New Moon	2: Waxing Crescent
	Describe:	Describe:
3: First Quarter (Half) Moon	4: Waxing Gibbous	5: Full Moon
Describe:	Describe:	Describe:
6. Waning Gibbous	7. Third Quarter (Half) Moon	8. Waning Crescent
Describe:	Describe:	Describe:

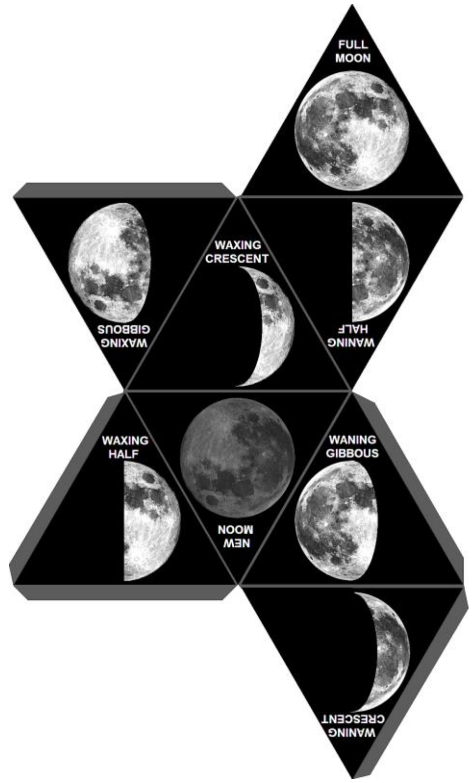
The Phases of the Moon!



	Phase:	Phase:
	Describe:	Describe:
Phase:	Phase:	Phase:
Describe:	Describe:	Describe:
Phase:	Phase:	Phase:
Describe:	Describe:	Describe:

Phase 8! Moon Review

Variations:



1. Roll the blank moon dice (full size in pages below) and have students compete to name the moon phase and/or present a fact about that phase.

2. Have the moon phases (and other lunar related celestial occurrences or objects ex. Eclipse, sun, etc) drawn or scattered across the board. Have students in two groups and give a name of a moon phase. Players race to identify the phase by slapping the appropriate picture of the moon phase on the board with a fly swatter. The student that identifies it first gains a point for their team.

3. Have teams put the pictures of phases of the moon in order starting and ending with the new moon. Remind them that the team that finishes first may not win, as they must be in correct order!

Unit 5: Old Wives Tales and Moon Legends

Note: This unit is optional to be stand-alone or incorporated into all of the above units as you teach them.

The myth that the Moon was made of green cheese, in 1546, The Proverbs of John Heywood claimed "the moon is made of a greene cheese," is only one of the many longstanding fallacies that have surrounded the Earth's only satellite. Some of these will have originated from observations of the land, environment and night-time sky such as in farmers planting by the Moon and in forecasting a higher tide than normal when the moon is low. Other Moon-beliefs may not have such logical explanations.

But after Apollo XI's lunar module reached its surface, enabling Neil Armstrong to become the first person to set foot on a planet other than his own, the Moon could never again exert quite the same hold on human imagination as it did in the past. Even so, throughout the world, superstitions revolve around the Moon.

For instance in parts of Britain, anyone seeking good fortune should bow to the new moon and turn over any silver coins in his pocket. The silver color of the Moon is rumored to have a direct affinity with the silver from which the coins were made. So if a person holds up a coin to a new moon and wishes for money, over the days ahead as the moon "increases" in size, so too will their bank balance!

New projects should be started at the time of the new moon while country-dwellers have long held the opinion that the time of the new moon is the time to plant crops. The full moon pulls the crops upwards from the ground to result in a bumper harvest. It is considered to be better to

plant vegetables which grow underground, i.e. potatoes and carrots, in the dark of the moon and plant vegetables which grow above ground, i.e. corn and beans, in the light of the moon.
Image Credit: http://www.bradleywebdesignstudios.com/graphDsnPrt.html

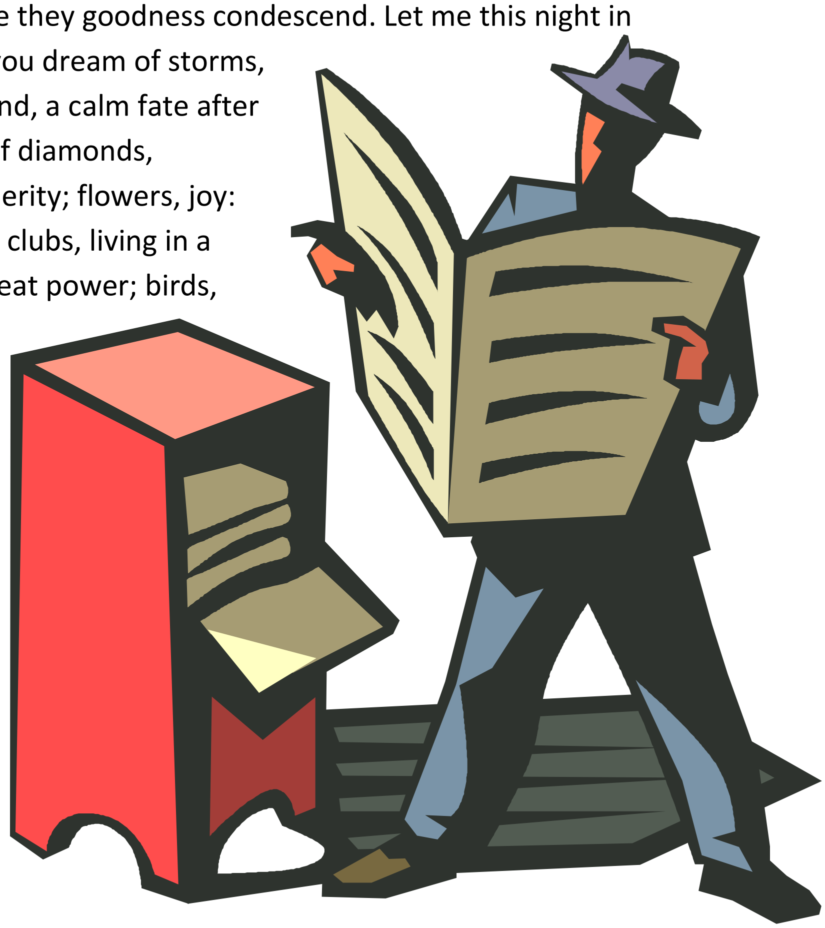
The time of the full moon is also said to be a good time for curing many illnesses.

In Wales, fishermen avoid the Moon line, or the moonlight showing on the water, when setting out to sea; they consider crossing this bad luck. However, in other areas they say to make a wish when crossing the Moon line.

Wood cut at the New Moon is hard to split. If it is cut at the Full Moon it is easy to split.

To the Chinese, the Old Man in the Moon was Yue-lao. It was his duty to predestine the marriages of mortals. They said he tied the future husband and wife together with an invisible silk cord that never parted as long as they lived.

An old English harvest Moon ritual was to gather a key, a ring, a flower, a sprig of willow, a small piece of cake, a crust of bread, 10 of clubs, 9 of hearts, ace of spades, and ace of diamonds. Wrap these in a handkerchief and place it under your pillow. Saying upon going to bed: "Luna, every woman's friend, To me they goodness condescend. Let me this night in visions see, Emblems of my destiny." If you dream of storms, it means coming trouble; if the storms end, a calm fate after strife. If you dream of a ring or the ace of diamonds, marriage: bread, a good job; cake, prosperity; flowers, joy: willow, treachery in love: spades, death: clubs, living in a foreign land: diamonds, money: keys, great power; birds, many children; and geese, more than one marriage.



It was often said that if a person was born at a Full Moon, he or she would have a lucky life.

According to some superstitions, if a girl wants to know whether or not she is going to marry, if she holds a silk handkerchief up in front of the moon, the number of moons she can see through it represents the number of months she must wait before she will get wed.

In Cuba in 1928, a law was passed forbidding the felling of trees for building railroads while the Moon was waxing.

For thousands of years it was believed that when you should cut your hair should be determined by what phase the moon is in. People believed that hair cut during the waxing phases of the moon would be quick to grow back , but if you cut your hair during the waning phases of the moon, then your hair would stay short and lose all of its shine. Even today, In Ireland it is thought to be good to cut your hair at the new moon, by the light of the moon but never on a Friday!

This predilection for believing what one wants to believe was still strong in the mid-19th century when Richard Adams Locke, editor of the New York Sun, duped people all over the world with a magnificent hoax concerning were written by Dr Andrew Grant, a made up reporter, who claimed to be a colleague of the famous British astronomer Sir John Herschel, For eleven days in August and September 1835, the Sun published accounts of Herschel's "observations" of the Moon and its inhabitants as seen through a 24 foot,14,823lb lens capable of magnifying 42,000 times and mounted on 150 foot pillars situated east of Cape Town in South Africa.

Purportedly, Herschel "observed" goats, unicorns, tailless beavers walking upright and winged humanoids covered in red hair, as well as a crimson mountain glittering with seams of pure gold and temples of polished sapphire. Grant's article also gave a vivid description of the moon itself, describing it as having craters, huge purple crystals, rivers and tons of plant life.

It started out as a joke but the public failed to get the humor and millions of people believed the story to be true. Reporters at the Sun even managed to fool a group of visiting Yale University scientists, who travelled to New York to find out more about the 'discovery'. The Sun came clean on September 16th 1835 and the hoax was regarded with general amusement by the public. Herschel, the scientist, was himself amused at the hoax to begin with, but later became annoyed at having to answer questions on it from people, because even after the ruse [deception/trick] was revealed, millions went on believing it to be real, even many years later.

Pourquoi?

What do your students think? Why are there so many different beliefs about the moon? Have they heard any other stories or beliefs about the power of the moon? Have them share.

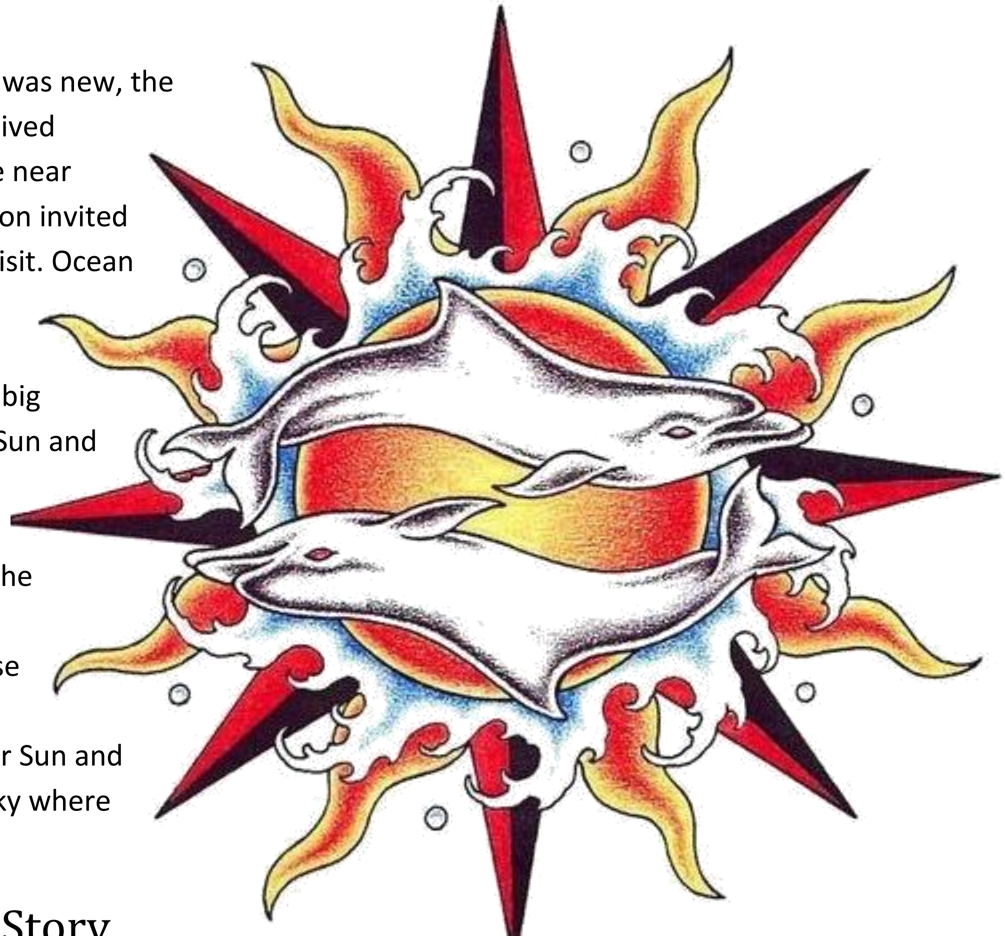
Children are naturally curious about the wonders of nature. To feed this interest in the natural world — as well as inspire great imaginative writing — you can use pourquoi tales! Pourquoi [por-kwa] means "why" in French. Pourquoi tales are old legends told to explain why certain events happened or why things are the way they are. These tales often start in the past, e.g. A long, long time ago . . . and end when the explanation is complete. Pourquoi tales are most often concerned with the natural world. As you begin to read pourquoi tales together, encourage your students to discover similarities and differences in the various stories. Keep a large class chart on the board and as you talk about each story and moon legend, record the class's new discoveries on your list.

After reading a series of pourquoi tales with your class, short ones like the following, or longer ones [like *The Man in the Moon* by William Joyce, *Moon Rabbit Builds A Fine House* by Terry Avery, or *Thirteen Moons on Turtle's Back* by Joseph Bruchac] talk about the many elements they contain. As you read these tales, it's a good time to work on vivid descriptions and imaginative language.

Why the Sun and the Moon Live In the Sky (A Zuni Legend Of New Mexico)

A long time ago, there was no day. It was always dark and always summer. This was because the Kachina, a very powerful people, had stolen the Sun and the Moon and locked them away in a box. In the dim light, Coyote and Eagle, two friends, wandered the desert. Coyote and Eagle had always hunted together, but Coyote could not hunt anymore because he could not see at night. Coyote suggested that they go to find the Sun and Moon and make them light up the world. Eagle was worried. He reminded Coyote that the Sun and Moon were very strong, and it was dangerous to try to trick them. In the end, Eagle agreed to help Coyote. While the Kachina were sleeping, Coyote and Eagle crept into their village, stole the Sun and Moon, and headed into the hills. Coyote told Eagle that he wanted to open the box containing the Sun and the Moon. Eagle said no. They must wait until after their travels and open it with their eyes closed. Coyote grumbled. He couldn't wait to see what was in that box. Finally he grew so curious that he threw it open. The light of the Sun was so bright it blinded Coyote's eyes. The Sun and Moon laughed and flew far away, up into the sky where they are today.

Why The Sun And The Moon Live In The Sky (Southeastern Nigeria)



A long time ago, when the world was new, the Sun married the Moon and they lived happy as can be in a little cottage near the Ocean. One day, Sun and Moon invited Ocean over to their house for a visit. Ocean liked it so much he wanted to stay. Sun and Moon liked Ocean, and hoped the cottage would be big enough for all three of them. So Sun and Moon invited Ocean to stay with them. In came Ocean with all his friends: the whales, the fish, the porpoises, and all the creatures that live in the sea. The water rose higher and higher in the cottage. Soon there was no more room for Sun and Moon, so they rose up into the sky where they have lived ever since!

Pourqoui? Shaping a Story

Working together as a class, in small groups, in pairs, or have students work individually to write and illustrate their own legend about the moon and why it changes shape in the night sky.

If students struggle, create a story together first as a class and model story writing techniques and brainstorming techniques for students. Ex prompt: What would the world be like if one morning the sun forgot to rise?

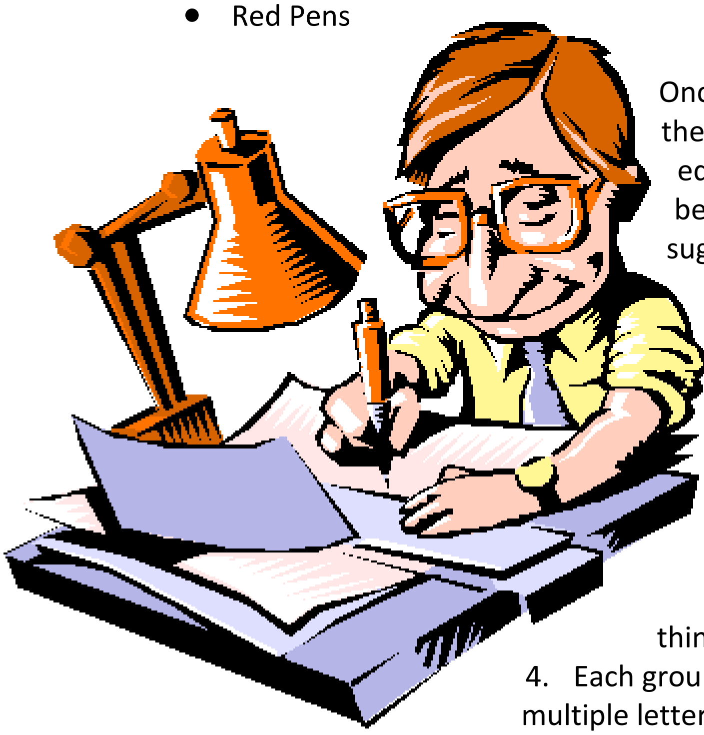
During group discussion, ask your students what descriptive words can students find in each story you read? Adjectives that might describe the Sun in the Nigerian tale are generous and happy. Other "Sun-ny" adjectives are fiery and enormous. Ask each child to come up with twelve adjectives, [ask students think about the sights, sounds, feel, tastes, and smells that they want to write about] and write them down. Have students volunteer their favorite adjectives, write them up on the board for the whole group, and then have students choose the best six for his or her story.

Now work with students to help them to choose characters for their stories that arouse their curiosity. Next, have children start to write using a story frame [and the included graphic organizers to systematize their thoughts]. The Plot Diagram graphic organizer is a way for students to illustrate the plot of a story. Students can use this organizer to put together their thoughts on writing their own Pourquoi story. This Observation Chart graphic organizer makes students think about the words they are using in their writing and helps students think about the sights, sounds, feel, tastes, and smells that they want to write about. For a basic plot structure have students begin with "Long ago...," and end with "...and that's why (example: the Moon sometimes turns red!)"

The Editor's Corner

Materials:

- Red Pens

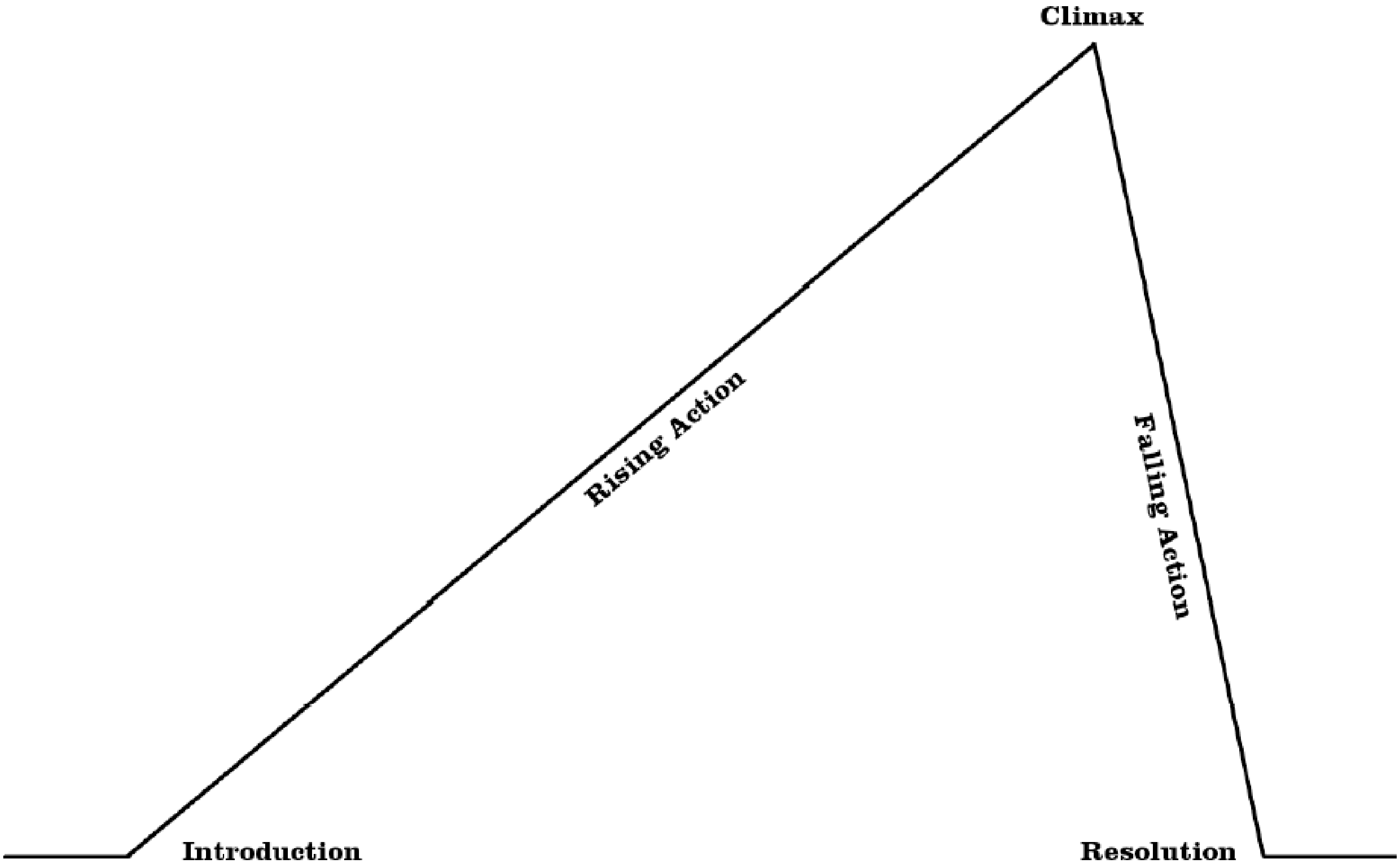


Once students have completed their first draft discuss the following with them: Writers and story tellers have editors who make sure that a story is the best it can be, drawing out the best in the story, giving suggestions on where a story could go, where it could be improved, and what else they would like to know about the characters, plot, setting, etc of a story.

1. Have students trade letters with another student.
2. Give each pair of students red pens.
3. Groups or students get points for correcting each other's papers and lose points for marking things up only to make the page red.
4. Each group or student gets to edit another groups letter (or multiple letters) and give suggestions and ask questions.

Then: Have students write a second/final draft, after revising and correcting the first for punctuation, content, vivid word use, unneeded information, etc.

When the stories are finished, have the children illustrate them and bind them into a book.


Climax
Rising Action
Falling Action
Introduction
Resolution

What is the **main idea** of your story? What happens?

Topic Sentence:

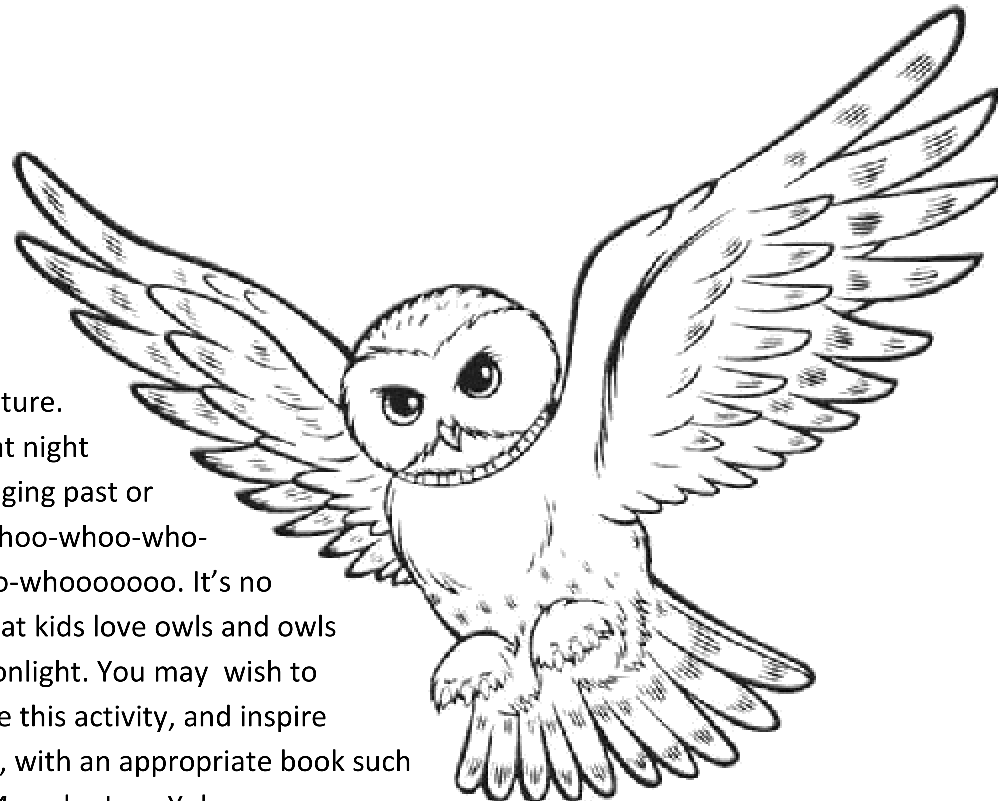
Who and what can be **seen** during this experience?

Describe how characters **feel** during this experience:

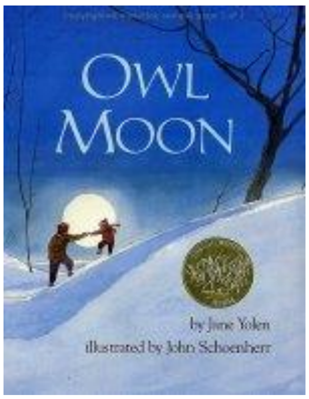
What do characters **hear** during this experience?

Closing Sentence:

Moonlight Flight



Among the greatest charms of children is their ability to view a simple activity as a magical adventure. Such as a walk in the woods late at night and their awe at a silent form winging past or the thrill of hearing a shivering Whoo-whoo-who-who-who-whoooooooo. It's no secret that kids love owls and owls love moonlight. You may wish to introduce this activity, and inspire students, with an appropriate book such as *Owl Moon* by Jane Yolen,



For this lesson give your students a few "owl" options. They could draw a realistic owl, a whimsical one or an owl in flight. Demonstrate basic drawing techniques for all three and provide a few black and white illustrations such as those included or others available on the net.

Materials:

- White paper [watercolor if possible]
- Oil pastels
- Blue or black watercolor wash
- Brushes
- Paper Towels

Start with a directed line drawing. It's important to note that even though you may use,   "directed line drawing", it's rare that you want to give your students just one option, most of the time you'll end up with many drawings on the white board. Look at pictures and brainstorm together what a planet, black hole, moon, or rocket can look like, and create sketches up on the board.

Teacher Tip!

Ban pencils and erasers.

Sounds harsh, right? It's not being mean, the reason is purely practical: small pencil leads encourage small drawings. If a kinder is drawing an owl and then is required to paint that very portrait, using a pencil will surely lead to frustration. It's hard to paint teeny tiny eyes! There is another reason: pencil markings can be erased, which leads to second guessing, which leads to lots of eraser action, which leads to class being over before the child has anything on his paper. Using oil pastels, crayons, and/or markers allows the artist to move quickly, commit to the drawing and forgive their "mistakes". This is a big part of creating art; giving into the process and not worrying about the details.

Give lots of examples! Draw a few different owls; some realistic, some silly, some animated,

then talk with students how you could change the wings, the shape, that sort of thing. This technique works well, as you want the children to learn to draw but also want them to be as individual as possible.

In the process of drawing on the white board, always incorporate mistakes. **Always.** Laugh at your "mistakes", tell the kids to expect them and then show them how to turn mistakes into something else. It's critical that you show your artistic side, no matter what you privately think of it, and inspire your students.

After watching your demos, have students make their choice of owl and began drawing with an oil pastel, not pencil! Encourage light strokes until the owl began to take shape and then have students darken the oil pastel when lines become clear they are keepers.

After instructions are given, the paper handed out and the children are engaged in their project, begin a ten-minute quiet time. This is their time; the chance to reflect on their work, the opportunity to lose themselves in their art, and perhaps the most important of all, the permission ***not*** to speak to their best friend.

- *Oil Pastel/Wax Crayon Resist*: If they want their outlines to show through, oil pastel will repel the paint, create clear outlines, and allow the drawing to show through the paint. Note: Wax crayons can also work for this, but aren't quite as clear, though they are less messy.

A watercolor wash acts as a basic resist giving the drawing a night-time feel. When they're ready to paint, have students paint the background and its details first. If they used oil pastels or wax crayons, students don't need to worry about avoiding painting near or on the outlines, as the

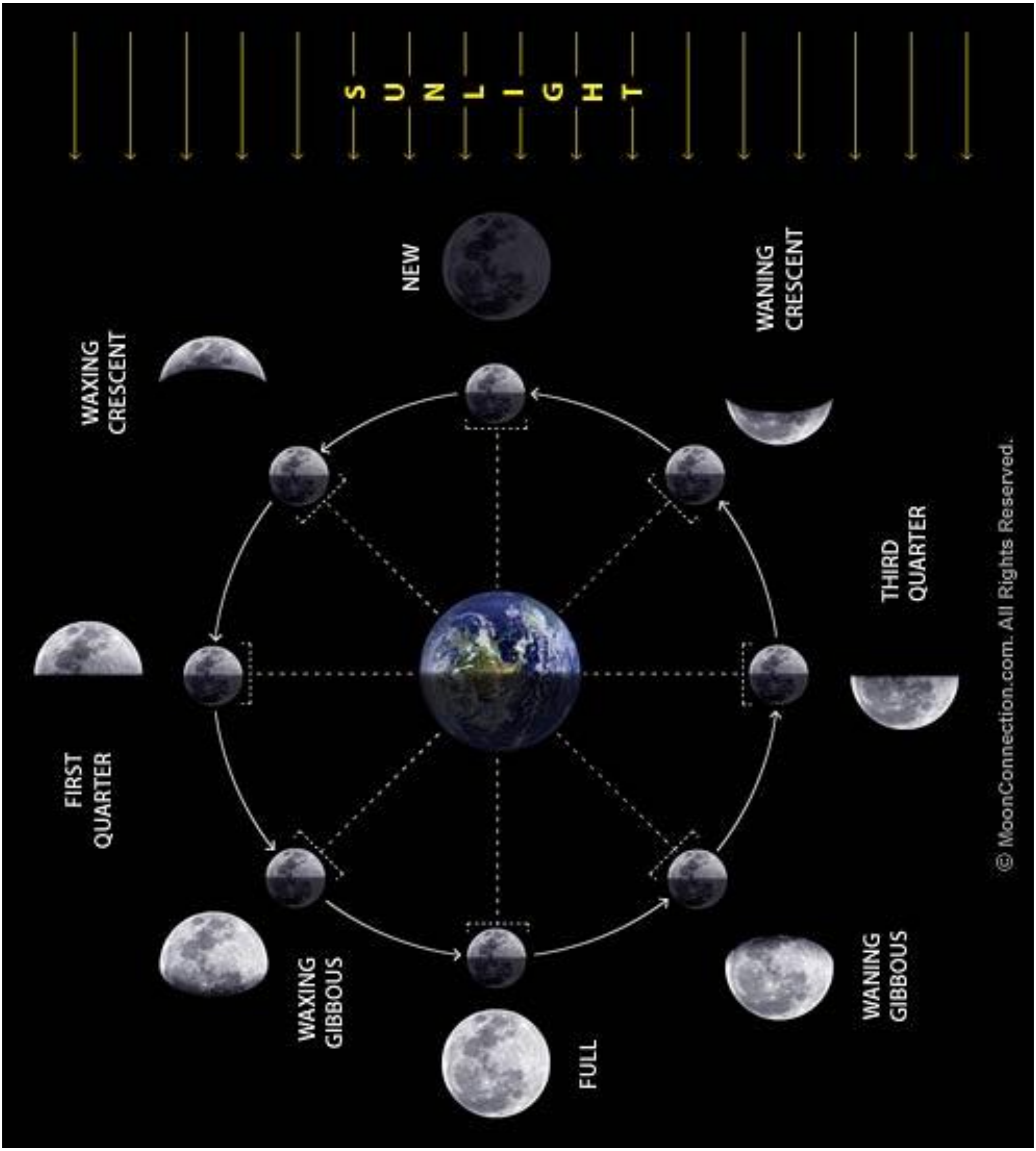
watercolor paint will bead off the oil pastel/crayon. If they paint the background first, they don't have to worry about accidentally painting the background colors into the main figure/subject's colors later on. Encourage the children to mix paints on their paper, not in paint palettes, and use the double-loading technique when you can. It produces very cool results and clean-up is much easier!

Notes on Additional Techniques:

- *Wet-On-Dry Technique:* First, students dilute their pain with water and placing it onto the dry paper. The color lies on solid **without** gradient (Gradient is blending of shades from light to dark or from one color to another).

- W*et-On-Wet Technique*: Which is painting a wash of water (or paint), and then painting on top of that area while it's still wet. The result is a blotchy and clouded effect with gradient.

- *Erasing/Creating a Glow*: It's night time and you want things to glow. When first starting to use watercolors students always tend to resort to their white paint to create shine, or think they can't have shine without white paint. Don't do this. There is a better way. Applying diluted white paint can muddle colors, so use the erasing technique. SAMPLE: For a glowing moon students could paint a light wash of yellow on the moon, or leave it white, keeping it light to reflect the moon's brightness. But, as a moon, it must cast a glow. So, have students get their paper towel ready, and wet an inch and a half around its outside in the sky. They don't have to press hard, just brush some water on the paper. Then, have them take their paper towel and gently rub off the water which removes some blue paint to reveal the original yellow wash. Now, the moon glows. This also works if an area is too dark, erase = wetting down the spot and wiping excess paint away with a paper towel.


SUNLIGHT
NEW
WAXING CRESCENT
WANING CRESCENT
FIRST QUARTER
THIRD QUARTER
WAXING GIBBOUS
WANING GIBBOUS
FULL
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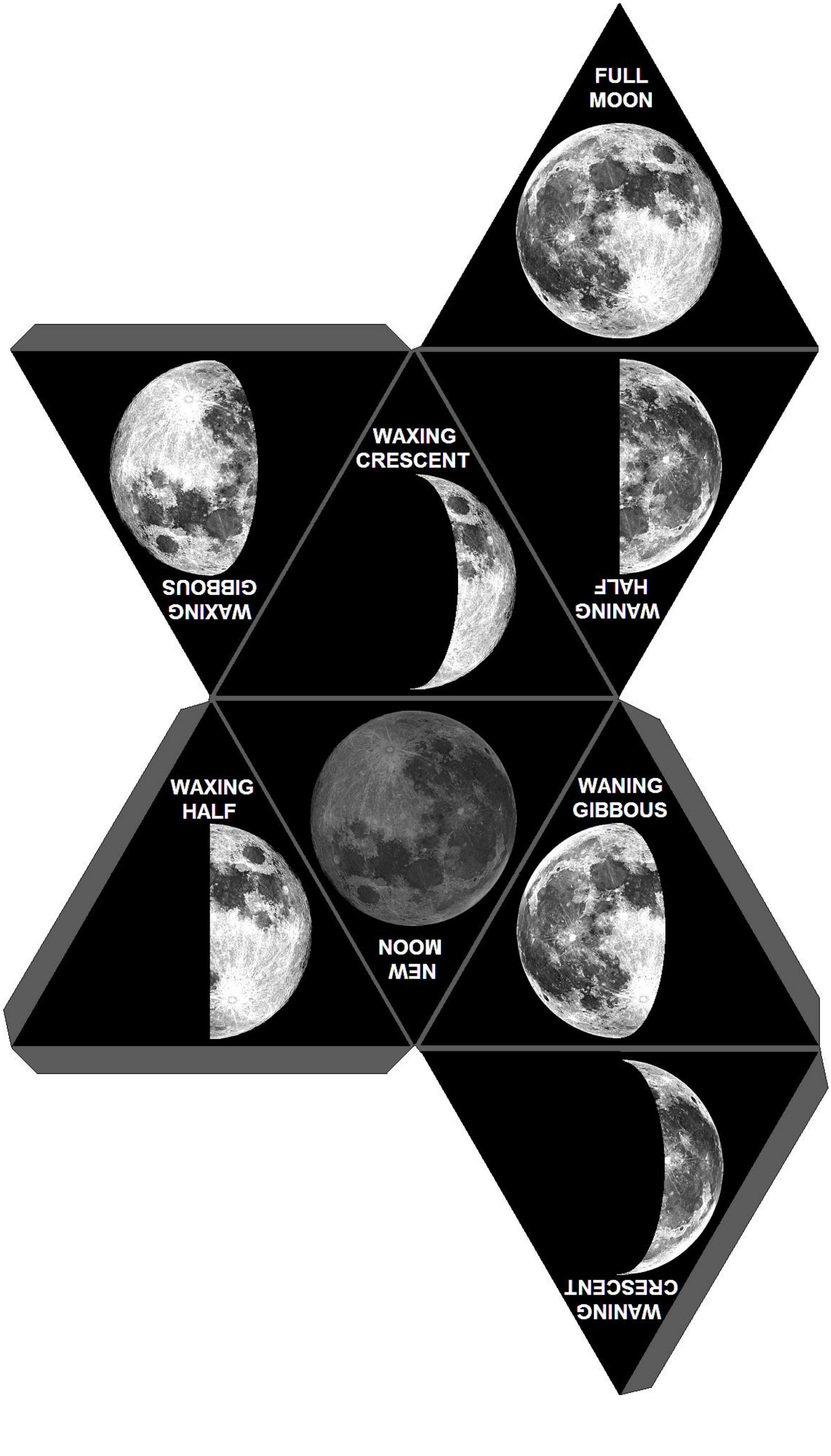
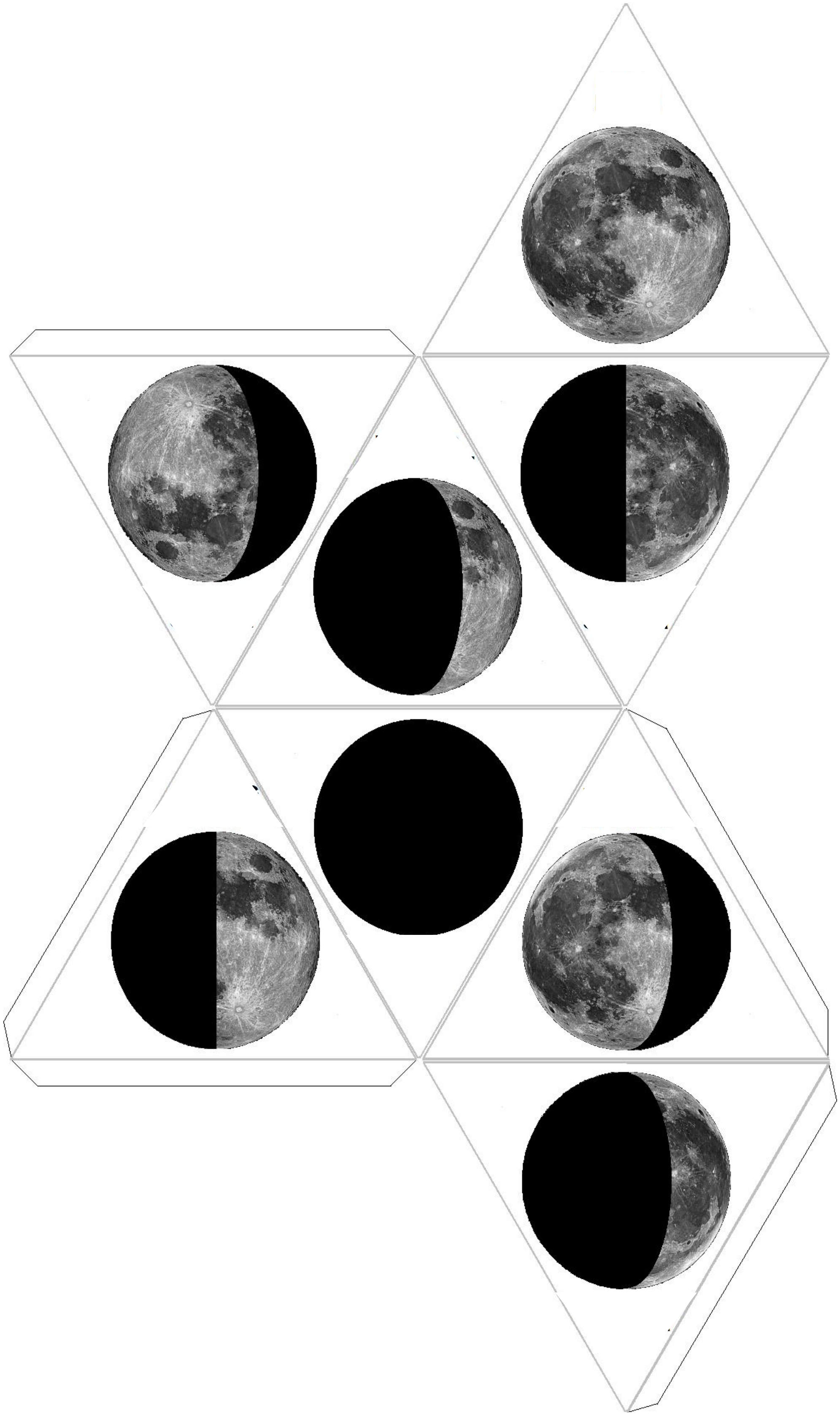
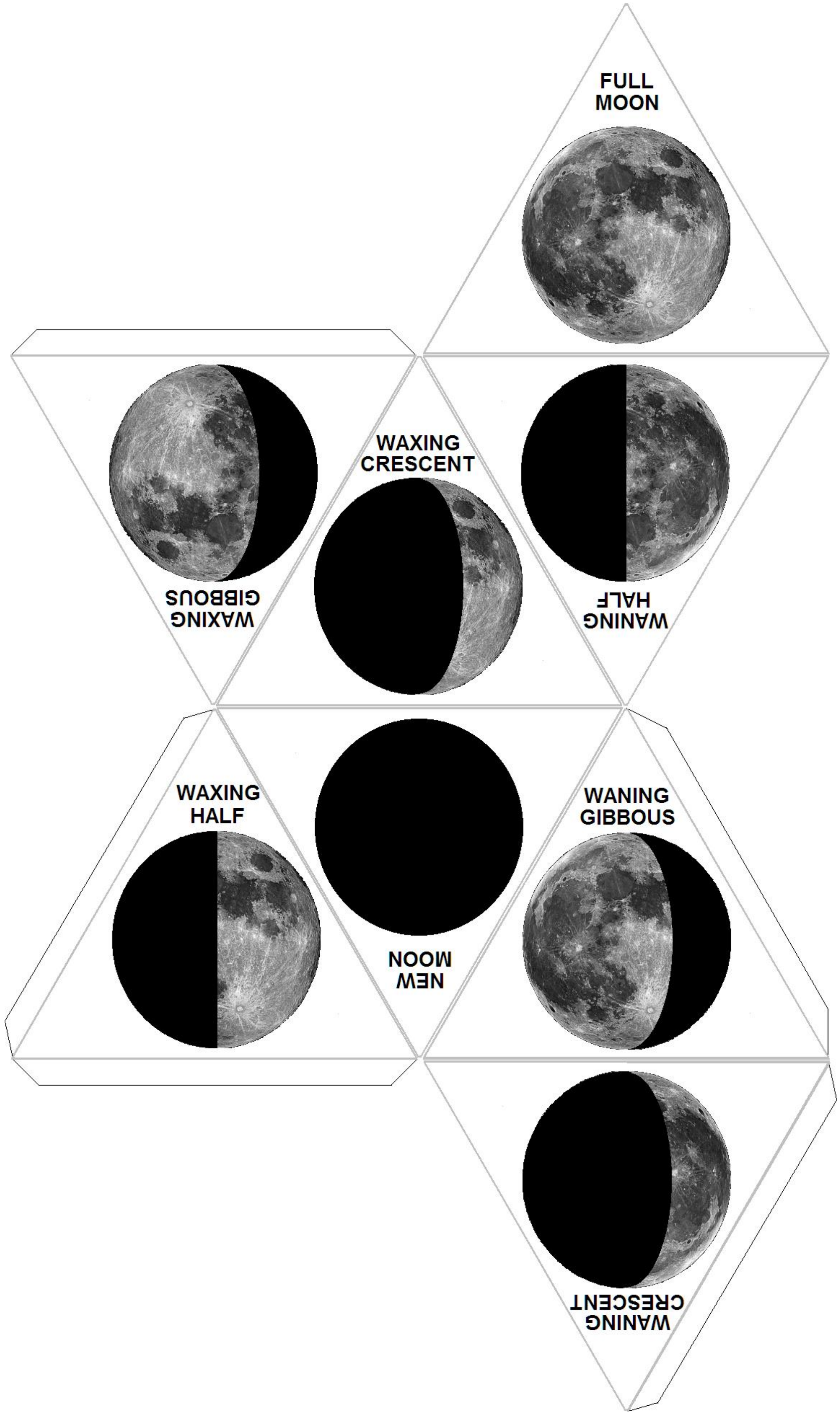

FULL MOON
WAXING GIBBOUS
WAXING CRESCENT
WANING HALF
WAXING HALF
NEW MOON
WANING GIBBOUS
WANING CRESCENT




FULL MOON
WAXING GIBBOUS
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WANING HALF
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