

Teacher Notes- “Moon Phases-*Finally* Making Sense Of Them”

The moon phases ranks as one of the most misunderstood topics in all of science (the seasons and why the sky is blue also rank up there). What causes the moon phases to change- is it clouds? Earth’s shadow? No, and no.

This activity will transform your classroom into a giant sun, earth, and moon model. An earth will hang in the center of your room and a sun will glare from the side. Then 4 moons will be put around the earth, one representing each major phase. By observing the model, students will be able to understand the moon phases even without an explanation.



Materials per student:

1-student handout- Moon Phases (see p. 8)

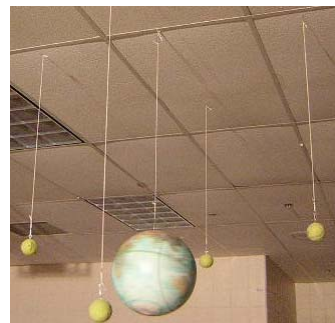
Additional Teacher Materials:

- 1-Earth globe (one you don’t mind taking apart)
- 6-Tennis balls
- 1-Bright shop light
- 2-Toggle bolts
- Paper clips
- String
- 4-Small eye hooks
- A 1/2” x 4 foot dowel rod (or meter stick)-optional

“PowerPoint-Moon Phases” (see p.7)

Beforehand: (begin 2-3 days early)

1. Build your sun, earth, and moon model- see the document in the Resources folder “*Building the Moon Phase Model*”.
2. After you set up the model, spend some quiet time by yourself looking at it, walking around it, and thinking about it. Study it until you feel comfortable explaining the moon phases using it.
3. Close all classroom blinds.
4. Check the dates and times of upcoming moon phases at <http://sunearth.gsfc.nasa.gov/eclipse/phase/phasecat.html> . The times there are



listed in Universal Time. Subtract 5 hours to convert to Eastern Time in the U.S. Students will put this info in the lower-left corner of their handouts.

5. Take the time to fill out the student handout while at the same time going through the activity in your mind. That will give you a better feel for what's going on, and help you explain things better too.
6. When students enter the classroom, have the globe already hanging on its string, unless you absolutely cannot trust them. This will immediately captivate them. Leave the moons (tennis balls) unattached and the sun turned off at first.
7. Set out all materials *the day before*. Leave yourself time to realize you're missing something, research something or even make a change. The morning of, read through the notes one last time. And don't over-do your preparation- that will make you worry about every little detail. This lesson makes it tempting to throw in all kinds of extra topics.*¹ Use the slideshow to guide you through and keep you focused.

Procedure:

1. As students enter class, decide which 4 tall students will help hang the tennis ball moons. (They need to be able to reach and hang their moons without standing on anything. Have the tallest kid in class hang the full moon.) Give them each a tennis ball moon just to hold onto for now.
2. Give each student a copy of the handout, then turn off all classroom lights and plug in the "sun" (bright light).
3. After students have finished reacting to that, give an introduction. As you talk, remember that they're seeing all this for the first time, so talk slowly and deliberately:

Introduction

"Today is about the Moon Phases. Who can name one? (full moon, new moon, 1st quarter and 3rd quarter. If you hear "crescent", connect that with the quarter moons).

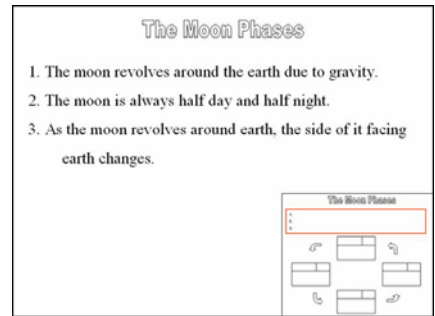
Good! Those are the 4 main phases we'll be covering today. We've all seen a full moon and crescent moons, too. Have you noticed they keep repeating? About how often do we get a full moon? (every month)

My goal is for everyone in this room to understand the moon phases, or why it keeps changing its appearance, when you leave this classroom today. Most people think the earth's shadow is the cause, but this is not true, as you'll see."

4. At this point, walk around the earth globe hanging, and notice what it looks like from each side.*² Since students are seated and cannot see it from all sides like you, refer to 4 students on 4 different sides of it and what they see. One side of the class sees the day side of earth, and the other sees only the night side. Those in the middle have the best seats in the house today. From their perspective, the earth is half and half- the side facing the sun is lit up, and the other is not.

Copy 3
Statements

5. Start the PowerPoint, if you're using it. It will guide you and your students through the entire activity^{*3}. If you don't have a multimedia projector for your screen, copy the student handout onto overhead transparency and fill it in with erasable marker.
6. Begin by having students copy the 3 statements-



1. The moon revolves around the earth due to gravity.

While students are writing statement #1, revolve your moon-on-a-stick around the earth globe counterclockwise over and over and over.... All they have to do is simply watch it revolve and understand that this is what our moon does.^{*4} Most students know that the moon revolves around earth, but have never really thought about what it means or looks like.

The last part of statement 1 mentions gravity, which your moon-on-a-string will help them understand better. Swing the ball around your head and notice that you, the more massive object, are pulling it in towards you.^{*5} That's what the earth does to the moon too- it's as if the moon is swinging around the earth on an invisible rope.

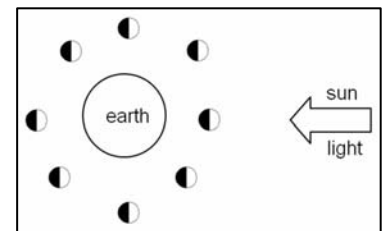
2. The moon is always half day and half night.

To demonstrate this, revolve your moon-on-a-stick again, this time more slowly, noticing that at no time is the moon ever *not* half day and half night.

3. As the moon revolves around earth, the side of it facing earth changes.

This statement combines the first two, showing how they cause the moon phases.

7. The next 3 PowerPoint slides will prompt students to draw a sun, earth, and series of moons (students love it when you refer to them as "moonies") around earth in the middle of their paper.^{*6} This drawing summarizes what they just wrote in those first 3 statements. Their minds should now be primed and ready.^{*7}



Hang New
Moon

8. Call up the first tall student with a tennis ball and tell them to hang their moon on the string that would cause a *new moon*. You can tell them what a new moon looks like, or simply let them guess. They can get assistance from other students, or make up their minds on their own.
9. After they've chosen a string and hung it there, explain what a new moon is and see if they still agree with where the moon was put, or if they want to change to a different string. ("Looking at it from earth, all you can see is the night side- remember class that the moon is always half day and half night".)

10. With the new moon now in the correct position, revisit the 3 statements students wrote down earlier. Call on a student to re-read statement number 1 (*revolves around earth*), then say:

“...The moon revolves around the earth. This is where it all begins, right here at new moon phase. There are 4 strings around our earth because each represents one of the 4 major moon phases. But every time we hang another moon remember that it doesn’t magically just skip from this spot to that spot. (*If you’re using the moon on a stick, demonstrate it revolving again*). The moon never stops moving continuously around earth. These 4 strings are just snapshots of something that’s never still.”

11. Have another student re-read statement #2 (*is always half day/night*):

“Is that true? You people on the far ends of the room only have a day or night perspective, and that won’t change all day. But you people in the middle- look at our new moon. Is it half day and half night? (yes)
Yes it is, and will be, no matter where it’s at around earth, right?”

12. Stand beneath or behind the earth gazing at the new moon, and invite students to use their imaginations to fly over to where you are standing, to see what you are seeing. What do they see? Do they understand that you see the night side? Why it is that when you look at a new moon you see nothing?

“Students, if we could turn off all lights and make this room pitch black, and I looked in your direction, would you still be there even though I couldn’t see you? (yes).
Aha! We’ve discovered something- when it’s a new moon, it’s there, but you can’t see it.*8

13. Advance the slide so students can see the perspective from beneath the earth, looking at the night side of the moon, with the sun glaring right at them.





14. Ask another student to read the third statement (*revolves, side facing earth changes*) then say:

“You said ‘the day/night side facing earth changes.’ That would explain for right now how we can say our moon is half day, half night, and see nothing right now. The night side is facing earth, so we see nothing. The day side is there, but it’s turned away from us. We know there are crescents and full moons coming later as the moon moves around us.”

Fill in first box

15. Now it’s time for students to fill in their first box with information about the *New Moon* phase. For this first one, everything is presented one item at a time, which they are to copy onto their papers. Begin with a “bird’s eye” view drawing of the sun, earth, and moon. Then add what the face looks like in the upper-right, the name, and the day

New Moon	
	
3-7 12:14 pm	Day 1

number.

16. Since this is a repeating system, have students go ahead and put a sun and earth in all 4 boxes of the boxes. The moons will be added as each phase is discussed. Put the date and time of that upcoming phase in the lower-left corner.*⁹
17. The next 3 phases will move along just like the first: have a student hang the next tennis ball moon, talk about what you see from earth, then move through the information on the handout. Keep your talk simple by staying focused on the 3 points students wrote down (1.revolves, 2.day/night, 3.changes).*¹⁰
18. Give them any remaining time in class to work on the assignment- a good explanation that a 10 year-old would understand (that will force them to keep it simple and brief).
19. At the end of the day, put each moon in its own little baggie that's been marked. That will make it tons easier to remember which is which next year, and keep the strings from tangling.
20. Spend tomorrow reviewing. A good way is to have students read their homework assignment. It would also be an ideal time to move into another related topic since you've still got the model up.
21. If you have computer access, there are plenty of great websites you could visit too.*¹¹




Accessories: Other sub-topics you can add for more length and depth.

- *¹ Other related topics will come to mind: seasons, day and night, eclipses, and orbit speed, distance, and inclination. Decide now what other things you will bring up. It's incredibly easy (and tempting!) to keep throwing in other things because this grand model applies to so many things. The problem is that after a couple of those extra things, you've got too much for one day and have lost your focus on the main topic- moon phases.
- *² This would be a good time to bring up scale and dimensions-

“Let's establish the scale. You of course see the earth here and the sun there. In real life, they're not this close together. How far apart are the earth and sun? (~100,000,000 miles)

100,000,000 miles! Can anyone imagine that? That's what called an intangible number. Let me try to make it more tangible- if you drove to the sun traveling 70mph and never stopped it would take 163 years! ($100,000,000 / 70 / 24 / 365$).

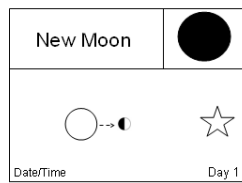
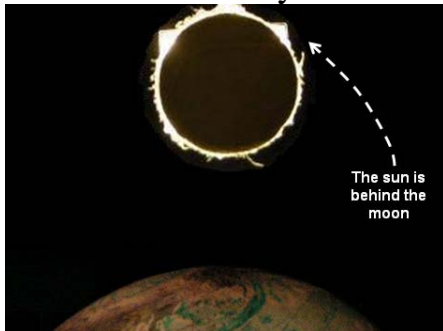
And if our earth was really this size (point to the globe), how big would our sun be? (109 times bigger- *most of your teachers can say the sun would be as big as your school building and be in the ballpark*)”

- *³ To keep students clear throughout the day, the section of the handout being referred to on each PowerPoint slide will be highlighted in a red box in the lower-right corner.
- *⁴ Essential moon data:
 - Distance between earth/moon:
 - Average: 238,000 miles
 - At perigee (closest to earth): 225,000 miles
 - At apogee (furthest): 252,000 miles
 - Its orbit is inclined by about 5 degrees. That means when it's in front of earth (new moon) it dips down a bit, and when it's behind (full) it's a little above. That's why there are not eclipses every month. ***When revolving your moon-on-a-stick, remember to swing it a little high when behind earth, and a little low when in front, so you avoid those shadows (unless, of course, you want to show them what causes eclipses).***
 - Its path around earth is a total distance of about 1.5 million miles.
 - Its orbit period, with respect to the stars, is 27.3 earth days. This is known as its *sidereal period*. But since the Earth, at the same time, is revolving around the sun, the moon has a bit further to travel. That's why it takes 29.5 days to go from new moon to new moon. This is referred to as the it's *synodic period*.
 - It travels about 2,300 miles per hour around earth.
 - The theory now about how the moon formed is that a mars-sized asteroid ("Theia") collided with earth when it was just 30 million years old, which nearly blew it to bits. The earth's gravity kept the debris from that collision close by, where it formed into the moon within about a year.
- *⁵ But if all forces move in a straight line, why does this "moon" go in a circle? There's a second force at work- the ball's inertia. Imagine that the string snapped- what would the ball do? It would go outward in a line, away from you. That is its own inertia, or momentum. Both forces (you pulling in, the ball pulling out) together "compromise" and form a circular orbit.
- *⁶ To save class time, you could instead give students handouts with these drawings already done for them. Look in the *Other Student Handouts* folder.
- *⁷ As you move through the PowerPoint, a small  symbol in the lower-left corner will pop up when the next click will move onto the next phase.

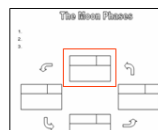
- *⁸ And you can't see a new moon for 2 reasons-1. you are looking at the night side of the moon, and 2. it would always be up in the day, in the same line of sight as the sun
- *⁹ You might have noticed on the PowerPoint that after you've clicked to make the little moon appear, a blinking arrow comes up next, and stays on until you click again. Students must be continually reminded today, and in different ways, that they're on that earth with that view of the moon.
- *¹⁰ The date for Easter is based on the moon phases. Easter is the first Sunday following the first full moon on or after the vernal equinox. This method is called the "Computus". Confusing, isn't it?
- *¹¹ Recommended links:
 - <http://www.wonderville.ca/v1/activities/phases/phases.html>
 - <http://www.learningmedia.co.nz/staticactivities/dayandnight/dswmedia/moon4.html>
 - http://sunshine.chpc.utah.edu/labs/moon/lunar_phases_main.html
 - <http://www.astro.uiuc.edu/projects/data/MoonPhases/index.html>
 - <http://antwrp.gsfc.nasa.gov/apod/ap070610.html>

Come back and visit InteractiveScienceTeacher.com to upgrade this lesson with:

PowerPoint- lead your students through the lesson click-by-click



Go ahead & put a sun and earth in all 4 boxes



Your Homework:

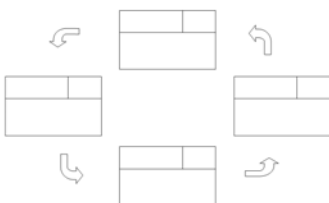
Explain what causes the moon phases. Pretend you are writing to a 10 year old.

Interactive Science Teacher™

Student Handout

The Moon Phases

- 1.
- 2.
- 3.



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QuickNotes

Teacher Quick Notes- "Moon Phases"

Materials per group of 4 students:

1-handout- Moon Phases

Additional Teacher Materials:

1-Globe

6-Tennis balls

1-Bright shop light

1-Toggle switch

Paper clips

String

4-small eye hooks

1-1/2" x 4 foot dowel rod (or meter stick)

"PowerPoint-Moon Phases"

Procedure:

1. Give 4 tall students a tennis ball.
2. Turn off all classroom lights and plug in the bright light.
3. Introduce what's going on and briefly mention any other sun/earth/moon topics you want to hit before going into the moon phases.
4. Begin the PowerPoint. Have students copy the 3 statements and then make the sun, earth drawings in the middle of their papers.
5. Have tall student #1 hang their ball at new moon position.
6. Look at the ball while standing beneath earth and talk openly about what you see.
7. Move through the presentation slides and copy information about New Moon phase
8. Move through the next 3 phases the same way.