# Why Does the Moon Have Phases?

## About the Activity

Using a simple 3D model, allow participants to discover why the Moon has phases. This is one of the biggest misconceptions about the night sky and a very rewarding "ah-ha!" moment for the participants.

## Materials Needed

- "Moon balls" for your audience members. 1"-2" dylite balls work well. *See Helpful Hints for more information.*
- Skewers or toothpicks for holding your Moon
- *(Optional)* Earth Globe four times the diameter of the Moon balls

## Topics Covered

- Why does the Moon have phases?
- Why does the Moon rise a little later each day?
- *Extra:* If I were on the Moon, would the Earth have phases?

## Participants

Use this activity with families, the general public, and school or youth groups ages 7 and up.

## Location and Timing

Do this activity outside during the day when the Moon is visible in the sky. This will be the case:

- In the morning a few days after full to a few days after last quarter
- In the afternoon a few days before first quarter to a couple days before full.

This activity can take 10-30 minutes; depending on how much discussion you get into.


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## Detailed Activity Description

### Why does the Moon have phases?

| Leader's Role | Participants' Role (Anticipated) |
|---|---|
| *To Do:*<br>This must be done outside in the daytime when both the Moon and the Sun are in the sky.<br>This will be the case in the morning a few days after full to a few days after last quarter and in the afternoon a few days before first quarter to a couple days before full.<br>Point to the Moon or ask, "Who can find the Moon?"<br>Once the visitors are looking at the Moon:<br>*To say:*<br>Why does the Moon look like it does right now? Why does the Moon appear to change shape? Why does the Moon have phases?<br>OR:<br>Would you like to find out a way to show why the Moon has phases?<br>*To do:*<br>Hand out Moon balls. | Visitors point.<br><br>Guesses. |
| **Optional:** Have participants take a couple minutes and use the Moon ball to try to show why the Moon looks like it does.<br><br>**Misconception Alert:**<br>Many people believe the Moon's phases are caused by the Earth's shadow.<br>Others think it is clouds passing in front of the Moon. | |
| *To say:*<br>This ball will represent the Moon. Your head is the Earth. And the Sun, well, where is the Sun?<br>Where is the real Moon?<br>And the real Earth? | Over there.<br>Points.<br>Below our feet. |
| *To Say* (if you've already talked about the Earth's shadow):<br>Just like the Earth, the Moon has a shadow too. Where is your Moon ball's shadow?<br>Where is it nighttime on your Moon? | Points to dark side of their Moon ball. |
| **Short Version:**<br>*To say:*<br>Face South. Look for the real Moon.<br>Hold your moon just below the real Moon. How much of your moon is lit up compared to the real Moon? | Whoa. It's the same amount. |

| Leader's Role | Participants' Role (Anticipated) |
|---|---|
| <u>*To say:*</u><br>Now put the Moon in orbit (*demonstrate by turning to your left, making sure the move the Moon counterclockwise around your head)* and watch how the phase of the Moon changes.<br> <br>Make a full Moon.<br>Make a last quarter Moon.<br><br>Bring it all the way back around and line it up again with the real Moon.<br><br>So why does the Moon have phases?<br><br>Sure – the dark area is the shadow side of the Moon – where the Sun is not shining. The lit side of the Moon will always be pointing in the direction of the Sun! | The Sun is shining on the Moon and the Moon is orbiting us. |

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| Leader's Role | Participants' Role (Anticipated) |
|---|---|

***Presentation Tip:***

If the Sun is within about 20 degrees of the horizon, you and your visitors can orbit the Moon in a level plane even with the horizon and make the phases look right.

If the Sun is much higher in the sky, or if you want to make the Moon ball's orbital path around your head to be more like the real Moon's orbit around Earth, you'll need to adjust the way you orbit the Moon ball around your head. For example, if you orbit the Moon ball level with the horizon when the Sun is high in the sky, you'll never get a full Moon, since the Moon ball needs to be on an almost straight line on the opposite side of your head from where the Sun is.

You might want to say:
"We want to make our Moon ball go around our head in the same way the real Moon orbits the real Earth."
Then demonstrate this for your visitors: Face south and imagine a hula hoop encircling your head. Mentally line up the imaginary hoop such that the real Moon and Sun are aligned at points along the hoop. Note that the imaginary hoop is at a considerable angle compared to the horizon. Then imagine tracing the hoop with your Moon ball. The phases on your Moon ball will look more convincing.

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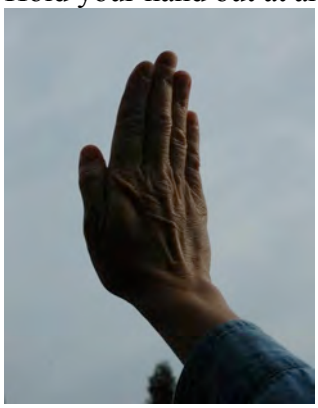
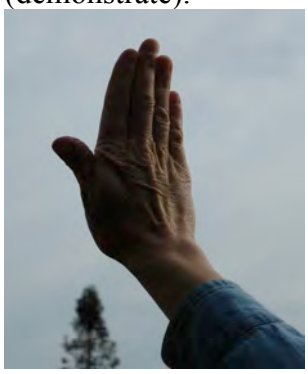
| Leader's Role | Participants' Role (Anticipated) |
|---|---|
| **Long Version (you can continue with this if your audience has an interest):**<br>*To say:*<br>How long does it take the Moon to make one full orbit around the Earth?<br><br>Why do you suppose we call it a "Moon-th?"<br>So every day the Moon moves a little farther over. How many degrees in a circle?<br>How many days in a month?<br>So about how many degrees does the Moon move every day?<br>Roughly 12 degrees. (360 / 30)<br>Hold your hand out at arm's length (*demonstrate*).<br>  <br>That's covers about 10 degrees of sky. Stick your thumb out just a little (demonstrate).<br>  <br>That's about 12 degrees.<br>Hold this side of your hand against the Moon and look at where the tip of your thumb is. At this time tomorrow night, the Moon will be approximately where the end of your thumb is.<br>So in three/seven/xxx days, about where will the Moon be?<br>And what will it look like – use your Moon balls to see.<br><br>Now let's take a look at the Moon through the telescope. | Various answers are likely: A day – a month – a few weeks – 29 days.<br>Oh. A month.<br><br>360 degrees<br>about 30<br>12 degrees?<br><br>Really?<br><br>Use hand to measure over.<br>Use Moon balls.<br><br>Yeah! |

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## If I lived on the Moon would the Earth have phases?

| Leader's Role | Participants' Role (Anticipated) |
|---|---|
| ***Presentation tip:***<br>This must be done outside in the daytime when the Sun is in the sky – preferably when the Sun is within 20 degrees of the horizon or roughly within an hour and a half before sunset. | |
| *To Do:*<br>Put a person holding the Earth above their head in the center of a circle of participants. Each person in the circle is holding a Moon ball.<br>People in circle move around Earth, always facing Earth.<br><br>*To Ask:*<br>You live on the Moon: does the Earth have phases? | Yes! |

EXTENDED ACTIVITY:
Showing that Moon rises a little later each day.

Have one person standing holding the Earth.
Have another person holding the Moon a few feet away, ready to orbit the Earth.
Start Moon-person at first quarter.
Please a sticker on Earth where you live. Position Earth so sticker is facing Moon.
Have Earth rotate once as Moon-person takes one step counter-clockwise. Continue for at least half a Moon orbit (~14 days).

At each step, ask what time it is (or at least if it is day or night) on Earth when the Moon rises (comes into view for your position on the Earth).

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## Background Information

### Earth's Shadow

For another way to model day and night on the Earth and talk about the shadow of Earth:
http://128.241.173.3/pubs/mercury/9803/dahlman.html

### Moon Phases

For a photo mosaic of the phases of the Moon:
http://www.astro.virginia.edu/class/oconnell/astr130/im/moon-phases-lrg-cidadao-sm.jpg

### Moon's Rotation

Does the Moon rotate? Why does the Moon always keep the same face to Earth? What does the other side of the Moon look like?
A discussion of these topics can be found here:
http://www-spof.gsfc.nasa.gov/stargaze/SMoon.htm

## Helpful Hints

There are many options for "Moon Balls" but the dylite balls work by far the best. Most importantly, the balls need to be smooth and white. It is useful to be able to mount them on skewers or toothpicks.

- 1-2" (3-5 cm) dylite/polystyrene balls: http://plasteelcorp.com/. You might also find polystyrene balls at arts and craft stores, but be sure you are using polystyrene, *NOT styrofoam*. The material is also called "dylite".
- Ping-pong balls with hole: sporting goods - you need to poke your own small hole with a pencil. Beware, kids love to smash these.


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