



Exploring Moon Phases

How to use these cards: Print pages single-sided and fold in half. These create a set of 10 cards to use when observing an evening Moon with visitors of all ages.

When the Moon is up in the evening, observe what phase (or shape) it is. Match it most closely to a phase on one of these cards. The back of each card explores features that can be viewed on the Moon that day as well as other interesting facts.

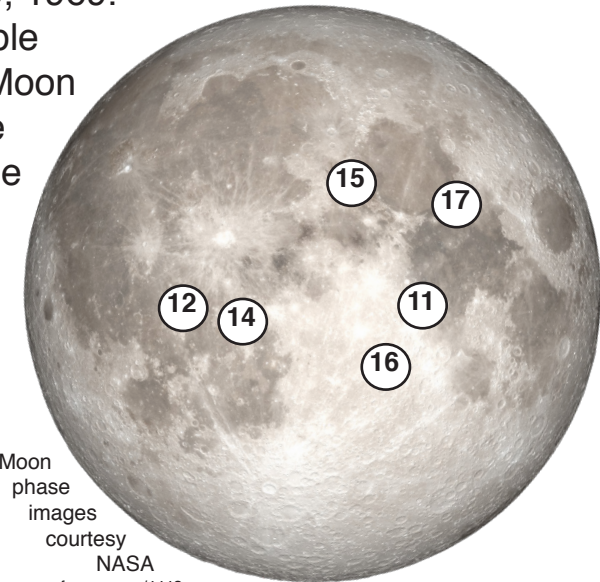
Lunar cycle: The Moon goes from New to Full and back to New again in about 29 days. This card set begins with the 3rd day after New Moon, when the Moon becomes more visible in the early evening.

Challenge: How long is a lunar day?

Neil Armstrong became the first person to set foot on the Moon, landing in the Apollo 11 spacecraft on July 20, 1969.

In total, a dozen people have walked on the Moon on six missions in the 1960s and 1970s. The Apollo landing sites are shown right.

Note that when looking through a telescope, images may be mirrored, opposite from what is shown on these cards.



Moon phase images courtesy NASA
svs.gsfc.nasa.gov/4442



Exploring Moon Phases

Cards Included

- Day 3: Phases
- Day 4: History
- Day 5: Color
- Day 6: Craters
- Day 7: Maria
- Day 8: Geology
- Day 9: Mountains
- Day 10: Highlands
- Day 11: Rays



Phases and the Terminator

Day 3

“Waxing” refers to the Moon phase getting larger, and “Crescent” is the shape.

Cleomedes —

Mare Crisium
“Sea of Crises” —

Langrenus —

Vendelinus —

Petavius —

Fernurius —

Waxing Crescent

Did you know? The Moon does not give off light of its own. The Sun is always lighting up exactly one half of the Moon. We see the entire lit-up side during a Full Moon. Most of the month, we see some of the lit side and some of the unlit side.

When the Moon is a thin crescent, you can often see the dark part slightly illuminated. This is called **earthshine**. That’s the sunlight reflecting off of Earth and lighting up the Moon just slightly.

The **terminator** is the line separating the illuminated part of the Moon from the unlit side. Through the sequence of lunar phases, the terminator always moves from right to left in the northern hemisphere and left to right in the southern hemisphere.

Activity: When you see the Moon up during the day, hold up a ball or an orange just under the Moon and so that the Sun shines on it. What side of the ball is lit up? Can you see a phase on the ball as well?





Day 4

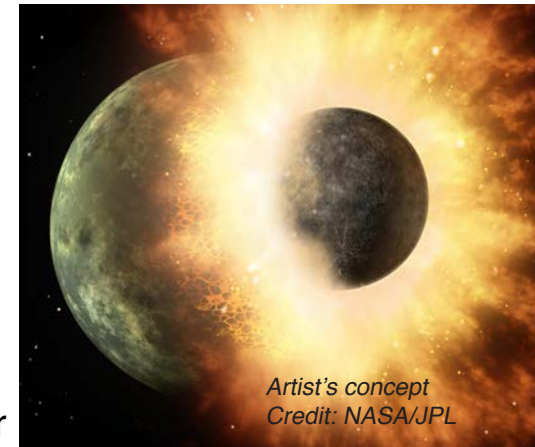


Waxing Crescent

Lunar History

History of the Moon:

The Moon likely formed early in the history of the Solar System when an object the size of Mars smashed into early Earth, splashing much of its outer layers into a ring. This material eventually came together to form our Moon.



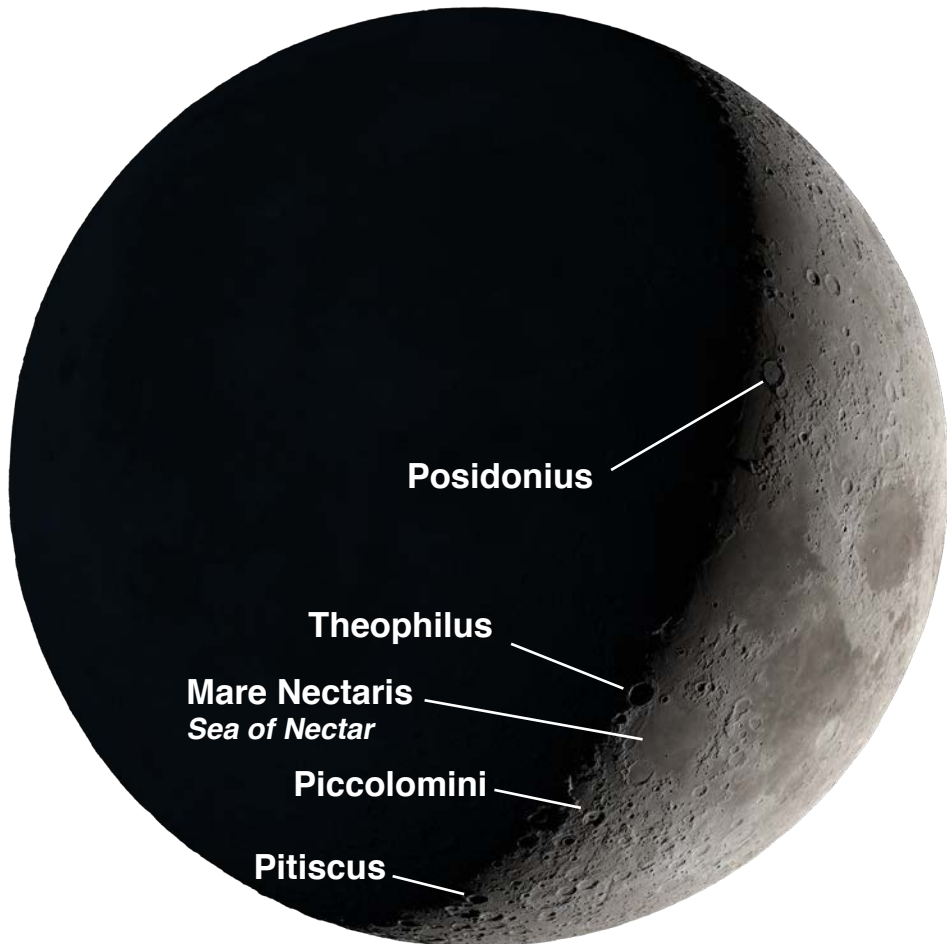
The Gutenberg crater, center left, can appear elongated in binoculars. Looking more closely, we see it is instead many overlapping craters. Can you find a crater that occurred more recently than Gutenberg? How can you tell?

Did you know? Craters tell us the history of impacts on the lunar surface. Can you tell which crater above formed first? This is called “relative dating.” Most crater-forming impacts happened in the very early history of our Solar System, but some impacts occur currently as well.



Moon Color

Day 5



Waxing Crescent

Did you know? While the Moon appears bright in the night sky, the maria (the dark, flatter areas) are actually very dark - about as reflective as a worn asphalt road. Maria appear darker than the highlands because the rocks contain greater amounts of iron and magnesium. See *Day 7* for more information about their formation.



Why does the Moon appear so bright in the sky?

Above, the same 5 shades are repeated on two different backgrounds. Notice how the middle color looks on each background. When does it appear brighter? How might this phenomena influence our observations of the Moon?

Astronomers call the amount of light reflected by a surface its “**albedo**.” Snow has high albedo. Asphalt has low albedo, as do even the brightest areas on the Moon.

Lunar rock returned from the Apollo missions showed variations of dark gray (right).

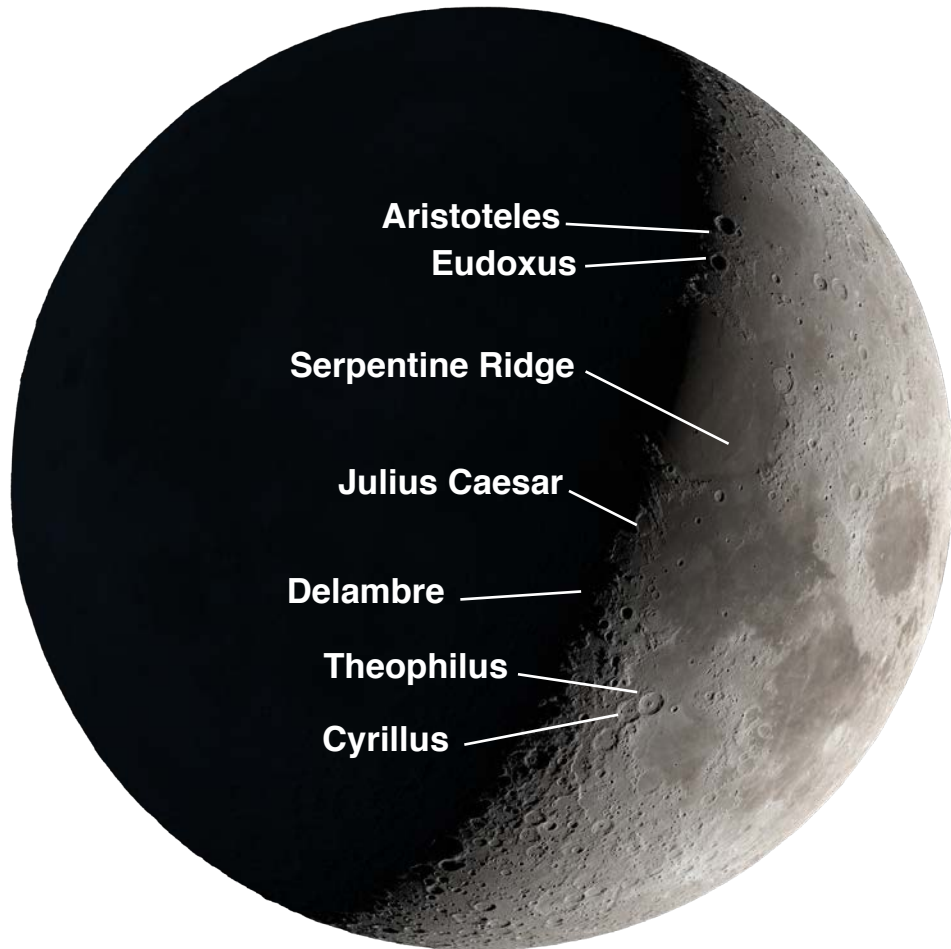
Apollo 17 basalt sample
Credit: NASA





Craters

Day 6



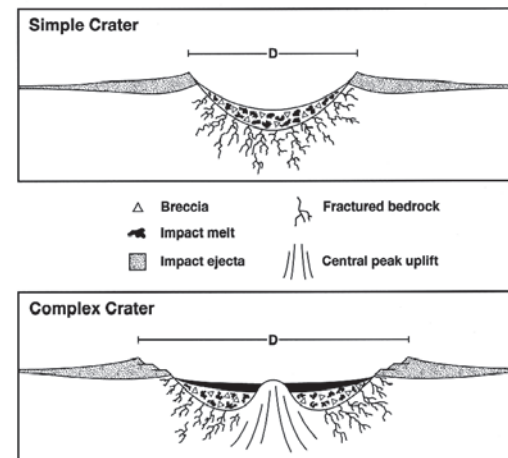
Waxing Crescent

Creating Craters: Where did all of those craters come from? Most have been there a very long time (see *Day 4*). Rocks from space collided with the early Moon, creating tremendous explosions.

Challenge: Why doesn't the surface of Earth look like the Moon?

Did you know? The Moon is roughly 2,160 miles across, just a bit smaller than the width of the continental US. The smallest feature most humans with good eyesight can see on the Moon is about 60 miles across, approximately the size of a large city. That's also about the size of some of the most prominent craters, Tycho (53 miles wide) and Copernicus (58 miles wide). These are also some of the brightest craters.

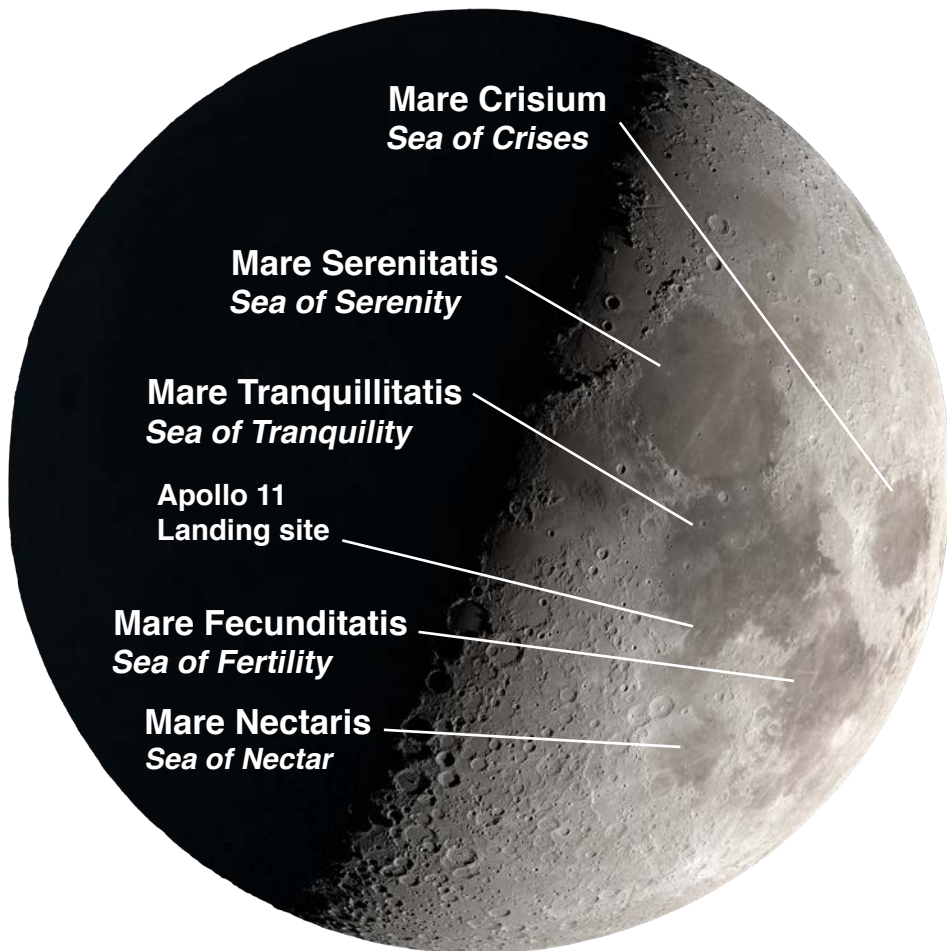
Notice that some of the craters have mountains in the middle. Those are created when the material in the middle rebounds after an impact, like a waterdrop (below).



Activity: Can you find any craters on the Moon with a central peak in binoculars or a telescope?



Day 7



First Quarter

One quarter of the way through the lunar cycle, we see half of the Earth-facing side illuminated.

Maria

Seas on the Moon? Upon looking through a telescope for the first time, Galileo imagined the dark areas on the Moon as watery seas or “**maria**.” We now know they are very dry, just like most of the Moon.

These dark areas are mostly the remains of lava (or magma) that seeped through cracks made by a large impact and settled in the bottom of a huge crater. Can you see the outlines of those ancient craters at the edge of the mare? They appear darker because the rocks have more iron and magnesium than the highlands (see Day 5).

The first names for lunar features were written by Italian astronomer and priest G.B. Riccioli in 1651. Many of those names are still in use today (below). Crater names are now given by the International Astronomical Union to honor deceased scientists.

Maria is Latin for seas, pronounced **mare** “mar-AY” in the singular or **maria** “MAR-ee-uh” plural.

Challenge:
If day 7 is first quarter, what do we call day 14?

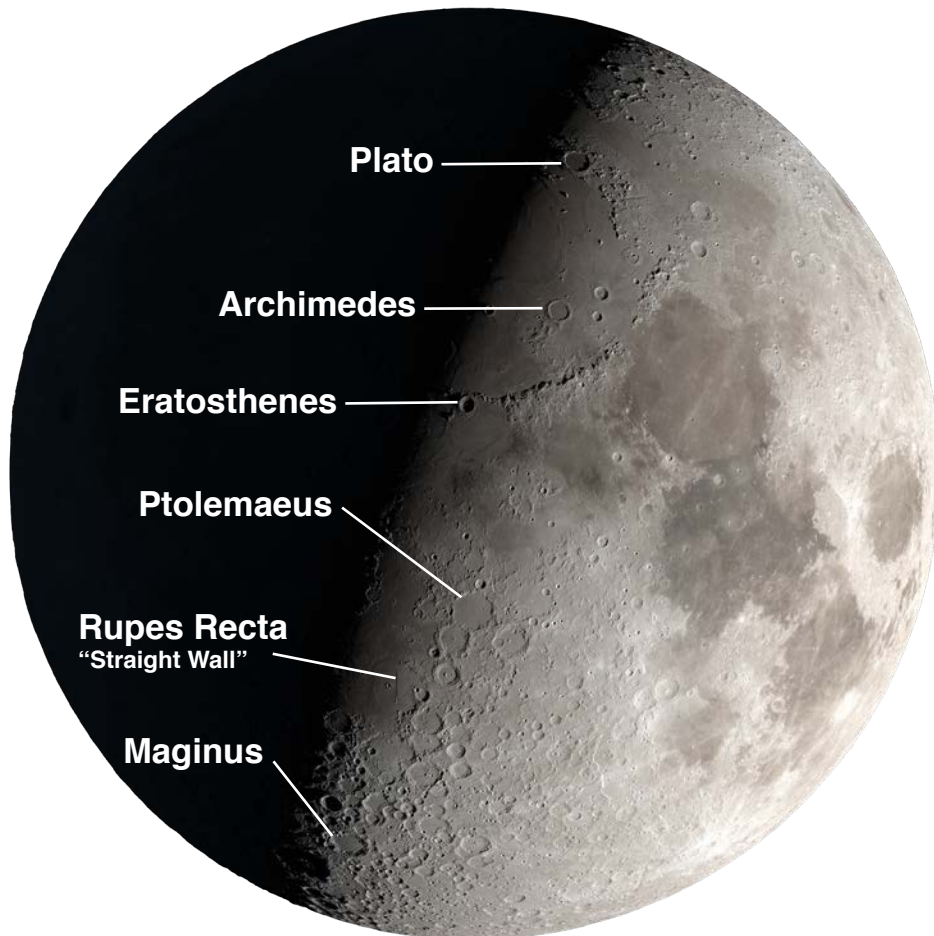


Detail from Riccioli's *New Almagest*



Lunar Geology

Day 8



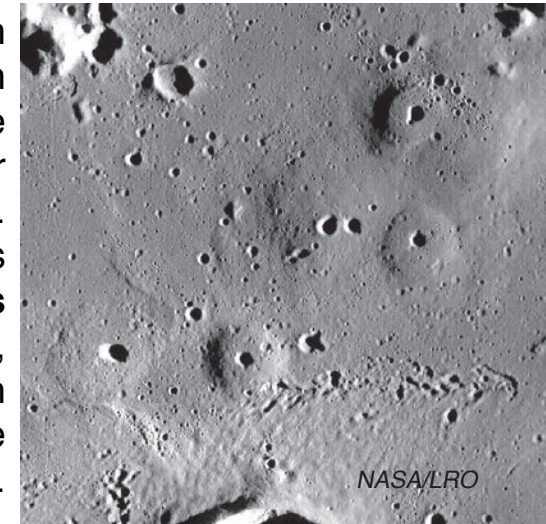
Waxing Gibbous

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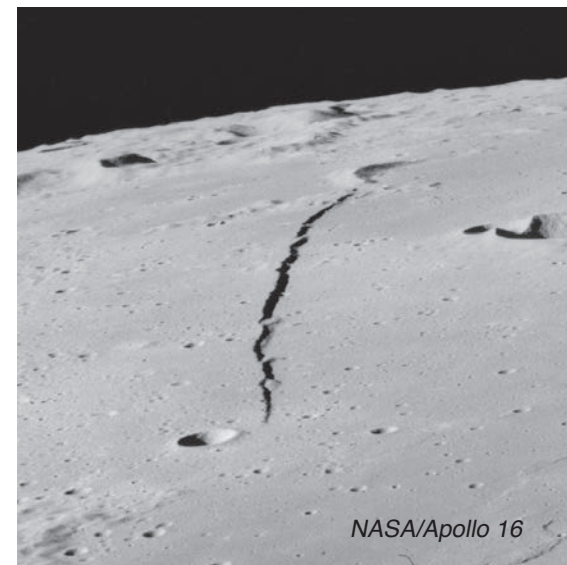
A “Gibbous” Moon is when more than half of the Earth-facing side is illuminated.

Did you know? Studying the Moon closely, astronomers have discovered more activity than they expected. There are still faint moonquakes on this mostly inactive world, but the surface shows evidence of past geologic activity. Most of these formations are hard to see through small telescopes, but orbiters send information back to Earth.

Besides the common craters and maria seen on the Moon, there are also extinct lunar **volcanoes** (right). Old lava channels are called **rilles** (rhymes with pills), the grooves seen to the right of the bottom dome.



NASA/LRO



NASA/Apollo 16

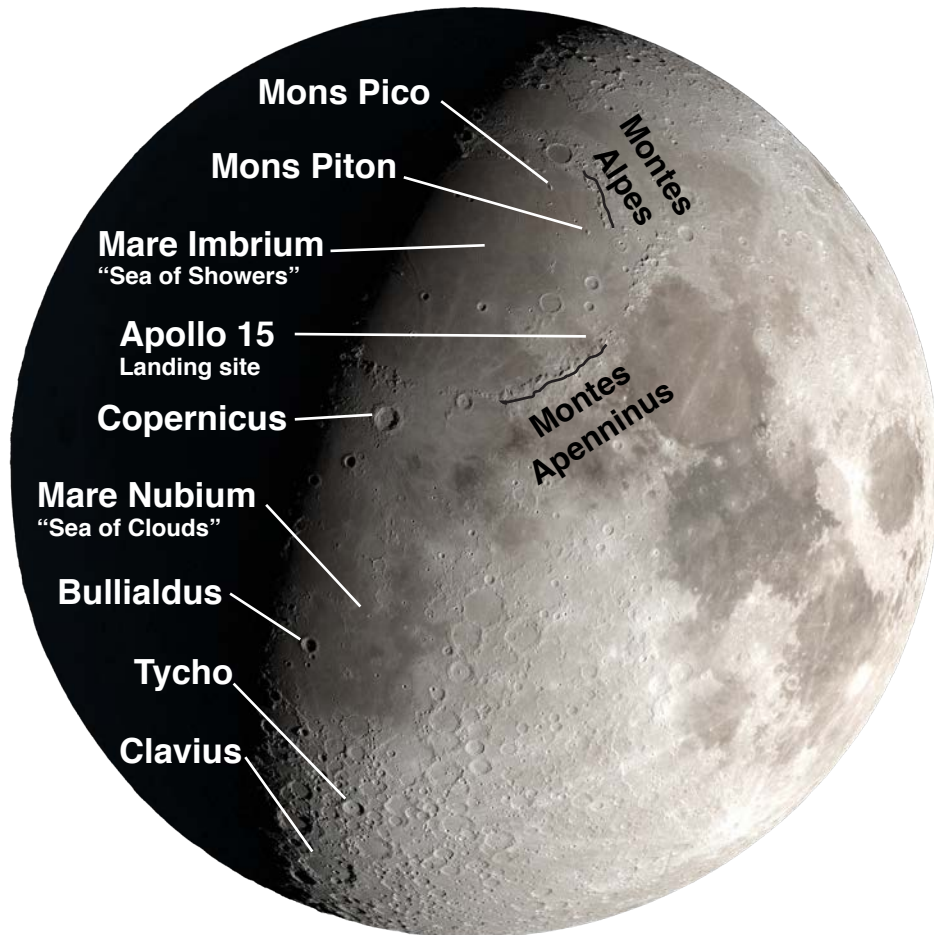
Faults of various types show us that the Moon got smaller as it cooled and is likely still shrinking.

Compare the Apollo 16 picture of Rupes Recta (left) with what you can see through a telescope (reverse side).



Mountains

Day 9



Waxing Gibbous

Mare Imbrium - This “sea” is actually one of the largest impact basins in the Solar System! It formed almost 4 billion years ago when a large asteroid collided with the Moon, and the crater then filled with lava, appearing smooth.

Montes Apenninus, Montes Alpes - Look at *Day 10* to see how these ranges are the rims of the giant crater underlying Mare Imbrium.

Mons Piton and Mons Pico are seemingly isolated peaks in the north of Mare Imbrium that actually form another ring inside the larger mountain ranges.

Did you know? Mountains on Earth are often formed by recent tectonic activity. On the Moon, mountains are mostly crater rims or old volcanoes.

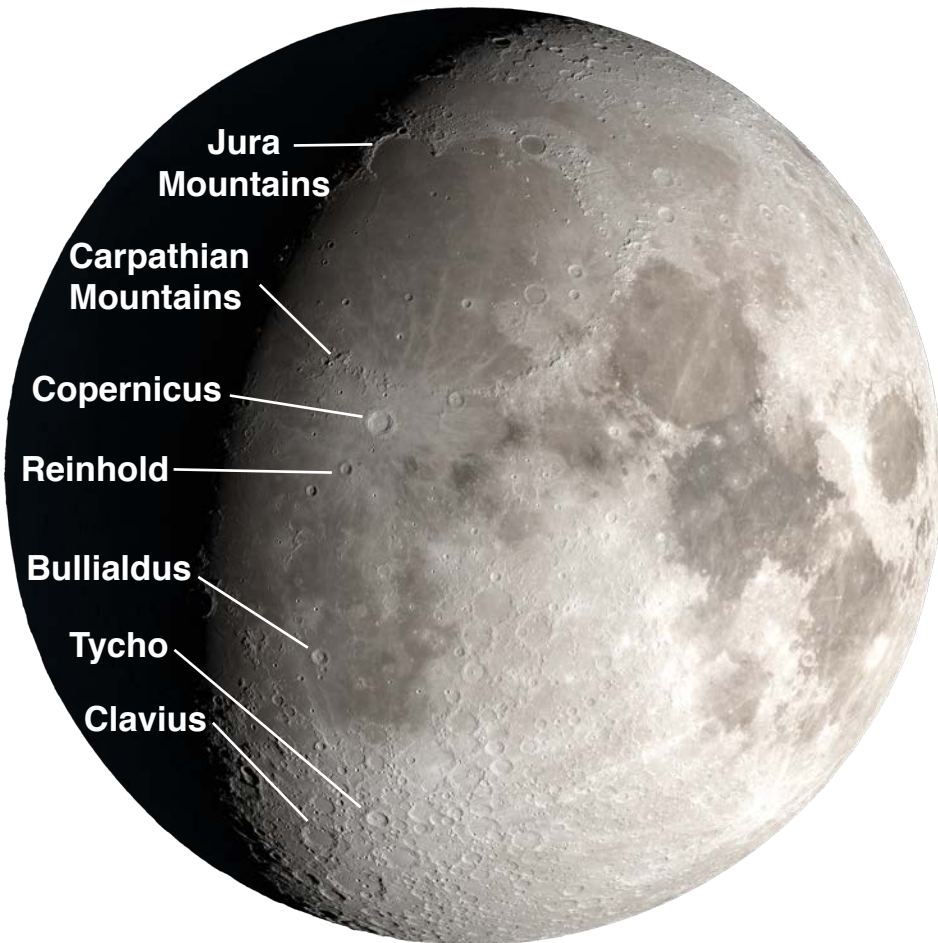


Credit: NASA

Apollo 15 landed in the southeastern part of Mare Imbrium by Mons Hadley in 1971. This was the first Apollo mission to use a Rover, seen above with Jim Irwin.



Day 10



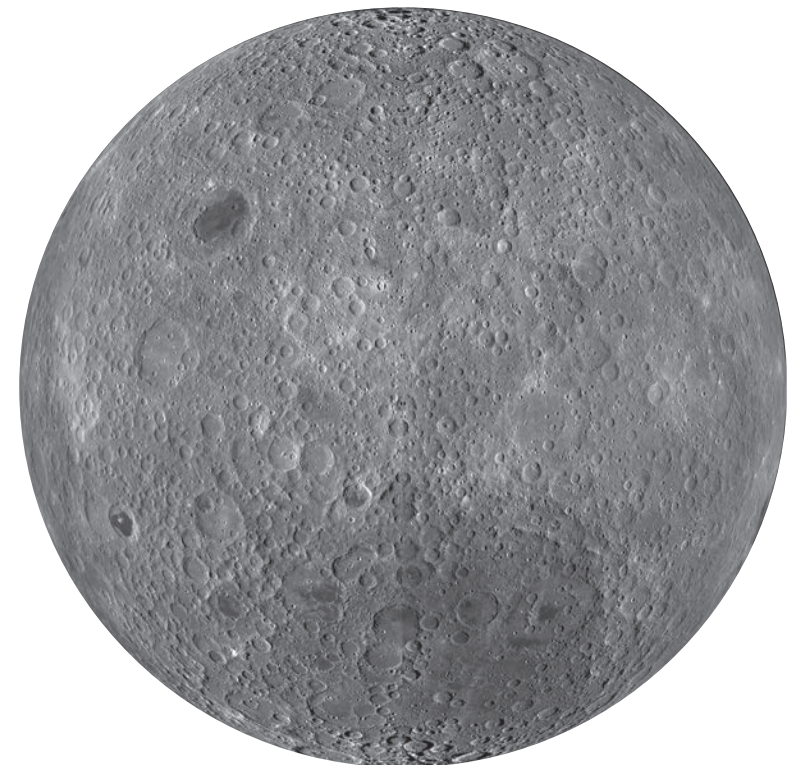
Waxing Gibbous

Highlands and the Far Side

Lunar Highlands: The light patches seen with the unaided eye are the lunar **highlands**, some of the oldest surfaces on the Moon, covered with craters. Highland rock and soil contain more silica and aluminum, and thus are lighter in color.

Far Side of the Moon: The Moon always faces the same side to Earth, called “tidally locked.” The far side of the Moon (left) is only seen by orbiters.

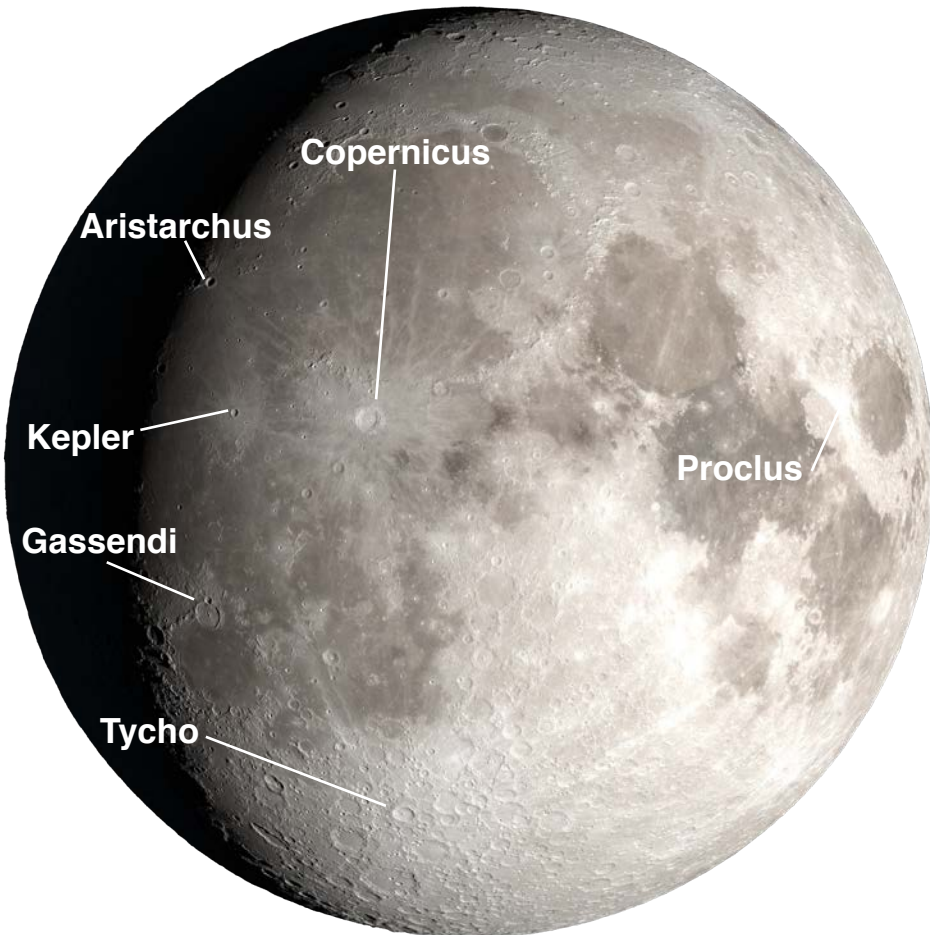
Challenge: Do you notice any difference between the far side and the near side (cover photo)?



Did you know? The entire Moon is covered in a sharp, glassy soil called **regolith**.



Day 11



Waxing Gibbous

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Rays

Rays are those bright streaks that radiate out from some of the largest and most recent craters. Large impacts throw out ejecta (particles from under the surface) many times the diameter of the crater.

Tycho Crater: Figuring prominently in many science-fiction stories, this crater is prominent as the Full Moon approaches. Its extensive system of rays stands out against both highlands and maria.

Activity: Compare the two large craters Copernicus and Tycho with their appearance on days 9 and 10. What features become more prominent? When can you see more detail? Why do you think that is?

For more information on the Moon, its features, and human exploration, see: nasa.gov/moon

Download these cards, find local events, and more from the NASA Night Sky Network: bit.ly/nsnmoon

