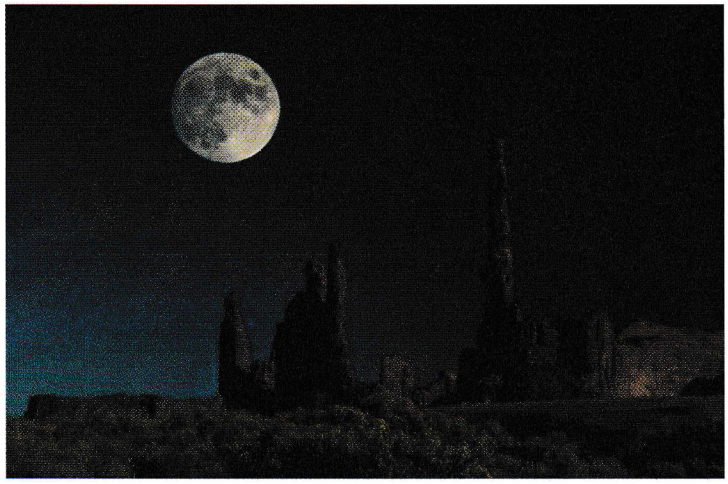
The Moon

Isn't it wonderful to look up at the sky on a clear night? The moon brightens up the night sky. We get our word "month" from the word "moon." Try to say the word "month" with two "o's" in the middle like the word moon: "moonth." Doesn't that sound like month and moon put together? Many years ago, people guessed what day of the month it was by looking at the moon. Another word we use when talking about the moon is **lunar** (loo' nur). It comes from Latin. A lot of scientific words come from Latin. Latin is a good language to learn if you want to be a scientist someday. The Latin word for moon is ***lun***, which is why we often use the word "lunar" to refer to the moon.

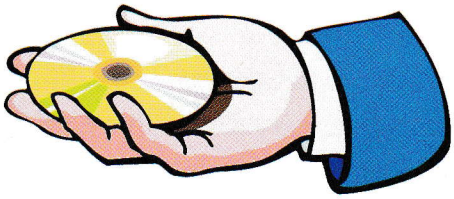
Do you remember that the moon is a satellite of the earth? The moon revolves around the earth, like the earth revolves around the sun. We do not call the moon a planet; we call it a satellite. Take a ball, hold it above your head, and move it slowly around your head. The ball orbits your head like the moon orbits the earth. We usually think of satellites as man-made machines that we send up into space to orbit the earth. We use those kinds of satellites to take pictures, collect information, and transmit television and telephone signals. The moon is also a satellite, but it is a *natural* satellite, because it was made by God, not man.

The moon looks like a big light up in the sky. But, actually, the moon is a very dark satellite with no light coming from it at all. "Why is it lit up?" you ask. Well, remember why we can see the planets shining like stars in the night sky. They reflect light that comes from the sun, making it look like they are shining with their own light. Well, the moon does the same thing. The sun is always shining on some part of the moon, so it is always daytime somewhere on the moon. The light we see coming from the moon, then, is actually the light of the sun reflecting off the surface of the moon.



Even though the moon doesn't make its own light, it can be very bright in the night sky. When the moon is big and round, the night is not very dark because the sun's light reflecting off the moon provides some light by which we can see. When the moon is a small sliver, we have darker nights. If you want to play hide-and-seek during the night, it is easier to hide when the moon is either not visible in the sky or when it is just a small sliver.

To understand the fact that the moon's brightness is just the result of how it reflects light onto the earth, try this experiment. Take a compact disc (CD) into a room that has a lamp or a closet with a light bulb nearby. Remove the lampshade from the lamp, and turn on the light. Now move your compact disc in a way that makes the light shine from the compact disc onto your other hand (the one that is not holding the CD). You are reflecting the light from the bulb (which is like the sun) off the CD (which is like the moon) onto your hand (which is like the earth.) The compact disc is not producing light on its own. If you took the compact disc into a dark room, no light would come from it. That is like the moon. The only way the CD can shine light onto your hand is to reflect it from a lamp that is producing its own light. In the same way, the moon reflects the light from the sun onto the earth.

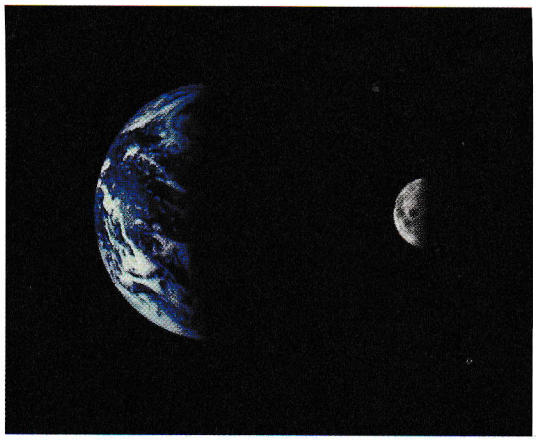


Tell someone all that you have learned about the moon in your own words.

The Moon's Phases

Have you ever noticed that the moon seems to change shape in the sky? Sometimes it's a big round ball; sometimes it's a semi-circle; and sometimes it's a sliver, which is called a crescent. Also, one night during every month, the moon seems to completely disappear.

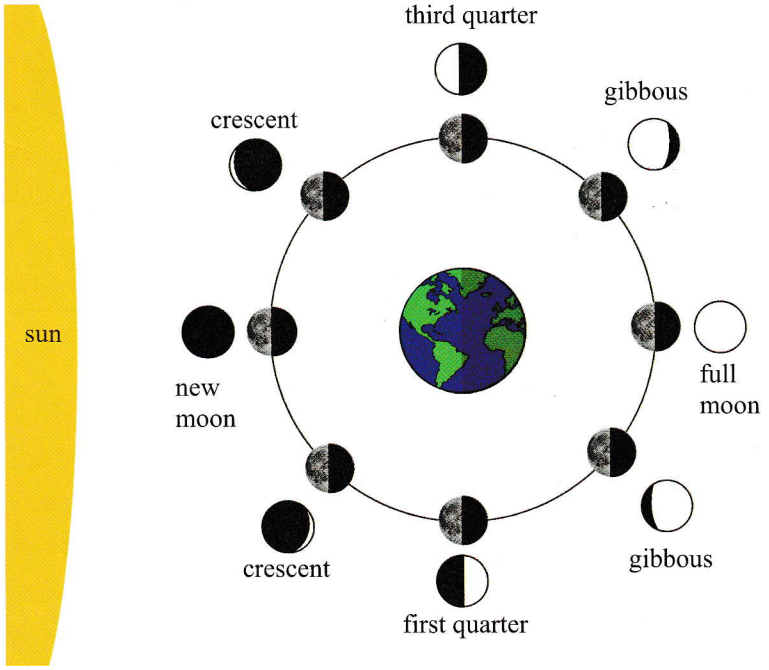
Well, the moon never really disappears, and it doesn't really change shape. It's always the big round ball that God created it to be. The reason it looks like it has changed shape is because we can only see the part of the moon that reflects light back to the earth. Why do you think only part of the earth and part of the moon are lit up in the picture on the left? It is because the sun's rays are only shining on half of the earth and half of the moon. The bright side of the earth is experiencing daytime, while the dark side of the earth is experiencing nighttime. The people who are experiencing nighttime on earth in this picture would see a full moon, because the entire face of the moon would reflect sunlight onto the earth.



This is a photo of the earth and the moon both reflecting the sun's light.

Do you remember in Lesson 4 when we discussed the fact that if you look through a telescope at Venus, you will see Venus change shape from day to day? Do you remember what we called that? We called it the **phases** of Venus. Well, the reason that the moon seems to change shape in the night sky is that it has phases as well. It's really hard for people to understand how the phases of the moon work. The best way to understand it is to do an experiment.

You will need a lamp and a lightly colored ball (like a baseball or a white Styrofoam ball) on a stick. Put the lamp with its shade removed at one end of a darkened room. Sit at the other end of the room and hold the ball on the stick up in front of you so that it is between your face and the lamp and just slightly above your head. In this exercise, the lamp is the sun; the ball is the moon; and your head is the earth. Now keep your arm straight and slowly spin around in place so that you are constantly looking at the ball and so that the ball is traveling in a circle around where you are sitting. Do this very slowly so you can see how different sections of the ball are lit up. As the ball travels in a circle around where you are sitting, you will see it go through the same phases that the moon goes through. When the ball is between you and the lamp, you see only the dark side of the ball. When the moon is between the earth and the sun like this, it is called a **new moon**. We can't see a new moon because it's totally dark. The night side of the moon is the side facing the earth, and the day side of the moon is reflecting light back to the sun, not at the earth.



This is a drawing of the moon's phases. The moon is drawn in its orbit. The side facing the sun is bright, while the other side is dark. The drawings beside each image of the moon represent what the moon looks like from earth.

Now look what happens as the ball moves so that it is no longer between the lamp and your face. As it moves, you first see that a small sliver of the ball reflects the lamp's light into your eyes. In the same way, when the moon moves so that it is not directly between the earth and the sun, we begin to see a little sliver of the moon. This little sliver is called the **crescent moon**.

As you continue to spin around, you will get to the point where you can see a semicircle of light reflecting off the ball. When the moon reaches a point like that, it looks like a semicircle in the sky. That is called a **quarter moon**. It's not called a "half moon," even though you see it as a half circle. This is because the word "quarter" refers to the fact that at this point, the moon is ¼ (or a quarter) of the way through its orbit around the earth.

As you continue to spin around, you will see that the portion of the ball that reflects light into your eyes gets larger and larger. When the moon starts getting bigger and bigger after the quarter moon, it's called a **gibbous moon**. As you continue to spin around, you will eventually reach the point where your head is in between the lamp and the ball. Because the ball is slightly above your head, however, your head does not block the light from the lamp, and you see the entire side of the ball

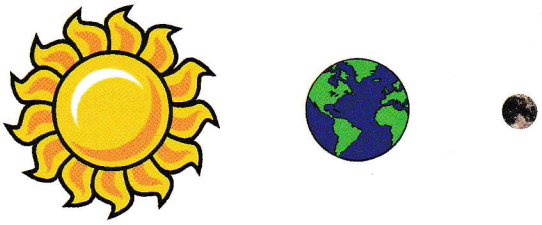
shining with the lamp's light. When the earth is between the moon and the sun, we see the entire side shining down on us, so we call it a **full moon**.

As you continue to spin around, you will see the pattern reverse. The bright part of the ball that you see will get smaller and smaller. Eventually, you will see only half a circle, then a sliver, then a dark ball again. The moon goes through exactly the same phases that your ball went through, and it takes about 28 days. That means it takes 28 days for the moon to revolve around the earth. After that, the whole process starts over again. Twenty-eight days is almost a month, which is why the word "month" comes from the word moon.

In the activity at the end of this lesson, you will begin observing the moon every night for 28 days. In your notebook, you will make a calendar and illustrate the phases that you see.

Lunar Eclipse

Every once in a while, as it is making its way around the earth, the moon gets lined up perfectly with the sun and the earth, as shown in the drawing below. When this happens, you could draw a straight line from the center of the sun, through the earth, and to the moon. This causes a **lunar eclipse**. Do you remember what a solar eclipse is? It's when the moon gets in between the sun and the earth, blocking out the sun. Well, a lunar eclipse is when the earth gets right in between the moon and the sun, blocking the sun's light from the moon.



You should never look directly at a *solar* eclipse. However, you can stare right at a lunar eclipse, and it's a beautiful thing to see! When a lunar eclipse occurs, the shadow of the earth crosses over the moon. If you watch a lunar eclipse as it happens, you will see a circular shadow slowly pass over the moon. It will start at one side of the moon and gradually cover more and more of the moon. In a partial lunar eclipse, the shadow covers only part of the moon. In a total lunar eclipse, the shadow covers the entire moon. The portion of the moon covered in the shadow will be a beautiful reddish-copper color. This happens because the sun's light must travel right through the earth's atmosphere before it shines on the moon. Do you remember what happens when the sun's white light travels through the earth's atmosphere? It bounces off of the gases in the atmosphere. Since blue light tends to bounce off these gases more than other colors of light, the blue light does not make it through the atmosphere. As a

This is a photograph of the moon during a total lunar eclipse.

result, it does not reach the moon. Instead, the red, yellow, and orange light from the sun ends up striking the moon, giving it the beautiful color shown in the picture on the previous page.

Do you understand why it is safe to look at a lunar eclipse, even though it is quite dangerous to look at a solar eclipse? It's because the moon does not produce any light. The only light that we see coming from the moon is the sunlight that it reflects. Because of that, the amount of light that comes from the moon is very small compared to the amount of light that comes from the sun. As a result, looking at a lunar eclipse is very safe, and you should try to see one yourself. I have listed some of the upcoming lunar eclipses in the red box. You can learn more about how to see these upcoming lunar eclipses by visiting the course website I told you about in the introduction to the course.

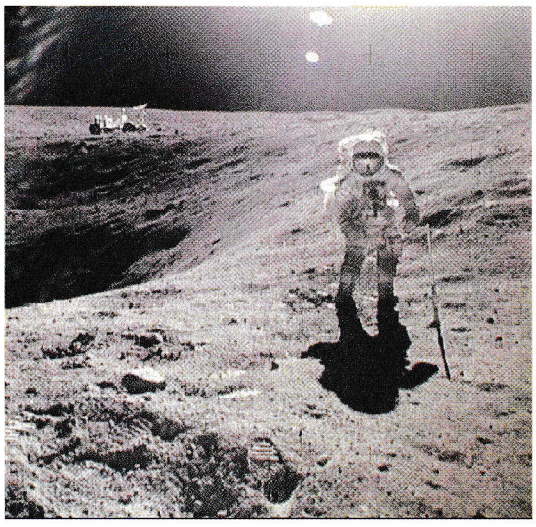
Upcoming Lunar Eclipses

October 28th, 2004
October 17th, 2005
March 14th, 2006
March 3rd, 2007

Lunar Atmosphere

You might hear someone say that a restaurant "has no atmosphere." This means that the restaurant is kind of boring and not very cozy. Sometimes, you'll hear people say, "That place has a lot of atmosphere!" When people say that, they mean the place is warm and friendly. Sayings like these are just expressions, but they do contain a bit of truth. The earth's atmosphere does make the earth a warm and friendly place to live. Remember how our atmosphere is one important thing that protects us and gives us air to breathe? The moon has no atmosphere. So, the moon would not be a very warm or friendly place to live. We would definitely say, "This place has no atmosphere!"

If you went to the moon, everything would be so different from the earth. Without an atmosphere, there would be no protection from the sun's rays. You would need an extra heavy spacesuit so you wouldn't get sunburned. The spacesuit would also carry the oxygen you would need in order to breathe. Because of this, you could only stay outside of your spaceship until your oxygen level got low. You would then have to head back for a refill so that you could explore some more.



This is a photograph of an astronaut walking on the moon. Do you see the very bright glare near the top of the picture? That's from the sun. Notice that the sky is black when the sun is shining, because the moon has no atmosphere.

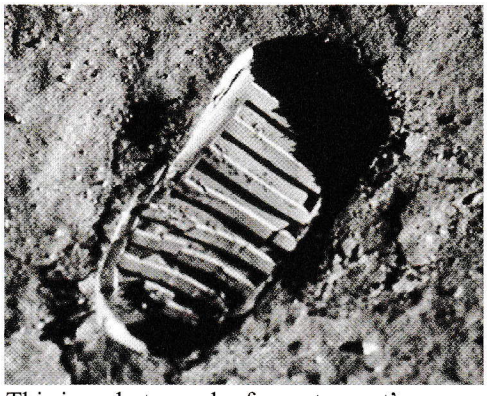
Do you remember why earth's sky is blue? The blue rays of the sun bounce off the gases in our atmosphere, making it look like blue light is coming from the entire sky. As a result, the sky looks blue. Since the moon has no atmosphere, its sky looks black, even during the day. You should remember from Lesson 3 that Mercury's sky is the same. It looks black even during the day because Mercury also has no atmosphere.

Do you remember how our atmosphere protects us from rocks that fall from outer space? Well, space rocks also fall from outer space onto the moon. Without an atmosphere, all those flying rocks crash right into the moon. Some have been so enormous that they have left huge dents on the surface, which we call craters. The moon is scarred with thousands of these craters.

Interestingly enough, the moon rotates very slowly. It takes just as long for the moon to make one rotation as it does for the moon to make one orbit around the earth. Because of this, the same side of the moon is always facing the earth. We call that side of the moon the **maria** (mar' ee uh). Whenever you look up at the moon, then, you always see the same side: the maria. Compared to the other side of the moon, the maria has very few craters. This is a bit confusing to scientists who want to believe that the moon is billions of years old. If the moon were really that old, there should be craters all over its surface, since there is no atmosphere to protect the moon. The maria should not have so few craters as compared to the other side of the moon. Of course, if you really want to believe that the moon is old, you can always come up with some reason to explain the fact that there are few craters on the maria. Those who want to think that the moon is billions of years old say that the maria's surface has been smoothed out over the years due to changes that have occurred on the moon. Of course, a more reasonable explanation for the fact that the maria has few craters is that the moon is not as old as some scientists think.

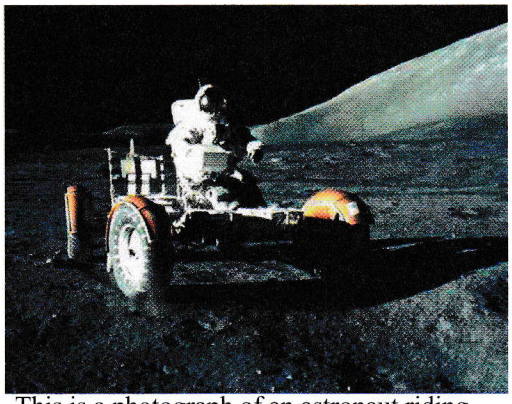
Walking on the Moon

The moon is the only place in our whole solar system, besides the earth of course, that people have actually visited. The first man who walked on the moon was an American named Neil Armstrong. He went to the moon on a spaceship called Apollo 11 and took the first steps on the moon on July 20, 1969. Do you see the footprint in the picture on the right? That is an astronaut's footprint in the dirt on the moon. Even though this footprint was left on the moon quite some time ago, it is most likely still there. Why? Well, if you leave footprints in the dirt in your backyard, wind will eventually blow the dirt around, filling in your footprints. That will make your footprints disappear. Rain might also smooth out the dirt, once again destroying your footprints. On the moon, however, there is no wind or rain. Because of that, the footprints do not get filled in. If people visit the moon again sometime in the future, they will probably see the same footprints left by astronauts way back in 1969.



This is a photograph of an astronaut's footprint on the moon.

Many spaceships have gone to the moon, but only 12 men have ever walked on the moon. Some of these men not only walked on the moon, but they actually rode a special car that they took with them. It was called the **lunar rover** (see the picture on the next page), and it allowed them to


This is a photograph of an astronaut riding the lunar rover on the moon.

explore more of the moon than they otherwise would have been able to explore. Some people say that we have never actually been to the moon. They say that the pictures we have of men on the moon have all been faked, and that the samples of moon dust and moon rocks are not from the moon at all. There are many arguments which show that these people wrong. If you would like to read more about the people who think we did not visit the moon and the reasons they are wrong, you might visit the course I told you about in the introduction.

Do you think you will ever walk on the moon? If you become an astronaut, you might walk on the moon, or even a planet like Venus or Mars!

The Moon's Gravity

A spacesuit seems like it would be very heavy doesn't it? Interestingly, your spacesuit would not feel very heavy on the moon. That's because there is a lot less gravity on the moon compared to the gravity on earth. Why? Do you remember what determines a planet's gravity? It is the mass of the planet. Well, the mass of the moon is a *lot* smaller than the mass of the earth. As a result, the moon's gravity is weaker than the earth's gravity.

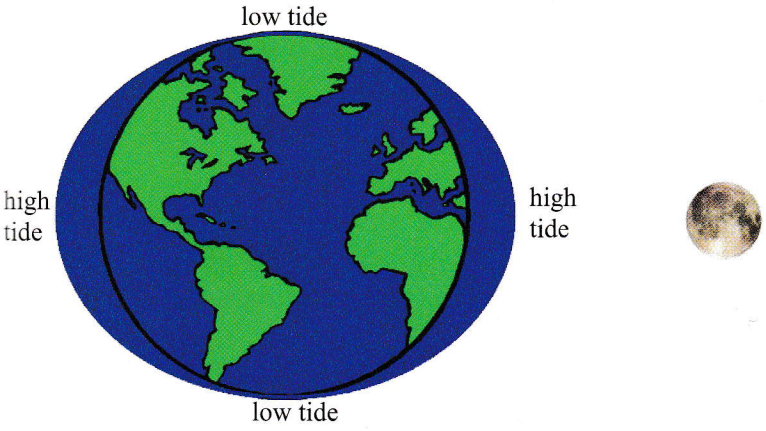
Even though the moon's gravity is weaker than the earth's gravity, it is still there. Because of that, if you were to drop a ball on the moon, it would fall to the ground. However, it would not fall nearly as quickly as it would on earth. If you jumped up as high as you could on the moon, you would still end up falling back to the ground. However, you would go up a lot higher than you could here on earth, and you would not fall back to the ground nearly as quickly as you would on earth. You could jump up and do a somersault in midair and not hurt yourself at all, even if you didn't land on your feet. That's because the moon's gravity would not pull you down as hard as the earth's gravity does.

Because the moon's gravity is so weak, you would not weigh very much on the moon. Look at the chart below to see if you can figure out how much you would weigh on the moon.

Your Weight on Earth	Your Weight on the Moon	Your Weight on Earth	Your Weight on the Moon
20 pounds	3 pounds	70 pounds	Over 11 pounds
30 pounds	5 pounds	80 pounds	Over 13 pounds
40 pounds	Over 6 pounds	90 pounds	15 pounds
50 pounds	8 pounds	100 pounds	Over 16 pounds
60 pounds	10 pounds	150 pounds	25 pounds

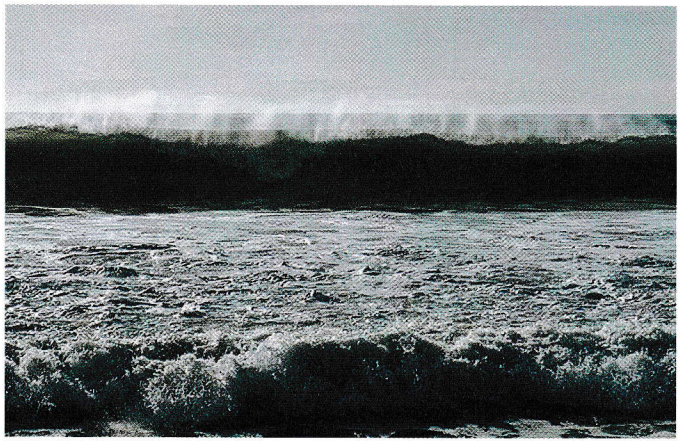
If you have ever been to the beach, you might remember walking a long way just to get to the water. If you visited that same beach at another time, you might have noticed that you did not have to walk nearly as far to get to the water. In other words, when you stand on the beach, sometimes the water is near you, and sometimes the water is far away. This is because the ocean has **tides**. When it does not take very long for you to walk down to the water, we say that the ocean is at **high tide**. When it takes a long time for you to walk down to the water, we say that the ocean is at **low tide**.

Believe it or not, the moon's gravity is what causes the tides. It pulls on the earth's oceans, making them bulge outwards toward the moon. Do you know what "bulge" means? If you put your stuffed animals in your shirt, it would bulge out. To "bulge" is to be "pushed outward." The moon pulls on the oceans, and the oceans bulge towards the moon. If the moon makes the ocean bulge towards the shore where you are standing, you see the high tide of the ocean. If the moon makes the ocean bulge towards the shore on another part of the world, you see the low tide of the ocean.



The moon's gravity pulls on the oceans, causing them to bulge out towards the moon. This makes parts of the earth experience high tide, while other parts of the earth experience low tide.

If you have visited the beach, you have probably seen that the ocean has waves. Although the tides can cause certain types of waves, the waves that we see on the shore are not caused by the tides. They are usually caused by wind. Please don't confuse the tides with waves. Tides determine how close the ocean water is to you when you walk onto a beach. At high tide, the water is much closer to you than at low tide. Waves cause the ocean water to heave back and forth. They do not really affect how close the ocean is to you.



If the moon were no longer in the sky, our oceans would not have tides. God gave us an unusually large moon that has enough gravity to pull on the ocean's water. He did this because when the tide comes in and goes out, it cleanses the shoreline. The motion caused by the tides also refreshes the water. Still water can get pretty stagnant, and the tides keep the ocean from getting that way. God planned it so that the earth would have an extra big moon to help keep the oceans fresh and clean.