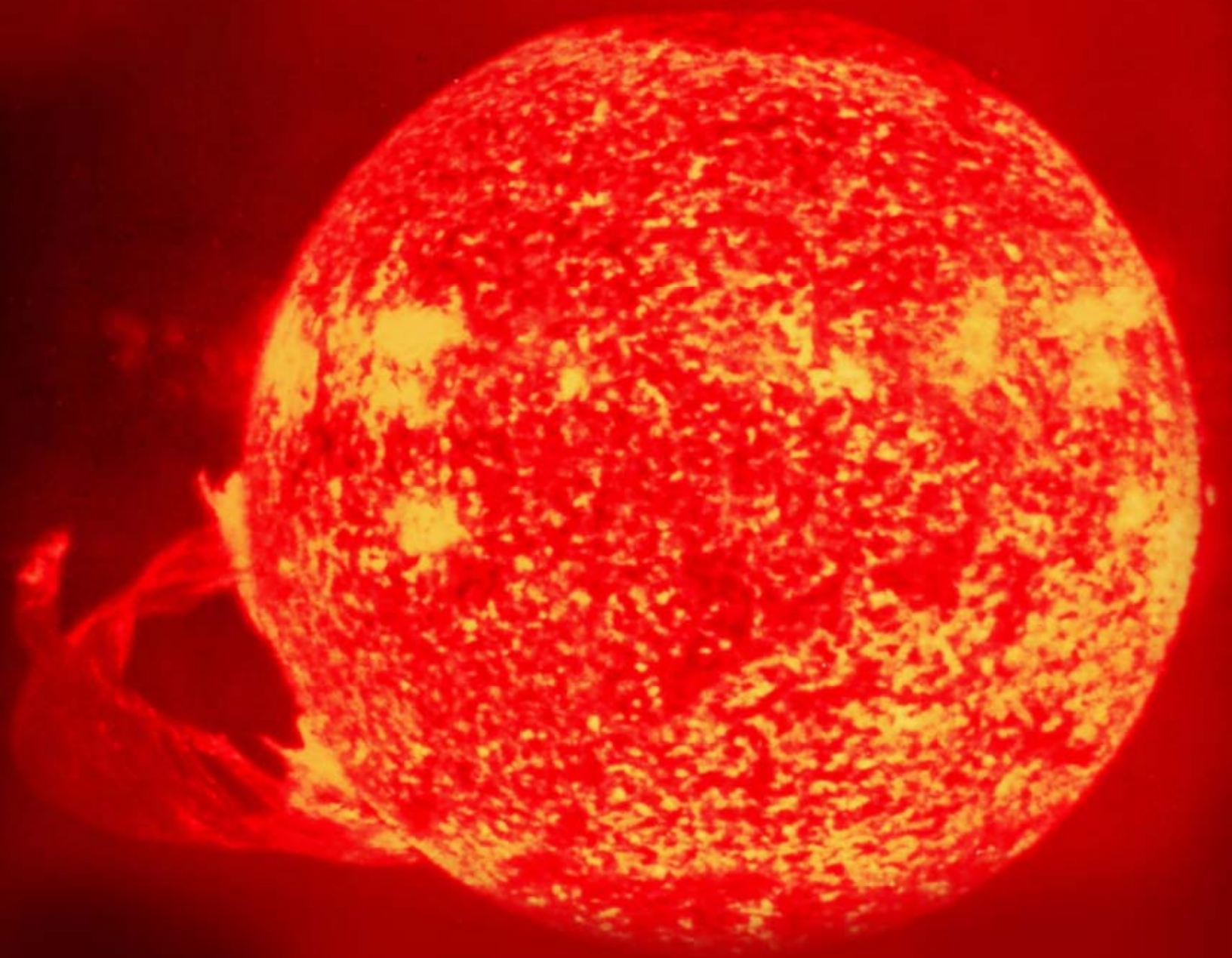
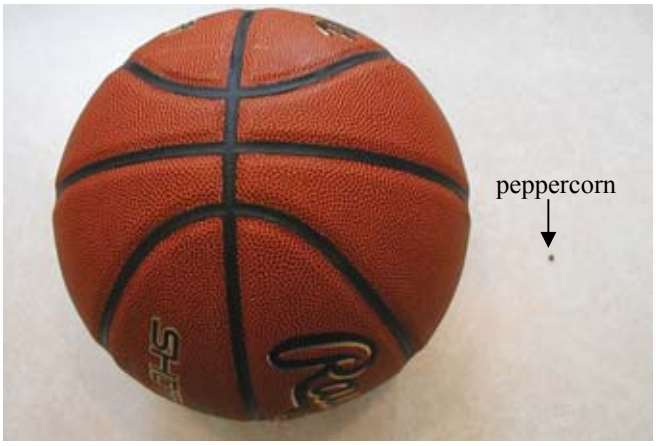
Lesson 2
The Sun



The Star of Stars

The sun seems so small up in the sky, but it is one of the biggest things God created. It is so enormous, so gigantic, that you have never seen anything so big in all of your life. It's bigger than the biggest thing on earth. What's the biggest thing you can think of that you have seen on the earth? Did you know that the sun is millions of times bigger than that? The sun makes everything on earth, and even most things in space, look like tiny little specks of dust or tiny little ants. The difference in size between the earth and the sun is very great. You can see the difference if you compare a small peppercorn to a basketball. If you don't have a basketball, a dinner plate will work also. Just remember that the sun is not flat like a plate.



If the sun were the size of the basketball in this picture, the earth would be the size of the peppercorn on its right.

Now look at these two objects next to each other. The peppercorn represents the earth, and the basketball or plate represents the sun. Amazing isn't it? One million earths would fit inside the sun! The whole entire earth is like a tiny speck compared to the sun. If the earth is so small compared to the sun, imagine a mountain on the earth compared to the sun. Imagine a person compared to the sun. Imagine an ant compared to the sun!

Why does the sun seem small in the sky if it so much bigger than the earth? Shouldn't it look big to us since we are tiny in comparison? Well, look out the window. Find something on the earth, a house or tree or mountain that is really far away, as far away as you can see. Then close one of your eyes and hold your finger up next to that far away object. Do that now.

Doesn't it look like that object is smaller than your finger? You know that the object is much larger than your finger, but your finger seems bigger is because it's closer. The closer an object is to us, the bigger it will seem. Even big objects look tiny when they are far away.

92,935,700

Can you say that number? It will help if you call the first comma "million" and the second comma "thousand." That is a giant number. Ninety-two million, nine hundred thirty-five thousand and

seven hundred is how we say it. That's how many miles we are away from the sun. That is further than you can even imagine. Most people "round up" and just say ninety-three million miles.

How many miles did you travel last time you went on a trip? Did you go 100 miles? 700 miles? I bet you didn't go ninety-three million miles. It would take years and years to get to the sun if we tried to travel there. But we wouldn't ever do that, because it is just too hot!

The sun is alight with heat and swirling gases. God made the sun so hot that we can feel its heat millions of miles away. The hottest your oven can get is about 500 degrees. The sun is usually about 10,000 degrees on the outside and millions of degrees on the inside! If something were as hot as the sun and it touched the earth, it would burn a hole all the way through in an instant. God put the sun the perfect distance from the earth. If it were closer, the water in the oceans would evaporate. The trees and plants would all die, and we would all burn up. If the sun were further away, its warming energy would not reach us, and the oceans would freeze into big blocks of ice, and so would we.

Don't Stare!

The sun's light is so powerful that it isn't even safe to look at the sun! It can cause terrible damage to your eyes if you stare at the sun. Have you ever looked at a bright light bulb and then had to look away after a moment? Well, the sun is about a million times brighter than a light bulb. This is why you can injure your eyes if you look directly at the sun. The sun is so bright that it wouldn't even be safe to look right at the sun if you were standing on Pluto, the furthest planet from the sun! To study the sun, scientists look at it with the help of special tools.

Did you know that you can take a magnifying glass out into the sun and burn little holes in leaves? This works especially well during the summer when the sun is shining its light more directly upon us. When you focus the sunlight coming through the curved lens of the magnifying glass for a short period of time, it will burn a hole in the leaf. This happens because the rays of light get bent by the curved lens and concentrated to a small spot, focusing all of the heat and energy there. That's a lot of heat and energy to be going to one spot. That's why it burns a hole in the leaf. Well guess what! You have a lens just like a magnifying glass in your eye! If you look at the sun, your eye-lens will concentrate the sun's light and focus it to a very small spot on the back of your retina (the back wall of your eye.) This can cause permanent eye damage or blindness. Also, there are no pain sensors in

your retina, so you wouldn't even know it's happening! Please do not ever look directly at the sun, but you are welcome (with your parent's permission) to take a magnifying glass to a leaf!

Can you explain what you have learned so far in your own words?

Revolve and Rotate

When one object travels in a circle around another object, it is orbiting that object. In other words, it is revolving around that object. We use the word "orbit" or "revolve" to mean the same thing. One object is in the center, while the other object moves in a circle around it.

The earth *revolves* around the sun

Have you ever heard it said that someone's life or world revolves around something or someone? One person might say, "Her life revolves around ballet." Another person might say, "That mother's world revolves around her baby." That is just an expression. It means that something is very important to someone. What does your life revolve around? It is best for all our lives to revolve around Jesus, for He should be the Ruler of our lives!

Many years ago, astronomers and everyone else believed that the sun revolved around the earth. Every morning they would see the sun coming up in the east and going down in the west. It just seemed logical that it was circling around the earth.

But now we know that the sun is in the center of the solar system, and the earth revolves, or orbits, in a circle around the sun. Remember that a satellite is an object in space that revolves around another object. The earth is a satellite of the sun, just as the moon is a satellite of the earth! The sun has many satellites, including the nine planets and thousands of asteroids, comets, and meteoroids. The earth has only one natural satellite (the moon), but there are thousands of artificial satellites orbiting the earth.

Take a Walk Around the Sun

Here is an activity to try, but you will need another person and an area that has some space. Place an object on the floor and call it the sun. If you have three people, you can make one person the sun. Have someone be the earth and walk in a circle around the sun. Now you be the moon and walk in a circle around the earth while the earth circles the sun. The same side of the moon always faces the

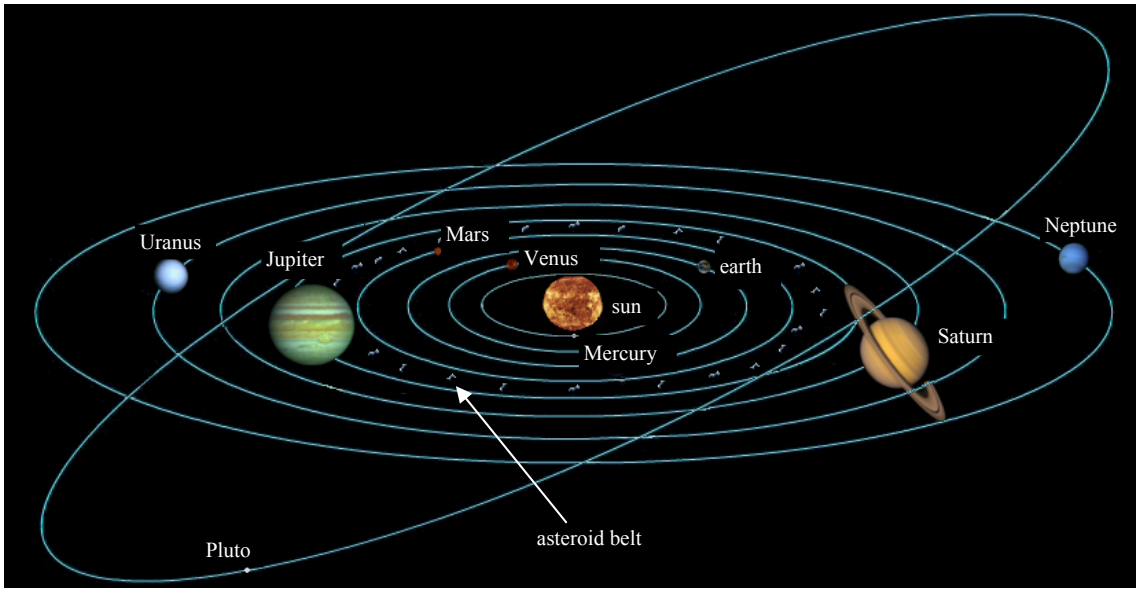
earth, so while you are the moon, be certain that you are always facing the person that is the earth. Do this several times until you can do it easily.

Was that hard to do? That's what the planets are doing every day, all day long!

Every time a planet goes all the way around the sun and comes back to the same spot, it has completed one revolution around the sun. We would say it has done one orbit, or has revolved one time. When the earth completes one revolution around the sun, we say that a year has passed.

Did you know that as the planets orbit around the sun, they are also spinning around at the same time? This is called rotating. They are rotating as they orbit the sun. Now try this little adventure: just as before, put something or someone in the middle of the floor to be the sun. Now you pretend that you are a planet. Before you begin to walk around the sun, start turning around and around in place. Just twirl around in place, and then begin to walk around the sun while you twirl around at the same time.

I bet you got a little dizzy. Even so, that is what's happening with all the planets every moment of every day.



This is a drawing of our solar system. The planets orbit around the sun in paths that are almost (but not quite) circles. While they orbit around the sun, they also rotate. A planet's rotation causes night to turn into day.

Did you notice that while you were twirling around, sometimes you faced the sun and sometimes you faced away from the sun? Well, it's the same with the planets! One part is facing the sun, and then it turns and is facing away from the sun. When we face the sun, it's very bright and light. We call this day. When we are facing away from the sun, there isn't any light shining on us. We call it night. One side of the planet is always facing the sun, so it is always day somewhere on the earth. Every planet rotates, so every planet has a day and a night. Even the moon has a day and a night.

This spinning around, or rotating, is happening right now! We are rotating while we revolve around the sun, and God made it so that we don't even get dizzy! Try not to confuse these two terms: revolve and rotate. Rotating is the spinning that makes it day and night. You can think of it this way: "It rotates between day and night." Revolving is the orbiting around the sun that takes a year. Remember that people say someone's life revolves around things. Well, it's easy to remember that someone's life would revolve around that thing for a whole year.

The earth *rotates*, which turns night into day.

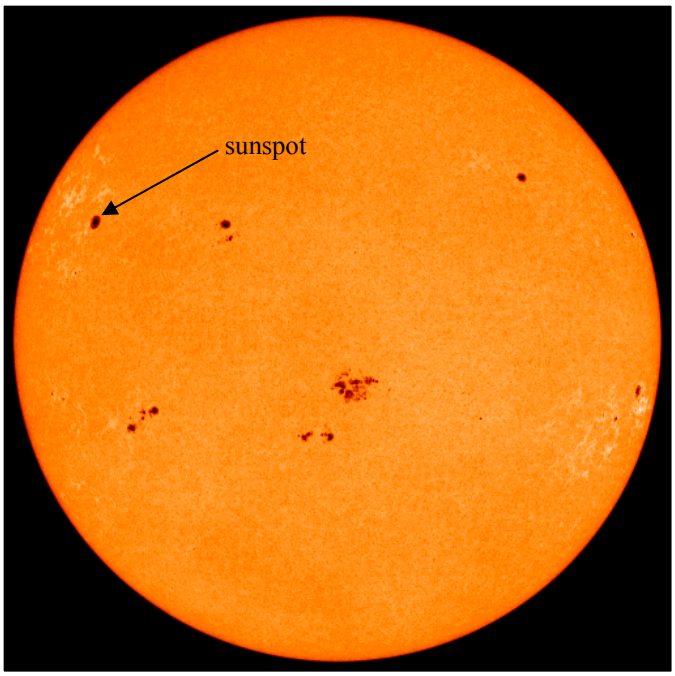
Can you explain in your own words the difference between rotating and revolving? Explain it to someone else today so that you will always remember it.

Solar Flares and Sun Spots

The sun is very active. The fire on the sun is jumping and hopping and rolling about, something like a campfire does. It is a huge ball of very active fire that is spinning around and around. In the large picture of the sun on the right, you can see flares of fire darting out from the sun. That is called a solar flare. It is a giant tower of fire that is many times larger than any planet in our solar system. Look at the drawing of the earth that has been placed in the picture. See how small the earth is compared to the solar flare? That gives you some idea of how big it is! Solar flares burst out millions of miles from the sun. The solar flares throw so much energy and electricity toward the earth that people in the far north and the far south can see colorful electrical lights up in the sky at night caused by these flares. These lights are called **auroras** (uh roar' uhs). Sometimes a solar flare can make a burst of energy come through a city's power lines so forcefully that the entire city can lose its power and electricity. Solar flares can also cause problems in telephones and radios.

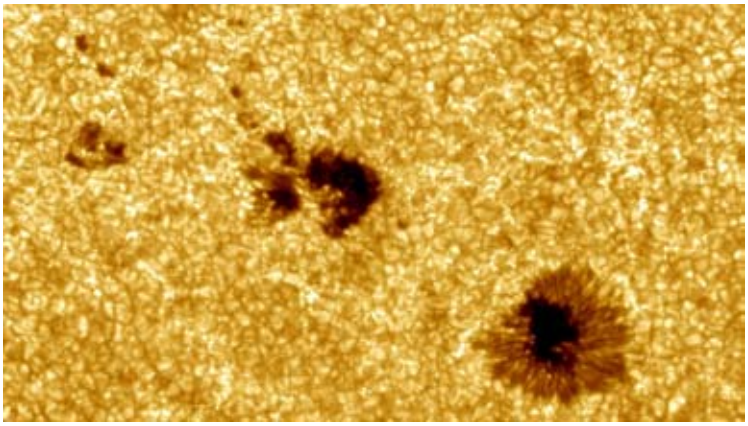
This is a photograph of a solar flare coming off the sun. The earth has been drawn in the picture to give you an idea of how big the flare is.

Look at this picture of the sun. It was taken with special tools used to study the sun. Do you notice anything interesting about this picture? There are little dark spots on the sun. They are called **sunspots**. They are spots that are cooler than the rest of the sun. They are about 4,500 degrees. That's still very hot, but much cooler than the rest of the outer part of the sun. Do you see the dark spot pointed out in the photograph? That spot is bigger than the entire earth! Some are so big that they are ten times bigger than the earth.



This is a picture of the sun. The dark spots are sunspots.

Many scientists believe that sunspots affect the weather here on earth. You see, when the number of sunspots on the sun is large, the sun is actually *hotter* than when the number of sunspots is small. This may seem strange to you, since the sunspots themselves are cooler than the rest of the sun. However, scientists think that sunspots result in more activity in the sun, so the sun actually gets hotter when there are more sunspots. Without sunspots the earth would be cooler than it is today. This happened a few hundred years ago (1645-1710). During those years, scientists could not see any sunspots on the sun, and the earth was many degrees cooler than normal. In the same way, if there were too many sunspots, the earth would get really hot, and rain would not fall as often. This would cause severe **droughts** (drouts) on the earth. Droughts are long seasons with no rain. When it doesn't rain, the plants die. Without the plants, many animals die as well. People also depend on rain to live. The food we eat cannot grow without a lot of rain. A drought can be a very dangerous thing for life on earth. God has designed our sun with sunspots to help the earth stay at the right temperature. Everything in the universe is God's design. He has taken special care with every feature of the universe to protect us on earth.


This is a close-up view of a few sunspots.

Mid-lesson Assignments

Because there are so many interesting things to learn about the sun, we are going to break up this lesson with two assignments and an activity.

First Assignment:

Make an illustration for the sun chapter of your notebook.

Second Assignment:

Write or dictate a speech about why people should not look at the sun. You may want to begin with some interesting facts about the sun that you have learned so far. Be sure to explain what happens to your retina when you do it. You can also make a poster with illustrations. Practice your speech several times. Try to memorize it so you will not sound like you are reading when you give your speech to others. It often helps to write one important key word from each sentence on an index card. Then you just glance at the key word and remember what your next sentence is. This will help you to sound like you are *talking* to your audience and not *reading* to your audience. Once you have practiced the speech and feel as though you know it by heart, give your speech to your family, your school, or your homeschool group. If there are several ages of children giving speeches in one family, allow the youngest children to go first.

Mid-lesson Activity

Use a Magnifying Glass to Focus Heat

You will need:

- A magnifying glass
- A refrigerated chocolate bar (Any candy bar that has a lot of chocolate in it will do. Make sure it has been in the refrigerator for a while so that it is cold.)
- A nice sunny day

Instructions

1. Break the chocolate bar into at least three pieces.
2. Take those pieces and your magnifying glass outside.
3. Set the pieces of chocolate bar on the ground, and hold the magnifying glass in your hand.
4. Point the magnifying glass down at the ground away from the pieces of chocolate. Make sure that light from the sun is hitting the magnifying glass.
5. Move the magnifying glass up and down, and play with how you are holding it, until you see a circle of light on the ground. This circle of light is made because light rays from the sun are traveling through the lens of the magnifying glass and are concentrated into a circle.
6. Move the magnifying glass up and down. You should see the size of the spot of light change. It will get bigger or smaller, depending on how close the magnifying glass is to the ground. Get used to how the size of the spot varies as you move the magnifying glass up and down.
7. Lay your pieces of chocolate out on the ground so that they are a few inches apart from one another.
8. Use the magnifying glass to make a spot of light hit one of the pieces of chocolate. Try to make the spot of light as small as possible. Watch what happens for the next few minutes.
9. Do the same thing to the next piece of chocolate, but this time, make the spot of light a little bigger. Once again, watch what happens for a while.
10. Try this on the last piece of chocolate as well, but make the spot even bigger this time. Once again, watch what happens for a while.

What did you see in the experiment? You should have noticed that the chocolate didn't melt much when it just sat out in the sun. However, as soon as you used the magnifying glass, the chocolate should have melted quickly. Why? The magnifying glass concentrated the energy of the sun's light into a small spot. That heated up the chocolate, which made it melt. You should also have noticed that the smaller the spot, the faster the chocolate melted. That's because the smaller the spot, the more concentrated the energy. That resulted in even more heat, which melted the chocolate more quickly.

Creation Confirmation

Did you know that God designed the sun to get its power by little explosions that happen over and over again deep inside the sun? Something called **thermonuclear** (thur' moh new' klee ur) **fusion** is making all those little explosions. That's a big word, but now you know it. So next time someone asks you how the sun gets its power, tell them, "thermonuclear fusion!" What is even more exciting is that thermonuclear fusion makes the sun brighter and brighter each year. Can you believe the sun is actually getting hotter and hotter as it gets brighter and brighter? It is!

Thermonuclear fusion tells us that there could not have been life on earth billions, or even millions, of years ago. You see, since the sun is getting brighter and brighter each year, if we were to go back in time, we would see the sun getting dimmer and dimmer each year. In fact, if we were to go back billions of years, the sun would have been so dim, or faint, that it could not have provided enough warmth for life on earth.

If temperatures on earth were much cooler than they are now, there would be terrible consequences. Oceans would freeze, and it would be winter all the time. Even with the sun's current hot temperature, Antarctica is still very, very cold. Scientists have discovered that the sun would have been many times cooler, actually more than 30% cooler, if it were here billions of years ago. No life could have survived on the earth if the sun were that cool, because the earth would have been a frozen chunk of ice water, with frozen land scattered about. Not a single thing could survive such temperatures. This gives us good evidence that life on earth is young, certainly not millions or billions of years old, as some might want you to believe.

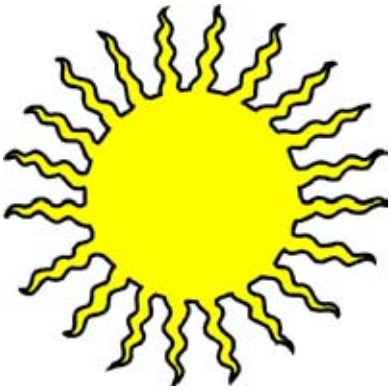
The Color of God's Love

What color is the sun? When we look through special equipment or when the sun is setting in the sky, we see it as orange. However, the color of the sun is actually all the colors of the rainbow! So the sun is red, orange, yellow, green, blue, indigo, and violet. All those colors make every single color in the whole world, so we have a very colorful sun. All the color you see in the world comes from the sun. Without the sun, we would have no color at all!

The sun shines out white light, but that white light is actually all the colors put together, except for black. We call it white light, but it's really very colorful light, since it makes all the colors in the rainbow.

Light always travels in a straight line. It does not bend or go around corners. You know this because when you put your hand in front of your face to shield your eyes from a bright light, like the sun, it casts a shadow across your face. The light does not bend and go around your hand into your face. The reason it is shady under a tree is because light travels in a straight line that does not bend around tree branches.

How do we get color? Let me see if I can explain this so that you will understand. Pay close attention. Light is a form of energy. Light energy travels out from the sun in a straight line. Although that line is going on a straight path, the line is curvy, or wavy. In other words, light energy is wavy. Each color is a different size wave. Blue waves are short, as in the picture below. Yellow waves are long, as in the picture below that. I know it's strange to think of color as different kinds of waves, but that is what it really is.



BLUE LIGHT HAS SHORT WAVES

YELLOW LIGHT HAS LONG WAVES

How does it all work? Well, when light hits an object, many of the waves of light absorb into it. To "absorb" means to "take in" or "suck up," the way a towel absorbs water. Almost everything absorbs at least some light waves. Some waves absorb but some don't. Instead, they bounce off. The waves that bounce off the object bounce up into your eye. Your eye sees the bounced light waves. So, when you see a yellow object, you are really seeing the long yellow light waves that bounced off the object and hopped into your eye.

Your eyes and brain are what make it appear yellow. God made your eyes and brain in such a marvelous way. Your eye tells your brain what kind of light it is seeing, and your brain makes the color appear as it does. Now, if there was no eye there to see the object, yellow light would still bounce off the object, but it wouldn't go into anyone's eye to see it as yellow. It would just bounce up until it hit an object that would absorb it. So, here's a question: Is the yellow object still the color yellow if there is no eye there to see it? Hmmm…that is an interesting question. You decide.

Now why does the sun look orange if its light is really all colors? Well, the earth is covered with a layer of mist and gases called our **atmosphere** (at' muh sfear). When the sun's light waves

travel through the atmosphere, the short-waved light bounces off the stuff in the atmosphere. When we look up at the sky, those bounced light waves hit our eyes, so our atmosphere appears the color of the bounced light waves. Remember that blue light has short waves. That is why the sky looks blue. All the blue light gets bounced off the stuff in the atmosphere, so the atmosphere looks blue.

If we look at the sun, we see light that has traveled straight from the sun to our eyes. In other words, we see the light that does not get bounced around. If the sun's rays were not bouncing off stuff in our atmosphere, the sun would look white, because all the colors combined make white light. Sometimes the sun does look white when it is straight overhead. That's because the light is not passing through as much atmosphere when it is straight overhead, so not much light is bounced around. As a result, we see all colors of light coming from the sun, which makes the sun look white.

When you see the sun at sunset, the light waves travel through much more atmosphere, and most of the short-waved blue and green light has bounced off by the time it reaches your eye. This makes the sun looks a very deep orange, because those are the colors that do not get bounced around in the atmosphere. We call this a beautiful sunset.

White light coming out of the sun is all the colors together except for black. What, then, is black? Well, when all the colors of light get absorbed into the same object, it makes the object appear black to the human eye. None of the colors bounced off, and that is why it is black. So a black object does not have any waves bouncing into your eye. It absorbs all the energy that the sun's light is pouring down on it. Nothing is bouncing up to make it a particular color. That is why black is not really a color. Color is what you see when something bounces into your eye.

Now, if every single color from the rainbow bounced off the object and into your eye, what color would the object be? Well, think about it. All the colors from the rainbow make white light. So…if the whole rainbow bounced into your eye, you would see the object as white!

White objects do not absorb much light energy, because all colors of light bounce off them. Black objects absorb a great deal of light energy, because they absorb all colors of light. That is fine inside when the light is coming from light bulbs. But when the light is coming from the sun outside, you will notice that black objects are very, very hot. They have a lot of energy sucked into them. White objects are not very hot. They reflect, or bounce off, all the sun's light. So, when you are barefoot in a parking lot during the middle of the summer, and you are waiting for your mom to open the car door, stand on the white dividing lines instead of the black pavement. They are much cooler.

Do you understand why we see color? This is something that is easy to forget. Explaining what you have just learned to someone will help you remember it. Do that now!

God's Light Shines Brighter

The sun is splendid, indeed. But we know God is even more splendid. If it is dangerous to look at the sun because it's so bright, think how much more difficult it would be to look at God in all His glory.

Did you know that when Moses asked to see God, God said, "You cannot see My face, for no man can see Me and live." (Exodus 33:20) So God hid Moses behind some rocks and passed by Moses, who just got a glance of the backside of God's glory passing by. Just from glancing at the tail end of God's glory, Moses' face glowed for a long time. He had to wear a veil over his face so that the Israelites would not be afraid of him. When we read in the Bible about people seeing angels or Jesus when he was transfigured, they are described as being very bright, like a light. God's holy angels are called angels of light.

This is an illustration of the angel Gabriel announcing to Zacharias that his wife is pregnant with John the Baptist. (Luke 1:11-20)

The sun gives us a small clue as to the splendor of God. Isn't it astonishing that our God is so much brighter and more glorious than even the very bright and amazing sun? It's hard for our minds to imagine that, but if we ask God, He will give us a better understanding of all this.

The Bible tells us we will not always need the sun as we do now. When the Lord returns and transforms the world back to its original perfection, God will be the light for us in the day and the night. His light will be all the light we need. Isaiah 60:19 says, "No longer will you have the sun for light by day, Nor for brightness will the moon give you light; But you will have the LORD for an everlasting light, And your God for your glory."

So, even though the sun is so important to life here today, it is only temporary. God is eternal, which means He is forever. We can be certain in our hearts that everything is going to work out according to His wonderful plan! The day will come when God sets up His kingdom on a perfect earth with flawless beauty and splendor in the heavens. We wait eagerly for that day!

Solar Eclipse

What would you think if you went outside one day, in the middle of the day, and there was no sun? You looked around for it, but it was completely gone. It was the middle of the day, but there was

darkness all around. Well, something like this happens every once in a while. The sun seems to disappear in the middle of the day for a few minutes, and it seems like nighttime. Then the sun reappears. What makes the sun seem to disappear? It's the moon! The sun gets hidden behind the moon, and its light does not shine down upon us for a moment. It's called a **solar eclipse** (ee klips'). Every year at least two solar eclipses occur. Sometimes there are up to five in one year! You do not see this many, because they are not all visible from where you live. Only certain parts of the world can see an eclipse when it happens. Most eclipses last for only a few minutes, but some have lasted for up to seven minutes. When that happens, animals get confused and sometimes prepare to go to sleep, thinking it's nighttime.

This is a picture of a solar eclipse. The dark circle in the middle is the moon, and you can see that it is blocking out most of the light that is coming from the sun.

A solar eclipse happens when the moon gets right in the path between the earth and the sun. Since the sun's light does not bend around the moon, it casts the moon's shadow across the earth. The moon is teeny tiny compared to the sun, but since the moon is so much closer, it appears bigger and blocks out most of the light from the sun for a few minutes.

Try this to see how it works: Look at the light in the room you are in. Now, close one eye and hold your thumb up in front of your face. When you do this, your thumb blocks out the light. Your thumb is much smaller than the light bulb, but you could block out the light because the light was far away and your thumb was close. Do you see how the moon could make the sun seem to disappear?

When there is a **total eclipse**, the sun is completely hidden behind the moon. During an **annular** (an' yuh ler) **eclipse** the sun is directly behind the moon, but a ring of sunlight can be seen around the blackened moon. This happens because the moon is sometimes farther away from the earth during an eclipse, and it cannot completely hide the sun.

With one eye closed, hold your thumb so it blocks the light in your room again. Now slowly move your thumb farther away from you. Can you see a little bit of the light bulb behind your thumb? That is like an annular eclipse.

Sometimes during an eclipse, the moon is not directly between the sun and the earth. It is only partially between the two. These are called **partial eclipses**. "Partial" means, "part." During a partial eclipse, you can see a part of the moon pass in front of the sun. It is still an amazing site to see. Full and partial eclipses are astounding, but you must only look at them through special eclipse-viewing glasses or a special eclipse-viewing box. It is important that you understand that looking directly at the sun, even during an eclipse, could cause permanent eye damage and even blindness. We will make a special eclipse box at the end of this lesson so that you can view the sun and a solar eclipse safely. You can save the box for when there is an eclipse in your area.

The moon is not a perfectly round ball. It has many gigantic holes, called craters that give it an uneven surface. You can see these holes very clearly through a telescope. During an eclipse, little points of light reflect off these holes. We call these bright points of light **Bailey's Beads**. They look like little bright balls, or beads.

As long as you use the right equipment, watching a solar eclipse is a lot of fun. Of course, solar eclipses don't happen very often, so you need to make sure you know when the next one is. That way, you won't miss it. Go to the course website that I told you about in the introduction to the course. That website will have links to other websites that tell you when the next solar eclipses are supposed to happen. Make sure to mark them on your calendar so that you won't forget to watch!

What Do You Remember?

Do you remember how many earths would fit inside the sun? How many miles away is the sun? What is the solar system? Explain what sunspots are. Do sunspots help us at all? Does the sun have a satellite? Can you explain the difference between revolving and rotating? How does the sun tell us that there were not living things on the earth billions of years ago? Do you remember why you see color? Which color has short waves? Can you explain what a solar eclipse is? If you had trouble answering these questions, it might be a good idea to read this lesson again. Explaining these things to someone will help you better understand and remember what you have learned.

Assignment

Older Students: Look through old magazines and cut out pictures of the sun. Make a collage with all these pictures in your notebook. On a separate page of your notebook, write down important facts that you wish to remember about the sun.

Younger Students: Have your child look through old magazines to cut out pictures of the sun. Help him to make a collage of these images in his notebook. Have him dictate to you what he remembers about the sun, and write that in his notebook.

Activity

Make a Solar Eclipse

You will need:

- A flashlight
- A globe (or round ball)
- A Styrofoam® ball (or any small ball) on a string

1. Place your globe on a table or floor.
2. Set your flashlight upon a stack of books until it is shining directly on the center countries of your globe.
3. Turn off the lights.
4. Lower the Styrofoam® ball down between the flashlight and the globe, but make sure it is closer to the globe than it is to the flashlight. Move it until it is projecting a dark shadow on the globe, as shown in the picture. Notice the dark, round circle that is projected onto the globe. That is called the "umbra" (uhm' bruh) of the eclipse. The people within that dark circle experience a total solar eclipse. The lighter shadow that surrounds the dark circle is called the "penumbra" (puh nuhm' bruh), and the people in that section experience a partial solar eclipse. Notice that the umbra and penumbra are not on most of the globe. The parts of the globe that do not have an umbra or penumbra do not experience any kind of eclipse. This is why a solar eclipse is not visible in all parts of the world. Though we have several eclipses a year, they are visible in only a few countries.

Project
Pinhole Viewing Box

You are going to make a pinhole viewing box that will help you to safely study the sun. You will not look at the sun directly through the pinhole. Instead, you will project an image of the sun onto a sheet of paper at the back of your box. The light from the sun will come through your pinhole and will shine an image of the sun onto the paper.

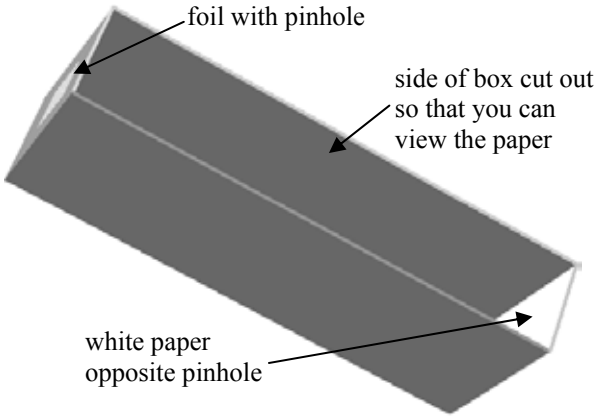
You can use this to view the sun and, if they are big enough this year, you will be able to see its sunspots! Be sure to save it for when there is a solar eclipse! **Do not ever look through the pinhole directly at the sun**. The pinhole will shine the shape of the sun onto the back of your box, and that's what you need to look at.

Instructions

You will need:

- A parent
- A box
- Scissors
- White paper
- A pin or needle
- Tape
- Aluminum foil

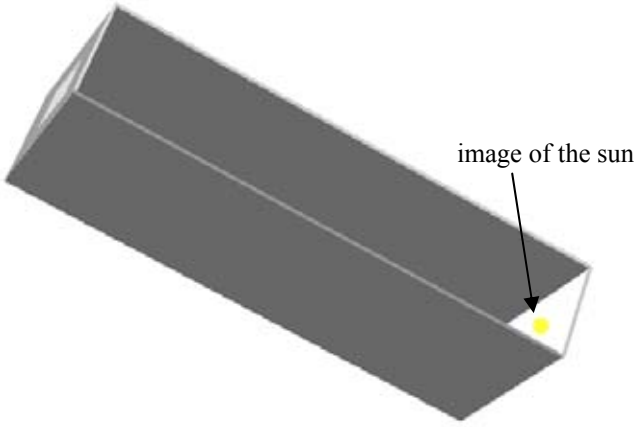
1. Find a box. The length of the box is important. The longer the box, the bigger, but fuzzier, the pinhole image. A shorter box gives you a smaller, clearer image. If you can't find a long box, you can tape together two or more boxes to make a longer one.
2. Use the scissors to cut a viewing hole in the side of the box. You can cut the whole side off of the box, or just a hole big enough so that you can see the back end of the box.
3. Use the scissors to cut a hole in the center of one end of the box. This will be the pinhole side.
4. Tape a piece of foil over the hole you just cut into the pinhole side.
5. Use the pin to poke a small hole in the foil. Make sure that the pinhole is over the hole that you cut in step 3, so light that passes through the pinhole will reach the other end of the box. You will not be looking through this pinhole; it is for the sun to shine through onto the other side of the box. A small hole will give you a sharp, but dim image. A larger hole will give you a brighter, but fuzzy image.
6. Put a piece of white paper inside the back end of the box, opposite the pinhole.



7. Point the end of the box with the pinhole at the sun so that you see a round image on the paper at the other end. If you are having trouble pointing the box at the sun, look at the shadow of the box on the ground. Move the box so that the shadow looks like the end of the box. In other words, make sure that the sides of the box are not casting a shadow. The round spot of light you see on the paper is a pinhole image of the sun.
8. As you look at the image of the sun, see if you find dark spots within the image. Those are the sunspots! Make an illustration of them in your notebook.
9. If you want a brighter image of the sun, you can remove the foil that you currently have and replace it with new foil. Then, poke a larger hole in the new foil. If you want a sharper (but dimmer) image of the sun, replace the foil with new foil and poke a smaller hole in it.
10. If you want a larger image of the sun, you can make another pinhole viewing box out of a longer box. If you want a sharper (but smaller) image of the sun, you can make another pinhole viewing box out of a shorter box.
11. If you use your viewer during an eclipse, you will be able to safely observe the moon moving over the sun, blocking its light.

Look only at the image on the paper! Do not look through the pinhole at the sun!

sun



pinhole viewing box