Lessons 1-15: Science in the First Day of the Creation Week

Lesson 1: Let There Be Light!

Note to the parent/teacher: To start this lesson, you should have Genesis 1:2-3 memorized (or at least be able to say the gist of it – especially the part about darkness and "Let there be light"):

The earth was formless and void, and darkness was over the surface of the deep, and the Spirit of God was moving over the surface of the waters. Then God said, "Let there be light;" and there was light.

Take your children into a room or closet with no windows. Close the doors and turn off the lights so the room is totally dark. Say the verse, and when you get to "Let there be light," turn on the lights. After you are done, go somewhere comfy and start reading the lesson.

What were you thinking when you were in that dark room? Were you scared, confused, or worried? How did that change when the light was turned on? Were you surprised? Did your eyes have to adjust to the light? Whatever you were thinking in the darkness went right out of your mind, didn't it? For most people, darkness is mysterious and maybe even frightening. Light, on the other hand, is usually pleasing and comforting. It's no wonder God started His creation by making light. In fact, as you learn more about science this year, you will find out how important light is to all of God's creation!

Let's start learning about light by finding out how it allows us to see objects, which is a truly amazing process. It all starts with light **reflecting** off objects. To learn what that means, do the following experiment.

Reflecting Light

What you will need:

- A flashlight
- A hand-held mirror (the mirror should be bigger than the light on the flashlight)
- A dark room, like the one in which you started this lesson

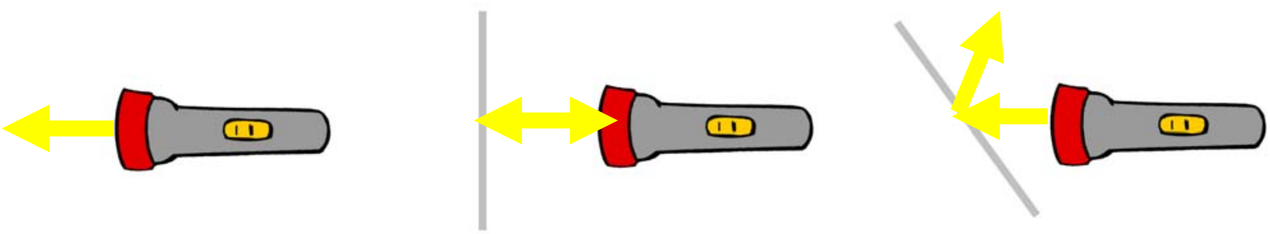
What you should do:

1. Put the flashlight in one hand and the mirror in the other hand and go into the room.
2. Close the door, turn on the flashlight, and turn out the lights so that the only light in the room is coming from the flashlight
3. Stand near a wall and lift the hand that is holding the flashlight out to your side. Stand so that the back end of the flashlight is just touching the wall, as shown in the picture on the right.
4. Because of the way you are holding the flashlight, it should be pointed directly away from the wall that you are standing near. Look at the circle of light that the flashlight makes on whatever it hits.

5. Hold up the mirror so the light from the flashlight hits the mirror, as shown in the picture on the left. Where did the circle of light go?
6. Keep the flashlight still, but tilt the mirror with the hand that is holding it. Look for the circle of light made by the flashlight. Where is it?
7. Spend some time tilting the mirror back and forth and up and down. Watch what that does to the circle of light.
8. Put everything away.

What did you see in the experiment? When the mirror was put in front of the flashlight, the circle of light moved, didn't it? It probably hit your hand, the flashlight, or the wall you were near. As you tilted the mirror in many different directions, what happened to the circle of light? It moved on the wall you were near, didn't it?

When you put the mirror in front of the flashlight, the light hit the mirror and then "bounced" off the mirror. Because light travels in a straight line, when its direction changed, it hit something other than what the flashlight was being aimed at. That's what it means for light to **reflect**. It hits something and "bounces" off it, changing direction and going in a straight line somewhere else. When you started tilting the mirror, the light ended up changing direction again, going to a completely new place. Let me show you a drawing of what I mean:



Light travels straight from the flashlight. — If light hits a mirror head on, it bounces straight back. — If light hits a tilted mirror, it bounces off, going in different direction.

Why is reflection important when it comes to seeing objects? Because in order for you to see something, light has to reflect off it and hit your eyes. Otherwise, you can't see it. Think back to the beginning of the lesson. You couldn't see anything when you were in the dark room, because there was no light. When the lights were turned on, suddenly there was light streaming from its source. Some of that light started hitting the people and objects in the room. It then reflected off those people and objects and went into your eyes. Your eyes then sent information about the people and objects to your brain, and that allowed you to see them.

In order for us to see an object, then, light must come from that object and hit our eyes. Usually, this happens because light comes from a light source (like light bulbs in the ceiling of the room), reflects off the object, and enters our eyes. Think, for example, about what happens when you look up at the moon in the night sky. The moon shines not because it makes its own light, but because light from the sun reflects off the moon and enters your eyes. This allows you to see the beautiful moon in the night sky.

The moon is visible in the sky because light from the sun reflects off it and hits your eyes.

LESSON REVIEW

Youngest students: Answer these questions:

1. What does it mean for light to reflect off something?

2. Why can't you see anything in a room that is completely dark?

Older students: Remember the journal I told you about in the introduction to the course? It is time to get it out and do some work. On the first page of your journal, write "Day 1: Light" at the top of the page, and then use the rest of the page to draw a picture that comes to mind when you think of light. After you have completed the first page, start a new page and write in your own words what it means for light to reflect off something.

Oldest students: Do what the older students are doing. In addition, make another drawing that shows how we see objects. Draw a table that has a flower or something else interesting sitting on top of it. Next, draw a light bulb on the ceiling above the table. Then draw a person looking at the flower. Finally, draw arrows (like you see in the drawing on the previous page of this book) that represent light coming down from the light bulb, hitting the flower, and then reflecting into the eyes of the person who is looking at the flower. Underneath the picture, explain why this allows the person to see the flower. Explain what the person would see if the light were turned off.

Lesson 2: The Colors in Creation

In the previous lesson, you learned how light is necessary for you to see objects. When light reflects off an object and enters your eyes, information gets sent to your brain, and your brain interprets that information so you can see. Now, it turns out that there are really two ways our eyes and brain use light in order to see, and the difference between those two ways is stunning. For example, look at the two pictures below, both of which show the same garden:

Which picture is better at showing the beauty of the garden? Obviously, it's the one on the right, because that picture is in color. The colors of the flowers in this garden are wonderful, but since the picture on the left is only black-and-white, it simply cannot show the incredible beauty of the garden.

We can see both in black-and-white as well as in color, thanks to how wonderfully God designed light and our eyes.

The Colors in Light

What you will need:
- A Compact Disc (CD) or Digital Video Disk (DVD). It doesn't matter whether or not it is blank.
- A candle and something you can use to light it
- A dark room

What you should do:
1. Put the candle on a table or counter in the dark room and light it. **Be careful! Open flames can be dangerous!**
2. Close the doors so that the only light in the room comes from the candle.
3. Position yourself in front of the candle with your eyes at the same height as the flame.
4. Hold the CD with both hands so the shiny side (the underside) of the CD faces you, the candle is between you and the CD, and the hole in the middle of the CD is also at eye level. In the end, the flame should basically be framed by the hole in the CD.
5. If you look at the CD, you will see several colors. Play with the tilt of the CD to see how the position and shape of the colors change. You should be able to play with the tilt of the CD until the colors form full circles around the center of the CD.
6. Blow out the candle and put everything away.

Where did the colors in the experiment come from? Believe it or not, *they came from the light of the candle*. When you look directly at a candle flame, it looks mostly white. When you look at the light coming from a normal light bulb, it looks white. When you look at the sun high in the sky, the light looks white. However, *white light is actually a mixture of many colors*, and the shiny surface of a CD has the ability to separate them. So, while the light from the candle looked mostly white to you, when it hit the shiny surface of the CD and reflected back to you, it got split into all its different colors, including blue, green, yellow, and red. When you positioned the CD just right, you ended up seeing those colors as circles on the CD.

A rainbow is the result of water droplets in the air splitting the white light coming from the sun into its many colors.

Did that circle remind you of anything? It should have. It probably looked a lot like a rainbow. You might have noticed that the colors on the CD were in the same order as the colors in the rainbow. The blue circle was closest to the center of the CD, followed by green, followed by yellow, followed by red. That's because a rainbow is also the result of light being split into its colors. Instead of little CDs doing the job, however, little droplets of water in the air do the splitting. Because of the way light behaves when it hits water, water droplets in the air can split the white light coming from the sun into its many colors, and that's what forms a rainbow.

Think about what this means. White light is actually light that is made up of all the colors in the rainbow! The light coming from the sun, from the light bulbs in your home, and from a flashlight really contains **red** light, **orange** light, **yellow** light, **green** light, **blue** light, **indigo** light, and **violet** light. You might not recognize those last two colors, but they are important ones that you need to learn. Here is an illustration that shows all the basic colors of the rainbow:

Red Orange Yellow Green Blue Indigo Violet

All the colors you see in the drawing (and all the colors in between those colors) are contained in the white light you see coming from the sun, from the lights in your home, and from a flashlight. Isn't that amazing?

There is a really easy way for you to remember all seven of these colors as well as the order they appear in a rainbow. Just think of a man I like to call "Mr. White Light." His real name? It's Roy G. Biv. That's an odd name, isn't it? Look at what it tells you, though. "R" is for red, "o" is for orange, "y" is for yellow, "G" is for green, "B" is for blue, "i" is for indigo, and "v" is for violet. Thus, Mr. White Light's odd name reminds you of all the colors in the rainbow as well as the order in which they are found, starting at the top of the rainbow and moving to the bottom.

LESSON REVIEW

Youngest students: Answer these questions:

1. Where did all the colors seen on the CD in the experiment come from?

2. Remember Mr. White Light's name: Roy G. Biv. Use it to tell me the seven basic colors found in a rainbow.

Older students: Draw a rainbow in your journal, putting the colors in the proper place, as is pictured on page 5. Label each color. Underneath the rainbow, write Mr. White Light's name and explain why it tells you the order of the basic colors in a rainbow.

Oldest students: Do everything the older students are doing. In addition, think about the experiment that you did in this lesson. Suppose you used a red Christmas tree light instead of a candle. Would you still see the rainbow? Explain in your notebook why or why not.

All the wonderful colors of creation are contained in white light!

Lesson 3: Absorbing and Reflecting

In the previous lesson, you learned that white light actually contains light from all the colors of the rainbow and every color in between. In the experiment you did, you used a CD to separate that light into its different colors. You also learned that water droplets in the sky can do the same thing, forming a rainbow. The fact that white light contains all colors plays an important role in allowing us to see things in color. How? Well, let's do another experiment to find out.

Reflecting and Absorbing Colors

What you will need:
- Two sheets of white construction paper
- A sheet of black construction paper
- A sheet of red construction paper
- A flashlight
- A dark room
- Someone to help you

What you should do:
1. Take the materials in the dark room and turn on the flashlight. Close the doors so the only light in the room comes from the flashlight.
2. Have your helper stand near you holding one piece of white construction paper.
3. Hold the flashlight so it is level with the piece of construction paper your helper is holding, and shine it *away from* the paper.
4. Look at the paper. You can probably see it, because some of the light from the flashlight reflects off the walls of the room, then reflects off the paper, and then ends up hitting your eyes. However, you probably don't see the paper very well.
5. Hold up the other sheet of white construction paper so it is level with your helper's sheet of paper and the flashlight shines on it. Your experiment should look something like the picture on the right.
6. Look at the paper your helper is holding. You should see it much more clearly now.
7. Put down the white piece of paper you are holding and pick up the black piece of paper. Hold it in the same way, so it is level with the white piece of paper your helper is holding and the flashlight shines on it.
8. Look at your helper's piece of paper. Can you see it very well? Probably not.
9. Put down the black piece of paper and now use the red paper in the same way. When the flashlight shines on the red paper, what does your helper's paper look like?
10. Put everything away.

What happened in the experiment? When you shone the flashlight on the white piece of paper, you saw your helper's paper more clearly, because the light from the flashlight reflected off the paper you were holding and onto the paper your helper was holding. When you shined the flashlight on the red piece of paper, your helper's white paper should have looked red, or at least reddish. That's because the red paper was reflecting light, but *only red light*. Remember – the white light coming from the flashlight has all the colors of the rainbow in it. However, the red paper didn't reflect all those colors; it only reflected red. That's why the paper looks red. When white light hits red paper, the paper doesn't reflect blue, yellow, or green – just red. What does that tell you about how we see color in objects? *It is because colored objects reflect only one type of light*. A red object reflects only the red light that hits it. A blue object reflects only the blue light that hits it.

Now, wait a minute. What happened to the other colors? After all, we know white light is really a mixture of all the colors of the rainbow. If the red paper only reflected the red light, where did the other colors of light go? Well, think about what happened when you used the black paper. Were you able to see your helper's paper? Probably not very well. That's because the black paper didn't reflect any light. Instead, it **absorbed** all the colors. In other words, all of the light got "sucked up" by the black paper. It went into the paper and stopped; it didn't reflect. As a result, there was no light directed to your helper's paper, and you couldn't see it very well.

So, in the end, when white light hits an object, all the light might be reflected (making the object white), or all the light might be absorbed (making the object black). In addition, *certain colors of light might be reflected, while other colors are absorbed*. That's what allows us to see color. If we see an object as green, for example, it is because the object absorbs all colors of light *except* green. When white light shines on it, only the green light reflects off it to hit our eyes. Since we see only green light, the object looks green.


Most old cameras like this one could take only black-and-white photos.

In the end, then, black is what we see when an object reflects no light. White is what we see when an object reflects *all* the colors of the rainbow at once. Go back and look at the black-and-white picture of the garden on page 4. A black-and-white picture is only able to tell you where the camera detected light and where it did not. If a lot of light was detected, the object in the picture looked white. If no light was detected, the object in the picture looked black. If a little light was detected, the object looked a shade of gray. When cameras were first made, that was the best they could do. The film inside them could detect a lot of light, a little light, or no light. As a result, all pictures were initially black-and-white pictures.

As time went on, scientists and engineers became better at figuring out how to do what our eyes do naturally – detect individual colors of light. When they were able to make camera film that could do what our eyes do naturally, the pictures the camera took were in color. At first, however, the color detection was not all that good, so the colors that were in the pictures weren't all that good, either. As time went on, our film-making technology got better, and so did the pictures that we could take.

Of course, even though we have great cameras today that can take really nice pictures, they still aren't anywhere close to being as good at detecting color as our eyes are. Have you ever heard the phrase, "A picture can't do it justice"? It means that a picture just isn't as pretty as seeing the sight for yourself. That's true, because even the best camera we have today cannot capture light as well as your eyes do. As a result, when you see something for yourself, the colors are more vivid, and the scene is just more beautiful. There are a lot of reasons for this, but they all boil down to the fact that despite the amazing science and technology we have today, we still can't produce a camera that detects light as well as the human eye. Of course, it's easy to understand why. God made the human eye. What He makes is superior to what people can make!

I took this picture when I was in Cape Town, South Africa. While the picture is pretty, I can tell you that it doesn't do the scene justice, because my eyes detect light much better than the camera does.

LESSON REVIEW

Youngest students: Answer these questions:

1. When you see something that is red, what color of light does it reflect?

2. When you shine white light on a red object, what happens to all the other colors of light that are not reflected?

Older students: Draw a red rose sitting on a table in a vase and a person looking at the rose. Draw a light bulb above the rose, and then draw seven arrows coming from the light and hitting the rose. Each arrow should be one of the basic colors of the rainbow. They don't have to be perfectly matched to the colors of the rainbow, however. If you can't find a violet crayon, pencil, or marker, for example, don't worry. Just use purple. If you can't find indigo, just use a color between blue and purple. Now draw one red arrow reflecting off the rose and hitting the person's eye. In your notebook, explain what the seven arrows represent and what the red arrow hitting the person's eye represents.

Oldest students: Make the same drawing that the older students are supposed to make. Instead of answering the questions, however, explain how the drawing shows why the rose appears red to the person who is looking at it. Explain what happened to all the other colors of light.

Lesson 4: Light and Energy

Note to the parent/teacher: The experiments in this lesson require a sunny day. If today isn't sunny, you can put science off until a sunny day. If you really want to do science today and it isn't sunny, you can do Lesson 8 instead. You can't do Lessons 5-7, however, as they are built on this lesson.

To start this lesson, you need to set up an experiment. The experiment will run while you continue the lesson.

What Happens When Light is Absorbed?

What you will need:

- A white plastic garbage bag
- A black (or very dark) plastic garbage bag
- Scissors
- A window that has direct, bright sunlight shining through
- A table or other flat surface that can be put in the path of the sunlight

What you should do:

1. Use the scissors to cut a rectangle of white plastic from the white garbage bag. The rectangle needs to be a bit larger than your hand.
2. Use the scissors to cut a rectangle of the same size from the black garbage bag.
3. Place both rectangles on a table or other flat surface so they are side-by-side and are both being hit directly by the sunlight coming in through the window.
4. Once that is all set up, start reading the rest of the lesson.

In Lesson 3, you learned why we can see colors. When light hits an object, some colors of light can be absorbed, while the other colors can be reflected. You are able to see only the colors that are reflected. A leaf is green, for example, because when white light (which contains all the colors of the rainbow) hits it, most of the colors are absorbed. However, the green light is reflected, and since that's the only color of light hitting your eyes, that's the color you see.

Because Lesson 3 was about what we actually see, I didn't want to talk about what happens to the light that is absorbed by a colored object. However, now that you understand why we see colors, it is time for you to learn the rest of the story – what happens to the light that is absorbed by an object.

The best way to start answering this question is to think about the black piece of paper you used in the experiment of Lesson 3. When you shined light on it, not much was reflected from it. That's because a black object absorbs all colors of light and reflects none. So, when the light shined on the black paper, the paper absorbed the light and didn't reflect it. What happened to that light? Did it just magically disappear? Of course not! To understand what happened to it, you need to know a bit more about what light is.

Light is a form of **energy**. Now, you probably have some idea of what that word means, but scientists must be very specific when they define things, so in science, energy has a very specific definition. Energy is the ability to do **work**. While you might think of work in a negative way (chores, schoolwork, what someone does to earn money, and so on), scientists think of work differently. Even when you are playing a game of tag, a scientist would say you are working. After all, you might be having fun, but in order for you to run around and play, your body does a lot of work.

So, from a scientific point of view, we would say that when you are playing, your body is actually working. Well, in order to have the ability to do work, you need energy. This tells us that in order to play, you need energy. How do you get the energy that you need to play? You eat food. Food contains energy, and when you eat it, your body turns some of it into energy it can use, and that allows you to do all sorts of things, including play a game of tag!

Now, let me ask you a question. Suppose you wanted to play but didn't have much energy. Would sitting out in the sun give you the energy you need to play? Of course not! Even though light is a form of energy, it's not the form that your body needs. Your body needs energy in the form of food. Think about what this means. It means energy comes in different forms. Light is one form of energy, and food is another. Your body can use the energy in food to allow you to do the "work" of playing. However, it cannot use the energy in light to allow you to play.

It turns out there are many forms of energy. Light is called **radiant** (ray' dee unt) **energy**. The energy in food is called **chemical energy**, because it is stored in the chemicals that make up the food. Sugar, for example, is a chemical that contains lots of energy. When you eat food that contains sugar, your body can break down the sugar and use the energy stored in it. Now, think about what happens when your body uses that chemical energy to allow you to play a game of tag. What is one thing you do a lot of when you play tag? You run, right? Believe it or not, that is a form of energy as well. It is called **mechanical energy**.

When you eat food (left), your body can change the chemical energy in the food into mechanical energy as you run and play (right).

Think about what that means. You eat food, which has chemical energy, and then your body uses it so that you can run and play, which is mechanical energy. What did your body do? *It changed the chemical energy into mechanical energy*. The food had chemical energy, and your body used it to give you mechanical energy. In other words, your body changed the chemical energy in the food to the mechanical energy in your game of tag. It turns out that this happens all the time throughout creation, including in the experiment you set up at the beginning of the lesson.

If it has been at least five minutes, go back to the experiment now. If not, take a break, and once the plastic has been sitting in the sun for at least five minutes, press one hand on the black plastic and the other hand on the white plastic. Do you feel any difference between them? The black piece of plastic should feel much warmer than the white piece of plastic.


This fire is producing thermal energy and radiant energy. You know it is producing thermal energy, because it is hot. You know it is producing radiant energy, because you see light coming from it.

Why did the pieces of plastic feel different? Remember, the black piece of plastic appears black because it absorbs all the colors in the sunlight. The white piece of plastic appears white because it reflects all the colors in the sunlight. Well, when light (radiant energy) is absorbed by an object, it is usually changed into another form of energy, called **thermal** (thur' muhl) **energy**. We feel thermal energy as heat. The black plastic absorbed a lot of sunlight, so it changed a lot of radiant energy into thermal energy. As a result, it felt warm.

So, that's what happens to the colors of light that are absorbed. They don't magically disappear. Instead, they are changed from their current form of energy (radiant energy) into a new form of energy (thermal energy). Just as your body changes chemical energy into mechanical energy to allow you to play, an object that absorbs light can change the radiant energy of that light into thermal energy and get warmer. Have you ever noticed that when you wear a dark shirt on a hot, sunny day, you get a lot warmer than if you wear a white shirt? That's because the dark shirt is absorbing a lot of light and changing its radiant energy into thermal energy, which makes you warmer. If you want to stay as cool as possible on a hot, sunny day, then, you need to wear something that is white. That way, the colors in the sunlight will be reflected away from your body. While it won't cool you down any, at least you won't be wearing something that heats itself up by absorbing a lot of the sunlight! If you can't find something white, wearing a lighter color is better than wearing a darker color, since darker colors absorb more light.

LESSON REVIEW

Youngest students: Answer these questions:

1. Fill in the blank: Light is a form of _____________.

2. Fill in the blank: When an object absorbs light, the object gets _____________ because the light's radiant energy is changed to thermal energy.

Older students: List the four kinds of energy you learned about today. Look through some old magazines or on the internet to find pictures that represent each of those forms of energy, and paste them in your journal, labeling the form of energy each picture represents. If you're feeling artistic, you could draw your own pictures that illustrate each form of energy instead of looking for pictures.

Oldest students: Do everything that is listed for the older students. In addition, explain in your own words why a black shirt will be warmer than a white shirt on a bright, sunny day. Be sure to use the terms "radiant energy" and "thermal energy" in your explanation.

Lesson 15: Refraction and Magnification

In the previous lesson, you learned that when light passes through a transparent object at an angle, it bends. The amount that it bends depends on the angle at which it hits the object. If the light hits the object straight on, there is no bending. If it hits the object at an angle, there is a lot of bending. It turns out that we can use this to our advantage. Perform the experiment below to see what I mean.

A Simple Magnifier

What you will need:

- A clear two-liter plastic bottle, like the kind used to hold soda pop
- Scissors
- Water
- An old newspaper or something else that has words on it. You should make sure that your parents won't mind if it gets wet.

What you should do:

1. Have an adult cut the top off the bottle right where the top no longer tapers, as shown in the photo on the right.
2. Cut a small rectangle out of the side of the bottom part of the bottle.
3. Hold the rectangular piece of plastic (which will be curved because the side of the bottle was curved) with your fingers, and put just a bit of water on it. You want more than a drop, but you don't want a lot. Use the picture below as a guide.
4. Hold the plastic over the newspaper, and look at the words through the water.

5. Change the distance between the plastic and the newspaper and see how that changes the words you are reading.
6. Gently squeeze the rectangular piece of plastic so that it curves more.
7. Once again, change the distance between the plastic and the newspaper. Do you notice a difference between now and when you did it without squeezing the plastic?
8. Play around with this for a while, squeezing the rectangular piece of plastic more and less to change how it curves, and changing the distance between the plastic and the newspaper. Try to get an idea of what makes the biggest change in the words.
9. Clean up your mess.

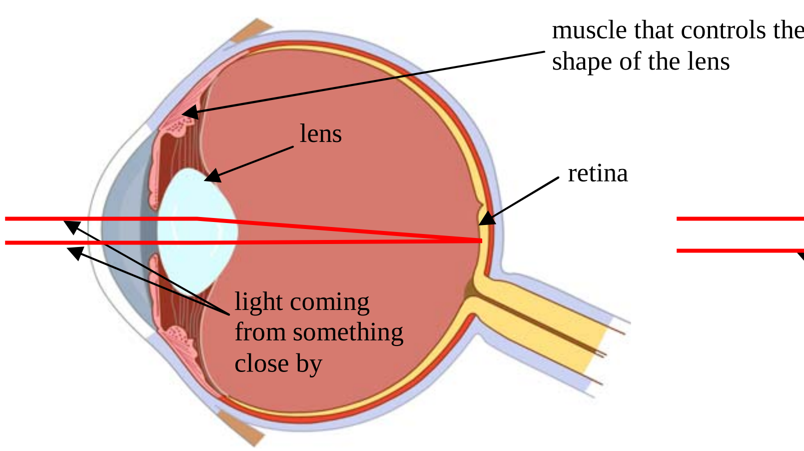
What did you see in the experiment? You should have seen that the words were bigger when you looked at them through the water. In the end, the water was acting like a magnifier. Why is that? Well, remember the experiment you did in the previous lesson. When light hit the water in the cake pan, it bent. The larger the angle, the more it bent.

When you read words, light must reflect off the page and hit your eyes. You see the pattern of light and use it to recognize the words on the page. When you read through the water, the light had to pass from the page and through the water to hit your eyes. When it passed through the water, it bent. Now, the page was flat, but the plastic was curved. Because of this, the angle at which the light hit the water depended on where it was coming from on the page. Light from directly below your eyes didn't get bent at all, because it hit the water straight. However, light coming from parts of the page that were not directly below your eyes hit the curved edge of the water, which caused the light to bend toward the center of the curve. What does that mean? The curved puddle of water was actually concentrating the light coming from the page. As a result, the words on the page looked bigger!

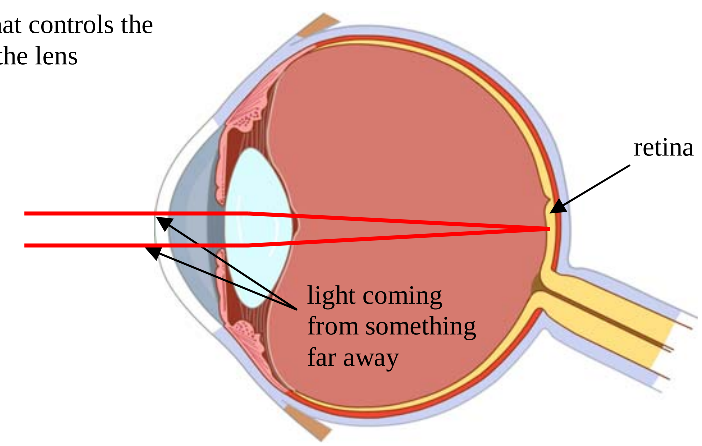
When you changed the distance between the plastic and the newspaper, the size of the words changed, didn't they? That's because the curved puddle of water concentrated the light differently depending on how far it was from the page. Also, when you changed the curve of the plastic by squeezing it, that changed the size of the words as well, didn't it? Once again, that's because when the curve changed, that changed the angle at which the light hit the water, which changed how the curved puddle of water could concentrate the light.

So, a curved puddle of water acts like a magnifier. You have already used a magnifying glass in this course, and you saw that it concentrates light as well. Can you guess what a magnifying glass is made of? It's made of *curved glass*. Light travels more slowly in glass than it does in air, so when light hits glass at an angle, it bends, just like when it hits water. A curved piece of glass, then, will act like the curved puddle of water in the experiment and magnify what is beneath it.

What's really cool about this is that refraction allows us to do some amazing things, like help us see really well! As you learned in Lesson 9, each one of your eyes has a lens in it. Light travels more slowly in your eye's lens than it does in the air, so when light hits your eye's lens, the light bends. The lens is curved, so it concentrates light to a part of your eye called the retina. That's how the lens **focuses** light onto the retina, which allows you to see what you are looking at. Remember, however, that the amount of the curve affects how the light is bent. To take advantage of this, your eye's lens *can actually change shape* so that it bends light in different ways. When the lens is short and fat, it focuses light that is coming from something nearby onto your retina, so you see objects that are nearby. When the lens is longer and thinner, it focuses light from far away onto your retina, so you see objects that are far away.



When you are looking at something close to your eyes, each lens is short and thick so it can bend the light to your retina, allowing you to see it clearly.



When you are looking at something far from your eyes, each lens is tall and thin so it can bend the light to your retina, allowing you to see it clearly.

Right now, for example, your eyes' lenses are pretty short and fat, because you are focusing on this page, which is near your eyes. If you look up from the page to see something far away, the lenses in your eyes will get longer and thinner.

Without refraction, then, you wouldn't be able to see everything you want to see. Because God designed your eyes with lenses that can change shape, however, your eyes can use refraction to bend light so that it hits your eyes just where it needs to hit in order for you to see what you want to see clearly. What a marvelous design!

LESSON REVIEW

Youngest students: Answer these questions:

1. Fill in the blank: A magnifying glass is made from a __________ piece of glass.

2. Why does the lens in your eye change shape?

Older students: Explain in your own words why the puddle of water in your experiment acted as a magnifying glass.

Oldest students: Do what the older students are doing. In addition, explain why a curved piece of glass acts as a magnifying glass, but a flat piece of glass will not.

A curved piece of glass is a magnifier because of refraction.