HOME SCIENCE TOOLS
THE GATEWAY TO DISCOVERY

Young Science Explorers
Science fun for 4 to 9-year-olds!

April 2009 – All About Rainbows

Rainbows are more than just random colors in the sky.

Find out how rainbows are formed, why the colors are always in the same order, and even learn how to make your own!

Rainbow Science Projects

Project 1 – Watch Light Bend

What You Will Need:

- A glass of water
- A pencil

What To Do:

1. Set the glass of water on the table and put the pencil in so that part of it is sticking out above the water.
2. Look at the pencil through the side of the glass.
3. Now look at the pencil from the top of the glass.
4. Now take the pencil out of the water and look at it.

What's Happening?

The pencil looked bent when you looked at it through the side of the glass, but when you looked from above and when you took it out of the water, of course it wasn't really bent! When light passes through the glass and water, it ***refracts***, or bends. Since the light is being bent in different directions by the glass and the water, it hits your eye from different angles than normal and makes the pencil look bent! (The same thing happens when you dangle your legs into a swimming pool.) It also makes the pencil look bigger than it really is. As the light passes through the water, it bends in odd directions and magnifies the part of the pencil that is in the water. The more water between you and the pencil, the bigger the pencil will look. Try holding it right up to the side of the glass nearest you, and then move it to the other side and watch it grow!

Project 2 – Make a Prism

Most of the time light looks white, but it is actually made up of colors: red, orange, yellow, green, blue, indigo, and violet. Those seven colors are the same ones you see in a rainbow! A prism is usually made of glass and is used to separate light into its colors. In this project, you can make your own prism to show the colors of light.

What You Will Need:

- a clear glass
- water
- 2 sheets of white paper or cardstock
- a chair
- flashlight (one with a small beam works best)

What To Do:

1. Fill the glass a little more than half-way full.
2. Set the glass on the edge of the chair so that nearly half of the bottom of the glass hangs over the edge. The glass might be a little wobbly, so be careful not to let it fall.
3. Lay both sheets of paper side by side on the floor next to the chair where the glass is.
4. Turn on the flashlight and hold it near the outside of the glass at the level of the water, pointing towards the paper on the floor.
5. Look for a rainbow pattern to appear on the white paper. You might need to adjust where you are shining the flashlight or where your paper is at in order to see the rainbow clearly. Depending on the shape of your glass and how much water is in it, you might see more than one rainbow. You could also try this by putting the glass of water in a window where sunlight will shine through it instead of using a flashlight.

What's Happening?

When the beam of light from your flashlight hits the outside of the glass, it bends slightly and breaks into its seven different colors. This bending is called refraction. The beam of light is separated into its different colors because each color bends at a slightly different angle. When the light comes out the other side of the glass, it is no longer a beam of white light. Instead, you see all the colors that make up white light in a rainbow shape on the white paper! This setup is a type of prism. A normal prism is a triangular piece of glass, but it works in the same way as the prism you just made.

A prism refracts light in almost the same way that raindrops refract sunlight to make a rainbow. The seven colors of the rainbow are called the visible colors of light. White light is made up of all of those colors, our eyes just can't see them until they are separated by water, glass, or something else. There are more colors of light, but our eyes can't detect them. Another way to see the rainbow colors of white light is to hold the back of a cd up to a light bulb. To see the colors even more clearly, poke a small hole in a piece of foil and cover a flashlight with the foil so the hole is in the middle, then shine it at the cd.

Project 3 – Make a Rainbow

What You Will Need:

- a garden hose (connected to a faucet outside)
- a sunny day
- permission to go outside and use the hose

What To Do:

1. Get the hose and turn the faucet on.
2. Stand in a spot where the sun is behind you, shining on your back. (You will be able to see your shadow in front of you when the sun is behind you.)
3. Put your thumb over part of the nozzle of the hose so that the water creates a spray when it comes out.
4. Hold the hose out in front of you and turn slowly. Keep you finger over the hose to make a spray. Watch for a rainbow to appear above the water.

What's Happening?

A rainbow should appear just above the spray of water from your hose when sunlight hits the water at the right angle. The water from the hose does the same things that rain does to make a real rainbow in the sky - it refracts the beams of sunlight so that they separate into their different colors. You can see the colors in the rainbow that appears above the water. The rainbow you made is much smaller than one you would see in the sky. Do you know why? It's because the water from your hose is only spraying in a small area. If there were more drops of water for the sunlight to hit, you would see a larger rainbow.

Fun Facts

- The colors of a rainbow are always in the same order. You can remember them by saying the name "Roy G. Biv," which stands for red, orange, yellow, green, blue, indigo, and violet.
- A scientist named Sir Isaac Newton first discovered the visible colors of light, or the colors of the rainbow.
- It has to be both sunny and rainy at the same time in order to see a rainbow!

Silly Science

- What kind of bow can't be tied? (Answer: A rainbow!)
- When does it rain money? (Answer: When there is a change in the weather.)
- What's the difference between a horse and the weather? (Answer: One is reined up and the other rains down.)

Way Cool Websites

- Check out this photo gallery of real rainbows.
- See how the size of water drops affects the colors of a rainbow.

Teacher Tidbits

What Is A Rainbow?

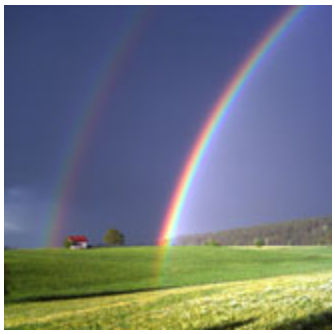
A rainbow is a colorful half-circle shape. It is formed when light hits water and is ***refracted*****,** or bent. Light that appears white (like light from the sun) is actually made up of several colors!

The colors that make up white light are the same colors that make a rainbow, they are red, orange, yellow, green, blue, indigo, and violet. Here's how refraction works to make a rainbow:

You can see a rainbow when the sun is low in the sky behind you and there is rain off in the distance in front of you. Beams of light from the sun shine towards the rain in the air and when the light goes into the raindrops, it is bent (refracted). When the light bends, it breaks into all of its colors (the colors of the rainbow). When the light hits the back of the rain drop, it is ***reflected*** and bounces back in the opposite direction (back towards you). Each color leaves the raindrop at its own angle, different from all the others. The colors of light bounce back to your eyes and form a half-circle shape, because of their different angles, and you see a rainbow of all the colors!

The colors of the rainbow always appear in the same order because each color always bends at the same angle. The red angle is reflected into your eye at the top, violet at the bottom, and the others at their specific place in between.

If we could see a rainbow from above the horizon, we would see that it actually forms a perfect circle! The reason it appears to be a half-circle is because the horizon blocks the other half of it from our view when we are on the ground. If you were able to get up above the horizon, the place where the ground and the sky appear to meet in the distance (even though they don't really meet), you might be able to see a full circular rainbow.



When light is reflected two times in the same water drop, a second rainbow will show up right above the first one. The colors of the second rainbow (called secondary) will look a little different. They will be in the opposite order since they are a reflection of the rainbow, so red will be on the inside and violet will be at the top! The colors will look much lighter than the colors of the main rainbow. Have you ever looked into a lake or other pool of water and seen a reflection of yourself? If you remember, you probably looked a lot lighter and backwards in your reflection. To learn more about how a reflection works, try this: write your name in big letters on a piece of paper. Stand in front of a mirror and hold up the paper. What happens? The letters look backwards in the mirror, because you are not seeing a picture taken from the front of you, you are seeing a reflection of yourself and the letters on the paper. The reason a reflection of a rainbow looks lighter is because there is less light to reach your eyes since it has already gone through the raindrop twice by the time you see it.

Other Lights in the Sky

A rainbow is just one type of optical wonder in the sky that is created by light. Here are a few others.

Moonbow - a moonbow or lunar rainbow is created by light from the moon instead of the sun. Moonbows are usually harder to see since the moon doesn't give off as much light. They are common around waterfalls where there are lots of drops of water in the air, even when it hasn't been raining. Here is a picture of a moonbow over Yosemite Falls in California.

Halo - a halo can appear around either the sun or the moon and usually happens when there are ice crystals in clouds very high up in the sky. Light is refracted and also reflected by the crystals of ice and a glowing ring, called a halo, is formed around the source of the light. Here is a picture of a sun halo.

Mirage - a mirage works sort of like a mirror. It is a reflection of a part of the sky and it happens when light moves from air of one temperature to a very different temperature (such as cool air to very warm air). The rays of light bend (or refract) in a way that causes an image of a different part of the sky than what is normal. A mirage can appear on the ground or above the ground. Have you ever ridden in a car on a hot summer day and thought that the road ahead of you was wet? As you got closer the "puddle" you thought you saw probably disappeared. That is a common road mirage, like in this picture.

More About Colors

Have you ever noticed all the pretty colors in soap bubbles? Bubbles have two thin layers of soap that reflect light, so when a ray of light hits a bubble, it separates into different colors, then the colors re-combine with each other on their way to your eye. However, since different colors of light bend at different angles, the colors don't match up perfectly when they combine. This is called interference and is what causes rainbow colors to appear on the surface of the bubble. You can learn more about bubbles here. A very similar thing happens when light hits the surface of certain types of oil (like the kind that gasoline comes from) in water that has spread out into a thin layer.

Red, yellow, and blue are called the primary colors. When those colors are mixed, lots of new colors can be made. Try this quick activity to let kids discover how colors mix: pour some whole milk into a bowl and put a few drops of red food coloring near the edge of the bowl. Add some yellow and blue spaced evenly away from the red (the three colors should form a triangle). Let kids dip a cotton swab in dish soap and then into the middle of the milk and watch the colors mix! Red and yellow combine to make orange, yellow and blue make green, and blue and red make purple (violet). These are all the colors of the rainbow except for indigo - indigo is made when there is more blue and violet is made when there is more red.

Science Words

Refraction - when light bends because it passes through a different material like when it goes from air into glass or water.

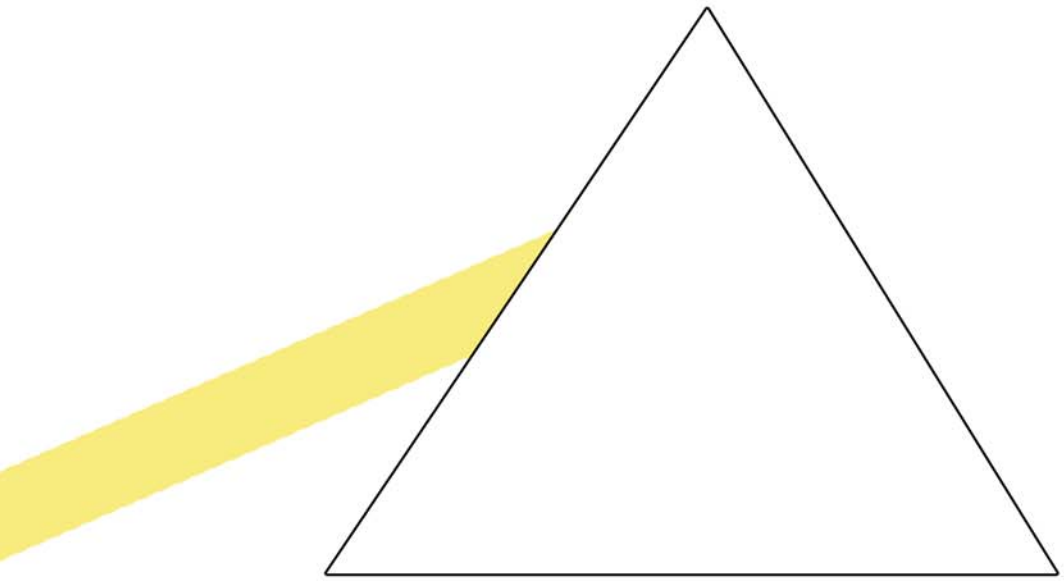
Reflection - when light hits an object and bounces back in the opposite direction. A reflection could also mean an image, such as a reflection of yourself in a mirror or a puddle of water.

Printable Worksheet

Use the worksheet below with the "Make a Prism" activity to help kids review what happens to light when it moves from air to glass. Use the bottom half to help them learn the mnemonic phrase "Roy G Biv" to remember the order of the colors of white light and the rainbow.

1. Use crayons to draw what happens to the beam of light when it enters the prism.

Hint: remember that light bends and separates into its colors when it moves from air to something else!



2. Write the colors of the rainbow that each letter stands for:

R =

O =

Y =

G =

B =

I =

V =