Introduction: Optic Science

Overview: An Introduction of Optic Science

A Native American Story About Light (Gallinomero Tribe)

What's Your Story?: Exploration & Journaling Exercise

Explore More (Resources on Optics)

iSTEM Project, 2012

Optics is the area of science that is concerned with vision and the properties of light and behavior of light.

Questions about Optic Science!

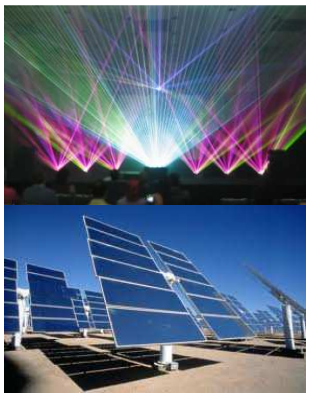
1) What is light made out of?
2) How long does it take light from the sun to reach the earth?
3) What color is an object that absorbs the light of all wavelengths?

See Fun Facts for Answers (Page 2)

Why do we *CARE* about controlling light *ANYWAY*?

Some important, useful, and very cool "things" depend on being able to produce, control, and/or detect light in special ways:

- Your eyes
- Eyeglasses and contact lenses
- Lenses for TV, movie, and cameras
- Photocopiers and fax machines
- Binoculars and telescopes
- Microscopes and magnifiers
- Projectors (overhead, movie, slide, TV)
- CD players
- Cashier laser scanners
- Weather and surveillance satellites
- Medical systems (to look inside the body)
- Solar energy systems



Optic Scientists Say: What is Light?

Visible light is the light that humans can see. Other animals can see different types of light. Dogs can see only shades of gray and some insects can see light from the ultraviolet part of the spectrum. The key thing to remember is that our light is what scientists call visible light.

Light is made of billions of tiny particles called photons. These photons travel from one place to another in waves.

Visible light is the subset of photons that move at a wavelength that we can see. Among the different photons that are in visible light, the ones that have the longest wavelength look red to us, and the ones that have the shortest wavelength look blue to us. All colors come from different wavelengths of light.

Most of the light on our planet comes from the Sun. The Sun releases billions of photons every second in all directions. When these photons get to the Earth (it take 8 minutes for these protons to reach the earth), they first run into Earth's atmosphere. Some of the photons are absorbed by the atmosphere itself, especially the ultraviolet ones whose wavelength is shorter.

This is a good thing for us, because too much ultraviolet light would kill us, and all other living things on the planet. (In fact, doctors sometimes use ultraviolet light to kill germs!). Because blue light has the shortest wavelength of the visible light photons, some of the blue light is also absorbed by the atmosphere. That's why the sky looks blue from the ground in the daytime, because you can see all that blue light up there. But when the light hits clouds instead, the clouds reflect all of the light down to Earth, so the clouds look white to us.

Most of the visible light does get through the atmosphere and comes down to the surface of the Earth. In addition, a lot of infrared light also gets through the atmosphere. This is light that has a longer wavelength, so we can't see it.

Color is caused by differing qualities of light being reflected by them. To see color, you have to have light. When light shines on an object some colors bounce off the object and others are absorbed by it. Our eyes only see the colors that are bounced off or reflected.

The sun's rays contain all the colors of the rainbow mixed together. This mixture is known as white light. When white light strikes a white crayon or marker barrel, it appears white to us because it absorbs no color and reflects all color equally. A black crayon or marker cap absorbs all colors equally and reflects none, so it looks black to us. While artists consider black a color, scientists do not because black is the absence of all color.

- What is light made out of?
  Light is made of billions of tiny particles called photons. These photons travel from one place to another in waves.
- How long does it take light from the sun to reach the earth?
  8 Minutes! Wow, that's fast!
- What color is an object that absorbs the light of all wavelengths?
  Black

Careers/Jobs Related to Optics

- Research Scientist
- Educator
- Industrial engineer
- Optical engineer
- Laser Technician
- Optics Designer
- Medical Laser Technician
- Industrial Laser Technician
- Fiber Optics Technician

Work and Research Areas

- Medical optics: (laser surgery, CAT scans, MRI technology, digital monitoring
- Space Exploration: Designs for telescopes and other imaging systems
- Construction: Using lasers to level the ground and layout of infrastructure and structures
- Entertainment: Laser shows, holographic art
- Industrial Manufacturing: Use of lasers for welding, drilling, and cutting.
- Defense Industry: Infrared Sensors, navigation, search and rescue, missile defense systems and navigation.
  Installation: Build and install fiber optic network systems in schools, businesses, buildings (to run internet, cable, phones, etc.)

Education After High School

Associate Degree in Laser and Optical Technology: Pima Community College (2 years after high school)

Bachelor's Degree Optical Sciences and Engineering, University of Arizona & Arizona State University (4-5 years after high school):

Master of Science Optical Sciences, (6-7 after high school) University of Arizona
PhD in Optical Sciences (8-10 years after high school) University of Arizona

✓Check It Out!

Dr. Ellen Ocha was the first Latina in Space. She is a scientist and an astronaut.

Ochoa has worked throughout her career with optical systems and is a co-inventor on three optics related inventions.

A Gallinomero Story About Light

(Native people from Northern California also referred to as "Pomo")

In the earliest beginning, the darkness was thick and deep. There was no light. The animals ran here and there, always bumping into each other. The birds flew here and there, but continually knocked against each other.

Hawk and Coyote thought a long time about the darkness. Then Coyote felt his way into a swamp and found a large number of dry reeds. He made a ball of them.

He gave the ball to Hawk, with some flints, and Hawk flew up into the sky, where he touched off the tulle reeds and sent the bundle whirling around the world.

But still the nights were dark, so Coyote made another bundle of tulle reeds, and Hawk flew into the air with them, and touched them off with the flints.

But these reeds were damp and did not burn so well. That is why the moon does not give so much light as the sun.

JOURNAL IT!

1) Draw a picture of a rainbow you have seen from where you live.

2) What do you know, think and believe about Rainbows?

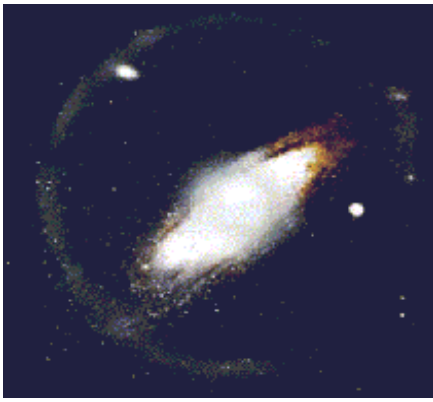
3) When do you see them?

4) What do you notice about when they appear and when they don't?

5) Ask an Elder about the meaning of Rainbow and for stories about rainbows.

Discover More Optics!!

The History of Light:
http://www.mts.net/~william5/history/hol.htm



Bill Nye the Science Guy: Light and
Color: *http://www.youtube.com/watch?v=gtgBHsSzCPE&feature=related*

Exploring the Science of Light:
http://www.optics4kids.org/

What Determines Sky's Colors At Sunrise And Sunset?
http://www.sciencedaily.com/releases/2007/11/071108135522.htm

Resource: Light: Its Secrets
Revealed: *http://www.amnh.org/education/resources/rfl/pdf/du_x01_light.pdf*

Neok12/Light Optics **Very Cool Videos!!**
http://www.neok12.com/Light-Optics.htm

Activity One: Prisms and Rainbows

Warm-up 1: How an Optic Scientist Explains Rainbows

A Native American Story About Rainbow Crow (Lenape Tribe)

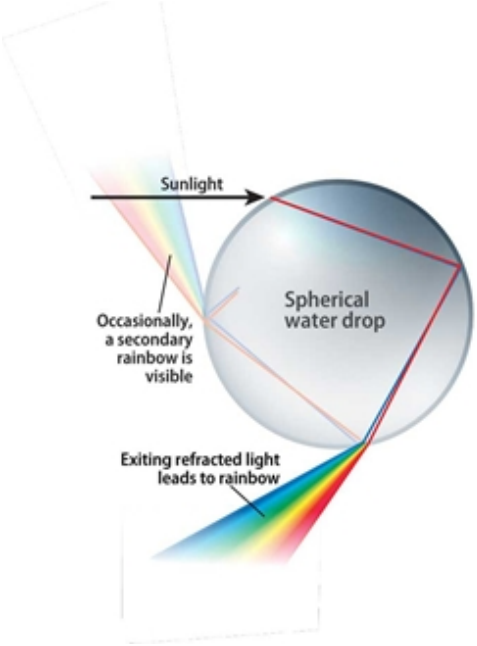
DO IT!! : Prisms and Natural Light

iSTEM Project, 2012

Here is how an Optic Scientist might explain how Rainbows are formed.

White light is composed of all the visible colors in the color spectrum, a fact that can be easily proven through the use of a prism. As light passes through a prism, it is bent, or refracted, by the angles and plane faces of the prism and each wavelength of light is refracted by a slightly different amount.

Violet has the highest frequency and is refracted the most. Red has the lowest frequency and is refracted the least. Because each color is refracted differently, each bends at a different angle, resulting in a fanning out and separation of white light into the colors of the spectrum. Water droplets in the air can act in a manner similar to that of a prism, separating the colors of sunlight to produce a spectrum known as a rainbow.



To be able to see a rainbow, you must be standing with the sun behind you.

The sunlight shines into the water droplets in the air, bending as it moves from the air into the water, reflecting off the sides the drops, and bending again as it exits the drops. As a result, all of the colors in the white light of the sun separate into the individual bands of color that are characteristic of a rainbow.

Rainbow Crow by Minna Biggs

Story: Rainbow Crow: A Lenape Legend

Excerpt from a book written by James Alexander Throm called: The Red Heart.

"The Rainbow Crow was beautiful to hear and to see, back in the days when it never got cold, back in the Ancient Days, before Snow Spirit appeared in the World.
When the Snow Spirit did appear, all the people and animals were freezing and a messenger was selected to go up to kijilamuh ka'ong, The Creator Who Creates By Thinking What Will Be.

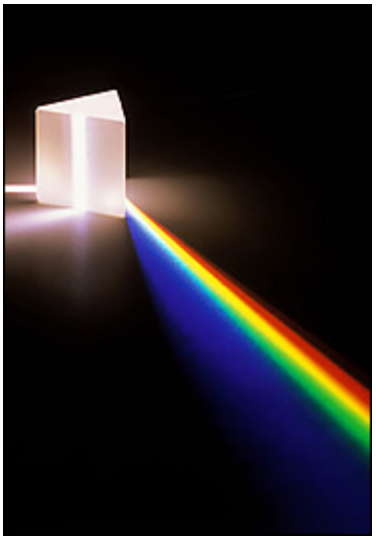
The messenger was to ask The Creator to think of the World as being warm again so that they would not all freeze to death. Rainbow Crow was chosen to go and he flew upward for three days. He got the Creator's attention by singing beautifully, but even though he begged the Creator to make it warm again, the Creator said He could not, because He had thought of Cold and He could not unthink it. But He did think of Fire, a thing that could warm the creatures even when it was cold. And so He poked a stick into the Sun until it was burning, and then gave it to Rainbow Crow to carry back to earth for the creatures. The Creator told Rainbow Crow to hurry before it burned all up.

Rainbow Crow dove down and flew as fast as he could go. The burning stick charred all of his beautiful feathers until they were black and since he was carrying the stick in his beak, he breathed the smoke and heat until his voice was hoarse.

And so the Rainbow Crow was black and had an unpleasant cawing voice forever after, but all the creatures honored him, for he had brought Tindeh, fire, for everyone to use.

The Crow is to this day, still honored by hunters and animals, who never kill it for food…and, if you look closely at the Crow's black feathers you can still see many colors gleaming in the black."

Activity 1: Prisms & Natural Light

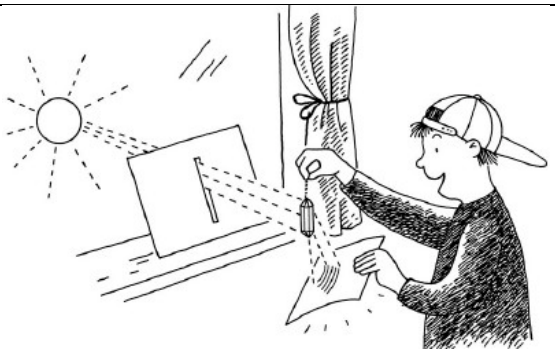


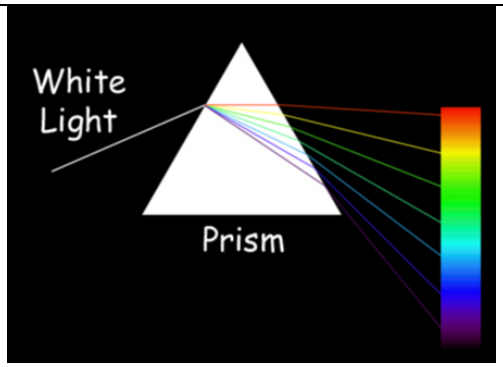
What you will need

- Scissors
- Cardboard
- Prism
- White paper
- A flash light
- Your Science Journal
- Colored pencils, crayons or markers

Activity Directions

1) Cut a slit in a large piece of cardboard.
2) Place the cardboard in a sunny window so that a shaft of sunlight shines through the slit.
3) In one hand, hold a prism in front of the cardboard so that the sunlight passes through it.
4) With your other hand, hold a sheet of white paper so that the light passing through the prism shines on it.
5) You will see a rainbow of colors on the paper.
6) In your journal, make a sketch of what you see and label the colors of the spectrum.





Optic Science: The Science of Light

Activity Two: Prisms, Flashlights & Other Artificial Light Sources

DO IT! Using Prisms To Investigate Light Sources

iSTEM Project, 2012

Activity 2: Prisms, Flashlight & Other Artificial Light Sources

What you will need:

- A prism
- A flashlight
- Different kinds of light sources (look around at school for sources of light)

Activity Directions

1) Place the prism on a flat surface with plenty of space.
   Shine the flashlight on the prism in a manner that allows the light to pass through the prism from one side to the other, rotating the prism until it produces the spectrum.
2) Observe the colors and write down your observations.
3) Experiment with other light sources, fluorescent lights, computer screens, light bulbs.

Question? How are the rainbows different depending on the light source?

JOURNAL IT!

Sketch out the different spectrums (rainbows) you create, make sure to write down the kind of light you used to create each spectrum.

What's happening here?

White light is composed of all the rainbow colors, A prism can be used to break up light to its equivalent spectral colors, which include the colors red, orange, yellow, green, blue, indigo and violet.

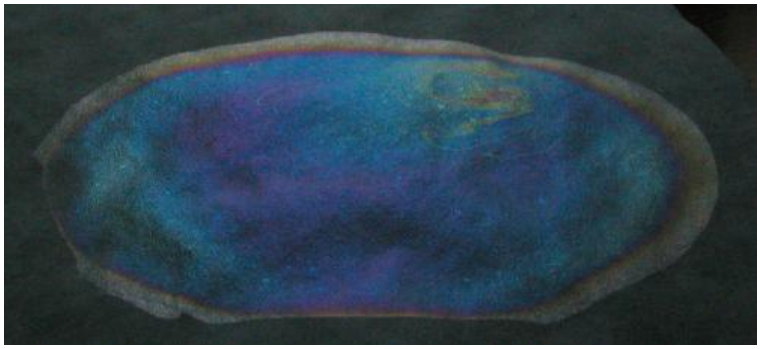
Activity Three: Make a Permanent Rainbow

Do IT!

Journal It! & What's Happening Here?

iSTEM Project, 2012

Activity *3*: Make a Permanent Rainbow



You have probably seen the beautiful rainbow colors caused by a tiny bit of oil floating in a puddle of water. In this project, we are going to capture those colorful patterns on paper, in a permanent form, so you can view them anytime you like, without a messy puddle.

What you will need

1) A piece of black construction paper.
2) A pan or similar container that can hold water
3) Clear Nail fingernail polish
4) An eye dropper or a pipette. Cut a slit in a large piece of cardboard.

Activity Directions

1) Fill the pan with water to cover the paper with at least a half of an inch of water.

2) Put the eyedropper into the nail polish bottle, and squeeze just a little air out of it, to get just a half of an inch or so of nail polish into the eyedropper. We only need a single drop.

3) Drop a single drop of nail polish onto the surface of the water.

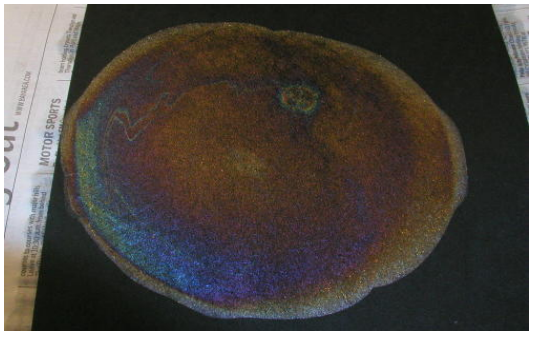
4) The nail polish drop will quickly expand to make a circle of film on the water. This film will be so thin, that it will only be as thick as one wavelength of light.

5) Let the circle of nail polish film dry for a few minutes. The edges will generally wrinkle a bit, and the center will take longer to dry than the edges.

6) Gently lift one end of the paper out of the water, making sure you catch the edge of the thin circle onto the paper.

7) Let the water drip off the paper into the pan, and then set the paper onto some newspaper to dry.

8) To view the colors, hold the paper flat towards the light, and view it at a low angle.



JOURNAL IT!

1) Where and when do you see rainbows in real life?
2) What are some stories you have heard about rainbows?

What's happening here?

The colors are caused by the interactions of several interesting qualities of light. Light travels at different speeds in different materials. In air it travels very fast (about 299,792,458 meters per second). In water, light travels slower than it does in air. In the film we made from the drop of nail polish, the light is even slower, because light even slower in dried nail polish. Light travels in waves. We can picture the waves of light as looking like waves of water in the ocean.

Activity Four: Spectroscope/Gradient Glasses

Do IT!

Journal It! & What's Happening Here?

Take it Home!! (Take home your gradient glasses and try them out around your house and your neighborhood.)

Activity 4: Spectroscope/Gradient Glasses

What you will need:

- Diffraction Gradient Glasses
- Incandescent light bulb (in a lamp, can you find one?)
- Flashlight
- String of clear holiday lights (Mentor or facilitator should plug in a strand of holiday lights for use with this experiment)
- Fluorescent light bulbs (in your school)

Separating White Light into Colors

1) Set up a few different kinds of white light sources in a room. The best rainbows come from the smallest points of light; for example, a single holiday light or a small, bright flashlight.
2) Look at the different light sources with the glasses on and notice what the rainbows look like.
3) Turn the light source off and on, what do you see?

JOURNAL IT!

1) Are the colors always arranged in the same order (red, orange, yellow, green, blue, indigo, and violet)?
2) Is the same color always closest to the light source?
3) Draw your own pictures of the rainbows you saw in the prism glasses.
4) Where do you think the colors in the rainbows come from?

What's happening here?

These colors were already there, hidden in the white light, and the glasses separated them out into their individual colors. Raindrops work the same way, separating sunlight into the colors we see in rainbows in the sky. These colors are actually contained in sunlight all the time, but we cannot see them because they are usually mixed together into white.

These glasses contain a series of very narrow lines called a diffraction grating. When light passes through a series of tiny slits or grooves called a diffraction grating, white light is spread out into a spectrum according to wavelengths of the light source.

Gradient Glasses: Take them home!

Besides looking cool, use your gradient diffraction glasses explore the spectra effects of different lights sources.

Diffraction Grating Glasses

Check out your:

- TV
- Computer Monitor
- Different Lights in your house (incandescent light bulb, a fluorescent bulb, a black light, and others)
- Street lights,
- Car lights
- Neon Lights
- A flashlight

Warning: Don't ever look directly at the Sun!!! It can cause serious damage to your eyes.

Compare the spectra of various sources. When you view different light sources, look for specific colors and notice the spacing between colored lines. The heated tungsten filament of an incandescent light bulb produces a continuous spectrum, and one color shades into another. The electrically excited mercury vapor in a fluorescent bulb produces distinct colored lines; the phosphors that coat the inside of the bulb produce a continuous spectrum.

Some other suggested light sources are a candle flame, a camping lantern, yellow streetlights (sodium produces the color), blue streetlights (mercury vapor produces the color), neon signs, and slide projector lamps.