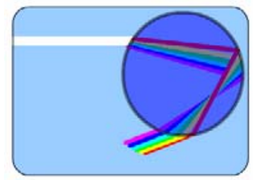
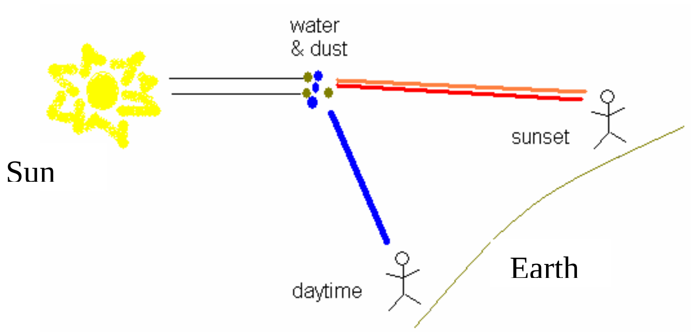
Light and Color

Light is a kind of energy that can travel through space. Light from the sun or a light bulb looks white, but it is really a mixture of many colors. The colors in white light are red, orange, yellow, green, blue and violet. You can see these colors when you look at a rainbow in the sky.



The sky is filled with air. Air is a mixture of gas, tiny drops of water, and small bits of solid stuff, like dust. As sunlight goes through the air, it bumps into the gas, water, and dust. When this happens, different colors of the light will bounce off in a different direction.

Some colors of light, like red and orange, pass almost straight through the air. Most of the blue light bounces off in all directions- it gets scattered all around the sky. When you look up, some of this blue light reaches your eyes from all over the sky. Since you see blue light from everywhere overhead, the sky looks blue. At sunset, you see the last bit of sunshine before the sun goes down- those colors of light that didn't get bounced around as much. That's why the sunset is red and orange – those are the colors of light you can see because of the position of the sun relative to the earth.



In outer space, there is no air. Because there is nothing for the light to bounce off, it just goes straight. None of the light gets scattered, and the "sky" looks dark and black.

Here are the activities we'll do as we investigate light and color:

1. Bend a stick – just add water
2. Chasing rainbows - split white light into a spectrum
3. Mixing colors- blend colors back into white
4. Let the light shine in- a look at the iris
5. Chromatography- split the ink from Sharpie markers into different colors

The experiment kit contains:

1. A square of foamcore
2. A small bag with two eyelets (small metal tubes) and a piece of string
3. A compact disc (these are blank)
4. A sheet of plastic with color paddles to cut out
5. Several index cards marked with ink

****You will also need rubbing alcohol, this is not in your kit****

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Bend A Stick

What you need:

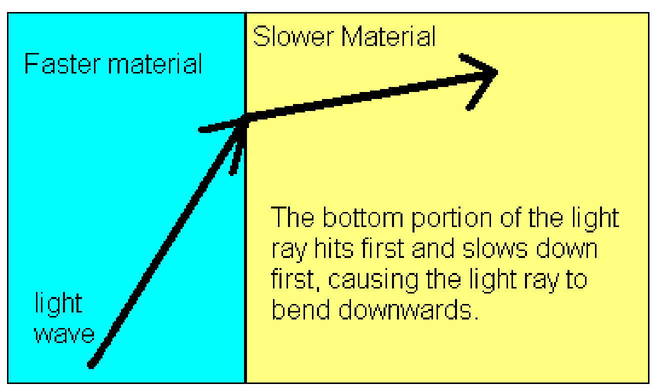
1. A plain clear glass (without etching or patterns)
2. Water
3. A marker, pencil, or similar object that is taller than the glass

What to do:

1. Put the stick into the glass, and let the top rest against the side of the glass.
2. Look at the stick from the side of the glass and from the top of the glass. What do you see?
3. Add water to the glass. The glass should be about 2/3 full.
4. Look at the stick from the side and through the top of the water. The stick should look different in both cases - from the side it looks bigger, from the top it looks like it has a bend in it near the waterline.

What is happening:

When light passes from one material to another, for example from air to water, its speed and direction change. This is called refraction. The light reflected (or bounced back) to your eye from the stick above the water is moving faster than the light reflected from the stick below the water. This makes the image of the stick appear “bent” at the waterline.



Refraction can also happen in a single material if the material has areas of different temperature. For example, in the desert, the air near the ground is hotter than the air above the ground. Light travels faster through the hotter air near the ground and it can appear that the ground is shimmering, or like there is a lake up ahead. This is called a mirage.

Neat words to remember

Reflection
Refraction
Mirage

Chasing Rainbows

Splitting Light Into the Spectrum

What you need:

1. A sheet of white paper
2. Colored pencils or crayons (yellow, orange, red, pink, violet, blue & green)
3. A compact disc (CD)
4. Water
5. Dish soap
6. A small dish for soap bubbles

What to do:

1. Look at the back of the compact disc (the side with no writing on it). You'll see different colors. Move the CD back and forth and the colors will shift and change.
2. Look at the colors you see. As you move the CD around, you will be able to find rainbows. Write down the colors you see. What order are the colors in?

   Did you know rainbows have another name? ROY G. BIV. The letters in this name are from the colors that make up the rainbow (the first letter of each color):

   Red Orange Yellow Green Blue Indigo Violet

   Is this what your rainbow looks like? Draw one of the rainbows you see with your colored pencils.

3. Put a small amount of water and dish soap on a small plate and mix them together. Try and make a few bubbles. (You can also try this in the bathtub). Look at the bubbles and the soapy water. Can you find little rainbows and different colors?

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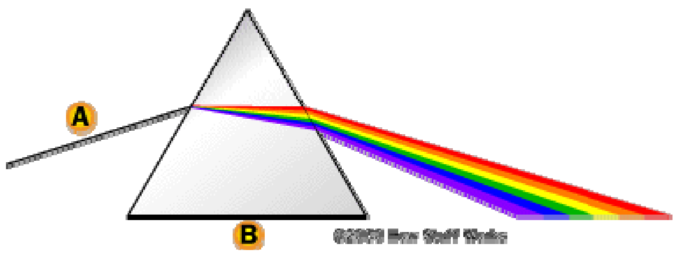
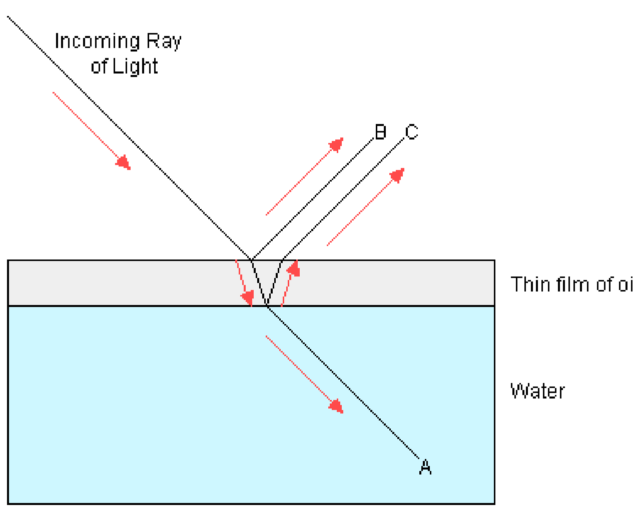
What is happening?

When light passes from one material or medium to another, for example from air to water, its speed and direction change. This is called refraction. A prism is a piece of glass or plastic shaped like a triangle that uses simple refraction to split white light into the colors of the spectrum or rainbow. As the white light (**A** in the picture below) moves through the two sides of the prism, the different colors bend different amounts and spread out into a rainbow. Violet light slows the most and bends the most. Red light slows and bends the least. When the different colors of light that make up white light are spread out and separated, we can see the spectrum, or the different colors of light.

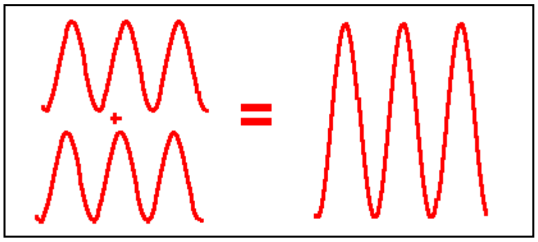


In a rainbow in the sky, raindrops in the air act as tiny prisms. Light enters the raindrop, and the white light is broken into a spectrum just like in a prism. The next time you spot a rainbow, you will see it in a whole new light!

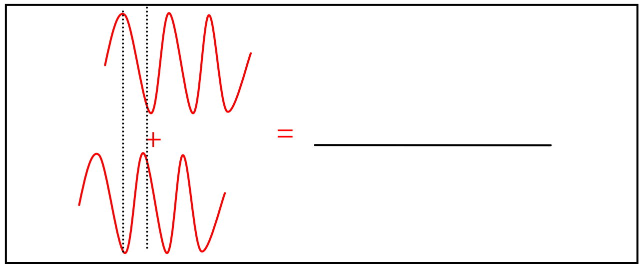
Rainbow patterns can also be made by the reflection of light. When you stand in front of a window in your house, you can see a reflected image in the window. Most of the light is passing through the window and out of the house, but some is reflected back at you, and this is how you see yourself in the window. Now think about a very thin film of oil (or soap) floating on water. As shown in the picture below, when white light strikes the film, most of the light passes through (A), but some is reflected off of the top (B) and bottom (C) layers of the film.



Now, you can think of light as being made up of waves - like the waves in the ocean. Sometimes the waves add together, making certain colors brighter, and sometimes they cancel each other, taking certain colors away.



Two waves added together that make a bigger wave- the stronger wave is easier to see



Two waves added together that cancel each other- the weaker wave is very hard to see

In the case of the thin film of oil or soap on the water, the light that reflects off the top layer (B in the picture on the previous page) travels a slightly shorter distance than the light reflecting off the bottom layer (C). If the film is just the right thickness, a colored light wave, like red, will bounce off the top and bottom layers in perfect alignment, and the two resulting waves will combine to double the amount of red light seen (just like you see in the picture above). Or, they may be exactly opposite (or out of phase), and red will be eliminated. This is called interference.

Take a close look at your CD. It's made of aluminum with lots of tiny ridges that is coated with plastic. The colors that you see on the CD are created by white light reflecting from very small ridges in the aluminum. When light waves reflect off the ridges on your CD, they overlap and interfere with each other. The colors you see reflecting from a CD are interference colors, like the shifting colors you see on a soap bubble or an oil slick.

Neat words to remember:

Prism, Medium, Reflection, Refraction, Spectrum

Mixing colors

What you need:

1. A pencil
2. Scissors
3. White paper
4. Crayons or markers in yellow, orange, red, pink, violet, blue & green
5. A ruler
6. A CD
7. String
8. A piece of white foamcore
9. Color paddles (colored circles on transparencies)
10. A grown-up with grown-up scissors

What to do:

First, let mix just a few colors-

1. Cut out the color paddles provided in your kit.
2. Hold the color paddles up to the light in different combinations to see what colors they make when added together. Fill out the chart below:

Red + **Yellow** = ______________

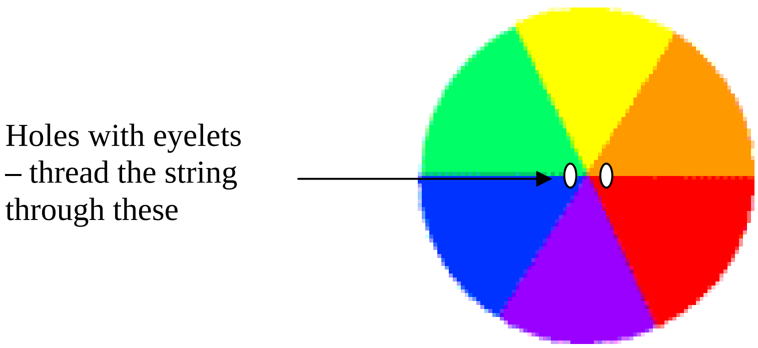
Yellow + **Blue** = _____________

Blue + **Red** = ________________

3. Now, hold the red and yellow paddles together in one hand. In the other hand, hold up the orange paddle. Hold your color paddles up to the light. Do the red and yellow paddles look almost the same as the orange paddle?
4. Based on the chart you made above, hold up the yellow and blue paddles together and compare them to the ___________ paddle. Do they look the same? What about for blue and red together?

Now, let's make a color spinner to see what all the colors mixed together look like-

5. Use the CD to trace a circle onto a piece of white foamcore (from your kit).
6. Use the CD to trace a circle on a regular piece of paper.
7. Cut out both circles. Get your parents to cut the foamcore, it is tough!
8. With the ruler, divide the circle on the piece of paper into six equal pie-shaped sections. Color the six sections with the colors of the spectrum as shown (look at the picture on next page)
9. Glue the paper circle onto the foamcore circle.
10. Poke two small holes, about 1 inch apart, through the middle of the circle. Push the eyelets through these holes so the string (see the next step) won't tear your foamcore wheel.
11. Thread the string through the holes, and tie the ends together.



12. Now your color spinner is ready to use. Hold one end of the string loop in each hand. Gently swing the spinner in circles until the entire loop is twisted, then gently pull the ends apart. As the spinner unwinds, it will wind back up in the opposite direction. Keep doing this, and you will get the spinner to spin fast enough to see the colors on the wheel blend into white. ****This may take a little practice to get right, so be patient!**
13. Try the experiment again, going back to step 5. Try to use different patterns and colors- just glue the paper circles over your first one. What colors do you see when you mix yellow and red only? What happens if you use red and blue only?
14. What is your favorite color? Using your color wheel and paddles, can you find what colors make your favorite color?

What is happening:

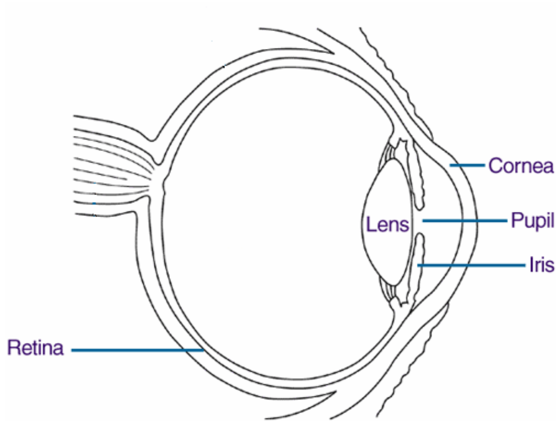
The colors on the wheel are the main colors in white light. When the wheel spins fast enough, the colors blend together, and the wheel looks white. The color spinner is also known as a Newton's wheel, named for a very famous scientist (Sir Isaac Newton) who studied light and color with a similar wheel.

Red, yellow, and blue are known as primary colors. Mixtures of these three colors result in the remaining colors on the wheel, as shown by your experiment with the color paddles. Purple, orange, and green are known as secondary colors. Try experimenting with different color combinations to see which ones you like the most.

Let The Light Shine In

A Look At The Iris

The eye is made up of several parts: the cornea, pupil, iris, lens, and retina. Each has an important function.



Have you ever seen a picture of yourself where your eyes are red? This happens when the camera's flash reflects off the retina - or back wall - of your eye.
Look closely at your eye in the mirror. The iris is the colored part of your eye. The iris is the muscle that lets the proper amount of light through the pupil and into the eye. The pupil is the black dot in the middle of the iris. The iris opens to make the pupil big when there is only a little light and closes to make the pupil smaller when there is a lot of light.

What to do:

1. Get someone to help you- Mom, Dad, or a brother or sister.
2. Go outside on a sunny day, or go to a brightly lit room.
3. Tell your helper to close their eyes and count to ten.
4. Tell your helper to open their eyes. What happens to their eyes?

What is happening:

The pupil will start out large then become smaller. When the eye was shut, the iris relaxed and made the pupil large, trying to get more light into the pupil. When the eye opened, there was a flood of light - the iris shut and made the pupil smaller, trying to limit the light coming in.

Neat words to remember:

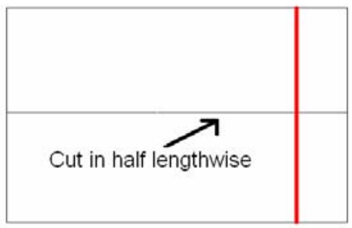
Pupil, Iris, Cornea, Retina

Chromatography

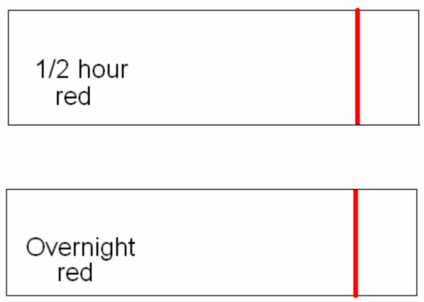
Breaking up colors

What you need:
1. The marked index cards from your experiment kit
2. Several cups, maybe two for each card (see step 5 below)
3. Rubbing alcohol **(not provided with your kit)
4. Paper towels

What to do:
1. Cut each index card in half lengthwise as shown, so that you get two strips of paper with an ink line on one end.



2. Label your test strips on the end opposite the ink line. Mark one with a "1/2 hour" and the other "overnight." Below this write the color of the ink.



3. Set out the cups in a row on the paper towels.
4. Put 2-3 tablespoons of rubbing alcohol in each cup, enough to cover the bottom of the cup.
5. Place one of the paper strips inside each cup, putting the edge with the colored ink line down. <u>Make sure the mark does not sit in the alcohol.</u>

**You can put more than one strip in a cup, just make sure they do not touch.

6. Wait about 30 minutes. Look at the strips. Take the ones marked "1/2 hour" out of the cups and lay them on the paper towels to dry a little.
7. Using your ruler, measure how far the ink moved on the paper. Write down your results in the chart on the next page.
8. In the morning, take out the strips marked "overnight" and place them on the paper towels to dry a little. Again, using your ruler, measure how far the ink moved on the paper, and write your results in the chart on the next page.
9. Look at your completed chart. What do you see? Did the ink on the strips left overnight move more than the ink for the strips left only for 30 minutes? Did the original color of the ink change? Do you see different colors?

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Chromatography Chart

Time: ½ hour	Starting Color:	Starting Color:	Starting Color:	Starting Color:
How far did the ink move?				
What colors of ink do you see?				
Time: Overnight				
How far did the ink move?				
What colors of ink do you see?				

What is happening:
Chromatography is a technique for separating mixtures. Each color of ink, just like white light, is made up of several different colors or pigments. This experiment uses chromatography to separate out the different pigments used in the ink. The paper placed in the cup serves as a wick to slowly draw the alcohol upwards. As the alcohol moves up the paper, the alcohol dissolves the ink and allows the pigments to separate. The different pigments move up the paper with the alcohol at different speeds. The speed depends upon the type of ink (analyte), the solvent (such as alcohol or water), and the absorbing medium (paper in this case).

The ink line on each index card was made with a Sharpie permanent marker. You can try more ink colors and different types of markers with different solvents at home.

Neat words to remember:
Analyte, Chromatography, Pigment, Solvent

Interested in learning more about light and color?

Check out the library science section. Ask for books about light, rainbows, and colors.
Here are a few examples:

1. Switch On, Switch Off by Melvin Berger (*Advanced Reader book*)
2. All About Light by Lisa Trumbauer (*Advanced Reader book*)
3. What Makes a Rainbow? by Betty Ann Swartz
4. Lets Find Out About Color by Ann Campbell
5. Colors by Pamela Schroeder and Jean Donisch
6. What Makes a Shadow? by Clyde Bulla
7. Raindrops and Rainbows by Rose Wyler and Steven Petruccio (*Advanced Reader book*)
8. All the Colors of the Rainbow by Allan Fowler (*Advanced Reader book*)

Credit where credit is due….

The experiments, discussions, and pictures in this handout were taken or adapted from the following websites and books:

1. Science Made Simple (http://www.sciencemadesimple.com/)
2. Franklin Institute Online (http://fi.edu/tfi/)
3. How Stuff Works (http://science.howstuffworks.com/question41.htm)
4. NASA (http://whyfiles.larc.nasa.gov/treehouse.html)
5. HyperPhysics website, Georgia State University, R. Nave, (http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)
6. "My Big Science Book," Simon Mugford, St. Martin's Press, New York, New York

Coming soon: Science Club website

As soon as we are up and running, we will post the web address in the school newsletter.

The next experiment packets will available from the school library on the following days:

Second Grade: Feb 27
First Grade: Feb 28
Kindergarten (and pre-K): March 2

NOTE TO PARENTS

Dear Parents-

We have had several questions regarding whether or not kids are required to turn back in their work. The answer is NO. These experiments and handouts are intended not as homework to be turned in, but rather fun activities for the kids to do when the family has time. Some may want to do the entire kit in one day. Others may do one activity every couple of weeks. That is up to your family schedule.

The basic kit did come with a folder. If your child makes a picture, adds to the experiment, finds a neat website, or does some other form of work that they want to share with ANS and the rest of the club, then they will print their first name and last initial and their grade on the work, put it on their folder, and return it to the library cart. The information on the label of the front of the folder ensures that you will get your child’s work back. The folders will be returned to the children via the library cart- when they pick up the next kit, the folders should be there. (Since this is the first time we have done this, there may be some snags in this process, but having the child’s information on the folder means that you will eventually get their work back.)

ANS/WIN would like to post results the kids provide on the website. However, if this is not possible (because of the volume of material), the ANS/WIN members (who do not have children at FPS) will look at the returned work and pick out several to post on the website. When we return the folders, we’ll stick a note in the folder letting you know to look for their work on the web. Any information, such as recommended websites, books, etc., will be incorporated into the website, it just may not be possible to post all the pictures.

Regardless, your feedback is crucial to the success of the club. Even if your child doesn’t want to send anything back, to help us improve, please fill out and return the questionnaire on the back of this note. The questionnaires do not need to be returned in the folders. We appreciate it!!

Light and Color Questionnaire

Were the materials provided appropriate? Yes _____ No _____
Please explain.____

1. Did you have enough materials for each experiment? Yes_____ No_____

   Please explain.____

2. Did the experiments work? Yes_____ No_____

   If not, please explain____

3. Please provide any suggestions for improvements or additional

   experiments/explanations.____

   ____