EXPLORING LIGHT AND COLOR
Spectroscope

Name _______________

Purpose: To build a homemade spectroscope.

Materials: shoebox
diffraction grating (slide mounted)
index card
tape
scissors

Procedures:

1. Cut a rectangle at one end of the shoebox.
2. Cut the index card in half and position the cards so that they create a very narrow slit in the center of the rectangular hole made in step 1. The slit should run up and down.
3. On the other end of the box, cut a hole a bit smaller than the diffraction grating.
4. Tape the diffraction grating loosely to the inside of the hole in the shoebox. Tape it loosely because you may have to adjust it later. The grating must be lined up in a certain way. The scratches on the grating must go parallel to the slit on the other end of the box.
5. Put the lid on the box and aim it at a light source such as a light bulb. Look through the grating with the slit aimed at the light. If you don't see colors, the diffraction grating may be facing the wrong way. Un-tape the grating and turn it a quarter turn and re-tape it.
6. Look again and you should see color spectrums on the left and right of the slit.
7. You may have to move the cards closer together to get a clear color spectrum.

Observations:

1. Look into the spectroscope and describe what you see.
2. Try different light sources. DON'T AIM THIS SPECTROSCOPE TOWARDS THE SUN. You can look at a reflection from a white piece of paper.

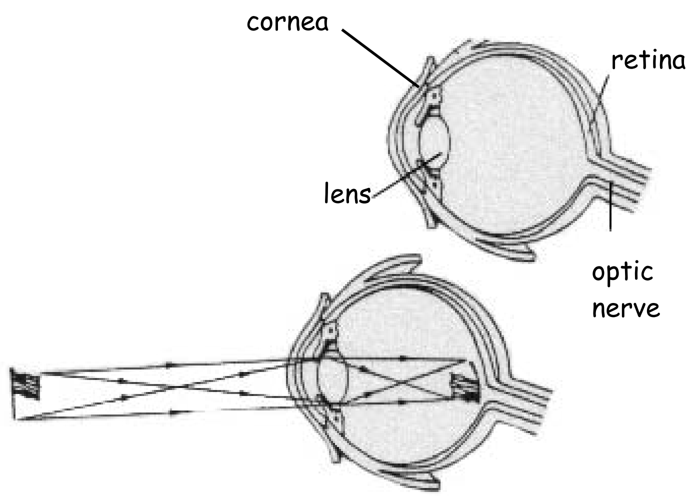
Conclusion: The colors you see are specific to the light source you are looking at.

EXPLORING LIGHT AND COLOR
The Human Eye

Name _______________

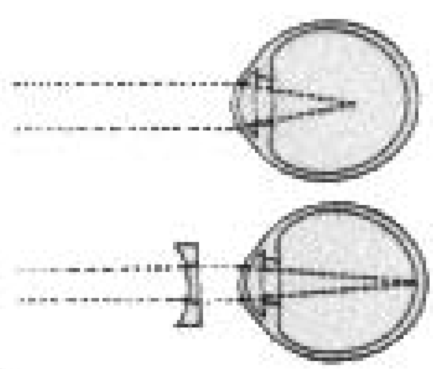
The eye and brain work together to allow us to see. The eye receives light and sends the message on to the brain where interpretation of the image occurs.

The light goes through the lens and Strikes the cones and rods on the retina. The cones and rods send messages through the optic nerve to the brain.

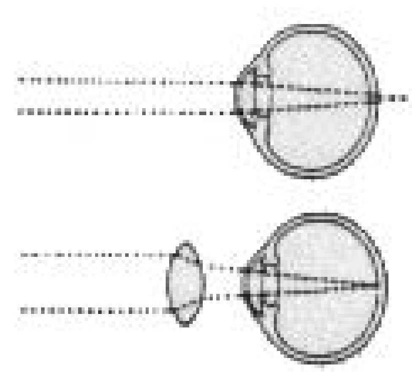


The image on the retina is inverted.
Can you explain why?

Nearsightedness
Some people suffer from nearsightedness, which is a case where the eyeball is too long and the image forms in front of the retina. It can be corrected with glasses using a concave lens.



Farsightedness
This condition occurs when the image forms behind the retina. A convex lens can correct this problem.



EXPLORING LIGHT AND COLOR
Blind Spot

Name _______________

At the back of the eye is the retina. The retina is made up of rods and cones, which react to the light that enters the eye. The retina sends signals to the brain where this information is interpreted and we are able to see. There is a part of the retina that is called the blind spot. This is where the nerves from the rods and cones come together and travel to the brain. This area of the retina has no rods or cones so it is incapable of sensing light and therefore can't send information to the brain. Normally, this blind spot isn't a problem with vision.

We can detect this blind spot with the following simple experiment.

Purpose: To demonstrate that our eyes have a blind spot.

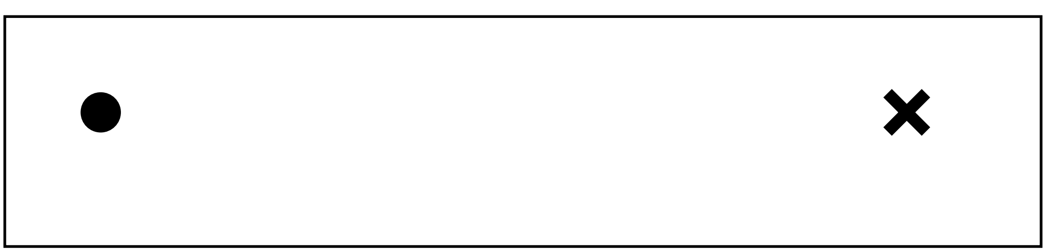
Materials: 3 x 5 inch index card
Marker

Procedures:

1. Use the marker to make an X and O on the index card.
2. Hold the card in front of your face with the X on the right side.
3. Close your right eye.
4. Stare at the X with your left eye and continue to stare at it as you move the card towards and away from your face slowly.
5. Make observations.

Observations: At what point does the O disappear?

When does the O return to view?



EXPLORING LIGHT AND COLOR
Pre-test

Name _______________

A. Directions: Give a definition for the terms below.

1. photosynthesis ____
2. retina ____
3. visible spectrum ____
4. optic nerve ____
5. ultraviolet ____
6. infrared ____
7. ROY G BIV ____
8. fiber optics ____

B. Directions: The following questions need a short answer.

1. Humans are said to have binocular vision. What does that mean?
2. Why do birds and fish have their eyes on the sides of their heads?
3. Newton found that reflected light was responsible for objects of different colors. How does this work?
4. What are the primary colors of light?
5. What is a prism used for?
6. How fast does light travel?
7. What is refraction of light?
8. Describe each of these terms; transparent, translucent, and opaque.
9. What is persistence of vision?
10. What is the difference between concave and convex lenses?

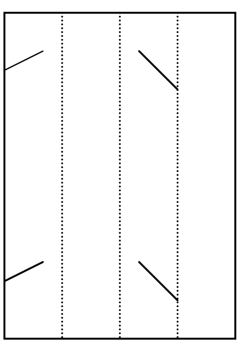
EXPLORING LIGHT AND COLOR Name ______________

Homemade Periscope

Purpose: To build a periscope that can be used to see over walls and around corners.

Materials: two flat mirrors of the same size (pocket mirrors work fine)
large sheet of cardboard (side of a cardboard box)
scissors
ruler
pencil
protractor

Procedures:



1. Start with the cardboard. Refer to the illustration for help. You will need four equal sections along the width of the cardboard. Use one of the mirrors to determine how wide each cardboard section should be. Measure the sections so that they are about an inch shorter than the mirror width.
2. Use the ruler to draw in the crease lines. The length of the cardboard will determine the height of the periscope.
3. Use the protractor to measure a forty-five degree angle at each end of the first and third cardboard sections. Notice the way the forty-five degree angle lines are facing.
4. Use the scissors to cut the mirror slots you have just measured. These slots must be large enough for the mirrors to slide into place.
5. Cut viewing holes as shown in the diagram.
6. Crease the cardboard along the dotted lines you drew before when sectioning the cardboard. The cardboard is then folded along these creases. Use tape to hold the box together.
7. Slide the mirrors into the forty-five degree slots. The mirrors should rest secure in those slots and extend slightly out of either side of the box.

Observations: Try the periscope by looking into either of the two viewing squares.

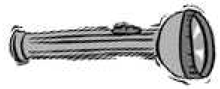
Conclusion: Determine if the image in the viewing mirror is reversed or not.

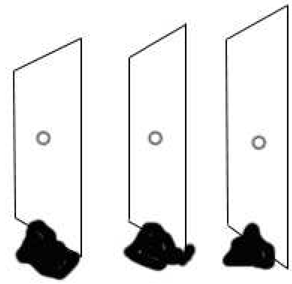
Name _______________

EXPLORING LIGHT AND COLOR
How Does Light Travel?

Purpose: To find out how light travels.

Materials: three pieces of index card
ruler
pencil
clay
flashlight





Procedures:

1. Draw diagonal lines from corner to corner of each card. Where the lines cross is the center of the card.
2. Poke a hole in the center of all three cards.
3. Use the clay to stand the cards up.
4. Line the cards up so that you can see through all three cards even when they are spaced a few inches apart.
5. Shine the beam from the flashlight onto the center of the first card.

Observations:

1. When the three cards are lined up in a straight path how does the flashlight beam behave?

2. Now move the center card slightly to one side and again use the flashlight to shine the beam at the center of the first card. How have the results changed?

Conclusion: Explain why you get different results for observations 1 and 2.

EXPLORING LIGHT AND COLOR
Post Test

Name _______________

Directions: Answer the following questions in the space provided.

1. How fast does light travel?

2. Why do birds and fish have their eyes on the sides of their heads?

3. What is persistence of vision?

4. What are the primary colors of light?

5. Light from the sun is a key component in photosynthesis. Describe how photosynthesis works.

6. Humans have binocular vision. What is binocular vision?

7. Define these terms:
   a. opaque
   b. transparent
   c. translucent
   d. optic nerve
   e. retina
   f. cornea
   g. iris
   h. pupil
   i. blind spot

EXPLORING LIGHT AND COLOR

Name ________________

Pinhole Scope

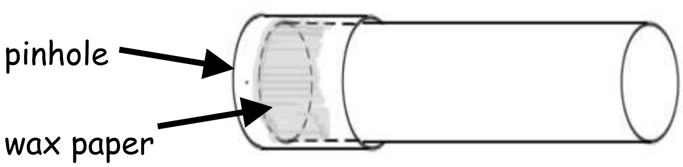
Purpose: To build a pinhole scope using handy throwaway materials.

Materials:
wax paper
aluminum foil
tape
pin
two tubes – one larger than the other (paper towel and bathroom tube work well)

Procedures:

1. The shorter tube should be slightly wider around than the longer tube as shown here:

2. Tape a piece of wax paper over one end of the longer tube.
3. Tape a piece of aluminum foil over one end of the shorter tube.
4. Use a pin to poke a pinhole in the center of the aluminum foil. Be careful to make only one hole.
5. Slide the shorter tube over the longer tube as illustrated.



Observations: Look out a window with your scope. The image will appear on the wax paper. You can adjust the size of the image by moving the shorter tube in and out.

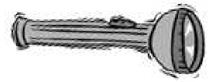
Conclusion: Why is the image in this scope upside down?

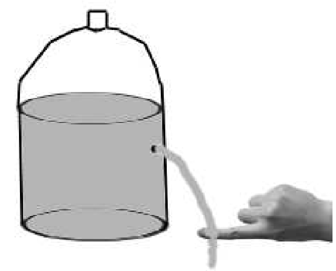
EXPLORING LIGHT AND COLOR
Reflections Inside Water

Name ________________

Purpose: To explore the reflection of light in a water stream.

Materials: large plastic bottle
water
flashlight
pin
pencil





Procedures:

1. Make a small hole in the plastic bottle with the pin about one-third the way up the side of the bottle. Use the pencil to make the hole a little larger than the width of the pin.
2. Fill the bottle with water and quickly put the cap on the bottle to stop the water from escaping.
3. Take the bottle to a sink and position it so the water will run into the sink.
4. Have a partner turn on the flashlight and hold it so it shines through the bottle.
5. Loosen the bottle cap and allow the water to run out of the bottle and into the sink. Hold a finger into the stream of water.

Observations: You should see the light on your finger even though the flashlight is aimed in a different direction.

Conclusions: Explain why the light of the flashlight is bent in the water stream.

How is this demonstration related to work being done with fiber optics?

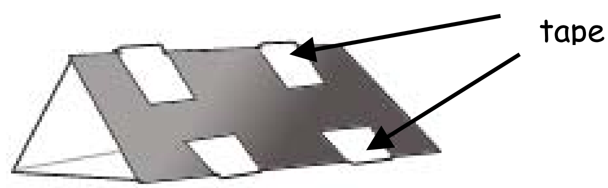
Name _______________

EXPLORING LIGHT AND COLOR
Kaleidoscope

Purpose: To build a homemade kaleidoscope.

Materials: three equal-sized mirrors
White paper tape small colored shapes of paper or beads

Procedures:
1. Position the mirrors so that their ends form a triangle. The reflective surfaces should all face inward.
2. Tape the mirrors securely in this position.
3. Put the mirrors on the white paper and drop the pieces of colored paper and beads into the mirror kaleidoscope.



Observations:
1. Look into the kaleidoscope and draw a picture of what you see.

2. Try moving the mirrors or the colored paper to see how the patterns change.

Conclusions: How does this kaleidoscope compare to purchased products?

Name ________________

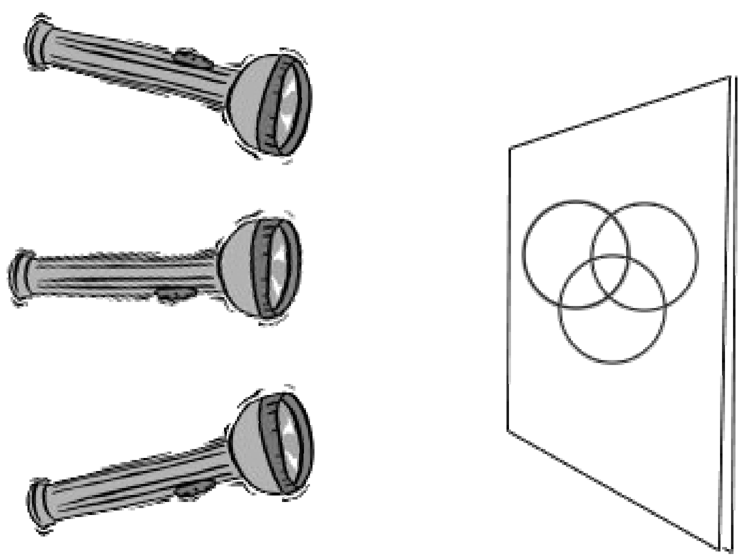
EXPLORING LIGHT AND COLOR
Mixing Colors With Light

Purpose: To demonstrate how mixing colored light can make different colors.

Materials: colored cellophane (red, green, blue)
three flashlights
white cardboard or paper
rubber bands

Procedure:
1. Wrap a different transparent paper around each of the ends of the flashlight.
2. Use the rubber bands to hold the paper in place.

Observations: Color in the circles and the overlap sections to indicate what colors are made when other colors are mixed.



Conclusions: The primary colors of light are red, green, and blue. All other colors are made from combinations of these three colors.

Take a magnifying glass and use it to take a look at a television screen. You will see tiny dots of red, green, and blue.

Name ________________

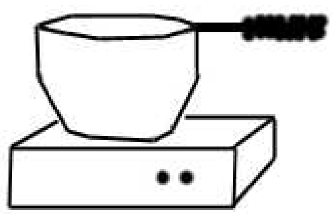
EXPLORING LIGHT AND COLOR
Making Dyes

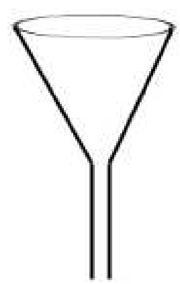
Purpose: To make some colored dyes using vegetables and fruits.

Materials: cooking pot
cherries, spinach, onion skins
hot plate or stove
water
cloth or material to be dyed
coffee filter
funnel

Procedures:

1. Boil the vegetables or fruits one at a time in a little water. Simmer for about 15 minutes.
2. Let the mixture cool and pour it into a funnel that contains a coffee filter. Let the liquid drain into a pan.
3. Place the cloth or material to be dyed into the pan for a few minutes.





Observations:

1. What color do you get from different fruits and vegetables?
2. Try different berries and leaves to see what colors you can produce. If you mix some of these colors, what are the results?

Conclusion: How do these natural dyes boiled from leaves and berries compare to the dyes used in clothing?

EXPLORING LIGHT AND COLOR
The Angle of Incidence Compared To the Angle of Reflections, Part 1

Name ________________

Purpose: To compare the angle at which light strikes a mirror (angle of incidence) with the angle of the reflected light.

Materials:
- cardboard
- tape
- 4 straight pins
- pocket mirror
- wood block for support of mirror
- protractor

Procedures:

1. Tape the mirror to the wood support.
2. Place the blackline master called "The Angle of Incidence Compared To The Angle of Reflection, Part 2" on the cardboard and put the mirror on the mirror line.
3. Put a pin in each of the points marked 1 and 2.
4. Move your head to the left and look into the mirror at the reflection of pins 1 and 2. Move your head until the pins line up with the images in the mirror.
5. Draw a straight line connecting the pins with point B.
6. Use the protractor to measure angles ABC and angles DBC.

Observations:

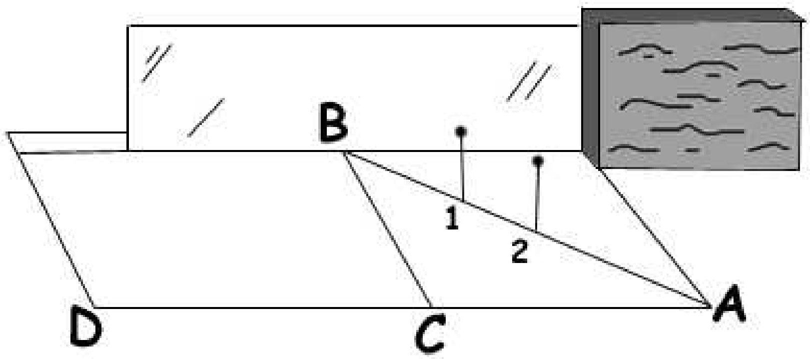
1. How do the angles compare?

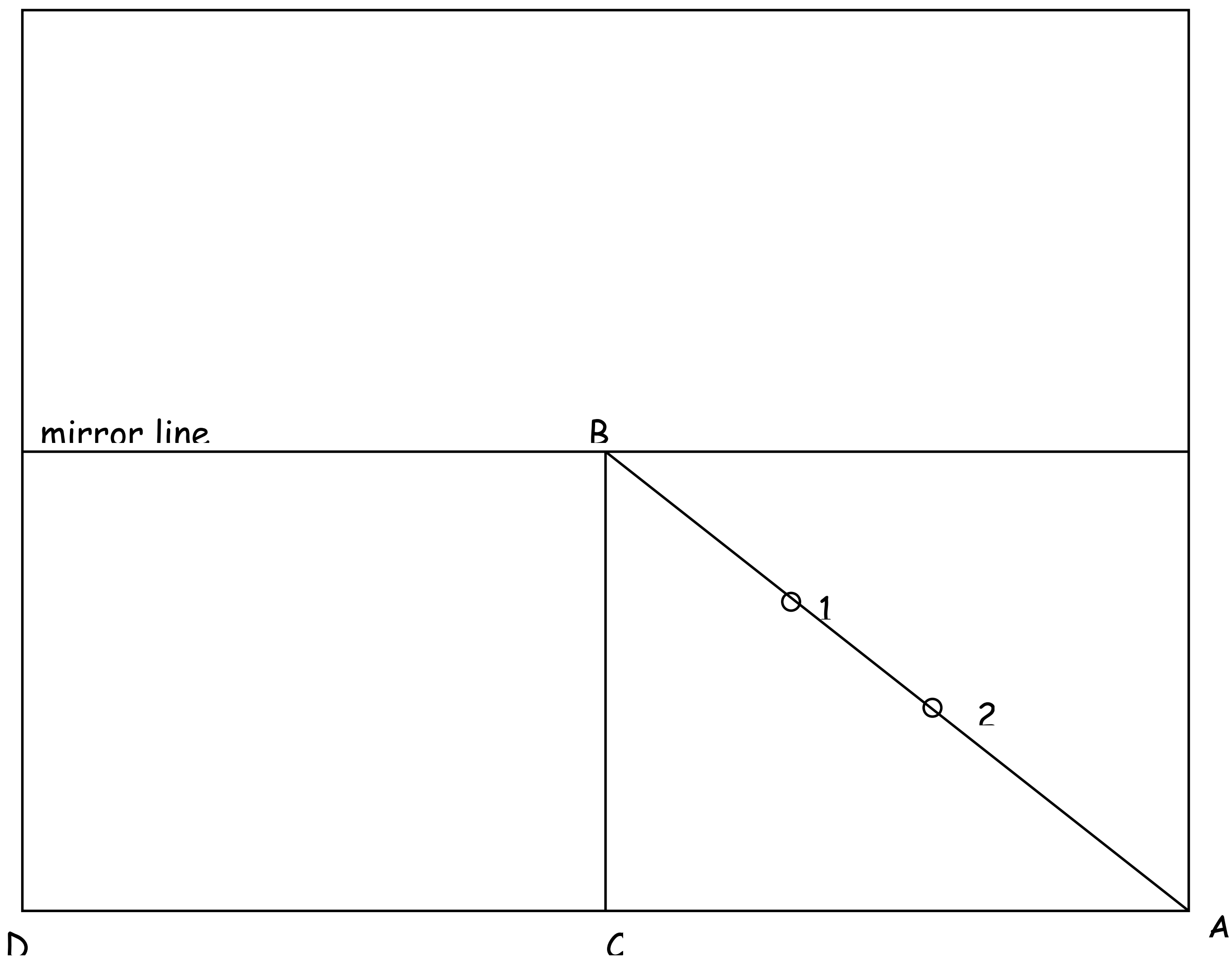
2. Try this again with your own set-up and a different angle. Do you get a similar relationship?

Conclusion: How does the angle of incidence compare to the angle of reflection?

EXPLORING LIGHT AND COLOR
The Angle of Incidence Compared To The Angle of Reflection, Part 2

Name ________________





EXPLORING LIGHT AND COLOR
Mirror Maze

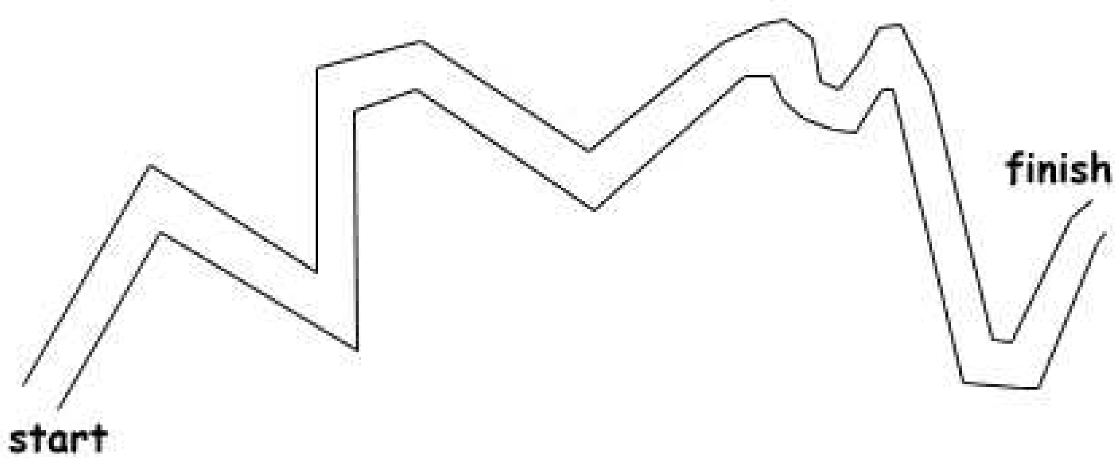
Name ________________

Purpose: To challenge yourself to move a pencil through a mirror maze.

Materials: large mirror
books
pencil

Procedures:

1. Prop the mirror up with a couple of books.
2. Place the maze shown below in front of the mirror so that you can see the reflection in the mirror.
3. Hold up a book so that the maze can only be seen in the mirror.
4. Use the pencil to move through the maze as you look at its reflection in the mirror.
5. Make some mazes of your own. The lines should be about half of an inch apart.



Observations:

1. Time how long it takes you to get through the maze.

2. Were you able to get through the maze without going out of the lines?

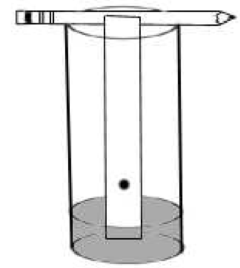
Conclusion: Why was it difficult to get through the maze quickly and without hitting the maze lines?

EXPLORING LIGHT AND COLOR

Name ________________

Chromatography

Purpose: To determine the pigments used in colored pens and inks.

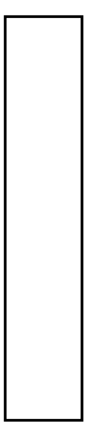


Materials:
- blotting paper
- scissors
- drinking glass
- pencil
- scotch tape
- colored pens and inks (India ink should be one choice)

Procedure:

1. Cut the blotting paper into a length that equals the height of the glass and a width of one inch.
2. Pour a small amount of water into the glass.
3. Put a small dot of ink or colored marker near the bottom of one end of the blotter paper. The ink dot should be about half an inch above the water level of the glass.
4. Place the end of the blotter paper that has the dot of ink into the water. Tape the other end to the pencil which is placed across the glass mouth.
5. Make observations over the next few minutes as the water slowly moves up the blotter paper.

Observations:



1. As the water moves up past the dot of ink, what happens?

2. As time goes on and the water continues to climb the blotter paper, describe what you see. Identify the colors that you see by coloring this blotter paper.

Conclusion: What colors are discovered in various markers and inks?

EXPLORING LIGHT AND COLOR
Water Drop Lens

Name ________________

Purpose: To demonstrate the magnifying ability of a water lens.

Materials:
newspaper
water
medicine dropper
wax paper

Procedures:

1. Spread the newspaper on a smooth surface like a desktop.
2. Place the wax paper on the newspaper.
3. Use the medicine dropper to dab drops of water onto the wax paper.
4. Make drops of various sizes.

Observations:

1. Look through the drops of water at the newsprint underneath.
2. Which drop magnifies the most? _________________
3. Draw the shapes of three different sized drops (small, medium, and large).

4. How does the shape that magnifies the best differ from other drops?

Conclusion: Why do certain drops magnify things so well? (The first magnifying glasses were actually drops of water held in a wire loop. You can make one by twisting the end of a piece of wire around the tip of a pencil. Then dip the loop in some water and look at something through the water drop lens).

EXPLORING LIGHT AND COLOR
Program Quiz

Name ________________

Directions: These questions appear at the end of the video presentation.

1. If we shine a green light on this lemon, how will the lemon appear?

2. The primary colors of light are?

3. The seven colors of the light spectrum are?

4. Why do black objects absorb more heat energy than white or colored objects?

5. Why does light refract or bend when going through glass or water?

6. Describe how concave and convex mirrors are different from one another.

7. Draw arrows on the concave and convex lenses to show how light moves through them.

8. How do we see colors from objects bathed in white light?

EXPLORING LIGHT AND COLOR
Persistence of Vision

Name ________________

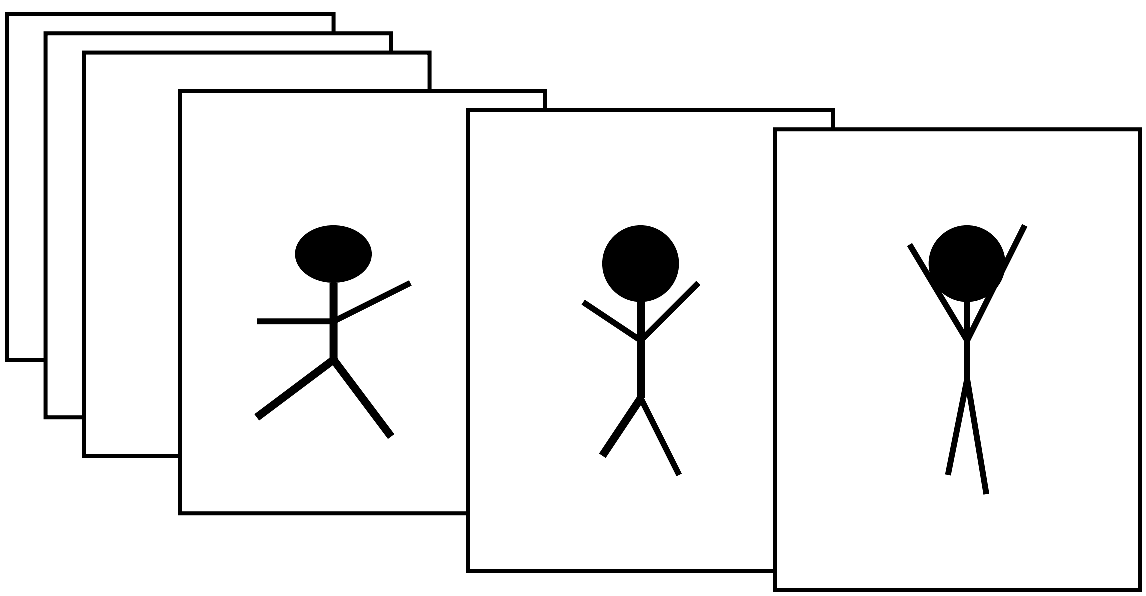
You can make a flip book to see what is meant by persistence of vision. Our eyes retain an image for a brief time after the image is gone from view. This is how movies work. They are actually made up of many still pictures and when shown quickly one after another, they give the impression of motion.

Problem: To build a flip book to demonstrate how persistence of vision works.

Materials: 15 to 20 squares of paper (4" by 4")
Colored pencils or markers
Stapler

Procedures:

1. You will be drawing a little scene on the pages of the flip book. Think of something to draw, such as a dolphin jumping out of the water, a stick figure doing jumping jacks, or a car zooming up a mountain.
2. Start the first drawing on the last page.
3. One each page change the drawing slightly as shown below.
4. Staple the pages together at the top so they can be easily flipped through your fingers.
5. When you are finished , flip the book from the back page quickly through to the first page.



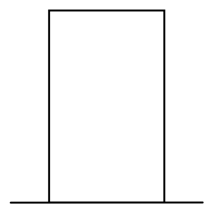
EXPLORING LIGHT AND COLOR
Optical Illusions

Name ________________

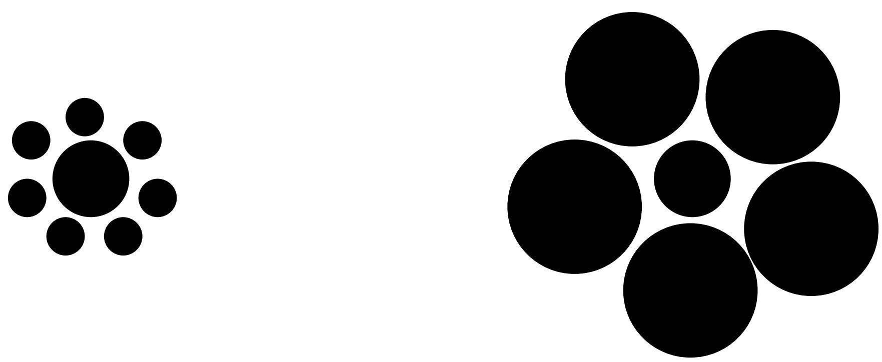
Directions: Answer the questions about the following optical illusions.

1. Which line is longer A or B?

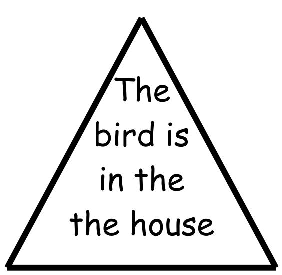
2. Is this hat wider or taller?



3. Which inner circle is larger?



4. Read the message carefully.



5. Which line B or C is the continuation of A?