Investigating Light

Eisenhower Science Mini-Unit
Donna Shartzer - Irvington Elementary
shartzed@breck.k12.ky.us

MAJOR CONCEPTS

Physical Science – Transfer of Energy

SC-M-1.3.3 Light energy interacts with matter by transmission (including reflection), absorption, or scattering (including reflection).

Science Inquiry – Scientific Ways of Thinking and Working

- Use appropriate equipment, tools, techniques, technology, and mathematics to gather, analyze, and interpret scientific data.
- Design and conduct scientific investigations.
- Communicate (e.g. writing, graph) designs, procedures, observations, and results of scientific investigations.
- Review and analyze scientific investigations and explanations of other students.

OVERVIEW

In this unit students will discover how light produces energy due to various physical and chemical changes.

SKILLS

- observation
- data interpretation
- comparing and contrasting
- recording data
- communicating
- categorizing

CHALLENGE

Light is a form of energy that has certain properties. In this unit students will discover through investigations what light is, light travels in a straight line, light travels in waves, and that light reflects and refracts.

TEACHER NOTES

I brainstorm with students to see what they know by asking them to list in a K-W-L chart what they know about the subject light, and what are some questions they have about light, and then we investigate different concepts of light. Once we finish our investigation we refer back to the K-W-L to review and discuss what we have learned. The students are then asked to review what they first thought about light, and record in their science journal what they learned after the investigations.

Pre-assessment
Light

Name ______________________________

Matching: Fill in the blank with the correct term on the left. You only have to write the letter in the blank. Don't forget to circle "DO" words, <u>underline</u> key words, and in any significant numbers.

A. Electromagnetic waves
B. electrons
C. wavelength
D. light family
E. visible light
F. frequency
G. reflection
H. refraction
I. intensity
J. crest
K. trough

1. The distance between waves is called a _______.
2. _______ is the number of waves that pass by a point in one unit of time.
3. The top part of a wave is called a ______.
4. The brightness or dimness of light is called _______.
5. Light can be produced whenever excited _____ fall from a higher energy level into a more stable energy level.
6. _______ are produced whenever excited electrons give off pulses of energy such as light.
7. Radio, heat, light, ultraviolet rays, x-rays, and gamma rays are examples of the ______.
8. The bottom part of a wave is called a ______.
9. The color we see (ROY G BIV) is called ______.
10. ______ is the process of "bouncing off" an object's surface.
11. ______ is the process of "bending" light energy through different materials.

Pre-assessment – Answer Sheet
Light
11 pts.

Name ______________________________

Matching: Fill in the blank with the correct term on the left. You only have to write the letter in the blank. Don't forget to circle "DO" words, underline key words, and in any significant numbers.

A. electromagnetic waves
B. electrons
C. wavelength
D. light family
E. visible light
F. frequency
G. reflection
H. refraction
I. intensity
J. crest
K. trough

a. The distance between waves is called a ___I___.
b. ___F__ is the number of waves that pass by a point in one unit of time.
c. The top part of a wave is called a ___J__.
d. The brightness or dimness of light is called ___I___.
e. Light can be produced whenever excited __B__ fall from a higher energy level into a more stable energy level.
f. ___A___ are produced whenever excited electrons give off pulses of energy such as light.
g. Radio, heat, light, ultraviolet rays, x-rays, and gamma rays are examples of the __D__.
h. The bottom part of a wave is called a __K__.
i. The color we see (ROY G BIV) is called __E__.
j. __G__ is the process of "bouncing off" an object's surface.
k. __H__ is the process of "bending" light energy through different materials.

OPEN RESPONSE

We know white light contains all of the colors of the visible spectrum: red, orange, yellow, green, blue, indigo, and violet, but in our everyday life we can only see these rainbow colors under certain conditions.

a. **Describe 2 examples of where you might see a rainbow affect in every day life.**
b. **Choose one of the examples you listed in "a" to explain what conditions produce a visible light spectrum.**

Rubrics

Score	
4	**Student clearly describes 2 examples of where a visible light spectrum might be seen in everyday life, and clearly explains an understanding of what conditions can produce a spectrum of visible light.**
3	**Student clearly describes 2 examples of where a visible light spectrum might be seen in everyday life, and explains a basic understanding of what conditions can produce a spectrum of visible light.**
2	**Student vaguely describes 2 examples of where a visible light spectrum might be seen in everyday life, and vaguely explains what conditions can produce a spectrum of visible light.**
1	**Student may or may not lists 2 correct examples of where a visible light spectrum might be seen in everyday life and incorrectly describes what conditions can produce a spectrum of visible light.**

Task 1: What is light?

Materials/Group

- pliers
- safety goggles
- large plastic storage bag
- assorted Lifesavers including, but not limited to wintergreen, peppermint, butterscotch, cherry, tropical fruits, and root beer
- assorted breath mints (sugar-free and regular)
- assorted antacid mints
- rock candy

Teacher note: Prior to this activity we have been discussing various forms of light (lightning, artificial light, sunlight) and introduced ways light can be produced - friction, chemical change. Discuss the terms bioluminescence and triobolumiescences (The emission of light from various substances caused by grinding or crushing them.) In this activity students will test for sugar by using pliers to crush hard candies and observe whether triboluminescence occurs. When sugar is crushed, nitrogen that adheres to sucrose crystals is released as the sugar crystals break. Nitrogen is released in a high–energy state. As the nitrogen decays, it releases a small amount of red, purple, or blue light.

Purpose

The purpose of this activity is to show how animals like a firefly give off light due to a chemical change.

Guiding Question

How does a firefly give off light?

Procedure

1. Divide the class into groups of two students.
2. Distribute to each team a pair of pliers, a large plastic bag, and safety goggles for each team member and the first type of candy to be tested.
3. Have each team designate one person to be the "crusher" so the candies will be crushed in a consistent manner.
4. The other team members will make observations and record results.
5. Have all team members gather around the "crusher" to observe the pliers.
6. Before crushing candies turn the lights off.
7. Crush each candy in a storage bag.
8. Record intensity of the spark (none, dim or bright) and any colors observed on data chart.
9. Repeat #7 & #8 with remaining candies.
10. Answer the questions at the bottom of the data sheet.

Task #1

What is triboluminescent?

CANDY	SPARK	COLOR
1. wintergreen		
2. peppermint		
3. butterscotch		
4. cherry		
5. tropical fruits		
6. root beer		
7. sugar-free mint		
8. regular mint		
9. antiacid mint		
10. rock candy		

REFLECTION QUESTIONS – Write your answers to the questions below on the back of this paper. Be sure to write complete sentences.

1. Which candies emitted (gave off) light when crushed?
2. Describe the color of light that you observed from all the candies.
3. Which candies produced the most light?
4. Based on your investigation write a definition of triboluminescent in your own words?
5. Look up the definition of triboluminescent. Was your definition similar to the book definition? Explain what was different about you wrote and what was the same.
6. Where in nature do you think you might see triboluminescent?

Task #2

How does light travel?
(Angular Laws of Reflection)

PURPOSE

In this experiment, you will explore how light bounces off an object, such as a mirror.

Teacher Note:

During discussion time, you can compare how light bounces off an object to a ball that has been bounced down at the ground. The ball will bounce straight back up into your hand following a straight-line path. If you toss a ball to the ground at an angle, it will rebound at the same angle in the opposite direction. Light behaves in the same way. The angle of incidence (the angle at which the light approaches) is always equal to the angle of reflection (the angle at which the light bounces back).

MATERIALS

- flat mirror
- white paper (no lines)
- protractor
- flashlight
- masking tape or electrical tape

PROCEDURE

1. Take flashlight and mask the front so that only a slit of light can come through. (Completely block out all light except for the slit.)
2. Take a flat mirror and place it on a sheet of paper, straight up and down. (Anchor it in some way that it can stand freely.)
3. Shine a light at it using the flashlight prepared earlier at the mirror's surface.
4. Use a protractor to measure the angles.
5. Move the flashlight to different positions and measure the angles again.
6. Record data in a chart showing the angle the light strikes the mirror and the angle of reflection.
7. Discuss and answer reflection questions.

Task #2

How does light travel?
(Angular Laws of Reflection)

Discussion & Reflection Questions

1. In this activity what represented the incident angle?
2. What represented the angle of reflection?
3. How do the incident angle sizes and angle of reflection sizes compare?
4. Why is the narrow slit in the flashlight important?
5. In general, a definition of reflection based on this data might read: "Reflection occurs when light bounces off another object at the __________ angle, but in the _________ direction."
6. A basketball that needs to bounce off at a 40 degree angle on one side of the goal should be thrown at what angle on the opposite side of the goal?

Task #3

Refraction
(Concave and Convex Mirrors)

Purpose

Convex and Concave lenses refract (bend) light so those images appear different than they really are. In this activity, we will use drops of water to construct both a convex and a concave lens, and then we will observe the effect of each lens on printed words.

Materials

- Plastic cups (1/group)
- Petroleum jelly
- Rubber washer (1/group)
- Water
- Dropper
- Newspaper

Procedure

Concave

1. Divide students into groups of two.
2. Distribute materials to each group.
3. Turn plastic cup upside down.
4. Spread petroleum jelly on **ONE** side of the rubber washer.
5. Place the greased washer on the bottom of the plastic cup (avoid any letters or indentations on the bottom of the cup).
6. To make a concave lens, place 2-3 drops of water inside the center of the washer. There should be just enough water to stretch entirely inside the washer as thinly as possible. It might be easiest to fill the inside of the washer and then remove as much water as possible to leave just a thin layer of water.
7. Move the cup over the newspaper and observe the effect of the lens as you look through the water droplet.
8. Describe you results by drawing a neat picture of what you observe. Be sure to label your drawing concave.

Convex

1. Repeat steps 3-8 for concave lens, **EXCEPT**: In step 6, to make a convex lens, add 2-3 more drops (for a total of 4-6 drops) of water into the center of the washer. There should be enough water to pile up over the edges of the washer without spilling over.

Task #3

Reflection Questions

1. What kind of effect does a concave lens have on the appearance of objects?
2. What kind of effect does a convex lens have on the appearance of objects?
3. Sketch a side view of a concave lens and a convex lens.
4. Which lens discussed above would allow a person with eye trouble see better? Explain why.
   a. Farsightedness (A person can see far away but not up close.)
   b. Nearsightedness (A person can see up close but not far away.)

Task #4

Pinhole Viewer

Purpose

You have discovered in the last couple of activities that light travels in straight lines. In this activity, you will investigate how scientists predict how the eye works by constructing a device to observe refraction and another device to observe reflection after it travels in straight lines through a pinhole.

Materials

- Beakers
- Plastic rulers
- Water
- Tracing paper
- Metal can (needs to have a small hole on one side and open completely on the opposite side)
- Rubber bands
- Candle
- Pan

Procedure

Refraction

1. Fill a beaker with water and place a plastic ruler in it.
2. Observe the beaker and ruler from the side.
3. Sketch what you observe on your lab sheet.

Reflection

4. Place a piece of tracing paper over the opening of the metal can provided, and secure it in place with a rubber band.
5. Place the candle in the pan away from the back of the table and away from any paper.
6. Have the teacher light the candle. (If it goes out later, you may light it from your neighbor's candle.)
7. The metal can has a tiny hole in its closed end. Turn this end toward the candle flame about 4 inches from the flame so that the side of the flame faces the pinhole.
8. Move the can around so that the light from the candle becomes visible on the tracing paper through the can.
9. Observe the direction that the top of the flame is pointing. It may be helpful to gently fan the flame so that it moves at its top.

10. Sketch the flame as it is seen on the tracing paper on your lab sheet.
11. Draw a side view of how the light must pass through the can to cause the flame tip to point as it is. Use arrows to represent the movement of light.

LAB SHEET & DISCUSSION QUESTIONS
TASK #4

1. Sketch the flame as it is seen on the tracing paper.
2. Draw a side view of how the light must pass through the can to cause the flame tip to point as it is. Use arrows to represent the movement of light.
3. What direction is the candle flame pointing?
4. Why is the candle pointing the way it is?
5. Is the image on the tracing paper "screen" the same size as the actual flame?
6. What might account for the difference in the size of the image?
7. Compare the pinhole viewer to the human eye. Which part of the viewer is similar to the pupil? The retina?

Task #5

Types of Visible Light

Purpose

Students will use a diffraction grating to separate light into a color spectrum, then build a spectrometer to observe four different light sources.

Materials – per student

- 1 diffraction grating cut up into 2.5 cm by 2.5 cm squares
- 1 toilet paper tubes
- 1 aluminum foil
- straight pin
- clear tape
- scissors
- rubber band
- crayons or paint

Procedure

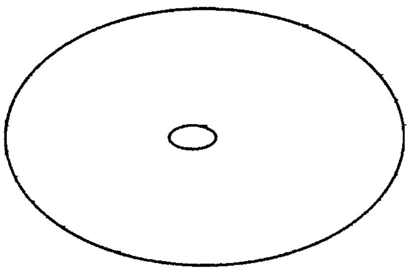
1. Find the center of the index card.
2. Draw a 2 cm by 2 cm square in the center of the card. Cut it out.
3. Carefully tape the piece of diffraction grating to the card.
4. Attach the card to one end of the paper towel tube, centering the grating in the middle. Tape index card in place. (If you cut diagonal lines up to center card, the card will be easier to fold).
5. Carefully cover the other end of the paper towel tube with the aluminum foil, stretching the foil tightly across the tube hole. Use the rubber band to hold the foil in place.
6. Take the straight pin and gently poke a small hole in the center of the foil. Be careful not to rip the foil.
7. Your teacher will direct you to point the tube toward different light sources and observe through diffraction grating what you see.
8. Record what you see on lab sheet.
9. If time permits create an abstract picture using the various patterns of light discovered in this activity.

Task #4

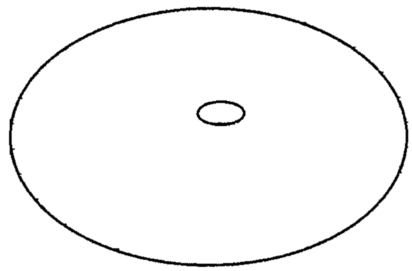
Visible Light Lab

Observe the various light sources by rotating the diffraction grating until you see color on the left and right of the pinhole. Draw the colors in the order you see them on both sides of the light source with crayons. The small circle in the center represents the light source.

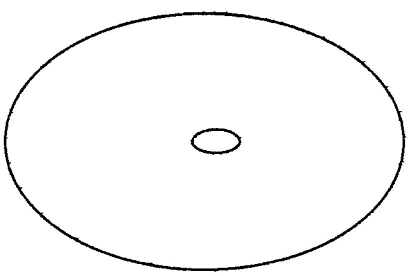
Light source 1: __________



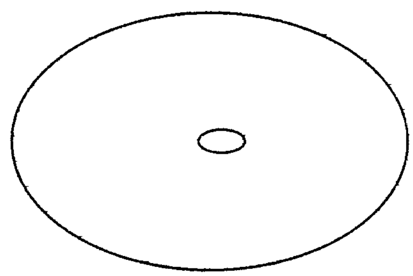
Light source 2: ___________



Light source 3: __________



Light source 4: __________



Why do you think different types of light have different spectrums?

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