Week 5: Color and Light

Objectives:

- Students will summarize the unit's inventions by discussing aloud as a class the four prior week's topics. (Pinhole camera, paper airplanes, parachutes, and catapults).
- Students will list on the board ways people get sources of light, including inventions related to light.
- Students will draw accurate depictions, using pencils and paper, showing basic properties of how light travels and how shadows are made.
- Students will compare and record properties of light and color by mixing colored paints.
- Students will construct a spectroscope, using the materials provided, to observe the visible color spectrum in a variety of light sources.
- Students will illustrate accurate replications, using colored pencils and paper, showing how the visible color spectrum appears through their spectroscopes.

Standards:

- *Nature of Science:*
    - Grade 4, 5, 6: Plan and carry out investigations as a class, in small groups or independently, often over a period of several class lessons.
    - Grade 6: Keep accurate records in a notebook during investigations
- 4.1.3 Construct a complete circuit through which an electrical current can pass as evidenced by the lighting of a bulb or ringing of a bell.
- 4.1.5 Demonstrate that electrical energy can be transformed into heat, light, and sound.

Teacher Content Knowledge:

- The concept of light was first looked into when Newton, in the 17^{th} century found that light was formed from tiny particles. He allowed white light to hit the prism, which created a rainbow. He was able to show that light came from the sun and not the clear crystal of the prism itself. Huygens came up with the concept that light travels in waves.
- The primary colors that everyone is familiar with are red, green, and blue. With these colors, mixing them can make all other colors of the rainbow. What a lot of people don't know, there is another entire set of primary colors, called secondary colors of light that consists of magenta, cyan, and yellow.
- A spectrum works by allowing white light through and producing a rainbow while exiting. The refraction index is what causes the different light particles to disperse.
- In order for a rainbow to be created, the water particles in the air act as tiny prisms refracting the light rays and making a rainbow.

- A spectroscope has become an useful scientific took because it allows scientists to measure how much light is coming from an object, specifically a star, which can help determine the temperature, age, or life span of the star.
    - "Primary Colors." *Hyperphysics*. N.p., n.d. Web. 1 Mar 2011. <http://hyperphysics.phy-astr.gsu.edu/hbase/vision/pricol2.html>.
    - "Color Addition." *The Physics Classroom*. N.p., n.d. Web. 1 Mar 2011. <http://www.physicsclassroom.com/class/light/u12l2d.cfm>.
    - "What Causes a Rainbow." *HowStuffWorks*. Discover Channel, 2011. Web. 1 Mar 2011. <http://www.howstuffworks.com/question41.htm>.
    - "A Brief (Incmplete) History of Light and Spectra." *Chem Team*. N.p., n.d. Web. 1 Mar 2011. <http://www.chemteam.info/Electrons/Spectrum-History.html>.
    - "The Basics About Spectroscopes and Spectroscopy." N.p., n.d. Web. 1 Mar 2011. <http://nfsi-server.yerkes.uchicago.edu/FTProot/spectroscope/Spectroscopy/basics1.htm>.

Materials:

-From the supply closet:

- 12 small rectangular mirrors
- 12 flashlights
- 2-3 Extra D cell batteries for the flashlights (just incase)
- 3 portable, plug in, light bulb sockets
- 5 prisms of assorted shapes
- 1 red light bulb (25 watt)
- 1 green light bulb (25 watt)
- 1 blue light bulb (25 watt)
- 3 frosted incandescent light bulbs 75 or 100 watt
- 12 pieces black construction paper (at least 6”x4” in size)
- 12 pieces white construction paper
- 1 red, blue, green, magenta, cyan, yellow paints
- 10 paint brushes
- 10 small paper plates
- 10 rolls of Scotch tape
- 10 plastic colored kitchen scrubby brushes (circular in shape, some see through spots, some not)
- 12 pencils
- 12 scissors
- 6 sets of colored pencils (sets of 8 pencils in a pack is sufficient)

-The items listed below to construct spectroscopes will be purchased by our group members and turned in with a receipt in order to be reimbursed:

- 12, 1" diameter sturdy cardboard pvc pipe- 6" long
- CD fragments (6 per CD), 3 total CDs
- Black cardstock

Engage:

- As students enter the classroom, invite them to record in their journals predictions or drawings allowing them to initially explain, "What are ways we can get light? What inventions are related to light?"
- Welcome the students to the last week of Saturday Science. Summarize the past four weeks and the inventions created by asking students to recall what we have done thus far. List on the board students' ideas.
    - Prompt students to explore: the purposes of the inventions, how they have or have not changed through history, and why they think inventions are important in the world.
- Then, return to discussing aloud students' responses to the journal question. List students' ideas on the board, or invite them to draw pictures on the board to better explain their thoughts. Make sure to cover how light is used in our daily lives.
- Next, invite students to explore the idea of how light works to help us see things.
    - Parts of body: Light enters pupil, refracts on cornea, project image on retina acting like a tiny screen in back of eye
    - Devices that produce light: Incandescent bulbs, fluorescent bulbs, sun, lightning bugs, lasers
- By now many of students' prior ideas about light should be expressed. Explain to the students that we are going to explore the properties of light and later on we are going to make an awesome invention called a spectroscope!
    - (If by chance some students already know what a spectroscope is, pleasantly ask them to keep their ideas to themselves, so all students can learn about the invention as the day goes on.)

Explore:

- Transition the students into inquiry of properties of light by beginning to introduce how light travels. Ask the students to predict how they think light travels in terms of direction. Use appropriate probing questions to further explore students' thoughts. Record ideas on the board.
- Then, ask students if they have seen or made shadows before? Prompt them to explain aloud how they think shadows are made, where light is visible, and where there is an absence of light.
    - Explain to students they will then explore different properties of shadows using a flashlight and various objects provided to observe how light travels.
- Next, students will use their flashlights to observe what happens when they shine their flashlights into a mirror. First, prompt the students to predict in their journals

what they think will happen to the light. Where will it go? Will they be able to see it?
    - Then explore what will happen in terms of reflection when students hold their flashlights at different angles towards the mirror other than straight on.
- Re-group as a class to lead a short discussion about what the students learned from the two activities. How was light similar in the activities? How was light different in the activities? Record on the board.
- Then ask the students what they have learned to be the three primary colors in school. Record on the board.
    - Flash the slide showing 6 circles of color: the 3 primary colors of light and of paint. Ask students to identify the names of the colors.
    - Pass out the paints and painting supplies.
    - Then demonstrate using a white light color orb that emits white light while standing still, then emits red, blue, and green lights when put into motion.
    - Give students the challenge of creating white paint using the colors provided. Students will observe that adding colored paints will not ever create white paint, but rather we see "black" paint because no colors are reflecting into our eyes with mixing more and more colors.
    - Have students mix what they think to be the primary colors: red, blue, yellow. What color does it make?
    - Then, restring the white light color orb and have students rethink what is going on. Which colors do they see when the ball is in motion? When standing still? How is this different than the mixing of the paint colors: red, blue, and green.
    - Continue to explore the mixing properties of light and color using this simulation in a whole class activity: http://www.ontariosciencecentre.ca/scizone/games/adding/default.asp
- Relate this activity back to the shadows and mirrors activity. What properties of light and color can we now discuss? Similarities? Differences? Presence of light? Absence of light? Record in a graphic organizer on the board.
- **BREAK TIME**
- Regroup from break, introduce the concept of the Electromagnetic Spectrum by first asking the class if they have heard of the Electromagnetic Spectrum before and discuss what they may think it means in terms of light. Record on board, and then play this video using a free trial membership. http://www.brainpop.com/science/energy/electromagneticspectrum/
- Ask students what they have learned from the video. Did any ideas change?
    - Lead discussion to discuss the visible light spectrum. What colors did they see in the video that made up the visible spectrum? Where else have they seen these colors in the world around them?
    - Ask students if they have seen or heard of a prism before. Have them predict what a prism may be used for? Predict what they think will happen when a white light shines through a prism.
        - Allow students to use flashlights to shine a white light into a prism.

        - Relate this the properties of the electromagnetic spectrum and the visible light spectrum. Students will see the colors of the rainbow!
    - Ask students to express how they think rainbows are made. Discuss ideas. Then, play the video to enhance students' understanding the visible light spectrum.
        - **http://www.brainpop.com/science/energy/rainbows/**
        - After the video discuss what they have learned.
- Transition the students to making the actual spectroscopes. Explain the students will be able to observe the visible spectrum in the world around them.

    - "Place the piece black construction paper inside pvc tube, which should help eliminate glare on the inside. Tape is usually not necessary.
    - Place pvc tube on end and trace circle around the pipe on the CD and on the dark cardstock. Use scissors to cut out each circle.
    - Cut the cardstock circle in half – making two semi-circles.
    - Tape the pieces on one end of the pvc pipe so that a narrow slit is left open. Do not tape over this slit. Slit size is "trial and error," but a width of 1-2 mm is usually fine.
    - Use the tape to flake off remaining metal from the CD circle.
    - Hold the tube up and look through open end at a light source such that the slit is vertical and toward the light source. Place the CD circle over the open end near your eye and rotate it until you see vertical color bands on each side of the slit opening.
    - Carefully tape the CD circle on the end of the tube at this orientation. Try not to cover too much of the CD with the tape."
    - Procedure taken from Dr. Joel A. Bryan, http://jabryan.iweb.bsu.edu/HASTI2011/index.htm
- Students will then have the opportunity to look at white incandescent lights through their spectroscopes. Students will draw with color pencils what they see.

Explain:

- Regroup and discuss students' findings and discuss their drawings. Refer back to the rainbow video that discussed the visible spectrum and why colors are placed in the order that they are due to their wavelengths.
- Some of the connections we want to make sure the students take from this discussion are:
    - The shorter the wavelength, higher the frequency, higher the energy and at the "blue" end of the visible spectrum.
    - The longer the wavelength, the lower the frequency, lower the energy and at the "red" of the visible spectrum.
    - Primary colors of light are red, blue, and green that make white light when mixed.
    - Primary colors of paint are cyan, yellow, and magenta that make black when mixed.

- In order for a rainbow to be created, the water particles in the air act as tiny prisms refracting the light rays and making a rainbow.

Elaborate:

- Students will look through their spectroscopes at red lights, blue lights, and green lights in order to observe how their visible spectrum appears through their spectroscope.
- Students will draw with color pencils what they see at each light bulb, and compare and contrast how the visible spectrum appears compared to while observing it in white light.
    - Explain that a spectroscope has become an useful scientific took because it allows scientists to measure how much light is coming from an object, specifically a star, which can help determine the temperature, age, or life span of the star.
    - How is this helpful in the world around us?

Evaluate:

- Prompt students to answer in their journals using both written descriptions and pictures (colored pencils if they prefer):
    - Define what visible light is and give an example.
    - What colors make up white light?
    - What is a prism? How does it work?
    - What is refraction?
    - What do spectroscopes help us do?
- Pass out the t-shirts and certificates and do our closing to Saturday Science.

Handouts/Journal:

- As students enter the classroom, invite them to record in their journals predictions or drawings allowing them to initially explain, “What are ways we can get light? What inventions are related to light?”
- Students will use their flashlights to observe what happens when they shine their flashlights into a mirror. First, prompt the students to predict in their journals what they think will happen to the light. Where will it go? Will they be able to see it?
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