Light
5th Grade
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References: (Checked 1/2005)

- http://www.scientemadesimple.com/sky_blue.html#PROJECTS
- http://www.exploratorium.edu/science_explorer/

Benchmarks:

SLC 10B: Identify simple patterns in physical phenomenon
Benchmark: Students will investigate properties of light and sound waves.

Objectives:

Students will discover the basic properties of light:

1. Light is what enables us to see objects
2. Light will be reflected or refracted when it changes from one medium to another
3. Different materials are opaque, translucent, or transparent to light
4. White light is a combination of all colors; we perceive the colors that are reflected by an object
5. Light travels as a transverse wave

Materials:

- See materials listed below for each demonstration

Initial Demonstration:

As with sound, a series of demonstrations will be used to introduce the basic properties of light. Again, students will be asked to brainstorm explanations for the unusual events they witness. Analogies to the properties of sound can be made along the way.
Demonstration #1:

Materials:

• Construction paper of different colors

Procedure:

Shut all the blinds in the classroom (before class has begun). Once the students are sitting quietly, snap off the lights. Let their eyes adjust for a moment then pull out a couple pieces of construction paper. Have them vote on the color you are holding up. Turn the lights back on.

Was it easy to discern the color of each piece of paper? Were they right? Why was it difficult when the lights were off? Our eyes perceive objects and colors as a result of light reflecting off of surfaces (to see in the dark, infrared goggles are used- these detect objects by sensing the heat the objects give off).

Target Observations:

• It was hard to tell the different colors apart in the dark.
• It was much easier when the lights were shining on the paper.

Target Model:

• In order to see color we need light to reflect off of surfaces.

Demonstration #2: Mirror, mirror on the wall

Materials:

• Small mirror
• Flashlight

Procedure:

Have a student look in a mirror. What does she see? Her reflection of course! But why? Take a piece of dark paper and hold it in front, but also to the side of the mirror. Shine a flashlight on the mirror so that its reflection is on the piece of paper.

What did the students see? The light was reflected off the mirror and formed a perfect (circular) image on the paper. We see ourselves in the mirror because light bounces off of us onto the mirror and then back to our eyes. Because the mirror is flat we get an accurate reflection, although it is (left-right) reversed. Not all mirrors are created equally, however. Curved mirrors will distort shapes by reflecting light rays in all sorts of crazy directions so that
when they are picked up by the eye they are perceived as coming from very different locations than they actually did. Besides being a lot of fun at carnivals, curved mirrors can be helpful. Side-view mirrors on cars are slightly curved to help drivers see cars behind them. Curved mirrors are also used on roads and in some buildings (especially hospitals) to help drivers and pedestrians see around corners to avoid collisions.

**Target Observations:**

- Light reflects off of the mirror well enough to see an accurate picture of the students.

**Target Revised Model:**

- Light reflects off of mirrors so well because they are flat.

**Demonstration #3: What did you do to my pencil?!**

**Materials:**

- Three beakers filled with: air, water and oil, respectively
- Three long pencils

**Procedure:**

Fill one beaker with water and one with oil. Hold up a nice, straight pencil. Maybe even pass it around so that the students are convinced that there is nothing funny about the pencil. Place the pencil in the empty beaker. “Ta da!” Nothing happens. Next, place a pencil in the beaker of water and another in the beaker with oil. Have the students look from the side into the water.

What did they observe? The pencil is bent! What happened?! While some materials, like mirrors, reflect light, others allow light to go through, but not without changing it a little bit. As light travels from one medium to another transmitted light becomes bent, or refracted. This is related to the fact that light (like sound) travels at different speeds through different materials. (The speed of light in air is $3 \times 10^8$ m/s! That means light can travel 3743 times around the Earth in one second!) The makeup (or density) of the material determines how much the light is bent. In this experiment, the oil bends the pencil more than the water.

**Target Observations:**

- The pencil looks bent when it is put in the beaker with water or oil.

**Target Revised Model:**

- Some materials allow light to pass through them, bending the light as it does so.
- This bending is called *refraction.*
Demonstration #4: What you see is what you get

Materials:

- Clear plastic cups
- Water, oil, milk, juice (any number of different liquids)

Procedure:

Shine a flashlight through each of the liquids and have the students observe the light they see coming through on the other side.

How much light makes it through? It is not the case that all light is reflected or all light is refracted. Instead, a little of both can occur. As well, light can be absorbed. The words used to describe how much light makes it through are: opaque, translucent and transparent.

opaque: no light gets through
translucent: some light gets through
transparent: all light gets through

Target Observations:

- Different amounts of light shine through the different cups.
- Some of the light is reflected off the cup or the liquid inside of it.

Target Revised Model:

- When no light gets through (100% absorption) we call the material opaque.
- When all light gets through, we call it transparent.
- When light can be partially reflected or absorbed, we call the material translucent.

Demonstration #5: Black and white

Materials:

- White paper
- Markers (red, orange, yellow, green, blue, purple)
- Pencils
- Paper cups
- Coffee filters
- Black permanent marker
- Beaker filled with water

Procedure:

Before class: Trace a circle on a piece of white paper. Cut the circle out and divide it into six equal sections. This will be used to make a color wheel. Similarly, cut a circular piece out of a coffee filter. Repeat for every student in the class.
In class: Start with the color wheel. Have the students color their wheels according to the diagram below. Next, have them poke a hole through the center of the color wheel, then through the bottom of the paper cup using a pencil. Once this is complete, they can spin the color wheel and look down from above. What did the students observe? The colors should blend together, turning the wheel white. White light includes all colors.

Now, have the students take turns using a marker to draw a black line on their coffee filter. Let each student dip his/her finger into the beaker of water and put a couple of drops on the black line. The dye should spread out and turn colors as it goes. Why? The colors we see are the colors reflected by an object. We see black when all colors are absorbed and none are reflected. Putting water on the ink separates it out so that the separate inks required to absorb all colors (and make black) are pulled apart. These different dyes absorb and reflect different colors.

**Target Observations:**

- Light is what enables us to see objects
- Light will be reflected or refracted when it changes from one medium to another
- Different materials are opaque, translucent, or transparent to light
- White light is a combination of all colors; we perceive the colors that are reflected by an object

**Target Revised Model:**

- We see objects (and colors) as a result of the reflection of light.
- Light can also be refracted, or bent, when it moves from one medium to another.
- The colors we see are the colors reflected by an object; all other colors are absorbed.

**Summary:**

The students have been introduced to the basic properties of light. Because analogies can be drawn between the properties of light and sound, the students should feel pretty confident that they understand these properties. This lesson, then, can either be ended here or be continued with the “Waves” lesson, which introduces the idea of light as a transverse wave and uses tables and graphs to analyze the basic properties of waves.