DISCOVERY
SCIENCE CENTER

7th GRADE

Seventh Grade Science Content Standards:
Physical Principles in Living Systems (Physical Science)

6. Physical principles underlie biological structures and functions. As a basis for understanding this concept, students know:

a. Visible light is a small band within a very broad electromagnetic spectrum.

b. For an object to be seen, light emitted by or scattered from it must enter the eye.

c. Light travels in straight lines except when the medium it travels through changes.

d. White light is a mixture of many wavelengths (colors), which retinal cells react differently with different wavelengths.

e. Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).

f. The angle of reflection of a beam is equal to the angle of incidence.

Structure and Function in Living Systems (Physical Science)

5. g. Students know how to relate the structures of the eye and ear to their functions.

How We See
If you are reading these pages by sunlight, the visible-light particles which allow you to see, left the Sun's surface eight minutes ago at a speed of 186,000 miles per second. As those particles of light strike this page, two things happen:

1.) The light particles, which hit the letters of this text, are absorbed into the black molecules of the print.

2.) The molecules of white paper reflect the light particles, bouncing them up into your eye. Some of those light particles slip through your open pupil. The lens of your eye then focuses those light particles into an image of this page on the back of your eye (the *retina*). That image is transmitted through your optic nerve to the brain. The brain then interprets what you see.

Activity One: White Light

Materials:
Colored and white paper

Procedure:
Hold up a green piece of paper and explain that as white light strikes the paper, the color "green" is reflected (bounced back into our eyes) while the other colors that make up white light is absorbed (drawn into the paper). White light from the Sun makes up the visible part of the spectrum (a series of colored bands of light arranged in order of their respective wavelengths). The full visible spectrum of light is composed of the colors: red, orange, yellow, green, blue, indigo, violet (red being the longest wavelength (lower frequency) and violet being the shortest wavelength (higher frequency).

Have the students place a 1" X 4" strip of green paper in the center of a white sheet of paper. Have the students look at the colored square (staring is not necessary as long as their eyes do not leave the colored paper) while you time them for 45 – 60 seconds. After the time has passed, have the students remove the colored paper, but continue to look in the exact same spot where the colored paper was until they are able to see an image of a piece of paper appear on their white paper. Students should raise their hands as a signal that they are able to see an image of the paper.

Ask the students what color the image was which appeared. Was it the same color as the green paper they had removed? Repeat this activity with a second, different colored strip of paper. Ask the students to predict what they think is going to happen. Run the experiment. Were their predictions correct?

Repeat this activity a third time allowing students to design a pattern with the two colored papers, again predicting what the results might be. Or have the students close their eyes after looking at the colored image for 30 seconds. Does the design appear in complimentary colors with their eyes closed?

Explanation:
As you stare at a color, the retinal cones (light-sensing cells that detect color) in your eyes which detect that particular color (green in this case) are working and become tired (the "green" cones temporarily exhaust the chemical that helps them function). However, in order to continue to see that color, opponent cones help out. The brain translates the information from the opponent cone into the color green, so that your visual environment remains stable. Imagine what would happen if, after a set of cones gets tired (as in the case of the green-detecting cones) that the green color switched to the color red. What a confusing world that would be.

Later, when you suddenly remove the source of the color (the green strip of paper) and look at a white background, the opponent cone perceives its normal color (red in this case) and sends that image to the brain. In this way, the eye is not really like a camera, but like a computer ~ designed to construct a stable, visual representation of reality.

Activity Two: Plane Mirrors

Materials:

Plane (flat) mirrors
Paper and pencils
Large sequins, paperclips or other small objects

Procedure:

The images that we see in a single plane mirror are laterally inverted (reversed from side-to-side). These images appear to be the same size and have the same orientation distance from the mirror, but in fact, they are reversed. By combining two plane mirrors, the directional orientation changes.

Hand out plane (flat) mirrors to the students and have them wink their right eye while looking into the mirror. Notice that the image in the mirror is winking its left eye. If this is difficult to understand, call two students to the front of the room and have them face each other as though one is a reflection in a mirror. Have each of them raise their right hand (in fact, to show a mirror image, one of the students needs to raise their left hand).

The image is laterally inverted because the mirror is flat ~ the light rays reflect at exactly the same angle at which they meet the mirror (this is the angle of incidence). The angle of incidence equals the angle of reflection. Have the students write their name on a piece of paper and hold their mirror perpendicular to the paper at the end of their name. Notice that the image is reversed. Then have them share mirrors with their neighbor, to place a mirror at the front of their name and at the end of their name. Notice in the reflections that the reflection of the mirror image is reversed, so the name appears as originally written. By combining two plane mirrors, the directional orientation changes.

Have the students share their mirrors to create a hinged door. Hold the hinged mirrors up to your face to see your image (move the mirrors slightly to make sure you see yourself clearly where the two mirrors meet ~ then wink your right eye. You will notice that the image in the mirror will also wink the right eye.

Place a large sequin or paperclip between two parallel mirrors and observe the multiple images. Then place the sequin or other object in front of two hinged mirrors standing upright on the table, then "open and close" the hinged mirrors. Notice that the number of images increases, the closer the mirrors come to one another. This is a good activity to incorporate math and working with angles. A full circle is 360 degrees. If you hold your mirrors at a right angle (90 degrees) you see <u>four</u> objects (<u>three</u> images and the fourth <u>one</u> is the actual object)…360 divided by four is 90. Use the paper with the angles drawn on it to have the students discover the angle by placing the mirrors on the angled lines, counting the number of objects, then dividing 360 degrees by that number of objects. [The first angle is 90 degrees; the second is 120 degrees; and the third is 60 degrees.]

Activity Three: Curved Mirrors

Materials:
Curved mirrors (optional)
Large, shiny tablespoons

Procedure:
Reflected images change depending on the curve of the mirror. Experiment with curved mirrors if you have them, or large, shiny tablespoons, to understand the difference between a convex and concave mirror and why the images are different.

An easy way to have the students remember concave is to remember that you go into a cave, therefore a concave mirror bends away from the viewer. By bending a mirror (reflective surface) you are causing all or part of the mirror to reflect light rays at different angles, thereby distorting the image you would typically see in a plane mirror. Have the students describe how their images are distorted in a concave mirror. If you are using a tablespoon, have the students look at their concave reflection, holding the spoon vertical to the floor.

Have the students make a prediction about what would happen if they could bent the mirror's edges away from themselves with the center of the mirror closer to them. This action would create a convex mirror. Look in a convex mirror or turn the spoon over to see your reflection in the backside of the spoon, again holding the spoon vertical to the floor. Describe the reflections.

The image produced by a concave mirror from which the light rays converge (come together) may be large and upright ~ or may be inverted (flipped upside down). This depends on the severity of the mirror's curvature and the distance of the object from its surface. Usually a large, distorted image is seen when a person or object is close to a concave mirror. However, a large reflective spoon is usually deep enough to flip one's image upside-down.

The image produced by a convex mirror will always be upright and generally shorter or squatter, than the object. However, due to the elongated shape of the spoon, the image may be elongated when the spoon is held vertical to the floor. Hold the spoon horizontal to the floor and see what happens to your image. The image has a rather widened appearance, showing an area farther to the left and to the right of the original image as the light rays diverge (move apart). This ability to reproduce smaller images of a larger area is useful in rear view mirrors.

[Side note: You may also want to have the students look for curved mirrors at home and have them bring in samples of concave and convex mirrors (car mirrors, shiny pie pans, curved pot lids, spoons) and distribute them so the class can experiment with the objects.]