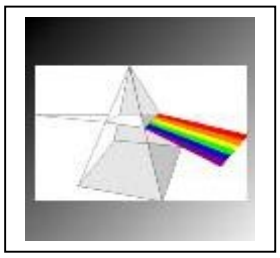
Activity #5: Visible Light--Teacher's Copy



National Science Education Standards:

Science Content Standards: 5-8

Science as Inquiry

CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

USE APPROPRIATE TOOLS AND TECHNIQUES TO GATHER, ANALYZE, AND INTERPRET DATA.

DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

Physical Science

CONTENT STANDARD B: grades 5-8

- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object--emitted by or scattered from it--must enter the eye.
- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Note to the teacher: In this activity students will become aware that white light is composed of several wavelengths of light which can be separated and analyzed by the use of a prism. The light source from the Pasco Optics Kits work very well for this purpose (as variable slits are incorporated into its case), but a reasonably inexpensive alternative would be to use a small flashlight and passing the light beam through a narrow slit cut from a 3 x 5 index card.

Purpose: To create and investigate the visible light spectrum.

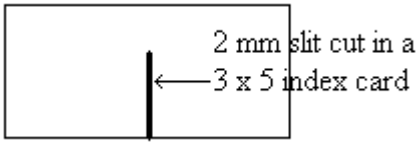
Materials: white light source, Lucite prism, convex lens magnifying glass, 2 white index cards (approx. 3" x 5"), protractor, blank white sheet of paper.

Materials Sources:

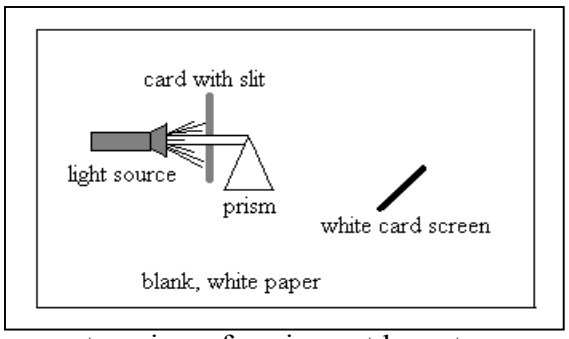
- Lucite prism; Frey Scientific, 100 Paragon Parkway, P.O. Box 8101, Mansfield, OH 44903---2002 catalogue, pg. 777, #15562391, $$6.25
- Magnifier, student; Frey Scientific, 100 Paragon Parkway, P.O. Box 8101, Mansfield, OH 44903---2002 catalogue, pg.154, #15568400, $1.00
- Light Source, 4-in-1 (has built-in projection slits) ; PASCO Scientific, P.O. Box 619011, 10101 Foothills Boulevard, Roseville CA 95747-9011, # OS-8517, Price: $124.00 (If this Pasco light source is used, there will be no need to construct the slotted 3 x 5 index card in Procedure #1 below. If a flashlight is substituted, proceed with step #1 below.)

Hazards: Do not handle electrical devices with wet hands or near running water.

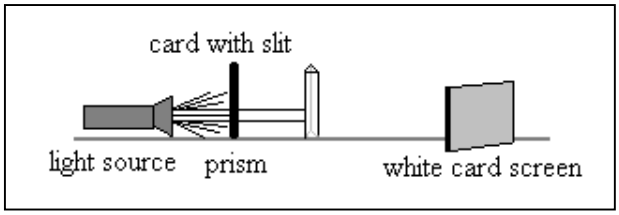
Procedure: 1. Position your light source on a blank white sheet of paper on the lab table so that its beam passes through a narrow slit (approx. 2 mm) in a 3 x 5 card. This will produce a single, narrow beam of light that can be seen on the paper. Note to teacher: The 3 x 5 cards with the slits can be prepared in advance. The slit should be no wider than 2 mm.



2. Position the Lucite prism on end in such a manner in the narrow beam of light so that it looks similar to the diagrams below. The light ray should pass through the very tip of the prism.



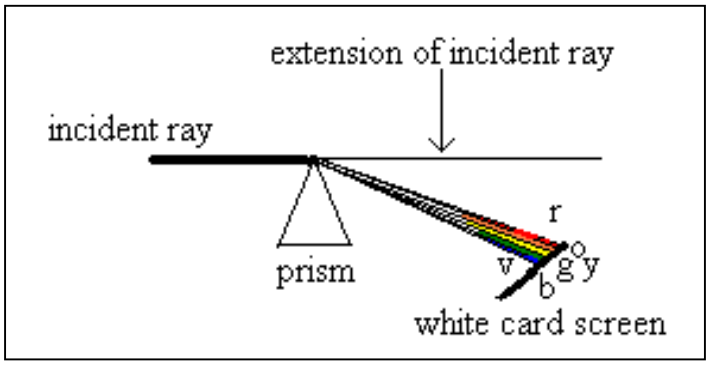
top view of equipment layout



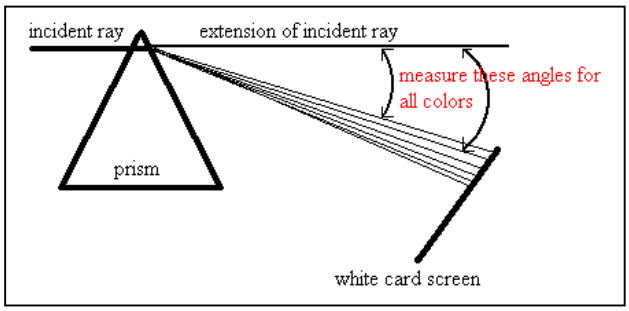
side view of setup

3. Place a white 3 x 5 card in the path of light that exits the prism and examine the projected pattern with the magnifying glass. Adjust the prism so that you can view the entire visible spectrum (all possible colors) on the white card

4. On your blank white paper trace the incoming (incident) ray of light, the outline of the prism, and the edge of the 3 x 5 card—where it touches the white paper. From the exit point on the prism, draw lines to each projected color at the base of the 3 x 5 card. You should have a line to at least six different colors. Label each line by using the first letter of the representative color (i.e., r = red, b= blue, etc.). Also, from the point where the light beam exits the prism, extend the incoming light beam to show where it WOULD be located if it hadn't been refracted by the prism. Note to the teacher: The students' diagrams should resemble the one shown below. Be aware that the entire "spread" of the spectrum from red to violet is only about two degrees, so measurements with the protractor in the next step will have to be done carefully. Also, depending upon the light source employed, not all colors of the visible spectrum may be observed. Flashlights with discharging batteries tend to lose the blue end of the spectrum.

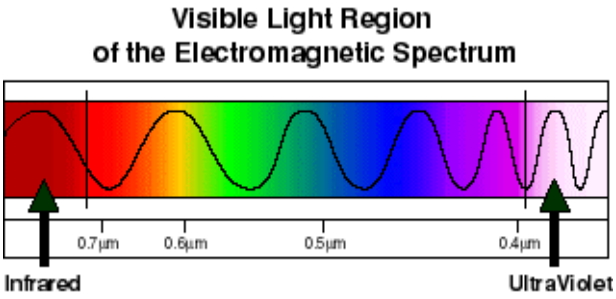


5. Using your protractor, measure and record the angle formed between the extended incident ray of light as it passes through the prism and each of the lines drawn to the various colors on your white paper. (See the diagram below to assist with your measurements.)



6. Construct a data chart similar to the one below, and record the specified information. Some data such as the angle between the incident ray and the transmitted color is determined experimentally while other data may be obtained from the reference chart below.

color produced by the separation of white light	angle of refraction (degrees)	wavelength of color (μm)
red		
violet		



Analysis questions:

1. From observations made in this activity, of what colors is white light composed?
2. What piece of optical equipment was necessary to separate white light into its component colors?
3. Describe what must be occurring within the prism to cause the white light to separate into the various colors of the visible spectrum.
4. State the relationship between the wavelength of each colored light and the degree to which it is refracted as it passes through the prism. (Ex. The longer wavelengths of light appear to be refracted _____ (more, less, the same as) than the shorter wavelengths of light.
5. Infrared light is also known as heat (thermal) energy. From information given in the "Visible Light Region of the Electromagnetic Spectrum" chart above, where on your diagram (Procedure step #4) would you expect this invisible infrared energy to appear?
6. Describe a test you could perform to prove that the infrared energy is, in fact, where you predicted on your diagram.
7. If sunlight were used as our light source in this activity, where on your diagram would you expect its invisible ultraviolet light to appear?