Everyday Chemistry

CSI: Kamloops - Investigating Light With a Homemade Spectroscope

The information presented in this article is modified from "CD-ROM Spectroscope: A Simple and Inexpensive Tool for Classroom Demonstrations on Chemical Spectroscopy", Journal of Chemical Education, volume 75, page 1569 (1998).

Chemists use light to help them analyze and identify substances. Some things, such as the sun, light bulbs and burning substances, give off light on their own. Chemists also pass light through solids and liquid solutions to see what types of light are absorbed by the substances present. One of the tools that chemists use to analyze light is called a ***spectroscope***. A spectroscope uses a ***prism*** or ***diffraction grating*** to spread out a beam of light and display the ***light spectrum***; that is, the spread-out colours present in the light beam. (A prism is a triangular block of glass that spreads out white light into a rainbow of colour. A diffraction grating consists of thousands of closely-spaced lines on a glass or plastic surface, and these closely-spaced lines spread out light into a rainbow in the same way that a prism does.)

This edition of Everyday Chemistry shows you how to start setting up your own CSI lab by building a spectroscope. After building your spectroscope, you will be told how to use it to make some really interesting observations about light.

What You Need

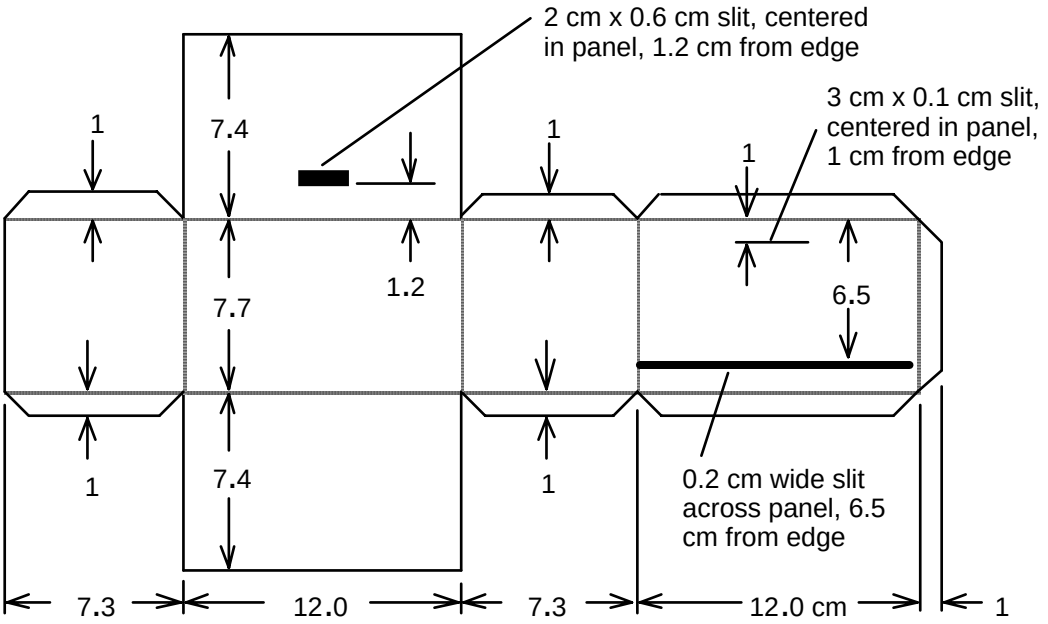
- rectangle of thin cardboard, 39.6 cm x 22.5 cm. (Try using a flattened cereal box)
- sharp craft knife (Parents: see warning below)
- sharp pencil or fine black felt marker
- pair of scissors
- adhesive tape or glue
- cutting board
- metric ruler
- straight edge
- a 5–inch compact disk (CD). Any old, unwanted CD will do.

Parents: You may wish to cut out the three slits (mentioned below) rather than trusting that your youngster will not get cut with the sharp craft knife.

Making the Spectroscope Box

Mark off your piece of cardboard, as shown in *Diagram 1*, below. The dotted lines indicate where folds will be made. The corners of the 7 gluing tabs are cut at a 45^{o} angle. You can cut out the basic outline with scissors, but use a straight edge and sharp craft knife (with a cutting board behind!) to cut out the three slits. Note: If you have a problem cutting the 0.1 cm (1 mm) slit, cut the slit wider and then tape a piece of cardboard over part of your widened slit to create a narrow slit. Score the fold lines (dotted lines) **lightly** with a sharp craft knife to help give sharp, straight folds. Fold the cardboard along the dotted lines into a box shape and tape or glue the edges shut.

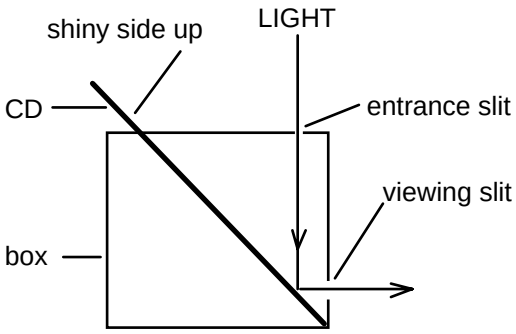
Diagram 1: Spectroscope plan



Using the Spectroscope

Place the box with the wide slit (0.2 cm, completely across on side) facing up. Place the CD into the slit, such that the shiny side faces up.

Diagram 2: How to Use the Spectroscope



The way to use the spectroscope is to "aim" the thin entrance slit at a source of light and look through the 2 cm x 0.6 cm viewing slit. By looking slightly downward into the viewing slit, you will see a rainbow of colours. If you look even farther down, you will see a second rainbow, which is not as bright as the first but is more spread out.

Some Experiments to Try with Your Spectroscope

1. Look at the spectrum produced by the sun. WARNING: DO NOT LOOK DIRECTLY AT THE SUN WHEN USING THE SPECTROSCOPE! Point the entrance slit toward the sun and then look into the viewing slit to see the spectrum of colours produced by the sun. Describe exactly what you see. (All good CSI people make good notes and drawings because they must have accurate records of the tests they do.)

2. Look at the spectrum produced by an ordinary light bulb. Is the spectrum identical to the one produced by the sun or is the spectrum different in any way?

3. Look at the spectrum produced by a fluorescent light. Is the spectrum identical to the one produced by an ordinary light bulb, or is part of the spectrum brighter or different in some way?

4. If possible, look at the spectrum produced by a mercury light at the side of a highway. Describe what you see.

5. Get a piece of coloured transparent plastic or cellophane. (If you can't find any coloured plastic, take a piece of plastic wrap and colour it with a felt marker.) Now place your coloured plastic over the entrance slit, aim it at an ordinary light bulb or fluorescent light and look at the spectrum produced. Describe what you see – not only the colours you see but the colours you don't see. Try different colours of plastic or cellophane (red, green, blue and yellow) and describe what you see (and don't see) with them.

6. Get a small colourless drinking glass and put about 100 mL of water in it. Add one drop of food colouring to the water and gently swirl the glass to mix the colour into the water. Carefully, place the glass on top of the entrance slit and aim light down through the glass and into the entrance slit. Describe the spectrum you see. Add another drop of the same food colouring and look at the spectrum again. Do you see any difference in the spectrum? Try 2 more drops and see if there is any difference in the spectrum. Next, pour out half of the water and see if it makes a difference when there is less liquid in the glass.

Complementary Colours

White light is actually an equal mixture of three primary light colours: red, blue and green. If one of the three primary light colours is filtered out of (or subtracted from) white light, the remaining colour is called the ***complementary*** colour. For example, removing red light from white light produces blue-green light (the complementary colour of red). Similarly, removing blue light from white light produces yellow light and removing green light from white light produces purple light.

Did you see any complementary colours being produced in 5 and 6, above?

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