

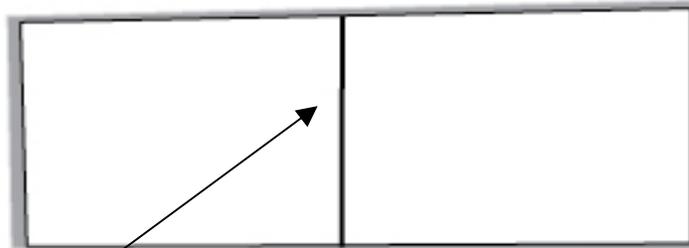


# Designing an Open Spectrograph

## Instructions:

### *Making the screen*

- 1) Find the center of the longer side of the foam core board. Draw a line down the center as demonstrated in the image below:



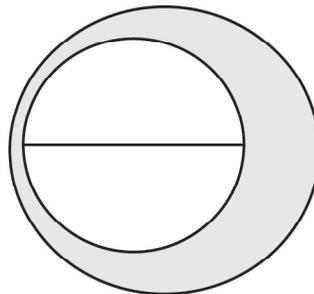
*Line drawn down center  
of foam core board*

- 2) Push a table or desks against a wall. Tape the foam core board above the table, leaving a small gap between the bottom of the board and the table. This is your screen.

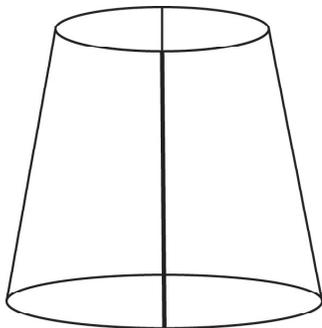
### *Making the grating stand*

- 1) Cut a 5 cm long slit in the bottom of the Styrofoam cup as shown below:

*Cut a slit in the  
bottom of the cup*

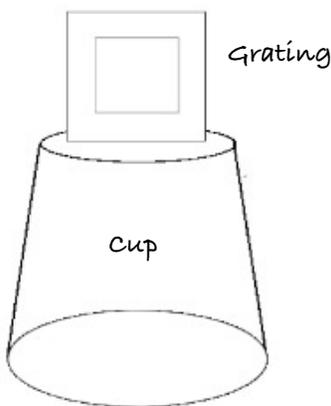


- 2) Using a straight edge, draw a line perpendicular to the slit as shown below:



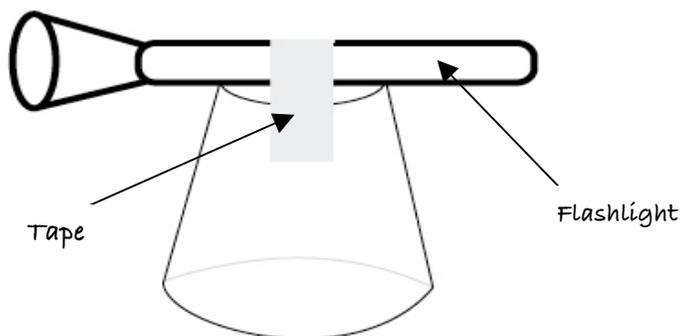
Draw a line down the side of the cup perpendicular to the slit

- 3) Take your diffraction grating and place it into the slit on the bottom of the cup to complete your stand as in the figure below:



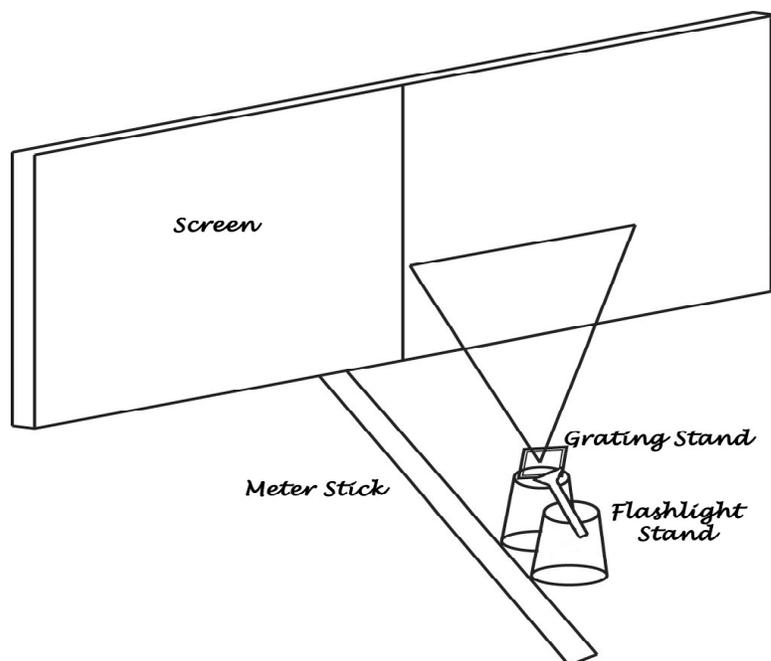
### ***Making the flashlight stand***

- 1) Loosely tape the flashlight to the bottom of a Styrofoam cup using masking tape as in the figure below:



## Experiment:

- 1) Place the grating stand in front of the screen so that the center of the grating lines up with the central line on the screen.
- 2) Place the meter stick on the table perpendicular to the screen. Align the zero centimeter line with the front of the screen and the edge of the meter stick against the Styrofoam cup. Using masking tape, tape the meter stick at each end so that it does not shift.
- 3) Turn on and then focus the flashlight so it makes a small, bright beam.

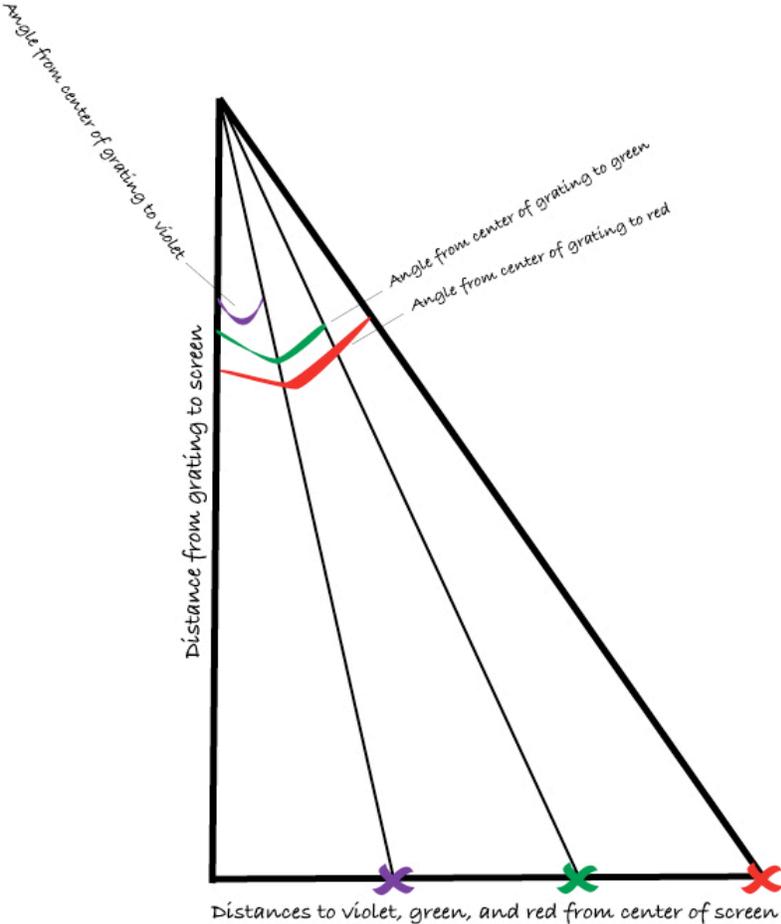


- 4) Place the flashlight stand directly behind the grating stand facing the screen. Rest the head of the flashlight on the grating stand so the beam of light is traveling directly through the center of the grating.
- 5) Slide the two stands backward and forward along the meter stick until your spectrum is clear and bright. As long as the spectrum is on the screen, you can place the stands anywhere along the meter stick. Do not shift the stands between measurements.
- 6) Choose either the spectrum on the right OR left to make your measurements.
- 7) Measure the distance from the grating and the screen by reading the meter stick where it lines up with the black line on the cup. Record this distance.
- 8) Measure the distances from the centerline on the screen to the very edge of the red and violet light. Record these distances.



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- 9) Choose a point in the green area of the light, and measure and record the distance.
- 10) Using the measurements recorded, on a sheet of paper draw a right triangle using the distance from the grating to the screen, and each of the distances to the colors measured. Mark the location of each of the colors with an X, and connect the apex of the triangle with each X as demonstrated below.
- 11) Measure and record the angles to each color using a protractor.





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- 12) Using the Pythagorean theorem and a calculator, determine the hypotenuse lengths of the violet and red triangles. Measure them with a ruler to confirm the lengths. Do your numbers match? Why or why not?

## **Part II**

### **Designing and building a closed spectrograph**

Now that you have found the angles to the colors in the spectrum, design an enclosed spectrograph with your group. As a group, explore these questions before your start.

#### *Shape and size*

- What shape will make your spectrum lie on a flat surface?
- What is the simplest design to build and look through?
- How big does a spectrograph need to be to work?
- Is there a limit to how big it could be?
- Do you want a smaller spectrograph that is easy to take with you?
- What is the best size to use for it to be useful and portable?

#### *Placement and design of Parts*

- Where will you place your diffraction grating?
- How will the light come through, and how much light is needed?
- Where will the light come through, and where will you see the spectrum?
- Where will your spectrum be when you look into the spectrograph?
- Is there anything you can do to make your spectrum easier to see?



# *Designing an Open Spectrograph*

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## ***Designing your mission***

Conduct research and create an imaginary mission your spectrograph might undertake. Consider the following questions as a group:

- Is your mission ground or space-based?
- If your mission is space-based, will it orbit the Earth or travel to another planet?
- What will your mission goals be?
- What limitations does your spectrograph have?
- What will the spacecraft look like?
- Are there size or weight restrictions you need to consider?
- How much will the mission cost?

## ***Presenting your findings***

Present your design and mission to the rest of the class. Have the class give you feedback, and be open to suggestions.

## ***Building your spectrograph***

Gather the materials needed to make your spectrograph with your group. Create a materials list for items your teacher needs to buy. Use materials from around your home or school whenever possible. Keep a record of how much the items cost. Estimate cost when necessary. After building the spectrograph, present it to the class along with your mission outcomes, and final cost analysis.