

## Laboratory 6

### Wavelength of Light

In today's lab, we will use a double slit experiment to determine the wavelengths of various colors of light. **Steps marked with an asterisk(\*) are steps related to data which must be shared amongst the group, and so should be completed before lab time ends. Read each step completely before performing the step.**

1. Before we take data, we should understand the setup and how this can give us the wavelength of the light. For light impinging on two thin vertical slits in some material, the two slits become new identical sources of light themselves. Since there are now two sources of light waves, the waves can interfere constructively or destructively. To see this interference, we can put up a screen to reflect the interference pattern a certain distance from the slits. The diagram below shows the geometry of this situation.

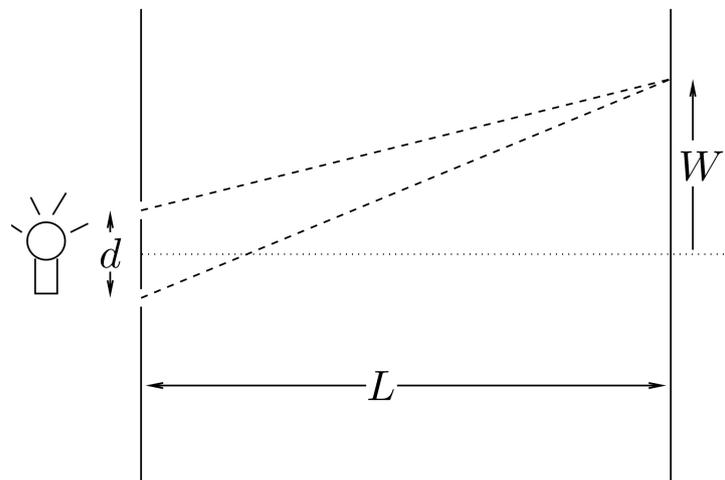


FIG. 1:

Constructive interference occurs at locations whose distances to the two slits are different by an integer multiple of the wavelength. Since the distance from the slits to the screen is large compared to the distance between the slits, we can approximate this relation with the

formula:

$$W = n \cdot \lambda \cdot \frac{L}{d}$$

where  $W$  is the distance from the center of the screen to a point of constructive interference (bright spot),  $n$  is an integer number,  $\lambda$  (reads *lamda*) is the wavelength of the light,  $L$  is the distance between the screen and the slit, and finally  $d$  is the slit separation. For our setup today, we will be specifically interested in  $n = 1$ . Since we will be given  $d$  and measuring  $L$  and  $W$ , the unknown value will be  $\lambda$ , the wavelength of the light, and so we can rearrange this formula to

$$\lambda = d \cdot \frac{W}{L}.$$

Our setup specifically looks like below: This may seem backwards from the first diagram,

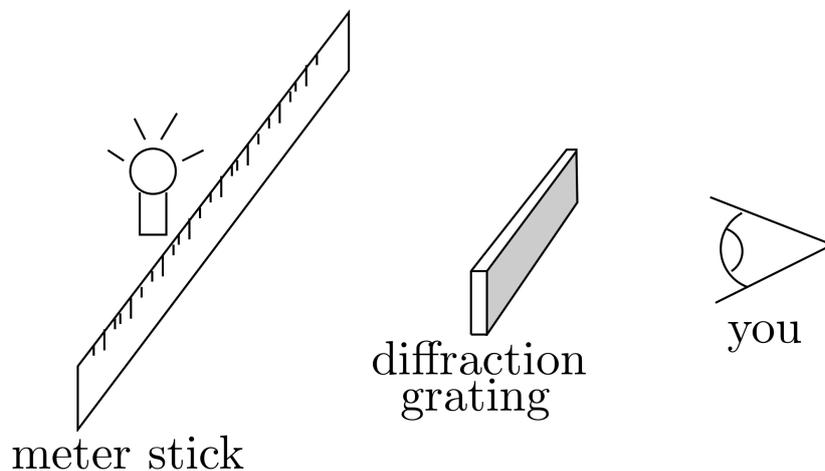


FIG. 2:

but it functions equivalently.

\*2. The diffraction grating we are using has been designed with 13,400 slits per inch, which means the distance between adjacent slits is  $d = 1,896 \text{ nm}$  ( $1 \text{ nm}$  is  $10^{-9} \text{ m}$ ). Make sure the light source is right up against the meter stick and aligned to its 50 cm mark. Measure 1.0 m from the light bulb and place a piece of tape. This will mark the location of the diffraction grating. Then, by design, the distance between the meter stick and the diffraction grating is  $L = 1.0 \text{ m}$ . Record the values for  $d$  and  $L$  in your lab notebook.

\*3. Hold the diraction grating above the taped mark and look through it at the light source. You should see continuous bands of color on the left and right. Because white light is made up of all colors, and each color has a different wavelength, the distance between constructive

interference points is different for all colors in a continuous way. Select three colors, one each in the middle of the blues, greens, and reds, and measure  $W_\ell = (50 - x_\ell)$  and  $W_r = (x_r - 50)$  (in cm) for each, where  $x_\ell$  is the raw meter stick position of the color you selected on the left of the light source and  $x_r$  is the raw meter stick position of the color you selected on the right of the light source. Summarize this data in a table in your lab notebook.

4. Add another column to your table for  $\bar{W} = (W_r + W_\ell)/2$ , the average distance to the constructive interference points and use the equation:

$$\lambda = d \cdot \frac{\bar{W}}{L},$$

to find the wavelength for each of your three colors. Record these wavelengths in the table as well.

5. Draw a top-down diagram of the setup in your lab notebook with all distances labeled, including those for the three colors you selected (it need not be to scale, make it big enough to clearly label everything in the setup).

6. Since you are to select your own colors, there is no one single number with which to compare each wavelength; however, red is commonly given the range 620 nm to 750 nm, green has the range 495 nm to 570 nm, and blue has the range 450 nm to 495 nm. Did your wavelengths fall into their respective ranges? Were they at the low end, high end, or about the center?