Names ______________________ Date _________
____

Double-Slit Interference

Experimental Objectives

To observe the interference pattern formed by monochromatic light passing through a double slit. Use the light sensor to measure the intensity of the maxima in a double-slit diffraction pattern created by monochromatic laser light passing through a double-slit. Use the rotary motion sensor to measure the relative positions of the maxima in the diffraction pattern. Use DataStudio to record and display the light intensity and the relative position of the maxima in the pattern and to plot intensity versus position.

Theory

In 1801, Thomas Young obtained convincing evidence of the wave nature of light. Light from a single source falls on a slide containing two closely spaced slits. If light consists of tiny particles, or corpuscles as described by Isaac Newton, we might expect to see two bright lines on a screen placed behind the slits. Young observed a series of bright lines. Young was able to explain this result as a wave interference phenomenon. Because of diffraction, the waves leaving the two small slits spread out from the edges of the slits. This is equivalent to the interference pattern of ripples produced when two rocks are thrown into a pond.

In general, the distance between slits is very small compared to the distance from the slits to the screen where the diffraction pattern is observed. The rays from the edges of the slits are essentially parallel. Constructive interference will occur on the screen when the extra distance that rays from one slit travel is a whole number of wavelengths in difference from the distance that rays from the other slit travel. Destructive interference occurs when the distance difference is a whole number of half-wavelengths.

For two slits, there should be several bright points or maxima of constructive interference on either side of a line that is perpendicular to the point directly between the two slits. Analysis of wave diagrams for light of wavelength, λ, passing through a double slit with slit spacing, d, gives the following formula:

$$d \sin\Theta = m\lambda \qquad \text{(Eq. 1)}$$

The angle Θ, is related to the linear distance x by $\tan\Theta = \frac{x}{L}$, (Eq. 2) where L is the distance from the double slit accessory to the aperture bracket.

Equipment Needed

Optics Bench	Light Sensor
Rotary Motion Sensor	Aperture Bracket
Linear Translator	Diode Laser
Double Slit Accessory	

Name _____________________ Date _________

____

PART A: Computer and Equipment Setup

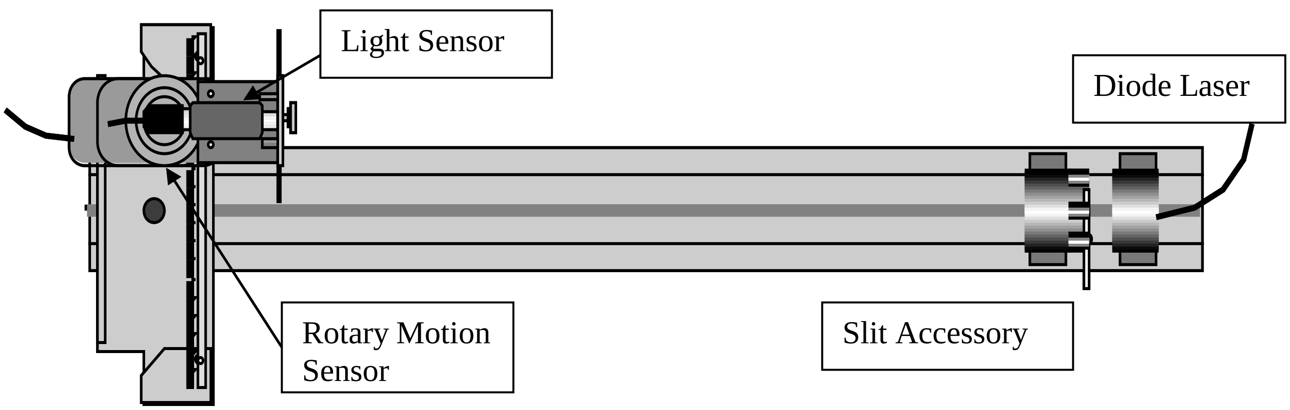
1. The experimental apparatus has 3 plugs. Insert the yellow jack into digital input 1 of the 850 interface. Insert the black jack into digital input 2. Insert the 8 pin din plug into analog input A. Make sure the box's power button is lit.

2. Double click on the Capstone icon 

3. When the software is running, click on the "Hardware Setup" icon 

4. An image of the 850 box should appear. If it doesn't, ask for assistance. On the 850 image, click on digital input 1 and choose "Rotary Motion Sensor." Click on analog input A and choose "Light Sensor." Then click again on the "Hardware Setup" icon to dismiss it.

5. Double click the graph icon  on the righthand side of the window. A graph should appear.



6. Click on <Select Measure> on the horizontal axis and choose "Position" under "Rotary Motion Sensor." Click on <Select Measurement> on the vertical axis and choose "Light Intensity."

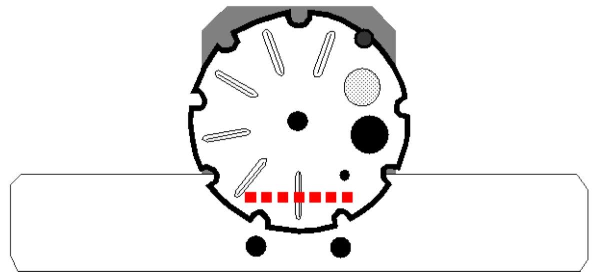
7. Place the linear rack with the rotary motion sensor on the other end of the optics bench at the 100 cm mark. Mount the Single Slit holder at the 8.5 cm position on the optics bench.

8. Mount the light sensor onto the aperture bracket by screwing the aperture bracket post into the threaded hole on the bottom of the light sensor.

9. Put the post into the rod clamp on the end of the rotary motion sensor. Tighten the rod clamp thumbscrew to hold the aperture bracket and light sensor in place.

10. Rotate the aperture disk on the front of the aperture bracket until the number "2" slit is in front of the light sensor opening.

11. Set the switch on top of the light sensor to 10.



12. Turn on the power switch on the back of the diode laser. Adjust the position of the multiple slit set on the slit accessory so that the laser beam passes through the double-slit pair with a = 0.04 mm, d = 0.25 mm. If needed adjust the vertical and horizontal knobs on the back of the laser until you see a clear, horizontal diffraction pattern on the white screen of the aperture bracket.

13. Move the rotary motion sensor/light sensor along the rack until the maximum at one edge of the diffraction pattern is next to the slit in front of the light sensor.

14. Place the end stop so it sits up against the rotary motion sensor, this will help you start each run from the same position.

PART B: Data Recording

- Before recording any data, you should experiment with the rotary motion sensor and light sensor setup. Slowly and smoothly, move the rotary motion sensor/light sensor so that the maxima of the diffraction pattern move across the slit on the aperture disk.

1. Move the rotary motion sensor/light sensor along the rack until the maximum at one edge of the diffraction pattern is next to the slit in front of the light sensor.
2. Begin recording data.
3. Slowly and smoothly, move the rotary motion sensor/light sensor so that the maxima of the diffraction pattern move across the slit on the aperture disk.
4. When the entire diffraction pattern has been measured, stop recording data.

PART C: Data Analysis

1. Measure the distance between the central peak and the second maxima on the double-slit graph. Click the Zoom Select button to select a region from the central maxima over to the second maxima.
2. Click on the  icon and choose “Add Coordinates/Delta Tool.” When the tool appears, right click on it and choose “Show Delta Tool.”
3. Move the main tool to the center of the central maxima.
4. Move the other part of the tool to the first minimum.
5. The delta *x* is the linear distance between positions. Record your value of the order *m* and *x* in the Data Table for each minima position.

6. Measure the distance form the double-slit accessory to the aperture bracket. Record in the Lab Report section as *L* in meters.
7. Repeat procedure for the remaining double slits in the multiple slit set.

Names ______________________ Date __________

____

Lab Report

L = ________________________ m

Data Table:

Slit Width (a), m	Slit Spacing (d), m	Linear Distance (x)	Wavelength (λ)	% Error

Calculations

1. Using equation 2 calculate the angular separation, Θ, for the second peak.
2. Calculate your measured wavelength, λ, for the laser.
3. Calculate the percent error of your measured wavelength and the theoretical wavelength of the laser (650 nm).

Questions

1. What is interference?
2. How can the observance of interference patterns be used to verify the wave nature of light?