Wave Phenomena Remote Lab Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Purpose: Determine the wavelength of light using wave phenomena.

Theory:  
Single slit <http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/sinslit.html>  
Multiple slits <http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/mulslid.html#c1>

A. Double-Slit Interference of light  
Go to the following simulation: <https://www.geogebra.org/m/ZSbeWGbe>

|  |
| --- |
|  |
|  |
|  |

1. What you see is the double slit interference pattern with diffraction superimposed. Write down the following [simulation](https://www.geogebra.org/m/ZSbeWGbe) parameters:   
Wavelength, λ =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Single-Slit Width, a = \_\_\_\_\_\_\_\_\_\_\_  
Double-Slit separation, d = \_\_\_\_\_\_\_\_\_\_\_\_\_Slit to screen distance, D =\_\_\_\_\_\_\_\_\_\_\_

2. Change each of the above parameters and find out, what parameter is the interference pattern independent of? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Change each of the above parameters and find out, what parameter is the diffraction pattern independent of? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Describe what happens to the fringe width (Z) of the double-slit interference pattern as you change the following:  
  
i. Wavelength (λ): directly proportional or inversely proportional  
ii. Slit to screen distance (D): directly proportional or inversely proportional  
iii. Slit-separation (d): directly proportional or inversely proportional  
  
iv. Deduce an equation for Z (fringe-width) using the above observation and a proportionality constant of 1.   
 Z =  
  
5. Describe what happens to the half-width (Y) of the central diffraction pattern as you change the following:  
  
i. Wavelength (λ): directly proportional or inversely proportional  
ii. Single-Slit-width (a): directly proportional or inversely proportional  
iii. Slit to screen distance (D): directly proportional or inversely proportional   
  
iv. Deduce an equation for Y (half-width) using the above observation and a proportionality constant of 1.   
 Y =

Procedure:

1. Open the following simulation: <http://physics.bu.edu/~duffy/HTML5/double_slit.html>

|  |  |
| --- | --- |
|  |  |
| Figure I | Figure II |

What you see (Figure I) is a single-slit diffraction pattern for red color of light. Purpose is to measure the wavelength. To determine the wavelength, we need to measure the half-width of the central bright fringe. It will be easier and more accurate, if the minima fall on major grid lines. Adjust the distance to the screen until the minima fall on major grid lines (as shown in Figure II), and measure the half-width, complete the first row of the data table, and calculate the wavelength in nanometer (nm).

2. Repeat the measurements for other colors and complete the data table.

DATA Table for Diffraction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Color | Slit width, *a* (μm) | Distance to screen, *D* (m) | Half-width, *Y* (cm) | Wavelength, *λ=aY/D* |
| Red |  |  |  |  |
| Green |  |  |  |  |
| Violet |  |  |  |  |

3. Open the following simulation: <http://physics.bu.edu/~duffy/HTML5/double_slit.html>

4. Set the following simulation parameters: Color of light = Violet, Type of opening = Double slit, Slit width = 8 μm, and Distance between slits = 72 μm.

|  |  |
| --- | --- |
|  |  |
| Figure I | Figure II |

5. What you see (Figure I) is a double-slit interference pattern for violet color of light. Purpose is to measure the wavelength. To determine the wavelength, we need to measure the fringe width. Since the fringe width is narrow, total width for multiple fringes need to be measured. Adjust the distance to the screen until the fringes are bigger and one of the minimum falls on a major grid line, for example at 6 cm, as shown in Figure II. Measure the total width, number of fringes, complete the first row of the data table, and calculate the wavelength in nanometer (nm).

6. Repeat the measurements for other colors and complete the data table.

DATA Table for Double Slit Interference

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Color | Slit width (μm) | Distance between slits, *d* (μm) | Distance to screen, *D* (m) | Total Width (cm) | Number of fringes | Fringe Width, *Z* (cm) | Wavelength, *λ* |
| Violet | 8 | 72 |  |  |  |  |  |
| Green | 8 | 72 |  |  |  |  |  |
| Red | 8 | 72 |  |  |  |  |  |

B. Diffraction Grating

Theory: <https://www.youtube.com/watch?v=E2duVLCkHqI>

Procedure:

1. Open the following simulation: <https://www.geogebra.org/m/myyuuhbg>



What you see is a green laser pointed at a screen with a diffraction grating nearby.

2. Click “Grating in place” to place the grating on the path of the laser beam. Keep the screen to grating distance to 10 m, wavelength to 532 nm, and set the grating lines per mm to 430.



Now, what you see are the diffraction maxima spots on the screen, in addition to the central spot. Only the first order diffraction maxima are shown at a distance x from the central spot. Screen to grating distance is L. Also shown, the diffraction angle, θ for the first order diffraction maximum on the right. Complete the first row of the data table below.

3. Repeat the measurements for the rest of the screen to grating distances shown in the data table and complete the data table.

DATA Table for Diffraction Grating

Diffraction peaks are given by,

Grating lines per mm = 430 *d* = \_\_\_\_\_\_\_\_ mm = \_\_\_\_\_\_\_\_\_\_nm

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Screen to grating distance, *L* (m) | Diffraction order, n | Right diffraction spot length,  *x* (m) | Diffraction angle, | Sin θ | Wavelength, |
| 10 | 1 |  |  |  |  |
| 7.5 | 1 |  |  |  |  |
| 2 |  |  |  |  |
| 5.0 | 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| Average wavelength | | | | |  |
| Simulation wavelength | | | | |  |
| % Error | | | | |  |

C. Write an overall conclusion for the purpose.