Light Double Slit Interference

Purpose

In this experiment we will use the double slit interference to determine the wavelength of monochromatic laser.

Prelab

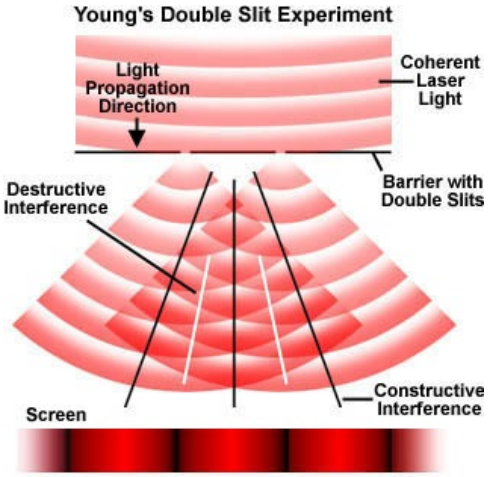


Figure 1

Question 1. Write down the equation for the angle θ of the mth order maximum in an interference experiment with slit separation d.

Question 2. Figure 1 shows a typical interference pattern for a double slit experiment. Suppose the separation of the bright fringes on the screen are $\Delta y = 2.5mm$, and the distance between the screen and the barrier with slits is $L = 605mm$. This implies that the location of the first order maximum is $y_1 = \Delta y = 2.5mm$. Find the angle θ_1 of the first order bright fringe. Draw a diagram when you calculate this.

Question 3. Given that the separation between the slits is $d = 0.125mm$, what is the wavelength λ?

Table 1: Slit Information

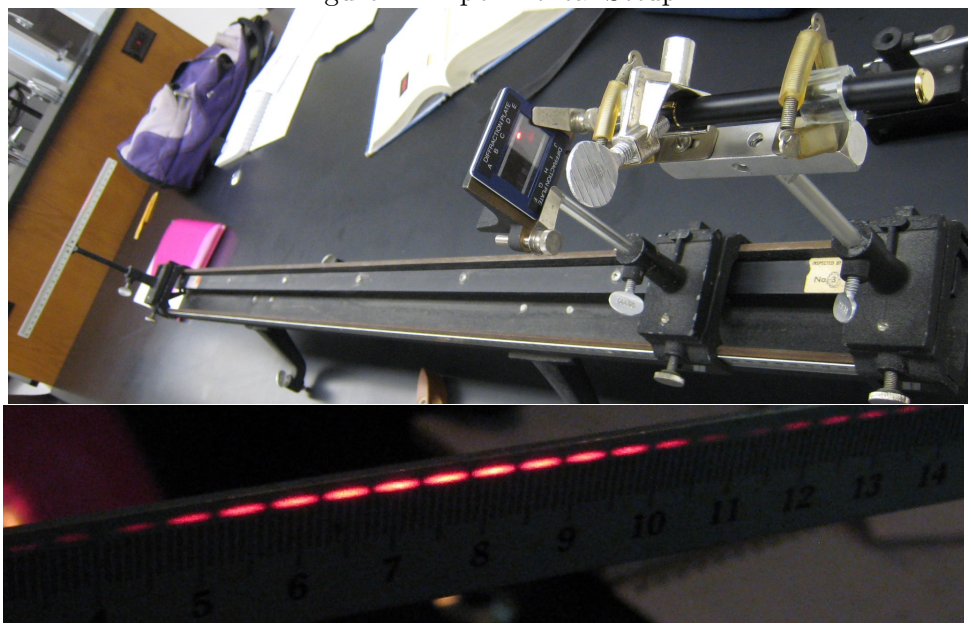
Slits	Width a (mm)	Separation d (mm)
D	0.04	0.125
E	0.04	0.250
F	0.08	0.250

Table 2: Wavelength for Lasers

Laser Type	Wavelength (nm)
He-Ne	633
Red LED	$630 - 680^{\dagger}$
Green LED	532
Yellow LED	$589 - 594^{\ddagger}$
Blue LED	405
Purple LED	401

†: Wavelength depends on the laser. Find the range from the manual of the red laser and use the mean value. If no information available, use $\lambda = 654nm$.
‡: For the yellow laser, use the mean value $591.5nm$

Figure 1: Experimental Setup



Procedure

1. Set up the equipment on the optical bench as shown in Figure 1. You can use either the laser pointer or the gas laser. Put the slits as close to the laser as possible, but as far away from the screen as possible. Large separation (L) from the screen will give you a more accurate λ.
2. Point the laser into slits D. Adjust the height of the ruler (the screen) so that the fringes appear right above the millimeter markings of the ruler.
3. Measure the distance between 5 to 6 bright fringes (the number of fringes you measured is the number N in Table 3, and the total distance is Δy_N) and use that to deduce the average separation ($y_1 = \Delta y$) of the neighboring fringes. Then follow the calculation above to calculate the wavelength.
4. Repeat the measurement for slits E and F. At the end calculate the average wavelength. Compare your result with the wavelength of the color of the laser (which you can find in Table 2).
5. Repeat all the steps above for different lasers to complete all the tables below.

Table 3: Data and Analysis for Laser 1

Slits	D	E	F	Average
Number of Fringes N				NA
Distance between N fringes Δy_N (mm)				NA
$y_1 = \Delta y = \Delta y_N / N$ (mm)				NA
θ_1 (rad)				NA
λ (nm)				
Percentage Difference				

Laser type: _____

Actual wavelength: $\lambda_{actual} =$ _____

Distance between the screen and the barrier with slits: $L =$ _____

Table 4: Data and Analysis for Laser 2

Slits	D	E	F	Average
Number of Fringes N				NA
Distance between N fringes Δy_N (mm)				NA
$y_1 = \Delta y = \Delta y_N / N$ (mm)				NA
θ_1 (rad)				NA
λ (nm)				
Percentage Difference				

Laser type: _____

Actual wavelength: $\lambda_{actual} =$ _____

Distance between the screen and the barrier with slits: $L =$ _____

Table 5: Data and Analysis for Laser 3

Slits	D	E	F	Average
Number of Fringes N				NA
Distance between N fringes Δy_N (mm)				NA
$y_1 = \Delta y = \Delta y_N / N$ (mm)				NA
θ_1 (rad)				NA
λ (nm)				
Percentage Difference				

Laser type: _____

Actual wavelength: $\lambda_{actual} =$ _____

Distance between the screen and the barrier with slits: $L =$ _____

Table 6: Data and Analysis for Laser 4

Slits	D	E	F	Average
Number of Fringes N				NA
Distance between N fringes Δy_N (mm)				NA
$y_1 = \Delta y = \Delta y_N / N$ (mm)				NA
θ_1 (rad)				NA
λ (nm)				
Percentage Difference				

Laser type: _____

Actual wavelength: $\lambda_{actual} =$ _____

Distance between the screen and the barrier with slits: $L =$ _____

Table 7: Data and Analysis for Laser 5

Slits	D	E	F	Average
Number of Fringes N				NA
Distance between N fringes Δy_N (mm)				NA
$y_1 = \Delta y = \Delta y_N / N$ (mm)				NA
θ_1 (rad)				NA
λ (nm)				
Percentage Difference				

Laser type: _____

Actual wavelength: $\lambda_{actual} =$ _____

Distance between the screen and the barrier with slits: $L =$ _____