Diffraction and Interference

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CONTENTS

I. INTRODUCTION

THE purpose of this experiment is to investigate the patterns produced by single slit diffraction and double slit interference, and to verify that the minima and maxima occur respectively at the locations predicted by theory.

II. THEORY

A. Single Slit

In the case of a single slit, the angle between the slit and the minima in the diffraction pattern is given by

$$a \sin\theta = m\lambda. \tag{1}$$

, where a is the slit width and λ is the wavelength of the incident light.

Since this angle is small, we make the approximation that

$$\sin\theta \approx \tan\theta,$$

and from the geometry of the experimental setup, we find that

$$\tan\theta = \frac{y}{D},$$

where y is the distance from the center to the mth minimum, and D is the distance from the slit to the screen.

Substituting this into Equation 1 gives the following expression for the slit width,

$$a = \frac{m\lambda D}{y}, \qquad m \in \mathbb{N}. \tag{2}$$

B. Double Slit

In the case of two slits, the angle to the mth maxima in the interference pattern is given by

$$d \sin\theta = m\lambda, \tag{3}$$

where d is the distance between the slits.

The small angle approximation is again used, and trigonometry shows that

$$\tan\theta = \frac{y}{D},$$

which after substitution yields the following expression for the slit separation,

$$d = \frac{m\lambda D}{y}, \qquad m \in \mathbb{N}. \tag{4}$$

III. ANALYSIS

A. Part 1

Wavelength, Green Laser: 532 nm
Given Slit Width: 0.08 mm

Table I
DATA AND RESULTS FOR 0.08 MM SINGLE SLIT, GREEN LASER

	Order $(m =)$	**Order**$(m =)$
Distance Between Side Orders		
Distance From Center To Side (y)		
Calculated Slit Width		
% Error		

Slit-to-Light Sensor Probe Distance: D = n

Table II
DATA AND RESULTS FOR 0.08 MM SINGLE SLIT, RED LASER

	Order $(m =)$	**Order**$(m =)$
Distance Between Side Orders		
Distance From Center To Side (y)		
Calculated Slit Width		
% Error		

Slit-to-Light Sensor Probe Distance: D = n
Calculated Wavelength, Red Laser: nm
Given Wavelength, Red Laser: nm
Percent Error: %

B. Part 2

Table III
DATA AND RESULTS FOR 0.04 MM/0.25 MM DOUBLE SLIT, GREEN LASER

	Third Order ($m = 3$)	**Fourth Order**($m = 4$)
Distance Between Side Orders		
Distance From Center To Side (y)		
Calculated Slit Separation		
% Error		

Slit-to-Light Sensor Probe Distance: D = n

Table IV
DATA AND RESULTS FOR 0.04 MM/0.25 MM DOUBLE SLIT, RED LASER

	Third Order ($m = 3$)	**Fourth Order**($m = 4$)
Distance Between Side Orders		
Distance From Center To Side (y)		
Calculated Slit Separation		
% Error		

Slit-to-Light Sensor Probe Distance: D = n
Calculated Wavelength, Red Laser: nm
Percent Error: %

IV. QUESTIONS

1) *For the single slit, does the distance between minima increase of decrease when the slit width is increased?*
2) *For the double slit:*
   a) *How does the distance between maxima change when the slit separation is increased?*
   b) *How does the distance between maxima change when the slit width is increased?*
   c) *How does the distance to the first minima in the diffraction envelope change when the slit separation is increased*
   d) *How does the distance to the first minima of the diffraction envelope change when the slit width is increased?*
3) *What are the similarities and difference between the single slit and double slit patterns?*