DIFFRACTION

Objective

Part I: To use the interference pattern produced by a double slit to calculate the wavelength of the light source being used.

Part II: To use the diffraction pattern produced by single slits to determine the wavelength of the light source being used.

Equipment

Helium-neon laser, glass slide with optical double slits (with different spacing), glass slide with optical single slits (with different width), meter stick, tape and paper.

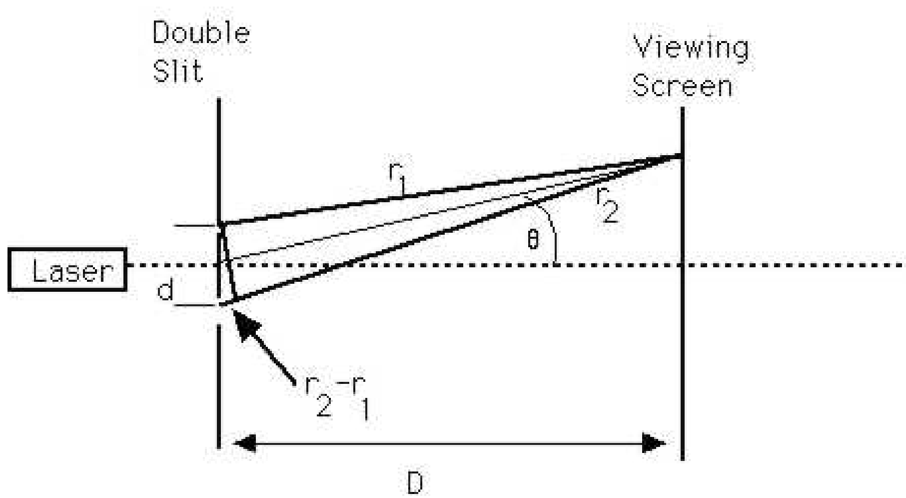
Outline

Caution: Laser light can damage your eyes! DO NOT look into the beam or at any intense reflections from the beam.

Part I:

Step 0: Record the given value for the wavelength of your laser.

Step 1: When light passes through two closely spaced slits an interference pattern can be produced on the wall. The laser beam must be incident on both slits and perpendicular to the glass face. **Choose one double slits** and set up the lab as shown in the diagram. Your data will consist of measuring the locations of the various maxima (bright spots) produced. The locations of these maxima are referenced from the location of the zeroth order maximum. The distance you will be projecting the beam after it has passed through the double slits is D: **This distance should be close to the length of the table**. **Measure D and record your data**.



d = distance between the slits D = distance between the double slits and the wall

Step 2: Shine the laser through one of the double slits available making sure that both slits are covered by the beam. **Record the distance between the slits d** (slit space).

Step 3: Observe the interference pattern on the wall. You may have to rotate the slits slightly to get the sharpest pattern. Tape a piece of paper to the wall so that you can draw as many lines as possible at the locations of the maxima. **DO NOT make any marks on the wall!**

Important note: A bright spot of the interference pattern may be mixed with a dark spot of the single slit diffraction pattern and therefore may not be visible: **You should draw your interference pattern assuming that the distance between two bright spots remains constant in the small angle approximation, by adding the “missing” bright spots of your interference pattern.**

On the interference pattern, **label the maxima with their order number by labeling the center of the central bright spot "zero" and counting outward in both directions. Use only positive numbers.**

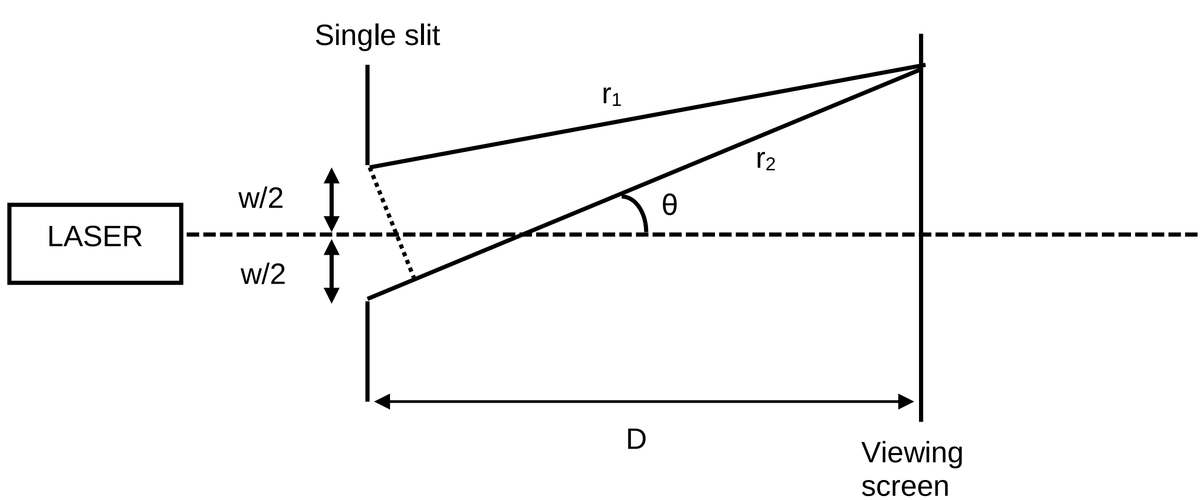
Deduce the best estimate of the distance between two maxima.

Step 4: Rotate the slits, keeping the beam perpendicular to the glass face. **Record your observations.**

Part II:

Step 5: Replace the double slit frame by the single slits frame.

Step 6: Shine the laser through one single slit (A) making sure that the slit is covered by the beam. When light passes through a single slit, a diffraction pattern can be produced on the wall. The laser beam must be incident on the slit and perpendicular to the glass face. Set up the lab as shown in the diagram. Your data will consist of measuring the locations of the various minima (dark spots) produced. The locations of these minima are referenced from the location of the central zeroth order maximum. The distance you will be projecting the beam after it has passed through the single is D: **Record the distance between the slit and the wall D**. **This distance should be close to the length of the table.**



Step 7: Observe the single slit diffraction pattern on the wall. You may have to rotate the slit slightly to get the sharpest pattern. Tape a piece of paper to the wall so that you can draw lines at the location of the central maximum and at the location of each minimum. **DO NOT make any marks on the wall!**

Label each destructive minimum by labeling the first one next to the central bright spot "one" and counting outward in both directions. Use only positive numbers.

Step 8: Record the slit width w.

Step 9: Repeat step 6, 7 and 8 for all the other slits.

Step 10: For each slit, use the single slit diffraction patterns to determine the best estimate of the distance between the central bright maximum and the first minimum. Compute the corresponding angle θ. Compute $\sin(\theta)$ also.

Graph / Patterns

Part I and II: **Attach all the patterns to the lab report.**

Part II: Using your data for the 4 slits A B C and D, plot $\sin(\theta)$ versus 1 over the slit width.

Questions and Calculations

Part I:

1. Using your interference pattern, compute the best estimate of the distance between two maxima.

2. Using the previous result and the distance from the slits to the wall, compute the angle between the central maximum (order 0) and the next maximum (or order 1), θ. Compute $\sin(\theta)$ also.

3. Deduce the wavelength of the laser light. Compare with the given value.

4. What happened when you rotated the slits? Explain.

5. Why do maxima (bright spots) and minima (dark areas) appear when light is passed through the slits? Why don't we observe just two bright spots on the wall separated by the same distance as the slits?

6. Thomas Young used a single slit for the light to pass through before it hit the double slits, why don't we use a single slit before the double in our experiment?

Part II:

7. Using your graph deduce the wavelength of the laser light. Compare with the given value.

8. What is the difference between interference and diffraction?

Last name: ……………………………… First name: ………………………………

DATA SHEETS

Part I: Double slit

Step 0, 1 and 2:

Wavelength of the laser (given value) = d (slit space) =

D (distance between the wall and the slits) =

Best estimate of the distance between two maxima =

Step 3: Record the interference pattern on a separate piece of paper. Label the maxima with their order number by labeling the central bright spot "zero" and counting outward in both directions. Use only positive numbers.

Step 4: Observation when you rotate the slits:

Part II: Single slits A B C D

Step 7: Record the single slit diffraction patterns on one sheet of paper (for the slit A B C D). Label each destructive minimum by labeling the first one next to the central bright spot "one" and counting outward in both directions. Use only positive numbers.

Step 5 to 10:

For each **single** slit (A B C and D), record the slit width w, the distance between the slit and the wall D, the distance between the central bright maximum and the first minimum, the angle θ (in radian)and sin(θ). **Record all those data in a table.**