Physics Exploration Homework Supplement P111-19.pdf

Exploring Two Slit Interference and Single Slit Diffraction

Go to the Physics Exploration Center. Enter through the resource room in 311/312 Thaw Hall. This exploration involves exploring the wave nature of light, in particular, the phenomena of interference and diffraction of light. It is best performed by dimming the light in the room and pulling the window shades. Go to the set up with a screen, single slit (slit A) and double slit (slit B) with diode-laser source behind them. Before you begin the exploration, answer the following questions:

(I) Which statement best explains why interference patterns are not usually observed for light from two ordinary light bulbs?
(a) Diffraction effects predominate.
(b) The two sources are out of phase.
(c) The two sources are not coherent.
(d) The interference pattern is too small to observe.
(e) Light from ordinary light bulb is not polarized.

(II) In a Young's double-slit experiment, the slit separation is doubled. This results in:
(a) an increase in fringe intensity
(b) a decrease in fringe intensity
(c) a halving of the wavelength
(d) a doubling of the fringe spacing
(e) a halving of the fringe spacing

(III) In a double-slit diffraction experiment the number of interference fringes within the central diffraction maximum can be increased by:
(a) increasing the wavelength
(b) decreasing the wavelength
(c) increasing the slit separation
(d) decreasing the slit separation
(e) increasing the slit width

(IV) Light from a red laser passes through a single slit to form a diffraction pattern. If the width of the slit is increased by a factor of two, what happens to the width of the central maximum? Assume that the angle θ is sufficiently small so that $\sin\theta$ is nearly equal to θ.
(a) It increases by a factor of 4.
(b) It decreases by a factor of 2.
(c) It decreases by a factor of 4.
(d) It decreases by a factor of 2.
(e) It does not change.

Now perform the following explorations. Measure the distance from the slit to the screen (with graph paper attached) using a meter stick. Assume that the wavelength of red light used in the laser is A=655 *nm.* The width of slit A in the single slit diffraction experiment is the same as the width of slits B in the double slit interference experiment.

(1) Turn on the laser using the switch behind slit A (single slit). What kind of pattern do you observe on the screen? Trace the outline of the single slit pattern on the graph paper by putting the graph paper against the screen on which the diffraction pattern is formed. Pay particular attention to the central bright fringe.

(2) Predict how the single slit pattern on the screen will change if two narrow slits of the same width simultaneously allow light to pass through them. Now turn on the laser behind slit B (double slit). Is the additional pattern you observe on the screen consistent with your prediction? Trace the outline of the double slit pattern on top of the single slit pattern on the same graph paper. Pay particular attention to the double slit pattern within the central bright fringe of the single diffraction pattern.

Please replace a fresh graph paper on the screen after you finish and turn off the laser light. Take the tracings home with you and calculate the size and spacing of the slits. Is the slit size and spacing reasonable to observe interference and diffraction effects?