Chapter L - Problems

Blinn College - Physics 2426 - Terry Honan

Problem L.1

Young's double slit experiment is performed by shooting a He-Ne laser beam ($\lambda = 632.8$ nm) through two slits separated by 0.15 mm onto a screen 8 m away.
(a) What is the distance between bright fringes on the screen?
(b) What is the distance between dark fringes?
(c) What is the distance from the center of the central maximum to the third dark fringe?
(d) What is the smallest distance from the central maximum where the intensity is 3/4 its maximum?

Problem L.2

700 nm light shines through a single slit of width 1.2×10^{-5} m and shines on a screen 55 cm away.
(a) What is the distance from the center to the third maximum? (Do not use the small angle approximation here?
(b) Repeat part (a) using the small angle approximation.

Problem L.3

When 632.8 nm light shines through a diffraction grating the first bright line is observed at a deflection angle of 15°. What is the spacing between the slits in the grating?

Problem L.4

The visible spectrum varies between $\lambda_{\text{violet}} = 400$ nm and $\lambda_{\text{red}} = 700$ nm. Consider a diffraction grating with an arbitrary slit separation d. Show that for white light the $m = 1$ maximum gives pattern that doesn't overlap the $m = 2$ maximum. Also show that the $m = 2$ and $m = 3$ patterns always overlap.

Problem L.5

A diffraction grating has 300 lines/mm. What is the highest order violet (400 nm) line seen? What is the highest order red line (700 nm).

Problem L.6

550 nm light passes through a single vertical slit of width 0.16 mm. What is the width of the central maximum observed on a screen 1.2 m away?

Problem L.7

When a He-Ne laser beam ($\lambda = 632.8$ nm) passes through a narrow vertical slit a diffraction pattern is observed on a screen 80 cm away. If the distance from the first dark fringe to the third is 2.5 mm then what is the width of the slit?

Problem L.8

When light of wavelength λ passes through a narrow vertical slit the highest order dark fringe observed (over all possible angles) is 5. (The fifth fringe can be seen and the sixth cannot.) What can one conclude about the width of the slit?

Problem L.9

A soap film in air has a thickness of 120 nm. What visible wavelengths are strongly reflected by this film? Take the index of the soap film to be the same as for water, 1.33. The visible spectrum is between 400 nm and 700 nm.

Problem L.10

Red light ($\lambda = 650$ nm) is normally incident on a thin oil layer ($n = 1.25$) that sits on a puddle of water.
(a) What is the smallest nonzero thickness that will strongly reflect the red light?
(b) What is the smallest nonzero thickness that will minimally reflect the red light?

Problem L.11

You are asked to design an antiglare coating for a computer monitor. Sitting on the glass ($n = 1.50$) screen is a thin coating of magnesium fluoride with an index of refraction of 1.38. To be an antiglare coating it must satisfy two conditions. It must give destructive interference for light in the middle of the visible spectrum, at 550 nm. Secondly, there must be no constructive interference for any wavelength in the visible spectrum, from 400 nm to 700 nm. First find the different thicknesses that give the destructive interference and then use the lack of consructive interference to select the thickness uniquely.

Problem L.12

Unpolarized light with an intensity of $4000\,\mathrm{W}/\mathrm{m}^2$ passes through three polarizing filters, the first is at a 15° angle from vertical, the second is 40° from vertical and the third is horizontal. What are the intensities between the first and second filters, between the second and third filters and after the third filter?

Problem L.13

When the sun is what angle *above the horizon* will sunlight reflected off a still pond be totally polarized?