GIANCOLI Diffraction/Polarization Problems

Young's Doubles Slit ↓

SECTION 24–3

2. (I) Monochromatic light falling on two slits 0.035 mm apart produces the fifth-order fringe at a 9.3° angle. What is the wavelength of the light used?

3. (I) The third-order fringe of 500 nm light is observed at an angle of 15° when the light falls on two narrow slits. How far apart are the slits?

4. (II) Monochromatic light falls on two very narrow slits 0.040 mm apart. Successive fringes on a screen 5.00 m away are 5.5 cm apart near the center of the pattern. What is the wavelength and frequency of the light?

5. (II) A parallel beam of light from a He-Ne laser, with a wavelength 656 nm, falls on two very narrow slits 0.050 mm apart. How far apart are the fringes in the center of the pattern if the screen is 2.0 m away?

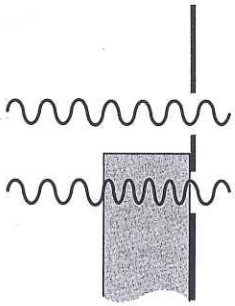

FIGURE 24–41 Problem 9.

6. (II) In a water tank experiment, water waves are generated with their crests 2.5 cm apart and parallel. They pass through two openings 5.0 cm apart in a long wooden board. If the end of the tank is 1.5 m beyond the boards, where would you stand, relative to the "straight-through" direction, so that you received little or no wave action?

7. (II) Light of wavelength 520 nm falls on two slits and produces an interference pattern in which the fourth-order fringe is 48 mm from the central fringe on a screen 1.5 m away. What is the separation of the two slits?

8. (II) If 480-nm and 680-nm light passes through two slits 0.60 mm apart, how far apart are the second-order fringes for these two wavelengths on a screen 2.0 m away?

9. (II) Suppose a thin piece of glass were placed in front of the lower slit in Fig. 24–6 so that the two waves enter the slits 180° out of phase (Fig. 24–41). Describe in detail the interference pattern on the screen.

10. (II) In a double-slit experiment it is found that blue light of wavelength 460 nm gives a second-order maximum at a certain location on the screen. What wavelength of visible light would have a minimum at the same location?

11. (III) 400-nm light falls on two slits 3.80×10^{-2} mm apart. The slits are immersed in water, as is a viewing screen 32.0 cm away. How far apart are the fringes on the screen?

12. (III) A very thin sheet of plastic ($n = 1.60$) covers one slit of a double-slit apparatus illuminated by 620-nm light. The center point on the screen, instead of being a maximum, is dark. What is the (minimum) thickness of the plastic?

14. (I) How much less is the speed of light in silicate flint glass (see Fig. 24–11) for blue light of wavelength 450 nm than red light of 650 nm? Express as a percent.

15. (II) A light beam strikes a piece of glass at a 60.00° incident angle. The beam contains two wavelengths, 450.0 nm and 700.0 nm, for which the index of refraction of the glass is 1.4820 and 1.4742, respectively. What is the angle between the two refracted beams?

16. (II) A parallel beam of light containing two wavelengths, $\lambda_1 = 400$ nm and $\lambda_2 = 650$ nm, strikes a piece of silicate flint glass at an incident angle of 45.0°. Calculate the angle between the two color beams inside the glass (see Fig. 24–11).

17. (II) Suppose the light beam in Problem 16 is entering the glass of an equilateral prism (Fig. 24–42). At what angle does each beam leave the prism (give angle with normal to the face)?

*18. (III) A double convex lens whose radii of curvature are both 22.0 cm is made of crown glass. Find the distance between the focal points for 400-nm and 700-nm light. [*Hint*: Use the lens-maker's equation, Eq. 23–10, and Fig. 24–11.]

Diffraction Gratings

SECTIONS 24–6 AND 24–7

27. (I) At what angle will 650-nm light produce a second-order maximum when falling on a grating whose slits are 1.15×10^{-3} cm apart?
28. (I) A 2500-line/cm grating produces a third-order fringe at a 22.0° angle. What wavelength of light is being used?
29. (II) The first-order line of 650-nm light falling on a diffraction grating is observed at a 12° angle. How far apart are the slits? At what angle will the fourth order be observed?
30. (II) Light falling normally on a 10,000-line/cm grating is revealed to contain three lines in the first-order spectrum at angles of 31.2°, 36.4°, and 47.5°. What wavelengths are these?
31. (II) How many lines per centimeter does a grating have if the third-order occurs at a 22.0° angle for 500-nm light?
32. (II) A grating has 6000 lines/cm. How many spectral orders can be seen when it is illuminated by white light?
33. (II) What is the highest spectral order that can be seen if a grating with 6000 lines per cm is illuminated with 633-nm laser light? Assume normal incidence.
34. (II) Two and only two full spectral orders can be seen on either side of the central maximum when white light is sent through a diffraction grating. What is the maximum number of lines per cm for the grating?
35. (II) White light containing wavelengths from 400 nm to 750 nm falls on a grating with 6000 lines/cm. How wide is the first-order spectrum on a screen 2.00 m away?
36. (II) The α and δ lines of the atomic hydrogen spectrum have wavelengths of 656 nm and 410 nm. If these fall at normal incidence on a grating with 4800 lines per cm, what will be the angular separation of the two wavelengths in the first-order spectrum?
37. (II) Two first-order spectrum lines are measured by a 10,000-line/cm spectroscope at angles, on each side of center, of $+26°38'$, $+41°08'$ and $-26°48'$, $-41°19'$. What are the wavelengths?
38. (III) Suppose the angles measured in Problem 37 were produced when the spectrometer (but not the source) was submerged in water. What then would be the wavelengths?

Polarization

SECTION 24–10

55. (I) What is Brewster's angle for an air–glass ($n = 1.52$) surface?
56. (I) The axes of two polarizers make a 70° angle to one another. Unpolarized light falls on them. What fraction of the light intensity is transmitted?
57. (I) What is Brewster's angle for a diamond submerged in water if the light is hitting the diamond while traveling in the water?
58. (II) The critical angle for total internal reflection at a boundary between two materials is 52°. What is Brewster's angle at this boundary?
59. (II) Two Polaroids are aligned so that the light passing through them is a maximum. At what angle should one of them be placed so that the intensity is subsequently reduced by half?
60. (II) At what angle should the axes of two Polaroids be placed so as to reduce the intensity of the incident unpolarized light by an additional factor (after the first Polaroid cuts it in half) of (*a*) 25 percent, (*b*) 10 percent, (*c*) 1 percent?
61. (II) Two polarizers are oriented at 40° to each other and plane-polarized light is incident on them. If only 15 percent of the light gets through both of them, what was the initial polarization direction of the incident light?
62. (II) Two polarizers are oriented at 58.0° to one another. Light polarized at a 29.0° angle to each polarizer passes through both. What reduction in intensity takes place?
63. (II) What would Brewster's angle be for reflections off the surface of water for light coming from beneath the surface? Compare to the angle for total internal reflection, and to Brewster's angle from above the surface.
64. (III) Describe how to rotate the plane of polarization of a plane-polarized beam of light by 90° and produce only a 10 percent loss in intensity using "perfect" polarizers.