16. (III) A parallel beam of light containing two wavelengths, $\lambda_1 = 450\,\text{nm}$ and $\lambda_2 = 650\,\text{nm}$, enters the silicate flint glass of an equilateral prism as shown in Fig. 24–58. At what angle does each beam leave the prism (give angle with normal to the face)?

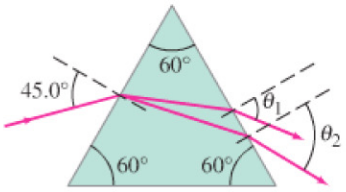

FIGURE 24–58
Problems 16 and 87.

24–5 Single-Slit Diffraction

17. (I) If 580-nm light falls on a slit 0.0440 mm wide, what is the full angular width of the central diffraction peak?
18. (I) Monochromatic light falls on a slit that is 2.60×10^{-3} mm wide. If the angle between the first dark fringes on either side of the central maximum is 35.0° (dark fringe to dark fringe), what is the wavelength of the light used?
19. (II) Light of wavelength 520 nm falls on a slit that is 3.20×10^{-3} mm wide. Estimate how far the first brightish diffraction fringe is from the strong central maximum if the screen is 10.0 m away.
20. (II) A single slit 1.0 mm wide is illuminated by 450-nm light. What is the width of the central maximum (in cm) in the diffraction pattern on a screen 5.0 m away?
21. (II) Monochromatic light of wavelength 653 nm falls on a slit. If the angle between the first bright fringes on either side of the central maximum is 32°, estimate the slit width.
22. (II) How wide is the central diffraction peak on a screen 2.30 m behind a 0.0348-mm-wide slit illuminated by 589-nm light?
23. (II) When blue light of wavelength 440 nm falls on a single slit, the first dark bands on either side of center are separated by 55.0°. Determine the width of the slit.
24. (II) When violet light of wavelength 415 nm falls on a single slit, it creates a central diffraction peak that is 9.20 cm wide on a screen that is 2.55 m away. How wide is the slit?
25. (II) If a slit diffracts 650-nm light so that the diffraction maximum is 4.0 cm wide on a screen 1.50 m away, what will be the width of the diffraction maximum for light of wavelength 420 nm?
26. (II) For a given wavelength λ, what is the maximum slit width for which there will be no diffraction minima?

24–6 and 24–7 Gratings

27. (I) At what angle will 560-nm light produce a second-order maximum when falling on a grating whose slits are 1.45×10^{-3} cm apart?
28. (I) A 3500-line/cm grating produces a third-order fringe at a 28.0° angle. What wavelength of light is being used?
29. (II) How many lines per centimeter does a grating have if the third-order occurs at an 18.0° angle for 630-nm light?
30. (II) A grating has 8300 lines/cm. How many complete spectral orders can be seen (400 nm to 700 nm) when it is illuminated by white light?
31. (II) The first-order line of 589-nm light falling on a diffraction grating is observed at a 15.5° angle. How far apart are the slits? At what angle will the third order be observed?
32. (II) A diffraction grating has 6.0×10^5 lines/m. Find the angular spread in the second-order spectrum between red light of wavelength 7.0×10^{-7} m and blue light of wavelength 4.5×10^{-7} m.
33. (II) Light falling normally on a 9700-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?
34. (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.
35. (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?
36. (II) White light containing wavelengths from 410 nm to 750 nm falls on a grating with 8500 lines/cm. How wide is the first-order spectrum on a screen 2.30 m away?
37. (II) A He-Ne gas laser which produces monochromatic light of a known wavelength $\lambda = 6.328 \times 10^{-7}$ m is used to calibrate a reflection grating in a spectroscope. The first-order diffraction line is found at an angle of 21.5° to the incident beam. How many lines per meter are there on the grating?
38. (II) Two first-order spectrum lines are measured by a 9500-line/cm spectroscope at angles, on each side of center, of +26°38′, +41°08′ and −26°48′, −41°19′. What are the wavelengths?

24–8 Thin-Film Interference

39. (I) If a soap bubble is 120 nm thick, what wavelength is most strongly reflected at the center of the outer surface when illuminated normally by white light? Assume that $n = 1.34$.
40. (I) How far apart are the dark fringes in Example 24–8 if the glass plates are each 26.5 cm long?
41. (II) What is the smallest thickness of a soap film ($n = 1.42$) that would appear black if illuminated with 480-nm light? Assume there is air on both sides of the soap film.
42. (II) A lens appears greenish yellow ($\lambda = 570\,\text{nm}$ is strongest) when white light reflects from it. What minimum thickness of coating ($n = 1.25$) do you think is used on such a glass ($n = 1.52$) lens, and why?
43. (II) A total of 31 bright and 31 dark Newton's rings (not counting the dark spot at the center) are observed when 550-nm light falls normally on a planoconvex lens resting on a flat glass surface (Fig. 24–31). How much thicker is the center than the edges?
44. (II) A fine metal foil separates one end of two pieces of optically flat glass, as in Fig. 24–33. When light of wavelength 670 nm is incident normally, 28 dark lines are observed (with one at each end). How thick is the foil?
45. (II) How thick (minimum) should the air layer be between two flat glass surfaces if the glass is to appear bright when 450-nm light is incident normally? What if the glass is to appear dark?
46. (II) A piece of material, suspected of being a stolen diamond ($n = 2.42$), is submerged in oil of refractive index 1.43 and illuminated by unpolarized light. It is found that the reflected light is completely polarized at an angle of 59°. Is it diamond?
47. (III) A thin film of alcohol ($n = 1.36$) lies on a flat glass plate ($n = 1.51$). When monochromatic light, whose wavelength can be changed, is incident normally, the reflected light is a minimum for $\lambda = 512\,\text{nm}$ and a maximum for $\lambda = 640\,\text{nm}$. What is the minimum thickness of the film?