PHYSICS 4
CHAPTER 2 WAVE OPTICS
EXERCISES

1. Two radio-frequency point sources S_1 and S_2, separated by distance d = 2.0 m, are radiating in phase with λ = 0.50 m. A detector moves in a large circular path around the two sources in a plane containing them. How many maxima does it detect?

2. A double-slit arrangement produces interference fringes for sodium light (λ = 589 nm) that have an angular separation of 3.50×10^{-3} rad. For what wavelength would the angular separation be 10.0% greater?

3. In a double-slit experiment, the distance between slits is 5.0 mm and the slits are 1.0 m from the screen. Two interference patterns can be seen on the screen: one due to light of wavelength 480 nm, and the other due to light of wavelength 600 nm. What is the separation on the screen between the third-order bright fringes of the two interference patterns?

4. A double-slit arrangement produces bright interference fringes for sodium light (λ = 589 nm) that are angularly separated by 0.30^o near the center of the pattern. What is the angular fringe separation if the entire arrangement is immersed in water, which has an index of refraction of 1 .33?

5. Light of wavelength 624 nm is incident perpendicularly on a soap film (n = 1.33) suspended in air. What are the
(a) least and
(b) second least thicknesses of the film
for which the reflections from the film undergo fully constructive interference.

6. White light, with a uniform intensity across the visible wavelength range of 400 to 690 nm, is perpendicularly incident on a water film, of index of refraction 1.33 and thickness L = 320 nm, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer?

7. We wish to coat flat glass (n = 1.50) with a transparent material (n = 1.25) so that reflection of light at wavelength 600 nm is eliminated by interference. What minimum thickness can the coating have to do this?

8. A soap bubble (n = 1.33) floating in air has the shape of a spherical shell with a wall thickness of 120 nm.
(a) What is the wavelength of the visible light that is most strongly reflected?
(b) Explain how a bubble of different thickness could also strongly reflect light of this same wavelength.
(c) Find the two smallest film thicknesses larger than 120 nm that can produce strongly reflected light of the same wavelength.

9. A thin film of oil (n = 1.25) is located on smooth, wet pavement. When viewed perpendicular to the pavement, the film reflects most strongly red light at 640 nm and reflects no green light at 512 nm. How thick is the oil film?

10. An oil film (n = 1.45) floating on water is illuminated by white light at normal incidence. The film is 280 nm thick. Find
(a) the wavelength and color of the light in the visible spectrum most strongly reflected and
(b) the wavelength and color of the light in the spectrum most strongly transmitted. Explain your reasoning.

11. A slit of width a is illuminated by white light.
(a) For what value of a will the first minimum for red light of wavelength λ = 650 nm appear at $\theta = 15^o$?
(b) What is the wavelength λ' of the light whose first side diffraction maximum is at 15^o, thus coinciding with the first minimum for the red light?

12. Light of wavelength 633 nm is incident on a narrow slit. The angle between the first diffraction minimum on one side of the central maximum and the first minimum on the other side is 1.20^o. What is the width of the slit?

13. A slit 1.00 mm wide is illuminated by light of wavelength 589 nm. We see a diffraction pattern on a screen 3.00 m away. What is the distance between the first two diffraction minima on the same side of the central diffraction maximum?

14. Light of wavelength 587.5 nm illuminates a slit of width 0.75 mm.
(a) At what distance from the slit should a screen be placed if the first minimum in the diffraction pattern is to be 0.85 mm from the central maximum?
(b) Calculate the width of the central maximum.

15. Helium–neon laser light (λ = 632.8 nm) is sent through a 0.300-mm-wide single slit. What is the width of the central maximum on a screen 1.00 m from the slit?

16. Sound with a frequency 650 Hz from a distant source passes through a doorway 1.10 m wide in a soundabsorbing wall. Find
(a) the number and
(b) the angular directions of the diffraction minima at listening positions along a line parallel to the wall.

17. The second-order dark fringe in a single-slit diffraction pattern is 1.40 mm from the center of the central maximum. Assuming the screen is 85.0 cm from a slit of width 0.800 mm and assuming monochromatic incident light, calculate the wavelength of the incident light.

18. Light from a helium–neon laser (λ = 632.8 nm) is incident on a single slit. What is the maximum width of the slit for which no diffraction minima are observed?

19. A helium–neon laser (λ = 632.8 nm) is used to calibrate a diffraction grating. If the first-order maximum occurs at 20.5°, what is the spacing between adjacent grooves in the grating?

20. White light is spread out into its spectral components by a diffraction grating. If the grating has 2 000 grooves per centimeter, at what angle does red light of wavelength 640 nm appear in first order?

21. If the spacing between planes of atoms in a NaCl crystal is 0.281 nm, what is the predicted angle at which 0.140-nm x-rays are diffracted in a first-order maximum?

22. Potassium iodide (KI) has the same crystalline structure as NaCl, with atomic planes separated by 0.353 nm. A monochromatic x-ray beam shows a first-order diffraction maximum when the grazing angle is 7.60°. Calculate the x-ray wavelength.

23. Monochromatic x-rays (l 5 0.166 nm) from a nickel target are incident on a potassium chloride (KCl) crystal surface. The spacing between planes of atoms inKCl is 0.314 nm. At what angle (relative to the surface) should the beam be directed for a second-order maximum to be observed?

24. The first-order diffraction maximum is observed at 12.6° for a crystal having a spacing between planes of atoms of 0.250 nm.
(a) What wavelength x-ray is used to observe this first-order pattern?
(b) How many orders can be observed for this crystal at this wavelength?