24.1 Young's Double-Slit Experiment

1. **MC** In a Young's double-slit experiment using monochromatic light, if the slit spacing *d* decreases, the interference maxima spacing will (a) decrease, (b) increase, (c) remain unchanged, (d) disappear. (b)

2. **MC** If the path-length difference between two identical and coherent beams is 2.5λ when they arrive at a point on a screen, the point will be (a) bright, (b) dark, (c) multicolored, (d) gray. (b)

3. **MC** When white light is used in Young's double-slit experiment, many maxima with a spectrum of colors are seen. In a given maximum, the color closest to the central maximum is (a) red, (b) blue, (c) all colors. (b)

4. **CQ** Non–cable television pictures often flutter when an airplane passes by (▸Fig. 24.29). Explain a possible cause of this fluttering, based on interference effects. path-length difference changes; so does interference

5. **CQ** Describe what would happen to the interference pattern in Young's double-slit experiment if the wavelength of the monochromatic light were to increase. the spacing between the maxima would increase

6. **CQ** The intensity of the central maximum in the interference pattern of a Young's double-slit experiment is about four times that of either light wave. Is this a violation of the conservation of energy? Explain. no, there are minima

8. ● To study wave interference, a student uses two speakers driven by the same sound wave of wavelength 0.50 m. If the distances from a point to the speakers differ by 0.75 m, will the waves interfere constructively or destructively at that point? What if the distances differ by 1.0 m? destructively; constructively

9. ● Two parallel slits 0.075 mm apart are illuminated with monochromatic light of wavelength 480 nm. Find the angle between the center of the central maximum and the center of the first side maximum. 0.37°

11. ●● In a double-slit experiment that uses monochromatic light, the angular separation between the central maximum and the second-order maximum is 0.160°. What is the wavelength of the light if the distance between the slits is 0.350 mm? 489 nm

24.2 Thin-Film Interference

20. **MC** For a thin film with $n_1 > n_o$ and $n_1 > n_2$, where n_1 is the index of refraction of the film, a film thickness for constructive interference of the reflected light is (a) $\lambda'/4$, (b) $\lambda'/2$, (c) λ', (d) both a and b. (a)

21. **MC** For a thin film with $n_o < n_1 < n_2$, where n_1 is the index of refraction of the film, the minimum film thickness for destructive interference of the reflected light is (a) $\lambda'/4$, (b) $\lambda'/2$, (c) λ'. (a)

22. **MC** When a thin film of kerosene spreads out on water, the thinnest part looks bright. The index of refraction of kerosene is (a) greater than, (b) less than, (c) the same as that of water. (b)

23. **CQ** Most lenses used in cameras are coated with thin films and appear bluish-purple when viewed with reflected light. What wavelengths are not visible in the reflected light? all wavelengths except bluish-purple

24. **CQ** When destructive interference of two waves occurs at a certain location, there is no energy at that location. Is this situation a violation of the conservation of energy? Explain. no; there are regions where waves interfere constructively

25. **CQ** At the center of a Newton's rings arrangement (Fig. 24.10a), the air wedge has a thickness of zero. Why is this area always dark? destructive interference due to 180° phase shift

26. **IE** ● A film on a lens with an index of refraction of 1.5 is 1.0×10^{-7} m thick and is illuminated with white light. The index of refraction of the film is 1.4. (a) The number of waves that experience the 180° phase shift is (1) zero, (2) one, (3) two. Explain. (b) For what wavelength of visible light will the lens be nonreflecting? (a) (3) two (b) 560 nm

24.3 Diffraction

36. **MC** In a single-slit diffraction pattern, (a) all maxima have the same width, (b) the central maximum is twice as wide as the side maxima, (c) the side maxima are twice as wide as the central maximum, (d) none of the preceding. (b)

37. **MC** As the number of lines per unit length of a diffraction grating increases, the spacing between the maxima (a) increases, (b) decreases, (c) remains unchanged. (a)

38. **MC** In a single-slit diffraction pattern, if the wavelength of light increases, the width of the central maximum will (a) increase, (2) decrease, (c) remain the same. (a)

39. **CQ** From Eq. 24.8, can the $m = 2$ minimum be seen if $w = \lambda$? How about the $m = 1$ minimum? no; yes (barely, at $\theta = 90°$)

40. **CQ** In our discussion of single-slit diffraction, the length of the slit was assumed to be much greater than the width. What changes would be observed in the diffraction pattern if the length were comparable with the width of the slit? a second diffraction pattern perpendicular to the first

41. **CQ** In a diffraction grating, the slits are very closely spaced. What is the advantage of this design? wider diffraction pattern, as *d* is smaller

42. ● A slit of width 0.20 mm is illuminated with monochromatic light of wavelength 480 nm, and a diffraction pattern is formed on a screen 1.0 m away from the slit. (a) What is the width of the central maximum? (b) What are the widths of the second and third-order maxima? (a) 4.8 mm (b) 2.4 mm, 2.4 mm

48. ●● A certain crystal gives a deflection angle of 25° for the first-order maximum of monochromatic X-rays with a frequency of 5.0×10^{17} Hz. What is the lattice spacing of the crystal? 7.1×10^{-10} m

24.4 Polarization

57. **MC** Light can be polarized by (a) reflection, (b) refraction, (c) absorption, (d) all of the preceding. (d)

58. **MC** The Brewster angle depends on (a) the indices of refraction of materials, (b) Bragg's law, (c) internal reflection, (d) interference. (a)

59. **MC** A sound wave cannot be polarized. This is because sound is (a) not a light wave, (b) a transverse wave, (c) a longitudinal wave, (d) none of the preceding. (c)

60. **CQ** Given two pairs of sunglasses, could you tell whether one or both were polarizing? see Soltions

61. **CQ** Suppose that you held two polarizing sheets in front of you and looked through both of them. How many times would you see the sheets lighten and darken (a) if one were rotated through one complete rotation, (b) if both were rotated through one complete rotation at the same rate in opposite directions, (c) if both were rotated through one complete rotation at the same rate in the same direction, and (d) if one rotates twice as fast as the other and the slower one rotates through one complete rotation? (a) twice (b) four times (c) none (d) six times

62. **CQ** How does selective absorption produce polarized light? one of the two electric field components is absorbed

63. **CQ** If you place a pair of polarizing sunglasses in front of your calculator's LCD display and rotate them, what do you observe? the numbers appear and disappear as the sunglasses are rotated

68. ●● A beam of light is incident on a glass plate $(n = 1.62)$ in air and the reflected ray is completely polarized. What is the angle of refraction for the beam? 31.7°

71. ●● Sunlight is reflected off a vertical plate-glass window $(n = 1.55)$. What would the Sun's altitude (angle above the horizon) have to be for the reflected light to be completely polarized? 57.2°

72. **IE** ●● A piece of glass $(n = 1.60)$ could be in air or submerged in water. (a) The polarizing (Brewster) angle in water is (1) greater than, (2) less than, (3) the same as that in air. Explain. (b) What is the polarizing angle when it is in air and submerged in water? (a) (2) less than (b) 58.0°, 50.3°