Section 27.1 The Principle of Linear Superposition
Section 27.2 Young's Double Slit Experiment

☐ 1. Complete the following sentence: The term *coherence* relates to
(a) the phase relationship between two waves.
(b) the polarization state of two waves.
(c) the diffraction of two waves.
(d) the amplitude of two waves.
(e) the frequency of two waves.

◘ 2. Two identical light waves, **A** and **B**, are emitted from different sources and meet at a point **P**. The distance from the source of **A** to the point **P** is L_A; and the source of **B** is a distance L_B from **P**. Which of the following statements is necessarily true concerning the interference of the two waves?
(a) **A** and **B** will interfere constructively because their amplitudes are the same.
(b) **A** and **B** will interfere constructively if $L_A = L_B$.
(c) **A** and **B** will interfere destructively if $L_A - L_B = m\lambda$ where m = 0, 1, 2, 3, ...
(d) **A** and **B** will interfere destructively if L_A is not equal to L_B.
(e) **A** and **B** will interfere constructively because their wavelengths are the same.

◘ 3. Which one of the following statements provides the most convincing evidence that *visible light* is a form of electromagnetic radiation?
(a) Two light sources can be coherent.
(b) Light can be reflected from a surface.
(c) Light can be diffracted through an aperture.
(d) Light can form a double-slit interference pattern.
(e) Light travels through vacuum at the same speed as X-rays.

◘ 4. Which one of the following statements best explains why interference patterns are not usually observed for light from two ordinary light bulbs?
(a) Diffraction effects predominate.
(b) The two sources are out of phase.
(c) The two sources are not coherent.
(d) The interference pattern is too small to observe.
(e) Light from ordinary light bulbs is not polarized.

◘ 5. A double slit is illuminated with monochromatic light of wavelength 6.00×10^2 nm. The $m = 0$ and $m = 1$ bright fringes are separated by 3.0 cm on a screen which is located 4.0 m from the slits. What is the separation between the slits?
(a) 4.0×10^{-5} m
(b) 8.0×10^{-5} m
(c) 1.2×10^{-4} m
(d) 1.6×10^{-4} m
(e) 2.4×10^{-4} m

◘ 6. What does one observe on the screen in a Young's experiment if white light illuminates the double slit instead of light of a single wavelength?
(a) a white central fringe and no other fringes
(b) a dark central fringe and a series of alternating white and dark fringes on each side of the center
(c) a white central fringe and a series of colored and dark fringes on each side of the center
(d) a continuous band of colors with no dark fringes anywhere
(e) a dark screen since no constructive interference can occur

◘ 7. In two separate double slit experiments, an interference pattern is observed on a screen. In the first experiment, violet light (λ = 754 nm) is used and a second-order bright fringe occurs at the same location as a third-order dark fringe in the second experiment. Determine the wavelength of the light used in the second experiment.

(a) 1320 nm (c) 594 nm (e) 388 nm
(b) 862 nm (d) 431 nm

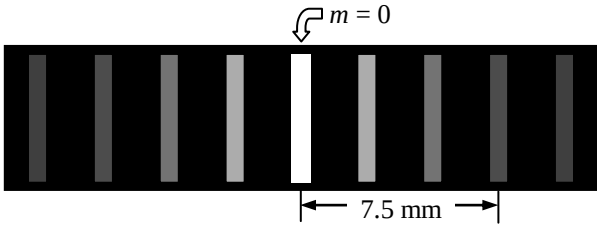
■ 9. Two slits are separated by 2.00×10^{-5} m. They are illuminated by light of wavelength 5.60×10^{-7} m. If the distance from the slits to the screen is 6.00 m, what is the separation between the central bright fringe and the third dark fringe?

(a) 0.421 m (c) 0.168 m (e) 0.070 m
(b) 0.224 m (d) 0.084 m

■ 10. In a Young's double slit experiment, the separation between the slits is 1.20×10^{-4} m; and the screen is located 3.50 m from the slits. The distance between the central bright fringe and the second-order bright fringe is 0.0415 m. What is the wavelength of the light used in this experiment?

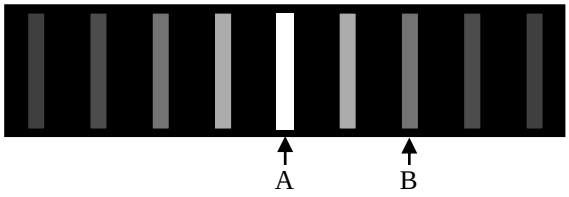
(a) 428 nm (c) 517 nm (e) 711 nm
(b) 474 nm (d) 642 nm

■ 11. Light is incident on two slits that are separated by 0.2 mm. The figure shows the resulting interference pattern observed on a screen 1.0 m from the slits. Determine the wavelength of light used in this experiment.



(a) 0.05 nm (c) 50 nm (e) 5000 nm
(b) 0.50 nm (d) 500 nm

■ 12. The figure shows the interference pattern produced when light of wavelength 500 nm is incident on two slits. Fringe **A** is equally distant from each slit. By what distance is fringe **B** closer to one slit than the other?



(a) 250 nm (c) 750 nm (e) 1500 nm
(b) 500 nm (d) 1000 nm

■ 13. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which one of the following changes would cause the fringes to be more closely spaced?

(a) Reduce the slit separation distance.
(b) Use red light instead of green light.
(c) Use blue light instead of green light.
(d) Move the screen farther away from the slits.
(e) Move the light source farther away from the slits.

◘ 27. A lens that has an index of refraction of 1.61 is coated with a non-reflective coating that has an index of refraction of 1.45. Determine the minimum thickness for the film if it is to be non-

reflecting for light of wavelength 5.60×10^2 nm.
(a) 1.93×10^{-7} m (c) 4.83×10^{-8} m (e) 8.69×10^{-8} m
(b) 3.86×10^{-7} m (d) 9.66×10^{-8} m

Section 27.6 Resolving Power

◘ 44. The Hubble Space Telescope in orbit above the Earth has a 2.4 m circular aperture. The telescope has equipment for detecting ultraviolet light. What is the minimum angular separation between two objects that the Hubble Space Telescope can resolve in ultraviolet light of wavelength 95 nm?
(a) 4.8×10^{-8} rad (c) 1.9×10^{-7} rad (e) 3.3×10^{-9} rad
(b) 7.0×10^{-8} rad (d) 1.5×10^{-7} rad

◘ 45. A spy satellite is in orbit at a distance of 1.0×10^6 m above the ground. It carries a telescope that can resolve the two rails of a railroad track that are 1.4 m apart using light of wavelength 600 nm. Which one of the following statements best describes the diameter of the lens in the telescope?
(a) It is less than 0.14 m.
(b) It is greater than 0.14 m and less than 0.23 m.
(c) It is greater than 0.23 m and less than 0.35 m.
(d) It is greater than 0.35 m and less than 0.52 m.
(e) It is greater than 0.52 m.

■ 46. The headlights of a car are 1.6 m apart and produce light of wavelength 575 nm in vacuum. The pupil of the eye of the observer has a diameter of 4.0 mm and a refractive index of 1.4. What is the maximum distance from the observer that the two headlights can be distinguished?
(a) 8.0 km (c) 11 km (e) 16 km
(b) 9.1 km (d) 13 km

◘ 47. Two stars are just barely resolved by a telescope with a lens diameter of 0.500 m. Determine the angular separation of the two stars. Assume incident light of wavelength 500.0 nm.
(a) 1.22×10^{-6} rad (c) 2.44×10^{-7} rad (e) 1.22×10^{-7} rad
(b) 5.66×10^{-5} rad (d) 4.88×10^{-5} rad

◘ 48. The wavelength of light emitted from two distant objects is 715 nm. What is the minimum angle at which these objects can just be resolved when using binoculars with a 50-mm objective lens?
(a) 10^{-2} degrees (c) 10^{-4} degrees (e) 10^{-6} degrees
(b) 10^{-3} degrees (d) 10^{-5} degrees

◘ 49. Two candles are lit and separated by 0.10 m. If the diameter of the pupil of an observer's eye is 3.5 mm, what is the maximum distance that the candles can be away from the observer and be seen as two light sources? Use 545 nm for the wavelength of light in the eye.
(a) 170 m (c) 530 m (e) 850 m
(b) 340 m (d) 680 m

Section 27.7 The Diffraction Grating
Section 27.8 Compact Discs, Digital Video Discs, and the Use of Interference

◘ 50. A 30.0-mm wide diffraction grating produces a deviation of 30.0° in the second order principal maxima. The wavelength of light is 600.0 nm. What is the total number of slits on the grating?

(a) 10 000 (c) 12 500 (e) 15 000
(b) 11 500 (d) 14 000

■ 51. A beam of light that consists of a mixture of red light (λ = 660 nm in vacuum) and violet light (λ = 410 nm in vacuum) falls on a grating that contains 1.0×10^4 lines/cm. Find the angular separation between the first-order maxima of the two wavelengths if the experiment takes place in a vacuum.
(a) 11° (c) 24° (e) 65°
(b) 17° (d) 41°

◘ 52. Red light of wavelength 600.0 nm is incident on a grating. If the separation between the slits is 5.0×10^{-5} m, at what angle does the first principal maximum occur?
(a) 0.6×10^{-2} rad (c) 1.2×10^{-2} rad (e) 5.0×10^{-2} rad
(b) 0.8×10^{-2} rad (d) 3.6×10^{-2} rad

◘ 53. A diffraction grating that has 4500 lines/cm is illuminated by light that has a single wavelength. If a second order maximum is observed at an angle of 42° with respect to the central maximum, what is the wavelength of this light?
(a) 1500 nm (c) 930 nm (e) 740 nm
(b) 370 nm (d) 1100 nm

◘ 54. Light from two sources, λ_1 = 623 nm and λ_2 = 488 nm, is incident on a diffraction grating that has 5550 lines/cm. What is the angular separation, $\theta_1 - \theta_2$, of the second order maxima of the two waves?
(a) 11.0° (c) 25.0° (e) 43.8°
(b) 15.0° (d) 32.8°

◘ 56. Visible light of wavelength 589 nm is incident on a diffraction grating that has 3500 lines/cm. At what angle with respect to the central maximum is the fifth order maximum observed?
(a) 17.9° (c) 35.7° (e) A fifth order maximum
(b) 23.8° (d) 71.3° cannot be observed.

◘ 57. White light is passed through a diffraction grating that has 2.50×10^5 lines/m. On each side of the white central maximum, a spectrum of colors is observed. What is the wavelength of the light observed at an angle of 7.00° in the first-order bright fringes?
(a) 487 nm (c) 632 nm (e) 731 nm
(b) 589 nm (d) 668 nm