11.18: Interference (Answers)

Check Your Understanding

3.1. 3.63° and 7.27°, respectively

3.2. a. 853 nm, 1097 nm;

b. 731 nm, 975 nm

3.3. a. too small;

b. up to 8×10^{-5}

Conceptual Questions

1. No. Two independent light sources do not have coherent phase.

3. Because both the sodium lamps are not coherent pairs of light sources. Two lasers operating independently are also not coherent so no interference pattern results.

5. Monochromatic sources produce fringes at angles according to $dsin\theta = m\lambda$. With white light, each constituent wavelength will produce fringes at its own set of angles, blending into the fringes of adjacent wavelengths. This results in rainbow patterns.

7. Differing path lengths result in different phases at destination resulting in constructive or destructive interference accordingly. Reflection can cause a 180° phase change, which also affects how waves interfere. Refraction into another medium changes the wavelength inside that medium such that a wave can emerge from the medium with a different phase compared to another wave that travelled the same distance in a different medium.

9. Phase changes occur upon reflection at the top of glass cover and the top of glass slide only.

11. The surface of the ham being moist means there is a thin layer of fluid, resulting in thin-film interference. Because the exact thickness of the film varies across the piece of ham, which is illuminated by white light, different wavelengths produce bright fringes at different locations, resulting in rainbow colors.

13. Other wavelengths will not generally satisfy $t = \frac{\lambda/n}{4}$ for the same value of **t** so reflections will result in completely destructive interference. For an incidence angle θ, the path length inside the coating will be increased by a factor $1/cos\theta$ so the new condition for destructive interference becomes $\frac{t}{cos\theta} = \frac{\lambda/n}{4}$.

15. In one arm, place a transparent chamber to be filled with the gas. See Example 3.6.

Problems

17. 0.997°

19. $0.290\mu m$

21. $5.77 \times 10^{-7} m = 577 nm$

23. 62.5; since **m** must be an integer, the highest order is then $m = 62$.

25. $1.44\mu m$

27. a. 20.3°;

b. 4.98°;

c. 5.76, the highest order is $m = 5$.

29. a. 2.37 cm;

b. 1.78 cm

31. 560 nm

33. 1.2 mm

35. a. $0.40^{\circ}, 0.53^{\circ}$;

b. $4.6 \times 10^{-3} m$

37. 1:9

39. 532 nm (green)

41. $8.39 \times 10^{-8} m = 83.9 nm$

43. 620 nm (orange)

45. 380 nm

47. a. Assuming **n** for the plane is greater than 1.20, then there are two phase changes: 0.833 cm.

b. It is too thick, and the plane would be too heavy.

c. It is unreasonable to think the layer of material could be any thickness when used on a real aircraft.

49. $4.55 \times 10^{-4} m$

51. $D = 2.53 \times 10^{-6} m$

Additional Problems

53. 0.29° and 0.86°

55. a. 4.26 cm;

b. 2.84 cm

57. 6

59. 0.20 m

61. 0.0839 mm

63. a. 9.8, 10.4, 11.7, and 15.7 cm;

b. 3.9 cm

65. 0.0575°

67. 700 nm

69. 189 nm

71. a. green (504 nm);

b. magenta (white minus green)

73. 1.29

75. $52.7 \mu m$ and $53.0 \mu m$

77. 125 nm

79. 413 nm and 689 nm

81. $73.9 \mu m$

83. 47

85. $8.5 \mu m$

87. $0.013^{\circ} C$

Challenge Problems

89. Bright and dark fringes switch places.

91. The path length must be less than one-fourth of the shortest visible wavelength in oil. The thickness of the oil is half the path length, so it must be less than one-eighth of the shortest visible wavelength in oil. If we take 380 nm to be the shortest visible wavelength in air, 33.9 nm.

93. $4.42 \times 10^{-5} m$

95. for one phase change: 950 nm (infrared); for three phase changes: 317 nm (ultraviolet); Therefore, the oil film will appear black, since the reflected light is not in the visible part of the spectrum.