Chapter 27

Problems & Exercises

1.

$1/1.333 = 0.750$

3.

1.49, Polystyrene

5.

0.877 glass to water

6.

0.516°

8.

1.22×10^{-6} m

10.

600 nm

12.

2.06°

14.

1200 nm (not visible)

16.

(a) 760 nm

(b) 1520 nm

18.

For small angles $\sin\theta - \tan\theta \approx \theta$ (in radians).

For two adjacent fringes we have,

$d \sin\theta_{\mathrm{m}} = m\lambda$

and

$d \sin\theta_{\mathrm{m+1}} = (m+1)\lambda$

Subtracting these equations gives

$$d(\sin\theta_{m+1} - \sin\theta_m) = [(m+1) - m]\lambda$$
$$d(\theta_{m+1} - \theta_m) = \lambda$$
$$\tan\theta_m = \frac{y_m}{x} \approx \theta_m \Rightarrow d\left(\frac{y_{m+1}}{x} - \frac{y_m}{x}\right) = \lambda$$
$$d\frac{\Delta y}{x} = \lambda \Rightarrow \Delta y = \frac{x\lambda}{d}$$

20.

450 nm

21.

5.97°

23.

8.99×10^3

25.

707 nm

27.

(a) $11.8º$, $12.5º$, $14.1º$, $19.2º$

(b) $24.2º$, $25.7º$, $29.1º$, $41.0º$

(c) Decreasing the number of lines per centimeter by a factor of x means that the angle for the x-order maximum is the same as the original angle for the first-order maximum.

29.

589.1 nm and 589.6 nm

31.

28.7°

33.

43.2

35.

90.0

37.

(a) The longest wavelength is 333.3 nm, which is not visible.

(b) 333 nm (UV)

(c) 6.58×10^3 cm

39.

1.13×10^{-2} m

41.

(a) 42.3 nm

(b) Not a visible wavelength

The number of slits in this diffraction grating is too large. Etching in integrated circuits can be done to a resolution of 50 nm, so slit separations of 400 nm are at the limit of what we can do today. This line spacing is too small to produce diffraction of light.

43.

(a) 33.4

(b) No

45.

(a) 1.35×10^{-6} m

(b) 69.9

47.

750 nm

49.

(a) 9.04^{o}

(b) 12

51.

(a) 0.0150^{o}

(b) 0.262 mm

(c) This distance is not easily measured by human eye, but under a microscope or magnifying glass it is quite easily measurable.

53.

(a) 30.1

(b) 48.7

(c) No

(d) $2\theta_1 = (2)(14.5^{o}) = 29^{o}$, $\theta_2 - \theta_1 = 30.05^{o} - 14.5$=$15.56^{o}$. Thus, $29^{o} \approx (2)(15.56^{o}) = 31.1$.

55.

23.6 and 53.1

57.

(a) 1.63×10^{-4} rad

(b) 326 ly

59.

1.46×10^{-5} rad

61.

(a) 3.04×10^{-7} rad

(b) Diameter of 235 m

63.

5.15 cm

65.

(a) Yes. Should easily be able to discern.

(b) The fact that it is just barely possible to discern that these are separate bodies indicates the severity of atmospheric aberrations.

70.

532 nm (green)

72.

83.9 nm

74.

620 nm (orange)

76.

380 nm

78.

33.9 nm

80.

4.42×10^{-5} m

82.

The oil film will appear black, since the reflected light is not in the visible part of the spectrum.

84.

45.0

86.

45.7 mW/m^2

88.

90.0%

90.

I_0

92.

48.8

94.

41.2

96.

(a) 1.92, not diamond (Zircon)

(b) 55.2

98.

$B_2 = 0.707\ B_1$

100.

(a) 2.07×10^{-2} °C/s

(b) Yes, the polarizing filters get hot because they absorb some of the lost energy from the sunlight.

101.

(a) $\sin\theta = \frac{4.00\times10^{-7}}{10^{-6}} = 0.400\ \theta = 0.400 = 23.6^\circ$

(b) $\sin\theta = \frac{(2)(4.00\times10^{-7})}{10^{-6}} 0.800\ \theta = 0.800 = 53.1^\circ$

(c) $\sin 23.9^\circ = \frac{x}{10^{-6}\text{ cm}}\ x = \sin 23.9^\circ(10^{-6}) = 4.05 \times 10^{-7} = 405$ nm

(d) $\sin\theta = \frac{4.00\times10^{-7}}{2.00\times10^{-6}} = 0.200\ \theta = 0.200 = 11.5^\circ$

(e) No.