Chapter 17

Problems & Exercises

1.

0.288 m

3.

332 m/s

5.

$$\begin{aligned} v_{\text{w}} &= (331\ \text{m/s})\sqrt{\tfrac{T}{273\ \text{K}}} = (331\ \text{m/s})\sqrt{\tfrac{293\ \text{K}}{273\ \text{K}}} \\ &= 343\ \text{m/s} \end{aligned}$$

7.

0.223

9.

(a) 7.70 m

(b) This means that sonar is good for spotting and locating large objects, but it isn't able to resolve smaller objects, or detect the detailed shapes of objects. Objects like ships or large pieces of airplanes can be found by sonar, while smaller pieces must be found by other means.

11.

(a) 18.0 ms, 17.1 ms

(b) 5.00%

(c) This uncertainty could definitely cause difficulties for the bat, if it didn't continue to use sound as it closed in on its prey. A 5% uncertainty could be the difference between catching the prey around the neck or around the chest, which means that it could miss grabbing its prey.

12.

$3.16 \times 10^{-4}\ \text{W/m}^2$

14.

$3.04 \times 10^{-4}\ \text{W/m}^2$

16.

106 dB

18.

(a) 93 dB

(b) 83 dB

20.

(a) 50.1

(b) 5.01×10^{-3} or $\frac{1}{200}$

22.

70.0 dB

24.

100

26.

1.45×10^{-3} J

28.

28.2 dB

30.

(a) 878 Hz

(b) 735 Hz

32.

3.79×10^{3} Hz

34.

(a) 12.9 m/s

(b) 193 Hz

36.

First eagle hears 4.23×10^{3} Hz

Second eagle hears 3.56×10^{3} Hz

38.

0.7 Hz

40.

0.3 Hz, 0.2 Hz, 0.5 Hz

42.

(a) 256 Hz

(b) 512 Hz

44.

180 Hz, 270 Hz, 360 Hz

46.

1.56 m

48.

(a) 0.334 m

(b) 259 Hz

50.

3.39 to 4.90 kHz

52.

(a) 367 Hz

(b) 1.07 kHz

54.

(a) $f_n = n(47.6\ Hz),\ n = 1,\ 3,\ 5, ...,\ 419$

(b) $f_n = n(95.3\ Hz),\ n = 1,\ 2,\ 3, ...,\ 210$

55.

1×10^6 km

57.

498.5 or 501.5 Hz

59.

82 dB

61.

approximately 48, 9, 0, –7, and 20 dB, respectively

63.

(a) 23 dB

(b) 70 dB

65.

Five factors of 10

67.

(a) 2×10^{-10} W/m^2

(b) 2×10^{-13} W/m^2

69.

2.5

71.

1.26

72.

170 dB

74.

103 dB

76.

(a) 1.00

(b) 0.823

(c) Gel is used to facilitate the transmission of the ultrasound between the transducer and the patient's body.

78.

(a) 77.0 μm

(b) Effective penetration depth = 3.85 cm, which is enough to examine the eye.

(c) 16.6 μm

80.

(a) 5.78×10^{-4} m

(b) 2.67×10^{6} Hz

82.

(a) $v_w = 1540\ m/s = f\lambda \Rightarrow \lambda = \frac{1540\ m/s}{100 \times 10^3\ \text{Hz}} = 0.0154\ m\ <\ 3.50\ m.$ Because the wavelength is much shorter than the distance in question, the wavelength is not the limiting factor.

(b) 4.55 ms

84.

974 Hz

(Note: extra digits were retained in order to show the difference.)