Name: Key

Practice – 17.1-17.3 Sound

1. When poked by a spear, an operatic soprano lets out a 1200-Hz shriek. What is its wavelength if the speed of sound is 345 m/s?

$$v = \lambda f \Rightarrow \lambda = \frac{v}{f} = \frac{345\ \frac{m}{s}}{1200\ Hz} = \boxed{0.288\ m}$$

2. What frequency sound has a 0.10-m wavelength when the speed of sound is 340 m/s?

$$v = \lambda f \Rightarrow f = \frac{v}{\lambda} = \frac{340\ \frac{m}{s}}{0.10\ m} = \boxed{3400\ Hz}$$

3. Calculate the speed of sound on a day when a 1500 Hz frequency has a wavelength of 0.221 m.

$$v = \lambda f = (0.221\ m)(1500\ Hz) = \boxed{332\ \frac{m}{s}}$$

4. A. What is the speed of sound in a medium where a 100-kHz frequency produces a 5.96-cm wavelength?

$$v = \lambda f = (5.96 \times 10^{-2}\ m)(100 \times 10^{3}\ Hz) = \boxed{5.96 \times 10^{3}\ \frac{m}{s}}$$

B. Which substance in Table 17.1 (found in Section 17.2) is this likely to be?

Steel

5. Air temperature in the Sahara Desert can reach 56.0°C (about 134°F). What is the speed of sound in air at that temperature?

$$v = 331.3\sqrt{1 + \frac{T}{273.15}} = 331.3\sqrt{1 + \frac{56.0}{273.15}} = \boxed{364\ \frac{m}{s}}$$

6. A sonar echo returns to a submarine 1.20 s after being emitted. What is the distance to the object creating the echo? (Assume that the submarine is in the ocean, not in fresh water.)

$$d = vt = \left(1540\frac{m}{s}\right)\left(\frac{1.20s}{2}\right) = \boxed{924m}$$

7. If a submarine's sonar can measure echo times with a precision of 0.0100 s, what is the smallest difference in distances it can detect? (Assume that the submarine is in the ocean, not in fresh water.)

$$2\Delta d = v\Delta t \Rightarrow \Delta d = \frac{v\Delta t}{2} = \frac{\left(1540\frac{m}{s}\right)(0.0100s)}{2}$$

$$= \boxed{7.70m}$$

8. A physicist at a fireworks display times the lag between seeing an explosion and hearing its sound, and finds it to be 0.400 s. How far away is the explosion if air temperature is 24.0°C and if you neglect the time taken for light to reach the physicist?

$$d = vt = \left(331.3\sqrt{1+\frac{24.0°C}{273.15}}\right)(0.400s) = \left(346\frac{m}{s}\right)(0.400s)$$

$$= \boxed{138m}$$

9. Suppose a bat uses sound echoes to locate its insect prey, 3.00 m away. Calculate the echo times for temperatures of 5.00°C and 35.0°C.

$$2d = vt \Rightarrow t_{5°C} = \frac{2d}{v} = \frac{2(3.00m)}{331.3\sqrt{1+\frac{5.00}{273.15}}} = \frac{2(3.00m)}{334\frac{m}{s}} = \boxed{0.0179s}$$

$$t_{35.0°C} = \frac{2(3.00m)}{331.3\sqrt{1+\frac{35.0}{273.15}}} = \frac{2(3.00m)}{352\frac{m}{s}} = \boxed{0.0171s}$$