38. The frequency is $f$ = 686 Hz and the speed of sound is $v_{\text{sound}}$ = 343 m/s. If $L$ is the length of the air-column, then using Eq. 17–41, the water height is (in unit of meters)

$$h = 1.00 - L = 1.00 - \frac{nv}{4f} = 1.00 - \frac{n(343)}{4(686)} = (1.00 - 0.125n) \text{ m}$$

where $n$ = 1, 3, 5,… with only one end closed.

(a) There are 4 values of $n$ ($n$ = 1, 3, 5, 7) which satisfies $h > 0$.

(b) The smallest water height for resonance to occur corresponds to $n$ = 7 with $h = 0.125$ m.

(c) The second smallest water height corresponds to $n$ = 5 with $h$ = 0.375 m.

39. (a) When the string (fixed at both ends) is vibrating at its lowest resonant frequency, exactly one-half of a wavelength fits between the ends. Thus, $\lambda = 2L$. We obtain

$$v = f\lambda = 2Lf = 2(0.220 \text{ m})(920 \text{ Hz}) = 405 \text{ m/s}.$$

(b) The wave speed is given by $v = \sqrt{\tau/\mu}$, where $\tau$ is the tension in the string and $\mu$ is the linear mass density of the string. If $M$ is the mass of the (uniform) string, then $\mu = M/L$. Thus,

$$\tau = \mu v^2 = (M/L)v^2 = [(800 \times 10^{-6} \text{ kg})/(0.220 \text{ m})]\ (405 \text{ m/s})^2 = 596 \text{ N}.$$

(c) The wavelength is $\lambda = 2L = 2(0.220 \text{ m}) = 0.440$ m.

(d) The frequency of the sound wave in air is the same as the frequency of oscillation of the string. The wavelength is different because the wave speed is different. If $v_a$ is the speed of sound in air, the wavelength in air is

$$\lambda_a = v_a/f = (343 \text{ m/s})/(920 \text{ Hz}) = 0.373 \text{ m}.$$

40. At the beginning of the exercises and problems section in the textbook, we are told to assume $v_{\text{sound}}$ = 343 m/s unless told otherwise. The second harmonic of pipe $A$ is found from Eq. 17-39 with $n$ = 2 and $L = L_A$, and the third harmonic of pipe $B$ is found from Eq. 17-41 with $n$ = 3 and $L = L_B$. Since these frequencies are equal, we have

$$\frac{2v_{\text{sound}}}{2L_A} = \frac{3v_{\text{sound}}}{4L_B} \Rightarrow L_B = \frac{3}{4}L_A.$$

(a) Since the fundamental frequency for pipe $A$ is 300 Hz, we immediately know that the second harmonic has $f$ = 2(300 Hz) = 600 Hz. Using this, Eq. 17-39 gives

$$L_A = (2)(343 \text{ m/s})/2(600 \text{ s}^{-1}) = 0.572 \text{ m}.$$

(b) The length of pipe $B$ is $L_B = \frac{3}{4} L_A = 0.429 \text{ m}$.

43. (a) Since the pipe is open at both ends there are displacement anti-nodes at both ends and an integer number of half-wavelengths fit into the length of the pipe. If $L$ is the pipe length and $\lambda$ is the wavelength then $\lambda = 2L/n$, where $n$ is an integer. If $v$ is the speed of sound, then the resonant frequencies are given by $f = v/\lambda = nv/2L$. Now $L = 0.457$ m, so

$$f = n(344 \text{ m/s})/2(0.457 \text{ m}) = 376.4n \text{ Hz}.$$

To find the resonant frequencies that lie between 1000 Hz and 2000 Hz, first set $f = 1000$ Hz and solve for $n$, then set $f = 2000$ Hz and again solve for $n$. The results are 2.66 and 5.32, which imply that $n = 3$, 4, and 5 are the appropriate values of $n$. Thus, there are 3 frequencies.

(b) The lowest frequency at which resonance occurs is ($n = 3$) $f = 3(376.4 \text{ Hz}) = 1129$ Hz.

(c) The second lowest frequency at which resonance occurs is ($n = 4$)

$$f = 4(376.4 \text{ Hz}) = 1506 \text{ Hz}.$$