11. (a) The amplitude of a sinusoidal wave is the numerical coefficient of the sine (or cosine) function: $p_m = 1.50$ Pa.

(b) From the theory presented in Ch. 17, we identify $k = 0.9\pi$ and $\omega = 315\pi$ (in SI units), which leads to $f = \omega/2\pi = 158$ Hz.

(c) We also obtain $\lambda = 2\pi/k = 2.22$ m.

(d) The speed of the wave is $v = \omega/k = 350$ m/s.

13. Let L_1 be the distance from the closer speaker to the listener. The distance from the other speaker to the listener is $L_2 = \sqrt{L_1^2 + d^2}$, where d is the distance between the speakers. The phase difference at the listener is $\phi = 2\pi(L_2 - L_1)/\lambda$, where λ is the wavelength.

(a) For a minimum in intensity at the listener, $\phi = (2n+1)\pi$, where n is an integer. Thus $\lambda = 2(L_2 - L_1)/(2n+1)$. The frequency is

$$f = \frac{v}{\lambda} = \frac{(2n+1)v}{2\left(\sqrt{L_1^2 + d^2} - L_1\right)} = \frac{(2n+1)(343\,\mathrm{m/s})}{2\left(\sqrt{(3.75\,\mathrm{m})^2 + (2.00\,\mathrm{m})^2} - 3.75\,\mathrm{m}\right)} = (2n+1)(343\,\mathrm{Hz})\ .$$

Now $20,000/343 = 58.3$, so $2n+1$ must range from 0 to 57 for the frequency to be in the audible range. This means n ranges from 1 to 28 and $f = 1029,\ 1715,\ \ldots,\ 19550\,\mathrm{Hz}$.

(b) For a maximum in intensity at the listener, $\phi = 2n\pi$, where n is any positive integer. Thus $\lambda = (1/n)\left(\sqrt{L_1^2 + d^2} - L_1\right)$ and

$$f = \frac{v}{\lambda} = \frac{nv}{\sqrt{L_1^2 + d^2} - L_1} = \frac{n(343\,\mathrm{m/s})}{\sqrt{(3.75\,\mathrm{m})^2 + (2.00\,\mathrm{m})^2} - 3.75\,\mathrm{m}} = n(686\,\mathrm{Hz})\ .$$

Since $20,000/686 = 29.2$, n must be in the range from 1 to 29 for the frequency to be audible and $f = 686,\ 1372,\ \ldots,\ 19890\,\mathrm{Hz}$.

26. We use $\Delta\beta_{12} = \beta_1 - \beta_2 = (10\,\text{dB})\log(I_1/I_2)$.

(a) Since $\Delta\beta_{12} = (10\,\text{dB})\log(I_1/I_2) = 37\,\text{dB}$, we get $I_1/I_2 = 10^{37\,\text{dB}/10\,\text{dB}} = 10^{3.7} = 5.0 \times 10^3$.

(b) Since $\Delta p_m \propto s_m \propto \sqrt{I}$, we have $\Delta p_{m\,1}/\Delta p_{m\,2} = \sqrt{I_1/I_2} = \sqrt{5.0 \times 10^3} = 71$.

(c) The displacement amplitude ratio is $s_{m\,1}/s_{m\,2} = \sqrt{I_1/I_2} = 71$.

31. 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. 18-39 with $n = 2$ and $L = L_A$, and the third harmonic of pipe B is found from Eq. 18-41 with $n = 3$ and $L = L_B$. Since these frequencies are equal, we have

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

(a) Since the fundamental frequency for pipe A is 300 Hz, we immediately know that the second harmonic has $f = 2(300) = 600$ Hz. Using this, Eq. 18-39 gives $L_A = (2)(343)/2(600) = 0.572$ m.

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

50. We are combining two effects: the reception of a moving object (the truck of speed $u = 45.0$ m/s) of waves emitted by a stationary object (the motion detector), and the subsequent emission of those waves by the moving object (the truck) which are picked up by the stationary detector. This could be figured in two steps, but is more compactly computed in one step as shown here:

$$f_{\text{final}} = f_{\text{initial}} \left(\frac{v+u}{v-u} \right) = (0.150\,\text{MHz}) \left(\frac{343\,\text{m/s} + 45\,\text{m/s}}{343\,\text{m/s} - 45\,\text{m/s}} \right) = 0.195 \text{ MHz} .$$