17. 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.

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

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

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 0 to 28.

(a) The lowest frequency that gives minimum signal is (n = 0) $f_{\min,1} = 343$ Hz.

(b) The second lowest frequency is (n = 1) $f_{\min,2} = [2(1)+1]343\text{ Hz} = 1029\text{ Hz} = 3f_{\min,1}$. Thus, the factor is 3.

(c) The third lowest frequency is (n=2) $f_{\min,3} = [2(2)+1]343\text{ Hz} = 1715\text{ Hz} = 5f_{\min,1}$. Thus, the factor is 5.

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

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

Since 20,000/686 = 29.2, n must be in the range from 1 to 29 for the frequency to be audible.

(d) The lowest frequency that gives maximum signal is (n =1) $f_{\max,1} = 686$ Hz.

(e) The second lowest frequency is (n = 2) $f_{\max,2} = 2(686\text{ Hz}) = 1372\text{ Hz} = 2f_{\max,1}$. Thus, the factor is 2.

(f) The third lowest frequency is (n = 3) $f_{\max,3} = 3(686\text{ Hz}) = 2058\text{ Hz} = 3f_{\max,1}$. Thus, the factor is 3.