Problems

1. Since the speed of light is much, much greater than the speed of sound
    we can ignore the time it takes the light to reach our eyes.

    $$s = \frac{d}{t}$$

    $$d = s \bullet t = \left(343\frac{m}{s}\right)(16.2s) = 5560m = 5.56km$$

7. Using 343 m/s from problem #1:

    $$t_{air} = \frac{d}{v_{air}}$$

    $$t_{water} = \frac{d}{v_{water}}$$

    $$t_{air} = t_{water} + 4.50s$$

    $$\frac{d}{v_{air}} = \frac{d}{v_{water}} + 4.50s$$

    $$\frac{d}{v_{air}} - \frac{d}{v_{water}} = 4.50s$$

    $$\frac{d}{v_{air}}\left(\frac{v_{water}}{v_{water}}\right) - \frac{d}{v_{water}}\left(\frac{v_{air}}{v_{air}}\right) = 4.50s$$

    $$\frac{d\left(v_{water} - v_{air}\right)}{v_{water}v_{air}} = 4.50s$$

$$d = 4.50s\frac{v_{water}v_{air}}{\left(v_{water} - v_{air}\right)} = 4.50s\frac{\left(1530\frac{m}{s}\right)\left(343\frac{m}{s}\right)}{\left(1530\frac{m}{s} - 343\frac{m}{s}\right)}$$

$$d = 1990m = 1.99km$$

45.

$$L = \frac{1}{4}\lambda$$

$$\lambda = 4L = 4(2.8cm) = 11.2cm = 0.112m$$

$$f = \frac{v}{\lambda} = \frac{340\frac{m}{s}}{0.112m} = 3000Hz = 3kHz$$

47. a.

$$\lambda = \frac{v}{f}$$

$$L = \frac{1}{2}\lambda$$

$$\lambda = 2L$$

$$\frac{v}{f} = 2L$$

$$L = \frac{v}{2f} = \frac{331\frac{m}{s}}{2(300Hz)} = 0.552m$$

b.

$$v = \left(331\frac{m}{s}\right)\sqrt{\frac{T}{273K}} = \left(331\frac{m}{s}\right)\sqrt{\frac{303K}{273K}} = 349\frac{m}{s}$$

$$\frac{v}{f} = 2L$$

$$f = \frac{v}{2L} = \frac{349\frac{m}{s}}{2(0.552m)} = 316Hz$$