1. (b).
2. (a).
3. (a).
4. (d).
5. Some insects produce sounds with frequencies that are $\boxed{\text{not all in our audible range}}$.
6. Sound is a traveling disturbance like any other wave. $\boxed{\text{Warmer air molecules vibrate faster}}$, so they can pass the disturbance along faster.
7. They arrive at the $\boxed{\text{same time}}$, because sound is not dispersive, i.e., speed does not depend on frequency.
8. At the same temperature and pressure, water vapor has a smaller density than air. The speed of sound is inversely proportional to the square root of the density of the medium. Generally, the less dense air (O_2 and N_2 molecules replaced by H_2O molecules), the faster sound travels.

   So the $\boxed{\text{speed increases with increasing humidity}}$.
9. (a) Neglect the time taken by the lightning since light travels at a much faster speed.

   $d \approx (1/3\ \text{km/s})(3.0\ \text{s}) = \boxed{1.0\ \text{km}}$.

   (b) $d \approx (1/5\ \text{mi/s})(3.0\ \text{s}) = \boxed{0.60\ \text{mi}}$.

$\boxed{10}$. (a) $v = (331 + 0.6T_C)\ \text{m/s} = [331 + 0.6(10)]\ \text{m/s} = \boxed{337\ \text{m/s}}$.

   (b) $v = [331 + 0.6(20)]\ \text{m/s} = \boxed{343\ \text{m/s}}$.

$\boxed{16}$. $f = \dfrac{v}{\lambda} = \dfrac{1500\ \text{m/s}}{3.0 \times 10^{-4}\ \text{m}} = \boxed{5.0 \times 10^{6}\ \text{Hz}}$, where v = 1500 m/s is the speed of sound in water.

17. (a) The smallest detectable object is in the order of the wavelength.

   $\lambda = \dfrac{v}{f} = \dfrac{1500\ \text{m/s}}{20 \times 10^{6}\ \text{Hz}} = \boxed{7.5 \times 10^{-5}\ \text{m}}$.

   (b) Depth = $200(7.5 \times 10^{-5}\ \text{m}) = \boxed{1.5 \times 10^{-2}\ \text{m}}$.

21. The sound travels twice through the distance (to and from).

   $d = \dfrac{vt}{2} = \dfrac{(1500\ \text{m/s})(0.12\ \text{s})}{2} = \boxed{90\ \text{m}}$.

28. (c).
29. (b).
30. (d).
32. They are used $\boxed{\text{to compress a large range into a smaller numerical scale}}$. For example, the range from $10^{-12}\ \text{W/m}^2$ to $1\ \text{W/m}^2$ is 12 orders of magnitude (a big range). After converting them to the decibel scale, it is from 0 to 120, a compressed scale.
33. $\boxed{\text{Yes}}$. Since $\beta = 10 \log \dfrac{I}{I_o}$ and $\log x < 0$ for $x < 1$, if $I < I_o$.

So for $\boxed{\text{an intensity below the intensity of threshold of hearing}}$, β is negative.

47. $\beta = 10 \log \dfrac{I}{I_o}$, ☞ $\dfrac{I}{I_o} = 10^{\beta/10}$ so $I = 10^{\beta/10} I_o$.

For each individual, the sound intensity is $I = 10^{8.0}(10^{-12}\ \text{W/m}^2) = 1.00 \times 10^{-4}\ \text{W/m}^2$.

The total intensity is $I = 10^{8.7}(10^{-12}\ \text{W/m}^2) = 5.01 \times 10^{-4}\ \text{W/m}^2$.

Therefore the number of people rooting for you is $\dfrac{5.01 \times 10^{-4}\ \text{W/m}^2}{1.00 \times 10^{-4}\ \text{W/m}^2} = 5 = \boxed{\text{five}}$.

51. $\dfrac{I_B}{I_A} = \dfrac{R_A^2}{R_B^2} = \dfrac{(150\ \text{m})^2}{(200\ \text{m})^2} = 0.563$. So $\boxed{I_B = 0.563 I_A}$;

$\dfrac{I_C}{I_A} = \dfrac{R_A^2}{R_C^2} = \dfrac{(150\ \text{m})^2}{(300\ \text{m})^2} = 0.250$. So $\boxed{I_C = 0.250 I_A}$;

$\dfrac{I_D}{I_A} = \dfrac{R_A^2}{R_D^2} = \dfrac{(150\ \text{m})^2}{(200\ \text{m})^2 + (300\ \text{m})^2} = 0.173$. So $\boxed{I_D = 0.173 I_A}$.

56. (c).

57. (a).

58. (b).

63. At the first destructive point, $\Delta L = \tfrac{1}{2}\lambda = \tfrac{1}{2}\dfrac{v}{f} = \dfrac{343\ \text{m/s}}{2(1000\ \text{Hz})} = \boxed{0.172\ \text{m}}$.

64. The beat frequency is $f_b = |f_2 - f_1| = 440\ \text{Hz} - 436\ \text{Hz} = \boxed{4\ \text{Hz}}$.

68. $v = (331 + 0.6T_C)$ m/s = [331 + 0.6(25)] m/s = 346 m/s, v_s = 90 km/h = 25 m/s. Source is in motion.

(a) $f_o = \dfrac{v}{v - v_s} f_s = \dfrac{346\ \text{m/s}}{346\ \text{m/s} - 25\ \text{m/s}}(400\ \text{Hz}) = \boxed{431\ \text{Hz}}$.

(b) $f_o = \dfrac{v}{v + v_s} f_s = \dfrac{346\ \text{m/s}}{346\ \text{m/s} + 25\ \text{m/s}}(400\ \text{Hz}) = \boxed{373\ \text{Hz}}$.

79. (a) $v = (331 + 0.6 \times 20.0)$ m/s = 343 m/s. This is a case of the source moving.

$f_o = \dfrac{v}{v - v_s} f_s = \dfrac{343\ \text{m/s}}{343\ \text{m/s} - 12.0\ \text{m/s}}(35.0\ \text{kHz}) = \boxed{36.3\ \text{kHz}}$.

(b) Upon reflection, the insect acts as a source of sound with a frequency of 36.3 kHz, so this is a case of the observer moving. $f_o = \dfrac{v + v_o}{v} f_s = \dfrac{343\ \text{m/s} + 12.0\ \text{m/s}}{343\ \text{m/s}}(36.3\ \text{kHz}) = \boxed{37.6\ \text{kHz}}$

(c) $\boxed{\text{Yes}}$, if both objects are moving, then Eq. 14.14a applies.

81. (b).

82. (b).

83. (d).

84. (a).

85. (a) The snow absorbs sound so there is little reflection.

(b) In an empty room, there is less absorption. So the reflections die out more slowly; and therefore, the sound seems hollow and echoing.

(c) Sound is reflected by the shower walls, and standing waves are set up, giving rise to more harmonics and therefore richer sound quality.

96. For a closed pipe in the fundamental mode, $\lambda = 4L = 4(1.1.0\text{ m}) = 4.40\text{ m}$. $v = \lambda f = (4.40\text{ m})(60\text{ Hz}) =$ $\boxed{264\text{ m/s}}$.