Sound Ideas

1. For normal environmental temperatures, the speed of sound in dry air can be described by the following equation $v = (331 + 0.6T_C)\ m\ s^{-1}$ where T_C is the temperature in degrees Celsius. A wider-range equation is $v = (331\sqrt{1 + \frac{T_c}{273}})\ m\ s^{-1}$.
    a. Calculate the percent difference between the approximations at:
        i. Room temperature (20 °C).
        ii. Boiling point of water (100 °C)
    b. Explain why the humidity of the air would impact the speed of sound.

2. Imagine you are in a swimming pool, 10 meters from the wall. You place one ear in the water and the other out of the water. Your friend bangs on the wall of the pool. Assume the speed of sound through air in the pool is 340 m s^{-1} and the speed of sound through the water is 1500 m s^{-1}. Calculate the time delay between the two signals you hear.

3. Explain why the speed of sound through solids is generally greater than the speed of sound through liquids which is generally greater than the speed of sound through gases.

4. In order to calculate how far a storm is from their location, many people count the time between the moment they see a lightning flash and the moment they hear the associated thunder. Devise a rule that would allow a person to approximate the distance in miles knowing the time in seconds.

5. A sound wave has a wavelength of 5.0 meters when produced in 20 °C air.
    a. Calculate the frequency of the sound wave.
    b. Would a human with a “typical” hearing range hear this sound? If so, would this be considered a relatively high pitch or low pitch?

6. An open pipe in an organ produces a 440 Hz first harmonic at 20 ℃. Unfortunately the heat goes out and the building cools to 10 °C.
    a. Calculate the change in the frequency due to the change in air conditions.
    b. Describe other factors that would change the sound produced by the organ.

7. The first three natural frequencies of an organ pipe are 126 Hz, 378 Hz and 630 Hz.
    a. Is the pipe an open or closed pipe?
    b. Assuming the speed of sound to be 340 m s^{-1}, calculate the length of the pipe.

8. Sketch a diagram that explains why the intensity of a sound produced by a point source decreases as a r^{-2} relationship.

9. You lost your phone, so you have a friend call it and listen for the ring. You find that when you move 1.0 meters towards the sound, the intensity increases by a factor of 9. Calculate the location of the phone relative to the original position.

10. There is such a great range of possible intensities of sound, the sound level is scaled to a log-based value. The decibel scale is $dB = 10log\left(\frac{I}{I_0}\right)$ where $I_0=10^{-12}\ W\ m^{-2}$, the threshold of human hearing.
    a. A sound level is measured to be 70 dB when standing a given distance from the source. Calculate the sound level that would be measured if the distance to the source is doubled.
    b. When standing close to a source, the sound level is at the threshold of pain, 130 dB. Calculate by what factor the distance would have to increase in order to reduce the sound level to the conversational 60 dB.