Problem 1: The speed ($v$) of sound through air is dependent upon the temperature of the air and follows the equation $v = 331 \text{ m/s} + 0.6 \text{ m/s/°C} \times T$ where $T$ is the Celsius temperature of the air. Determine the speed of sound ...

- a. On a cold day when the outdoor temperature is 4°C.
- b. Indoors where the temperature is 24°C.
- c. On a warm summer day when the outdoor temperature is 38°C.

Problem 2: You are playing a clarinet in the pep band on a cold November day at a UR football game. The band tunes up indoors where it is a warm 24°C and then you go out into the cold 4°C Rochester afternoon. Does the pitch of the clarinet go up or down when you go outside? By how many cents does the pitch change?

Problem 3: Herds of African elephants are generally spread over large areas. Infrasonic sound waves (sound waves below the human range of frequency detection) are used by these elephants to locate each other and to communicate. Sound waves with low frequencies have a greater ability to bend around obstacles and generally carry further. Scientists have detected sound waves with frequencies as low as 13 Hz being produced by elephants. Assuming a speed of sound of 343 m/s, determine the wavelength of these sounds waves.

Problem 4: Indoor pests such as mice and other rodents are sensitive to ultrasonic sound waves (sound waves above the human range of frequency detection). Some companies have produced (allegedly) rodent repellant devices that emit ultrasonic waves with frequencies of approximately 45 kHz. Assuming a speed of sound of 344 m/s, determine the wavelength of these sounds waves.

Problem 5: You are out hiking in the mountains and you notice that the sounds you make are reflected off a nearby rocky cliff as an echo 1.80 seconds later. Determine the distance to the rocky cliffs. Assume a speed of sound of 343 m/s.

Problem 6: The intensity of sound waves decreases as the distance from the source of sound increases. The relationship between intensity ($I$) and distance ($d$) is an inverse square relationship which follows the equation $I = P/(4\pi R^2)$ where $P$ is the power of the sound source, usually expressed in Watts. You recently purchased a stereo system for your dorm room. Determine the maximum intensity of the sound waves at the following distances from his 120-Watt main speaker assuming that the electrical to acoustic power conversion efficiency is 1%. Also, ignore reflections off the walls.

- a. 1.0 meter
- b. 2.0 meter
- c. 3.0 meter
**Problem 7:** Determine the decibel rating of the following sound sources and their estimated sound intensities.

a. Library: $I = 1 \times 10^{-9} \text{ W/m}^2$

b. Classroom before class: $I = 1 \times 10^{-6} \text{ W/m}^2$

c. Wilson Commons: $I = 1 \times 10^{-4} \text{ W/m}^2$

d. Spurrier gym during a Yellowjackets basketball game: $I = 8.1 \times 10^{-3} \text{ W/m}^2$

e. Rolling Stone’s concert - front row: $I = 7.4 \times 10^{-2} \text{ W/m}^2$

**Problem 8:** For the following decibel levels, determine the corresponding sound intensity levels in $\text{W/m}^2$.

a. 50 dBel

b. 90 dBel

c. 110 dBel

**Problem 9:** By some accounts, the record for the loudest rock band is 125 dB set at the House of Guitars in 1988, measured 75 feet from the stage. Determine the intensity in $\text{W/m}^2$ corresponding to this sound pressure level.

**Problem 10:** You recently moved into a home four blocks from a busy expressway. On a typical evening, the decibel level resulting from expressway traffic is 62 dB at the location of your house. Determine the decibel level on the same evening at a house 1 block from the expressway (four times closer).