

Homework Assignment #1 – due via Moodle at 11:59 pm on Thursday, Feb. 12, 2026***Instructions, notes, and hints:***

Provide the details of all solutions, including important intermediate steps. You will not receive credit if you do not show your work. You may make reasonable assumptions and approximations to compensate for missing information, if any.

The first set of problems will be graded and the rest will not be graded. Only the graded problems must be submitted by the deadline above. Do not submit the ungraded problems.

Graded Problems:

1. The minimum and maximum temperatures ever recorded on earth are approximately $-89\text{ }^{\circ}\text{C}$ and $58\text{ }^{\circ}\text{C}$, respectively. Find the corresponding speed of sound in air for each case.
2. Suppose that you observe a lightning strike during a thunderstorm. You happen to have a stopwatch with you (who wouldn't?) and discover that the thunder associated with the lightning arrives 3.5 seconds later. Assuming that the air temperature is $29\text{ }^{\circ}\text{C}$ and the relative humidity is 90%, determine how far the lightning was from your location.
3. Suppose that a certain sound pressure wave can be represented by the expression below, which gives the change in air pressure relative to the average value. The text in square brackets is the pascal unit. The sound wave is a longitudinal wave that moves along the x -axis. The variable t is time.
 - a. Determine whether the wave is a traveling or standing wave, and briefly explain your answer.
 - b. Find the wavelength λ of the wave in meters.
 - c. Find the frequency f of the wave in hertz.
 - d. Determine the speed v of the wave in meters per second. (Don't just assume 340 m/s. It could be different in this case.)
 - e. Determine the maximum change in air pressure from the average value over one complete cycle of the wave, and briefly explain your answer.

$$p(x, t) = 0.0013 \cos(9.82x - 3142t) \text{ [Pa]}$$

Hint: The wave progresses through one complete cycle (2π radians) in space over one wavelength and one complete cycle in time over one period.

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4. The extreme range of frequencies of the musical notes played in an orchestra spans roughly 50 Hz to 15 kHz. Find the corresponding range of wavelengths in air at room temperature (21 °C or 70 °F).
5. Suppose that a culvert (drain pipe) under a narrow road is 4.0 m long and has a diameter of 60 cm. Find the lowest resonant frequency of the culvert for the case when the air temperature is 21 °C (about 70 °F). Also find the lowest resonant frequency on a day when the air temperature is 0 °C (at the freezing point). Don't forget to account for end correction.

Ungraded Problems:

The following problems will not be graded, but you should attempt to solve them on your own and then check the solutions. Do not give up too quickly if you struggle with one or more of them. Move on to a different problem and then come back to the difficult one after a few hours.

1. To the nearest tenth, find the number of octaves spanned by the most extreme range of human hearing (20–20,000 Hz). Recall that an octave is a 2:1 range of frequencies.
2. The human outer ear canal is roughly 2.5 cm long, 0.7 cm in diameter, and capped at one end by the eardrum. Assuming that the canal can be approximated as a cylindrical pipe, find its lowest resonant frequency at room temperature (21 °C). Speculate on how your answer might relate to Figure 5.1 of the textbook (Rossing, et al., 3rd ed.).