1. (25 points) A snapshot of a wave on a string at time \( t = 0 \) is shown below. The wave is traveling to the right with velocity \( v \). The tension in the string is 4.00 N and the mass density is \( \mu = 0.0030 \text{ kg/m} \).

Find the following values (and units):

(a) amplitude = ___________________
(b) wavelength = ___________________

(c) angular frequency = ________________
(d) initial phase = ________________

(e) Determine the speed of the wave.

(f) Write an equation for the wave, substituting all appropriate quantities from above.

(g) Calculate the transverse velocity of the string at the point \( x = 0.4 \text{ m} \) at time \( t = 0.6 \text{ s} \).

The tension in the string is decreased by a factor of 4; nothing else is changed. What happens to

(h) the wave speed

(i) the wavelength

(j) the angular frequency of the traveling wave

Note: Your answers should be like: “doubles,” “is half as big,” “4 times larger,” …
3. I have two traveling waves in a medium. One of them is given below.

\[ y_1 = (7.00 \text{ mm}) \sin [(4.0 \text{ rad/m}) x + (5 \text{ rad/s}) t] \]

Write the function for a wave that
(a) Will produce standing waves when combined with the first wave.

(b) Will produce total destructive interference with the first wave.

(c) Will also produce total destructive interference with the first wave, but that is NOT the same as your answer to (b).

(d) Produces beats when added to the first wave.

4. A sound of intensity, I, is measured to have a sound intensity level of 60 dB when you are standing 250 m from the speaker. Assume that the speaker radiates isotropically (equally in all directions).

(a1) Calculate the ratio of the intensity of the sound at 250 m to the intensity of the sound at 10 m.

(a2) Is the sound **louder** or **quieter** at 10 m? (Circle one.)

(b) Calculate the new sound level in decibels at 10 m.
5. Two identical sound sources (with the same wavelength $\lambda$, frequency $= 3430$ Hz, and initial phase) are separated by a distance $d = 0.269$ m. Point P is 1.00 m from $S_1$.
(a) Will the listener at point P hear (Circle one.)
- totally constructive,
- totally destructive,
- or some intermediate type of interference?
(b) The separation of the two speakers is now increased by moving speaker 2 down, farther from speaker 1. Calculate the first value of the new distance $d'$ that will lead to complete constructive interference at point P.

6. (6 pts) A police car (with siren frequency 500 Hz) is traveling east at 35.0 m/s on his way to the scene of an accident. At the same time, an ambulance is heading west towards the same accident at 25.0 m/s.

Write an equation (with all numbers substituted) for the frequency that the ambulance driver hears for the police siren. Don’t calculate.

7. (15 pts) An organ pipe, open at both ends, has length $L = 1.44$ m.
(a) Draw a sketch on the first axis below showing the displacement wave of the fundamental frequency, then draw one showing the second allowed wave, and repeat showing the third allowed wave.
(b) On your second diagram, indicate the positions of the nodes by labeling them with the letter N and the positions of the antinodes using the letter A.
(c) What is the speed of the fundamental wave?
(d) What is the wavelength of the fundamental wave?
(e) What is the frequency of the fundamental wave?
8. Figure 33-59 depicts a simplistic optical fiber: a plastic core \((n_1 = 1.63)\) is surrounded by a plastic sheath \((n_2 = 1.59)\). A light ray is incident on one end of the fiber at angle \(\theta\). The ray is to undergo total internal reflection at point \(A\), where it encounters the core-sheath boundary. (Thus there is no loss of light through that boundary.) What is the maximum value of \(\theta\) that allows total internal reflection at \(A\)?

9. (a) Number the following in order from most energetic photons (=1) to least energetic photons (=8).

- _____ blue (visible) light
- _____ gamma rays
- _____ infrared
- _____ microwaves
- _____ radio/TV
- _____ red (visible) light
- _____ ultraviolet
- _____ x-rays

(b) Which of these photons has the largest speed?