Problem I.1: A traveling wave is described by

\[ y(x,t) = 0.5 \sin (10\pi x - 50\pi t) \]

where the amplitude is in meters, the angular wave number \( k \) in rad/m, and the angular frequency \( \omega \) in rad/s.

(a) (5 pts) What is the wavelength of the wave?

(b) (5 pts) What is the velocity of propagation of the wave?

Problem I.2 (10 pts): A source S generates circular waves on the surface of a lake; the pattern of wave crests is shown in the figure. The speed of the waves is 5.5 m/s, and the crest-to-crest separation is 2.3 m. You are in a small boat heading directly toward S at a constant speed of 3.3 m/s with respect to the shore. What frequency of waves do you observe?
Problem II.1 (25 pts): There are two organ pipes of length $L_1$ and $L_2$. The pipe of length $L_1$ is open on both ends, and pipe of length $L_2$ has one end open and one end closed. If the speed of sound is 343 m/s,

(a) What are the two lowest resonant frequencies for the pipe of length $L_1$? Draw the pipe and sketch the standing waves.

(b) What are the two lowest resonant frequencies for the pipe of length $L_2$? Draw the pipe and sketch the standing waves.
Problem II.2 (25 pts): A 3.0 kg mass attached to a spring of force constant \( k \) is in simple harmonic motion in one dimension and moves according to the equation:

\[
x = (5.0 m) \cos \left[ \left( \frac{\pi}{3} \text{ rad} / s \right) t - \left( \frac{\pi}{4} \text{ rad} \right) \right]
\]

(a) What is the total energy of the system?

(b) What is the force constant of the spring?

(c) How long does it take for the system to move from \( x = 5.0 \text{ m} \) to \( x = 0.0 \text{ m} \)?
Problem II.3 (25 pts): The amplitudes of two sinusoidal waves traveling in the same direction along a stretched string are 4.0 and 7.0 mm; their phase constants are 30° and 80°, respectively. The waves have the same wavelength.

(a) What is the amplitude of the resulting wave?

(b) What is the phase constant of the resulting wave?

(c) Is the resulting wave a standing or traveling wave?