Section 3: Waves

1. Wave Properties

A sound wave in air has a frequency of 440 Hz. If the speed of sound in air is 343 m/s, what is its wavelength? What is its wavelength in water, where the speed of sound is 1482 m/s?

2. String Harmonics

A guitar string is 64 cm long and has a fundamental frequency (one antinode) of 330 Hz. What is the speed of the wave on this string?

3. Superposition Principle

Two waves are described by the equations $y_1(x,t) = A\sin(kx - \omega t)$ and $y_2(x,t) = A\sin(kx + \omega t)$. What is the equation of the resulting standing wave? Identify the positions of the nodes.

4. Echo Ranging

A person shouts towards a cliff and hears the echo 4.0 seconds later. How far away is the cliff? (Speed of sound in air is 343 m/s).

5. Doppler Effect

A galaxy is receding from Earth at a speed of 5×10^6 m/s. It emits light with a wavelength of 486 nm (blue-green). What wavelength will be observed on Earth?

6. Wave Equation

A wave is described by the equation $y(x,t) = 0.05\sin(2\pi x - 50\pi t)$, where x and y are in meters and t is in seconds. Determine the wave's:

a) Amplitude

b) Wavelength

c) Frequency

d) Speed

7. Phase Difference

What is the phase difference in radians between two points on a wave that are separated by a distance of $\lambda/3$?

8. Standing Wave Modes

A standing wave with four antinodes is produced on a string of length L = 80 cm. What is the wavelength of this wave?

9. Waves

Which of the following functions can describe a traveling wave? (Hint: check if it satisfies the wave equation $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}$)

a) $y(x,t) = A\cos(kx^2 - \omega t)$

b) $y(x,t) = A(x - vt)^2$

c) $y(x,t) = A\log(x + vt)$

10. Resonance

Determine the frequency of a standing wave with two antinodes on a guitar string, given the wave velocity is 1500 m/s and the string length is 1.0 m.