Assignment 2

Waves II

Chapter 16: Sound and Hearing

Important Concepts and Formulas:

$$p_{max} = BkA$$

For fluids and solids speed of sound is given by $\quad\quad\quad\quad v = \sqrt{\dfrac{B}{\rho}} = \sqrt{\dfrac{Y}{\rho}}$

Sound Intensity Level $\quad\quad\quad\quad\quad\quad\quad\quad\quad \beta = (10\text{dB})\log\dfrac{I}{I_0}$

Doppler Effect $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad f' = f\dfrac{v \pm v_D}{v \pm v_S}$

Question 1:

(a) In a sinusoidal sound wave of moderate loudness, the maximum pressure variations are about 3.0×10^{-2} Pa above and below atmospheric pressure. Find the corresponding maximum displacement if the frequency is 1000 Hz . In air at normal atmospheric pressure and density, the speed of sound is 344 m/s and the bulk modulus is 1.42×10^5 Pa.

(b) Which has a more direct influence on the loudness of a sound wave: the displacement amplitude or the pressure amplitude? Explain your reasoning and write mathematical equation in support to your answer.   (10 Points)

Question 2:

Sound waves in air with frequency 1000 Hz, a displacement amplitude of 1.2×10^{-8} m produces a pressure of 3.0×10^{-2} Pa

(a) What is the wavelength of these waves?

(b) For 1000-Hz waves in air, what displacement amplitude would be needed for the pressure amplitude to be at the pain threshold, which is 30 Pa?

(c) For what wavelength and frequency will waves with a displacement amplitude of 1.2×10^{-8} m produces a pressure amplitude of 1.5×10^{-3} Pa?

Question 3:

(a) An 80.0-m-long brass rod is struck at one end. A person at the other end hears two sounds as a result of two longitudinal waves, one traveling in the metal rod and the other traveling in the air. What is the time interval between the two sounds?

(b) For metal speed of sound is given by v = $\sqrt{\dfrac{Y}{\rho}}$, where Y is young Modulus and ρ is density of metal, which factor has more effect on speed of sound in metals, and why? Explain your answer with reason.

Question 4:

The intensity due to a number of independent sound sources is the sum of the individual intensities.

(a) When four quadruplets cry simultaneously, how many decibels greater is the sound intensity level than when a single one cries?

(b) To increase the sound intensity level again by the same number of decibels as in part (a), how many more crying babies are required?

Question 5:

Two train whistles, A and B, each have a frequency of 392 Hz. A is stationery and B is moving toward the right (away from A) at a speed of 35.0 m/s. A listener is between the two whistles and is moving toward the right with a speed of 15.0 m/s (Fig. E16.45). No wind is blowing.

   (a) What is the frequency from A as heard by the listener?
   (b) What is the frequency from B as heard by the listener?
   (c) What is the beat frequency detected by the listener?

Figure **E16.45**