Sample Test for Unit VIII

Potentially useful equations:

$$\omega = 2\pi f \qquad T = \tfrac{1}{f} \qquad v = f\lambda \qquad f = \tfrac{1}{2\pi}\sqrt{\tfrac{k}{m}} \qquad f = \tfrac{1}{2\pi}\sqrt{\tfrac{g}{L}}$$

$$f_o = \frac{1}{1 \pm \frac{v_{\text{source}}}{v_{\text{sound}}}} f_{\text{source}} \qquad v_s = (331 + 0.6T_C)\,\text{m/s} \qquad v = \sqrt{\tfrac{F_T}{\mu}}$$

$$(dB) = 10 \log\left(\tfrac{I}{I_o}\right) \quad (\mathrm{I_o} = 1 \times 10^{-12}\,\mathrm{W/m^2})$$

(Will *not* include the formulae for wavelengths of standing waves on strings or in pipes.)

1. a) Define period.

   b) Define frequency.

2. The body of an automobile has a mass of 750 kg. During factory assembly it was noted that the auto body compresses the suspension system 10 cm. Find the period of oscillation when the car hits a bump.

3. a) Draw (sketch) a Displacement vs. Time graph for an undamped oscillating system with an amplitude of 2.5 cm and a period of 0.5 s. The amplitude is 2.5 cm at $t = 0$.

   b) Draw a Displacement vs. space graph for an undamped oscillating system with an amplitude of 1.5 cm and a wavelength of 4.0 cm. The amplitude is 0 cm at $x = 0$.

4. A commonly used ultrasonic wave has a frequency of 1.5 MHz. What is its wavelength in water if its speed is 1498 m/s?

5. a) Define and give an example of a transverse wave.

   b) Define and give an example of a longitudinal wave.

6. a) Give the perceptual variable (i.e., subjective quantity) that corresponds to:

   frequency:

   intensity:

   harmonics:

   b) Give the frequency range for normal human hearing.

7. a) The sound intensity level near a loud radio is about 1.0×10^{-4} W/m^2. Calculate the intensity in decibels. b) What is the intensity corresponding to a 65 dB sound level?

8. An ambulance with its siren (1000 Hz) turned on is traveling at 20 m/s. Assuming the speed of sound in air is 330 m/s, find the apparent frequency for an observer if

   a) the ambulance is approaching, and

   b) the ambulance is moving away from the observer.

9. A guitar string is 0.75 m long. Find the wavelengths of the fundamental and the second, third, and fourth harmonics of vibration.

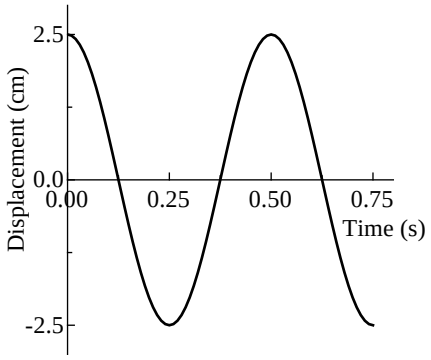
10. a) Define resonance.

    b) What are the first three harmonic frequencies for resonance of a 1.5 m pipe closed on one end? Assume the speed of sound in air to be 330 m/s.

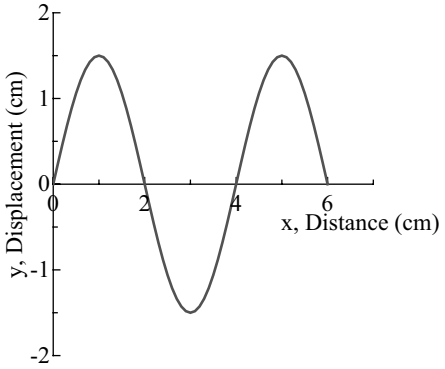
Short Answers:

1. (Look them up.)
2. $T = 0.63\,\text{s}$
3. See figures

a.)



b.)



4. From $v = f\lambda$, find that $\lambda = 1.0 \times 10^{-3}\,\text{m}$ or 1.0 mm.
5. (Look them up!)
6. a) frequency corresponds to *pitch*, intensity corresponds to *loundness*, and harmonics correspond to *timbre*

   b) The range of normal human hearing is 20 Hz to 20 kHz.

7. a) Sound level = $10\log\left(\frac{1\times10^{-4}\text{W/m}^2}{1\times10^{-12}\text{W/m}^2}\right)\,\text{dB} = 10\log(1\times10^{8})\,\text{dB} = 80\,\text{dB}$.
   b) For 65 dB, $I = 3.16 \times 10^{-6}\,\text{W/m}^2$
8. a) 1064 Hz; b) 943 Hz
9. $\lambda_1 = 2L = 1.5\,\text{m}$; $\lambda_2 = L = 0.75\,\text{m}$; $\lambda_3 = 2L/3 = 0.5$; $\lambda_4 = L/2 = 0.375\,\text{m}$.
10. a) Resonance is when a simple harmonic system is driven at its natural frequency, achieving maximum amplitude response.

    b) An open-closed pipe supports only odd-numbered harmonics, so the first three harmonics are 1, 3, and 5. From $f_m = m\frac{v}{4L}$ with $m = 1, 3, 5, ...$, and $f_m = mf_1$, $f_1 = 55\,\text{Hz}$, $f_3 = 165\,\text{Hz}$, $f_5 = 275\,\text{Hz}$