

Physics 1114: Unit 8 Homework

Problem set 1

1. Define and give units for period.
2. Define and give units for frequency.
3. What is the period of 60 Hz alternating electric current?
4. What is the frequency of the earth's rotation on its axis?
5. A 100 g object is suspended from a spring whose stiffness constant is 50 N/m. What is the period of oscillation?
6. An 80-kg portable generator is placed on a spring mount, compressing it by 2.0 cm. What is the natural frequency of vibration of this system? (First find the spring constant.)
7. Define each of these terms:
 - a) Undamped oscillation
 - b) Underdamped oscillation
 - c) Critically damped
 - d) Overdamped
8. What is the difference between a transverse and a longitudinal wave?
9. Draw two waves, one with twice the amplitude and half the wavelength of the other.

Problem set 2

1. A pendulum on the earth has a period of 1 s. How long is it? How long would it have to be on the moon? ($g_{\text{moon}} = 1.63 \text{ m/s}^2$)
2. State the (linear) Superposition principle.
3. When two waves that are in phase meet in time and space, the result will be _____ interference.
4. What is a standing wave?
5. How are standing waves produced?
6. The speed of sound in air is 334 m/s. A sound source with a frequency of 800 Hz moves at 50 m/s. Find the Doppler-shifted frequency for a stationary observer if the source approaches and if it is moving away.
7. Ultrasound is used diagnostically to image the interior of the body. If the speed of sound in the body is about $1.5 \times 10^3 \text{ m/s}$ and you want to resolve features that are 1.5 mm to 0.15 mm in size, what is the range of frequencies needed?

Problem set 3

1. What is the frequency of a red light whose wavelength is 6.8×10^{-7} m (680 nm)? (Speed of light in a vacuum: $c = 3.0 \times 10^8$ m/s.)
2. A tuning fork vibrating at 600 Hz in water produces sound waves 8.2 ft long. What is the speed of sound in water?
3. Give the frequency range of normal hearing for humans. How does this range change with increasing age?
4. A sound intensity of 1.0 W/m^2 will damage the ear. Find the sound intensity in dB (deci-Bel).
5. Heavy traffic produces a sound intensity of 0.003 W/m^2 . Find the sound intensity in dB.
6. How many times more intense is a 100 dB sound than a 60 dB sound? (Convert to W/m^2 and compare.)
7. Define resonance.
8. Draw sketches for the fundamental, 2nd and 3rd harmonics for strings and for pipes with one end closed and with both ends open. Indicate the relationship between λ (wavelength) and L (length of pipe or string) for each.
9. A certain organ pipe is 0.60 m long and has one closed end. Find the frequency of the third harmonic mode (i.e., the first overtone). Assume the speed of sound in air is 334 m/s.
10. A 2.0-meter organ pipe, open at both ends, is vibrating in the first overtone mode (second harmonic). What should be the length of a closed pipe so that its fundamental frequency will be the same? The speed of sound in air is 334 m/s.