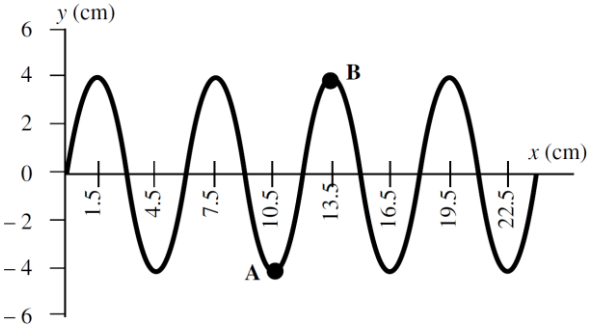
Physics Unit 10: Waves and Sound Review

1. Know meanings of reflect, interference, beats, constructive, destructive, frequency, superposition, wavelength, standing wave, fundamental frequency, harmonics (i.e. 1st harmonic, 2nd harmonic), overtones (i.e. 1st overtone, 2nd overtone), resonate.
2. Be able to classify waves by type (longitudinal, transverse, or both).
3. Know the value of the threshold of hearing.
4. Know how frequency and pitch are related.
5. Know how decibels and loudness are related.
6. Know what affects the speed of a wave ($v = f\lambda$ and how each variable is determined)
7. Know some drawings to represent standing waves in open and closed tubes.
8. How are standing waves produced?
9. How are beats produced?
10. What happens when two wave pulses traveling opposite directions meet?
11. Do waves: move energy? Move matter from place to place? Have a traveling disturbance?
12. What is the λ for a wave with a speed of 10 m/s and a period of 40 s?
13. A wave has a frequency of 30 Hz and a speed of 60 m/s. What is the wavelength of the wave?
14. In the following graph, what is the amplitude, wavelength and frequency of wave A is its speed is 5 cm/s?



15. A submarine sends out a sonar ping. The return echo is heard 20 s later. If the speed of sound is 1522 m/s, how far away is the reflecting surface?
16. A guitar string produces 10 beats/s when sounded with a 440 Hz tuning fork and 5 beats/s when sounded with a 445 Hz tuning fork. What is the vibrational frequency of the string?
17. The intensity of a spherical wave 5 m from the source is 200 W/m^2. What is the intensity at a point 10 m away from the source?
18. The decibel level of rock concert is 120 dB relative to the threshold of hearing. Determine the sound intensity produced by the concert.
19. A car moving at constant speed passes a boy playing a concert A (440 Hz) on an instrument. After the car has passed the driver hears the note as a concert E (330 Hz). How fast was the car going (speed of sound = 343 m/s)?
20. A car moving at 50 m/s approaches a train whistling. The train is moving towards the car at a speed of 10 m/s. The whistle is set at 200 Hz. What is the frequency heard by the driver of the car?
21. A 2-m long string vibrates in 4 segments. The wave speed is 40 m/s. What is the frequency of vibration?
22. A 2-m long string vibrates in 4 segments. The wave speed is 40 m/s. What is the lowest possible frequency for standing waves on this string?
23. Determine the shortest length of pipe, open at both ends, which will resonate at 440 Hz. The speed of sound is 343 m/s.

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Answers

3. $\mathbf{1 \times 10^{-12}\ W/m^2}$

11. a. **Yes** b. **No** c. **Yes**

12. $v = 10\frac{m}{s}, 40\ s$

$v = \frac{\lambda}{T}$

$10\frac{m}{s} = \frac{\lambda}{40\ s}$

$\lambda = 10\frac{m}{s}(40\ s) = \mathbf{400\ m}$

13. $f = 30\ Hz, v = 60\frac{m}{s}$

$v = f\lambda$

$60\frac{m}{s} = 30\ Hz\ \lambda$

$\lambda = \mathbf{2\ m}$

14. $A = \mathbf{4\ cm}, \boldsymbol{\lambda} = \mathbf{6\ cm}, \boldsymbol{f} = \mathbf{0.83\ Hz}$

$v = f\lambda = f \cdot 6\ cm = 5\frac{cm}{s}$

15. $t = 20\ s (t = 10\ s$ for one way$), v = 1522\frac{m}{s}$

$x = vt$

$x = 1522\frac{m}{s}(10\ s) = \mathbf{15220\ m}$

16. $|f_g - 440\ Hz| = 10\ Hz$

$f_g = \mathbf{450\ Hz}$ or $430\ Hz$

$|f_g - 445\ Hz| = 5\ Hz$

$f_g = \mathbf{450\ Hz}$ or $440\ Hz$

17. $5\ m, I = 200\frac{W}{m^2}$

$10\ m, I = ?$

$I = \frac{P}{A}, A = 4\pi r^2$

$200\frac{W}{m^2} = \frac{P}{4\pi(5\ m)^2} \rightarrow P = 62832\ W$

$I = \frac{62832\ W}{4\pi(10\ m)^2} = \mathbf{50\ W/m^2}$

18. $\beta = 120\ dB, I_0 = 10^{-12}\frac{W}{m^2}$

$\beta = (10\ dB)\ log\left(\frac{I}{I_0}\right)$

$120\ dB = (10dB)\ log\left(\frac{I}{10^{-12}\frac{W}{m^2}}\right)$

$12 = log\left(\frac{I}{10^{-12}\frac{W}{m^2}}\right)$

$10^{12} = \frac{I}{10^{-12}\frac{W}{m^2}}$

$\boldsymbol{I = 1.0\ W/m^2}$

19. $f_s = 440\ Hz, f_0 = 330\ Hz, v = 343\frac{m}{s}$

$f_0 = f_s\left(\frac{v_w \pm v_o}{v_w \mp v_s}\right)$

$330\ Hz = 440\ Hz\left(\frac{343\frac{m}{s} - v_o}{343\frac{m}{s} + 0}\right)$

$0.75 = \frac{343\frac{m}{s} - v_o}{343\frac{m}{s}}$

$257.25\frac{m}{s} = 343\frac{m}{s} - v_o$

$\boldsymbol{v_0 = 85.8\frac{m}{s}}$

20. $v_0 = 50\frac{m}{s}, v_s = 10\frac{m}{s}, f_s = 200\ Hz$

$f_0 = f_s\left(\frac{v_w \pm v_o}{v_w \mp v_s}\right)$

$f_0 = 200\ Hz\left(\frac{343\frac{m}{s} + 50\frac{m}{s}}{343\frac{m}{s} - 10\frac{m}{s}}\right) = \mathbf{236\ Hz}$

21. $L = 2\ m, n = 4, v = 40\frac{m}{s}, f = ?$

$f_n = n\left(\frac{v}{2L}\right)$

$f_4 = 4\left(\frac{40\frac{m}{s}}{2(2\ m)}\right) = \mathbf{40\ Hz}$

22. $L = 2\ m, n = 1, v = 40\frac{m}{s}$

$f_n = n\left(\frac{v}{2L}\right)$

$f_1 = 1\left(\frac{40\frac{m}{s}}{2(2\ m)}\right) = \mathbf{10\ Hz}$

23. $f_1 = 440\ Hz, n = 1, v = 343\frac{m}{s}$

$f = n\left(\frac{v}{2L}\right)$

$440\ Hz = 1\left(\frac{343\frac{m}{s}}{2L}\right)$

$440\ Hz = \frac{171.5\frac{m}{s}}{L}$

$L = \frac{171.5\frac{m}{s}}{440\ Hz} = \mathbf{0.390\ m}$