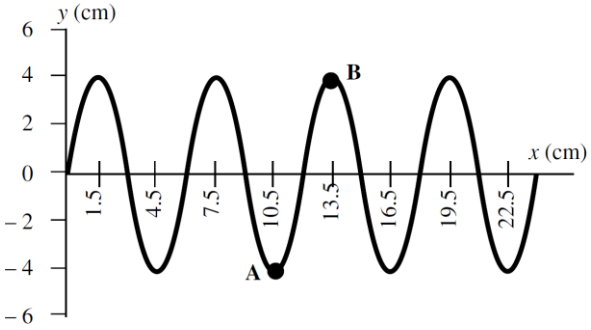
Physics

Unit 7: Waves and Sound

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 all the speed formulas)*
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. *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?*
17. *The decibel level of rock concert is 120 dB relative to the threshold of hearing. Determine the sound intensity produced by the concert.*
18. *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)?*
19. *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?*
20. *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 vibrational frequency of the string?*
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.*
24. *A spring is used on a jumping toy. The bottom of the toy has a suction cup that keeps the spring compressed. If the suction cup supplies 15 N of force to keep the spring compressed 3 cm, what is the spring constant?*
25. *The -string on a certain guitar is under 100 N of tension. If the frequency is 200 Hz and the wavelength is 2.0 m, find the linear density of the string.*

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

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

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

$10\ m, I = ?$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

24. $F = 15\ N, x = -0.03\ m$

$F = -kx$

$15\ N = -k(-0.03\ m)$

$\mathbf{500\ \frac{N}{m}} = k$

25. $F = 100\ N, f = 200\ Hzs, \lambda = 2.0\ m$

$v = f\lambda$

$v = (200\ Hz)(2.0\ m) = 400\frac{m}{s}$

$v = \sqrt{\frac{F}{m/L}}$

$400\frac{m}{s} = \sqrt{\frac{100\ N}{m/L}}$

$160000\frac{m^2}{s^2} = \frac{100\ N}{m/L}$

$m/L = \frac{100\ N}{160000\frac{m^2}{s^2}} = \mathbf{6.25 \times 10^{-4}\ kg/m}$