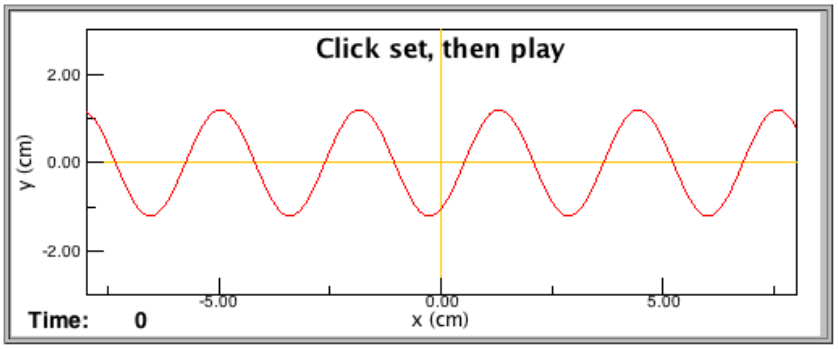
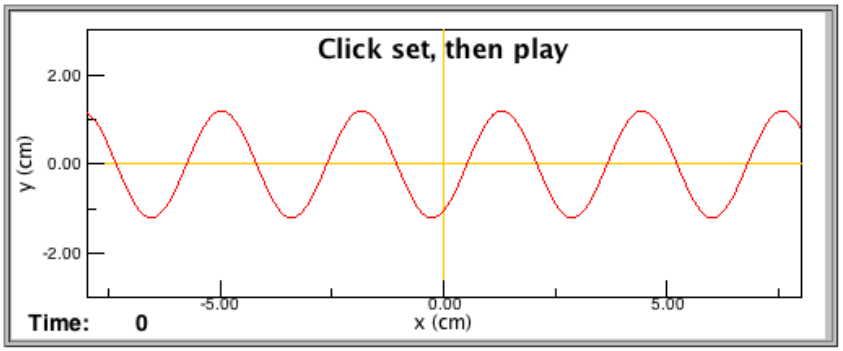
Questions on Wave Speed*.

$f = 1/T, v = f\lambda, v = \omega/k, \quad k = 2\pi/\lambda, \omega = 2\pi f, \quad y(x,t) = A\cos(kx - \omega t + \phi), \quad v = \sqrt{B/\varrho}$

1. Light travels at 3.0×10^8 m/s but sound waves travel at about 344 m/s. What is the time delay for light and sound to arrive from a source that is 10,000 m away?
2. What two mistakes are made in science fiction movies where you see and hear an explosion in space at the same time?
3. Consult the table for the speed of sound in various substances. If you have one ear in the water and one ear out while swimming in a pool and a bell is rung that is half way in the water, which ear hears the sound first?
4. At 20C the speed of sound is 344m/s. How far does sound travel in 1s? How far does sound travel in 60s?
5. Compare the last two answers with the distance traveled by light which has a speed of 3.0×10^8m/s. Why do you see something happen before you hear it?
6. The speed of sound in water is 1482m/s. How far does sound travel under water in 1s? How far does sound travel under water in 60s?
7. Using the equation for the speed of sound at different temperatures, what is the speed of sound on a hot day when the temperature is 30°C?
8. Using the speed of sound at 30°C from the last question, recalculate the distance traveled for the cases in question 14.
9. Suppose on a cold day the temperature is -10°C (14°F). You are playing in the marching band outside. How long does it take the sound from the band to reach the spectators if they are 100m away?
10. What would an orchestra sound like if different instruments produced sounds that traveled at different speeds?
11. The speed of a wave is fixed by the medium it travels in and so, for a given situation, is usually constant. What happens to the frequency of a wave if the wavelength is doubled?
12. What happens to the wavelength of a wave if the frequency is doubled and has the same speed?
13. Suppose a sound wave has a frequency 200 Hz. If the speed of sound is 343 m/s, what wavelength is this wave?
14. Find the wavelength of a 20Hz sound wave (about the lowest note humans can hear) and the wavelength of a 20,000 Hz sound wave (about the highest note humans can hear). Assume the speed of sound is 343 m/s.
15. What is the wavelength of a radio signal of 89.3 MHz, given than M = Mega = 10^6 and the speed of radio signals are the same as light (3.0×10^8 m/s)?
16. Alternating current in your house oscillates at 60 cycles per second. This gives off a radio signal (that can be detected by special antennas). What is the wavelength of this signal ($c = 3.0 \times 10^8$ m/s)?
17. The speed of sound in a fluid is given by $v = \sqrt{B/\varrho}$ where B is the Bulk Modulus (compressibility) and ϱ is the density. What happens to the speed if the density of the fluid increases?
18. What must be true about the compressibility, B, of water versus air, given that sound travels faster in water and water is denser than air?
19. The speed of sound in a fluid is given by $v = \sqrt{B/\varrho}$ where B is the Bulk Modulus (compressibility) and ϱ is the density. Can you think of a clever way to measure the Bulk Modulus of a fluid if you had an easy way to measure the speed of sound in a fluid? Explain.
20. The speed of sound on a string is given by $v = \sqrt{T/\mu}$ where T is the tension in Newtons and μ is the linear density (thickness) in kg/m. You also know that $v = f\lambda$. Give two ways of changing the frequency of vibration of a guitar string based on the knowledge of these two equations.
21. For the previous question, increasing the tension does what to the frequency? What does using a denser string do to the frequency?
22. The following graph is of a wave, frozen in time at t = 0. The equation describing the wave is $y(x,t) = A\cos(kx - \omega t + \phi)$. Sketch the effect of doubling the parameter A.



23. For the following graph of a wave, sketch the effect of doubling the wavelength.



24. The mathematical description of a sine wave is given by $y(x,t) = Acos(kx - \omega t + \phi)$. Explain what each of the terms (A, k, ω, ϕ) represent.

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* Many of these ideas came from *Conceptual Physics* 11th Ed. by Paul Hewitt (Addison Wesley, 2011).