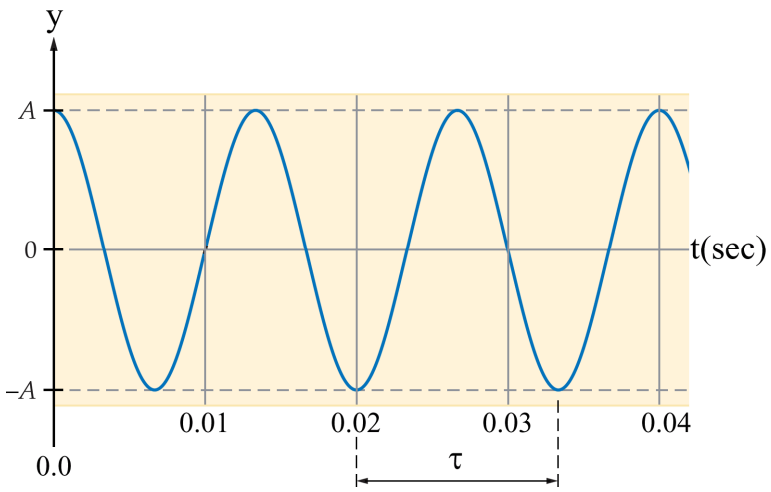
Sample Quiz Solutions

1) The graph at right is for a wave travelling down a stretched wire. During the time interval designated by τ, the wave moves 140 cm.



a) Let us assume that the function in the graph is given as $y = A \sin(\omega t + \delta)$. What are ω and δ?

b) What is the speed of the wave? What is its wavelength?

c) If the stretched wire was obtained from a large coil of wire that originally had a mass of 1.1 kg and a length of 500 m, how much tension is the stretched wire under?

Solution

The period of the wave can be read from the graph. The wave makes exactly three cycles in 0.04 s, so the period is 0.04 s / 3 = 0.0133 s. We have $\omega = 2\pi f = 2\pi/T = 6.2832 / 0.013333 \text{ s} = 471.2 \text{ rad/s}$. At $t = 0$, the amplitude of the sine function = 1. This means the argument must be $\pi/2$, so $\delta = \pi/2$.

The wave goes through one cycle during the time interval τ, so it travels one wavelength during that time. Thus $\lambda = 140 \text{ cm}$. The wave speed is $v = f\lambda = \lambda / T = 1.4 / 0.0133 = 105 \text{ m/s}$.

To find the tension in the wire, we use $v = (F/\mu)^{1/2}$, where $\mu = M/L$. We have $F = v^2\mu = v^2M/L = (105 \text{ m/s})^2(1.1 \text{ kg})/(500 \text{ m}) = 24.26 \text{ N}$.

2) Two sections of students are trying to out-cheer each other at a BCS bowl game. The first section has 500 students from ICC (Ivy Covered College); the second section has 1500 students from ESU (Enormous State University). A microphone left on the field by MGSN (Money Grabbing Sports Network) is 20 yards from the ICC students and 40 yards from the ESU students. It picks up a sound level of 70 dB when only the ICC students are cheering. If we assume that all students cheer with equal energy, what is the decibel level at the MGSN microphone when both the ICC and ESU students are cheering?

Possibly Useful Definition: $\text{dB} = 10 \log\left(\dfrac{\text{intensity}}{10^{-12} \text{ W/m}^2}\right)$

A sound level of 70 dB corresponds (inverting the above equation) to an energy intensity of $I = (10^{-12} \text{ W/m}^2)10^{(70/10)} = 10^{-5} \text{ W/m}^2$. This is the sound energy of the ICC students at a distance of 20 yards. If the ESU students are as loud on a per student basis, then they are emitting 1500 / 500 as much energy, or $3 \times 10^{-5} \text{ W/m}^2$ at 20 yards. However, they are twice as far from the microphone as the ICC students, so the energy reaching the microphone is $(3 \times 10^{-5} \text{ W/m}^2) / 4$. Thus, the total intensity at the MGSN microphone is $1.75 \times 10^{-5} \text{ W/m}^2$, which corresponds to $10 \log (1.75 \times 10^{-5} / 10^{-12}) = 72.4 \text{ dB}$