Model: Plane Waves

Act 8.1.3 Representing a 1-D Harmonic Wave Graphically (~90 min)

Learning Goals:

- Understanding that the displacement of the medium when a harmonic wave is present depends on two parameters: position and time
- Understanding that it takes two graphs, one as displacement of medium vs. time and one as displacement of medium vs. distance to completely represent a wave graphically
- Understanding that the graph of a harmonic wave as a function of either position or time is sinusoidal (i.e., corresponds to a sine or cosine function)
- Understanding that it takes a mathematical function of two variables (e.g., y and t) to represent a wave (i.e., a wave function)

Act 8.1.4 Waves and the Wave Equation (FNTs) (~50 min)

Learning Goals:

- Solidify ideas about wave parameters and graphing waves
- Understand that $y(x,t) - y_0 = A\sin\left(2\pi\frac{t}{T} \pm 2\pi\frac{x}{\lambda} + \phi\right) = A\sin\Phi(x,t)$ is the 1-D harmonic wave function and that when graphed as a function of either x or t, while holding the other variable constant, a sine wave results.
- Begin understanding the total phase $\Phi(x,t)$

Reading Assignment

- Read the first portion of the 7C Course Notes on Waves. (available online)

1) Review activities from this DLM. Finish any parts you did not complete during lab.

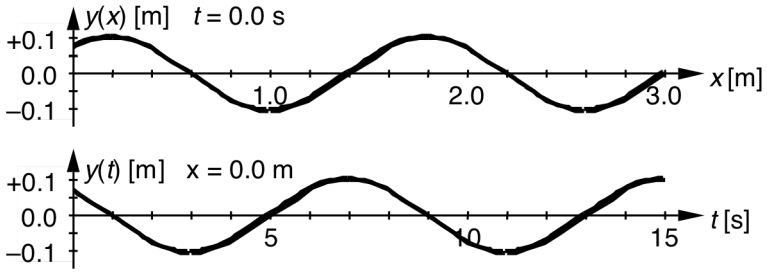
2) (Application) Go to the Physics 7C course webpage and load the "Transverse and Longitudinal Waves" applet. For both the transverse the longitudinal wave, describe the motion of the yellow dot and of the red dot. What does each one tell us about the wave? What does pausing the animation tell us about the wave?

3) (Solidification) A wave created by a certain source travels from medium 1 to another medium 2. You notice that its velocity is slower in medium 2 than in medium 1.
   (a) What happens to the frequency of the wave as it goes from medium 1 into medium 2? (Increases, Decreases, Stays the same, or Not Enough info)
   (b) What happens to the wavelength of the wave as it goes from medium 1 into medium 2? (Increases, Decreases, Stays the same, or Not Enough info)

4) (Application) Maximum wave amplitudes:
   (a) What is the biggest harmonic wave fluctuation in height that you can have in a 0.50 m deep swimming pool? Draw a picture showing what the largest wave would look like. Label the amplitude.
   (b) What is the biggest harmonic sound wave fluctuation in pressure that you can have in our atmosphere? How loud is this in Pascals? How loud is the loudest pulse sound wave?

5) (Solidification) An ocean wave traveling in one direction has a wavelength of 1.0 m and a frequency of 1.25 Hz. Take the direction of wave propagation to be the *positive* x direction.
   (a) What is the speed (in m/s) of this ocean wave?
   (b) Assuming that this wave is harmonic, and its amplitude is 2.0 m, what equation would describe its motion? Let the displacement at t = 0 s and x = 0 m be a *maximum*.
   (c) What will be the height of the wave 3.0 m from the origin at t = 10 s?

6) (Challenge) A $y(x)$ graph that depicts a one-dimensional water wave, as a function of position at the time t = 0.0 s; *and* a $y(t)$ graph that depicts the vertical displacement of a buoy at the origin x = 0.0 m, due to this one-dimensional water wave, as a function of time are shown.



   a) Explain how the $y(t)$ graph tells you whether this wave is moving to the right or to the left.
   b) Write the equation of motion $y(x,t)$ for this wave. Make sure you specify values for A, T, λ, and ϕ.

NOTE: Questions like that asked in FNT 6 will help you to better understand waves. You should approach it with the goal of learning. You will NOT be asked to determine the direction of travel from paired graphs on a quiz.