Phys 1140
Wave Applet Lab

A single-mode wave propagating to the right has form

$$y \;=\; A\sin(kx \,-\, \omega t \,+\, \phi)$$

where A is the amplitude and ϕ is the initial phase; these are the initial conditions. k is the wave number, and ω is the angular frequency. y is the value of the wave; for a wave propagating along a string, the x-direction is along the string, and y is the transerse (i.e., y) offset of the string.

This lab will use Dr. Knop's "Wave Play" applet, which may be found on the web at this address:

`http://www.sonic.net/~rknop/php/astronomy/applets/waveplay.php`

The applet shows a "wave medium"— think of it as a string. The left side of the string is $x = 0$, and it is five meters long (so that the right side is $x = 5$. The wave propagation speed is 1 m/s.

Run the applet, and play with it to get a sense of how it works. Then answer the following. Answer them on a separate piece of paper, and turn that in, not this page.

1. Reset the wave medium. Create a wave source at position 0 with frequency 1 Hz and amplitude 1. Start the wave. You'll see it come on to the screen from the left. Watch it as it starts. **What is the value of ϕ for this wave, if (as opposed to the time written in the upper right of the screen) you define $t = 0$ as the moment you start the wave?** (If you play with the interface, you can get it really to start at t=0.) Reset the medium and restart the wave several times if you need to see what it's doing.

2. Reset the wave medium. Create a single wave source at position 0 with frequency 1 Hz, direction to the right and amplitude 1 that starts at time t=0. This is just like the wave you created in the previous question. (You need to toggle *off* "Start When Added" for this to work. Your goal is to create a *second* wave source such that the two waves perfectly destructively interfere; that is, so that all you're left with is a straight line. When you have the two waves set up, press "start" for the wave medium in order to get the whole thing going, and to find out if you've got the right thing set up.

   You are allowed to play with any parameters (amplitude, frequency, direction, position, start time), but *you must keep both frequency and amplitude positive.*

   What are the parameters (frequency, amplitude, position, direction, and start time) for the second wave?

3. **For the second wave in the previous question, what was the value of the initial phase ϕ? What is the difference between the initial phases of the two waves?**

4. Your goal here is to create a standing wave– that is, a wave that doesn't appear to travel, but that goes up and down at each point in space. There will be some points that don't go up at down at all (these are called "nodes") and some points that go up and down maximally (these are called "antinodes"). You can make this out of two waves. Create the first wave at position 0, going to the right, with frequency 1, and amplitude 1. Figure out what the second wave you need is to have a standing wave. **What are the parmeters (frequency, amplitude, position, and direction) for the second wave?**

5. If you start the second wave in the previous question at different times, what does it change about the standing wave?

6. Create a starting wave at position 0, direction to the right, with frequency 0.5 and amplitude 1. **How does the period of this wave compare numerically with the period of the wave from the first question?**

7. Keep the wave from the previous question going. Create a second wave that is *four octaves up* (where one octave is a factor of two in frequency) on top of the first wave. **Sketch by hand what a plot of wave value vs. x looks like for a single pont in time once you have the two waves going.**

8. Keep the two waves from the previous question going. **Sketch by hand what a plot of wave value vs. t looks like for a single pont in time once you have the two waves going.** The program won't give you this directly! You'll have to figure out what it looks like....

9. Create two waves both at position 0, both to the right, and both with amplitude 1. The first wave should have frequency 4, the second wave frequency 4.2. **Describe what the resulting summed wave looks like. If this were a sound wave, describe what it would sound like.** (The name for this pheonomenon is "beats".)

10. If you want to have the "beat" phenomenon from the previous question have *faster* beats, do you need to make frequency of the *second* wave larger or smaller? Does this correspond to the frequency of the two waves being closer together, or farther apart? (You'll want to change the frequency of the second wave by numbers around 0.1; that is, you can go down to *just above* 4.0, or you can go up to 4.6 or so, but you won't want to change it much past that.)