Assignment 2; Phys 191 Name ________________

A *sinusoidal traveling wave* has the form

$$y(x,t) = A\cos(kx - \omega t - \delta)$$

Notice its similarity to the harmonic oscillator.

1. (20 points) This is a traveling wave, so it should equal $F(x - vt)$ for some F and v. What is the speed of this wave (in terms of A, k, ω, δ)?

2. (20 points) As in your last assignment, interpret the physical meaning of A, k, ω, and δ, and find relations between these variables and the period T and wavelength λ of the wave.

3. (60 points) Waves can travel in both directions along a string simultaneously. Suppose we have two sinusoidal traveling waves:

$$y(x,t) = A\cos(kx - \omega t) + B\cos(-kx - \omega t)$$

These waves have the same frequency but different directions and possibly different amplitudes.

Now suppose we clamp our string at two points: $x = 0$ and $x = L$. This means that $y = 0$ at those two points at *all* times t. Use that condition to eliminate variables: you should be able to find B in terms of A, and k in terms of L. You should note that there are multiple solutions for k—find the condition for allowed k values. A helpful trigonometric identity: $\cos(A + B) = \cos A \cos B - \sin A \sin B$.

You should find that only special values of k (and therefore ω) are allowed, but the amplitude is not restricted. These waves are called *standing waves* (because they have no overall translational motion) and the special frequencies are *resonant* or *harmonic* frequencies.