5.1.2: Speed of a Wave Simulation

The ***velocity*** of the wave, v, is a constant determined by the properties of the medium in which the wave is moving as we saw above. The velocity is a vector which gives the forward speed of the wave and the direction the wave is traveling. For now we will not worry about direction since the waves being discussed will all be assumed to travel along the x-axis. The speed of a sine wave is given by $v = \lambda/T$ where wavelength and period for a sine wave were defined in the previous exercise. Note that this is *NOT* the up and down speed of a point on the wave. Here we are talking about the forward speed of the wave crests.

In this simulation the original wave will remain in the window so that as you make changes to $f(x,t)$ you can see how the moving wave (in red) compares to the original stationary wave ($g(x,t)$, in blue).

This simulation is *misleading* in one important way. In the simulation you can set any combination of angular frequency and wavenumber you choose and so have any speed you want for the wave. But as we saw above, for mechanical and acoustic waves the speed is determined by the medium in which the wave travels. Since $v = \omega/k$ it is the case that the angular frequency and wavenumber are inversely proportional with a constant v.

Simulation Questions:

1. Determine the speed of the wave in the simulation using $v = \lambda/T$ where wavelength and period are determined from the simulation (wavelength is the peak to peak distance and period is the time for one peak to travel to the location of the next peak). What is the forward speed of this wave?
2. The speed of this wave is also given mathematically by $v = \omega/k$ since $\omega = 2\pi f = 2\pi/T$ and $k = 2\pi/\lambda$. What is the speed of this wave based on the values of ω and k in the equation? Does this match the speed you got from the simulation?
3. Reset the initial conditions and experiment with values of the wavenumber both smaller and larger than 2.0 rad/m keeping the angular frequency fixed. How does the wavenumber change the speed of the wave?
4. Reset the initial conditions and experiment with values of the angular frequency both smaller and larger than 0.8 rad/s keeping the wavenumber fixed. How does the angular frequency change the speed of the wave?
5. Reset the initial conditions. For a wavenumber of 4.0 rad/m experiment to find the correct angular frequency which gives the original speed of the wave you found in questions one and two (you should be able to see from the simulation when the new wave is traveling at the same speed as the original).
6. Calculate the wavenumber which gives the speed of the original wave for angular frequencies of 0.4, 0.6, 1.0,and 1.2 rad/s using the relationship in question two. Check your answers with the simulation if you are in doubt.

Chapter Six Summary

The speed of a wave is generally fixed by the properties of the physical material through which the wave is traveling, the exception being electromagnetic waves which require no medium (they can travel through a vacuum). In all cases of linear waves the wavelength and frequency are inversely proportional and given by $v = f\lambda = \omega/k$.