Ocean 420 Physical Processes in the Ocean
Project 6: Waves
Due: Thursday, February 15

To get started

a) Login
   Username: Ocean Class (click on the icon)
   Password: *ocwaves*
b) Start up MATLAB
c) At the MATLAB prompt, type: *cd c:\classes\ocean420* to change to the Ocean 420 directory
d) Type: *ocean420* to begin running program – you will see a small window pop up with Ocean 420 in the title bar, from here you can choose a demonstration.

1. Wave phase propagation (do not turn this question in)

From the Ocean 420 list of demonstrations, choose *Wave Phase Propagation*, then choose *Simple Sine Wave*. There are three parameters that you can vary, the amplitude, the frequency ω and the wavenumber k.

a. First, run the program with the initial parameters, and watch how the wave evolves in time. Next, double the amplitude of the wave. Does the wave propagate faster, slower, or at the same speed?
b. Now double the wavelength. How does the phase speed change? Explain.

2. Wave particle trajectory (do not turn this question in)

Under *Wave Particle Trajectory* again choose the simple sine wave case. In this demonstration, we are looking at surface gravity waves propagating in water 50 m deep. You can vary the wavelength and the amplitude.

a) Try a short wave example with moderate amplitude. What do the wave particle trajectories look like? Examine both the size of the particle excursions as well as their depth dependence.
b) Now try a long wave example. What do the particle trajectories look like? Examine both the size of the particle excursions as well as their depth dependence.
c) Examine the particle trajectories carefully. What is the sea surface height when the particles are at their highest position? At their lowest position? What is the sea surface height when the particles have the highest vertical velocity? At what point is their horizontal velocity highest? Make a sketch of horizontal particle velocity, vertical particle velocity and sea surface height as a function of time at a particle location.
d) Redo the simulation in (a) but this time, double the amplitude. What happens to the particle excursions?

3. **Capillary waves**
The phase speed for capillary waves is given by

$$C^2 = \frac{g}{k} + \frac{k}{\rho_0}\varsigma$$

Here ς is the surface tension and is $0.074\, kg/s^2$. You can read about capillary waves on pages 210 and 211 Knauss's book.

e) Derive a formula for the group velocity as a function of wave number for capillary waves.
f) Now calculate the phase and group velocities for waves with wavelength 25 cm and 1 mm.
g) What is the ratio of the group velocity to the phase velocity for the two wavelengths in (b)?

4. Quantifying wave properties
You are observing the sea level at two stakes by a peer. The data can be found on the web site in text format. Load it into Excel to answer the following questions about the wave that is seen in the observations. Time is the first column, the measurements at stake 1 in the 2nd, and stake 2 in the 3rd. The stakes are 2 meters apart.

a. What is the period of the wave?
b. What is the phase speed of the wave?
c. What is the wavelength of the wave?
d. What is the amplitude of the wave?
e. Does the wave satisfy the deep water wave dispersion relation?
f. If the wave is a shallow water wave, what must the depth of the water be by the peer?