CSCI 1200 Problem Set 2 (non-programming portion)
Due Friday, Feb. 28, 5 PM
Please hand in hard-copy either to Elizabeth White's office or mailbox.

Introduction. (Note: you'll need a reasonably good calculator for this problem!) In class, we looked at two simple algorithms for simulating a physical system: the "Euler method" and the "Euler-Cromer method". In this problem, you'll follow each method along (doing the calculations by hand) for a few steps to simulate a simple mass on a spring.

Suppose, then, we have a mass of 1 on a spring with force constant 1, as we saw in class. The spring is at rest when y = 0. So, for this system, the acceleration of the mass at any position y can be written simply as follows:

Acceleration = – y

Now let's start the mass at Y = -2, Velocity = 0 at Time = 0, and release it. Now that we've released the mass, we want to use our two alternative methods to see where the mass will be (and how fast it will be moving) at successive time steps.

A. The *Euler method* calculates the next position and velocity this way:

Position [at Time + Timestep]
= Position [at Time] + (Timestep * Velocity [at Time])

Velocity [at Time + Timestep]
= Velocity [at Time] + (Timestep * Acceleration [at Time])

Using the Euler method a timestep of 0.1, calculate the values of Y and Velocity for the mass for five successive timesteps (i.e., out to Time = 0.5).

B. The *Euler-Cromer* method is almost the same as the Euler method, but it calculates position and velocity this way (notice that we use the "ending" velocity for a timestep to calculate the next position):

Velocity [at Time + Timestep]
= Velocity [at Time] + (Timestep * Acceleration [at Time])

Position [at Time + Timestep]
= Position [at Time] + (Timestep * Velocity [at Time + Timestep])

Using the Euler-Cromer method and a timestep of 0.1, calculate the values of Y and Velocity for the mass for five successive timesteps (i.e., out to Time = 0.5).

C. The total energy (potential + kinetic) of our mass-and-spring system can be calculated by the following formula:

Energy = (0.5 * (Velocity * Velocity)) + (0.5 * (Position * Position))

The first part of the expression on the right side is the kinetic energy, and the second part is the potential energy.

For each the five calculated states in part A, compute the total energy; also, do the same for each of the five calculated states in part B. We would hope that in both cases, the energy would remain constant for each calculated state: that is, the real spring-and-mass has constant energy, so we'd hope that our simulated spring-and-mass would likewise have a constant energy throughout the simulation. When you actually calculate the total energy for our simulated system, how does it vary over successive using the two alternative methods?