PHYSICS 102
CLASSICAL MECHANICS LAB
FALL 2015

Assignment Four

Due Wednesday, November 4, 7:00 pm.

[1.] Type in the simplest "Euler" version of the simple harmonic oscillator molecular dynamics. Print it and hand it in.

[2.] Run code for the initial conditions $x_0 = 3., v_0 = 0.$, and for spring constant and mass $k = 2., m = 7$. Use a range of time steps and time intervals: $(N = 1000, dt = 0.05); (N = 5000, dt = 0.01)$. Plot $x(t)$ and $E(t)$ and hand in output.

[3.] Discuss results. Some things you might want to comment on include: What is the analytic solution? Does the accuracy improve as dt decreases? Do you get the correct period? Is energy conserved?

[4.] What does dt small *really* mean?

[5.] Type in the "leapfrog" version of the simple harmonic oscillator molecular dynamics. Print it and hand it in.

[6.] Run code for the initial conditions $x_0 = 3., v_0 = 0.$, and for spring constant and mass $k = 2., m = 7$. Use a range of time steps and time intervals: $(N = 1000, dt = 0.05); (N = 5000, dt = 0.01)$. Plot $x(t)$ and $E(t)$ and hand in output.

[7.] Discuss results. Some things you might want to comment on include: What is the analytic solution? Does the accuracy improve as dt decreases? Do you get the correct period? Is energy conserved?

[8.] Add an anharmonic term $(F = -kx - \frac{1}{3}bx^3)$ to your program. This should be a *tiny* change! One of the really interesting things about the 'usual' ($b = 0$) case is that the period T is independent of the amplitude. Is this true when b is non-zero? Provide numerical evidence one way or another.

[9.] Extra credit: Analyze the errors in the energy the "leapfrog" version of molecular dynamics. What order in dt are they? Are they always positive?