110a Homework 1, due Oct. 5.

1. Consider the harmonic oscillator: a particle of mass m is on a frictionless surface, and connected to a spring. Let x be the displacement of the mass from equilibrium. The spring provides the restoring force $F_x = -\kappa x$.

(a) Write the E.O.M. (equations of motion, i.e. Newton's second law) and show that a solution is $x_{sol}(t) = \text{Re } Ae^{-i\omega t}$ where $\omega = \sqrt{\kappa/m}$ and A is an arbitrary complex number. Write out the solution taking $A = |A|e^{i\phi}$. Note that there are two real integration constants, $|A|$ and ϕ so this is the general solution. Write the initial position $x_{sol}(t = 0)$ and velocity $v_{sol}(t = 0)$ in terms of the constants $|A|$ and ϕ (Part of the point of this problem is for you to get some practice and review of complex numbers, which will be very useful in this class.)

(b) Compute the kinetic energy T for the above solution.

(c) Note that $F = -\frac{d}{dx}U$ with $U = \frac{1}{2}\kappa x^2$. Compute U for the above solution, and verify that $E = T + U$ is a constant, independent of t.

2. Taylor 1.46.

3. Taylor 2.14.

4. Taylor 2.40.

5. Taylor 3.14.

6. Taylor 3.27.

7. Taylor 4.8.

8. Taylor 4.23.

9. Taylor 4.28.

10. Taylor 4.34.

* You should also do the following problems, but don't need to turn them in.

1*. Taylor 1.43.

2*. Taylor 1.45.

3*. Taylor 2.4.

4*. Taylor 4.20.