PHY121 Summer 2018
Problem Set #6
Due Thursday 6/7

1. Answer the following:

   (a) The maximum displacement of a mass oscillating about its equilibrium position is 0.2 m. Its maximum speed is 1.2 m/s. What is the period T of its oscillations?

   (b) If a mass $m = 0.2$ kg is tied to one end of a spring whose force constant $k = 80$ N/m and whose other end is held fixed, what are the angular frequency ω, frequency f, and period T of its oscillations?

   (c) If the initial position and velocity of the system in part b are $x_0 = 0$ and $v_0 = 40$ m/s, what are the constants A and δ in the position function $x(t) = A\cos(\omega t - \delta)$?

2. A pendulum with a length of 1.5 m is released from an initial angle of 15°. After 1500 s, its amplitude has been reduced (by friction) to 5.5°. What is the value of $\frac{b}{2m}$?

3. How do you measure the mass of an astronaut in orbit (scales don't work in microgravity!)? For Skylab, NASA engineers designed the Body Mass Measurement Device (BMMD). This is essentially a chair of mass m mounted on a spring with $k = 605.6$ N/m. (Note that the mass of Skylab is large enough to remain essentially fixed as the system oscillates.) The period of the empty chair is measured to be 0.90149 s; when an astronaut sits in the chair, the period is 2.12151 s. What is the mass of the astronaut?

4. A ladder of length L and mass m leans against the side of a house, with the bottom of the ladder a distance x from the wall. The contact interaction between the ladder and the ground has a coefficient of static friction μ. Assuming that the contact interaction between the ladder and the wall is essentially frictionless, how high can a person safely climb without risking the ladder slipping out from underneath them? What if the ladder is massless?

5. A person's forearm consists of a bone (which we can model by a rigid rod) that is free to rotate around the elbow. When the forearm is held level with the elbow bent at a 90°angle, the bone is supported by the biceps muscle, which is attached by a tendon to the bone a few centimeters away from the axis represented by the elbow. By making appropriate estimations, determine the tension on the tendon when you hold a 10 kg object in your hand (with forearm level and elbow bent at 90°).