Physics 121 - Spring 2008 - workshop module 4
Work and Energy

1. Crazy Jumpers Incorporated wants to test the elasticity of a new bungee cord without endangering anyone's life. While the clients are busy jumping from a bridge (using the older cords), the owner (M = 100 kg) is attached to a 10-meter length of the new cord and slowly lowered until he is hanging motionlessly. At that time it is noted that the cord has stretched to a new length of 20 meters.

   Make a FBD for the owner as he dangles (motionlessly) from the bungee cord.

   Using Newton's 2nd Law, determine the spring constant for this bungee cord.

   Now that the spring constant of the new cord is known, the owner (who recently completed a physics course) performs a few quick calculations and then decides to do a trial jump using a 40 m length (unstretched) of the new cord. He jumps from the 90 m tall bridge as his assistants (who unfortunately never learned physics) watch with a mixture of fascination and morbid curiosity. Your goal in this problem is to recreate the owner's calculations to determine whether it was safe for him to jump.

2. A car is stopped by a constant friction force that is independent of the car's speed. By what factor is the stopping distance changed if the car's initial speed is doubled? Hint: think about work and energy conservation.

3. Consider a mass sandwiched between two collinear springs that are arranged along the x-axis such that there is no force on the mass when it is centered at x = 0 m. Assume the mass slides on a frictionless surface and that both springs have a spring constant k.
   (a) What is the force on the mass as a function of x and k (for reasonable x that is smaller than the spring length)?
   (b) Qualitatively graph the potential energy function of the system as a function of x.

4. Consider a 2 kg mass stacked on top of at 7 kg mass as shown below. The two masses are attached to a spring (which is attached to the wall) and can move back and forth on a frictionless surface. The coefficient of static friction between the bottom surface of the top mass and the top surface of the bottom mass is 0.45. The spring constant is 200 N/m.
   a) What is the maximum amplitude of the simple harmonic motion (maximum amount the spring is compressed and stretched) of the system shown below such that the top mass does not slip during the oscillation?
   b) In a system that undergoes this limiting motion: What is the total energy of the system?