PHYS 102- Concepts of Physics II- Spring 2007
Homework #1
Due in class Wednesday February 7th

You must mostly type the text part of your work. But hand-write equations and drawings as needed; just please be neat. You must show your work, and/or explain your answers, for full credit. [Late work will not be carefully graded, but will be given a moderate amount of credit if it's generally satisfactory. If submitting late work, you must keep a back-up copy for yourself.]

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1. Imagine that you travel to the surface of the Moon. You drop a rock from a height of 2 meters above the surface, and it takes 1.55 seconds to fall.

   (a) Calculate g_{Moon} based on this data. As always, show your work.
   (b) How long would a feather take to fall this same distance on the Moon? Explain.
   (c) How long would the rock take to fall the 2 meters if your performed the experiment on Earth instead? Is it different than on the Moon? Why? (Assume the rock is small and smooth so that you can ignore air drag.)
   (d) What would happen if you dropped the feather on the Earth? Explain.

2. Use the formula that you employed for part (a) of Problem 1 above to measure the height of a building at UVA (your choice). Use an object that has little air drag, such as a smooth rock or a baseball. There is no need to climb to the top of the building—you can perform the entire experiment standing on the ground next to the building (how?). You will need some kind of stopwatch or at least a clock with a second hand.

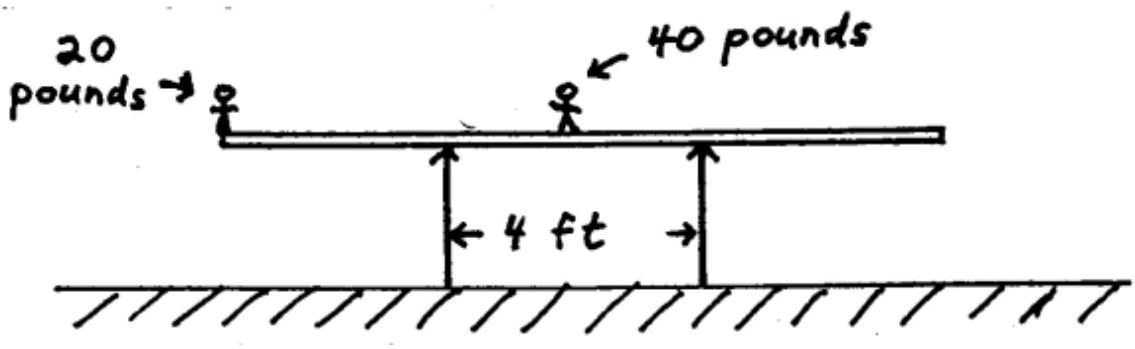
3. Chapter 4, Conceptual Exercise #48 on page 88 of Hobson, 4th edition (*Since the law of inertia states…*). Be sure to explain your answer.

4. Face a wall and stand against it, with your nose, chest and toes touching the wall. Now attempt to rise up on your toes. Can you remain balanced? Explain what happens and why. Be sure to explain why this is different than rising up on your toes when you are away from the wall. Include a sketch or two with your explanation.

5. For this problem you have to climb some stairs. (If you should not climb stairs, please arrange an alternative with instructor.)

   (a) Pick 2 or 3 flights of stairs that you can walk or run up consecutively. Measure the vertical height through which you will rise. Probably the easiest way to do this is to measure the height of one step and multiply. State dimensions of each step, the number of steps, and the total.
   (b) Convert the previous total to meters.
   (c) Time yourself, in seconds, ascending the stairs. What kind of timer did you use? What total time did you measure?
   (d) What is your weight in pounds? Convert to kilograms of mass.
   (e) Now calculate your power output, in watts, as you ascended the stairs.
   (f) Convert your previous answer to horsepower.
   (g) If your body were 100% efficient at converting food energy into useful work (as we assumed in class), calculate the number of food calories you would have burned while climbing the stairs.
   (h) In reality, your body is only about 20% efficient. (That is, for every 5 calories you burn, 1 is converted to useful work, and the other 4 to heat.) How many food calories did you actually burn?
   (i) How many individual steps would you actually have to climb (assuming 20% efficiency) in order to burn off the calories in a SNICKERS bar (280 food calories)?

6. Two narrow supports are erected 4 feet apart, and a 10-pound plank is centered on top of them, but not attached, as shown. The plank is 10 feet long. (As always, for full credit you must show your calculations.)



(a) A 40-pound child starts at the center of the plank and walks to the right. Where will the child be when the plank just begins to tip? Which way will it tip? Show your work in solving this, and make a new sketch showing the exact location of the child. (The 20-pound child is not yet on the plank.)

(b) The child reacts quickly enough and doesn't tip over. He walks back to the center. Now a 20-pound child stands at the very left end. With the 40-pound child still at the center, will the plank begin to tip? Explain.

(c) With the 20-pound child still on the left end, the 40-pound child begins to walk to the right. How far can he walk without tipping the plank? Explain.

(d) With the 20-pound child still on the left end, the 40-pound child now turns around and walks to the left. Where will he be when the plank begins to tip? Which way does it tip? Explain, and make a new sketch showing the exact location of the child.

7. A 100-lb person holds a 20-lb machine gun in his hands and fires it directly downward. The bullets each have a mass of 100 grams, and emerge from the gun traveling at a speed of 400 miles-per-hour. How many bullets per second must the gun fire in order to just lift the person and gun (120 lbs total) off the ground? Show your work and explain your method. (For this problem, ignore the fact that the mass of the gun decreases as the bullets leave it.)