Physics 206a

Homework Assignment VII
due February 23, 2007
*(Since the posting of this problem set was delayed, I **may** shift the due-date. I will announce whether I will do this on Wednesday. Until then, assume the due date is that stated above.)*

1. A teaspoon of sugar contains 62790 Joules of chemical potential energy. If a building is 3 meters per floor, how many floors up would a 75 kg person need to climb to use up the energy in a teaspoon of sugar? (An ungraded variation for your consideration: A can of Coke has about ten teaspoons of sugar. How high does the person need to climb to "burn off" a can of Coke?)
2. For each of the situations described below, state whether the forces involved are conservative or dissipative:
    a. A baseball bat swings and hits a ball.
    b. An outfielder catches the ball.
    c. A man places a bowling ball on a tall shelf.
    d. The bowling ball falls down and shatters the floor below it.
    e. A water molecule is ripped apart into its constituents—hydrogen and oxygen.
3. The potential energy of a compressed spring is given by $P.E. = \frac{1}{2}kx^2$ (we'll study springs in more detail later this semester) where k is a constant dependent on the particulars of the spring and x is the amount by which it is compressed. Consider the following situation: A spring, oriented horizontally, with $k = 70\frac{Newtons}{meter}$ is compressed by 13 cm. It is then allowed to expand, pushing against a ball with a mass of 37 grams. The ball rolls up a ramp with an incline of 17° relative to the horizontal. The ramp is 3 meters long.
    a. What will the ball's **velocity** be when it leaves the ramp?
    b. What will the ball's *speed* be when it hits the ground?

4. Which has a bigger change in kinetic energy: A ball thrown against the wall which bounces back to the thrower or one which (due to a nasty practical joke) sticks to the wall?

5. A rubber ball with a mass of 210 grams is thrown exactly horizontally from a height of 2 meters with an initial speed of $v = 13\frac{m}{s}$. When it strikes the ground, it bounces off at the same angle it made when it landed. During the bounce, it loses 20% of its kinetic energy to dissipative forces. How high does it go after bouncing?

6. Consider again the situation given in Problem #9 of Assignment #6: A man drags a heavy box across the floor at a constant speed using a rope. The rope makes an angle θ with the floor. The man exerts a force F_T on the rope. Assume the box has a mass of 15 kg, $\theta = 17°$, $F_T = 75$ N. If the man walks at a constant speed of $0.7\frac{\text{meters}}{\text{second}}$, how much power does he expend? (Note: This only makes sense if there is friction in the problem, so assume that there is friction—it won't affect your answer in any way and you will not need an explicit value for the coefficient of friction. But the statement of the problem is contradictory without it. Can you see why?)

7. Which has a bigger change in momentum: A ball thrown against a wall which bounces back to the thrower or one which (due to a nasty practical joke) sticks to the wall?

8. With what minimum speed would a housefly (with a mass of 1 gram) have to be thrown against a Volkswagen (with a mass of 1300 kilograms) traveling at $22\frac{\text{meters}}{\text{second}}$ in order to get it to stop?

9. A molecule of carbon monoxide (CO), which consists of one atom of carbon and one atom of oxygen, is forced to break apart by the addition of a certain amount of energy. There is a net excess of energy of 3×10^{-19} joules which all goes to kinetic energy of the "fragments" (i.e., the atoms). What are the speeds of each of the two fragments? (Carbon has a mass of 12 amu and oxygen has a mass of 16 amu.)