Physics I (PHYS 200): PS 6

Fall 2013 v1.0

Reading:

HRW Chapter 8 (energy) and Chapter 9 (conservation of momentum) sections 9-3, 9-5-through 9-9
New material for this week will be in the *beginning* of Chapter 9 and the first 3 sections of Chapter 10 (on rotation)

Problems:

Due in class Friday, October 25.

(1) A lever can be used to lift objects much more weighty than we would normally be able to lift. This must mean that levers increase the amount of force we can apply on objects. Show this by conservation of energy and computing the amount of work done by the person operating the lever and the amount of work done in lifting the object. Express your result in terms of the ratio of output force F_O to input force F_I. Start by making a well labeled sketch.

(2) At Deep Springs College there is a small-scale hydropower plant. There is a reservoir 420 ft above the station that contains the turbine. The flow rate of water is 790 gpm. Find the maximum power the station could produce.

(3) HRW Chapter 8 Problem 57

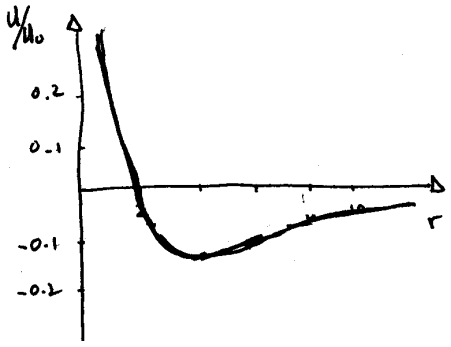
(4) HRW Chapter 8 Problem 77

(5) HRW Chapter 8 Problem 104

(6) For simple diatomic molecules, the potential energy is (approximately) given by the Lennard-Jones potential,

$$U(r) = u_o \left[\left(\frac{a}{r}\right)^{12} - \left(\frac{a}{r}\right)^{6} \right],$$

where r is the distance between the atoms and u_o, a are constants. For O_2, $u_o = 5.6 \times 10^{-21}$ J and $a = 3.5 \times 10^{-10}$m. It looks something like this



(a) Find the equilibrium radius.

(b) As we did in class sketch the "motion" of the diatomic molecule with an energy of -0.4×10^{-21} J. Identify the turning points.

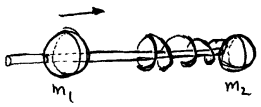
(c) Find the force on the molecule at the outermost turning point.

(7) HRW Chapter 9 Problem 18

(8) HRW Chapter 9 Problem 22

(9) HRW Chapter 9 Problem 43

(10) A bead with mass $m_1 = 2.5$ kg and a bead-with-spring of mass $m_2 = 5.8$ kg can slide on a frictionless track. A spring with $k = 1010$ N/m is attached to m_2. Initially, the bead m_1 has a velocity of 14 m/s toward the m_2 bead, which is at rest. The m_1 bead collides with the spring first. In the first part of this problem the beads and spring form one system. In the second, the beads have separated.



(a) What is the compression of the spring when the beads collide?
(b) What are the final velocities of the particles?