PHYS 2022 - Homework 2
Due Wednesday, February 3, 2010

Reading:

French: all of Chapter 1, pp. 43-45, 49-50.

Y&F: 13.1-5 (Periodic motion, SHM, energy, mathematical pendulum).

Problems:

1. A cylinder of mass m=1 kg and cross sectional area S is floating vertically in water so that the submerged volume is V. In equilibrium, the buoyant force, $F_b = \rho g V$, compensates for gravity, and the length of the submerged part is L. (Here, ρ is the density of water.)
    a) Write the Newtonian balance-of-forces condition at equilibrium. For a small displacement from equilibrium x, what is the net force on the cylinder? Would the frequency of small free oscillations depend on the amplitude? Why?
    b) Neglecting the resistance of water, derive a differential equation that would describe small vertical oscillations of the cylinder.
    c) For L=10 cm, find the period of small oscillations.
    d) Write the equation of motion for the cylinder, i.e. displacement vs. time, if at t=0 the cylinder is at its maximum displacement A=1 cm. Assume that the cylinder is never completely submerged.
    e) What is the maximum potential energy of the cylinder? The total energy?
    f) Using the principle of conservation of energy, find the maximum speed of the cylinder.
    g) Verify your result for the maximum speed using the equation you obtained in part d).
    h) Draw a graph of velocity versus time from t=0 to t = one period. Include the correct amplitude and phase.

2. French 1-1
3. French 1-4
4. French 1-6
5. French 1-12