PHYS 380

HOMEWORK #3

For Class Discussion on Sept. 20 and submission on Sept. 22.

1. a) Show that the gravitational binding energy of a self - gravitating sphere of mass M and radius R is :

$$U = \frac{-3}{5}\frac{G M^2}{R}$$

Assume the sphere has a constant density throughout. (Hint : Imagine the sphere being constructed by bringing in matter from infinity in a series of infinitesimal spherical shells)

b) Compare this binding energy to the total energy that could be released from all the nuclear weapons in the world. Assume there are approximately 10, 000 megatons (MT) of nuclear weapons remaining. (1 MT = the energy released by the explosion of 1 million tons of trinitrotolune (TNT); you may need to so some sleuthing to find the energy of detonation of TNT).

How likely do you think we could disrupt the structure of the Earth by simultaneously detonating all nuclear weapons?

c) Compare this binding energy to the kinetic energy of an incoming sphere of radius 5 km and approaching the earth at 30 km/s. Assume the object has a uniform density of $3000\,\mathrm{kg}/m^3$ (roughly the density of rocky matter.)

2. In the last homework assignment, you studied the orbital elements of Halley' s Comet. Use the orbital data contained in Chapter 2 to estimate how long Comet Halley is inside the Earth' s orbit. Show your work/method clearly. You might find it useful to estimate the upper bound of this time.

3. Starting with Eq. 3 - 22, show how you can derive eq. 3 - 23 from eq. 3 - 22; in other words, show they are equivalent expressions.

4. 3.2 page 81

5. 3.8 page 81

6. 3.9 pp 81 - 82

7. 3.12 page 82