

Your Name _____ Section _____

HOMEWORK #12 - 8.01 MIT - Prof. Kowalski

Due 4:00PM Wednesday Nov. 26, 2003

Topics: Universal Gravity and Harmonic Oscillators

Any following problems designated with a bold number indicate problems from Young and Freedman 11th edition.

1. Whither the Moon?

Consider the earth-moon system. The earth has $M_e = 5.98 * 10^{24}$ kg, $R_e = 6.378 * 10^6$ m, $I_e = 0.331 M_e R_e^2$, and $T_{day} = 86164$ sec (with respect to fixed stars). The moon has $M_m = 7.35 * 10^{22}$ kg, $T_{orbit} = 27.3$ days (with respect to fixed stars, called the sidereal period as opposed to the lunar month), and is $D_{em} = 3.84 * 10^8$ m from the center of the earth. Approximate the earth as lying at the center of mass of the system, and ignore the contribution of the moon's spin to its angular momentum. Also ignore any complications due to the presence of the sun.

The two bodies exert tidal forces on each other, which are strong enough to have slowed the moon's spin so that it always presents the same face to the earth. These tidal forces have the same effect on the earth: the drag of moving the earth through the ocean's tides reduces earth's spin angular momentum and dissipates energy.

- a. What is the effect of the tides: consider the variables of angular momentum about the center of the earth and rotational kinetic energy. What happens to each of these for the earth, the moon, and the earth-moon system?
- b. What configuration of the two bodies is stable against further change by the tidal forces? (i.e. describe the final configuration of this system?) Specify the final values for the length of the day, T_{day} and earth-moon separation, D_{em} . Note that you will find helpful the results of the CyberTutor problem on L(R) for a circular orbit.

2. **13.58**

3. **13.60**

4. **Happy Thanksgiving!**