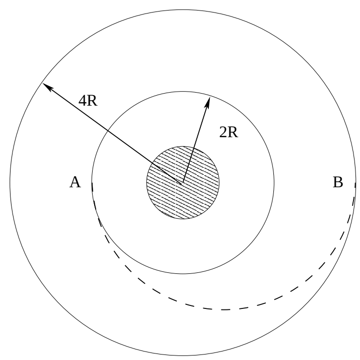
Course 141: MECHANICS

Problem Set 14

Date Issued: February 27, 2008

1. Halley's comet is in an elliptic orbit about the sun. The eccentricity of the orbit is 0.967 and the period is 76 years. The mass of the sun is $2 \cdot 10^{30}$ kg. Determine the distance of Halley's comet from the sun at perihelion and at aphelion. What is the speed of the Halley's comet when it is closest to the sun?

2. A spacecraft is in circular orbit about the earth. The mass of the spacecraft is 3.000 kg and the radius of the orbit is $2R_e = 12.800$ km. It is desired to transfer the spacecraft to a circular orbit of radius $4R_e$. What is the minimum energy for the transfer? A way to accomplish this mission is to use a semi-elliptical transfer orbit as shown in figure. What velocity changes are required at the points of intersection, A and B, respectively?



3. A mass of 2 kg on a frictionless table is attached to one end of a massless spring. The other end of the spring is held by a frictionless pivot. The spring produces a force of magnitude 3 ρ newtons on the mass, where ρ is the distance from the pivot to the mass. The mass moves in a circle and has a total energy 12 J. (a) Find the radius of the orbit and the velocity of the mass. (b) The mass is struck by a sudden blow, giving it instantaneous velocity of 1 m/s radially outwards. Show the state of the system before and after the blow on the energy diagramm. For the new orbit, find the maximum and minimum values of ρ.

4. The potential of the inverse-square force is $V(r) = -k/r$. For a circular orbit show that: (a) The total energy E is equal to the half of the potential energy, $E = V/2$. (b) The potential energy is always twice as large in magnitude as the kinetic energy.

5. The orbit of an asteroid extends from the earth's to that of Jupiter, just touching both. Find it orbital period.