ASTR430 HW#2 (due 10/12/05)

1. Transfer orbits.

   (a) Do problem #20 from Ch. 3 in the textbook (p. 73), assuming the orbits of Phobos and Deimos are circular and co-planar. Neglect the mass and finite size of the moons. Include a sketch of the situation showing Mars, Phobos, Deimos, and the desired orbit. This is an example of a Hohmann transfer orbit.

   (b) What is the eccentricity of the transfer orbit?

   (c) What is the minimum time required for the package to get from Phobos to Deimos?

   (d) At what relative orbital longitudes will the moons need to be at launch for Deimos to be at the correction position when the package arrives? How often does this configuration occur (in other words, what is the *synodic* period of Deimos relative to Phobos)?

2. Gravitational potential energy.

   (a) Derive an expression for the gravitational potential energy of a homogeneous sphere of bulk density ρ, mass M, and radius R. *Hint:* consider the contributions of thin concentric shells of thickness dr and mass dm.

3. Gravitational collapse.

   (a) Derive a formula for the free-fall gravitational collapse time of a uniform spherical cloud of density ρ. *Hint:* the trajectory of a gas parcel initially at rest at a distance r from the center of the cloud can be approximated as a very eccentric ellipse with semimajor axis $r/2$.

   (b) Calculate the collapse time for a cloud of H_2 molecules with 10^4 molecules per cubic centimeter.

   (c) Do problems #21 & 22 from Ch. 4 in the textbook (p. 97).

4. Planetesimal accretion.

   (a) Do problems #14 & 15 from Ch. 5 in the textbook (p. 125). For #14, assume the planetesimal is on a straight-line trajectory with speed V relative to the cloud, and ignore gravitational focusing.