Astronomy 505: Homework #6 (Planets)

1. (a) Compute the ratio of the height of the tides raised on Earth by the Moon to those raised by the Sun. (4 pts)

   (b) Compute the ratio of the tidal torque on the Moon and the Sun due to the Earth. (4 pts)

   Consider the following, if the Earth-Moon distance was reduced to half its current value.

   (c) Neglecting solar tides, how many times as large as at present would the maximum tide heights on Earth be? (3 pts)

   (d) Including solar tides, how many times as large as at present would the maximum tide heights on Earth be? (4 pts)

2. Estimate the amplitude of tides that the Moon raises on Earth. (10 pts)
   Hint: Integrate the tidal force to compute a tidal potential. Next, calculate the tidal potential of a test particle at the sublunar point on the Earth's surface. Finally, determine the height by which the blob must be raised for the change in its gravitational potential relative to Earth to be equal in magnitude to its tidal potential.

3. (a) Show that dust released at perihelion from a body on an eccentric Keplerian orbit will escape from the Solar System if β, the ratio of radiation pressure to the solar gravity, is as follows. (4 pts)

$$\beta \geq \frac{1-e}{2}.$$

   (b) Derive an analogous expression for the stability of a dust grain released at aphelion. (3 pts)

   (c) Assume that a dust grain is heated entirely by the interstellar radiation field at UV wavelengths, and that the UV flux is 2×10^5 photons $\mathrm{cm}^{-2}\mathrm{s}^{-1}\text{Å}^{-1}$. The bandwidth of the radiation is 1000Å, and the mean photon energy is 9 eV per photon. If the grain radiates with an efficiency of 0.1%, calculate its temperature. (3 pts)

4. Calculate the expected increase in the global average temperature of the Earth at a full Moon compared to a new Moon (neglecting eclipses). Which effect is larger, the change in position of the Earth around the center of mass of the Earth-Moon system, or the radiation reflected and emitted from the Moon in the full phase? (10 pts)