ASTR 311 STELLAR ASTROPHYSICS
Problem Set #3
(due 21 SEP 11)

1. Here are some measured properties of an eclipsing binary system: V_1=115.6 km s^{-1}, V_2=116.1 km s^{-1}, P=1.98 d. Because it is eclipsing and has a short period, we will assume that we are viewing the system's equatorial plane and that the orbits are circular.
   a) Calculate the mass ratio M_1/M_2
   b) Calculate the total mass, M_1+M_2. [HINT: To do this, we apply Kepler's 3rd Law [$P^2=(4\pi^2/G)/(M_1+M_2)*a^3$] by converting the 2-body problem into a 1-body problem using the orbit of a single object with a "reduced mass" [$\mu=M_1M_2/(M_1+M_2)$] around the system's (immobile) center of mass with semi-major axis of this orbit is equal to the sum of the semi-major axes of the two individual orbits. In this 1-d problem, the total mass remains the same.]
   c) Calculate the masses of the individual components in units of solar masses.

2. Let's take the opposite case, where we view the system from above the pole of the orbital plane and all the motion is in the "plane of the sky". Suppose a line between the observed position of the two stars (after removing parallax, proper motion, etc.) traces out an ellipse with a semi-major axis of 11 arc-seconds over a period of 50 years, and that from parallax observations we have measured the distance to both stars to be 2.6 pc.
   a) Derive an expression for the mass ratio M_1/M_2
   b) Derive an expression for the total mass M_1+M_2
   c) If you have enough information, evaluate this pair of expressions to calculate the masses of the individual components (relative to the Sun). If you don't have enough information, derive expressions to calculate each of the two individual masses.