PHYS4000 Introduction to Astrophysics HW #1 Due 3 Feb 2017

(1) Maoz, Problem 1.1.

(2) Maoz, Problem 2.1.

(3) Maoz, Problem 2.5.

(4) The object Cygnus X-1 is extremely bright in X-rays, but invisible in optical telescopes. It appears to be very near a 40 solar mass star called HDE 226868, which shows a Doppler shift that oscillates with a 5.6 day period and maximum velocity 76 km/sec. Assuming that Cygnus X-1 and HDE 226868 execute circular orbits about their common center of mass, and that orbit is viewed edge on, find the mass of Cygnus X-1. There is evidence that the orbit is inclined at an angle of 30° (instead of 90° for edge-on). What is the mass in this case? What do you think Cygnus X-1 *is*?

From time to time in this course, I will encourage you to look at journal articles regarding some subjects. In this case, you might look at one of the original "discovery" papers, namely *Cygnus X-1 – a Spectroscopic Binary with a Heavy Companion?*, by Louise Webster and Paul Murdin, Nature 235(07 January 1972)37.

(5) For a gas of molecules of mass m at temperature T, where the energies are all non-relativistic, the number of molecules with speeds between v and $v + dv$ is

$$dn = \frac{dn}{dv}dv = 4\pi N \left(\frac{m}{2\pi kT}\right)^{3/2} v^2 e^{-mv^2/2kT} dv$$

Show that N is the total number of molecules. Find the "most probable" and mean velocities (per particle), as well as the "most probable" and mean kinetic energies (per particle).