Ay 7b – Spring 2012
Section Worksheet 4
Accretion Disks

Constants/Conversions:

$$c = 3 \times 10^{10}\, cm/s \qquad G = 6.67 \times 10^{-8}\, cm^3/g/s^2$$
$$\sigma = 5.67 \times 10^{-5}\, erg/cm^2/K^4/s \qquad 1\, yr \approx \pi \times 10^7\, sec$$
$$M_\odot = 2 \times 10^{33}\, g \qquad R_\odot = 6.96 \times 10^{10}\, cm$$
$$M_\oplus = 6 \times 10^{27}\, g \qquad R_\oplus = 6.37 \times 10^8\, cm$$

Accretion disks around different objects: In general, the amount of matter falling onto an accretion disk and into the central object varies by several orders of magnitude, but a good approximate value for objects accreting in a binary system is $\dot{M} = 10^{-8}\, M_\odot/yr$, and for super-massive black holes is $\dot{M} = M_\odot/yr$.

Objects with their accompanying accretion disks:

Name	Object Mass	Disk Inner Radius
White Dwarf	$0.85\, M_\odot$	$0.0095\, R_\odot$
Neutron Star	$1.4\, M_\odot$	10 km
Stellar mass black hole	$3\, M_\odot$	
Super massive black hole	$10^8\, M_\odot$	
Main sequence star	$1\, M_\odot$	$1\, R_\odot$

1. **Disk Temperature and Radiation**
   What are T_{max} and λ_{pk} for your object? What range of the EM spectrum does this λ_{pk} fall within?

2. **Tidal forces**
   Approximate the self-gravity holding the Earth together.

   Now imagine that you've placed the Earth at R_{inner} for the disk. What is the magnitude of the tidal force the Earth feels?[1]

[1] You can imagine a planet just like Earth but named "Professor Chiang" if you'd rather.

3. **Keplerian Orbits**

   Assume now that the accretion disk follows Keplerian orbits. This means that the disk rotation is entirely due to the gravitational force by the central object.

   Derive the Keplerian angular velocity for this set of assumptions.

   Now, using your formula, what is Ω_{kep} and v_{kep} for something sitting at R_{inner} in your accretion disk?