Homeworks will be passed out about 1.5 weeks before they are due, and will also be posted on the web at http://www.astro.umd.edu/~hamilton/ASTR430/. You are welcome to work together on the problems, but try them on your own first as practice for the midterm and final. The volunteer TA and I will try to have homeworks graded and back to you within a week.

1. a) Read through the “Building Physical Intuition in Mechanics” handout. Then do problem #17 by checking units. For each of the incorrect candidate answers, show why the expression is incorrect.

b) Do problem #36 by checking limits.

c) Do problem #47.

d) Do problem #74.

2. Consider an alternate universe in which the strength of gravity is proportional to r (i.e. \( \mathbf{F} = -kr \), with k a positive constant). This is Hooke’s law, so we are in effect postulating that gravity behaves as if planets and stars were connected to one another by springs.

a) Derive new versions of Kepler’s laws for this force.

b) Discuss some reasons why this would be a very strange universe!

c) Check your answer to a) using the Central Force Integrator available from the ASTR430 website (follow Astronomy Workshop/Orbital Simulations links from the class webpage). Investigate other kinds of central forces to see what type of orbits are possible.

3. In this problem, you will derive a formula for the free-fall gravitational collapse time of a uniform spherical cloud of density \( \rho \).

a) Try using dimensional analysis. First, identify a list of variable(s) and constant(s) that the answer will depend on. Make a sketch and label it.

b) Now, from your list, form something with units of time, call this \( t \). Try to form a dimensionless quantity \( \chi \). From this, determine the form that the actual solution to the problem must take.

c) Now solve the problem exactly using the following 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 \( r/2 \). How good was your result from b)?

d) Use your result from c) to calculate the collapse time for a 1 solar mass cloud of H\(_2\) molecules with \( 10^4 \) molecules per cubic centimeter.