Central Forces Homework 1

Due 2/25/09

PRACTICE:

1. If a central force is the only force acting on a system of two masses (i.e. no external forces), what will the motion of the center of mass be?

2. Which of the following forces can be central forces? which cannot?

   (a) $m\vec{g}$

   (b) $q\vec{E}$

   (c) $q\vec{v} \times \vec{B}$

3. Show that the plane polar coordinates we have chosen are equivalent to spherical coordinates if we make the choices:

   (a) The direction of z in spherical coordinates is the same as the direction of $\vec{L}$.

   (b) The θ of spherical coordinates is chosen to be $\pi/2$, so that the orbit is in the equatorial plane of spherical coordinates.

4. Convince yourself that the plane of the orbit is perpendicular to the angular momentum vector $\vec{L}$.

REQUIRED:

5. (TM 9.6)
   Consider two particles of equal mass m. The forces on the particles are $\vec{F}_1 = 0$ and $\vec{F}_2 = F_0\hat{\imath}$. If the particles are initially at rest at the origin, find the position, velocity, and acceleration of the center of mass as functions of time. Solve this problem in two ways, with or without theorems about the center of mass motion. Write a short description comparing the two solutions.

6. Using your favorite graphing package, make a plot of the reduced mass μ as a function of m_1 and m_2. What about the shape of this graph tells you something about the physical world that you would like to remember. You should be able to find at least three things.

7. (a) Find $\mathbf{r}_{\rm sun} - \mathbf{r}_{\rm cm}$ and μ for the Sun–Earth system. Compare $\mathbf{r}_{\rm sun} - \mathbf{r}_{\rm cm}$ to the radius of the Sun and to the distance from the Sun to the Earth. Compare μ to the mass of the Sun and the mass of the Earth.

   (b) Repeat the calculation for the Sun–Jupiter system.