Physics 321
Homework 23

Due at midnight on the day of Hour 24.

The solution to the radial equation for the inverse square force law is:

$$r(\phi) = \frac{c}{1+\varepsilon\cos\phi} = \frac{1+\varepsilon}{1+\varepsilon\cos\phi}r(0)$$

In this form,$\epsilon$ is taken as positive with the minimum *r* on the positive *x* axis. If the minimum *r* is on the negative *x* axis, $\epsilon$ is negative.

You should recognize the following values of $\epsilon$:

| | |
|---|---|
| $\epsilon = 0$ | circle |
| $0 < \epsilon < 1$ | ellipse |
| $\epsilon = 1$ | parabola |
| $\epsilon > 1$ | hyperbola |

The energy is related to the eccentricity, $\epsilon$, by the following equation:

$$E = \frac{\alpha^2\mu}{2L^2}\left(\varepsilon^2 - 1\right)$$

where the force is $F = \alpha / r^2$ and $L$ is the angular momentum.

Problems:

1. We begin with essentailly the same problem as Problem 22.1. This time specify the following:
1) The particles are attracted by a central force = alpha/r^2. alpha = .1875e7
2) The masses of the two objects are m1=150 kg and m2=300 kg.
3) The total energy is E= -156250 J.
4) The separation distance at t=0 is  a=10 m.
5) At t=0, the radial velocity of each object is zero.

Make a plot of $r(\phi)$ and also a plot of *r1* and *r2* separately.

2. For the same data as in Problem 23.1, solve the radial equation for total energies of -180000 J, -100000 J, -50000 J, 0J, and +50000 J. Plot each orbit and make a graph of the total effective potential (real + centrigual) for each system.

3. Find the eccentricity for each orbit of Problem 23.2. Plot each orbit using Eq. 8.59 from the text combined with the initial conditions.