Central Forces Homework 3

Due 03/07/12

REQUIRED:

1. NASA has launched a satellite into a **circular** orbit around the earth and wants to increase the radius slightly while maintaining a circular orbit. NASA scientists propose to fire the engines briefly, applying a small impulse to the satellite.

   One scientist says that it doesn't matter if the impulse is applied in a direction tangential to the satellite motion or perpendicular to the motion, arguing that both approaches will simply fine tune the total energy of the system.

   A second scientist disagrees and argues that one of the options would work but the other would definitely not work.

   A third scientist says that neither option would work. Which scientist would you side with, and why?

2. Consider the frictionless motion of a hockey puck of mass m on a perfectly circular bowl-shaped ice rink with radius a. The central region of the bowl ($r < 0.8a$) is perfectly flat and the sides of the ice bowl smoothly rise to a height h at $r = a$.

   (a) Draw a sketch of the potential energy for this system. Set the zero of potential energy at the top of the sides of the bowl.

   (b) Situation 1: the puck is initially moving radially outward from the exact center of the rink. What minimum velocity does the puck need to escape the rink?

   (c) Situation 2: a stationary puck, at a distance $\frac{a}{2}$ from the center of the rink, is hit in such a way that it's initial velocity $\vec{v}_0$ is perpendicular to its position vector as measured from the center of the rink. What is the total energy of the puck immediately after it is struck?

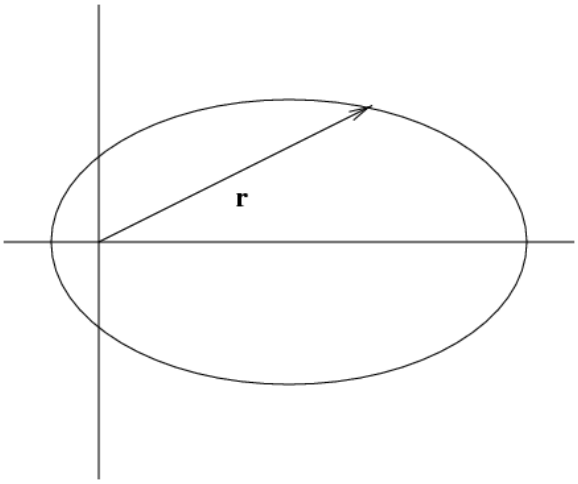
   (d) In situation 2, what is the angular momentum of the puck immediately after it is struck?

   (e) Draw a sketch of the effective potential for situation 2.

   (f) In situation 2, for what minimum value of $\vec{v}_0$ does the puck just escape the rink?

3. The figure below shows the position vector $\mathbf{r}$ and the orbit of a "fictitious" reduced mass.

   (a) Assuming that $m_2 = m_1$, draw on the figure the position vectors for m_1 and m_2 corresponding to $\mathbf{r}$. Also draw the orbits for m_1 and m_2. Describe a common physics example of central force motion for which $m_1 = m_2$.



(b) Repeat the previous problem for $m_2 = 3m_1$.