

Physics 321
Homework 22

Due at midnight on the day of Hour 23.

1) The force between two objects can be reduced to an effective one-body problem by separating the motion into the motion of the center of mass and the relative motion. You should understand how the “real problem” relates to the “effective problem.” Know what I mean when I say, “Total mass is series mass and reduced mass is parallel mass.”

2) Central forces are always conservative. Angular momentum and energy are both conserved.

3) The effective potential for the one body problem is the sum of the real potential and the centrifugal potential $U_{cent} = L^2 / 2\mu r^2$.

4) The motion of a system can be determined by solving the equations:

$$\mu \ddot{r} = -\frac{\partial U}{\partial r} + \frac{L^2}{\mu r^3}$$
$$L = \mu r^2 \dot{\phi}$$

5) The last term in the first equation is the centrifugal force. Be able to show it equals $m v^2 / r$. Know what “fictitious forces” mean.

Problems:

1. A system of two objects in otherwise empty space has a reduced mass of 100 kg. At time $t=0$, the objects are separated by 10 meters and have a total momentum (in the cm frame) of $p_0=2500$ kg m/s. At this time, the radial velocity of each object is zero. They experience an attractive potential of magnitude α/r . Find the motion as a function of time.

We'll call the coordinates of planet r and ϕ .

2. Redo the problem, but let the magnitude of the potential be $\alpha/r^{1.05}$ rather than α/r . Yes, you can cut and paste everything and change just a few numbers...