

Physics 106A: Classical Mechanics

Homework 4: Central Force Motion

DUE: Thursday, October 26 2000

Remember: Late homework will be granted 50% credit UNLESS PRIOR ARRANGEMENTS ARE MADE WITH ME OR A TA. If you have an extension, please indicate who granted it clearly on the top of the paper.

Reading Assignment: Hand and Finch Chapter 4

1. (*Center of mass motion*) H&F Chapter 4, problem 10
2. (*Central Force Motion.*) H&F Chapter 4, problem 13. Add the following part:
Sketch the effective potential as a function of the radial coordinate. Comment on the character of the motion for different values of E – is it bounded, unbounded etc?
3. (*Weighing the Sun, Earth and Moon*) H&F Chapter 4, problem 19
4. (*The Supernova*) Two stars are in a circular orbit about a common, stationary center of mass. One of them has a supernova explosion resulting in it losing a mass ΔM spherically symmetrically in its frame in a time short compared with the orbital period and leaving behind a system with combined mass M . Show that the relative orbit is bound and develops an eccentricity $\varepsilon = \Delta M/M$ provided that less than half the combined mass is lost. Show also that if the orbit is unbound, the supernova remnant star moves with constant speed.
5. (*Scattering*) Examine the scattering produced by a repulsive central force $f = kr^{-3}$. Show that the differential cross section is given by:

$$\sigma(\Theta)d\Theta = \frac{k}{2E} \frac{(1-x) dx}{x^2 (2-x)^2 \sin \pi x}$$

where x is the ratio Θ/π and E is the energy.