PHYSICS 603 - Winter/Spring Semester 2006 - ODU

Classical Mechanics - Problem Set 3

Problem 1)

Find the motion (as function of time) for a mass m in a gravitational potential $V = -k/r$ following the outline in Goldstein (p. 98 ff):

1) Start with Equation 3.65 and show that it can be transformed into Eq. 3.69
2) Replace r everywhere using the ansatz Eq. 3.68
3) Show that this leads eventually to Eq. 3.70 which you can solve.
4) What result follows for the time T that is needed for one full revolution ($\psi = 0 \rightarrow 2\pi$)?
5) Calculate the numerical result for T for the case of a planet circling the sun on an ellipse with major half axis $a = 1.5 \cdot 10^{11}$ m. Comment?

Use the handout showing the definition of all quantities for an ellipse. Note $G = 6.673 \cdot 10^{-11}$ $m^3 kg^{-1} s^{-2}$ and $M(\text{sun}) = 1.988 \cdot 10^{30}$ kg.

Solve ONE and ONLY ONE of the following two problems (no extra credit!):

Problem 2)

Solve Goldstein's Exercise 11, p.128. (Note: this problem can be solved either by brute force integration – not recommended – or by using a trick that mostly requires some creative thinking).

Problem 3)

A planet is circling Sun on an elliptic orbit with eccentricity e. Calculate the ratio between its maximum velocity (where does this occur? Why?) and its minimum velocity (ditto) as a function of e. By how much does the velocity of Earth ($e = 0.0167504$) vary over one orbit? (Use the numbers given in Problem 1 to calculate the actual value of the velocity at both the maximum and the minimum).