Math 221H Project : Ode to Newton

DUE DATE: WEDNESDAY, DECEMBER 10, 2008
POINTS: 50

Guidelines: This project is a group project which is based on material found on the textbook. The Maple notebook that you turn in should be a mix (not a clutter!) of equations, formulas and prose. Use complete sentences, good grammar, correct spelling and correct punctuation. Pay attention to organization; it's straightforward, really – have a beginning, middle and end; each part can involve multiple sections or simply be a brief section, as short as a paragraph. You should write your report in such a way that it can be read and understood by anyone who knows the material for this course. That is your target audience, not the instructor. Remember that part of the grade will be based on the quality of your written work. You will find it helpful to do the write-ups in the Math lab, where Maple is available.

Teams will consist of one to two members, which may be self-selected or selected by me if so requested. There is to be no inter-team collaboration on the project. Of course, any team may meet with me for help, if needed. Every team member *must* do his/her share of the work. To this end it would be a good idea for team members to establish a clear division of labor among themselves. In particular, each team member must help in proofreading the final report. Be prepared to answer the question of how much work you have contributed to the project.

The Project. In this project your team will write an essay, in the form of a Maple document, on application of the calculus to Kepler's laws of planetary motion. Your paper should contain the following elements:

1. An explanation of the text material on pages 256-258 that derives Kepler's first and second laws from Newton's second law of motion and law of universal gravitation. Your explanation should fill in all the details that are left out. It should be written in a narrative style, *not* an exercise style, so do not simply parrot the text narrative and give answers.

2. There is an important missing first step in the text explanation: Why does the inverse-square law imply that motion of a planet is planar? Show that it does. One way is to show that $\mathbf{v} \times \mathbf{r} = \mathbf{c}$, a constant vector, so that both $\mathbf{v}$ and $\mathbf{r}$ lie in a plane orthogonal to $\mathbf{c}$.

3. In Step 9, be sure to use $L = 12$, $\alpha = 0$ and $e = 0.5$ as one of your plots. Then set up the inverse-square law as a first order IVP system, and find initial conditions that will cause DEplot to plot the same solution as these values of L, α, e yield. You will find the Maple commands `plot` and `DEplot` helpful. Consult our notebooks. Pay attention to the quality of your graphs.