Physics 321
Homework 2

Due at midnight on the day of Hour 3.

This homework is intended to help you understand how Maple can arrive at the solution of complicated differential equations numerically. The basic idea is that we can start with initial conditions, and then move from step to step in the functional space by using the information given in the differential equations. We will use Excel, although the cumulative errors from a spreadsheet can be significant. (Note that some equations have been provided for you.) These problems are usually done best in a programming language, such as Matlab.

To do this assignment, you will need
1) For constant acceleration, we have (non-relativistically):

$$\ddot{x} = a$$
$$\Rightarrow \dot{x} = v, \quad \dot{v} = a$$
$$\Rightarrow \Delta x = v\Delta t, \quad \Delta v = a\Delta t$$

2) Treating x as one dimension and t as another dimension, we can write the same thing as:

$$F = ma = \dot{p}, \quad p = mv = m\dot{x}$$
$$\Rightarrow \Delta x = p\frac{\Delta t}{m} \equiv p\Delta u$$
$$\Delta p = Fm\frac{\Delta t}{m} \equiv Fm\Delta u$$
$$\Delta t = m\Delta u$$

3) Relativistically, it turns out that mass also varies with velocity, so we need one additional equation:

$$\Delta m = \frac{Fp}{c^2}\Delta u$$

1. An object of mass 2.000 kg is released from rest at the origin of a coordinate system. It experiences a constant force of 19.6 N in the +x-direction. Take the time step for each point in the calculation to be 10^5 sec. Continue the calculation through 10^8 sec. Graph $x(t)$ and $v(t)$ using Excel's x-y plots.

2. Repeat Problem 1 using the equations listed in 2) above.

3. Repeat Problem 2, allowing mass to vary in time according to the equation in 3) above. When applying the equations in 2), be sure to use relativistic mass and not the rest mass.