Modeling the motion of a projectile in air

In this lab you will do the following:

- Analyze the motion of an object dropped from a moving plane.
- Model the motion with a computer program (without air resistance).

Preparation: Analysis

An airplane is flying horizontally at a constant velocity of < 90, 0, 0> m/s at a height of 1000 m. A package with a mass of 100 kg is dropped from the plane. For simplicity, let's first consider the force of air resistance on the package to be *negligible*. Start from fundamental physics principles and be clear about your choice of system. Be prepared to show all steps in your work, not just the final answer.

1. Starting from kinematic equations, find the speed (magnitude of velocity) of the package just before it hits the ground.
2. Find the x- and y-components of the velocity of the package just before it hits the ground.
3. Find the amount of time it takes for the package to hit the ground after it is released.
4. At the instant the package hits the ground, where is the plane in relation to the package?
5. How far has the package traveled horizontally during the time it was falling? How far has the plane traveled in this same time? Draw a diagram showing the paths of the plane and the package during this time.

Save your answers to the above questions, so that you can compare them to the results you get using the computer model.

Modeling the motion without air resistance

Download the VPython shell file "airplane drop w-o drag.py". Read through the code carefully before moving on. Make sure you understand the structure of the code, and meanings of the various parameters. You already know how to code vectors, but you will need the expression, "package.pos.x" to state just the x-component of position and "package.v.x" for the x-component of velocity (and corresponding code for the y-component).

We will use the program to model the motion of the falling package in the case of no air resistance. You will need to insert the proper code into the second "while" loop of the program.
After the loop, add code to print the final values of:

- time
- the magnitude, x-component, and y-component of the package's velocity
- the x-component of both the package's and plane's position

When finished, run the program.
Observe the trajectory of the package and plane. What do you notice? Compare their final positions. Does this agree with what you predicted in your written analysis? Compare your calculated final speed and total time of drop to those predicted by the computer model.