Physics 1145 Homework # 2: 1-d Kinematics – Problems

Remember to draw complete diagrams for all problems. Every symbol you use in your calculation must be defined in the diagram. Beginning from the kinematics starting equations, derive symbolic expressions and calculate numerical answers. Assume air resistance is negligible.

1. A truck that had been waiting at a traffic light starts with a constant acceleration of 3m/s^2 as soon as the light turns green. At the same instant, a car traveling with a constant speed of 18 m/s passes the truck.
a) How far from its starting point does the truck overtake the car?
(Hint: Write an equation for the position of the car as a function of time and an equation for the position of the truck as a function of time. Find the time when the positions are equal.)
b) What is the truck's velocity when it passes the car?
c) Sketch, qualitatively, the position-vs-time graph and the velocity-vs-time graph for both vehicles.

2. A ball is thrown straight upwards from a cliff at height H=60 m with a speed of V_i=12 m/s. The ball just misses the cliff edge and continues down to the base of the cliff below.
a) How long does it take the ball to reach the highest point?
b) What is the height of the highest point above the ground?
c) What is speed with which the ball hits the ground?

3. A hot air balloon is rising vertically at a constant speed of 8.0m/s. When the balloon is 50.0m above the ground, a passenger inside drops a package which, subsequently, is in free fall.
a) What is the maximum height above the ground reached by the package?
b) How long does it take the package to reach the highest point?
c) What is the speed with which the package hits the ground?
b) Sketch, qualitatively, position, velocity, and acceleration of the package as functions of time.

4. A rocket is starting from rest at the ground and is taking off with a constant vertical acceleration of 5m/s^2. 10s after the start, the engines shut off.
a) Calculate the height above the ground at which the rocket runs out of fuel.
b) Calculate the velocity of the rocket at the instant the engines shut off.
c) Calculate the maximum height reached by the rocket. Consider the quantities found in parts b and c as given.
d) Sketch, qualitatively, the acceleration and velocity as functions of time. Mark the times when the engines shut off and when the rocket reaches its highest point.