Physics 1135  Homework for Recitation 2: 1-d Kinematics - Problems

1. A pickup truck is driving with a constant speed of 20 m/s when it passes a stationary police car. At that moment, the police car starts with a constant acceleration of 4.0 m/s².
   a) How far from its starting point does the police car overtake the truck?
   b) What is the police car’s velocity when it passes the truck?
   c) Sketch, qualitatively, the position-vs-time graph and the velocity-vs-time graph for both vehicles.

2. A ball is launched vertically upward from the edge of a cliff. The ball reaches its maximum height 1.6 seconds after launch. Barely missing the edge of the cliff as it falls downward, the ball strikes the ground 6 seconds after being launched.
   a) What was the ball’s initial velocity?
   b) What is the maximum height the ball reached above the cliff?
   c) How tall is the cliff?

3. A flying dragon is rising vertically at a constant speed of 6.0 m/s. When the dragon is 30.0 m above the ground, the rider on its back drops a small golden egg which, subsequently, is in free fall.
   a) What is the maximum height above the ground reached by the egg?
   b) How long after its release does the egg hit the ground?
   c) What is the egg’s velocity immediately before it hits the ground?
   d) Sketch, qualitatively, position, velocity, and acceleration of the egg as functions of time.

4. The engine of a rocket initially at rest on the ground is ignited, causing the rocket to rise vertically with a constant upward acceleration of magnitude $a=2g$. At altitude $L$, the rocket’s engine shuts off.
   a) Derive an expression for the speed of the rocket at the moment the engine is shut off.
   b) To what maximum height $H$ does the rocket rise above its initial position?
   c) Derive an expression for the total time the rocket is in the air, i.e. from start until it hits the ground.
   d) Sketch, qualitatively, position, velocity, and acceleration as functions of time. Identify the point where the engine shuts off and the highest point.