Homework #5

Due Oct. 11

1. The brakes on a typical car can give the car a maximum safe acceleration $1.5g$, that is 1.5×9.8 m/s^2. What should be the speed limit in a school zone if a car is supposed to be able to stop safely in a distance of 3 m? You may assume that the acceleration of the car is constant while it is braking.

2. A ball is thrown upward with an initial speed of 20 m/s. In this problem, you will need to use the quadratic equation. Solving the equation

$$ax^2 + bx + c = 0$$

for x gives two solutions:

$$x = \frac{1}{2a}\left[-b \pm \sqrt{b^2 - 4ac}\right].$$

(a) For what times do the equations say that the ball is 5 m above the starting point? What do the equations say is the velocity of the ball at these times? Explain the physical meaning of both mathematical solutions.

(b) Assume that the ball is thrown upward from the top of a tower, so that when it reaches its original position, it continues in free fall. For what times do the equations say that the ball is 5 m *below* the starting point? What do the equations say is the velocity of the ball at these times? Explain the physical meaning of both mathematical solutions.

3. A car is going at a constant speed of 55 m/s. It passes a motorcycle cop at rest by the side of the road. Just as the car passes the motorcycle, the motorcycle begins to accelerate with a constant acceleration of 3.5 m/s^2.

(a) Set up a coordinate system and sketch the motion of the car and the motorcycle on the same x *vs.* t graph. Use the graph to estimate the time it takes for the motorcycle to catch up with the car.

(b) Now find the time that the motorcycle catches the car using equations. Write an equation for the position of the car as a function of time. Write another equation for the position of the motorcycle as a function of time. Now write an equation that expresses the condition that the motorcycle has caught up with the car. Use this to find the time that the motorcycle needs to catch the car.

(c) How far down the road does the motorcycle catch up with the car?

4. A person sees a flowerpot falling past a window. The window is 1.5 m high, and the person notices that it takes 0.3 s for the flowerpot to fall past the window. (Given the reflexes of a person, this is probably not realistic, but we'll proceed anyway.)

(a) Find the speed that the flowerpot had when it was at the top of the window.

(b) Using your result from part (a), find the height from which the flowerpot fell, assuming that it fell from rest.

5. A spelunker (cave explorer) finds a deep hole in a cave. She drops a pebble into the hole and hears it splash into the water below 2 s later. She remembers that the acceleration due to gravity is about 10 $\mathrm{m/s^2}$, and that sound travels about 300 m/s. From this information, she determines the depth of the hole, taking into account the fact that it takes time for the sound to reach her. How deep is the hole?