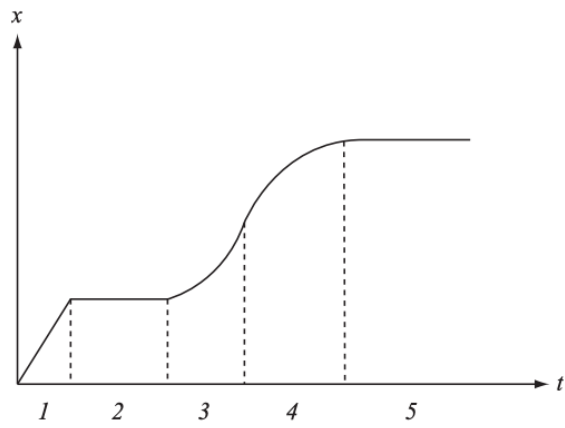


Physics 200  
Problem Set 1  
Solution

*Note: It's not very fun to punch numbers into a calculator. Plugging in numbers at the very end will often save you time and mistakes. This won't matter so much in this problem set, but try to get in the habit now.*

1. From the top of a building of height  $h = 100$  m I throw a stone up with velocity 10 m/s. What is the maximum height it reaches, and when does this occur? How many seconds does it spend on its way down between  $h = 50$  m and  $h = 0$  m? What is its velocity when  $h = 50$  m? If, while the stone is airborne, an earthquake opens up a hole 50 m deep in the ground, when and with what speed will the stone hit the bottom?

2. Below is the plot of position vs. time for a car. Explain what the car is doing in each numbered interval.



3. Romeo is at  $x = 0$  m at  $t = 0$  s when he sees Juliet at  $x = 6$  m.
- (a) Romeo begins to run towards her at  $v = 5$  m/s. Juliet, in turn, begins to accelerate towards him at  $a = -2$  m/s<sup>2</sup>. When and where will they cross? Sketch their motions by measuring time on the horizontal axis and position on the vertical axis.
- (b) Suppose, instead, that Juliet moved away from Romeo with *positive* acceleration  $a$ . Find  $a_{\max}$ , the maximum acceleration for which Romeo can catch up with her. For this case find the time  $t$  of their meeting. Show that for smaller values of  $a$  these star-crossed lovers cross twice. Draw a sketch for this case. Explain in words why they cross twice.

4. A particle moves according to the equation  $x = 3 + 4t + 6t^2 + 4t^3$ . Find its velocity and acceleration at all times. When does its velocity equal 10 m/s? What is its acceleration at that instant?

5. (Difficult) Ball  $A$  is dropped from rest from a building of height  $H$  exactly as ball  $B$  is thrown up vertically from the ground. When they collide  $A$  has twice the *speed* of  $B$ . If the collision occurs at height  $h$ , what is  $h/H$ ? *Hint:* Write equations for heights  $y_A, y_B$  and velocities  $v_A, v_B$ . What can you say about them at the time of the collision?