Assignment #1 solutions

1. Chapter 2, Question 17

The graph represents the position x of a car as a function of time t. Recall that the slope of the position graph at time t is the velocity at time t. It is obvious that at instant 1 the slope (and hence the velocity) is negative and the slope (velocity) at instant 2 is also negative.

2. Chapter 2, Problem 12

The velocity of the bicyclist can be obtained from the graph, since the slope of the position graph is the velocity. The slope is constant between t = 0 and t = 20 seconds: 

$$v = \frac{\Delta x}{\Delta t} = \frac{100-50}{20-0} = \frac{50}{20} = 2.5 \text{ m/s}.$$ 

Between t = 20 s and t = 30 s, the slope is 0, which means the bicyclist is motionless. Finally, the velocity between 30-40 s is negative:

$$v = \frac{\Delta x}{\Delta t} = \frac{0-100}{40-30} = -\frac{100}{10} = -10 \text{ m/s}.$$ 

So, these are the values to be placed on the (v, t) graph in the corresponding intervals.

3. Chapter 2, Problem 13

(a) The (x, t) graph can be divided into three regions (see figure below), each of which has a different velocity:

Region 1 (t = 0 – 1 s): 

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f-x_i}{t_f-t_i} = \frac{0-0}{1-0} = 0 \text{ m/s}$$

Region 2 (t = 1 – 2 s): 

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f-x_i}{t_f-t_i} = \frac{20-0}{2-1} = 20 \text{ m/s}$$

Region 3 (t = 2 – 4 s): 

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f-x_i}{t_f-t_i} = \frac{0-20}{4-2} = -10 \text{ m/s}$$

So, these are the values to be placed on the (v, t) graph in the corresponding intervals.
(b) The turning point of the particle occurs at $t = 2$ seconds, because of two reasons: (1) the position graph changes directions at this point, and (2) the velocity graph is discontinuous ($v$ goes from positive to negative).

4. Chapter 2, Problem 17

Given any kinematic graph for an object, we immediately know everything about the other two graphs. Let’s answer the questions in reverse order.

(a) We have a $(v, t)$ graph whose slope is constant over the range $t = 0$ to $t = 3$ seconds. That means the acceleration is constant, with value $a = \text{slope} = \frac{\Delta v}{\Delta t} = \frac{6-0}{3-0} = 2 \text{ m/s}^2$. So, the acceleration at $t = 2.0$ s is $a = 2 \text{ m/s}^2$.

(b) The velocity at $t = 2.0$ s can be read off the graph: $v = 4 \text{ m/s}$.

(c) The position can be obtained from the kinematic equation $x_f = x_i + v_i t + \frac{1}{2} a t^2$, where we know that $x_i = 2.0$ m, $v_i = 0$ m/s, and $a = 2$ m/s$^2$. This tells us that its position at $t = 2.0$ s is $x_f = 2.0 + (0)(2) + \frac{1}{2}(2)(2.0)^2 = 6.0$ m.