Chapter 2: For Thought and Discussion Answers

1. When velocity is constant, the instantaneous velocity is unchanging. That's velocity, not speed; speed—the magnitude of velocity—can be constant while direction changes. In that case average and instantaneous velocities aren't the same because instantaneous *velocity* changes.

2. It measures speed; it says nothing about direction. Round a curve at a constant speed, and your velocity is changing but your speed isn't.

3. If you travelled in a straight line without ever reversing.

4. They're not equivalent. Consider making an out-and-back round trip at constant speed. By definition (a), the average speed is equal to the magnitude of that constant speed. Since you've returned to your starting point, your displacement is zero, and so, therefore, is your average velocity. Definition (b) therefore gives 0 for your average speed. Clearly, definition (a) is the more useful one.

5. Yes; start at some position $x < 0$ and move in the positive direction. You'll pass through $x = 0$ and you'll be moving.

6. Yes, by analogy with the answer to the preceding question. An example is a ball thrown straight up. Its acceleration is always downward (with magnitude g), even when it's instantaneously stopped at the peak of its trajectory. Just before it reaches the top, it is moving up; just after, it is moving down. The associated Δv is downward, no matter how small the time interval about the peak. So there's always a downward acceleration, even at the peak when, instantaneously, the ball isn't moving.

7. The object can be at height y on the way up and again on the way down. If the object is launched upward from above height y, then only one answer is meaningful; the other answer gives the time it would have been at y had it not been launched. But if the object is launched from below y, both answers are meaningful. The smaller one is when it passes y on the way up, the larger answer on the way down.

8. NO! Equation 2.10 applies *only* to constant acceleration. Here the acceleration isn't constant. You'd have to use calculus to derive an equation analogous to Equation 2.10 for this case (which you can do in Problem 80 if you take $a_0 = 0$).

9. This is obviously true for (a), which represents constant acceleration (we used this fact to develop the equations of motion for constant acceleration). It's not true for (b) or (c); (b) shows a case where the average velocity is less than the average of the beginning and ending velocities, and (c) shows a case where the average velocity is greater. (d) is an unusual special case; over the interval shown, the lower velocities during the first half of the interval cancel the higher velocities during the second half, making the overall average equal to the averages of the velocities at the endpoints. But that works only for special choices of endpoints (this one or any endpoints spaced symmetrically about the middle). This contrasts with case (a) of constant acceleration, where the two averages are equal for *any* choice of endpoints.

10. Yes, it is; you go a total of 150 km/h in 2 hours, for an average of 75 km/h.

11. No, it isn't. The first part of the trip takes 1 h and the second part takes ½ h. So you go a total of 100 km in 1.5 hours, for an average of 66.7 km/h. Problem 75 provides a more general derivation of the speeds in this question and the preceding one.