1. C Displacement is a vector quantity that measures the distance between the starting point and ending point, not taking the actual path traveled into account. At the end of four laps, the athlete will be back at the starting line for the track, so the athlete’s total displacement will be zero.

2. D Statement I refers to distance, not displacement, since the five-mile distance is along a winding road and does not describe a straight-line path. Both statements II and III, however, contain a reference to displacement. The altitude of a town is a measure of the straight-line distance between the town and sea level. “As the crow flies” is a common way of saying “in a straight-line path.” Neither statement II nor statement III describes a certain route between the two points in question: they simply describe how far apart those two points are.

3. A Average velocity is a measure of total displacement divided by total time. Total displacement is the distance separating the starting point and the finishing point. Since the car both starts and finishes at point A, its total displacement is zero, so its average velocity is also zero.

4. B Average speed is a measure of total distance traveled divided by the total time of the trip. Solving this problem calls for a single calculation:

5. E 51The force of air resistance against a ball increases as the ball accelerates. At a certain point, the force of air resistance will be equal to the force of gravity, and the net force acting on the ball will be zero. At this point, its velocity will remain constant. This velocity is known as an object’s “terminal velocity,” and it explains why, in real life, many falling objects don’t continue accelerating all the way to the ground.

6. C Acceleration is a measure of the change in velocity over time. The car’s change in velocity is 40 – 20 = 20 m/s. Since this change in velocity takes place over 4 seconds, the car’s acceleration is

7. C Point A is below the t-axis, which means that the velocity is negative. Since velocity is the change in displacement over time, we can conclude that if the velocity is negative, then the displacement is decreasing.Acceleration is given by the slope of the graph. Since the line at point A has a positive slope, we know that the acceleration is increasing.

8. C Acceleration is given by the slope of the line. As we can see, the slope is greater at point A than at point B, so the acceleration is less at point B.The change in displacement is given by the area between the graph and the t-axis:As we can see, between points A and B, a great deal more of the graph is above the t-axis than below it. This means that, overall, displacement is positive between these two points.

9. D 52We know the total distance the sprinter covers, and we know the total time. However, since the acceleration isn’t uniform, we can’t calculate the velocity quite so simply. Rather, we need two equations, one for the first 50 meters of the race, and another for the second 50 meters. In the first 50 meters, the sprinter accelerates from an initial velocity of to a final velocity of v in an amount of time, . We can express this relationship using the kinematic equation that leaves out velocity, and then solve for t:In the last 50 meters of the race, the sprinter runs with a constant velocity of v, covering a distance of x = 50 m in a time . Solving for , we find:We know that the total time of the race, s. With this in mind, we can add the two sprint times together and solve for v:

10. A Average velocity is given by the total displacement divided by the total time elapsed. The displacement is not simply 30 + 40 = 70 m, however, since the woman doesn’t run in a straight-line path. The 40 m north and the 30 m east are at right angles to one another, so we can use the Pythagorean Theorem to determine that the total displacement is in fact 50 m. Her displacement is 50 m over a total time of 10 s, so her average velocity is 5.0 m/s.