## 2.2 One-Dimensional Displacement and Velocity: Vector Quantities

**1.** **MC** A scalar quantity has (a) only magnitude, (b) only direction, (c) both magnitude and direction. (a)

**2.** **MC** What can be said about distance traveled relative to the magnitude of displacement? (a) greater than, (b) equal to, (c) both a and b. (c)

**3.** **MC** A vector quantity has (a) only magnitude, (b) only direction, (c) both direction and magnitude. (c) $+5\ \text{km/h}$.

**4.** **MC** What can be said about average speed relative to the magnitude of the average velocity? (a) greater than, (b) equal to, (c) both a and b. (c)

**10.** ● What is the magnitude of the displacement of a car that travels half a lap along a circle that has a radius of 150 m? How about when the car travels a full lap? 300 m; zero

**11.** ● A student throws a rock straight upward at shoulder level, which is 1.65 m above the ground. What is the displacement of the rock when it hits the ground? 1.65 m down

**19.** **IE** ●● A student runs 30 m east, 40 m north, and 50 m west. (a) The magnitude of the student's net displacement is (1) between 0 and 20 m, (2) between 20 m and 40 m, (3) between 40 m and 60 m. (b) What is his net displacement? (a) (3) between 40 m and 60 m (b) 45 m at 27° west of north

**28.** ●●● A student driving home for the holidays starts at 8:00 AM to make the 675-km trip, practically all of which is on nonurban interstate highway. If she wants to arrive home no later than 3:00 PM, what must be her minimum average speed? Will she have to exceed the 65-mi/h speed limit? 59.9 mi/h; no

**30.** ●●● Two runners approaching each other on a straight track have constant speeds of $4.50\ \text{m/s}$ and $3.50\ \text{m/s}$, respectively, when they are 100 m apart (▼Fig. 2.20). How long will it take for the runners to meet, and at what position will they meet if they maintain these speeds? 12.5 s, 56.3 m (relative to runner on left)

## 2.3 Acceleration

**31.** **MC** On a position-versus-time plot for an object that has a constant acceleration, the graph is (a) a horizontal line, (b) a nonhorizontal and nonvertical straight line, (c) a vertical line, (d) a curve. (d)

**32.** **MC** An acceleration may result from (a) an increase in speed, (b) a decrease in speed, (c) a change of direction, (d) all of the preceding. (d)

**33.** **MC** A negative acceleration can cause (a) an increase in speed, (b) a decrease in speed, (c) either a or b. (c)

**34.** **MC** The gas pedal of an automobile is commonly referred to as the *accelerator*. Which of the following might also be called an accelerator: (a) the brakes; (b) the steering wheel; (c) the gear shift; or (d) all of the preceding? Explain. (d)

**48.** ●● A train on a straight, level track has an initial speed of $35.0\ \text{km/h}$. A uniform acceleration of $1.50\ \text{m/s}^2$ is applied while the train travels 200 m. (a) What is the speed of the train at the end of this distance? (b) How long did it take for the train to travel the 200 m? (a) $26.3\ \text{m/s}$ (b) 11.1 s

**52.** ●● A car initially traveling to the right at a steady speed of $25\ \text{m/s}$ for 5.0 s applies its brakes and slows at a constant rate of $5\ \text{m/s}^2$ for 3.0 s. It then continues traveling to the right at a steady but slower speed with no additional braking for another 6.0 s. (a) To help with the calculations, make a sketch of the car's velocity versus time, being sure to show all three time intervals. (b) What is its velocity after the 3.0 s of braking? (c) What was its displacement during the total 14.0 s of its motion? (d) What was its average speed for the 14.0 s? (a) see ISM (b) $10\ \text{m/s}$ (c) $2.4\times10^2\ \text{m/s}$ (d) $17\ \text{m/s}$

**54.** **MC** For a constant linear acceleration, the velocity-versus-time graph is (a) a horizontal line, (b) a vertical line, (c) a nonhorizontal and nonvertical straight line, (d) a curved line. (c)

**55.** **MC** For a constant linear acceleration, the position-versus-time graph would be (a) a horizontal line, (b) a vertical line, (c) a nonhorizontal and nonvertical straight line, (d) a curve. (d)

**56.** **MC** An object accelerates uniformly from rest for $t$ seconds. The object's average speed for this time interval is (a) $\frac{1}{2}at$, (b) $\frac{1}{2}at^2$, (c) $2at$, (d) $2at^2$. (a)

**57.** **CQ** If an object's velocity-versus-time graph is a horizontal line, what can you say about the object's acceleration? it is zero

## 2.4 Kinematic Equations (Constant Acceleration)

**75.** ●● (a) Show that the area under the curve of a velocity-versus-time plot for a constant acceleration is equal to the displacement. [*Hint*: The area of a triangle is $ab/2$, or one half the altitude times the base.] (b) Compute

the distance traveled for the motion represented by Fig. 2.22. (a) $A = v_o t + \frac{1}{2} a t^2$ (b) 96 m

**81.** ●●● A car accelerates horizontally from rest on a level road at a constant acceleration of $3.00\ \text{m/s}^2$. Down the road, it passes through two photocells ("electric eyes" designated by 1 for the first one and 2 for the second one) that are separated by 20.0 m. The time interval to travel this 20.0-m distance as measured by the electric eyes is 1.40 s. (a) Calculate the speed of the car as it passes *each* electric eye. (b) How far is it from the start to the first electric eye? (c) How long did it take the car to get to the first electric eye? (a) $12.2\ \text{m/s}, 16.4\ \text{m/s}$ (b) 24.8 (c) 4.07 s

## 2.5 Free Fall

*Neglect air resistance in the following Exercises.*

**83.** **MC** An object is thrown vertically upward. Which of the following statements is true: (a) Its velocity changes non-uniformly; (b) its maximum height is independent of the initial velocity; (c) its travel time upward is slightly greater than its travel time downward; (d) the speed on returning to its starting point is the same as its initial speed? (d)

**84.** **MC** The free-fall motion described in this section applies to (a) an object dropped from rest, (b) an object thrown vertically downward, (c) an object thrown vertically upward, (d) all of the preceding. (d)

**85.** **MC** A dropped object in free fall (a) falls 9.8 m each second, (b) falls 9.8 m during the first second, (c) has an increase in speed of $9.8\ \text{m/s}$ each second, (d) has an increase in acceleration of $9.8\ \text{m/s}^2$ each second. (c)

**86.** **MC** An object is thrown straight upward. At its maximum height, (a) its velocity is zero, (b) its acceleration is zero, (c) both a and b. (a)

**87.** **MC** When an object is thrown vertically upward, it is accelerating on (a) the way up, (b) on the way down, (c) both a and b. (c)

**98.** ●● The ceiling of a classroom is 3.75 m above the floor. A student tosses an apple vertically upward, releasing it 0.50 m above the floor. What is the maximum initial speed that can be given to the apple if it is not to touch the ceiling? slightly less than $8.0\ \text{m/s}$

**99.** ●● The Petronas Twin Towers in Malaysia and the Chicago Sears Tower have heights of about 452 m and 443 m, respectively. If objects were dropped from the top of each, what would be the difference in the time it takes the objects to reach the ground? $\Delta t = 0.096\ \text{s}$

**113.** Many highways with steep downhill areas have "runaway truck" inclined paths just off the main roadbed. These paths are designed so that if a vehicle's braking system gives out, the driver can steer it onto this incline (usually composed of loose gravel). The idea is that the vehicle can then roll up the incline and come permanently and safely to rest (in the gravel) with no need of a braking system. In one region of Hawaii the incline distance is 300 m and provides a (constant) deceleration of $2.50\ \text{m/s}^2$. (a) What is the maximum speed that a runaway vehicle can have as it enters the incline? (b) How long would such a vehicle take to come to rest? (c) Suppose another vehicle moving $10\ \text{mi/h}$ $(4.47\ \text{m/s})$ faster than the maximum value enters the incline. What speed will it have as it leaves the gravel-filled area? (a) $38.7\ \text{m/s}$ (b) 15.5 s (c) $19.2\ \text{m/s}$