KEY TERMS

acceleration the rate at which velocity changes
average speed distance traveled divided by time during which motion occurs
average velocity displacement divided by time over which displacement occurs
dependent variable the variable that changes as the independent variable changes
displacement the change in position of an object against a fixed axis
distance the length of the path actually traveled between an initial and a final position
independent variable the variable, usually along the horizontal axis of a graph, that does not change based on human or experimental action; in physics this is usually time
instantaneous speed speed at a specific instant in time
instantaneous velocity velocity at a specific instant in time
kinematics the study of motion without considering its causes
magnitude size or amount
position the location of an object at any particular time
reference frame a coordinate system from which the positions of objects are described
scalar a quantity that has magnitude but no direction
speed rate at which an object changes its location
tangent a line that touches another at exactly one point
vector a quantity that has both magnitude and direction
velocity the speed and direction of an object

SECTION SUMMARY

2.1 Relative Motion, Distance, and Displacement

- A description of motion depends on the reference frame from which it is described.
- The distance an object moves is the length of the path along which it moves.
- Displacement is the difference in the initial and final positions of an object.

2.2 Speed and Velocity

- Average speed is a scalar quantity that describes distance traveled divided by the time during which the motion occurs.
- Velocity is a vector quantity that describes the speed and direction of an object.
- Average velocity is displacement over the time period during which the displacement occurs. If the velocity is constant, then average velocity and instantaneous velocity are the same.

2.3 Position vs. Time Graphs

- Graphs can be used to analyze motion.
- The slope of a position vs. time graph is the velocity.
- For a straight line graph of position, the slope is the average velocity.
- To obtain the instantaneous velocity at a given moment for a curved graph, find the tangent line at that point and take its slope.

2.4 Velocity vs. Time Graphs

- The slope of a velocity vs. time graph is the acceleration.
- The area under a velocity vs. time curve is the displacement.
- Average velocity can be found in a velocity vs. time graph by taking the weighted average of all the velocities.

KEY EQUATIONS

2.1 Relative Motion, Distance, and Displacement

Displacement $\Delta \mathbf{d} = \mathbf{d_f} - \mathbf{d_0}$

2.2 Speed and Velocity

Average speed $v_{\text{avg}} = \frac{\textbf{distance}}{\textbf{time}}$

Average velocity $\mathbf{v}_{\text{avg}} = \frac{\Delta \mathbf{d}}{\Delta t} = \frac{\mathbf{d}_f - \mathbf{d}_0}{t_f - t_0}$

2.3 Position vs. Time Graphs

Displacement $\mathbf{d} = \mathbf{d}_0 + \mathbf{v}t$.

2.4 Velocity vs. Time Graphs

Velocity $\mathbf{v} = \mathbf{v}_0 + at$

Acceleration $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t}$

CHAPTER REVIEW

Concept Items

2.1 Relative Motion, Distance, and Displacement

1. Can one-dimensional motion have zero distance but a nonzero displacement? What about zero displacement but a nonzero distance?
   a. One-dimensional motion can have zero distance with a nonzero displacement. Displacement has both magnitude and direction, and it can also have zero displacement with nonzero distance because distance has only magnitude.
   b. One-dimensional motion can have zero distance with a nonzero displacement. Displacement has both magnitude and direction, but it cannot have zero displacement with nonzero distance because distance has only magnitude.
   c. One-dimensional motion cannot have zero distance with a nonzero displacement. Displacement has both magnitude and direction, but it can have zero displacement with nonzero distance because distance has only magnitude and any motion will be the distance it moves.
   d. One-dimensional motion cannot have zero distance with a nonzero displacement. Displacement has both magnitude and direction, and it cannot have zero displacement with nonzero distance because distance has only magnitude.

2. In which example would you be correct in describing an object in motion while your friend would also be correct in describing that same object as being at rest?
   a. You are driving a car toward the east and your friend drives past you in the opposite direction with the same speed. In your frame of reference, you will be in motion. In your friend's frame of reference, you will be at rest.
   b. You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, you will be in motion. In your friend's frame of reference, you will be at rest.
   c. You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, your friend will be moving toward the west. In your friend's frame of reference, he will be at rest.
   d. You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, your friend will be moving toward the east. In your friend's frame of reference, he will be at rest.

3. What does your car's odometer record?
   a. displacement
   b. distance
   c. both distance and displacement
   d. the sum of distance and displacement

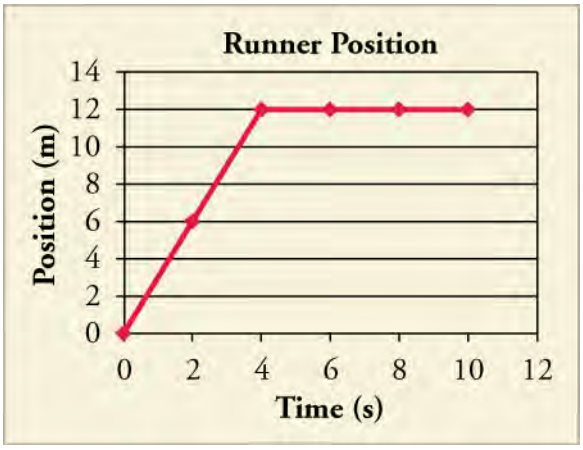
2.2 Speed and Velocity

4. In the definition of velocity, what physical quantity is changing over time?
   a. speed
   b. distance
   c. magnitude of displacement
   d. position vector

5. Which of the following best describes the relationship between instantaneous velocity and instantaneous speed?
   a. Both instantaneous speed and instantaneous velocity are the same, even when there is a change in direction.
   b. Instantaneous speed and instantaneous velocity cannot be the same even if there is no change in direction of motion.
   c. Magnitude of instantaneous velocity is equal to instantaneous speed.
   d. Magnitude of instantaneous velocity is always greater than instantaneous speed.

2.3 Position vs. Time Graphs

6. Use the graph to describe what the runner's motion looks like.



How are average velocity for only the first four seconds and instantaneous velocity related? What is the runner's net displacement over the time shown?
   a. The net displacement is 12 m and the average velocity is equal to the instantaneous velocity.
   b. The net displacement is 12 m and the average velocity

is two times the instantaneous velocity.

c. The net displacement is 10 + 12 = 22 m and the average velocity is equal to the instantaneous velocity.

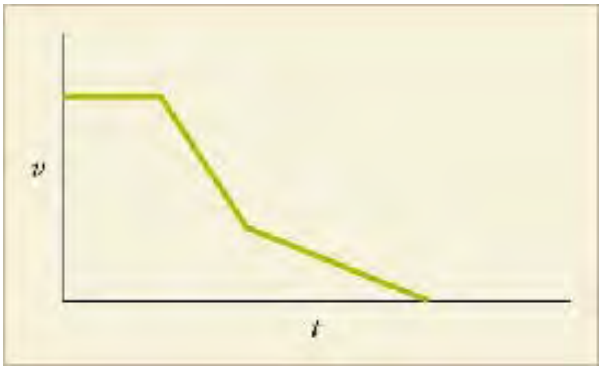
d. The net displacement is 10 + 12 = 22 m and the average velocity is two times the instantaneous velocity.

7. A position vs. time graph of a frog swimming across a pond has two distinct straight-line sections. The slope of the first section is 1 m/s. The slope of the second section is 0 m/s. If each section lasts 1 second, then what is the frog's total average velocity?

a. 0 m/s
b. 2 m/s
c. 0.5 m/s
d. 1 m/s

2.4 Velocity vs. Time Graphs

8. A graph of velocity vs. time of a ship coming into a harbor is shown.



Describe the acceleration of the ship based on the graph.

a. The ship is moving in the forward direction at a steady rate. Then it accelerates in the forward direction and then decelerates.

b. The ship is moving in the forward direction at a steady rate. Then it turns around and starts decelerating, while traveling in the reverse direction. It then accelerates, but slowly.

c. The ship is moving in the forward direction at a steady rate. Then it decelerates in the forward direction, and then continues to slow down in the forward direction, but with more deceleration.

d. The ship is moving in the forward direction at a steady rate. Then it decelerates in the forward direction, and then continues to slow down in the forward direction, but with less deceleration.

Critical Thinking Items

2.1 Relative Motion, Distance, and Displacement

9. Boat A and Boat B are traveling at a constant speed in opposite directions when they pass each other. If a person in each boat describes motion based on the boat's own reference frame, will the description by a person in Boat A of Boat B's motion be the same as the description by a person in Boat B of Boat A's motion?

a. Yes, both persons will describe the same motion because motion is independent of the frame of reference.

b. Yes, both persons will describe the same motion because they will perceive the other as moving in the backward direction.

c. No, the motion described by each of them will be different because motion is a relative term.

d. No, the motion described by each of them will be different because the motion perceived by each will be opposite to each other.

10. Passenger A sits inside a moving train and throws a ball vertically upward. How would the motion of the ball be described by a fellow train passenger B and an observer C who is standing on the platform outside the train?

a. Passenger B sees that the ball has vertical, but no horizontal, motion. Observer C sees the ball has vertical as well as horizontal motion.

b. Passenger B sees the ball has vertical as well as horizontal motion. Observer C sees the ball has the vertical, but no horizontal, motion.

c. Passenger B sees the ball has horizontal but no vertical motion. Observer C sees the ball has vertical as well as horizontal motion.

d. Passenger B sees the ball has vertical as well as horizontal motion. Observer C sees the ball has horizontalbut no vertical motion.

2.2 Speed and Velocity

11. Is it possible to determine a car's instantaneous velocity from just the speedometer reading?

a. No, it reflects speed but not the direction.

b. No, it reflects the average speed of the car.

c. Yes, it sometimes reflects instantaneous velocity of the car.

d. Yes, it always reflects the instantaneous velocity of the car.

12. Terri, Aaron, and Jamal all walked along straight paths.

Terri walked 3.95 km north in 48 min. Aaron walked 2.65 km west in 31 min. Jamal walked 6.50 km south in 81 min. Which of the following correctly ranks the three boys in order from lowest to highest average speed?

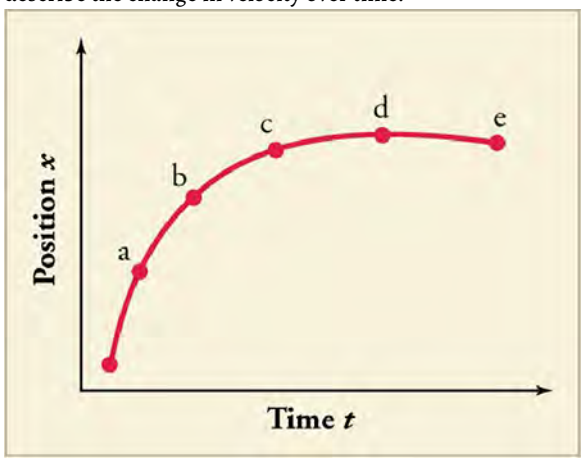
a. Jamal, Terri, Aaron
b. Jamal, Aaron, Terri
c. Terri, Jamal, Aaron
d. Aaron, Terri, Jamal

13. Rhianna and Logan start at the same point and walk due north. Rhianna walks with an average velocity $v_{\text{avg,R}}$. Logan walks three times the distance in twice the time as Rhianna. Which of the following expresses Logan's average velocity in terms of $v_{\text{avg,R}}$?

a. Logan's average velocity = $1.5v_{avg,R}$.
b. Logan's average velocity = $\frac{2}{3}v_{avg,R}$.
c. Logan's average velocity = $3v_{avg,R}$.
d. Logan's average velocity = $\frac{1}{2}v_{avg,R}$.

2.3 Position vs. Time Graphs

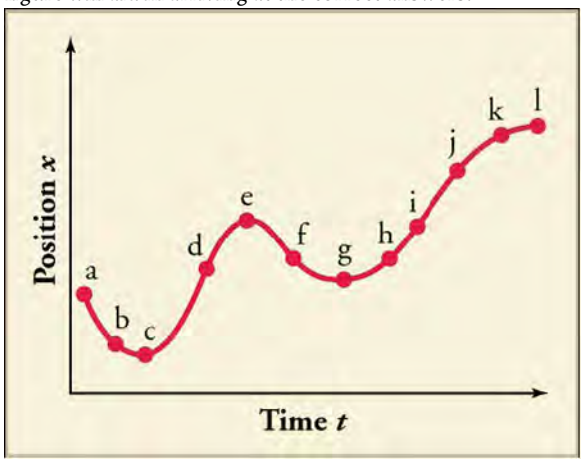
14. Explain how you can use the graph of position vs. time to describe the change in velocity over time.



Identify the time (t_a, t_b, t_c, t_d, or t_e) at which at which the instantaneous velocity is greatest, the time at which it is zero, and the time at which it is negative.

2.4 Velocity vs. Time Graphs

15. Identify the time, or times, at which the instantaneous velocity is greatest, and the time, or times, at which it is negative. A sketch of velocity vs. time derived from the figure will aid in arriving at the correct answers.



a. The instantaneous velocity is greatest at *f*, and it is negative at *d*, *h*, *I*, *j*, and *k*.
b. The instantaneous velocity is greatest at *e*, and it is negative at *a*, *b*, and *f*.
c. The instantaneous velocity is greatest at *f*, and it is negative at *d*, *h*, *I*, *j*, and *k*
d. The instantaneous velocity is greatest at *d*, and it is negative at *a*, *b*, and *f*.

Problems

2.1 Relative Motion, Distance, and Displacement

16. In a coordinate system in which the direction to the right is positive, what are the distance and displacement of a person who walks 35 meters to the left, 18 meters to the right, and then 26 meters to the left?

a. Distance is 79 m and displacement is −43 m.
b. Distance is −79 m and displacement is 43 m.
c. Distance is 43 m and displacement is −79 m.
d. Distance is −43 m and displacement is 79 m.

17. Billy drops a ball from a height of 1 m. The ball bounces back to a height of 0.8 m, then bounces again to a height of 0.5 m, and bounces once more to a height of 0.2 m. Up is the positive direction. What are the total displacement of the ball and the total distance traveled by the ball?

a. The displacement is equal to -4 m and the distance is equal to 4 m.
b. The displacement is equal to 4 m and the distance is equal to 1 m.
c. The displacement is equal to 4 m and the distance is equal to 1 m.
d. The displacement is equal to -1 m and the distance is equal to 4 m.

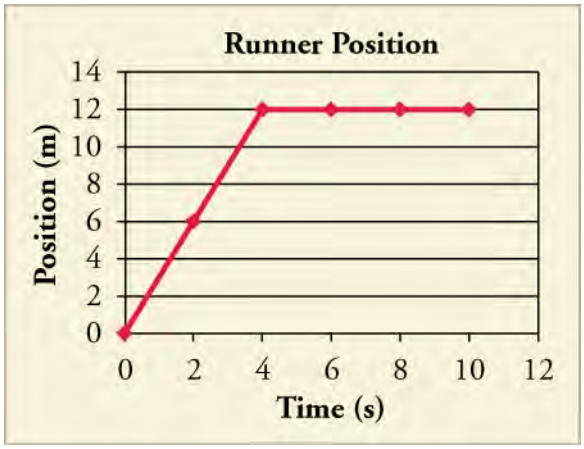
2.2 Speed and Velocity

18. You sit in a car that is moving at an average speed of 86.4 km/h. During the 3.3 s that you glance out the window, how far has the car traveled?

a. 7.27 m
b. 79 m
c. 285 km
d. 1026 m

2.3 Position vs. Time Graphs

19. Using the graph, what is the average velocity for the whole 10 seconds?



a. The total average velocity is 0 m/s.
b. The total average velocity is 1.2 m/s.
c. The total average velocity is 1.5 m/s.
d. The total average velocity is 3.0 m/s.

20. A train starts from rest and speeds up for 15 minutes until it reaches a constant velocity of 100 miles/hour. It stays at this speed for half an hour. Then it slows down for another 15 minutes until it is still. Which of the following correctly describes the position vs time graph of the train's journey?

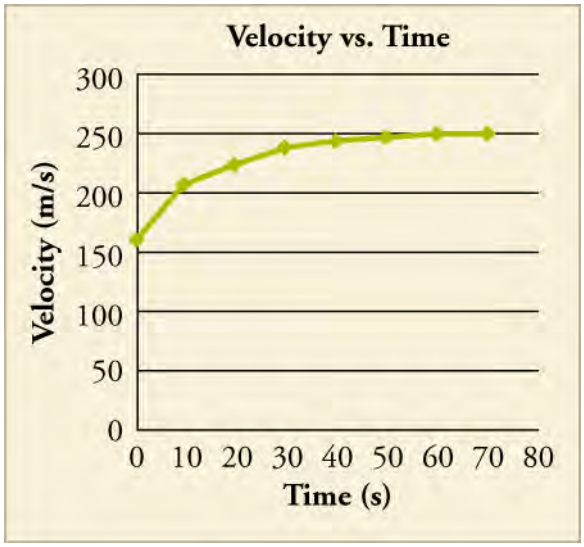
a. The first 15 minutes is a curve that is concave upward, the middle portion is a straight line with slope 100 miles/hour, and the last portion is a concave downward curve.
b. The first 15 minutes is a curve that is concave downward, the middle portion is a straight line with slope 100 miles/hour, and the last portion is a concave upward curve.
c. The first 15 minutes is a curve that is concave upward, the middle portion is a straight line with slope zero, and the last portion is a concave downward curve.
d. The first 15 minutes is a curve that is concave downward, the middle portion is a straight line with slope zero, and the last portion is a concave upward curve.

2.4 Velocity vs. Time Graphs

21. You are characterizing the motion of an object by measuring the location of the object at discrete moments in time. What is the minimum number of data points you would need to estimate the average acceleration of the object?

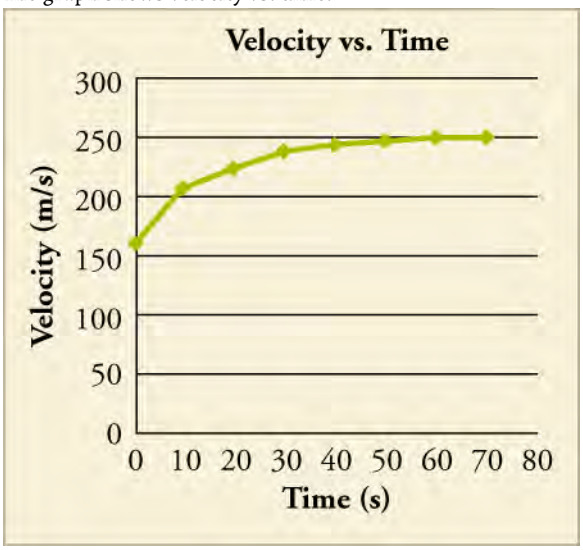
a. 1
b. 2
c. 3
d. 4

22. Which option best describes the average acceleration from 40 to 70 s?



a. It is negative and smaller in magnitude than the initial acceleration.
b. It is negative and larger in magnitude than the initial acceleration.
c. It is positive and smaller in magnitude than the initial acceleration.
d. It is positive and larger in magnitude than the initial acceleration.

23. The graph shows velocity vs. time.



Calculate the net displacement using seven different divisions. Calculate it again using two divisions: 0 → 40 s

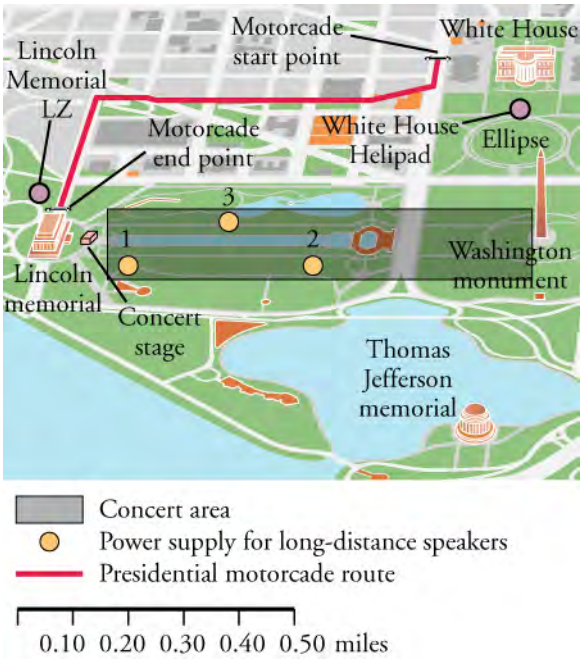
and $40 \rightarrow 70$ s . Compare. Using both, calculate the average velocity.

a. Displacement and average velocity using seven divisions are 14,312.5 m and 204.5 m/s while with two divisions are 15,500 m and 221.4 m/s respectively.
b. Displacement and average velocity using seven divisions are 15,500 m and 221.4 m/s while with two divisions are 14,312.5 m and 204.5 m/s respectively.
c. Displacement and average velocity using seven divisions are 15,500 m and 204.5 m/s while with two divisions are 14,312.5 m and 221.4 m/s respectively.
d. Displacement and average velocity using seven divisions are 14,312.5 m and 221.4 m/s while with two divisions are 15,500 m and 204.5 m/s respectively.

Performance Task

2.4 Velocity vs. Time Graphs

24. The National Mall in Washington, DC, is a national park containing most of the highly treasured memorials and museums of the United States. However, the National Mall also hosts many events and concerts. The map in shows the area for a benefit concert during which the president will speak. The concert stage is near the Lincoln Memorial. The seats and standing room for the crowd will stretch from the stage east to near the Washington Monument, as shown on the map. You are planning the logistics for the concert. Use the map scale to measure any distances needed to make the calculations below.



The park has three new long-distance speakers. They would like to use these speakers to broadcast the concert audio to other parts of the National Mall. The speakers can project sound up to 0.35 miles away but they must be connected to one of the power supplies within the concert area. What is the minimum amount of wire needed for each speaker, in miles, in order to project the audio to the following areas? Assume that wire cannot be placed over buildings or any memorials.

Part A. The center of the Jefferson Memorial using power supply 1 (This will involve an elevated wire that can travel over water.)

Part B. The center of the Ellipse using power supply 3 (This wire cannot travel over water.)

Part C. The president's motorcade will be traveling to the concert from the White House. To avoid concert traffic, the motorcade travels from the White House west down E Street and then turns south on 23rd Street to reach the Lincoln memorial. What minimum speed, in miles per hour to the nearest tenth, would the motorcade have to travel to make the trip in 5 minutes?

Part D. The president could also simply fly from the White House to the Lincoln Memorial using the presidential helicopter, Marine 1. How long would it take Marine 1, traveling slowly at 30 mph, to travel from directly above the White House landing zone (LZ) to directly above the Lincoln Memorial LZ? Disregard liftoff and landing times and report the travel time in minutes to the nearest minute.

TEST PREP

Multiple Choice

2.1 Relative Motion, Distance, and Displacement

25. Why should you specify a reference frame when describing motion?

a. a description of motion depends on the reference frame
b. motion appears the same in all reference frames
c. reference frames affect the motion of an object
d. you can see motion better from certain reference frames

26. Which of the following is true for the displacement of an object?

a. It is always equal to the distance the object moved

between its initial and final positions.
b. It is both the straight line distance the object moved as well as the direction of its motion.
c. It is the direction the object moved between its initial and final positions.
d. It is the straight line distance the object moved between its initial and final positions.

27. If a biker rides west for 50 miles from his starting position, then turns and bikes back east 80 miles. What is his net displacement?
a. 130 miles
b. 30 miles east
c. 30 miles west
d. Cannot be determined from the information given

28. Suppose a train is moving along a track. Is there a single, correct reference frame from which to describe the train's motion?
a. Yes, there is a single, correct frame of reference because motion is a relative term.
b. Yes, there is a single, correct frame of reference which is in terms of Earth's position.
c. No, there is not a single, correct frame of reference because motion is a relative term.
d. No, there is not a single, correct frame of reference because motion is independent of frame of reference.

29. If a space shuttle orbits Earth once, what is the shuttle's distance traveled and displacement?
a. Distance and displacement both are zero.
b. Distance is circumference of the circular orbit while displacement is zero.
c. Distance is zero while the displacement is circumference of the circular orbit.
d. Distance and displacement both are equal to circumference of the circular orbit.

2.2 Speed and Velocity

30. Four bicyclists travel different distances and times along a straight path. Which cyclist traveled with the greatest average speed?
a. Cyclist 1 travels 95 m in 27 s.
b. Cyclist 2 travels 87 m in 22 s.
c. Cyclist 3 travels 106 m in 26 s.
d. Cyclist 4 travels 108 m in 24 s.

31. A car travels with an average velocity of 23 m/s for 82 s. Which of the following could NOT have been the car's displacement?
a. 1,700 m east
b. 1,900 m west
c. 1,600 m north
d. 1,500 m south

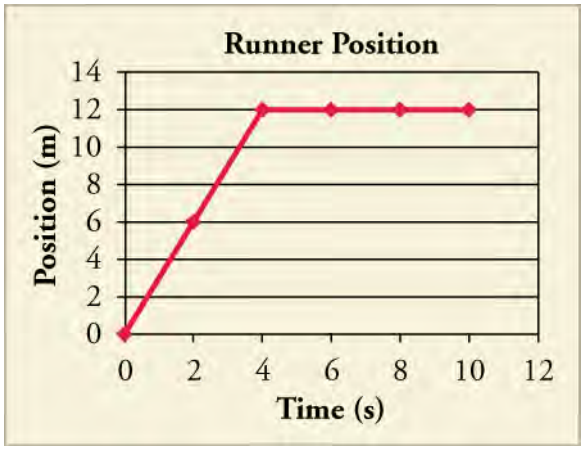
32. A bicyclist covers the first leg of a journey that is d_1 meters long in t_1 seconds, at a speed of v_1 m/s, and the second leg of d_2 meters in t_2 seconds, at a speed of v_2 m/s. If his average speed is equal to the average of v_1 and v_2, then which of the following is true?
a. $t_1 = t_2$
b. $t_1 \neq t_2$
c. $d_1 = d_2$
d. $d_1 \neq d_2$

33. A car is moving on a straight road at a constant speed in a single direction. Which of the following statements is true?
a. Average velocity is zero.
b. The magnitude of average velocity is equal to the average speed.
c. The magnitude of average velocity is greater than the average speed.
d. The magnitude of average velocity is less than the average speed.

2.3 Position vs. Time Graphs

34. What is the slope of a straight line graph of position vs. time?
a. Velocity
b. Displacement
c. Distance
d. Acceleration

35. Using the graph, what is the runner's velocity from 4 to 10 s?



a. −3 m/s
b. 0 m/s
c. 1.2 m/s
d. 3 m/s

2.4 Velocity vs. Time Graphs

36. What does the area under a velocity vs. time graph line represent?
   a. acceleration
   b. displacement
   c. distance
   d. instantaneous velocity

37. An object is moving along a straight path with constant acceleration. A velocity vs. time graph starts at 0 and ends at $10\ \text{m/s}$, stretching over a time-span of $15\ \text{s}$. What is the object's net displacement?
   a. $75\ \text{m}$
   b. $130\ \text{m}$
   c. $150\ \text{m}$
   d. cannot be determined from the information given

Short Answer

2.1 Relative Motion, Distance, and Displacement

38. While standing on a sidewalk facing the road, you see a bicyclist passing by toward your right. In the reference frame of the bicyclist, in which direction are you moving?
   a. in the same direction of motion as the bicyclist
   b. in the direction opposite the motion of the bicyclist
   c. stationary with respect to the bicyclist
   d. in the direction of velocity of the bicyclist

39. Maud sends her bowling ball straight down the center of the lane, getting a strike. The ball is brought back to the holder mechanically. What are the ball's net displacement and distance traveled?
   a. Displacement of the ball is twice the length of the lane, while the distance is zero.
   b. Displacement of the ball is zero, while the distance is twice the length of the lane.
   c. Both the displacement and distance for the ball are equal to zero.
   d. Both the displacement and distance for the ball are twice the length of the lane.

40. A fly buzzes four and a half times around Kit Yan's head. The fly ends up on the opposite side from where it started. If the diameter of his head is $14\ \text{cm}$, what is the total distance the fly travels and its total displacement?
   a. The distance is $63\pi\ \text{cm}$ with a displacement of zero.
   b. The distance is $7\ \text{cm}$ with a displacement of zero.
   c. The distance is $63\pi\ \text{cm}$ with a displacement of $14\ \text{cm}$.
   d. The distance is $7\ \text{cm}$ with a displacement of $63\pi\ \text{cm}$.

2.2 Speed and Velocity

41. Rob drove to the nearest hospital with an average speed of v m/s in t seconds. In terms of t, if he drives home on the same path, but with an average speed of 3v m/s, how long is the return trip home?
   a. t/6
   b. t/3
   c. 3t
   d. 6t

42. What can you infer from the statement, *Velocity of an object is zero*?
   a. Object is in linear motion with constant velocity.
   b. Object is moving at a constant speed.
   c. Object is either at rest or it returns to the initial point.
   d. Object is moving in a straight line without changing its direction.

43. An object has an average speed of 7.4 km/h. Which of the following describes two ways you could increase the average speed of the object to 14.8 km/h?
   a. Reduce the distance that the object travels by half, keeping the time constant, or keep the distance constant and double the time.
   b. Double the distance that the object travels, keeping the time constant, or keep the distance constant and reduce the time by half.
   c. Reduce the distance that the object travels to one-fourth, keeping the time constant, or keep the distance constant and increase the time by fourfold.
   d. Increase the distance by fourfold, keeping the time constant, or keep the distance constant and reduce the time by one-fourth.

44. Swimming one lap in a pool is defined as going across a pool and back again. If a swimmer swims 3 laps in 9 minutes, how can his average velocity be zero?
   a. His average velocity is zero because his total distance is zero.
   b. His average velocity is zero because his total displacement is zero.
   c. His average velocity is zero because the number of laps completed is an odd number.
   d. His average velocity is zero because the velocity of each successive lap is equal and opposite.

2.3 Position vs. Time Graphs

45. A hockey puck is shot down the arena in a straight line. Assume it does not slow until it is stopped by an opposing player who sends it back in the direction it came. The players are 20 m apart and it takes 1 s for the puck to go there and back. Which of the following describes the graph of the displacement over time? Consider the initial direction of the puck to be positive.

a. The graph is an upward opening V.
b. The graph is a downward opening V.
c. The graph is an upward opening U.
d. The graph is downward opening U.

46. A defensive player kicks a soccer ball 20 m back to her own goalie. It stops just as it reaches her. She sends it back to the player. Without knowing the time it takes, draw a rough sketch of the displacement over time. Does this graph look similar to the graph of the hockey puck from the previous question?

a. Yes, the graph is similar to the graph of the hockey puck.
b. No, the graph is not similar to the graph of the hockey puck.
c. The graphs cannot be compared without knowing the time the soccer ball was rolling.

47. What are the net displacement, total distance traveled, and total average velocity in the previous two problems?

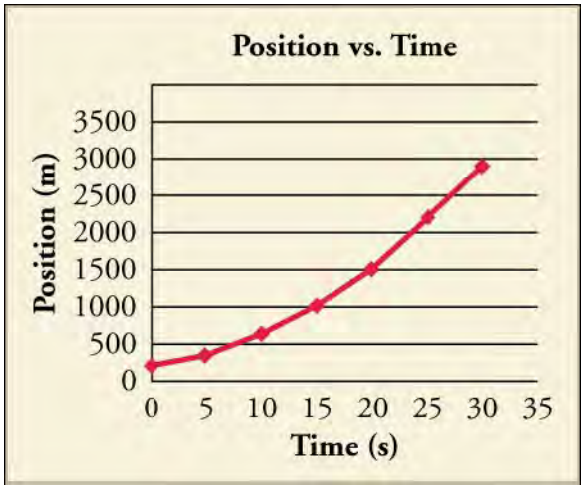
a. net displacement = 0 m, total distance = 20 m, total average velocity = 20 m/s
b. net displacement = 0 m, total distance = 40 m, total average velocity = 20 m/s
c. net displacement = 0 m, total distance = 20 m, total average velocity = 0 m/s
d. net displacement = 0 m, total distance = 40 m, total average velocity = 0 m/s

48. A bee flies straight at someone and then back to its hive along the same path. Assuming it takes no time for the bee to speed up or slow down, except at the moment it changes direction, how would the graph of position vs time look? Consider the initial direction to be positive.

a. The graph will look like a downward opening V shape.
b. The graph will look like an upward opening V shape.
c. The graph will look like a downward opening parabola.
d. The graph will look like an upward opening parabola.

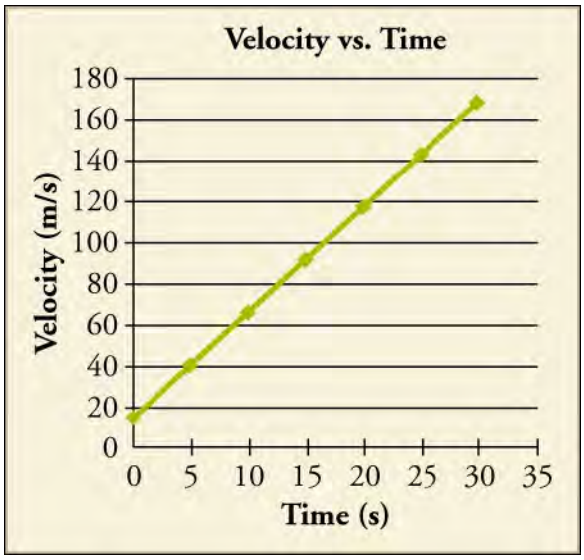
2.4 Velocity vs. Time Graphs

49. What would the velocity vs. time graph of the object whose position is shown in the graph look like?



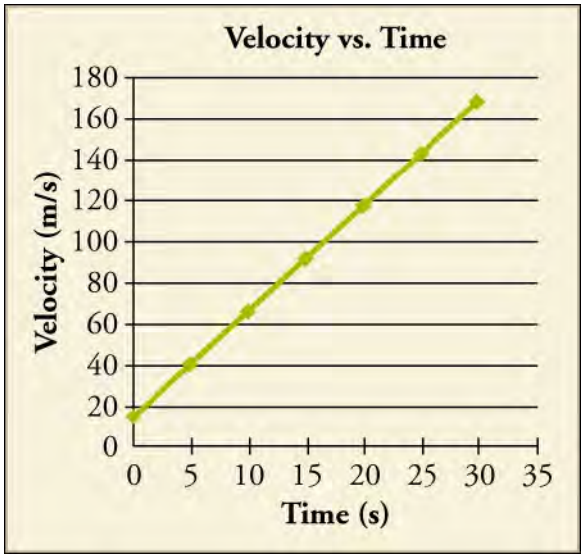
a. It is a straight line with negative slope.
b. It is a straight line with positive slope.
c. It is a horizontal line at some negative value.
d. It is a horizontal line at some positive value.

50. Which statement correctly describes the object's speed, as well as what a graph of acceleration vs. time would look like?



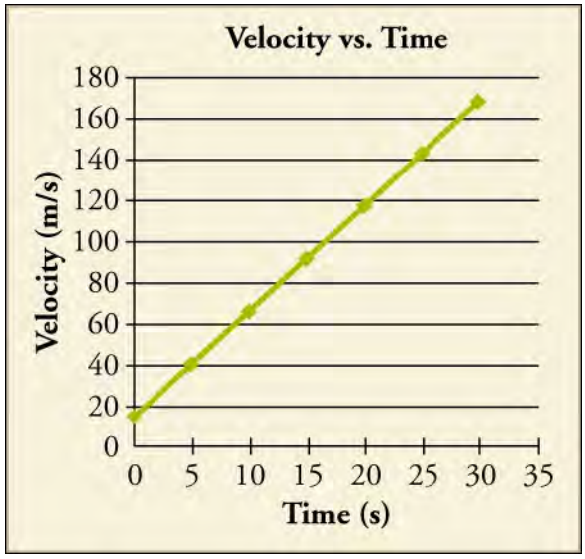
a. The object is not speeding up, and the acceleration vs. time graph is a horizontal line at some negative value.
b. The object is not speeding up, and the acceleration vs. time graph is a horizontal line at some positive value.
c. The object is speeding up, and the acceleration vs. time graph is a horizontal line at some negative value.
d. The object is speeding up, and the acceleration vs. time graph is a horizontal line at some positive value.

51. Calculate that object's net displacement over the time shown.



a. 540 m
b. 2,520 m
c. 2,790 m
d. 5,040 m

52. What is the object's average velocity?

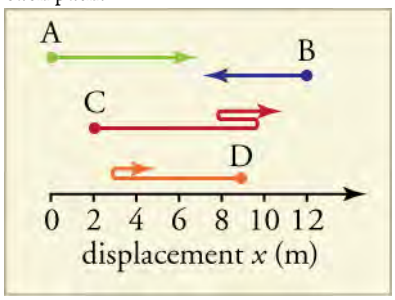


a. 18 m/s
b. 84 m/s
c. 93 m/s
d. 168 m/s

Extended Response

2.1 Relative Motion, Distance, and Displacement

53. Find the distance traveled from the starting point for each path.



Which path has the maximum distance?

a. The distance for Path A is 6 m, Path B is 4 m, Path C is 12 m and for Path D is 7 m. The net displacement for Path A is 7 m, Path B is −4m, Path C is 8 m and for Path D is −5m. Path C has maximum distance and it is equal to 12 meters.
b. The distance for Path A is 6 m, Path B is 4 m, Path C is 8 m and for Path D is 7 m. The net displacement for Path A is 6 m, Path B is −4m, Path C is 12 m and for Path D is −5 m. Path A has maximum distance and it is equal to 6 meters.
c. The distance for Path A is 6 m, Path B is 4 m, Path C is 12 m and for Path D is 7 m. The net displacement for Path A is 6 m, Path B is −4 m, Path C is 8 m and for Path D is −5 m. Path C has maximum distance and it is equal to 12 meters.
d. The distance for Path A is 6 m, Path B is −4 m, Path C is 12 m and for Path D is −5 m. The net displacement for Path A is 7 m, Path B is 4 m, Path C is 8 m and for Path D is 7 m. Path A has maximum distance and it is equal to 6 m.

54. Alan starts from his home and walks 1.3 km east to the library. He walks an additional 0.68 km east to a music store. From there, he walks 1.1 km north to a friend's house and an additional 0.42 km north to a grocery store before he finally returns home along the same path. What is his final displacement and total distance traveled?

a. Displacement is 0 km and distance is 7 km.
b. Displacement is 0 km and distance is 3.5 km.
c. Displacement is 7 km towards west and distance is 7 km.
d. Displacement is 3.5 km towards east and distance is 3.5 km.

2.2 Speed and Velocity

55. Two runners start at the same point and jog at a constant speed along a straight path. Runner A starts at time t = 0 s, and Runner B starts at time t = 2.5 s. The runners both reach a distance 64 m from the starting point at time t = 25 s. If the runners continue at the same speeds, how far from the starting point will each be at time t = 45 s?

a. Runner A will be 72×10^3 m away and Runner B

will be 59.5×10^3 m away from the starting point.

b. Runner A will be 1.2×10^2 m away and runner B will be 1.1×10^2 m away from the starting point.

c. Runner A will be 1.2×10^2 m away and Runner B will be 1.3×10^2 m away from the starting point.

d. Runner A will be 7.2×10^2 m away and Runner B will be 1.3×10^2 m away from the starting point.

56. A father and his daughter go to the bus stop that is located 75 m from their front door. The father walks in a straight line while his daughter runs along a varied path. Despite the different paths, they both end up at the bus stop at the same time. The father's average speed is 2.2 m/s, and his daughter's average speed is 3.5 m/s. (a) How long does it take the father and daughter to reach the bus stop? (b) What was the daughter's total distance traveled? (c) If the daughter maintained her same average speed and traveled in a straight line like her father, how far beyond the bus stop would she have traveled?

a. (a) 21.43 s (b) 75 m (c) 0 m

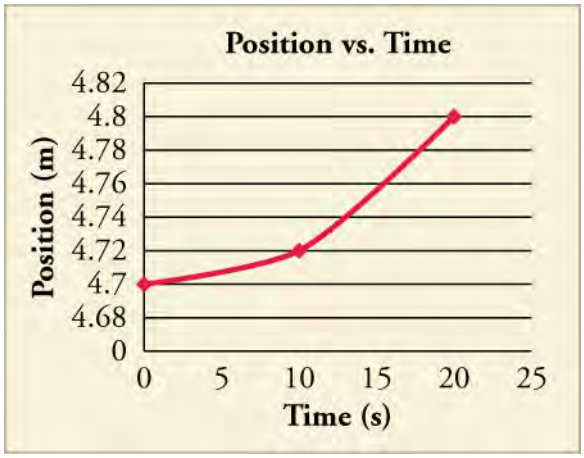
b. (a) 21.43 s (b) 119 m (c) 44 m

c. (a) 34 s (b) 75 m (c) 0 m

d. (a) 34 s (b) 119 m (c) 44 m

2.3 Position vs. Time Graphs

57. What kind of motion would create a position graph like the one shown?



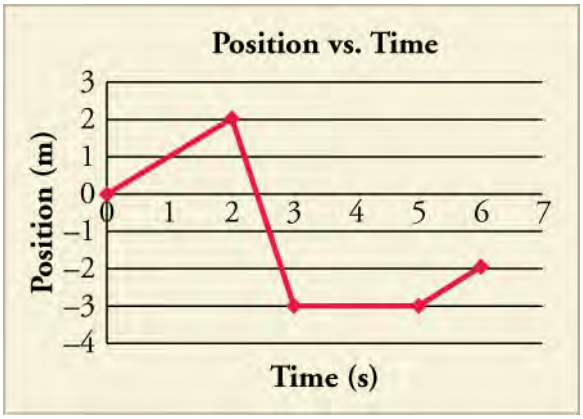
a. uniform motion

b. any motion that accelerates

c. motion that stops and then starts

d. motion that has constant velocity

58. What is the average velocity for the whole time period shown in the graph?



a. $-\frac{1}{3}$ m/s

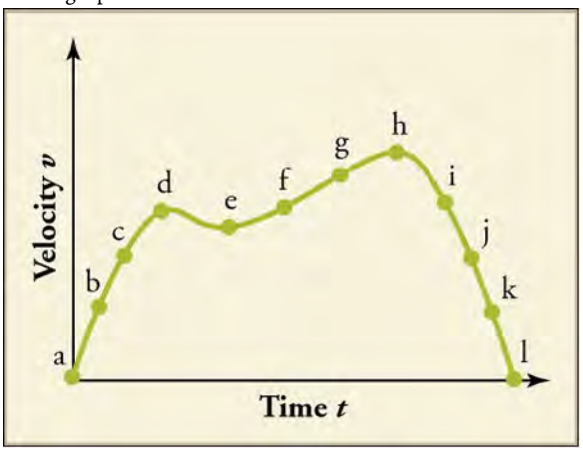
b. $-\frac{3}{4}$ m/s

c. $\frac{1}{3}$ m/s

d. $\frac{3}{4}$ m/s

2.4 Velocity vs. Time Graphs

59. Consider the motion of the object whose velocity is charted in the graph.



During which points is the object slowing down and speeding up?

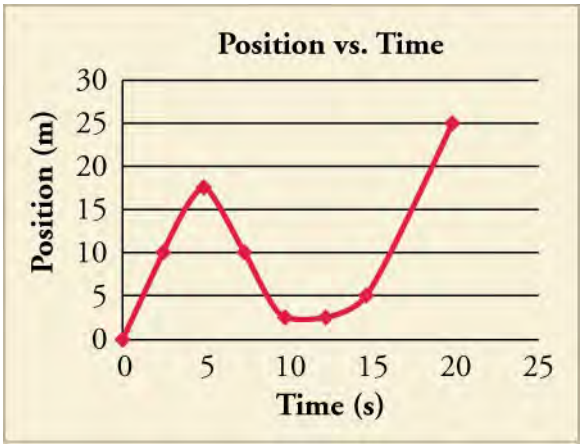
a. It is slowing down between *d* and *e*. It is speeding up between *a* and *d* and *e* and *h*

b. It is slowing down between *a* and *d* and *e* and *h*. It is speeding up between *d* and *e* and then after *i*.

c. It is slowing down between *d* and *e* and then after *h*. It is speeding up between *a* and *d* and *e* and *h*.

d. It is slowing down between *a* and *d* and *e* and *h*. It is speeding up between *d* and *e* and then after *i*.

60. Divide the graph into approximate sections, and use those sections to graph the velocity vs. time of the object.



Then calculate the acceleration during each section, and calculate the approximate average velocity.

a. Acceleration is zero and average velocity is 1.25 m/s.
b. Acceleration is constant with some positive value and average velocity is 1.25 m/s.
c. Acceleration is zero and average velocity is 0.25 m/s.
d. Acceleration is constant with some positive value and average velocity is 0.25 m/s.