Knowledge

For each question, select the best answer from the four alternatives.

1. Which is true for both uniform velocity and uniform acceleration as depicted by velocity–time graphs? (1.1) K/U
   (a) The velocity–time graphs for both uniform velocity and uniform acceleration are always straight lines.
   (b) The velocity–time graphs for both uniform velocity and uniform acceleration are always parallel to the *x*-axis.
   (c) The velocity–time graphs for both uniform velocity and uniform acceleration are always parallel to the *y*-axis.
   (d) The velocity–time graphs for both uniform velocity and uniform acceleration are always perpendicular to the *y*-axis.
2. You are standing at the origin of a set of coordinate axes. You walk 4.0 m [E] and then 4.0 m [N]. What is your displacement? (1.3) K/U T/I A
   (a) 5.7 m [NW]
   (b) 5.7 m [NE]
   (c) 8.0 m [NW]
   (d) 8.0 m [NE]
3. You walk 10 m [E 30° N]. What are the horizontal and vertical components of your displacement, respectively? (1.3) K/U T/I A
   (a) 9 m, 5 m
   (b) 5 m, 9 m
   (c) 5 m, 5 m
   (d) 9 m, 9 m
4. The speed of an object moving in a straight line increases from 10 m/s to 20 m/s in 2 s. What is the average acceleration? (1.4) K/U T/I A
   (a) 5 m/s^2 in the direction of motion of the object
   (b) 5 m/s^2 in the direction perpendicular to the motion of the object
   (c) 5 m/s^2 in the direction opposite to the motion of the object
   (d) $\sqrt{5}$ m/s^2 in the direction of motion of the object
5. The motion of a projectile is described in a coordinate system. At a particular instant, the magnitude of the horizontal component of velocity is 5 m/s and the magnitude of the vertical component of velocity is 8 m/s. Which is correct about the object? (1.5) K/U A
   (a) The projectile is at its maximum height.
   (b) The projectile is about to hit the ground.
   (c) The projectile is ascending.
   (d) The projectile has hit the ground.
6. A river flows with velocity 8 m/s [N] relative to the bank. A boat travels with a velocity of 6 m/s [E] relative to the river. What is the magnitude of the velocity of the boat relative to the bank? (1.6) K/U T/I A
   (a) 8 m/s
   (b) 10 m/s
   (c) 12 m/s
   (d) 14 m/s

Indicate whether each statement is true or false. If you think the statement is false, rewrite it to make it true.

7. Speed is always a positive quantity or zero, but never negative. (1.1) K/U
8. Average speed is the sum of all instantaneous speeds. (1.1) K/U
9. Velocity is the slope of the position–time graph, and acceleration is the slope of the velocity–time graph. (1.1) K/U
10. When a moving object starts to slow down on a straight track, the average acceleration of the object at any time interval after it starts slowing down is positive. (1.2) K/U
11. When two displacement vectors of equal magnitude are aligned opposite to each other, the resultant displacement is zero. (1.3) K/U
12. The average velocity of an object is always greater than or equal to the average speed. (1.4) K/U
13. A ball thrown horizontally from a cliff is an example of projectile motion. (1.5) K/U
14. Two students running toward each other with the same speed have the same velocity vector relative to each other. (1.6) K/U

Write a short answer to each question.

15. A toy car is moving on a straight track. (1.1) K/U C A
    (a) Can the toy car have a constant velocity but a varying speed? Explain.
    (b) Is the numerical ratio of speed to velocity of the toy car equal to one? Explain.
16. Is it possible for an object to have constant speed and variable velocity? Explain your answer. (1.1) K/U T/I C
17. Can two displacement vectors of the same length have a vector sum of zero? (1.3) K/U
18. Why can a sprinting football player not stop instantly? (1.4) K/U
19. A skier jumps off a ramp. In this case, air resistance is not negligible. How will air resistance affect the range and the speed with which she lands on the ground? (1.5) K/U
20. Explain what relative motion is using an example not mentioned in this section. (1.6) K/U C
21. In your own words, define relative velocity. (1.6) K/U C

Understanding

22. Discuss whether an object can have acceleration without speeding up or slowing down. (1.1) K/U T/I C
23. **Table 1** shows the combinations of values and corresponding signs for the velocity and the acceleration of an object in one dimension. Give an example of each situation in the table. (1.1) K/U A

Table 1

Velocity	Acceleration
(a) positive	positive
(b) positive	negative
(c) positive	zero

24. Compare the position–time graph and velocity–time graph for an object in uniform motion. Include a simple diagram of each. (1.1) K/U C
25. You note the odometer and the speedometer readings of your car at equal intervals of time over a long trip. What information about the motion of the car can you get from these readings? (1.1) K/U C
26. You throw a ball vertically upward, and it falls back to your hand. Identify the points where the instantaneous velocity is the same as the average velocity for the entire motion. (1.1) K/U T/I
27. Discuss what conditions are needed for three displacement vectors to have a vector sum of zero. (1.3) K/U C A
28. Provide an example in which an object moves in two dimensions but has acceleration in one dimension. (1.3) K/U A
29. A ball is thrown vertically upward from the roof of a building and lands back on the roof. Compare the displacement of the ball and the ball's velocity as seen from the roof and as seen by a person on the ground. (1.3) K/U
30. Give an example of why velocity and not acceleration should be taken into account when predicting the direction of motion of an object. (1.4) K/U C A
31. For a long jump event, describe the factors that affect the distance an athlete jumps. (1.5) K/U T/I A
32. A ball is dropped from the window of a moving car. Will the time it takes to fall to the ground be the same, more, or less than the time it takes to fall if the car is stationary? Explain your answer. (1.5) K/U C A
33. An object is at rest as well as in motion at the same time. Explain how this can be. (1.6) K/U C
34. You are piloting a fishing boat directly across a fast-moving river to reach a pier directly opposite your starting point. Explain how you would navigate the boat in terms of your velocity relative to the water. (1.6) K/U C

Analysis and Application

35. Describe the motion of an object in segments P, Q, R, and S in the position–time graph in **Figure 1**. (1.1) K/U T/I A

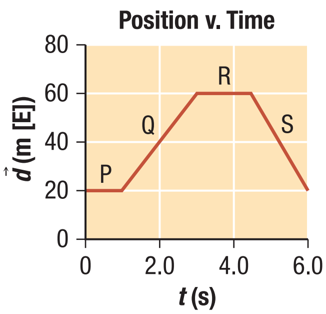

Figure 1

36. You start 1.5 m from a reference point, walk at a constant speed for 5 s, stay at this position for 1 s, and finally walk back with the same speed as earlier for the next 3 s. Draw a position–time graph of your movement. (1.1) K/U T/I C
37. Use concepts from this chapter to explain how a juggler is able to juggle balls with perfect timing. (1.2) K/U T/I A

38. A squirrel drops a nut from the top of a tree, and the nut falls to the ground. It takes 2.0 s for the nut to reach the ground. Calculate the height of the squirrel above the ground. (1.2) K/U T/I A

39. An athlete is running at a constant speed of 9 m/s. He takes 3 s to come to a stop after he crosses the finish line. Calculate his average acceleration from when he crosses the finish line to when he stops. (1.2) T/I A

40. At the start of a 100.0 m race, a sprinter increases her speed to 9.0 m/s in 2.0 s. (1.2) K/U T/I A
    (a) What is the acceleration of the sprinter during the first 2.0 s?
    (b) From this point, she runs the rest of the race with the same speed. Calculate the time to reach the finish line.

41. A race car reduces its speed from 20.0 m/s and comes to a complete stop after 50.0 m. (1.2) K/U T/I A
    (a) Determine the acceleration of the race car.
    (b) Calculate the time taken by the race car to come to a complete stop.

42. A bowler releases a ball at a bowling alley with a speed of 5.0 m/s. The ball covers the distance of 10.0 m to the pins in 2.2 s. Calculate the acceleration of the ball. (1.2) K/U T/I A

43. One stone is dropped from the top of a tall cliff, and a second stone with the same mass is thrown vertically from the same cliff with a velocity of 10.0 m/s [down], 0.50 s after the first. Calculate the distance below the top of the cliff at which the second stone overtakes the first. (1.2) K/U T/I A

44. Suppose the acceleration due to gravity on a certain planet is 2.0 m/s^2. (1.2) K/U T/I A
    (a) Will the height a high jumper can jump on this planet increase or decrease compared to a high jumper on Earth?
    (b) How high could you throw a baseball with an initial speed of 5 m/s on this planet?

45. A small aircraft is flying in a strong wind. The plane moves in a direction 60° west of south with a speed of 60 m/s. Determine the component of its velocity directed due west. (1.2) K/U T/I A

46. At the instant the traffic light turns green, a car starts from rest with a constant acceleration of 2 m/s^2. At that instant, a truck travelling with a constant speed of 10 m/s overtakes and passes the car. (1.2) K/U T/I A
    (a) How far beyond its starting point will the car overtake the truck?
    (b) Calculate how fast the car will be travelling.

47. A car slows down from 100.0 km/h to 0 km/h in 5.2 s. Determine the braking distance needed for the vehicle to come to a complete stop. (1.2) T/I A

48. A ball is thrown vertically upward from the ground with a velocity of 30.0 m/s. (1.2) K/U T/I A
    (a) How long will the ball take to rise to its highest point?
    (b) How high does the ball rise?
    (c) How long after the throw will the ball have a velocity of 10.0 m/s [upward]?
    (d) How long after the throw will the ball have a velocity of 10.0 m/s [downward]?
    (e) At what time is the displacement of the ball zero?

49. **Figure 2** shows the velocity of an object plotted as a function of time. (1.2) T/I A

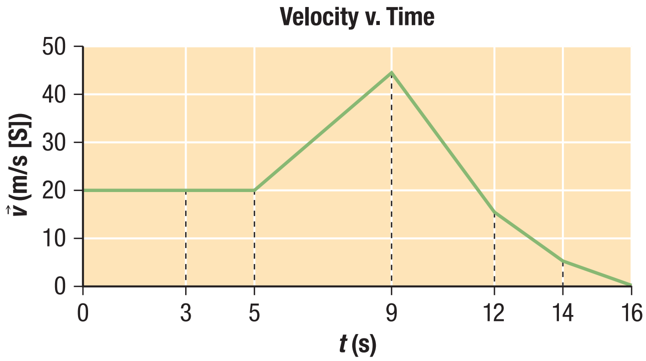

Figure 2

    (a) Calculate the instantaneous acceleration at $t = 3$ s, $t = 10$ s, and $t = 13$ s.
    (b) What is the average acceleration for the complete motion?

50. A ball thrown vertically upward passes the same height, h, at 2 s and 10 s on its way up and down, respectively. Calculate h. (1.2) K/U T/I A

51. Equation 3 in Table 1, page 18, is the equation of motion from which v_f has been eliminated. Show that Equation 3 is dimensionally correct. (1.2) K/U T/I

52. Refer to Table 1, page 18. (1.2) K/U T/I
    (a) Use Equations 1 and 2 to derive Equation 4.
    (b) Use Equations 1 and 2 to derive Equation 5.

53. Design an experimental procedure to determine the acceleration of a ball rolling down a slope. Describe your design in a few sentences. Which variables will you measure, and how will you calculate the acceleration? If possible, perform the activity. (1.2) T/I C A

54. The velocity–time graph in **Figure 3** describes the motion of an object. (1.2) K/U T/I A

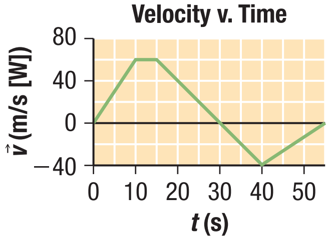

Figure 3

(a) At which intervals is the acceleration of the object positive, at which intervals is it negative, and at which intervals is it zero?

(b) Determine the average acceleration of the object for the complete motion.

(c) Determine the time(s) when the object changes its direction.

(d) How does the displacement between times 0 s and 10 s compare with the displacement between 10 s and 15 s?

55. You throw a dart horizontally with a speed of 10.0 m/s. The dart hits the board 0.49 m below the height from which it was thrown. Calculate your distance from the board. (1.3) K/U T/I A

56. Vector $\vec{A}$ of length 5.0 units makes an angle of 45° to another vector, $\vec{B}$, of length 5.0 units along the positive *x*-axis. Determine the components of $\vec{A} - \vec{B}$. (1.3) T/I A

57. A car travels 20.0 km due north and then 25.0 km in a direction 60.0° west of north. Determine the magnitude and direction of the car's resultant displacement. (1.3) K/U T/I A

58. In **Figure 4**, vectors $\vec{d}_1$ and $\vec{d}_2$ represent two displacements of a student. (1.3) K/U T/I A

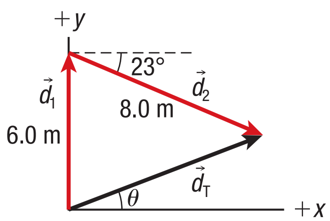

Figure 4

(a) Determine the components of the resultant displacement, $\vec{d}_T$.

(b) Determine the total displacement of the student.

59. A car is moving with a velocity of 15 m/s [E]. It makes a turn steadily in 5.0 s so that the velocity is 12 m/s [E 25° N]. Determine the average acceleration of the car. (1.4) K/U T/I A

60. A golf ball is hit from the ground, and it goes into a parabolic trajectory. What is the average acceleration in the *x*-direction? (1.4) K/U T/I A

61. The velocity–time graph in **Figure 5** shows the motion of a ball. (1.4) K/U T/I C A

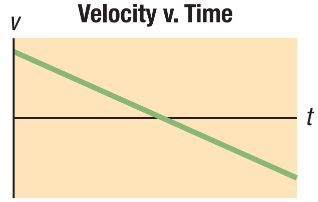

Figure 5

(a) Sketch, qualitatively, the corresponding position–time graph.

(b) Sketch, qualitatively, the corresponding acceleration–time graph.

62. A cyclist moves with a constant acceleration, covering the distance between two points in 6.0 s. The distance between these two points is 60.0 m. Her speed at the second point is 15 m/s. Calculate her acceleration and the speed at the first point. (1.4) K/U T/I A

63. A puma can jump to a height of 3.7 m when its initial velocity is at an angle of 45° to the horizontal. Calculate the initial speed of the puma. (1.5) K/U T/I A

64. Two footballs are kicked from the ground with equal initial speeds. Ball A is launched at a greater angle above the horizontal than ball B. (1.5) K/U T/I A

(a) Determine which ball reaches a higher elevation.

(b) Determine which ball stays in the air longer.

(c) Is it possible to calculate which ball travels farther?

65. A baseball player hits a 200.0 m home run. The ball travels at an angle of 45° with the horizontal just after being hit. Determine the initial speed with which the ball left the bat. Assume that air resistance is negligible and that the ball lands at approximately the same height from which it was hit. (1.5) K/U T/I A

66. A basketball player is standing 9.5 m from the basket, which is at a height of 3.1 m. She throws the ball from an initial height of 2.0 m at an angle of 35° above the horizontal. The ball goes straight through the basket. Determine the initial speed of the ball. (1.5) K/U T/I A

67. A batter hits a ball, which flies at an angle of 45° with the horizontal. The ball's speed after being hit by the bat is 30.0 m/s. Calculate the time the ball stays in the air. The ball lands at the same height at which it was hit. Air resistance is negligible. (1.5) K/U T/I A

68. A firefighter aims a hose at an angle of 60.0° with the horizontal. The water comes out of the hose with a speed of 60.0 m/s. (1.5) K/U T/I A
   (a) Calculate the maximum height the water can reach.
   (b) Determine the horizontal distance the water travels from the hose.
69. A dolphin leaps out of the water at an angle of 60.0° above the horizontal. The horizontal component of the dolphin's velocity is 8.0 m/s. Calculate the magnitude of the vertical component of its velocity. (1.5) K/U T/I A
70. A tennis ball is struck such that it leaves the racquet with a horizontal speed of 28.0 m/s. The ball hits the top of the net, and the player loses the point. What could she have done to avoid losing the point? (1.5) K/U T/I A
71. An athlete in a long jump trial leaves the ground at a certain angle and covers a horizontal distance of 8.7 m. The speed with which he can jump remains constant. What should he do to increase the distance of his jump? (1.5) K/U T/I A
72. In a snowball fight, a person throws one snowball at 26 m/s at an angle of 75° above the horizontal. While the target (his friend) is watching the snowball, he throws another at a smaller angle and the same speed as the first person, and both snowballs hit the friend at the same spot at the same time. Assume that the snowballs land at the same level as the initial throw. (1.5) K/U T/I A
   (a) What is the range of the first snowball?
   (b) At what angle was the second snowball thrown?
   (c) How long was the second snowball thrown after the first?
73. A soccer player kicks the ball in a parabolic path. The ball leaves the player's foot with a speed of 27 m/s, making an angle of 20.0° with the horizontal. (1.5) K/U T/I A
   (a) Calculate the maximum height of its trajectory.
   (b) Determine its speed as it hits the ground again. Air resistance is negligible.
74. In a practice session, a volleyball player hits a ball horizontally with a speed of 27 m/s from a height of 2.4 m. The ball travels until it hits the ground. (1.5) K/U T/I A
   (a) Determine the time the ball is in the air.
   (b) Determine the horizontal distance travelled by the ball.
   (c) Calculate the ball's speed as it hits the ground.
75. A boat is heading due north across a river with a speed of 12.0 km/h relative to the water. The water in the river has a uniform velocity of 6.00 km/h due east relative to the ground. Determine the velocity of the boat relative to an observer standing on either bank. (1.6) K/U T/I A
76. A person on a raft is drifting downstream with the current. Suddenly he dives off the raft and swims upstream for a quarter of an hour. He then swims downstream at the same velocity with respect to the water and catches back up to the raft at a position 1.0 km downstream from where he started. What is the speed of the current, in kilometres per hour? (1.6) K/U T/I A
77. A swimmer swims across a river at a velocity of 0.45 m/s [N] with respect to the water. The current is 2.5 m/s [W]. She crosses the river in 200.0 s. Determine the width of the river. (1.6) K/U T/I A
78. The current in a 35 m–wide river flows at a speed of 0.25 m/s. A student rows a boat directly across the river. The boat takes exactly 4.0 min to cross the river. Calculate the velocity of the boat relative to the water. (1.6) K/U T/I A
79. A plane is flying at 290 km/h [E 42° S] relative to the air when the wind velocity is 65 km/h [E 25° N]. Calculate the velocity of the plane relative to the ground. (1.6) K/U C

Evaluation

80. Two balls of different masses but the same surface area are dropped from the same height. Using equations of motion, prove that the time taken for both the balls to reach the ground is the same. (1.2) T/I A
81. Give an example of a scientific activity where the concepts of vectors and vector addition can be helpful. (1.4) K/U A
82. A javelin thrower argues with her coach that if her throw can keep the javelin in the air for a longer time, it will always travel a greater distance. Is the argument correct? Explain why or why not. (1.5) K/U T/I A
83. Using the concepts in the chapter, explain why an archer should aim at a point higher than the bull's-eye. (1.5) K/U T/I C A
84. Under non-windy conditions, a golfer can hit 200 m when the angle of flight of the ball is 12°. On a particular day, the wind is blowing from behind the golfer. Evaluate and explain how he should change the angle of flight of the ball such that it reaches a distance greater than 200 m. (1.5) K/U T/I A

85. The value for g on planet A is greater than the value for g on Earth, and the value for g on planet B is less than the value for g on Earth. An object is launched from planet A, and an identical object is launched from planet B. Both objects travel in a parabolic path. Speculate on how the equations and values for the time of flight, horizontal range, and maximum height compare to those on Earth. (1.5) T/I A

86. Using a projectile launcher, you launch a snowball at an angle of 35° from the roof of a building that is 45 m tall. The initial speed of the snowball is 29 m/s. The snowball lands on the ground. Your friend says the horizontal range of the snowball is 81 m. Is your friend correct? Explain why or why not. (1.5) K/U T/I A

Reflect on Your Learning

87. What did you find different from your preconceptions and intuitive understanding of the motion of objects? Which concept did you find most difficult to understand? Why was it difficult, and what helped clarify it? T/I C

88. You learned about different ways the motion of an object is measured and depicted and how various other parameters are calculated. Can you explain various physical phenomena where these concepts can be applied? Are there any exceptions to these concepts and theories in the real world? C A

89. Many people struggle to understand why the vertical acceleration of a projectile is constant. What helped to clarify this concept for you? T/I C

90. How can you apply the concepts in this chapter to enhance your performance in the sports you play? C A

Research

WEB LINK

91. Research how various scientists throughout history, such as Aristotle, Galileo, and Newton, have studied the motion of objects. Research the various experiments they conducted to test different laws. Create a timeline of advancements made by various scientists on the theory of motion and projectile motion. T/I C A

92. Research dirt bike tracks, and choose one. Research the design of the dirt bike track, with specific reference to the ramps and turns and how their design aids and affects the bikers' performance. Refer to velocity, acceleration, and trajectory. Identify the theories of kinematics that are used. T/I C A

93. Select a sport, and research how the theories of motion are involved in various aspects of the sport. Formulate a plan using the theories of motion to help an athlete perform better in the chosen sport. Your plan should contain concepts of trajectories and velocities. Describe the motion of any equipment used in the sport. T/I C A

94. In a 100 m race at the Olympics or any other prestigious event, runners start from rest and complete the event so quickly that it is difficult to see what is actually happening. Research the motion that occurs during one such event by looking up the split times for a particular runner. Use the terminology from this chapter to describe in detail how the runner moved to complete the race. Identify where the acceleration was largest and if at any time the velocity was basically uniform. Does the runner slow down at any time during the race? To help with your explanation, draw simple sketches of the motion graphs. T/I C A

95. A car driver's reaction time is the average time required for a driver to apply the brakes after seeing an emergency. The average reaction times for a car driver under the influence of alcohol are shown in **Figure 6**. T/I C A

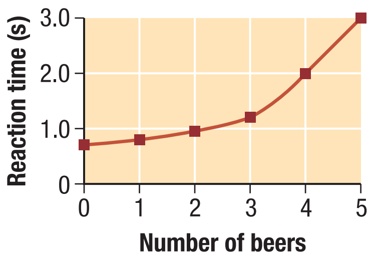

Figure 6

(a) Use Figure 6 to complete **Table 2**.

Table 2

Speed	Reaction distance (m)		
	No alcohol	4 bottles of beer	5 bottles of beer
17 m/s (60 km/h)			
25 m/s (90 km/h)			
33 m/s (120 km/h)			

(b) Using the Internet and other sources, research the effects of alcohol on the average reaction time. Search for direct evidence on how drivers are impaired when under the influence of alcohol. Prepare a brief summary of your findings.

(c) Some say there is no safe level of alcohol that can be consumed by drivers. Discuss the validity of this statement using examples from your research.