

Chapter 2--Motion in One Dimension

Student: _____

1. A change in a physical quantity w having initial value w_i and final value w_f is given by which of the following?
 - A. $w_i - w_f$
 - B. $w_i - w_i$
 - C. $(w_f + w_i)/2$
 - D. none of the above
2. Displacement is which of the following types of quantities?
 - A. vector
 - B. scalar
 - C. magnitude
 - D. dimensional
3. A truck moves 70 m east, then moves 120 m west, and finally moves east again a distance of 90 m. If east is chosen as the positive direction, what is the truck's resultant displacement?
 - A. 40 m
 - B. -40 m
 - C. 280 m
 - D. -280 m
4. Which of the following is not a vector quantity?
 - A. temperature
 - B. velocity
 - C. acceleration
 - D. displacement
5. In one-dimensional motion, the average speed of an object that moves from one place to another and then back to its original place has which of the following properties?
 - A. It is positive.
 - B. It is negative.
 - C. It is zero.
 - D. It can be positive, negative, or zero.

6. In one-dimensional motion where the direction is indicated by a plus or minus sign, the average velocity of an object has which of the following properties?
- A. It is positive.
 - B. It is negative.
 - C. It is zero.
 - D. It can be positive, negative, or zero.
7. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the sign associated with the average velocity of the object?
- A. +
 - B. -
 - C. 0 (no sign)
 - D. any of the above
8. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the average speed of the object?
- A. 0.50 m/s
 - B. -0.50 m/s
 - C. 0.73 m/s
 - D. 0 m/s
9. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the average velocity?
- A. 1.7 m/s
 - B. 2.5 m/s
 - C. 3.4 m/s
 - D. zero
10. A cheetah can run at approximately 100 km/hr and a gazelle at 80.0 km/hr. If both animals are running at full speed, with the gazelle 70.0 m ahead, how long before the cheetah catches its prey?
- A. 12.6 s
 - B. 25.2 s
 - C. 6.30 s
 - D. 10.7 s
11. A cheetah can maintain its maximum speed of 100 km/hr for 30.0 seconds. What minimum distance must a gazelle running 80.0 km/hr be ahead of the cheetah to escape?
- A. 100 m
 - B. 167 m
 - C. 70.0 m
 - D. 83.0 m

12. Jeff throws a ball straight up. For which situation is the vertical velocity zero?
- A. on the way up
 - B. at the top
 - C. on the way back down
 - D. none of the above
13. A railroad train travels forward along a straight track at 80.0 m/s for 1 000 m and then travels at 50.0 m/s for the next 1 000 m. What is the average velocity?
- A. 65.0 m/s
 - B. 61.5 m/s
 - C. 63.7 m/s
 - D. 70.0 m/s
14. The distance of the Earth from the sun is 93 000 000 miles. If there are 3.15×10^7 s in one year, find the speed of the Earth in its orbit about the sun.
- A. 9.28 miles/s
 - B. 18.6 miles/s
 - C. 27.9 miles/s
 - D. 37.2 miles/s
15. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average velocity is:
- A. 19.6 m/s.
 - B. 9.80 m/s.
 - C. 4.90 m/s.
 - D. not given.
16. Changing the positive direction in a reference frame to the opposite direction does not change the sign of which of the following quantities?
- A. velocity
 - B. average velocity
 - C. speed
 - D. displacement
17. On a position versus time graph, the slope of the straight line joining two points on the plotted curve that are separated in time by the interval Δt , is which of the following quantities?
- A. average steepness
 - B. average velocity
 - C. instantaneous velocity
 - D. average acceleration

18. Consider the magnitude of the average speed, $v_{avg, speed, mag}$, and the magnitude of the average velocity, $v_{avg, velocity, mag}$, for the same trip. Which of the following is always true?
- $v_{avg, speed, mag} = v_{avg, velocity, mag}$
 - $v_{avg, speed, mag} \geq v_{avg, velocity, mag}$
 - $v_{avg, speed, mag} \leq v_{avg, velocity, mag}$
 - none of the above
19. A European sports car dealer claims that his car will accelerate at a constant rate from rest to 100 km/hr in 8.00 s. If so, what is the acceleration? (*Hint*: First convert speed to m/s.)
- 3.47 m/s²
 - 6.82 m/s²
 - 11.4 m/s²
 - 17.4 m/s²
20. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What is the speed after the first 5.00 s of acceleration? (*Hint*: First convert the speed to m/s.)
- 34.7 m/s
 - 44.4 m/s
 - 28.7 m/s
 - 17.4 m/s
21. An x vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the velocity of the ball is zero. We can be positive that at $t = 5$ s,
- the slope of the curve is non-zero.
 - the ball has stopped.
 - the acceleration is constant.
 - the curve is at $x = 0$, $t = 0$.
22. A v vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the acceleration of the ball is zero. We know that at $t = 5$ s,
- the slope of the curve is non-zero.
 - the velocity of the ball is not changing.
 - the curve is not crossing the time axis.
 - the curve is at $v = 0$, $t = 0$.

23. The value of an object's acceleration may be characterized in equivalent words by which of the following?
- A. displacement
 - B. rate of change of displacement
 - C. velocity
 - D. rate of change of velocity
24. A 50-g ball traveling at 25.0 m/s is bounced off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the average acceleration of the ball during this time interval?
- A. $13\,400\text{ m/s}^2$
 - B. $6\,720\text{ m/s}^2$
 - C. 857 m/s^2
 - D. 20 m/s^2
25. An object is dropped from a height. Once it is moving, which of the following statements is true, at least at one point?
- A. Its velocity is more than its acceleration.
 - B. Its velocity is less than its acceleration.
 - C. Its velocity is the same as its acceleration.
 - D. Its velocity is never equal to its acceleration.
26. The slope of the acceleration vs. time curve represents:
- A. the velocity.
 - B. the rate of change of acceleration.
 - C. the rate of change of displacement.
 - D. the area under the position vs. time curve.
27. A strobe photograph shows equally spaced images of a car moving along a straight road. If the time intervals between images is constant, which of the following cannot be positive?
- A. the speed of the car
 - B. the average velocity of the car
 - C. the acceleration of the car
 - D. the direction of motion of the car
28. A strobe photograph of a car moving along a straight road shows the interval between each successive image to be diminishing. If the direction of motion of the car is taken as positive, which of the following are negative?
- A. the speed of the car
 - B. the average velocity of the car
 - C. the average acceleration of the car
 - D. all of the above

29. A ball is pushed with an initial velocity of 4.0 m/s. The ball rolls down a hill with a constant acceleration of 1.6 m/s^2 . The ball reaches the bottom of the hill in 8.0 s. What is the ball's velocity at the bottom of the hill?
- A. 10 m/s
 - B. 12 m/s
 - C. 16 m/s
 - D. 17 m/s
30. A cart is given an initial velocity of 5.0 m/s and experiences a constant acceleration of 2.0 m/s^2 . What is the magnitude of the cart's displacement during the first 6.0 s of its motion?
- A. 10 m
 - B. 55 m
 - C. 66 m
 - D. 80 m
31. A vehicle designed to operate on a drag strip accelerates from zero to 30 m/s while undergoing a straight line path displacement of 45 m. What is the vehicle's acceleration if its value may be assumed to be constant?
- A. 2.0 m/s^2
 - B. 5.0 m/s^2
 - C. 10 m/s^2
 - D. 15 m/s^2
32. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant -7.5 m/s^2 . What displacement does it undergo during this deceleration period?
- A. 40 m
 - B. 80 m
 - C. 160 m
 - D. 240 m
33. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after 11 s?
- A. 1.8 m/s
 - B. 3.2 m/s
 - C. 5.1 m/s
 - D. zero

34. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?
- A. 0.21 m/s^2
 - B. 0.46 m/s^2
 - C. 0.64 m/s^2
 - D. 0.78 m/s^2
35. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What distance will the sports car travel during the 8 s acceleration period? (*Hint: First convert speed to m/s.*)
- A. 55.5 m
 - B. 77.7 m
 - C. 111 m
 - D. 222 m
36. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?
- A. 1.2 m
 - B. 4.7 m
 - C. 9.0 m
 - D. 12 m
37. An automobile driver puts on the brakes and decelerates from 30.0 m/s to zero in 10.0 s. What distance does the car travel?
- A. 150 m
 - B. 196 m
 - C. 336 m
 - D. 392 m
38. A drag racer starts from rest and accelerates at 10 m/s^2 for the entire distance of 400 m (1/4 mile). What is the velocity of the race car at the end of the run?
- A. 45 m/s
 - B. 89 m/s
 - C. 130 m/s
 - D. 180 m/s
39. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m?
- A. 2.31 m/s^2
 - B. 3.63 m/s^2
 - C. 4.63 m/s^2
 - D. 5.55 m/s^2

40. If the displacement of an object is given in SI units by $Dx = -3t + 4t^2$, at $t = 2$ s its velocity and acceleration are, respectively:
- A. positive, positive.
 - B. positive, negative.
 - C. negative, negative.
 - D. negative, positive.
41. In the case of constant acceleration, the average velocity equals the instantaneous velocity:
- A. at the beginning of the time interval.
 - B. at the end of the time interval.
 - C. half-way through the time interval.
 - D. three-fourths of the way through the time interval.
42. Two students are working on the same constant acceleration problem involving a car undergoing constant acceleration, having started from rest and after a certain time having traveled a distance of 108 m. The students are to find the average velocity. Both students are required to show their work and round any intermediate answers as well as the final answer properly to 3 significant figures. Each rounded answer is to be used in the next step of calculation as they proceed. For the final answer, Student A uses the formula $v_{avg} = (x_f - x_i) / (t_f - t_i)$ getting the result 7.26 m/s, and Student B uses the formula $v_{avg} = (v_0 + v) / 2$ getting the result 7.29 m/s. Assuming neither student makes a mistake, which student has the better answer?
- A. Student A
 - B. Student B
 - C. Under significant figure rounding, both answers are equally as good.
 - D. The described result cannot happen; this is physics after all.
43. A rock is thrown straight down with an initial velocity of 14.5 m/s from a cliff. What is the rock's displacement after 2.0 s? (Acceleration due to gravity is 9.80 m/s^2 .)
- A. 28 m
 - B. 49 m
 - C. 55 m
 - D. 64 m
44. A rock is thrown straight up with an initial velocity of 24.5 m/s. What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as 9.80 m/s^2 .)
- A. 9.80 m
 - B. 19.6 m
 - C. 24.5 m
 - D. 30.6 m

45. A rock is thrown straight up with an initial velocity of 19.6 m/s. What time interval elapses between the rock's being thrown and its return to the original launch point? (Acceleration due to gravity is 9.80 m/s^2 .)
- A. 4.00 s
 - B. 5.00 s
 - C. 8.00 s
 - D. 10.0 s
46. Two objects of different mass are released simultaneously from the top of a 20-m tower and fall to the ground. If air resistance is negligible, which statement best applies?
- A. The greater mass hits the ground first.
 - B. Both objects hit the ground together.
 - C. The smaller mass hits the ground first.
 - D. No conclusion can be made with the information given.
47. A baseball catcher throws a ball vertically upward and catches it in the same spot when it returns to his mitt. At what point in the ball's path does it experience zero velocity and non-zero acceleration at the same time?
- A. midway on the way up
 - B. at the top of its trajectory
 - C. the instant it leaves the catcher's hand
 - D. the instant before it arrives in the catcher's mitt
48. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? ($g = 9.8 \text{ m/s}^2$ and assume air resistance is negligible)
- A. $1.5 \times 10^2 \text{ m}$
 - B. $1.8 \times 10^2 \text{ m}$
 - C. $1.1 \times 10^2 \text{ m}$
 - D. $2.1 \times 10^2 \text{ m}$
49. A rock, released at rest from the top of a tower, hits the ground after 1.5 s. What is the speed of the rock as it hits the ground? ($g = 9.8 \text{ m/s}^2$ and air resistance is negligible)
- A. 15 m/s
 - B. 20 m/s
 - C. 31 m/s
 - D. 39 m/s

50. Omar throws a rock down with speed 12 m/s from the top of a tower. The rock hits the ground after 2.0 s. What is the height of the tower? (air resistance is negligible)
- A. 20 m
 - B. 24 m
 - C. 44 m
 - D. 63 m
51. Gwen releases a rock at rest from the top of a 40-m tower. If $g = 9.8 \text{ m/s}^2$ and air resistance is negligible, what is the speed of the rock as it hits the ground?
- A. 28 m/s
 - B. 30 m/s
 - C. 56 m/s
 - D. 784 m/s
52. John throws a rock down with speed 14 m/s from the top of a 30-m tower. If $g = 9.8 \text{ m/s}^2$ and air resistance is negligible, what is the rock's speed just as it hits the ground?
- A. 12 m/s
 - B. 28 m/s
 - C. 350 m/s
 - D. 784 m/s
53. Human reaction time is usually about 0.20 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? The nearest value is:
- A. 4.0 cm.
 - B. 9.8 cm.
 - C. 16 cm.
 - D. 20 cm.
54. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15.0 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff?
- A. 5.05 s
 - B. 3.76 s
 - C. 2.67 s
 - D. 1.78 s
55. Maria throws two stones from the top edge of a building with a speed of 20 m/s. She throws one straight down and the other straight up. The first one hits the street in a time t_1 . How much later is it before the second stone hits?
- A. 5 s
 - B. 4 s
 - C. 3 s
 - D. Not enough information is given to work this problem.

56. Mt. Everest is more than 8 000 m high. How fast would an object be moving if it could free fall to sea level after being released from an 8000-m elevation? (Ignore air resistance.)
- A. 396 m/s
 - B. 120 m/s
 - C. 1 200 m/s
 - D. 12 000 m/s
57. A basketball player can jump 1.6 m off the hardwood floor. With what upward velocity did he leave the floor?
- A. 1.4 m/s
 - B. 2.8 m/s
 - C. 4.2 m/s
 - D. 5.6 m/s
58. A water rocket, launched from the ground, rises vertically with acceleration of 30 m/s^2 for 1.0 s when it runs out of "fuel." Disregarding air resistance, how high will the rocket rise?
- A. 15 m
 - B. 31 m
 - C. 61 m
 - D. 120 m
59. A parachutist jumps out of an airplane and accelerates with gravity to a maximum velocity of 58.8 m/s in 6.00 seconds. She then pulls the parachute cord and after a 4.00-second constant deceleration, descends at 10.0 m/s for 60.0 seconds, reaching the ground. From what height did the parachutist jump?
- A. 914 m
 - B. 1 130 m
 - C. 1 520 m
 - D. 1 750 m
60. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average speed is:
- A. 19.6 m/s.
 - B. 9.80 m/s.
 - C. 4.90 m/s.
 - D. not given.

61. A ball of relatively low density is thrown upwards. Because of air resistance the acceleration while traveling upwards is -10.8 m/s^2 . On its trip downward the resistance is in the opposite direction, and the resulting acceleration is -8.8 m/s^2 . When the ball reaches the level from which it was thrown, how does its speed compare to that with which it was thrown?
- It is greater than the original speed upward.
 - It is the same as the original speed upward.
 - It is less than the original speed upward.
 - Without knowing the original speed, this problem cannot be solved.
62. Starting from rest, a car accelerates down a straight road with constant acceleration a_1 for a time t_1 , then the acceleration is changed to a different constant value a_2 for an additional time t_2 . The total elapsed time is $t_1 + t_2$. Can the equations of kinematics be used to find the total distance traveled?
- No, because this is not a case of constant acceleration.
 - Yes, use $(a_1 + a_2)/2$ as the average acceleration and the total time in the calculation.
 - Yes, use $a_1 + a_2$ as the acceleration and the average time $(t_1 + t_2)/2$ in the calculation.
 - Yes, break the problem up into 2 problems, one with the conditions for the first time interval and the other with the conditions for the second time interval, noting that for the second time interval the initial velocity is that from the end of the first time interval. When done, add the distances from each of the time intervals.
63. Starting from rest, a car accelerates down a straight road with constant acceleration a for a time t , then the direction of the acceleration is reversed, (i.e., it is $-a$), and the car comes to a stop in an additional time t , the time for the whole trip being $2t$. At what time, or times, is the average velocity of the car for the trip equal to its instantaneous velocity during the trip?
- There is no such time.
 - It is at the halfway point at t .
 - This occurs at 2 times, $0.5 t$ and $1.5 t$.
 - This occurs at 2 times, $0.707 t$ and $1.293 t$.
64. A ball rolls down an incline, starting from rest. If the total time it takes to reach the end of the incline is T , how much time has elapsed when it is halfway down the incline?
- $0.5 T$
 - $< 0.5 T$
 - $> 0.5 T$
 - More information is needed.
65. In which of the following cases is the displacement's magnitude half the distance traveled?
- 10 steps east followed by 3 steps west
 - 22 steps east followed by 11 steps west
 - 5 steps east followed by 10 steps west
 - 15 steps east followed by 5 steps west

Chapter 2--Motion in One Dimension **Key**

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 - B.** $w_f - w_i$
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 - C.** the acceleration of the car
 - D. the direction of motion of the car
28. A strobe photograph of a car moving along a straight road shows the interval between each successive image to be diminishing. If the direction of motion of the car is taken as positive, which of the following are negative?
- A. the speed of the car
 - B. the average velocity of the car
 - C.** the average acceleration of the car
 - D. all of the above

29. A ball is pushed with an initial velocity of 4.0 m/s. The ball rolls down a hill with a constant acceleration of 1.6 m/s^2 . The ball reaches the bottom of the hill in 8.0 s. What is the ball's velocity at the bottom of the hill?
- A. 10 m/s
B. 12 m/s
C. 16 m/s
D. 17 m/s
30. A cart is given an initial velocity of 5.0 m/s and experiences a constant acceleration of 2.0 m/s^2 . What is the magnitude of the cart's displacement during the first 6.0 s of its motion?
- A. 10 m
B. 55 m
C. 66 m
D. 80 m
31. A vehicle designed to operate on a drag strip accelerates from zero to 30 m/s while undergoing a straight line path displacement of 45 m. What is the vehicle's acceleration if its value may be assumed to be constant?
- A. 2.0 m/s^2
B. 5.0 m/s^2
C. 10 m/s^2
D. 15 m/s^2
32. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant -7.5 m/s^2 . What displacement does it undergo during this deceleration period?
- A. 40 m
B. 80 m
C. 160 m
D. 240 m
33. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after 11 s?
- A. 1.8 m/s
B. 3.2 m/s
C. 5.1 m/s
D. zero

34. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?
- A. 0.21 m/s^2
B. 0.46 m/s^2
C. 0.64 m/s^2
D. 0.78 m/s^2
35. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What distance will the sports car travel during the 8 s acceleration period? (*Hint*: First convert speed to m/s.)
- A. 55.5 m
B. 77.7 m
C. 111 m
D. 222 m
36. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?
- A. 1.2 m
B. 4.7 m
C. 9.0 m
D. 12 m
37. An automobile driver puts on the brakes and decelerates from 30.0 m/s to zero in 10.0 s. What distance does the car travel?
- A. 150 m**
B. 196 m
C. 336 m
D. 392 m
38. A drag racer starts from rest and accelerates at 10 m/s^2 for the entire distance of 400 m (1/4 mile). What is the velocity of the race car at the end of the run?
- A. 45 m/s
B. 89 m/s
C. 130 m/s
D. 180 m/s
39. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m?
- A. 2.31 m/s^2**
B. 3.63 m/s^2
C. 4.63 m/s^2
D. 5.55 m/s^2

40. If the displacement of an object is given in SI units by $Dx = -3t + 4t^2$, at $t = 2$ s its velocity and acceleration are, respectively:
- A. positive, positive.
 - B. positive, negative.
 - C. negative, negative.
 - D. negative, positive.
41. In the case of constant acceleration, the average velocity equals the instantaneous velocity:
- A. at the beginning of the time interval.
 - B. at the end of the time interval.
 - C. half-way through the time interval.
 - D. three-fourths of the way through the time interval.
42. Two students are working on the same constant acceleration problem involving a car undergoing constant acceleration, having started from rest and after a certain time having traveled a distance of 108 m. The students are to find the average velocity. Both students are required to show their work and round any intermediate answers as well as the final answer properly to 3 significant figures. Each rounded answer is to be used in the next step of calculation as they proceed. For the final answer, Student A uses the formula $v_{avg} = (x_f - x_i) / (t_f - t_i)$ getting the result 7.26 m/s, and Student B uses the formula $v_{avg} = (v_0 + v) / 2$ getting the result 7.29 m/s. Assuming neither student makes a mistake, which student has the better answer?
- A. Student A
 - B. Student B
 - C. Under significant figure rounding, both answers are equally as good.
 - D. The described result cannot happen; this is physics after all.
43. A rock is thrown straight down with an initial velocity of 14.5 m/s from a cliff. What is the rock's displacement after 2.0 s? (Acceleration due to gravity is 9.80 m/s².)
- A. 28 m
 - B. 49 m
 - C. 55 m
 - D. 64 m
44. A rock is thrown straight up with an initial velocity of 24.5 m/s. What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as 9.80 m/s².)
- A. 9.80 m
 - B. 19.6 m
 - C. 24.5 m
 - D. 30.6 m

45. A rock is thrown straight up with an initial velocity of 19.6 m/s. What time interval elapses between the rock's being thrown and its return to the original launch point? (Acceleration due to gravity is 9.80 m/s^2 .)
- A.** 4.00 s
B. 5.00 s
C. 8.00 s
D. 10.0 s
46. Two objects of different mass are released simultaneously from the top of a 20-m tower and fall to the ground. If air resistance is negligible, which statement best applies?
- A. The greater mass hits the ground first.
B. Both objects hit the ground together.
C. The smaller mass hits the ground first.
D. No conclusion can be made with the information given.
47. A baseball catcher throws a ball vertically upward and catches it in the same spot when it returns to his mitt. At what point in the ball's path does it experience zero velocity and non-zero acceleration at the same time?
- A. midway on the way up
B. at the top of its trajectory
C. the instant it leaves the catcher's hand
D. the instant before it arrives in the catcher's mitt
48. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? ($g = 9.8 \text{ m/s}^2$ and assume air resistance is negligible)
- A. $1.5 \times 10^2 \text{ m}$
B. $1.8 \times 10^2 \text{ m}$
C. $1.1 \times 10^2 \text{ m}$
D. $2.1 \times 10^2 \text{ m}$
49. A rock, released at rest from the top of a tower, hits the ground after 1.5 s. What is the speed of the rock as it hits the ground? ($g = 9.8 \text{ m/s}^2$ and air resistance is negligible)
- A.** 15 m/s
B. 20 m/s
C. 31 m/s
D. 39 m/s

50. Omar throws a rock down with speed 12 m/s from the top of a tower. The rock hits the ground after 2.0 s. What is the height of the tower? (air resistance is negligible)
- A. 20 m
 - B. 24 m
 - C. 44 m**
 - D. 63 m
51. Gwen releases a rock at rest from the top of a 40-m tower. If $g = 9.8 \text{ m/s}^2$ and air resistance is negligible, what is the speed of the rock as it hits the ground?
- A. 28 m/s**
 - B. 30 m/s
 - C. 56 m/s
 - D. 784 m/s
52. John throws a rock down with speed 14 m/s from the top of a 30-m tower. If $g = 9.8 \text{ m/s}^2$ and air resistance is negligible, what is the rock's speed just as it hits the ground?
- A. 12 m/s
 - B. 28 m/s**
 - C. 350 m/s
 - D. 784 m/s
53. Human reaction time is usually about 0.20 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? The nearest value is:
- A. 4.0 cm.
 - B. 9.8 cm.
 - C. 16 cm.
 - D. 20 cm.**
54. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15.0 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff?
- A. 5.05 s
 - B. 3.76 s
 - C. 2.67 s
 - D. 1.78 s**

55. Maria throws two stones from the top edge of a building with a speed of 20 m/s. She throws one straight down and the other straight up. The first one hits the street in a time t_1 . How much later is it before the second stone hits?
- A. 5 s
B. 4 s
C. 3 s
D. Not enough information is given to work this problem.
56. Mt. Everest is more than 8 000 m high. How fast would an object be moving if it could free fall to sea level after being released from an 8000-m elevation? (Ignore air resistance.)
- A.** 396 m/s
B. 120 m/s
C. 1 200 m/s
D. 12 000 m/s
57. A basketball player can jump 1.6 m off the hardwood floor. With what upward velocity did he leave the floor?
- A. 1.4 m/s
B. 2.8 m/s
C. 4.2 m/s
D. 5.6 m/s
58. A water rocket, launched from the ground, rises vertically with acceleration of 30 m/s^2 for 1.0 s when it runs out of "fuel." Disregarding air resistance, how high will the rocket rise?
- A. 15 m
B. 31 m
C. 61 m
D. 120 m
59. A parachutist jumps out of an airplane and accelerates with gravity to a maximum velocity of 58.8 m/s in 6.00 seconds. She then pulls the parachute cord and after a 4.00-second constant deceleration, descends at 10.0 m/s for 60.0 seconds, reaching the ground. From what height did the parachutist jump?
- A.** 914 m
B. 1 130 m
C. 1 520 m
D. 1 750 m

60. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average speed is:
- 19.6 m/s.
 - 9.80 m/s.**
 - 4.90 m/s.
 - not given.
61. A ball of relatively low density is thrown upwards. Because of air resistance the acceleration while traveling upwards is -10.8 m/s^2 . On its trip downward the resistance is in the opposite direction, and the resulting acceleration is -8.8 m/s^2 . When the ball reaches the level from which it was thrown, how does its speed compare to that with which it was thrown?
- It is greater than the original speed upward.
 - It is the same as the original speed upward.
 - It is less than the original speed upward.**
 - Without knowing the original speed, this problem cannot be solved.
62. Starting from rest, a car accelerates down a straight road with constant acceleration a_1 for a time t_1 , then the acceleration is changed to a different constant value a_2 for an additional time t_2 . The total elapsed time is $t_1 + t_2$. Can the equations of kinematics be used to find the total distance traveled?
- No, because this is not a case of constant acceleration.
 - Yes, use $(a_1 + a_2)/2$ as the average acceleration and the total time in the calculation.
 - Yes, use $a_1 + a_2$ as the acceleration and the average time $(t_1 + t_2)/2$ in the calculation.
 - Yes, break the problem up into 2 problems, one with the conditions for the first time interval and the other with the conditions for the second time interval, noting that for the second time interval the initial velocity is that from the end of the first time interval. When done, add the distances from each of the time intervals.**
63. Starting from rest, a car accelerates down a straight road with constant acceleration a for a time t , then the direction of the acceleration is reversed, (i.e., it is $-a$), and the car comes to a stop in an additional time t , the time for the whole trip being $2t$. At what time, or times, is the average velocity of the car for the trip equal to its instantaneous velocity during the trip?
- There is no such time.
 - It is at the halfway point at t .
 - This occurs at 2 times, $0.5 t$ and $1.5 t$.**
 - This occurs at 2 times, $0.707 t$ and $1.293 t$.
64. A ball rolls down an incline, starting from rest. If the total time it takes to reach the end of the incline is T , how much time has elapsed when it is halfway down the incline?
- $0.5 T$
 - $< 0.5 T$
 - $> 0.5 T$**
 - More information is needed.

65. In which of the following cases is the displacement's magnitude half the distance traveled?
- A. 10 steps east followed by 3 steps west
 - B. 22 steps east followed by 11 steps west
 - C. 5 steps east followed by 10 steps west
 - D.** 15 steps east followed by 5 steps west