MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Consider a deer that runs from point A to point B. The distance the deer runs can be greater than the magnitude of its displacement, but the magnitude of the displacement can never be greater than the distance it runs. 1) _____
A) True B) False

2) Which of the following quantities has units of a displacement? (There could be more than one correct choice.) 2) _____
A) 32 ft/s^2 vertically downward
B) 9.8 m/s^2
C) 40 km southwest
D) 186,000 mi
E) -120 m/s

3) Suppose that an object travels from one point in space to another. Make a comparison between the magnitude of the displacement and the distance traveled by this object. 3) _____
A) The displacement is either greater than or equal to the distance traveled.
B) The displacement is always equal to the distance traveled.
C) The displacement can be either greater than, smaller than, or equal to the distance traveled.
D) The displacement is either less than or equal to the distance traveled.

4) Consider a car that travels between points A and B. The car's average speed can be greater than the magnitude of its average velocity, but the magnitude of its average velocity can never be greater than its average speed. 4) _____
A) True B) False

5) Which of the following quantities has units of a velocity? (There could be more than one correct choice.) 5) _____
A) 40 km southwest
B) 9.8 m/s downward
C) 9.8 m/s^2 downward
D) 186,000 mi
E) -120 m/s

6) When is the average velocity of an object equal to the instantaneous velocity? 6) _____
A) when the velocity is constant
B) only when the velocity is increasing at a constant rate
C) never
D) only when the velocity is decreasing at a constant rate
E) always

7) You drive 6.0 km at 50 km/h and then another 6.0 km at 90 km/h. Your average speed over the 12 km drive will be 7) _____
A) greater than 70 km/h.
B) less than 70 km/h.
C) equal to 70 km/h.
D) exactly 38 km/h.
E) It cannot be determined from the information given because we must also know directions traveled.

8) If the velocity of an object is zero at some point, then its acceleration must also be zero at that po int.

8) _____
A) True B) False

9) Which of the following situations is *impossible*? 9) _____
A) An object has velocity directed east and acceleration directed east.
B) An object has zero velocity but non-zero acceleration.
C) An object has velocity directed east and acceleration directed west.
D) An object has constant non-zero velocity and changing acceleration.
E) An object has constant non-zero acceleration and changing velocity.

10) If the acceleration of an object is zero, then that object cannot be moving. 10) _____
A) True B) False

11) If the velocity of an object is zero, then that object cannot be accelerating. 11) _____
A) True B) False

12) Suppose that a car traveling to the west begins to slow down as it approaches a traffic light. Which of the following statements about its acceleration is correct? 12) _____
A) The acceleration is toward the west.
B) The acceleration is toward the east.
C) The acceleration is zero.
D) Since the car is slowing down, its acceleration must be negative.

13) An auto manufacturer advertises that their car can go "from zero to sixty in eight seconds." This is a description of what characteristic of the car's motion? 13) _____
A) instantaneous speed
B) average speed
C) instantaneous acceleration
D) average acceleration
E) displacement

14) An object moving in the +x direction experiences an acceleration of +2.0 m/s^2. This means the object 14) _____
A) is increasing its velocity by 2.0 m/s every second.
B) travels 2.0 m in every second.
C) is traveling at 2.0 m/s.
D) is decreasing its velocity by 2.0 m/s every second.

15) Suppose that a car traveling to the east (+x direction) begins to slow down as it approaches a traffic light. Which statement concerning its acceleration must be correct? 15) _____
A) Its acceleration is in the -x direction.
B) Its acceleration is zero.
C) Its acceleration is decreasing in magnitude as the car slows down.
D) Its acceleration is in the +x direction.

16) Suppose that a car traveling to the west (-x direction) begins to slow down as it approaches a traffic light. Which statement concerning its acceleration must be correct? 16) _____
A) Its acceleration is positive.
B) Its acceleration is decreasing in magnitude as the car slows down.
C) Its acceleration is negative.
D) Its acceleration is zero.

17) Suppose that an object is moving with a constant velocity. Which statement concerning its acceleration must be correct? 17) _____

A) The acceleration is constantly increasing.
B) The acceleration is a constant non-zero value.
C) The acceleration is constantly decreasing.
D) The acceleration is equal to zero.

18) If the velocity of an object is zero at one instant, what is true about the acceleration of that object? (There could be more than one correct choice.) 18) _____

A) The acceleration could be positive.
B) The acceleration could be negative.
C) The acceleration must be zero.
D) The acceleration could be zero.

19) Under what condition is average velocity equal to the average of the object's initial and final velocity? 19) _____

A) This can only occur if there is no acceleration.
B) This can occur only when the velocity is zero.
C) The acceleration must be constantly increasing.
D) The acceleration is constant.
E) The acceleration must be constantly decreasing.

20) A racing car accelerates uniformly from rest along a straight track. This track has markers spaced at equal distances along it from the start, as shown in the figure. The car reaches a speed of 140 km/h as it passes marker 2. 20) _____

Where on the track was the car when it was traveling at half this speed, that is at 70 km/h?

A) Between marker 1 and marker 2
B) At marker 1
C) Before marker 1

21) When a ball is thrown straight up with no air resistance, the acceleration at its highest point 21) _____

A) is downward
B) is upward
C) is zero
D) reverses from upward to downward
E) reverses from downward to upward

22) A rock from a volcanic eruption is launched straight up into the air with no appreciable air resistance. Which one of the following statements about this rock while it is in the air is correct? 22) _____

A) Throughout the motion, the acceleration is downward, and the velocity is always in the same direction as the acceleration.
B) On the way up, its acceleration is downward and its velocity is upward, and at the highest point both its velocity and acceleration are zero.
C) On the way down, both its velocity and acceleration are downward, and at the highest point both its velocity and acceleration are zero.
D) The acceleration is downward at all points in the motion except that is zero at the highest point.
E) The acceleration is downward at all points in the motion.

23) Suppose a ball is thrown straight up and experiences no appreciable air resistance. What is its acceleration just before it reaches its highest point? 23) _____

A) slightly less than g
B) zero
C) exactly g
D) slightly greater than g

24) A ball is thrown straight up, reaches a maximum height, then falls to its initial height. Which of the following statements about the direction of the velocity and acceleration of the ball as it is *going up* is correct? 24) _____

A) Both its velocity and its acceleration points downward.
B) Its velocity points downward and its acceleration points upward.
C) Its velocity points upward and its acceleration points downward.
D) Both its velocity and its acceleration point upward.

25) A ball is thrown downward in the absence of air resistance. After it has been released, which statement(s) concerning its acceleration is correct? (There could be more than one correct choice.) 25) _____

A) Its acceleration is zero.
B) Its acceleration is constantly increasing.
C) Its acceleration is constant.
D) Its acceleration is constantly decreasing.
E) Its acceleration is greater than g.

26) A 10-kg rock and a 20-kg rock are thrown upward with the same initial speed v_0 and experience no significant air resistance. If the 10-kg rock reaches a maximum height h, what maximum height will the 20-kg ball reach? 26) _____

A) $h/2$ B) $2h$ C) $h/4$ D) $4h$ E) h

27) A 10-kg rock and 20-kg rock are dropped from the same height and experience no significant air resistance. If it takes the 20-kg rock a time T to reach the ground, what time will it take the 10-kg rock to reach the ground? 27) _____

A) T B) $T/2$ C) $2T$ D) $4T$ E) $T/4$

28) A 10-kg rock and a 20-kg rock are dropped at the same time and experience no significant air resistance. If the 10-kg rock falls with acceleration a, what is the acceleration of the 20-kg rock? 28) _____

A) $a/2$ B) $4a$ C) $a/4$ D) $2a$ E) a

29) Two objects are dropped from a bridge, an interval of 1.0 s apart. Air resistance is negligible. During the time that both objects continue to fall, their separation 29) _____

A) decreases.
B) decreases at first, but then stays constant.
C) increases at first, but then stays constant.
D) stays constant.
E) increases.

30) From the edge of a roof top you toss a green ball upwards with initial speed v_0 and a blue ball downwards with the same initial speed. Air resistance is negligible. When they reach the ground below 30) _____

A) the green ball will be moving faster than the blue ball.
B) the two balls will have the same speed.
C) the blue ball will be moving faster than the green ball.

31) Ball A is dropped from the top of a building. One second later, ball B is dropped from the same building. Neglect air resistance. As time progresses, the difference in their speeds 31) _____

A) decreases.
B) remains constant.
C) increases.
D) cannot be determined from the information given.

32) Two objects are thrown from the top of a tall building. One is thrown up, and the other is thrown down, both with the same initial speed. What are their speeds when they hit the street? Neglect air resistance. 32) _____
A) The one thrown down is traveling faster.
B) They are traveling at the same speed.
C) The one thrown up is traveling faster.
D) It is impossible to tell because the height of the building is not given.

33) Brick A is dropped from the top of a building. Brick B is thrown straight down from the same building, and neither one experiences appreciable air resistance. Which statement about their accelerations is correct? 33) _____
A) The acceleration of A is greater than the acceleration of B.
B) The acceleration of B is greater than the acceleration of A.
C) Neither brick has any acceleration once it is released.
D) The two bricks have exactly the same acceleration.

34) An object is moving with constant non-zero velocity in the $+x$ direction. The position versus time graph of this object is 34) _____
A) a horizontal straight line.
B) a vertical straight line.
C) a straight line making an angle with the time axis.
D) a parabolic curve.

35) An object is moving with constant non-zero acceleration in the $+x$ direction. The position versus time graph of this object is 35) _____
A) a horizontal straight line.
B) a vertical straight line.
C) a straight line making an angle with the time axis.
D) a parabolic curve.

36) An object is moving with constant non-zero velocity in the $+x$ direction. The velocity versus time graph of this object is 36) _____
A) a horizontal straight line.
B) a vertical straight line.
C) a straight line making an angle with the time axis.
D) a parabolic curve.

37) An object is moving with constant non-zero acceleration in the $+x$ direction. The velocity versus time graph of this object is 37) _____
A) a horizontal straight line.
B) a vertical straight line.
C) a straight line making an angle with the time axis.
D) a parabolic curve.

38) The slope of a position versus time graph gives 38) _____
A) displacement.
B) velocity.
C) the distance traveled.
D) acceleration.

39) The slope of a velocity versus time graph gives 39) _____

A) displacement. B) the distance traveled.

C) acceleration. D) velocity.

40) If the position versus time graph of an object is a horizontal line, the object is 40) _____

A) moving with constant non-zero speed.

B) moving with constant non-zero acceleration.

C) at rest.

D) moving with increasing speed.

41) If the velocity versus time graph of an object is a horizontal line, the object is 41) _____

A) moving with zero acceleration.

B) moving with constant non-zero acceleration.

C) at rest.

D) moving with increasing speed.

42) If the velocity versus time graph of an object is a straight line making an angle of +30° (counter clockwise) with the time axis, the object is 42) _____

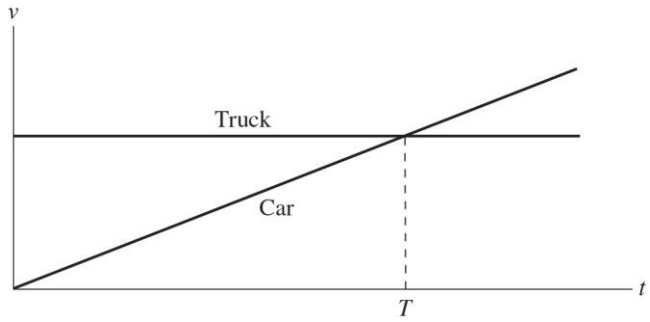
A) moving with constant non-zero speed.

B) moving with constant non-zero acceleration.

C) at rest.

D) moving with increasing acceleration.

43) The motions of a car and a truck along a straight road are represented by the velocity-time graphs in the figure. The two vehicles are initially alongside each other at time $t = 0$. 43) _____



At time T, what is true of the *distances* traveled by the vehicles since time $t = 0$?

A) The truck will not have moved.

B) They will have traveled the same distance.

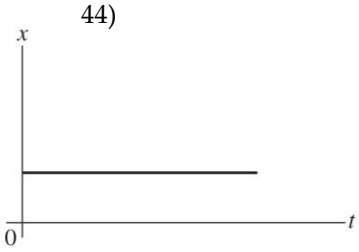
C) The car will have travelled further than the truck.

D) The truck will have travelled further than the car.

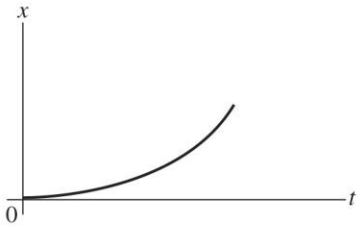
44) Which of the following graphs represent an object at rest? (There could be more than one correct choice.)

44) ___
___

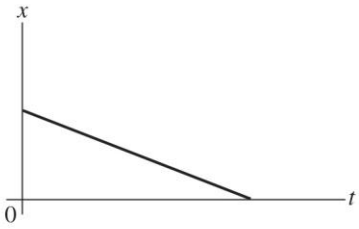
(a)



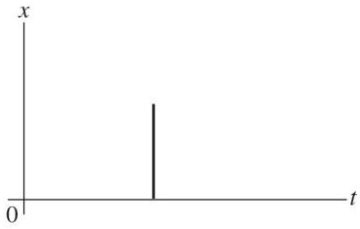
(b)



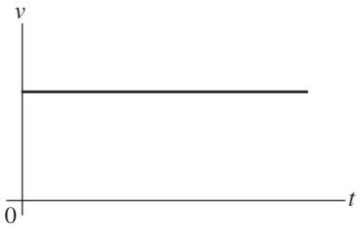
(c)



(d)



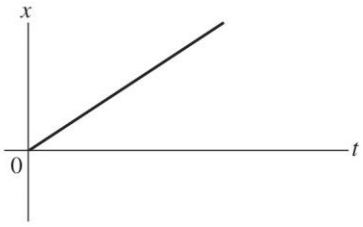
(e)



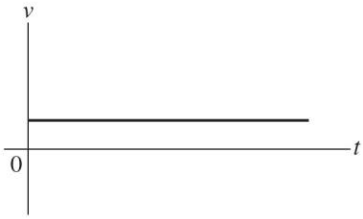
A) graph a B) graph b C) graph c D) graph d E) graph e

45) Which of the following graphs represent an object having zero acceleration? 45) _____

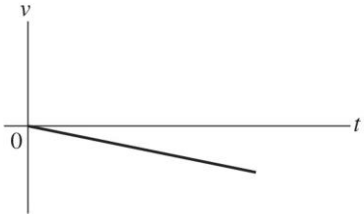
(a)



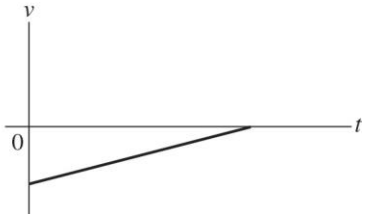
(b)



(c)

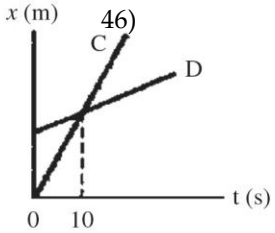


(d)



A) only graph a
B) only graph b
C) graphs b and c
D) graphs a and b
E) graphs c and d

46) The figure shows a graph of the position x of two cars, C and D, as a function of time t.

46) 

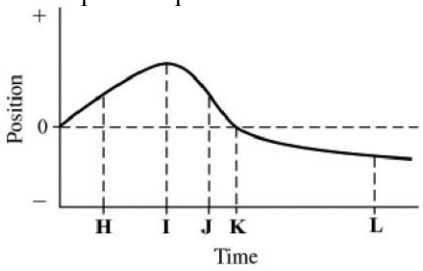
___
___

According to this graph, which statements about these cars must be true? (There could be more than one correct choice.)

A) The magnitude of the acceleration of car C is greater than the magnitude of the acceleration of car D.
B) The magnitude of the acceleration of car C is less than the magnitude of the acceleration of car D.
C) At time t = 10 s, both cars have the same velocity.
D) The cars meet at time t = 10 s.
E) Both cars have the same acceleration.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

47) The graph in the figure shows the position of an object as a function of time. The letters H-L represent particular moments of time. 47) _____

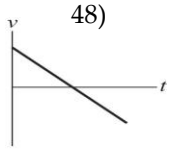


(a) At which moment in time is the speed of the object the greatest?
(b) At which moment in time is the speed of the object equal to zero?

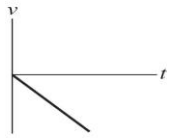
48) A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at time t = 0 s. If we take upward as the positive direction, which of the graphs shown below best represents the velocity of the stone as a function of time?

48)

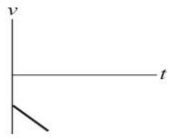
A)



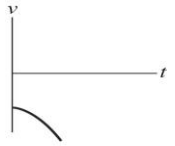
B)



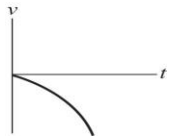
C)



D)

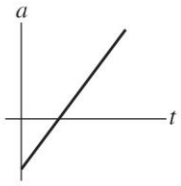


E)

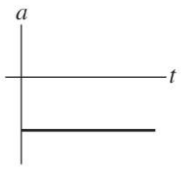


49) A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at time t = 0 s. If we take upward as the positive direction, which of the graphs shown below best represents the acceleration of the stone as a function of time? 49) _____

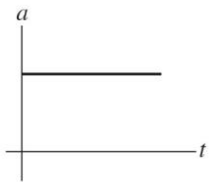
A)



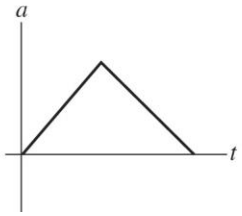
B)



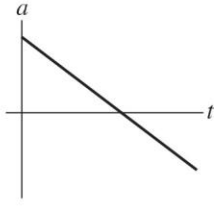
D)



C)

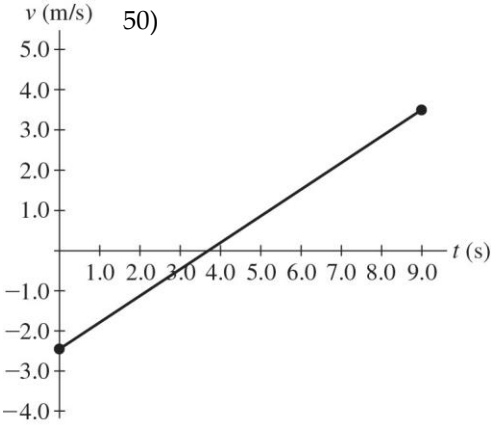


E)



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

50) The motion of a particle is described in the velocity vs. time graph shown in the figure.

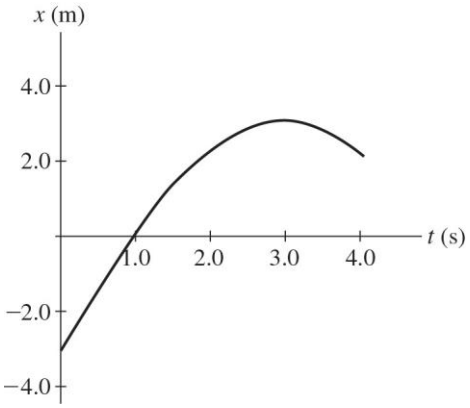
50) 

___
___

Over the nine-second interval shown, we can say that the *speed* of the particle

A) only decreases.
B) decreases and then increases.
C) remains constant.
D) increases and then decreases.
E) only increases.

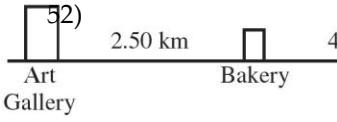
51) The graph in the figure shows the position of a particle as it travels along the x-axis. 51) _____



At what value of t is the speed of the particle equal to 0 m/s?
A) 2 s B) 3 s C) 1 s D) 0 s E) 4 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

52) If, in the figure, you start from the Bakery, travel to the Cafe, and then to the Art Gallery 52)
(a) what distance you have traveled?
(b) what is your displacement?



_____ _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

53) An object moves 15.0 m north and then 11.0 m south. Find both the distance it has traveled and the magnitude of its displacement. 53) _____
A) 26.0 m, 4.0 m B) 4.0 m, 26.0 m C) 4.0 m, 4.0 m D) 26.0 m, 26.0 m

54) What must be your average speed in order to travel 350 km in 5.15 h? 54) _____
A) 67.0 km/h B) 66.0 km/h C) 69.0 km/h D) 68.0 km/h

55) A runner ran the marathon (approximately 42.0 km) in 2 hours and 57 min. What was the average speed of the runner in m/s? 55) _____
A) 14.2 m/s B) 124 m/s C) 14,200 m/s D) 3.95 m/s

56) A light-year is the distance that light travels in one year. The speed of light is 3.00×10^8 m/s. How many miles are there in one light-year? (1 mi = 1609 m, 1 y = 365 d) 56) _____
A) 5.88×10^{12} mi B) 9.46×10^{15} mi C) 9.46×10^{12} mi D) 5.88×10^{15} mi

57) If you are driving 72 km/h along a straight road and you look to the side for 4.0 s, how far do you travel during this inattentive period? 57) _____
A) 20 m B) 80 m C) 40 m D) 18 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

58) If you run a complete loop around an outdoor track of length 400 m in 100 s, find your (a) average velocity and (b) average speed. 58) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

59) A polar bear starts at the North Pole. It travels 1.0 km south, then 1.0 km east, and then 1.0 km north to return to its starting point. This trip takes 45 min. What was the bear's average speed? 59) _____
A) 0.00 km/h B) 0.067 km/h C) 5.3 km/h D) 4.0 km/h

60) A polar bear starts at the North Pole. It travels 1.0 km south, then 1.0 km east, and then 1.0 km north to return to its starting point. This trip takes 45 min. What was the bear's average velocity? 60) _____
A) 0.00 km/h B) 5.3 km/h C) 0.067 km/h D) 4.0 km/h

61) You are driving home on a weekend from school at 55 mi/h for 110 miles. It then starts to snow and you slow to 35 mi/h. You arrive home after driving 4 hours and 15 minutes. How far is your hometown from school? 61) _____
A) 180 mi B) 210 mi C) 190 mi D) 200 mi

62) A motorist travels 160 km at 80 km/h and 160 km at 100 km/h. What is the average speed of the motorist for this trip? 62) _____
A) 84 km/h B) 91 km/h C) 90 km/h D) 89 km/h

63) A motorist travels for 3.0 h at 80 km/h and 2.0 h at 100 km/h. What is her average speed for the trip? 63) _____
A) 90 km/h B) 85 km/h C) 88 km/h D) 92 km/h

64) An airplane travels at 300 mi/h south for 2.00 h and then at 250 mi/h north for 750 miles. What is the average speed for the trip? 64) _____

A) 275 mi/h B) 280 mi/h C) 260 mi/h D) 270 mi/h

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

65) A race car circles 10 times around a circular 8.0-km track in 20 min. Using SI units 65) _____
(a) what is its average speed for the ten laps?
(b) what is its average velocity for the ten laps?

66) A bat, flying toward the east at 2.0 m/s, emits a shriek that is reflected back to it from a wall that is 20.0 m in front of the bat at the instant the shriek is emitted. Sound travels at 340 m/s in the air. How many milliseconds after emitting the shriek does the bat hear the reflected echo from the wall? 66) _____

67) If, in the figure, you start from the Bakery, travel to the Cafe, and then to the Art Gallery in 2.00 hours, what is your 67) _____
(a) average speed?
(b) average velocity?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

68) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average velocity? 68) _____
A) 5.0 m/s B) 0 m/s C) 2.5 m/s D) 1.3 m/s E) 10 m/s

69) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average speed? 69) _____
A) 2.5 m/s B) 1.3 m/s C) 10 m/s D) 0 m/s E) 5.0 m/s

70) You leave on a 549–mi trip in order to attend a meeting that will start 10.8 h after you begin your trip. Along the way you plan to stop for dinner. If the fastest you can safely drive is 65 mi/h, what is the longest time you can spend over dinner and still arrive just in time for the meeting? 70) _____
A) 2.6 h B) 1.9 h
C) 2.4 h D) You can't stop at all.

71) A motorist makes a trip of 180 miles. For the first 90 miles she drives at a constant speed of 30 mph. At what constant speed must she drive the remaining distance if her average speed for the total trip is to be 40 mph? 71) _____
A) 45 mph B) 52.5 mph C) 50 mph D) 55 mph E) 60 mph

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

72) Human reaction times are worsened by alcohol. How much *further* (in feet) would a drunk driver's car travel before he hits the brakes than a sober driver's car? Assume that both are initially traveling at 50.0 mi/h and their cars have the same acceleration while slowing down, and that the sober driver takes 0.33 s to hit the brakes in a crisis, while the drunk driver takes 1.0 s to do so. (5280 ft = 1 mi) 72) _____

73) Arthur and Betty start walking toward each other when they are 100 m apart. Arthur has a speed of 3.0 m/s and Betty has a speed of 2.0 m/s. How long does it take for them to me et? 73)

_____ _____

74) The position $x(t)$ of a particle as a function of time t is given by the equation $x(t) = (3.5\ \text{m/s})t - (5.0\ \text{m/s}^2)t^2$. What is the average velocity of the particle between $t = 0.30$ s and $t = 0.40$ s? 74) _____

75) A water rocket can reach a speed of 75 m/s in 0.050 seconds from launch. What is its average acceleration? 75) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

76) An airplane increases its speed at the average rate of 15 m/s^2. How much time does it take to increase its speed from 100 m/s to 160 m/s? 76) _____

A) 0.25 s B) 0.058 s C) 17 s D) 4.0 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

77) The captain orders his starship to accelerate from rest at a rate of "1 g" ($1\ g = 9.8\ \text{m/s}^2$). How many days does it take the starship to reach 10% the speed of light? (Light travels at 3.0×10^8 m/s.) 77) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

78) A car is traveling north at 17.7 m/s. After 12 s its velocity is 14.1 m/s in the same direction. Find the magnitude and direction of the car's average acceleration. 78) _____

A) 2.7 m/s^2, north B) 2.7 m/s^2, south
C) 0.30 m/s^2, north D) 0.30 m/s^2, south

79) A racquetball strikes a wall with a speed of 30 m/s and rebounds in the opposite direction with a speed of 26 m/s. The collision takes 20 ms. What is the average acceleration of the ball during the collision with the wall? 79) _____

A) 200 m/s^2 B) 0 m/s^2 C) 2800 m/s^2 D) 1300 m/s^2 E) 1500 m/s^2

80) The velocity $v(t)$ of a particle as a function of time is given by $v(t) = (2.3\ \text{m/s}) + (4.1\ \text{m/s}^2)t - (6.2\ \text{m/s}^3)t^2$. What is the average acceleration of the particle between $t = 1.0$ s and $t = 2.0$ s? 80) _____

A) 13 m/s^2 B) 0 m/s^2 C) -15 m/s^2 D) -13 m/s^2 E) 15 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

81) If a car accelerates at a uniform 4.0 m/s^2, how long will it take to reach a speed of 80 km/hr, starting from rest? 81) _____

82) A car that is initially moving at 7.50 m/s begins to accelerate forward uniformly at 0.550 m/s^2. 82) _____
(a) How long after beginning to accelerate does it take the car to move 3.50 km?
(b) How fast is the car moving just as it has traveled 3.50 km?

83) An auto accelerates forward from 7.0 m/s at a uniform 0.71 m/s^2. It travels a distance of 1.033 km while accelerating. 83) _____
(a) How fast is the auto moving just as it is traveled the 1.033 km?
(b) How many seconds did it take to travel the 1.033 km?

84) In a ballistics test, a bullet moving horizontally with a speed of 500 m/s strikes a sandbag and penetrates a distance of 10.0 cm. (a) at is the Wh magnitude of

the average acceleration of the bullet in the sandbag? (b) How many milliseconds does it take the bullet to come to rest in the sandbag?

84) ___ ___ ___ ___ _

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

85) A certain test car can go from rest to 32.0 m/s in 3.88 s. The same car can come to a full stop from that speed in 4.14 s. What is the ratio of the magnitude of the starting acceleration to the stopping acceleration? 85) _____
A) 1.14 B) 0.937 C) 1.07 D) 0.878

86) A car initially traveling at 60 km/h accelerates at a constant rate of 2.0 m/s^2. How much time is required for the car to reach a speed of 90 km/h? 86) _____
A) 4.2 s B) 45 s C) 30 s D) 15 s

87) A cart starts from rest and accelerates uniformly at 4.0 m/s^2 for 5.0 s. It next maintains the velocity it has reached for 10 s. Then it slows down at a steady rate of 2.0 m/s^2 for 4.0 s. What is the final speed of the car? 87) _____
A) 20 m/s B) 10 m/s C) 12 m/s D) 16 m/s

88) A car travels at 15 m/s for 10 s. It then speeds up with a constant acceleration of 2.0 m/s^2 for 15 s. At the end of this time, what is its velocity? 88) _____
A) 30 m/s B) 45 m/s C) 15 m/s D) 375 m/s

89) A cart with an initial velocity of 5.0 m/s to the right experiences a constant acceleration of 2.0 m/s^2 to the right. What is the cart's displacement during the first 6.0 s of this motion? 89) _____
A) 66 m B) 80 m C) 55 m D) 10 m

90) A jet plane is launched from a catapult on an aircraft carrier. In 2.0 s it reaches a speed of 42 m/s at the end of the catapult. Assuming the acceleration is constant, how far did it travel during those 2.0 s? 90) _____
A) 24 m B) 42 m C) 84 m D) 16 m

91) A car starting from rest accelerates at a constant 2.0 m/s^2 for 10 s. It then travels with constant speed it has achieved for another 10 s. Then it finally slows to a stop with constant acceleration of magnitude 2.0 m/s^2. How far does it travel after starting? 91) _____
A) 200 m B) 500 m C) 400 m D) 300 m

92) A car increases its forward velocity uniformly from 40 m/s to 80 m/s while traveling a distance of 200 m. What is its acceleration during this time? 92) _____

A) 8.0 m/s^2 B) 9.6 m/s^2 C) 24 m/s^2 D) 12 m/s^2

93) An object starts from rest and undergoes uniform acceleration. During the first second it travels 5.0 m. How far will it travel during the third second? 93) _____

A) 45 m B) 15 m C) 25 m D) 5.0 m

94) An object is moving in a straight line with constant acceleration. Initially it is traveling at 16 m/s. Three seconds later it is traveling at 10 m/s. How far does it move during this time? 94) _____

A) 48 m B) 39 m C) 30 m D) 57 m

95) A car starts from rest and accelerates uniformly at 3.0 m/s^2 toward the north. A second car starts from rest 6.0 s later at the same point and accelerates uniformly at 5.0 m/s^2 toward the north. How long after the second car starts does it overtake the first car? 95) _____

A) 24 s B) 21 s C) 12 s D) 19 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

96) A car with good tires on a dry road can decelerate (slow down) at a steady rate of about 5.0 m/s^2 when braking. If a car is initially traveling at 55 mi/h 96) _____

(a) how much time does it take the car to stop?

(b) what is its stopping distance?

97) At the instant a traffic light turns green, a car that has been waiting at the intersection starts ahead with a constant acceleration of 2.00 m/s^2. At that moment a truck traveling with a constant velocity of 15.0 m/s overtakes and passes the car. 97) _____

(a) Calculate the time necessary for the car to reach the truck.

(b) Calculate the distance beyond the traffic light that the car will pass the truck.

(c) Determine the speed of the car when it passes the truck.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

98) Starting from rest, a dragster travels a straight 1/4 mi racetrack in 6.70 s with constant acceleration. What is its velocity when it crosses the finish line? 98) _____

A) 296 mi/h B) 269 mi/h C) 135 mi/h D) 188 mi/h

99) A bicyclist starts a timed race at $6.0\ \text{mi/h}$. In order to win, he must average $21\ \text{mi/h}$. Assuming constant acceleration from the start, how fast must he be traveling at the end of the race? 99) _____

A) 30 mi/h B) 24 mi/h C) 36 mi/h D) 42 mi/h

100) A car accelerates from $5.0\ \text{m/s}$ to $21\ \text{m/s}$ at a constant rate of $3.0\ \text{m/s}^2$. How far does it travel while accelerating? 100) _____

A) 69 m B) 117 m C) 41 m D) 207 m

101) An airplane needs to reach a forward velocity of $203.0\ \text{km/h}$ to take off. On a 2000-m runway, what is the minimum uniform acceleration necessary for the plane to take flight if it starts from rest? 101) _____

A) 0.79 m/s^2 B) 1.0 m/s^2 C) 0.95 m/s^2 D) 0.87 m/s^2

102) Assuming equal rates of uniform acceleration in both cases, how much further would you travel if braking from $56\ \text{mi/h}$ to rest than from $28\ \text{mi/h}$? 102) _____

A) 3.2 times farther B) 5.2 times farther

C) 4 times farther D) 4.8 times farther

103) Acceleration is sometimes expressed in multiples of g, where $g = 9.8\ \text{m/s}^2$ is the acceleration of an object due to the earth's gravity. In a car crash, the car's forward velocity may go from $29\ \text{m/s}$ to $0\ \text{m/s}$ in $0.15\ \text{s}$. How many g's are experienced, on average, by the driver? 103) _____

A) 24 g B) 14 g C) 26 g D) 20 g

104) A baseball is hit with a bat and, as a result, its direction is completely reversed and its speed is doubled. If the actual contact with the bat lasts 0.45 s, what is the ratio of the magnitude of the average acceleration of the ball to its original speed? 104) _____

A) $2.2\ \text{s}^{-1}$ B) $4.4\ \text{s}^{-1}$ C) $6.7\ \text{s}^{-1}$ D) $0.15\ \text{s}^{-1}$

105) A train starts from rest and accelerates uniformly until it has traveled 5.6 km and acquired a forward velocity of $42\ \text{m/s}$. The train then moves at a constant velocity of $42\ \text{m/s}$ for 420 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The acceleration during the first 5.6 km of travel is closest to which of the following? 105) _____

A) $0.20\ \text{m/s}^2$ B) $0.16\ \text{m/s}^2$ C) $0.19\ \text{m/s}^2$ D) $0.17\ \text{m/s}^2$ E) $0.14\ \text{m/s}^2$

106) A train starts from rest and accelerates uniformly until it has traveled 2.1 km and acquired a forward velocity of $24\ \text{m/s}$. The train then moves at a constant velocity of $24\ \text{m/s}$ for 400 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The distance traveled by the train while slowing down is closest to 106) _____

A) 3.8 km. B) 3.6 km. C) 4.0 km. D) 4.2 km. E) 4.4 km.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

107) A soccer ball is released from rest at the top of a grassy incline. After 6.4 seconds the ball has rolled 91 m with constant acceleration, and 1.0 s later it reaches the bottom of the incline. 107) _____

(a) What was the ball's acceleration?

(b) How long was the incline?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

108) A car starts from rest and accelerates at a steady 6.00 m/s^2. How far does it travel in the first 3.00 s? 108) _____

A) 18.0 m B) 9.00 m C) 27.0 m D) 36.0 m E) 54.0 m

109) A car is moving with a constant acceleration. At time t = 5.0 s its velocity is 8.0 m/s in the forward direction, and at time t = 8.0 s its velocity is 12.0 m/s forward. What is the distance traveled in that interval of time? 109) _____

A) 20 m B) 10 m C) 50 m D) 40 m E) 30 m

110) An airplane starts from rest and accelerates at a constant 10.8 m/s^2. What is its speed at the end of a 400 m-long runway? 110) _____

A) 37.0 m/s B) 65.7 m/s C) 93.0 m/s D) 186 m/s E) 4320 m/s

111) A car is moving with a speed of 32.0 m/s. The driver sees an accident ahead and slams on the brakes, causing the car to slow down with a uniform acceleration of magnitude 3.50 m/s^2. How far does the car travel after the driver put on the brakes until it comes to a stop? 111) _____

A) 4.57 m B) 146 m C) 9.14 m D) 292 m E) 112 m

112) A car is traveling with a constant speed when the driver suddenly applies the brakes, causing the car to slow down with a constant acceleration of magnitude 3.50 m/s^2. If the car comes to a stop in a distance of 30.0 m, what was the car's original speed? 112) _____

A) 105 m/s B) 210 m/s C) 315 m/s D) 10.2 m/s E) 14.5 m/s

113) A car is traveling with a constant speed of 30.0 m/s when the driver suddenly applies the brakes, causing the car to slow down with a constant acceleration. The car comes to a stop in a distance of 120 m. What was the acceleration of the car as it slowed down? 113) _____

A) 4.75 m/s^2 B) 3.75 m/s^2 C) 4.25 m/s^2 D) 4.50 m/s^2 E) 4.00 m/s^2

114) A car is traveling at 26.0 m/s when the driver suddenly applies the brakes, causing the car to slow down with constant acceleration. The car comes to a stop in a distance of 120 m. How fast was the car moving when it was 60.0 m past the point where the brakes were applied? 114) _____

A) 18.4 m/s B) 22.5 m/s C) 15.0 m/s D) 12.1 m/s E) 9.20 m/s

115) Car A is traveling at 22.0 m/s and car B at 29.0 m/s. Car A is 300 m behind car B when the driver of car A accelerates his car with a uniform forward acceleration of 2.40 m/^{s2}. How long after car A begins to accelerate does it take car A to overtake car B? 115) _____

A) 12.6 s
B) 19.0 s
C) 316 s
D) 5.50 s
E) Car A never overtakes car B.

116) A stone is thrown with an initial upward velocity of 7.0 m/s and experiences negligible air resistance. If we take upward as the positive direction, what is the velocity of the stone after 0.50 s? 116) _____

A) 0.00 m/s B) 2.1 m/s C) -4.9 m/s D) -2.1 m/s E) 4.9 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

117) An astronaut on a strange new planet having no atmosphere finds that she can jump up to a maximum height of 27 m when her initial upward speed is 6.0 m/s. What is the magnitude of the acceleration due to gravity on the planet? 117) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

118) A laser is thrown upward with a speed of 12 m/s on the surface of planet X where the acceleration due to gravity is 1.5 m/s^2 and there is no atmosphere. What is the maximum height reached by the laser? 118) _____

A) 48 m B) 18 m C) 8.0 m D) 144 m

119) A laser is thrown upward with a speed of 12 m/s on the surface of planet X where the acceleration due to gravity is 1.5 m/s^2 and there is no atmosphere. How long does it take for the laser to reach the maximum height? 119) _____

A) 11 s B) 16 s C) 14 s D) 8.0 s

120) An instrument is thrown upward with a speed of 15 m/s on the surface of planet X where the acceleration due to gravity is 2.5 m/s^2 and there is no atmosphere. How long does it take for the instrument to return to where it was thrown? 120) _____

A) 10 s B) 12 s C) 6.0 s D) 8.0 s

121) A hammer is thrown upward with a speed of 14 m/s on the surface of planet X where the accel eratio

n due to gravity is 3.5 m/s^2 and there is no atmosphere. What is the speed of the hammer after 8.0 s? 121) ____

A) 14 m/s B) 7.0 m/s C) 64 m/s D) 21 m/s

122) Human reaction time is usually greater than 0.10 s. If your friend holds a ruler between your fingers and releases it without warning, how far can you expect the ruler to fall before you catch it, assuming negligible air resistance? 122) _____

A) At least 4.9 cm B) At least 3.0 cm C) At least 6.8 cm D) At least 9.8 cm

123) A ball is thrown upward at a velocity of 19.6 m/s. What is its velocity after 3.0 s, assuming negligible air resistance? 123) _____

A) 19.6 m/s downward B) 9.8 m/s upward
C) 0 m/s D) 9.8 m/s downward

124) A bullet shot straight up returns to its starting point in 10 s. What is the initial speed of the bullet, assuming negligible air resistance? 124) _____

A) 49 m/s B) 25 m/s C) 98 m/s D) 9.8 m/s

125) A ball is thrown straight up with a speed of 36 m/s. How long does it take to return to its starting point, assuming negligible air resistance? 125) _____

A) 11 s B) 15 s C) 7.3 s D) 3.7 s

126) A ball is thrown downward from the top of a building with an initial speed of 25 m/s. It strikes the ground after 2.0 s. How high is the building, assuming negligible air resistance? 126) _____

A) 50 m B) 70 m C) 20 m D) 30 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

127) A ball is thrown straight up with a speed of 30 m/s, and air resistance is negligible. 127) _____
(a) How long does it take the ball to reach the maximum height?
(b) What is the maximum height reached by the ball?
(c) What is its speed after 4.2 s?

128) A foul ball is hit straight up into the air with a speed of 30 m/s, and air resistance is negligible.
(a) Calculate the time required for the ball to rise to its maximum height.
(b) Calculate the maximum height reached by the ball above the point where it hit the bat.
(c) Determine the times at which the ball passes a point 25 m above the point where it was hit by the bat.
(d) Explain why there are two answers to part (c).

128) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

129) A ball is projected upward at time $t = 0$ s, from a point on a flat roof 10 m above the ground. The ball rises and then falls with insignificant air resistance, missing the roof, and strikes the ground. The initial velocity of the ball is $58.5\ \text{m/s}$. Consider all quantities as positive in the upward direction. At time $t = 5.97\ \text{s}$, the vertical velocity of the ball is closest to 129) _____

A) -12 m/s. B) -175 m/s. C) +175 m/s. D) +12 m/s. E) 0 m/s.

130) A ball is projected upward at time $t = 0$ s, from a point on a flat roof 90 m above the ground. The ball rises and then falls with insignificant air resistance, missing the roof, and strikes the ground. The initial velocity of the ball is $80.5\ \text{m/s}$. Consider all quantities as positive in the upward direction. The vertical velocity of the ball when it is $89\ \text{m}$ above the ground is closest to 130) _____

A) -32 m/s. B) -81 m/s. C) -64 m/s. D) -48 m/s. E) -97 m/s.

131) A test rocket at ground level is fired straight up from rest with a net upward acceleration of 20 m/s^2. After 4.0 s, the motor turns off but the rocket continues to coast upward with insignificant air resistance. What maximum elevation does the rocket reach? 131) _____

A) 490 m B) 330 m C) 160 m D) 410 m E) 320 m

132) A toy rocket is launched vertically from ground level at time $t = 0.00$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 64 m and acquired an upward velocity of $60\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The time interval during which the rocket engine provided the upward acceleration, is closest to 132) _____

A) 2.3 s. B) 1.5 s. C) 1.9 s. D) 1.7 s. E) 2.1 s.

133) A toy rocket is launched vertically from ground level at time $t = 0.00$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 81 m and acquired an upward velocity of $40\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The upward acceleration of the rocket during the burn phase is closest to 133) _____

A) $9.9\ \text{m/s}^2$. B) $9.6\ \text{m/s}^2$. C) $8.7\ \text{m/s}^2$. D) $9.3\ \text{m/s}^2$. E) $9.0\ \text{m/s}^2$.

134) A toy rocket is launched vertically from ground level at time $t = 0$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 49.0 m and acquired an upward velocity of $60.0\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The maximum height reached by the rocket is closest to 134) _____

A) 209 m. B) 233 m. C) 256 m. D) 244 m. E) 221 m.

135) A rock is projected upward from the surface of the Moon, at time $t = 0$ s, with an upward velocity of 30.0 m/s. The acceleration due to gravity at the surface of the Moon is $1.62\ \text{m/s}^2$, and the Moon has no atmosphere. The height of the rock when it is descending with a speed of 20.0 m/s is closest to 135) _____

A) 115 m. B) 154 m. C) 135 m. D) 145 m. E) 125 m.

136) A ball is thrown straight upward from ground level with a speed of $18\ \text{m/s}$. How much time passes before the ball strikes the ground if we disregard air resistance? 136) _____

A) 3.7 s B) 0.6 s C) 1.8 s D) 1.1 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

137) A rock is thrown directly upward from the edge of a flat roof of a building that is 56.3 meters tall. The rock misses the building on its way down, and is observed to strike the ground 4.00 seconds after being thrown. Take the acceleration due to gravity to have magnitude $9.80\ m/s^2$ and neglect any effects of air resistance. With what speed was the rock thrown? 137) _____

138) A package is dropped from a helicopter that is moving upward at $15\ m/s$. If it takes $8.0\ s$ before the package strikes the ground, how high above the ground was the package when it was released? Neglect air resistance. 138) _____

139) At the same moment, one rock is dropped and one is thrown downward with an initial velocity of $29\ m/s$ from the top of a building that is $300\ m$ tall. How much *earlier* does the thrown rock strike the ground? Neglect air resistance. 139) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

140) An object is dropped from a bridge. A second object is thrown downwards 1.0 s later. They both reach the water 20 m below at the same instant. What was the initial speed of the second object? Neglect air resistance. 140) _____
A) 9.9 m/s B) 21 m/s C) 20 m/s D) 15 m/s E) 4.9 m/s

141) To determine the height of a bridge above the water, a person drops a stone and measures the time it takes for it to hit the water. If the time is 2.3 s, what is the height of the bridge? Neglect air resistance. 141) _____
A) 32 m B) 14 m C) 10 m D) 52 m E) 26 m

142) To determine the height of a bridge above the water, a person drops a stone and measures the time it takes for it to hit the water. If the height of the bridge is 41 m, how long will it take for the stone to hit the water? Neglect air resistance. 142) _____
A) 2.6 s B) 3.2 s C) 2.9 s D) 2.3 s E) 3.6 s

143) An astronaut stands by the rim of a crater on the Moon, where the acceleration of gravity is 1.62 m/s^2 and there is no air. To determine the depth of the crater, she drops a rock and measures the time it takes for it to hit the bottom. If the time is 6.3 s, what is the depth of the crater? 143) _____
A) 26 m B) 32 m C) 14 m D) 38 m E) 10 m

144) An astronaut stands by the rim of a crater on the Moon, where the acceleration of gravity is 1.62 m/s^2 and there is no air. To determine the depth of the crater, she drops a rock and measures the time it takes for it to hit the bottom. If the depth of the crater is 120 m, how long does it take for the rock to fall to the bottom of the crater? 144) _____
A) 32.1 s B) 3.04 s C) 29.3 s D) 37.5 s E) 12.2 s

145) An object is thrown upwards with a speed of 16 m/s. How long does it take it to reach a height of 7.0 m on the way up? Neglect air resistance. 145) _____
A) 3.1 s B) 2.4 s C) 1.2 s D) 0.52 s E) 4.2 s

146) An object is thrown upwards with a speed of 13 m/s. How long does it take to reach a height of 4.0 m above the projection point while descending? Neglect air resistance. 146) _____
A) 1.2 s B) 4.2 s C) 3.1 s D) 0.42 s E) 2.3 s

147) To determine the height of a flagpole, Abby throws a ball straight up and times it. She sees that the ball goes by the top of the pole after 0.50 s and then reaches the top of the pole again after a total elapsed time of 4.1 s. How high is the pole above the point where the ball was launched? Neglect air resistance. 147) _____

A) 26 m B) 10 m C) 13 m D) 18 m E) 16 m

148) Abby throws a ball straight up and times it. She sees that the ball goes by the top of a flagpole after 0.50 s and reaches the level of the top of the pole after a total elapsed time of 4.1 s. What was the speed of the ball at launch? Neglect air resistance. 148) _____

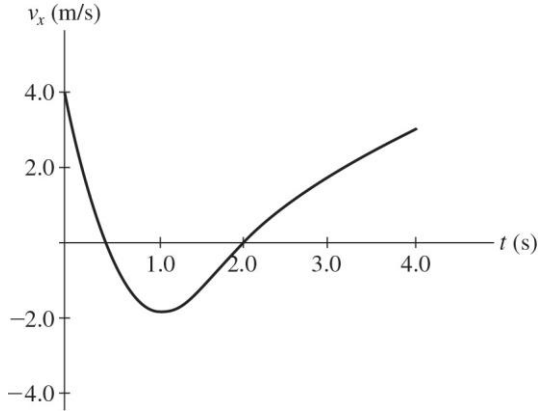
A) 45 m/s B) 23 m/s C) 48 m/s D) 11 m/s E) 34 m/s

149) Abby throws a ball straight up and times it. She sees that the ball goes by the top of a flagpole after 0.50 s and reaches the level of the top of the pole after a total elapsed time of 4.1 s. What was the speed of the ball at as it passed the top of the flagpole? Neglect air resistance. 149) _____

A) 16 m/s B) 33 m/s C) 18 m/s D) 29 m/s E) 6.4 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

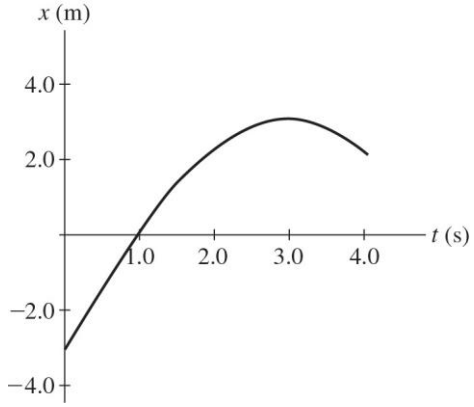
150) The graph in the figure represents the velocity of a particle as it travels along the x-axis. What is the average acceleration of the particle between t = 2.0 s and t = 4.0 s? 150) _____



151) The graph in the figure shows the position of a particle as a function of time as it travels along the x-axis. 151) _____

(a) What is the average speed of the particle between t = 2.0 s and t = 4.0 s?

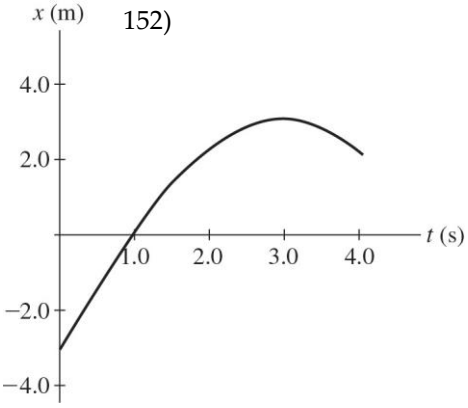
(b) What is the average velocity of the particle between t = 2.0 s and t = 4.0 s?



152) The graph in the figure shows the position of a particle as a function of time as it travels along the x-axis.

(a) What is the magnitude of the average velocity of the particle between t = 1.0 s and t = 4.0 s?

(b) What is the average speed of the particle between t = 1.0 s and t = 4.0 s?

152) 

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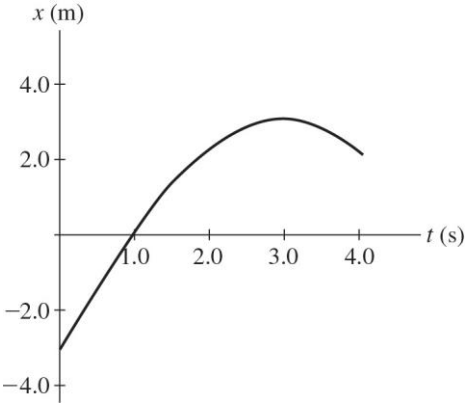
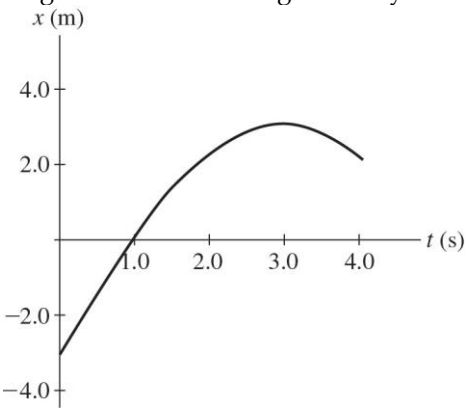
153) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the instantaneous velocity of the particle when t = 1.0 s? 153) _____



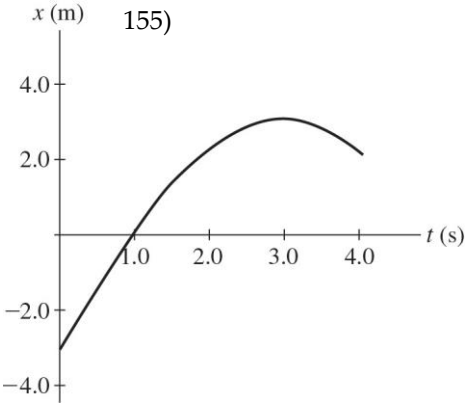
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

154) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the average velocity of the particle between t = 1.0 s and t = 4.0 s? 154) _____



A) 0.50 m/s B) 0.67 m/s C) 0.25 m/s D) 1.3 m/s E) 1.0 m/s

155) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the average speed of the particle between t = 1.0 s and t = 4.0 s?

155) 

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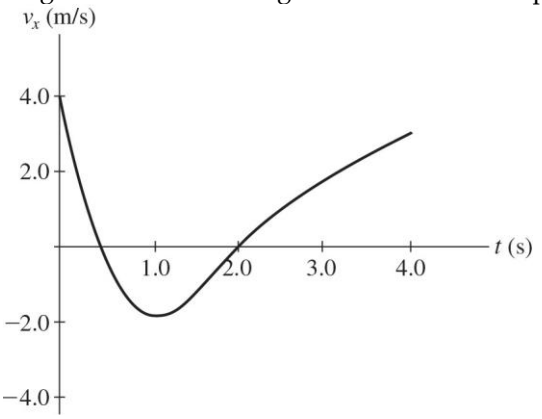
A) 1.3 m/s B) 0.25 m/s C) 0.67 m/s D) 1.0 m/s E) 0.50 m/s

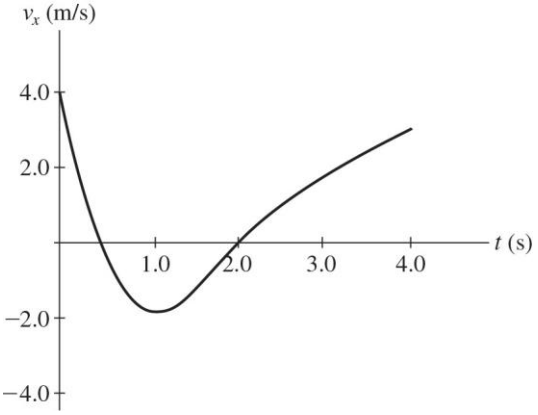
156) The graph in the figure shows the velocity of a particle as it travels along the x-axis. What is the magnitude of the average acceleration of the particle between t = 1.0 s and t = 4.0 s? 156) _____



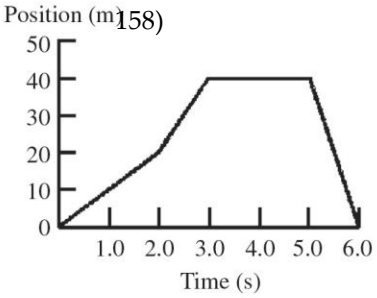
A) 0.33 m/s^2 B) 1.7 m/s^2 C) 3.0 m/s^2 D) 2.5 m/s^2 E) 2.0 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

157) The graph in the figure shows the velocity of a particle as it travels along the x-axis. (a) In what direction (+x or -x) is the acceleration at t = 0.5 s? 157) _____
(b) In what direction (+x or -x) is the acceleration at t = 3.0 s?
(c) What is the average acceleration of the particle between t = 2.0 s and t = 4.0 s?
(d) At what value of t is the instantaneous acceleration equal to 0 m/s^2?



158) The figure shows a graph of the position of a moving object as a function of time. What is the velocity of the object at each of the following times?
(a) At t = 1.0 s
(b) At t = 2.5 s
(c) At t = 4.0 s
(d) At t = 5.5 s

158) 

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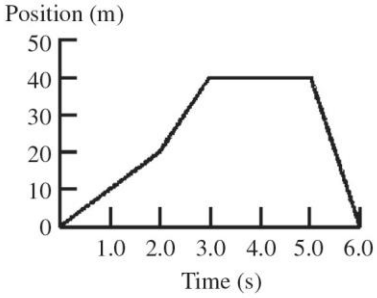
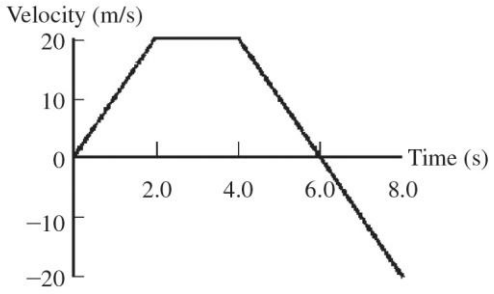
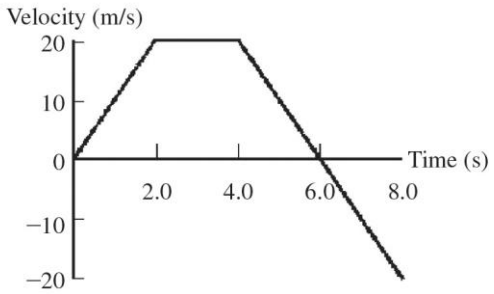
159) The figure shows a graph of the position of a moving object as a function of time. 159) _____
(a) What is the average velocity of the object from t = 0 s to t = 4.0 s?
(b) What is the average velocity of the object from t = 0 s to t = 6.0 s?



160) The figure shows a graph of the velocity of an object as a function of time. What is the acceleration of the object at the following times? 160) _____
(a) At 1.0 s
(b) At 3.0 s



161) The figure shows a graph of the velocity of an object as a function of time. What is the average acceleration of the object over the following time intervals? 161) _____
(a) From t = 0 s to t = 5.0 s
(b) From t = 0 s to t = 8.0 s



1) A
2) C, D
3) D
4) A
5) B, E
6) A
7) B
8) B
9) D
10) B
11) B
12) B
13) D
14) A
15) A
16) A
17) D
18) A, B, D
19) D
20) C
21) A
22) E
23) C
24) C
25) C
26) E
27) A
28) E
29) E
30) B
31) B
32) B
33) D
34) C
35) D
36) A
37) C
38) B
39) C
40) C
41) A
42) B
43) D
44) A
45) D
46) D, E
47) (a) J (b) I
48) C
49) B
50) B
51) B

52) (a) 10.5 km (b) 2.50 km south
53) A
54) D
55) D
56) A
57) B
58) (a) 0 m/s (b) 4 m/s
59) D
60) A
61) C
62) D
63) C
64) D
65) (a) 67 m/s (b) 0 m/s
66) 117 ms
67) (a) 5.25 km/h (b) 1.25 km/h south
68) B
69) E
70) C
71) E
72) 49 ft
73) 20 seconds
74) 0.00 m/s
75) 1500 m/s^2
76) D
77) 35 days
78) D
79) C
80) C
81) 5.6 s
82) (a) 1.00×10^2 s (b) 62.5 m/s
83) (a) 39 m/s (b) 45 s
84) (a) 1.25×10^6 m/s^2 (b) 0.400 ms
85) C
86) A
87) C
88) B
89) A
90) B
91) C
92) D
93) C
94) B
95) B
96) (a) 4.9 s (b) 60 m
97) (a) 15.0 s (b) 225 m (c) 30.0 m/s
98) B
99) C
100) A
101) A
102) C
103) D

104) C
105) B
106) E
107) *a) 4.4 m/s^2 (b) 120 m
108) C
109) E
110) C
111) B
112) E
113) B
114) A
115) B
116) B
117) 0.67 m/s^2
118) A
119) D
120) B
121) A
122) A
123) D
124) A
125) C
126) B
127) (a) 3.1 s (b) 46 m (c) 11 m/s
128) (a) 3.1 s (b) 46 m (c) 1.0 s and 5.1 s
(d) One value for the ball traveling upward; one value for the ball traveling downward.
129) E
130) B
131) A
132) E
133) A
134) B
135) B
136) A
137) 5.53 m/s
138) 190 m
139) 2.4 s
140) D
141) E
142) C
143) B
144) E
145) D
146) E
147) B
148) B
149) C
150) 1.5 m/s^2
151) (a) 1.0 m/s (b) 0 m/s
152) (a) 0.67 m/s (b) 1.3 m/s
153) 3.0 m/s
154) B

155) A
156) B
157) (a) $-x$ (b) $+x$ (c) 1.5 m/s^2 (d) 1.0 s
158) (a) 10 m/s (b) 20 m/s (c) 0 m/s (d) -40 m/s
159) (a) 10 m/s (b) 0 m/s
160) (a) 10 m/s^2 (b) 0 m/s^2
161) (a) 2.0 m/s^2 (b) -2.5 m/s^2