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College Physics, 5e **(Walker)**
Chapter 2 One-Dimensional Kinematics

2.1 Conceptual Questions

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.
A) True
B) False
Answer: A
Var: 1

2) Which of the following quantities has units of a displacement? (There could be more than one correct choice.)
A) 32 ft/s^2 vertically downward
B) 40 km southwest
C) 9.8 m/s^2
D) -120 m/s
E) 186,000 mi
Answer: B, E
Var: 1

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.
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 is either less than or equal to the distance traveled.
D) The displacement can be either greater than, smaller than, or equal to the distance traveled.
Answer: C
Var: 1

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.
A) True
B) False
Answer: A
Var: 1

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5) Which of the following quantities has units of a velocity? (There could be more than one correct choice.)
A) 40 km southwest
B) -120 m/s
C) 9.8 m/s^2 downward
D) 186,000 mi
E) 9.8 m/s downward
Answer: B, E
Var: 1

6) When is the average velocity of an object equal to the instantaneous velocity?
A) only when the velocity is increasing at a constant rate
B) only when the velocity is decreasing at a constant rate
C) when the velocity is constant
D) always
E) never
Answer: C
Var: 1

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
A) greater than 70 km/h.
B) equal to 70 km/h.
C) less than 70 km/h.
D) exactly 38 km/h.
E) It cannot be determined from the information given because we must also know directions traveled.
Answer: C
Var: 1

8) If the velocity of an object is zero at some point, then its acceleration must also be zero at that point.
A) True
B) False
Answer: B
Var: 1

9) Which of the following situations is *impossible*?
A) An object has velocity directed east and acceleration directed west.
B) An object has velocity directed east and acceleration directed east.
C) An object has zero velocity but non-zero acceleration.
D) An object has constant non-zero acceleration and changing velocity.
E) An object has constant non-zero velocity and changing acceleration.
Answer: E
Var: 1

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10) If the acceleration of an object is zero, then that object cannot be moving.
A) True
B) False
Answer: B
Var: 1

11) If the velocity of an object is zero, then that object cannot be accelerating.
A) True
B) False
Answer: B
Var: 1

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?
A) The acceleration is toward the east.
B) Since the car is slowing down, its acceleration must be negative.
C) The acceleration is zero.
D) The acceleration is toward the west.
Answer: A
Var: 1

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?
A) average speed
B) instantaneous speed
C) average acceleration
D) instantaneous acceleration
E) displacement
Answer: C
Var: 1

14) An object moving in the +*x* direction experiences an acceleration of +2.0 m/s^2. This means the object
A) travels 2.0 m in every second.
B) is traveling at 2.0 m/s.
C) is decreasing its velocity by 2.0 m/s every second.
D) is increasing its velocity by 2.0 m/s every second.
Answer: D
Var: 1

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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?
A) Its acceleration is in the +*x* direction.
B) Its acceleration is in the -*x* direction.
C) Its acceleration is zero.
D) Its acceleration is decreasing in magnitude as the car slows down.
Answer: B
Var: 1

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?
A) Its acceleration is positive.
B) Its acceleration is negative.
C) Its acceleration is zero.
D) Its acceleration is decreasing in magnitude as the car slows down.
Answer: A
Var: 1

17) Suppose that an object is moving with a constant velocity. Which statement concerning its acceleration must be correct?
A) The acceleration is constantly increasing.
B) The acceleration is constantly decreasing.
C) The acceleration is a constant non-zero value.
D) The acceleration is equal to zero.
Answer: D
Var: 1

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.)
A) The acceleration could be positive.
B) The acceleration could be negative.
C) The acceleration could be zero.
D) The acceleration must be zero.
Answer: A, B, C
Var: 1

19) Under what condition is average velocity equal to the average of the object's initial and final velocity?
A) This can only occur if there is no acceleration.
B) The acceleration is constant.
C) This can occur only when the velocity is zero.
D) The acceleration must be constantly increasing.
E) The acceleration must be constantly decreasing.
Answer: B
Var: 1

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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.



Where on the track was the car when it was traveling at half this speed, that is at 70 km/h?
A) before marker 1
B) at marker 1
C) between marker 1 and marker 2
Answer: A
Var: 1

21) When a ball is thrown straight up with no air resistance, the acceleration at its highest point
A) is upward.
B) is downward.
C) is zero.
D) reverses from upward to downward.
E) reverses from downward to upward.
Answer: B
Var: 1

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?
A) 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.
B) On the way down, both its velocity and acceleration are downward, and at the highest point both its velocity and acceleration are zero.
C) Throughout the motion, the acceleration is downward, and the velocity is always in the same direction as the acceleration.
D) The acceleration is downward at all points in the motion.
E) The acceleration is downward at all points in the motion except that is zero at the highest point.
Answer: D
Var: 1

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?
A) zero
B) slightly less than g
C) exactly g
D) slightly greater than g
Answer: C
Var: 1

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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?
A) Both its velocity and its acceleration point upward.
B) Its velocity points upward and its acceleration points downward.
C) Its velocity points downward and its acceleration points upward.
D) Both its velocity and its acceleration points downward.
Answer: B
Var: 1

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.)
A) Its acceleration is constantly increasing.
B) Its acceleration is constant.
C) Its acceleration is constantly decreasing.
D) Its acceleration is zero.
E) Its acceleration is greater than g.
Answer: B
Var: 1

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?
A) $h/4$
B) $h/2$
C) h
D) $2h$
E) $4h$
Answer: C
Var: 1

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?
A) $4T$
B) $2T$
C) T
D) $T/2$
E) $T/4$
Answer: C
Var: 1

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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?
A) $4a$
B) $2a$
C) a
D) $a/2$
E) $a/4$
Answer: C
Var: 1

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
A) increases.
B) decreases.
C) stays constant.
D) increases at first, but then stays constant.
E) decreases at first, but then stays constant.
Answer: A
Var: 1

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
A) the green ball will be moving faster than the blue ball.
B) the blue ball will be moving faster than the green ball.
C) the two balls will have the same speed.
Answer: C
Var: 1

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
A) increases.
B) remains constant.
C) decreases.
D) cannot be determined from the information given.
Answer: B
Var: 1

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.
A) The one thrown up is traveling faster.
B) The one thrown down is traveling faster.
C) They are traveling at the same speed.
D) It is impossible to tell because the height of the building is not given.
Answer: C
Var: 1

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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?
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) The two bricks have exactly the same acceleration.
D) Neither brick has any acceleration once it is released.
Answer: C
Var: 1

34) An object is moving with constant non-zero velocity in the +*x* direction. The position versus time graph of this object is
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.
Answer: C
Var: 1

35) An object is moving with constant non-zero acceleration in the +*x* direction. The position versus time graph of this object is
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.
Answer: D
Var: 1

36) An object is moving with constant non-zero velocity in the +*x* direction. The velocity versus time graph of this object is
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.
Answer: A
Var: 1

37) An object is moving with constant non-zero acceleration in the +*x* direction. The velocity versus time graph of this object is
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.
Answer: C
Var: 1

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38) The slope of a position versus time graph gives
A) the distance traveled.
B) velocity.
C) acceleration.
D) displacement.
Answer: B
Var: 1

39) The slope of a velocity versus time graph gives
A) the distance traveled.
B) velocity.
C) acceleration.
D) displacement.
Answer: C
Var: 1

40) If the position versus time graph of an object is a horizontal line, the object is
A) moving with constant non-zero speed.
B) moving with constant non-zero acceleration.
C) at rest.
D) moving with increasing speed.
Answer: C
Var: 1

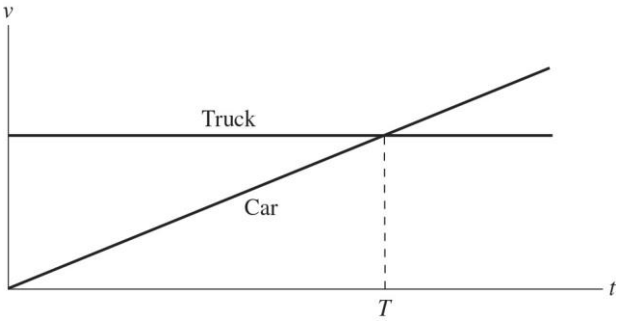
41) If the velocity versus time graph of an object is a horizontal line, the object is
A) moving with zero acceleration.
B) moving with constant non-zero acceleration.
C) at rest.
D) moving with increasing speed.
Answer: A
Var: 1

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
A) moving with constant non-zero speed.
B) moving with constant non-zero acceleration.
C) at rest.
D) moving with increasing acceleration.
Answer: B
Var: 1

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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 $t = 0$.



At time T, what is true of the *distances* traveled by the vehicles since time $t = 0$?
A) They will have traveled the same distance.
B) The truck will not have moved.
C) The car will have travelled further than the truck.
D) The truck will have travelled further than the car.
Answer: D
Var: 1

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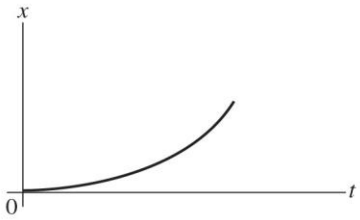
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44) Which of the following graphs represent an object at rest? (There could be more than one correct choice.)

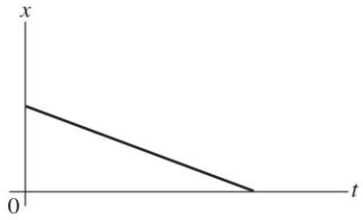
(a)



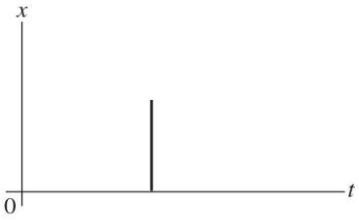
(b)



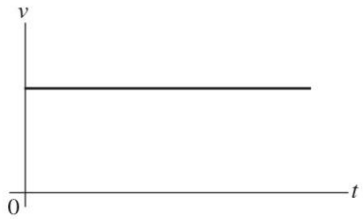
(c)



(d)



(e)

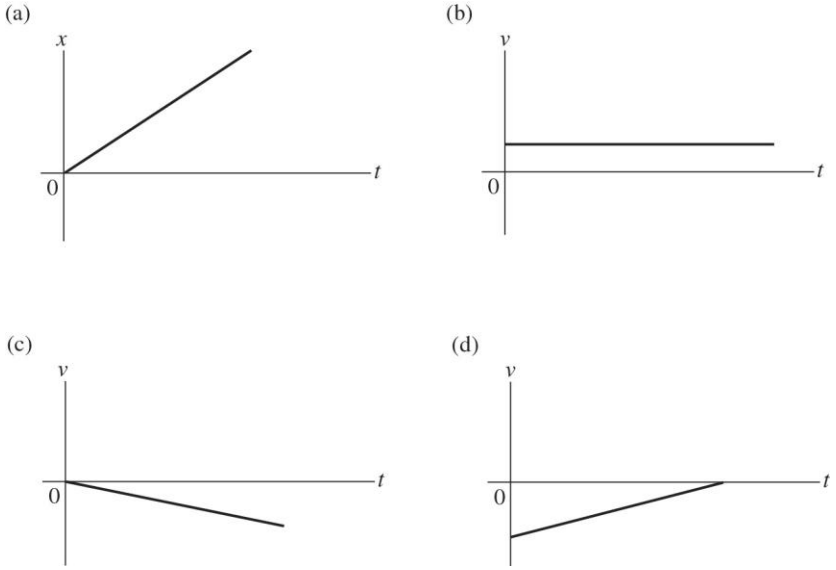


A) graph a
B) graph b
C) graph c
D) graph d
E) graph e
Answer: A
Var: 1

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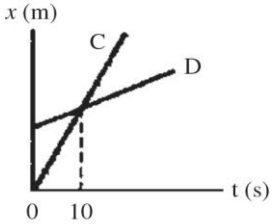
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45) Which of the following graphs represent an object having zero acceleration?



A) only graph a
B) only graph b
C) graphs a and b
D) graphs b and c
E) graphs c and d
Answer: C
Var: 1

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

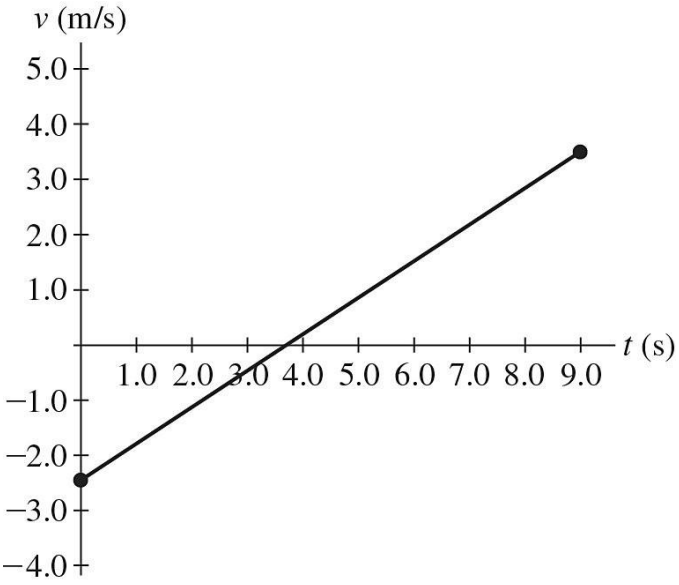


According to this graph, which statements about these cars must be true? (There could be more than one correct choice.)
A) The magnitude of the acceleration of car C is greater than the magnitude of the acceleration of car D.
B) The magnitude of the acceleration of car C is less than the magnitude of the acceleration of car D.
C) At time t = 10 s, both cars have the same velocity.
D) Both cars have the same acceleration.
E) The cars meet at time t = 10 s.
Answer: D, E
Var: 1

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

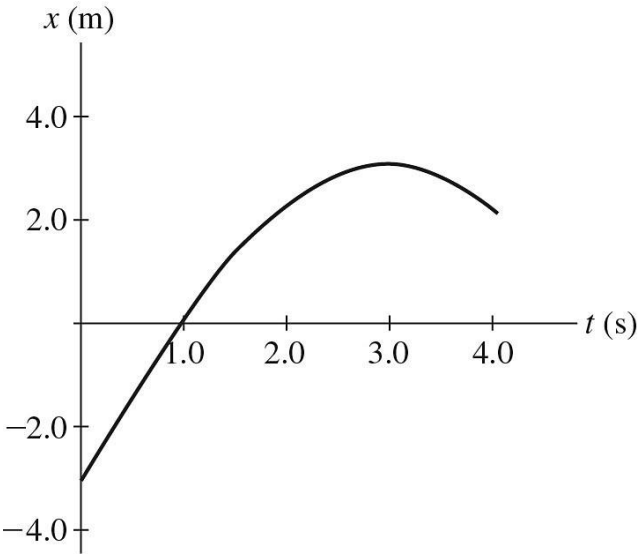


Over the nine-second interval shown, we can say that the *speed* of the particle
A) only increases.
B) only decreases.
C) increases and then decreases.
D) decreases and then increases.
E) remains constant.
Answer: D
Var: 1

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



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

49) The area under a curve in a velocity versus time graph gives
A) acceleration.
B) velocity.
C) displacement.
D) position.
Answer: C
Var: 1

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2.2 Problems

1) 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.
A) 4.0 m, 26.0 m
B) 26.0 m, 4.0 m
C) 26.0 m, 26.0 m
D) 4.0 m, 4.0 m
Answer: B
Var: 1

2) What must be your average speed in order to travel 350 km in 5.15 h?
A) 66.0 km/h
B) 67.0 km/h
C) 68.0 km/h
D) 69.0 km/h
Answer: C
Var: 1

3) 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?
A) 14,200 m/s
B) 124 m/s
C) 3.95 m/s
D) 14.2 m/s
Answer: C
Var: 1

4) 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)
A) 9.46×10^{12} mi
B) 9.46×10^{15} mi
C) 5.88×10^{12} mi
D) 5.88×10^{15} mi
Answer: C
Var: 1

5) 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?
A) 18 m
B) 20 m
C) 40 m
D) 80 m
Answer: D
Var: 4

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6) 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?
A) 0.00 km/h
B) 0.067 km/h
C) 4.0 km/h
D) 5.3 km/h
Answer: C
Var: 1

7) 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?
A) 0.00 km/h
B) 0.067 km/h
C) 4.0 km/h
D) 5.3 km/h
Answer: A
Var: 1

8) 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?
A) 180 mi
B) 190 mi
C) 200 mi
D) 210 mi
Answer: B
Var: 1

9) 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?
A) 84 km/h
B) 89 km/h
C) 90 km/h
D) 91 km/h
Answer: B
Var: 1

10) 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?
A) 85 km/h
B) 88 km/h
C) 90 km/h
D) 92 km/h
Answer: B
Var: 1

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11) 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?
A) 260 mi/h
B) 270 mi/h
C) 275 mi/h
D) 280 mi/h
Answer: B
Var: 1

12) 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?
A) 2.5 m/s
B) 5.0 m/s
C) 10 m/s
D) 0 m/s
E) 1.3 m/s
Answer: D
Var: 1

13) 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?
A) 2.5 m/s
B) 5.0 m/s
C) 10 m/s
D) 0 m/s
E) 1.3 m/s
Answer: B
Var: 1

14) 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?
A) 2.4 h
B) 2.6 h
C) 1.9 h
D) You can't stop at all.
Answer: A
Var: 50+

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15) 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?
A) 45 mph
B) 50 mph
C) 52.5 mph
D) 55 mph
E) 60 mph
Answer: E
Var: 1

16) 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?
A) 17 s
B) 0.058 s
C) 4.0 s
D) 0.25 s
Answer: C
Var: 1

17) 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.
A) 0.30 m/s^2, south
B) 2.7 m/s^2, south
C) 0.30 m/s^2, north
D) 2.7 m/s^2, north
Answer: A
Var: 50+

18) 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?
A) 0 m/s^2
B) 200 m/s^2
C) 2800 m/s^2
D) 1500 m/s^2
E) 1300 m/s^2
Answer: C
Var: 1

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19) 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?
A) $-13\ \text{m/s}^2$
B) $-15\ \text{m/s}^2$
C) $13\ \text{m/s}^2$
D) $15\ \text{m/s}^2$
E) $0\ \text{m/s}^2$
Answer: B
Var: 1

20) 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?
A) 0.937
B) 1.07
C) 0.878
D) 1.14
Answer: B
Var: 1

21) A car initially traveling at 60 km/h accelerates at a constant rate of $2.0\ \text{m/s}^2$. How much time is required for the car to reach a speed of 90 km/h?
A) 15 s
B) 30 s
C) 45 s
D) 4.2 s
Answer: D
Var: 1

22) A cart starts from rest and accelerates uniformly at $4.0\ \text{m/s}^2$ for 5.0 s. It next maintains the velocity it has reached for 10 s. Then it slows down at a steady rate of $2.0\ \text{m/s}^2$ for 4.0 s. What is the final speed of the car?
A) 20 m/s
B) 16 m/s
C) 12 m/s
D) 10 m/s
Answer: C
Var: 1

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23) 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?
A) 15 m/s
B) 30 m/s
C) 45 m/s
D) 375 m/s
Answer: C
Var: 1

24) 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?
A) 10 m
B) 55 m
C) 66 m
D) 80 m
Answer: C
Var: 1

25) 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?
A) 16 m
B) 24 m
C) 42 m
D) 84 m
Answer: C
Var: 1

26) 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?
A) 200 m
B) 300 m
C) 400 m
D) 500 m
Answer: C
Var: 1

27) 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?
A) 8.0 m/s^2
B) 9.6 m/s^2
C) 12 m/s^2
D) 24 m/s^2
Answer: C
Var: 1

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28) 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?
A) 5.0 m
B) 15 m
C) 25 m
D) 45 m
Answer: C
Var: 2

29) 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?
A) 30 m
B) 39 m
C) 48 m
D) 57 m
Answer: B
Var: 4

30) 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?
A) 12 s
B) 19 s
C) 21 s
D) 24 s
Answer: C
Var: 1

31) 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?
A) 269 mi/h
B) 188 mi/h
C) 296 mi/h
D) 135 mi/h
Answer: A
Var: 40

32) A bicyclist starts a timed race at 6.0 mi/h. In order to win, he must average 21 mi/h. Assuming constant acceleration from the start, how fast must he be traveling at the end of the race?
A) 36 mi/h
B) 30 mi/h
C) 24 mi/h
D) 42 mi/h
Answer: A
Var: 21

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33) A car accelerates from 5.0 m/s to 21 m/s at a constant rate of 3.0 m/s^2. How far does it travel while accelerating?
A) 69 m
B) 207 m
C) 41 m
D) 117 m
Answer: A
Var: 50+

34) An airplane needs to reach a forward velocity of 203.0 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?
A) 0.79 m/s^2
B) 0.87 m/s^2
C) 0.95 m/s^2
D) 1.0 m/s^2
Answer: A
Var: 50+

35) Assuming equal rates of uniform acceleration in both cases, how much further would you travel if braking from 56 mi/h to rest than from 28 mi/h?
A) 4 times farther
B) 3.2 times farther
C) 4.8 times farther
D) 5.2 times farther
Answer: A
Var: 50+

36) Acceleration is sometimes expressed in multiples of g, where $g = 9.8\ m/s^2$ 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 m/s to 0 m/s in 0.15 s. How many g's are experienced, on average, by the driver?
A) 20 g
B) 14 g
C) 24 g
D) 26 g
Answer: A
Var: 11

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37) 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?
A) 6.7 s^{-1}
B) 4.4 s^{-1}
C) 2.2 s^{-1}
D) 0.15 s^{-1}
Answer: A
Var: 1

38) A train starts from rest and accelerates uniformly until it has traveled 5.6 km and acquired a forward velocity of 42 m/s. The train then moves at a constant velocity of 42 m/s for 420 s. The train then slows down uniformly at 0.065 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?
A) 0.16 m/s^2
B) 0.14 m/s^2
C) 0.17 m/s^2
D) 0.19 m/s^2
E) 0.20 m/s^2
Answer: A
Var: 50+

39) A train starts from rest and accelerates uniformly until it has traveled 2.1 km and acquired a forward velocity of 24 m/s. The train then moves at a constant velocity of 24 m/s for 400 s. The train then slows down uniformly at 0.065 m/s^2, until it is brought to a halt. The distance traveled by the train while slowing down is closest to
A) 4.4 km.
B) 4.2 km.
C) 4.0 km.
D) 3.8 km.
E) 3.6 km.
Answer: A
Var: 50+

40) 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?
A) 9.00 m
B) 18.0 m
C) 27.0 m
D) 36.0 m
E) 54.0 m
Answer: C
Var: 1

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41) 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?
A) 10 m
B) 20 m
C) 30 m
D) 40 m
E) 50 m
Answer: C
Var: 1

42) 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?
A) 37.0 m/s
B) 93.0 m/s
C) 65.7 m/s
D) 4320 m/s
E) 186 m/s
Answer: B
Var: 1

43) 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?
A) 4.57 m
B) 9.14 m
C) 112 m
D) 146 m
E) 292 m
Answer: D
Var: 1

44) 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?
A) 10.2 m/s
B) 14.5 m/s
C) 105 m/s
D) 210 m/s
E) 315 m/s
Answer: B
Var: 1

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45) 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?
A) 3.75 m/s^2
B) 4.00 m/s^2
C) 4.25 m/s^2
D) 4.50 m/s^2
E) 4.75 m/s^2
Answer: A
Var: 1

46) 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?
A) 22.5 m/s
B) 18.4 m/s
C) 15.0 m/s
D) 12.1 m/s
E) 9.20 m/s
Answer: B
Var: 5

47) 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/s^2. How long after car A begins to accelerate does it take car A to overtake car B?
A) 5.50 s
B) 12.6 s
C) 19.0 s
D) 316 s
E) Car A never overtakes car B.
Answer: C
Var: 5

48) 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?
A) 2.1 m/s
B) 4.9 m/s
C) -2.1 m/s
D) -4.9 m/s
E) 0.00 m/s
Answer: A
Var: 1

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49) 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?
A) 8.0 m
B) 18 m
C) 48 m
D) 144 m
Answer: C
Var: 4

50) 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?
A) 8.0 s
B) 11 s
C) 14 s
D) 16 s
Answer: A
Var: 4

51) 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?
A) 6.0 s
B) 8.0 s
C) 10 s
D) 12 s
Answer: D
Var: 4

52) A hammer is thrown upward with a speed of 14 m/s on the surface of planet X where the acceleration 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?
A) 7.0 m/s
B) 14 m/s
C) 21 m/s
D) 64 m/s
Answer: B
Var: 2

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53) 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?
A) at least 3.0 cm
B) at least 4.9 cm
C) at least 6.8 cm
D) at least 9.8 cm
Answer: B
Var: 1

54) 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?
A) 9.8 m/s upward
B) 9.8 m/s downward
C) 0 m/s
D) 19.6 m/s downward
Answer: B
Var: 1

55) 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?
A) 9.8 m/s
B) 25 m/s
C) 49 m/s
D) 98 m/s
Answer: C
Var: 1

56) 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?
A) 3.7 s
B) 7.3 s
C) 11 s
D) 15 s
Answer: B
Var: 1

57) 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?
A) 20 m
B) 30 m
C) 50 m
D) 70 m
Answer: D
Var: 1

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58) 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 m/s. Consider all quantities as positive in the upward direction. At time t = 5.97 s, the vertical velocity of the ball is closest to

A) 0 m/s.
B) +175 m/s.
C) +12 m/s.
D) -175 m/s.
E) -12 m/s.
Answer: A
Var: 50+

59) 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 m/s. Consider all quantities as positive in the upward direction. The vertical velocity of the ball when it is 89 m above the ground is closest to

A) -81 m/s.
B) -64 m/s.
C) -48 m/s.
D) -32 m/s.
E) -97 m/s.
Answer: A
Var: 50+

60) 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?

A) 160 m
B) 330 m
C) 320 m
D) 410 m
E) 490 m
Answer: E
Var: 1

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61) 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 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
A) 2.1 s.
B) 2.3 s.
C) 1.9 s.
D) 1.7 s.
E) 1.5 s.
Answer: A
Var: 50+

62) 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 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
A) 9.9 m/s^2.
B) 9.6 m/s^2.
C) 9.3 m/s^2.
D) 9.0 m/s^2.
E) 8.7 m/s^2.
Answer: A
Var: 50+

63) 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 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
A) 233 m.
B) 221 m.
C) 209 m.
D) 244 m.
E) 256 m.
Answer: A
Var: 50+

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64) 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 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
A) 115 m.
B) 125 m.
C) 135 m.
D) 145 m.
E) 154 m.
Answer: E
Var: 1

65) A ball is thrown straight upward from ground level with a speed of 18 m/s. How much time passes before the ball strikes the ground if we disregard air resistance?
A) 3.7 s
B) 1.8 s
C) 1.1 s
D) 0.6 s
Answer: A
Var: 31

66) 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.
A) 4.9 m/s
B) 15 m/s
C) 9.9 m/s
D) 20 m/s
E) 21 m/s
Answer: B
Var: 1

67) 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.
A) 10 m
B) 14 m
C) 26 m
D) 32 m
E) 52 m
Answer: C
Var: 1

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68) 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.
A) 2.3 s
B) 2.6 s
C) 2.9 s
D) 3.2 s
E) 3.6 s
Answer: C
Var: 1

69) 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?
A) 10 m
B) 14 m
C) 26 m
D) 32 m
E) 38 m
Answer: D
Var: 1

70) 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?
A) 3.04 s
B) 12.2 s
C) 29.3 s
D) 32.1 s
E) 37.5 s
Answer: B
Var: 1

71) 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.
A) 0.52 s
B) 1.2 s
C) 2.4 s
D) 3.1 s
E) 4.2 s
Answer: A
Var: 5

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72) 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.
A) 0.42 s
B) 1.2 s
C) 2.3 s
D) 3.1 s
E) 4.2 s
Answer: C
Var: 5

73) 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.
A) 10 m
B) 13 m
C) 16 m
D) 18 m
E) 26 m
Answer: A
Var: 1

74) 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.
A) 11 m/s
B) 23 m/s
C) 34 m/s
D) 45 m/s
E) 48 m/s
Answer: B
Var: 1

75) 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.
A) 6.4 m/s
B) 16 m/s
C) 18 m/s
D) 29 m/s
E) 33 m/s
Answer: C
Var: 1

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76) A car is able to stop in a distance d. Assuming the same braking force (and therefore the same acceleration), what distance does this car require to stop when it is traveling twice as fast?
A) d
B) $2d$
C) $\sqrt{2}d$
D) $4d$
E) $2\sqrt{2}d$
Answer: D
Var: 1

77) Assuming equal rates of acceleration in both cases, how much longer would it take a car to stop if braking from 56 mi/h than from 28 mi/h?
A) 8 times as long
B) 4 times as long
C) 2 times as long
D) 1.4 times as long
E) the same in both cases
Answer: C
Var: 1

78) Two identical objects A and B fall from rest from different heights to the ground. If object B takes *twice* as long as object A to reach the ground, what is the ratio of the heights from which A and B fell? Neglect air resistance.
A) $h_A/h_B = 1/\sqrt{2}$
B) $h_A/h_B = 1/2$
C) $h_A/h_B = 1/4$
D) $h_A/h_B = 1/8$
Answer: C
Var: 1

79) Two cars are traveling at the same speed and hit the brakes at the same time. Car A decelerates (decreases its velocity) at twice the rate of car B. If car B takes time T to stop, how long does it take car A to stop?
A) $4T$
B) $2T$
C) T
D) $T/2$
E) $T/4$
Answer: D
Var: 1

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80) Two cars are traveling at the same speed and hit the brakes at the same time. Car A decelerates (decreases its velocity) at twice the rate of car B. If car A travels a distance *D* before stopping, how far does car B travel before stopping?
A) 4*D*
B) 2*D*
C) *D*
D) *D*/2
E) *D*/4
Answer: B
Var: 1

81) Car A is traveling at twice the speed of car B. They both hit the brakes at the same time and decrease their velocities at the same rate. If car B travels a distance *D* before stopping, how far does car A travel before stopping?
A) 4*D*
B) 2*D*
C) *D*
D) *D*/2
E) *D*/4
Answer: A
Var: 1

82) A car moving initially with speed v_0 slows down with an acceleration of magnitude *a* and comes to a full stop after traveling a distance *d*. What was the speed of the car when it had traveled half that distance, *d*/2?
A) $v_0/2$
B) $v_0/4$
C) $v_0/\sqrt{2}$
D) $v_0/8$
Answer: C
Var: 1

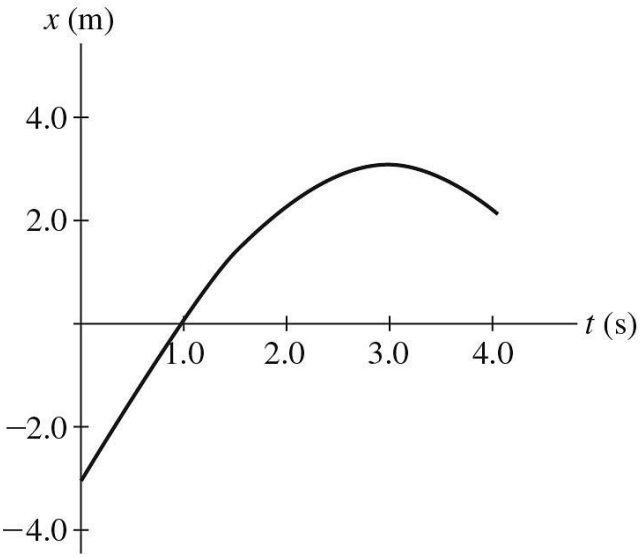
83) Two athletes jump straight up. John has twice the initial speed of Harry. Compared to Harry, John stays in the air
A) 0.50 times as long as Harry.
B) the same time as Harry.
C) twice as long as Harry.
D) three times as long as Harry.
E) four times as long as Harry.
Answer: C
Var: 1

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84) In the absence of air resistance, a ball is thrown vertically upward with initial speed v. An identical ball is thrown upward with initial speed $2v$. If the first ball reaches a maximum height h, what maximum height will the second ball reach?
A) $8h$
B) $4h$
C) $2h$
D) $\sqrt{2}h$
E) h
Answer: B
Var: 1

85) 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?

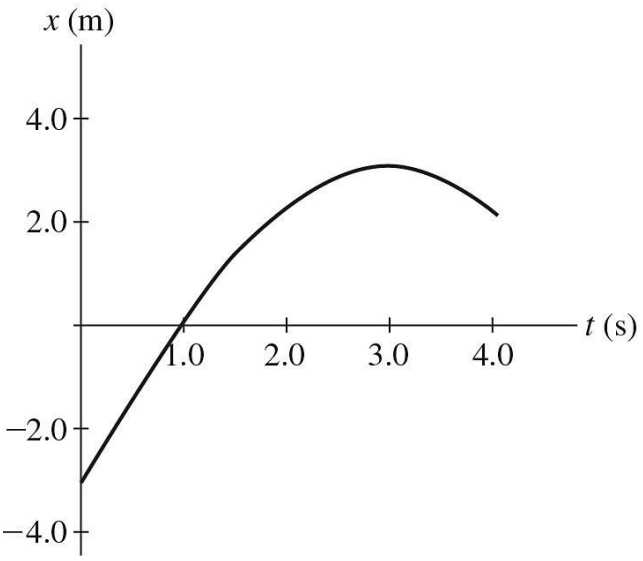


A) 0.25 m/s
B) 0.50 m/s
C) 0.67 m/s
D) 1.0 m/s
E) 1.3 m/s
Answer: C
Var: 1

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86) 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?

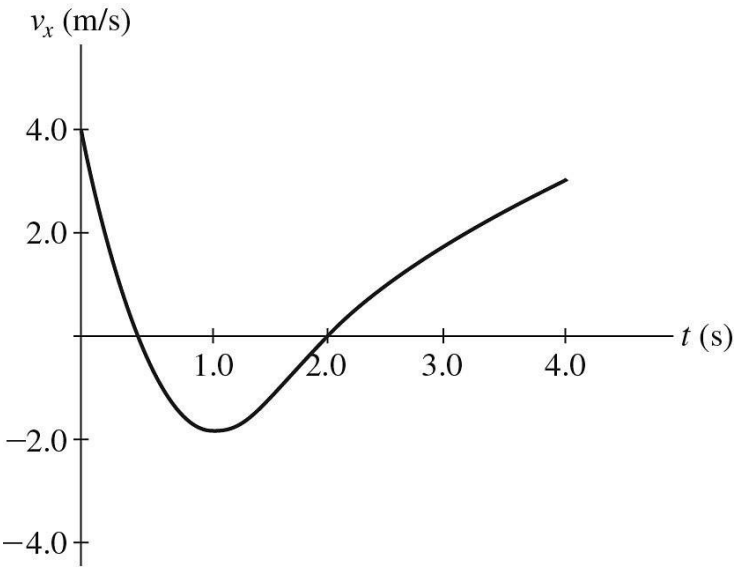


A) 1.0 m/s
B) 1.3 m/s
C) 0.67 m/s
D) 0.50 m/s
E) 0.25 m/s
Answer: B
Var: 1

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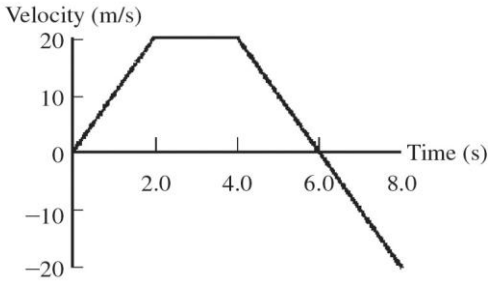
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87) The graph in the figure shows the velocity of a particle as it travels along the *x*-axis. What is the magnitude of the average acceleration of the particle between $t = 1.0$ s and $t = 4.0$ s?



A) 0.33 m/s^2
B) 1.7 m/s^2
C) 2.0 m/s^2
D) 2.5 m/s^2
E) 3.0 m/s^2
Answer: B
Var: 1

88) The figure shows a graph of the velocity of an object as a function of time. What is the displacement of the object from 0 s to 6.0 s?

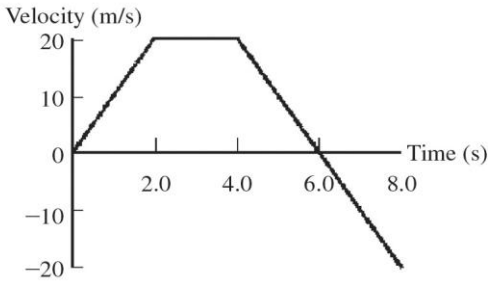


A) 20 m
B) 40 m
C) 60 m
D) 80 m
E) 100 m
Answer: D
Var: 1

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89) The figure shows a graph of the velocity of an object as a function of time. What is the displacement of the object from 0 s to 8.0 s?



A) 20 m
B) 40 m
C) 60 m
D) 80 m
E) 100 m
Answer: C
Var: 1

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