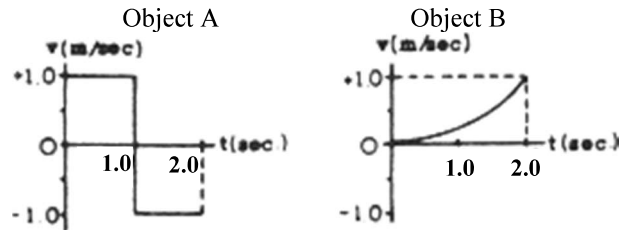
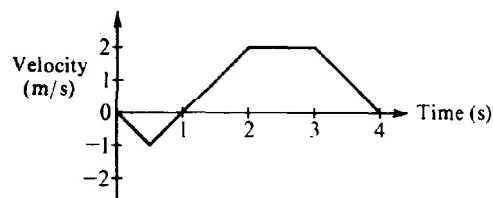


AP Physics Multiple Choice Practice – Kinematics

Questions 1–3 relate to two objects that start at $x = 0$ at $t = 0$ and move in one dimension independently of one another. Graphs, of the velocity of each object versus time are shown below

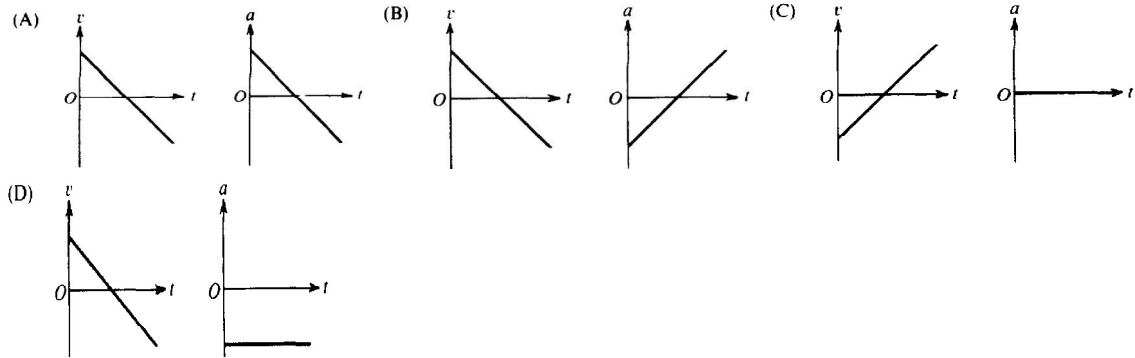


- Which object is farthest from the origin at $t = 2$ seconds.
 (A) A (B) B (C) they are in the same location at $t = 2$ seconds (D) They are the same distance from the origin, but in opposite directions
- Which object moves with constant non-zero acceleration?
 (A) A (B) B (C) both A and B (D) neither A nor B
- Which object is in its initial position at $t = 2$ seconds?
 (A) A (B) B (C) both A and B (D) neither A nor B

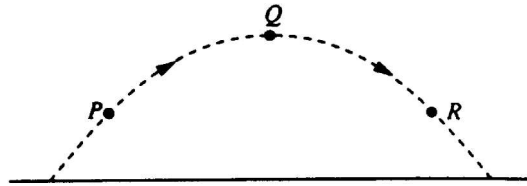


- The graph above shows the velocity versus time for an object moving in a straight line. At what time after $t = 0$ does the object again pass through its initial position?
 (A) 1 s (B) Between 1 and 2 s (C) 2 s (D) Between 2 and 3 s
- A body moving in the positive x direction passes the origin at time $t = 0$. Between $t = 0$ and $t = 1$ second, the body has a constant speed of 24 meters per second. At $t = 1$ second, the body is given a constant acceleration of 6 meters per second squared in the negative x direction. The position x of the body at $t = 11$ seconds is
 (A) + 99m (B) + 36m (C) - 36 m (E) - 99 m
- A diver initially moving horizontally with speed v dives off the edge of a vertical cliff and lands in the water a distance d from the base of the cliff. How far from the base of the cliff would the diver have landed if the diver initially had been moving horizontally with speed $2v$?
 (A) d (B) $\sqrt{2d}$ (C) $2d$ (D) $4d$

7. A projectile is fired with initial velocity v_0 at an angle θ_0 with the horizontal and follows the trajectory shown above. Which of the following pairs of graphs best represents the vertical components of the velocity and acceleration, v and a , respectively, of the projectile as functions of time t ?

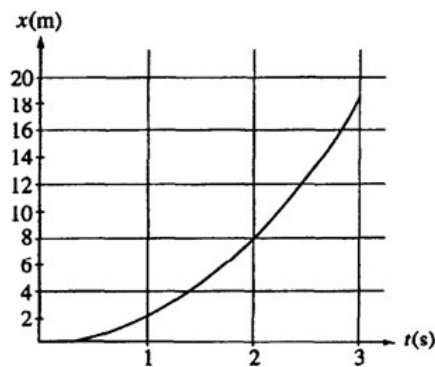
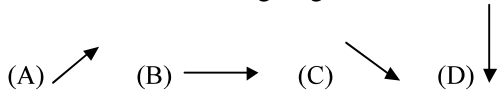


Questions 8-9



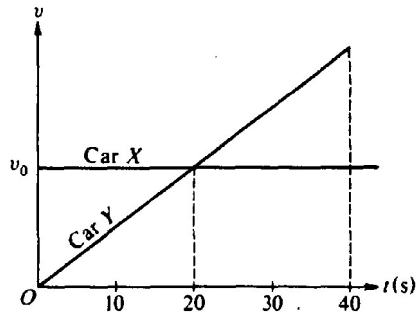
A ball is thrown and follows the parabolic path shown above. Air friction is negligible. Point Q is the highest point on the path. Points P and R are the same height above the ground.

8. How do the speeds of the ball at the three points compare?
 (A) $v_P < v_Q < v_R$ (B) $v_R < v_Q < v_P$ (C) $v_Q < v_R < v_P$ (D) $v_Q < v_P = v_R$
9. Which of the following diagrams best shows the direction of the acceleration of the ball at point P?



10. The graph above represents position x versus time t for an object being acted on by a constant force. The average speed during the interval between 1 s and 2 s is most nearly
 (A) 2 m/s (B) 4 m/s (C) 5 m/s (D) 6 m/s

Questions 11 – 12

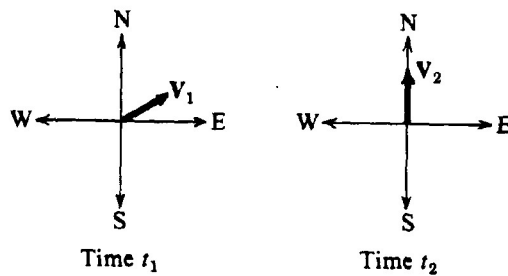


At time $t = 0$, car X traveling with speed v_0 passes car Y which is just starting to move. Both cars then travel on two parallel lanes of the same straight road. The graphs of speed v versus time t for both cars are shown above.

11. Which of the following is true at time $t = 20$ seconds?
 - (A) Car Y is behind car X.
 - (B) Car Y is passing car X.
 - (C) Car Y is in front of car X.
 - (D) Car X is accelerating faster than car Y.

12. From time $t = 0$ to time $t = 40$ seconds, the areas under both curves are equal. Therefore, which of the following is true at time $t = 40$ seconds?
 - (A) Car Y is behind car X.
 - (B) Car Y is passing car X.
 - (C) Car Y is in front of car X.
 - (d) Car X is accelerating faster than car Y.

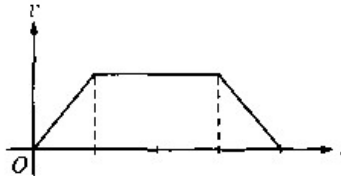
13. Which of the following pairs of graphs shows the distance traveled versus time and the speed versus time for an object uniformly accelerated from rest?
 - (A)
 - (B)
 - (C)
 - (D)



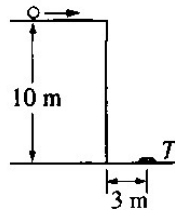
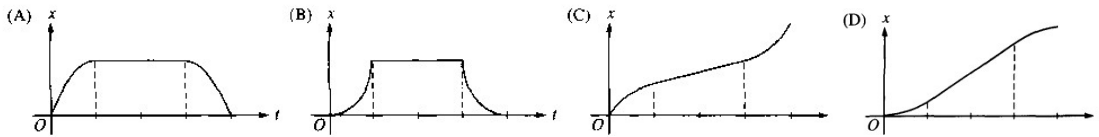
14. Vectors V_1 and V_2 shown above have equal magnitudes. The vectors represent the velocities of an object at times t_1 , and t_2 , respectively. The average acceleration of the object between time t_1 and t_2 was
 - (A) directed north
 - (B) directed west
 - (C) directed north of east
 - (D) directed north of west

15. The velocity of a projectile at launch has a horizontal component v_h and a vertical component v_v . Air resistance is negligible. When the projectile is at the highest point of its trajectory, which of the following shows the vertical and horizontal components of its velocity and the vertical component of its acceleration?

	Vertical Velocity	Horizontal Velocity	Vertical Acceleration
(A)	v_v	v_h	0
(B)	0	v_h	0
(C)	0	0	g
(D)	0	v_h	g

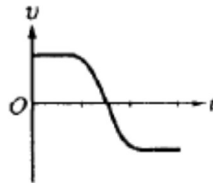


16. The graph above shows the velocity v as a function of time t for an object moving in a straight line. Which of the following graphs shows the corresponding displacement x as a function of time t for the same time interval?

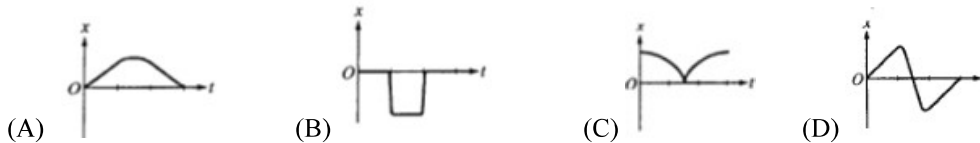


17. A target T lies flat on the ground 3 m from the side of a building that is 10 m tall, as shown above. A student rolls a ball off the horizontal roof of the building in the direction of the target. Air resistance is negligible. The horizontal speed with which the ball must leave the roof if it is to strike the target is most nearly

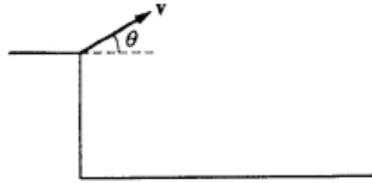
- (A) $3/10$ m/s (B) $\sqrt{2}$ m/s (C) $\frac{3}{\sqrt{2}}$ m/s (D) 3 m/s



18. The graph above shows velocity v versus time t for an object in linear motion. Which of the following is a possible graph of position x versus time t for this object?

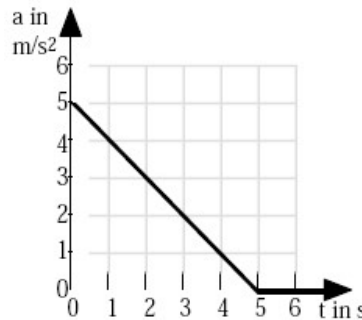


19. A student is testing the kinematic equations for uniformly accelerated motion by measuring the time it takes for light-weight plastic balls to fall to the floor from a height of 3 m in the lab. The student predicts the time to fall using g as 9.80 m/s^2 but finds the measured time to be 35% greater. Which of the following is the most likely cause of the large percent error?
- (A) The acceleration due to gravity is 70% greater than 9.80 m/s^2 at this location.
 (B) The acceleration due to gravity is 70% less than 9.80 m/s^2 at this location.
 (C) Air resistance increases the downward acceleration.
 (D) The acceleration of the plastic balls is not uniform.

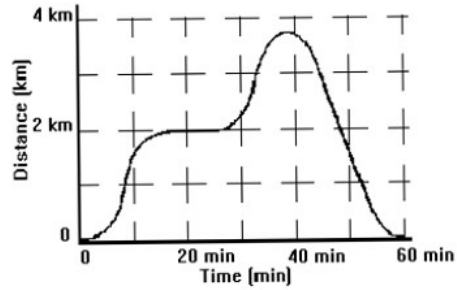


Note: Figure not drawn to scale.

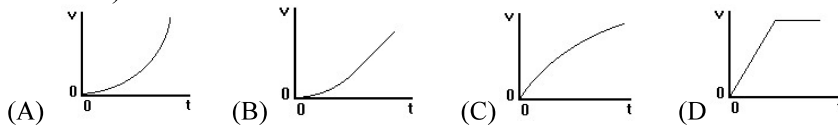
20. An object is thrown with velocity v from the edge of a cliff above level ground. Neglect air resistance. In order for the object to travel a maximum horizontal distance from the cliff before hitting the ground, the throw should be at an angle θ with respect to the horizontal of
- (A) greater than 60° above the horizontal
 (B) greater than 45° but less than 60° above the horizontal
 (C) greater than zero but less than 45° above the horizontal
 (D) greater than zero but less than 45° below the horizontal



21. Starting from rest at time $t = 0$, a car moves in a straight line with an acceleration given by the accompanying graph. What is the speed of the car at $t = 3 \text{ s}$?
- (A) 1.0 m/s (B) 2.0 m/s (C) 6.0 m/s (D) 10.5 m/s
22. A child left her home and started walking at a constant velocity. After a time she stopped for a while and then continued on with a velocity greater than she originally had. All of a sudden she turned around and walked very quickly back home. Which of the following graphs best represents the distance versus time graph for her walk?
- (A) (B) (C) (D)
23. A whiffle ball is tossed straight up, reaches a highest point, and falls back down. Air resistance is not negligible. Which of the following statements are true?
- I. The ball's speed is zero at the highest point.
 II. The ball's acceleration is zero at the highest point.
 III. The ball takes a longer time to travel up to the highest point than to fall back down.
- (A) I only (B) II only (C) I & II only (D) I & III only

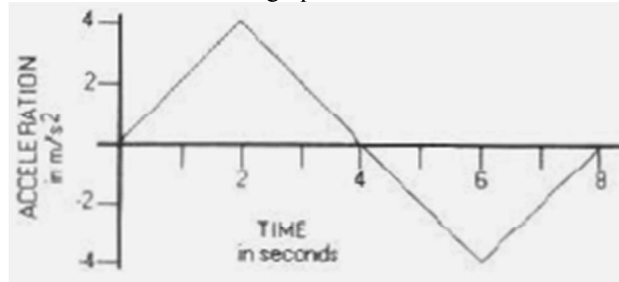


24. Above is a graph of the distance vs. time for car moving along a road. According the graph, at which of the following times would the automobile have been accelerating positively?
 (A) 0, 20, 38, & 60 min. (B) 5, 12, 29, & 35 min. (C) 5, 29, & 57 min. (D) 12, 35, & 41 min.
25. A large beach ball is dropped from the ceiling of a school gymnasium to the floor about 10 meters below. Which of the following graphs would best represent its velocity as a function of time? (do not neglect air resistance)

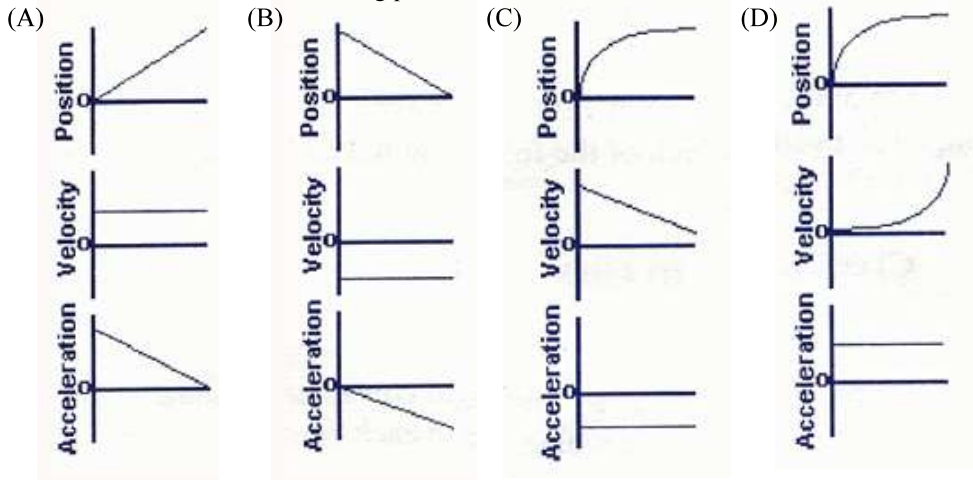


Questions 26-27

A car starts from rest and accelerates as shown in the graph below.

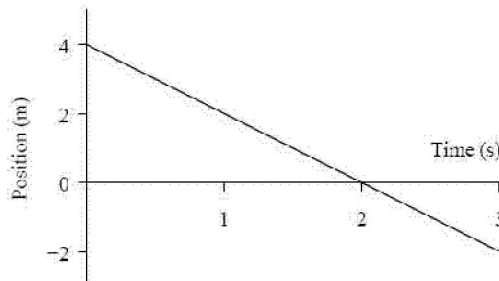


26. At what time would the car be moving with the greatest velocity?
 (B) 2 seconds (C) 4 seconds (D) 6 seconds (E) 8 seconds
27. At what time would the car be farthest from its original starting position?
 (A) 2 seconds (B) 4 seconds (C) 6 seconds (D) 8 seconds
28. Which of the following sets of graphs might be the corresponding graphs of Position, Velocity, and Acceleration vs. Time for a moving particle?



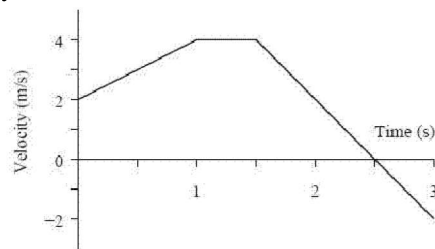
29. An object is thrown with a fixed initial speed v_0 at various angles α relative to the horizon. At some constant height h above the launch point the speed v of the object is measured as a function of the initial angle α . Which of the following best describes the dependence of v on α ? (Assume that the height h is achieved, and assume that there is no air resistance.)
- (A) v will increase monotonically with α .
 (B) v will increase to some critical value v_{\max} and then decrease.
 (C) v will remain constant, independent of α .
 (D) v will decrease to some critical value v_{\min} and then increase.

30. The position vs. time graph for an object moving in a straight line is shown below. What is the instantaneous velocity at $t = 2$ s?



- (A) -2 m/s (B) $\frac{1}{2}$ m/s (C) 0 m/s (D) 2 m/s

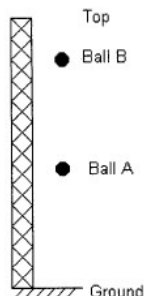
31. Shown below is the velocity vs. time graph for a toy car moving along a straight line. What is the maximum displacement from start for the toy car?



- (A) 5 m (B) 6.5 m (C) 7 m (D) 7.5 m

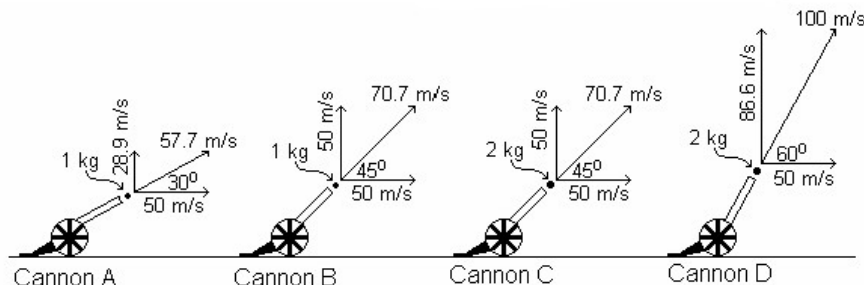
32. An object is released from rest and falls a distance h during the first second of time. How far will it fall during the next second of time?
- (A) h (B) $2h$ (C) $3h$ (D) $4h$

33. Two identical bowling balls A and B are each dropped from rest from the top of a tall tower as shown in the diagram below. Ball A is dropped 1.0 s before ball B is dropped but both balls fall for some time before ball A strikes the ground. Air resistance can be considered negligible during the fall. After ball B is dropped but before ball A strikes the ground, which of the following is true?



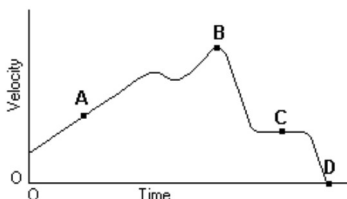
- (A) The distance between the two balls decreases.
- (B) The velocity of ball A increases with respect to ball (B)
- (C) The velocity of ball A decreases with respect to ball (B)
- (D) The distance between the two balls increases.

34. The diagram below shows four cannons firing shells with different masses at different angles of elevation. The horizontal component of the shell's velocity is the same in all four cases. In which case will the shell have the greatest range if air resistance is neglected?



- (A) cannon A (B) cannon B only (C) cannon C only (D) cannon D

35. Starting from rest, object 1 falls freely for 4.0 seconds, and object 2 falls freely for 8.0 seconds. Compared to object 1, object 2 falls:
- (A) half as far (B) twice as far (C) three times as far (D) four times as far
36. A car starts from rest and uniformly accelerates to a final speed of 20.0 m/s in a time of 15.0 s. How far does the car travel during this time?
- (A) 150 m (B) 300 m (C) 450 m (D) 600 m
37. An arrow is aimed horizontally, directly at the center of a target 20 m away. The arrow hits 0.050 m below the center of the target. Neglecting air resistance, what was the initial speed of the arrow?
- (A) 20 m/s (B) 40 m/s (C) 100 m/s (D) 200 m/s
38. A rocket near the surface of the earth is accelerating vertically upward at 10 m/s^2 . The rocket releases an instrument package. Immediately after release the acceleration of the instrument package is:
- (A) 20 m/s^2 up (B) 10 m/s^2 up (C) 0 (D) 10 m/s^2 down
39. A ball which is dropped from the top of a building strikes the ground with a speed of 30 m/s. Assume air resistance can be ignored. The height of the building is approximately:
- (A) 15 m (B) 30 m (C) 45 m (D) 75 m
40. In the absence of air resistance, if an object were to fall freely near the surface of the Moon,
- (A) its acceleration would gradually decrease until the object moves with a terminal velocity.
 - (B) the acceleration is constant.
 - (C) it will fall with a constant speed.
 - (D) the acceleration is zero

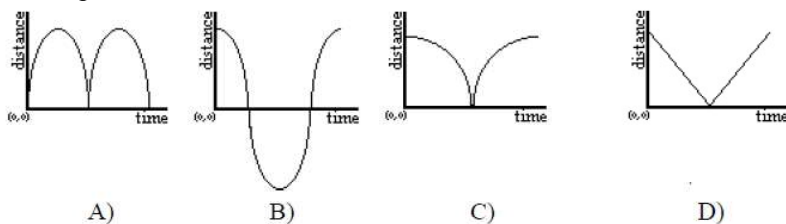


41. Given the graph of the velocity vs. time of a duck flying due south for the winter. At what point did the duck stop its forward motion?
 (A) A (B) B (C) C (D) D

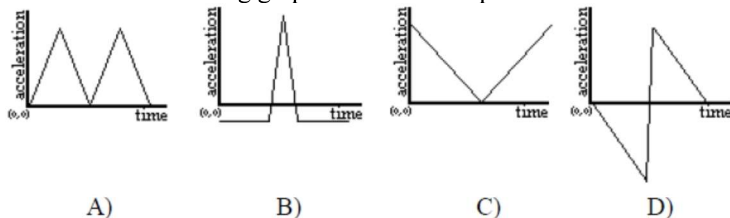
Questions 42-43

The following TWO questions refer to the following information. An ideal elastic rubber ball is dropped from a height of about 2 meters, hits the floor and rebounds to its original height.

42. Which of the following graphs would best represent the distance above the floor versus time for the above bouncing ball?

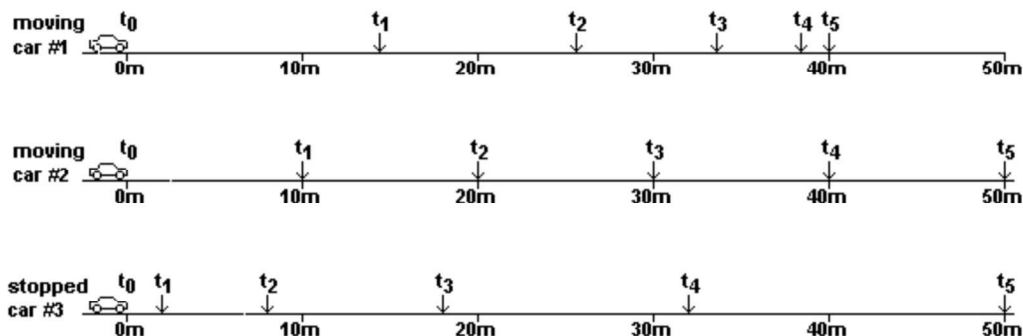


43. Which of the following graphs would best represent acceleration versus time for the bouncing ball?



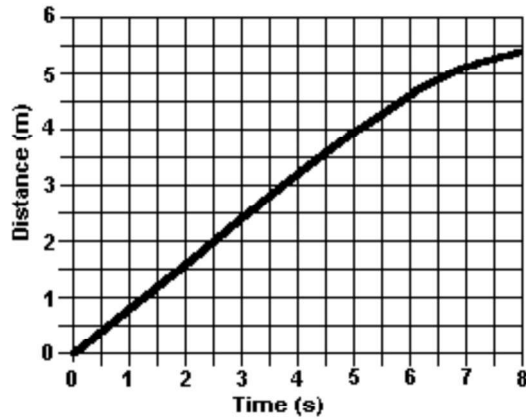
Questions 44-46

The following TWO questions refer to the following information. At t_0 , two cars moving along a highway are side-by-side as they pass a third car stopped on the side of the road. At this moment the driver of the first car steps on the brakes while the driver of the stopped car begins to accelerate. The diagrams below show the positions of each car for the next 5 seconds.



44. During which time interval would cars #2 and #3 be moving at the same average speed?
 (A) t_0 to t_1 (B) t_1 to t_2 (C) t_2 to t_3 (D) t_3 to t_4
45. Which of the three cars had the greatest average speed during these 5 seconds?
 (A) car #2 and car #3 had the same average speed (B) car #2
 (C) all three cars had the same average speed (D) car #3
46. If car #3 continues to constantly accelerate at the same rate what will be its position at the end of 6 seconds?
 (A) 24 m (B) 68 m (C) 72 m (D) 78 m

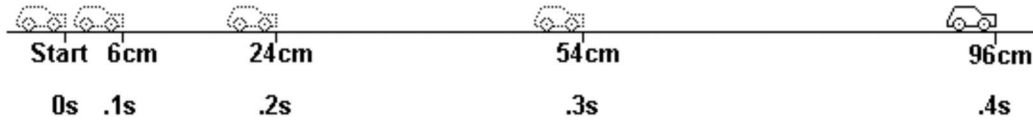
Questions 47-48



47. The graph represents the relationship between distance and time for an object that is moving along a straight line. What is the instantaneous speed of the object at $t = 5.0$ seconds?
 (A) 0.0 m/s (B) 0.8 m/s (C) 2.5 m/s (D) 4.0 m/s
48. Between what times did the object have a non-zero acceleration?
 (A) 0 s on (B) 0 s to 5 s (C) the object was not accelerating at any time (D) 5 s to 8 s
49. If a ball is thrown directly upwards with twice the initial speed of another, how much higher will it be at its apex?
 (A) 8 times (B) 2 times (C) 4 times (D) 2 times

Questions 50-51

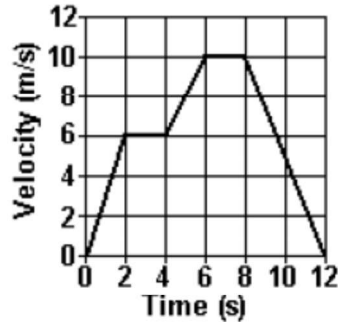
The diagram below represents a toy car starting from rest and uniformly accelerating across the floor. The time and distance traveled from the start are shown in the diagram.



50. What was the acceleration of the cart during the first 0.4 seconds?
 (A) 25 m/s^2 (B) 9.8 m/s^2 (C) 50 m/s^2 (D) 12 m/s^2
51. What was the instantaneous velocity of the cart at 96 centimeters from the start?
 (A) 0.6 m/s (B) 4.8 m/s (C) 1.9 m/s (D) 60 m/s (E) 2.4 m/s

Questions 52-53

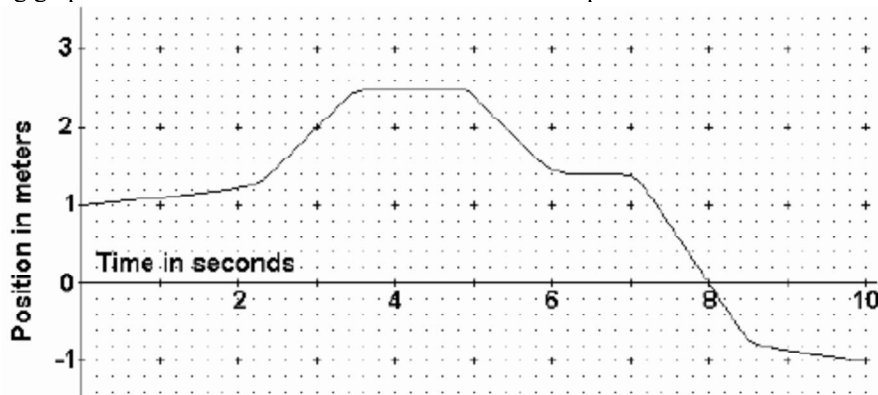
The motion of a circus clown on a unicycle moving in a straight line is shown in the graph below



52. What would be the acceleration of the clown at 5 s?
 (A) 1.6 m/s^2 (B) 8.0 m/s^2 (C) 2.0 m/s^2 (D) 3.4 m/s^2
53. After 12 seconds, how far is the clown from her original starting point?
 (A) 0 m (B) 10 m (C) 47 m (D) 74 m
54. When an object falls freely in a vacuum near the surface of the earth
 (A) the terminal velocity will be greater than when dropped in air
 (B) the velocity will increase but the acceleration will be zero
 (C) the acceleration will constantly increase
 (D) the acceleration will remain constant
55. Two arrows are launched at the same time with the same speed. Arrow A at an angle greater than 45 degrees, and arrow B at an angle less than 45 degrees. Both land at the same spot on the ground. Which arrow arrives first?
 (A) arrow A arrives first (B) arrow B arrives first (C) they both arrive together
 (D) it depends on the elevation where the arrows land

Questions 56-57

The accompanying graph describes the motion of a marble on a table top for 10 seconds.

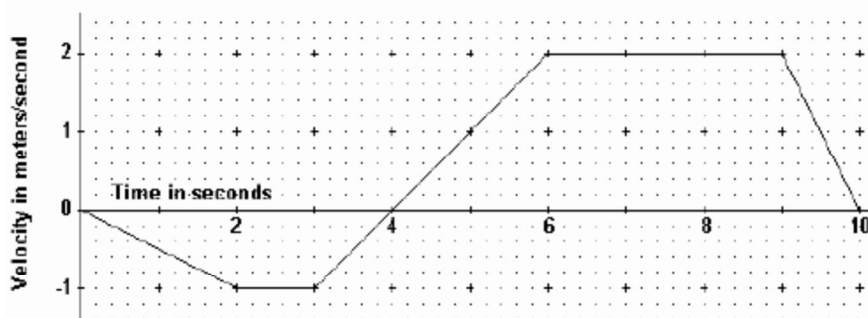


56. For which time interval(s) did the marble have a negative velocity?
 (A) from $t = 8.0 \text{ s}$ to $t = 10.0 \text{ s}$ only (B) from $t = 6.9 \text{ s}$ to $t = 10.0 \text{ s}$ only
 (C) from $t = 4.8 \text{ s}$ to $t = 10.0 \text{ s}$ only (D) from $t = 4.8 \text{ s}$ to $t = 6.2 \text{ s}$ and from $t = 6.9 \text{ s}$ to $t = 10.0 \text{ s}$ only
57. For which time interval(s) did the marble have a positive acceleration?
 (A) from $t = 0.0 \text{ s}$ to $t = 8.0 \text{ s}$ only (B) from $t = 0.0 \text{ s}$ to $t = 3.6 \text{ s}$ only
 (C) from $t = 3.8 \text{ s}$ to $t = 4.8 \text{ s}$ and $t = 6.2 \text{ s}$ to $t = 6.8 \text{ s}$ only
 (D) from $t = 2.0 \text{ s}$ to $t = 2.5 \text{ s}$, from $t = 5.8 \text{ s}$ to $t = 6.2 \text{ s}$, and from $t = 8.4 \text{ s}$ to $t = 8.8 \text{ s}$ only

58. What is the marble's average acceleration between $t = 3.1$ s and $t = 3.8$ s
 (A) -2.0 m/s² (B) 0.8 m/s² (C) 2.0 m/s² (D) 3.0 m/s²

Questions 59-60

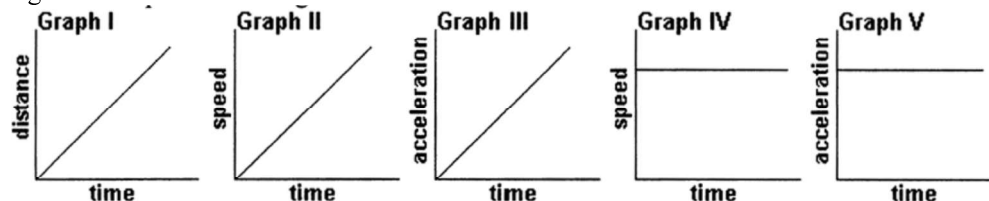
The accompanying graph describes the motion of a toy car across the floor for 10 seconds.



59. What is the acceleration of the toy car at $t = 4$ s?
 (A) -1 m/s² (B) 0 m/s² (C) 1 m/s² (D) 2 m/s²
60. What was the total displacement of the toy car for the entire 10 second interval shown?
 (A) 0 meters (B) 6.5 meters (C) 9 meters (D) 10 meters
61. An object is thrown upwards with a velocity of 30 m/s near the surface of the earth. After two seconds what would be the direction of the displacement, velocity and acceleration?

	<u>Displacement</u>	<u>velocity</u>	<u>acceleration</u>
(A)	up	up	up
(B)	up	up	down
(C)	up	down	down
(D)	up	down	up

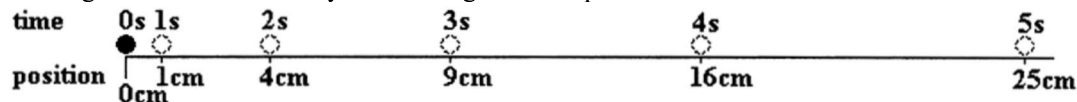
62. Which of the following graphs could correctly represent the motion of an object moving with a constant speed in a straight line?



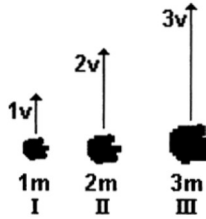
- (A) Graph I only (B) Graphs II and V only (C) Graph II only (D) Graphs I and IV only

Questions 63-64

The diagram shows a uniformly accelerating ball. The position of the ball each second is indicated.



63. What is the average speed of the ball between 3 and 4 seconds?
 (A) 3.0 cm/s (B) 7.0 cm/s (C) 3.5 cm/s (D) 12.5 cm/s
64. Which of the following is closest to the acceleration of the ball?
 (A) 1 cm/s² (B) 4 cm/s² (C) 2 cm/s² (D) 5 cm/s²



65. Three stones of different mass ($1m$, $2m$ & $3m$) are thrown vertically upward with different velocities ($1v$, $2v$ & $3v$ respectively). The diagram indicates the mass and velocity of each stone. Rank from high to low the maximum height of each stone. Assume air resistance is negligible.
 (A) I, II, III (B) II, I, III (C) III, II, I (D) I, III, II

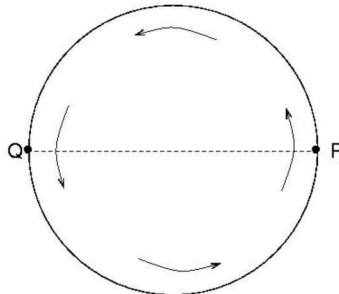


66. A rubber ball bounces on the ground as shown. After each bounce, the ball reaches one-half the height of the bounce before it. If the time the ball was in the air between the first and second bounce was 1 second. What would be the time between the second and third bounce?
 (A) 0.50 sec (B) 0.71 sec (C) 1.0 sec (D) 1.4 sec
67. The driver of a car makes an emergency stop by slamming on the car's brakes and skidding to a stop. How far would the car have skidded if it had been traveling twice as fast?
 (A) 4 times as far (B) the same distance (C) 2 times as far (D) the mass of the car must be known
68. A snail is moving along a straight line. Its initial position is $x_0 = -5$ meters and it is moving away from the origin and slowing down. In this coordinate system, the signs of the initial position, initial velocity and acceleration, respectively, are
- | Choice | x_0 | v_0 | a |
|--------|-------|-------|-----|
| (A) | - | + | + |
| (B) | - | - | + |
| (C) | - | - | - |
| (D) | - | + | - |
69. A rock is dropped from the top of a tall tower. Half a second later another rock, twice as massive as the first, is dropped. Ignoring air resistance,
 (A) the distance between the rocks increases while both are falling.
 (B) the acceleration is greater for the more massive rock.
 (C) they strike the ground more than half a second apart.
 (D) they strike the ground with the same kinetic energy.
70. A cart is initially moving at 0.5 m/s along a track. The cart comes to rest after traveling 1 m. The experiment is repeated on the same track, but now the cart is initially moving at 1 m/s. How far does the cart travel before coming to rest?
 (A) 1 m (B) 2 m (C) 3 m (D) 4 m

71. During an interval of time, a tennis ball is moved so that the angle between the velocity and the acceleration of the ball is kept at a constant 120° . Which statement is true about the tennis ball during this interval of time?
- (A) Its speed increases and it is changing its direction of travel.
 (B) Its speed decreases and it is changing its direction of travel.
 (C) Its speed remains constant, but it is changing its direction of travel.
 (D) Its speed remains constant and it is not changing its direction of travel.

Questions 72-73

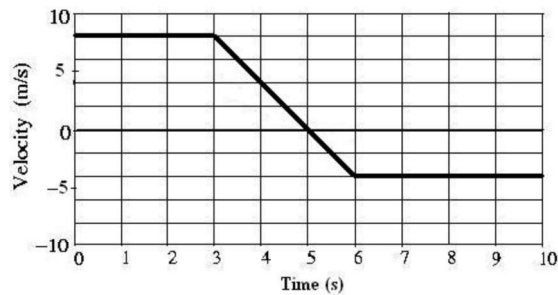
A particle continuously moves in a circular path at constant speed in a counterclockwise direction. Consider a time interval during which the particle moves along this circular path from point P to point Q. Point Q is exactly half-way around the circle from Point P.



72. What is the direction of the average velocity during this time interval?
 (A) \rightarrow (B) \leftarrow (C) \uparrow (D) The average velocity is zero.
73. What is the direction of the average acceleration during this time interval?
 (A) \rightarrow (B) \leftarrow (C) \downarrow (D) The average acceleration is zero.

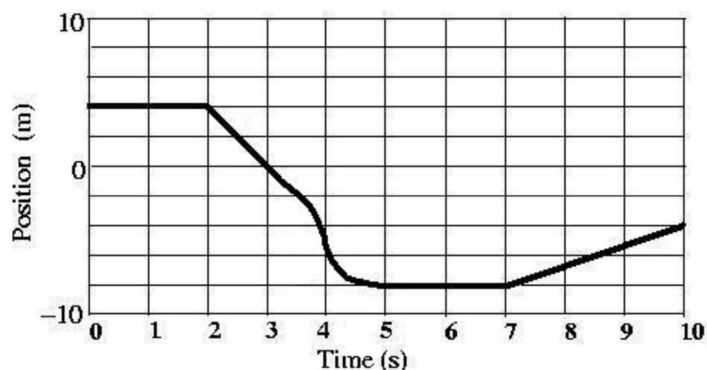
Questions 74-75

The velocity vs. time graph for the motion of a car on a straight track is shown in the diagram. The thick line represents the velocity. Assume that the car starts at the origin $x = 0$.



74. At which time is the car the greatest distance from the origin?
 (A) $t = 10$ s (B) $t = 5$ s (C) $t = 3$ s (D) $t = 0$ s
75. What is the average speed of the car for the 10 second interval?
 (A) 1.20 m/s (B) 1.40 m/s (C) 3.30 m/s (D) 5.00 m/s

76. Consider the motion of an object given by the position vs. time graph shown. For what time(s) is the speed of the object greatest?



- (A) At all times from $t = 0.0 \text{ s} \rightarrow t = 2.0 \text{ s}$ (B) At time $t = 3.0 \text{ s}$ (C) At time $t = 4.0 \text{ s}$
 (D) At time $t = 8.5 \text{ s}$

77. The free fall trajectory of an object thrown horizontally from the top of a building is shown as the dashed line in the figure. Which sets of arrows best correspond to the directions of the velocity and of the acceleration for the object at the point labeled P on the trajectory?

	velocity	acceleration
(A)	↘	↓
(B)	→	↓
(C)	→	↖
(D)	↘	↙

78. A toy car moves 3.0 m to the North in one second. The car then moves at 9.0 m/s due South for two seconds. What is the average speed of the car for this three second trip?
 (A) 4.0 m/s (B) 5.0 m/s (C) 6.0 m/s (D) 7 m/s
79. Two automobiles are 150 kilometers apart and traveling toward each other. One automobile is moving at 60 km/h and the other is moving at 40 km/h. In how many hours will they meet?
 (A) 1.5 (B) 1.75 (C) 2.0 (D) 2.5
80. Is it possible for an object's velocity to increase while its acceleration decreases?
 (A) No, because if acceleration is decreasing the object will be slowing down
 (B) No, because velocity and acceleration must always be in the same direction
 (C) Yes, an example would be a falling object near the surface of the moon
 (D) Yes, an example would be a falling object in the presence of air resistance

Questions 81-82

During a recent winter storm, bales of hay had to be dropped from an airplane to a herd of cattle below. Assume the airplane flew horizontally at an altitude of 180 m with a constant velocity of 50 m/s and dropped one bale of hay every two seconds. It is reasonable to assume that air resistance will be negligible for this situation.

81. As the bales are falling through the air, what will happen to their distance of separation?
 (A) the distance of separation will increase
 (B) the distance of separation will decrease
 (C) the distance of separation will remain constant
 (D) the distance of separation will depend on the mass of the bales
82. About how far apart from each other will the bales land on the ground?
 (A) 300 m (B) 180 m (C) 100 m (D) 50 m