3.MOTION IN A STRAIGHT LINE

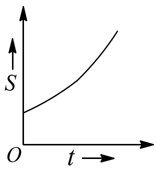
Single Correct Answer Type

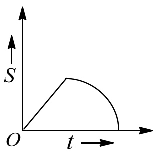
1. A train 100 m long travelling at 40 ms^{-1} starts overtaking another train 200 m long travelling at 30 ms^{-1}. The time taken by the first train to pass the second train completely is
a) 30 s b) 40 s c) 50 s d) 60 s

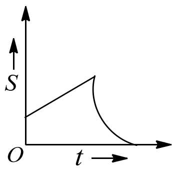
2. Water drops fall from a tap on the floor 5 m below at regular intervals of time, the first drop striking the floor when the fifth drop begins to fall. The height at which the third drop will be from ground (at the instant when the first drop strikes the ground), will be ($g = 10\ ms^{-2}$)
a) 1.25 m b) 2.15 m c) 2.75 m d) 3.75 m

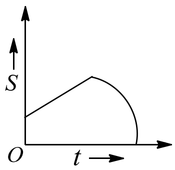
3. The position x of a particle varies with time (t) as $x = at^2 - bt^3$. The acceleration at time t of the particle will be equal to zero, where t is equal to
a) $\frac{2a}{3b}$ b) $\frac{a}{b}$ c) $\frac{a}{3b}$ d) Zero

4. An object accelerates from rest to a velocity 27.5 ms^{-1} in 10 s. Find the distance covered by the object during the next 10 s
a) 412.5 m b) 137.5 m c) 550 m d) 275 m

5. Two balls are dropped from the top of a high tower with a time interval of t_0 second, where t_0 is smaller than the time taken by the first ball to reach the floor, which is perfectly inelastic. The distance s between the two balls, plotted against the time lapse t from the instant of dropping the second ball is best represented by
a) 

b) 

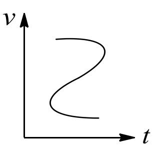
c) 

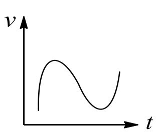
d) 

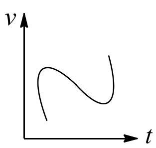
6. A body sliding on a smooth inclined plane requires 4 s to reach the bottom, starting from rest at the top. How much time does it take to cover one-fourth the distance starting from rest at the top?
a) 1 s b) 2 s c) 4 s d) 16 s

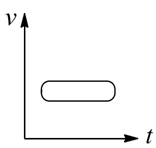
7. A ball is thrown from the top of a tower in vertically upward direction. Velocity at a point h metre below the point of projection is twice of the velocity at a point h metre about the point of projection. Find the maximum height reached by the ball above the top of tower
a) $2h$ b) $3h$ c) $(5/3)h$ d) $(4/3)h$

8. Drops of water fall at regular intervals from roof of a building of height $H = 16$ m, the first drop striking the ground at the same moment as the fifth drop detaches itself from the roof. The distance between separate drops in air as the first drop reaches the ground are
a) 1 m, 5 m, 7 m, 3 m b) 1 m, 3 m, 5 m, 7 m c) 1 m, 3 m, 7 m, 5 m d) None of the above

9. Which of the following velocity-time graphs shows a realistic situation for a body in motion?
a) 

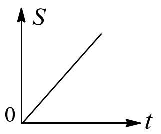
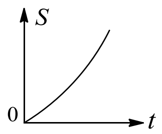
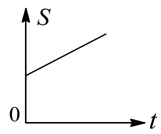
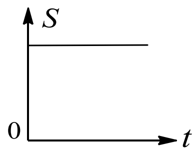
b) 

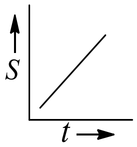
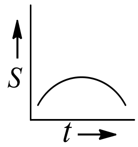
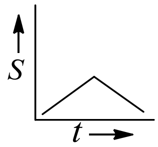
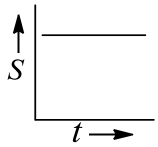
c) 

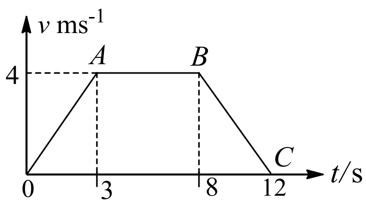
d) 

10. A drunkard is walking along a straight road. He takes 5 steps forward and 3 steps backward and so on. Each step is 1 m long and takes 1s. There is a pit on the road 11 m away from the starting point. The drunkard will fall into the pit after
a) 29 s b) 21 s c) 37 s d) 31 s

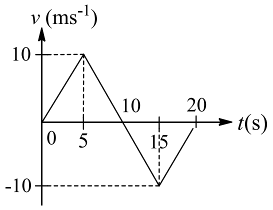
11. From a high tower, at time $t = 0$, one stone is dropped from rest and simultaneously another stone is projected vertically up with an initial velocity. The graph of distance S between the two stones plotted against time t will be

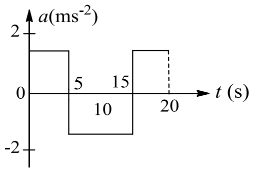
a)  b)  c)  d) 

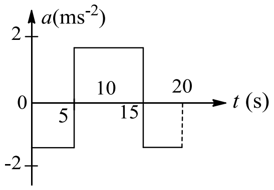
12. The displacement x of a particle moving in one dimension under the action of a constant force is related to time t by the equation $t = \sqrt{x} + 3$, where x is in metres and t is in seconds. Find the displacement of the particle when its velocity is zero
    a) Zero b) 12 m c) 6 m d) 18 m
13. The x and y coordinates of a particle at any time t are given by: $x = 7t + 4t^2$ and $y = 5t$, where x and y are in metres and t in seconds. The acceleration of the particle at 5 s is
    a) Zero b) 8 ms^{-2} c) 20 ms^{-2} d) 40 ms^{-2}
14. A particle starts from the origin with a velocity of 10 ms^{-1} and moves with a constant acceleration till the velocity increases to 50 ms^{-1}. At that instant, the acceleration is suddenly reversed. What will be the velocity of the particle, when it returns to the starting point?
    a) Zero b) 10 ms^{-1} c) 50 ms^{-1} d) 70 ms^{-1}
15. Which graph represents uniform motion?
    a)  b)  c)  d) 
16. A stone is dropped from rising balloon at a height of 76 m above the ground and reaches the ground in 6 s. What was the velocity of the balloon when the stone was dropped? Take g = 10 ms^{-2}
    a) 52/3 ms^{-1} upward b) (52/3) ms^{-1} downward
    c) 3 ms^{-1} d) 9.8 ms^{-1}
17. The distance travelled by a particle in a straight line motion is directly proportional to $t^{1/2}$, where t = time elapsed. What is the nature of motion?
    a) Increasing acceleration b) Decreasing acceleration
    c) Increasing retardation d) Decreasing retardation
18. From the velocity-time graph, given in Fig of a particle moving in a straight line, one can conclude that

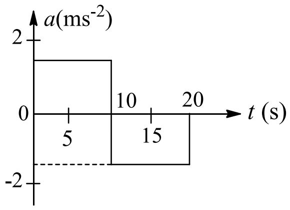


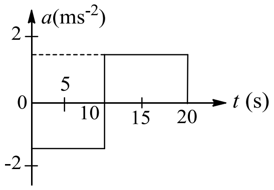
    a) Its average velocity during the 12 s interval is 24/7 ms^{-1}
    b) Its velocity for the first 3 s is uniform and is equal to 4 ms^{-1}
    c) The body has a constant acceleration between $t = 3$ s and $t = 8$ s
    d) The body has a uniform retardation from $t = 8$ s to $t = 12$ s
19. Plot the acceleration-time graph of the velocity-time graph given in Fig



a) 

b) 

c) 

d) 

20. A stone is dropped from a certain height which can reach the ground in 5 s. It is stopped after 3 s of its fall and then it is again released. The total time taken by the stone to reach the ground will be

a) 6 s b) 6.5 s c) 7 s d) 7.5 s

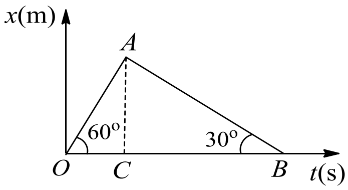
21. A stone thrown upwards with speed u attains maximum height h. Another stone thrown upwards from the same point with speed $2u$ attains maximum height H. What is the relation between h and H?

a) $2h = H$ b) $3h = H$ c) $4h = H$ d) $5h = H$

22. A stone is dropped from the top of a tower of height h. After 1 s another stone is dropped from the balcony 20 m below the top. Both reach the bottom simultaneously. What is the value of h? Take $\mathrm{g} = 10\ \mathrm{ms}^{-2}$

a) 3125 m b) 312.5 m c) 31.25 m d) 25.31 m

23. On the displacement-time graph, two straight lines make angle 60° and 30°, with time axis as shown in Fig. The ratio of the velocities represented by them is



a) 1 : 2 b) 1 : 3 c) 2 : 1 d) 3 : 1

24. A body starts from rest and travels a distance S with uniform acceleration, then moves uniformly a distance $2S$ uniformly, and finally comes to rest after moving further $5S$ under uniform retardation. The ratio of the average velocity to maximum velocity is

a) 2/5 b) 3/5 c) 4/7 d) 5/7

25. A body is released from the top of a tower of height H m. After 2 s it is stopped and then instantaneously released. What will be its height after next 2 s?

a) $(H - 5)$ m b) $(H - 10)$ m c) $(H - 20)$ m d) $(H - 40)$ m

26. The distance moved by a freely falling body (starting from rest) during 1$^{\text{st}}$, 2$^{\text{nd}}$, 3$^{\text{rd}}$,…,n$^{\text{th}}$ second of its motion are proportional to

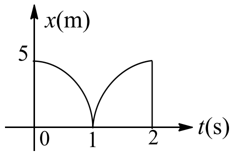
a) Even numbers b) Odd numbers

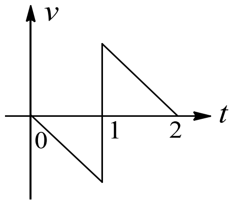
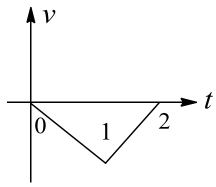
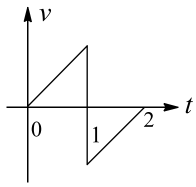
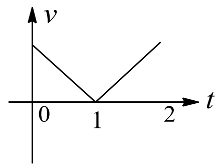
c) All integral numbers d) Squares of integral numbers

27. A point moves in a straight line so that its displacement x metre at time t second is given by $x^2 = 1 + r^2$. Its acceleration in ms^{-2} at time t second is

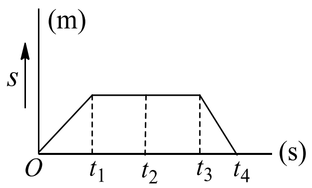
a) $\dfrac{1}{x^3}$ b) $-\dfrac{t}{x^3}$ c) $\dfrac{1}{x} - \dfrac{t^2}{x^3}$ d) $\dfrac{1}{x} - \dfrac{1}{x^2}$

28. The displacement-time graph of a moving particle with constant acceleration is shown in the figure. The velocity-time graph is given by

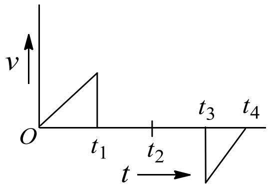
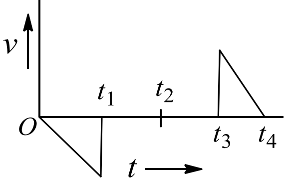
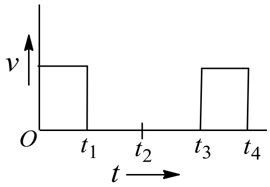
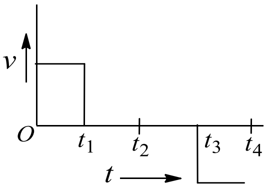


a) 
b) 
c) 
d) 

29. When the speed of a car is u, the minimum distance over which it can be stopped is s. If the speed becomes nu, what will be the minimum distance over which it can be stopped during the same time?
    a) s/n
    b) ns
    c) s/n^2
    d) n^2s
30. Check up only the correct statement in the following:
    a) A body has a constant velocity and still it can have varying speed
    b) A body has a constant speed but it can have varying velocity
    c) A body having constant speed cannot have any acceleration
    d) None of these
31. If a particle travels n equal distance with speeds $v_1, v_2, \ldots, v_n$, then the average speed $\bar{V}$ of the particle will be such that
    a) $\bar{V} = \dfrac{v_1 + v_2 + \ldots + v_n}{n}$
    b) $\bar{V} = \dfrac{nv_1v_2 + v_n}{v_1 + v_2 + v_3 + \ldots + v_n}$
    c) $\dfrac{1}{\bar{V}} = \dfrac{1}{n}\left(\dfrac{1}{v_1} + \dfrac{1}{v_2} + \ldots + \dfrac{1}{v_n}\right)$
    d) $\bar{V} = \sqrt{v_1^2 + v_1^2 + \ldots + v_n^2}$
32. The location of a particle is changed. What can we say about the displacement and distance covered by the particle?
    a) Both cannot be zero
    b) One of the two may be zero
    c) Both must be zero
    d) Both must be equal
33. A ball is released from the top of a tower of height h. It takes time T to reach the ground. What is the position of the ball (from ground) after time $T/3$?
    a) $h/9$ m
    b) $7h/9$ m
    c) $8h/9$ m
    d) $17h/18$ m
34. The displacement-time graph of a body is shown in Fig



The velocity-time graph of the motion of the body will be

a) 
b) 
c) 
d) 

35. The magnitude of displacement is equal to the distance covered in a given interval of time if the particle
    a) Moves with constant acceleration of time if the particle
    b) Moves with constant speed

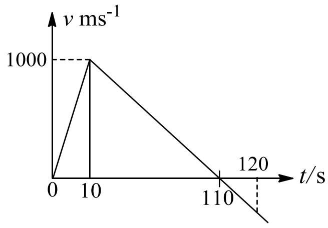
c) Moves in same direction with constant velocity or with variable velocity
d) Moves with constant velocity

36. A thief is running away on a straight road in a jeep moving with a speed of 9 ms^{-1}. A policeman chases him on a motor cycle moving at a speed of 10 ms^{-1}. If the instantaneous separation of the jeep from the motor cycle is 100 m, how long will it take for the policeman to catch the thief?
a) 1 s b) 19 s c) 90 s d) 100 s

37. The numerical value of the ratio of instantaneous velocity to instantaneous speed is
a) Always less than one
b) Always equal to one
c) Always more than one
d) Equal to or less than one

38. A body is thrown vertically upwards from A, the top of a tower. It reaches the ground in time t_1. If it is thrown vertically downwards from A with the same speed, it reaches the ground in time t_2. If it is allowed to fall freely from A, then the time it takes to reach the ground is given by
a) $t = \frac{t_1 + t_2}{2}$ b) $t = \frac{t_1 - t_2}{2}$ c) $t = \sqrt{t_1 t_2}$ d) $t = \sqrt{\frac{t_1}{t_2}}$

39. The following graph shows the variation of velocity of a rocket with time. Then the maximum height attained by the rocket is



a) 1.1 km b) 5 km c) 55 km d) None of these

40. A train is moving at a constant speed V when its driver observes another train in front of him on the same track and moving in the same direction with constant speed v. If the distance between the trains is x, then what should be the minimum retardation of the train so as to avoid collision?
a) $\frac{(V+v)^2}{x}$ b) $\frac{(V-v)^2}{x}$ c) $\frac{(V+v)^2}{2x}$ d) $\frac{(V-v)^2}{2x}$

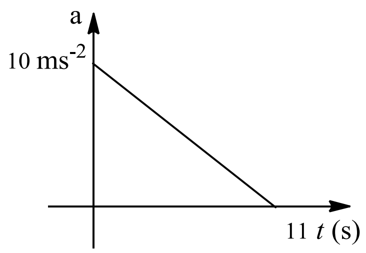
41. If two balls of same density but different masses are dropped from a height of 100 m, then (neglect air resistance)
a) Both will come together on Earth
b) Lighter will come earlier on Earth
c) Heavier will come earlier on Earth
d) None of these

42. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is
a) $\left(\frac{\alpha t + \beta^2}{\alpha\beta}\right)t$ b) $\left(\frac{\alpha^2 - \beta^2}{\alpha\beta}\right)t$ c) $\frac{(\alpha+\beta)t}{\alpha\beta}$ d) $\frac{\alpha\beta t}{\alpha+\beta}$

43. The average velocity of a body moving with uniform acceleration after travelling a distance of 3.06 m is 0.34 ms^{-1}. If the change in velocity of the body is 0.18 ms^{-1} during this time, its uniform acceleration is:
a) 0.01 ms^{-2} b) 0.02 ms^{-2} c) 0.03 ms^{-2} d) 0.04 ms^{-2}

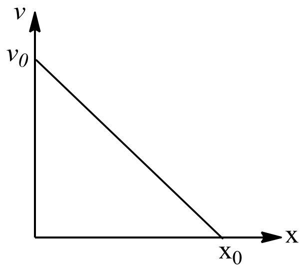
44. A wooden block is dropped from the top of a cliff 100 m high and simultaneously a bullet of mass 10 g is fired from the foot of the cliff upwards with a velocity of 100 ms^{-1}. The bullet and wooden block will meet after a time
a) 10 s b) 0.5 s c) 1 s d) 7 s

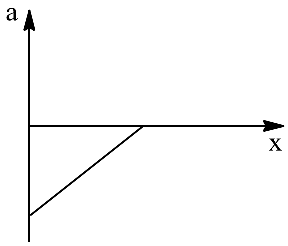
45. A particle starts from rest. Its acceleration (a) *versus* time (t) is as shown in the figure. The maximum speed of the particle will be



a) 110 ms^{-1} b) 55 ms^{-1} c) 550 ms^{-1} d) 660 ms^{-1}

46. The given graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement?



a)


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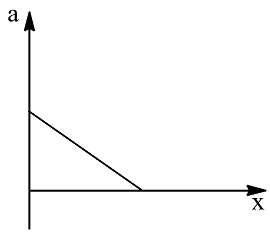

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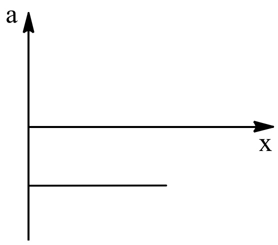

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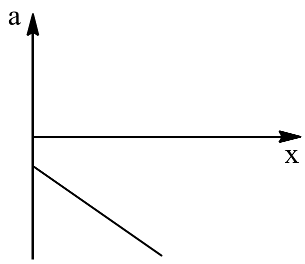


47. A particle moving in a straight line covers half the distance with speed of 3 m/s. The other half of the distance is covered in two equal time intervals with speed of 4.5 m/s and 7.5 m/s respectively. The average speed of the particle during the motion is
a) 4.0 m/s b) 5.0 m/s c) 5.5 m/s d) 4.8 m/s

48. If the distance covered is zero, then displacement
a) Must be zero
b) May or may not be zero
c) Cannot be zero
d) Depends upon the particle

49. Two trains, each travelling with a speed of 37.5 kmh^{-1}, are approaching each other on the same straight track. A bird that can fly at 60 kmh^{-1} files off from one train when they are 90 km apart and heads directly for the other train. On reaching the other train, it files back to the first and so on. Total distance covered by the bird is
a) 90 km b) 54 km c) 36 km d) 72 km

50. For motion of an object along the x-axis, the velocity v depends on the displacement x as $v = 3x^2 - 2x$, then what is the acceleration at $x = 2$ m
a) 48 ms^{-2} b) 80 ms^{-2} c) 18 ms^{-2} d) 10 ms^{-2}

51. An engine of a train moving with uniform acceleration passes an electric pole with velocity u and the last compartment with velocity v. The middle part of the train passes past the same pole with a velocity of

a) $\frac{u+v}{2}$ b) $\frac{u^2+v^2}{2}$ c) $\sqrt{\frac{u^2+v^2}{2}}$ d) $\sqrt{\frac{v^2-u^2}{2}}$

52. A body dropped from the top of a tower covers a distance $7x$ in the last second of its journey, where x is the distance covered in the first second. How much time does it take to reach the ground?
a) 3 s b) 4 s c) 5 s d) 6 s

53. The deceleration experienced by a moving motor boat, after its engine is cut-off is given by $\frac{dv}{dt}=-kv^3$, where k is constant. If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is
a) $v_0/2$ b) v c) v_0e^{-kt} d) $\frac{v_0}{\sqrt{2v_0^2kt+1}}$

54. An elevator in which a man is standing is moving upwards with a speed of 10 ms^{-1}. If the man drops a coin from a height of 2.45 m from the floor of elevator, it reaches the floor of the elevator after time (g $= 9.8\ ms^{-2}$)
a) $\sqrt{2}$ s b) $1/\sqrt{2}$ s c) 2 s d) 2 s

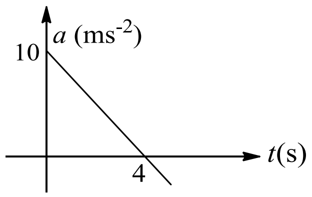
55. The ratio of the average velocity of a train during a journey to the maximum velocity between two stations is
a) $=1$ b) >1 c) <1 d) $>$ or <1

56. A particle moving in a straight line covers half the distance with speed of 3 m/s. The other half of the distance is covered in two equal time intervals with speed of 4.5 m/s and 7.5 m/s respectively. The average speed of the particle during the motion is
a) 4.0 m/s b) 5.0 m/s c) 5.5 m/s d) 4.8 m/s

57. Between two stations a train accelerates from rest uniformly at first, then moves with constant, and finally retards uniformly to come to rest. If the ratio of the time taken is 1: 8: 1 and the maximum speed attained be 60 kmh^{-1}, then what is the average speed over the whole journey?
a) 48 kmh^{-1} b) 52 kmh^{-1} c) 54 kmh^{-1} d) 56 kmh^{-1}

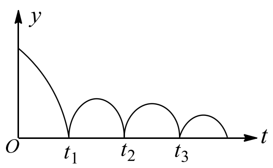
58. A body is dropped from a height 39.2 m. After it crosses half distance, the acceleration due to gravity ceases to act. The body will hit the ground with velocity (Take g $= 10\ ms^{-2}$):
a) 19.6 ms^{-1} b) 20 ms^{-1} c) 1.96 ms^{-1} d) 196 ms^{-1}

59. The acceleration-time graph of a particle moving along a straight line is as shown in Fig. At what time the particle acquires its initial velocity?



a) 12 s b) 5 s c) 8 s d) 16 s

60. The graph below describes the motion of a ball rebounding from a horizontal surface being released from a point above the surface. Assume the ball collides each time with the floor inelastically. The quantity represented on the y-axis in the ball's (take upward direction as positive



a) Displacement b) Velocity c) Acceleration d) Momentum

61. A juggler keeps on moving four balls in air throwing the balls after regular intervals. When one ball leaves his hand (speed $= 20\ ms^{-1}$) the position of other balls (height in metre) will be (take g $= 10\ ms^{-2}$)
a) 10, 20, 10 b) 15, 20, 15 c) 5, 15, 20 d) 5, 10, 20

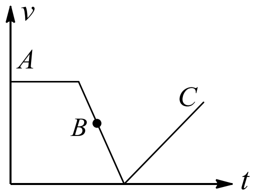
62. The numerical value of the ratio of average velocity to average speed is
a) Always less than one b) Always equal to one

c) Always more than one d) Equal to or less than one

63. A ball is dropped into a well in which the water level is at a depth h below the top. If the speed of sound is c, then the time after which the splash is heard will be given by

a) $h\left[\sqrt{\frac{2}{gh}}+\frac{1}{c}\right]$ b) $h\left[\sqrt{\frac{2}{gh}}-\frac{1}{c}\right]$ c) $h\left[\frac{2}{g}+\frac{1}{c}\right]$ d) $h\left[\frac{2}{g}-\frac{1}{c}\right]$

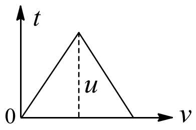
64. The velocity time graph of a body is shown in Fig. It indicates that

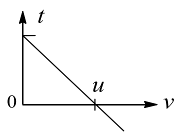


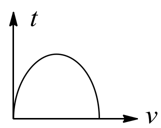
a) At B force is zero b) At B there is a force but towards motion

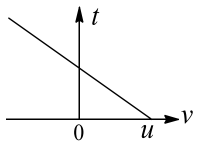
c) At B there is a force which opposes motion d) None of the above is true

65. An object is thrown up vertically. The velocity-time graph for the motion of the particle is

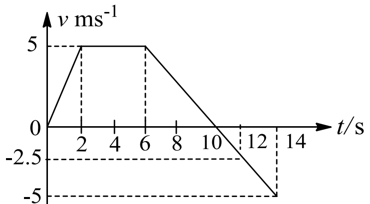
a) 

b) 

c) 

d) 

66. The variation of velocity of a particle moving along a straight line is shown in Fig. The distance travelled by the particle in 12 s is



a) 37.5 m b) 32.5 m c) 35.0 m d) None of these

67. Two trains, one travelling at 15 ms^{-1} and other at 20 ms^{-1}, are heading towards one another along a straight track. Both the drivers apply brakes simultaneously when they are 500 m apart. If each train has a retardation of 1 ms^{-2}, the separation after they stop is

a) 192.5 m b) 225.5 m c) 187.5 m d) 155.5 m

68. A parachutist drops first freely from an aeroplane for 10 s and then his parachute opens out. Now he descends with a net retardation of 2.5 ms^{-2}. If he bails out of the plane at a height of 2495 m and $g = 10$ ms^{-2}, his velocity on reaching the ground will be

a) 5 ms^{-1} b) 10 ms^{-1} c) 15 ms^{-1} d) 20 ms^{-1}

69. Two cars are moving in same direction with speed of 30 kmh^{-1}. They are separated by a distance of 5 km. What is the speed of a car moving in opposite direction if it meets the two cars at an interval of 4 min?

a) 60 kmh^{-1} b) 5 kmh^{-1} c) 30 kmh^{-1} d) 45 kmh^{-1}

70. A stone is dropped from the 25th storey of a multistoried building and it reaches the ground in 5 s. In the first second, it passes through how many storeys of the building? ($g = 10$ ms^{-2})

a) 1 b) 2 c) 3 d) None of these

71. A point moves with uniform acceleration and v_1, v_2, and v_3 denote the average velocities in the three successive intervals of time t_1, t_2, and t_3. Which of the following relations is correct?

a) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_2+t_3)$ b) $(v_1-v_2):(v_2-v_3)=(t_1+t_2):(t_2+t_3)$

c) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_1-t_3)$ d) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_2-t_3)$

72. If the displacement of a particle is zero, the distance covered

a) Must be zero b) May or may not be zero

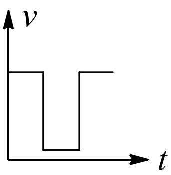
c) Cannot be zero d) Depends upon the particle

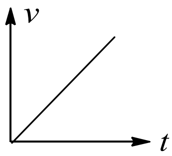
73. A particle slides from rest from the topmost point of a vertical circle of radius r along a smooth chord

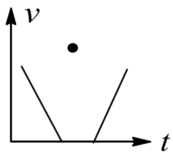
making an angle θ with the vertical. The time of descent is

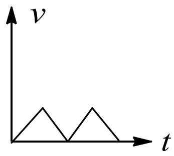
a) Least for $\theta = 0$ b) Maximum for $\theta = 0$ c) Least for $\theta = 45°$ d) Independent of θ

74. Which of the following velocity-time graphs is not possible practically?

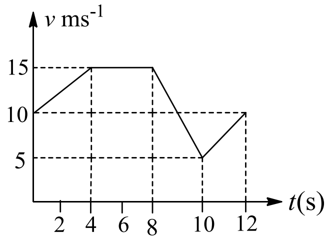
a) 

b) 

c) 

d) 

75. The velocity-time graph of a particle moving in a straight line is shown in Fig. The acceleration of the particle at $t = 9$ s is



a) Zero b) 5 ms^{-2} c) -5 ms^{-2} d) -2 ms^{-2}

76. A particle is dropped from rest from a large height. Assume g to be constant throughout the motion. The time taken by it to fall through successive distance of 1 m each will be

a) All equal, being equal to $\sqrt{2/g}$ second

b) In the ratio of the square roots of the integers 1, 2, 3,...,

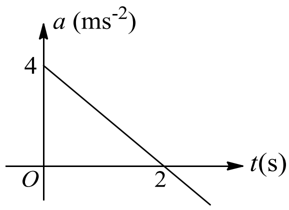
c) In the ratio of the difference in the square root of the integers, i.e., $\sqrt{1}, (\sqrt{2}-\sqrt{1}), (\sqrt{3}-\sqrt{2}), (\sqrt{4}-$ 3,......

d) In the ratio of the reciprocals of the square roots of the integers, i.e., $\frac{1}{\sqrt{1}}, \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{3}}, \dots$

77. The velocity—time relation of an electron starting from rest is given by $v = kt$ where $k = 2$ ms^{-2}. The distance traversed in first 3 s is

a) 9 m b) 16 m c) 27 m d) 36 m

78. The acceleration versus the graph of a particle moving in a straight line is shown in Fig. The velocity-time graph of the particle would be



a) A straight line b) A parabola c) A circle d) An ellipse

79. A person is throwing two balls in the air one after the other. He throws the second ball when the first ball is at the highest point. If he is throwing the balls every second, how high do they rise?

a) 5 m b) 3.75 m c) 2.50 m d) 1.25 m

80. B_1, B_2 and B_3, are three balloons ascending with velocities $v, 2v$, and $3v$, respectively. If a bomb is dropped from each when they are at the same height, then

a) Bomb from B_1 reaches ground first b) Bomb from B_2 reaches ground first

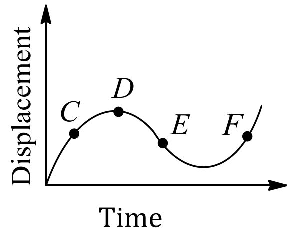
c) Bomb from B_3 reaches ground first d) They reach the ground simultaneously

81. Four persons are initially at the four corners of a square whose side is equal to d. Each person now moves with a uniform speed V in such a way that the first moves directly towards the second, the second directly towards the third, the third directly towards the fourth, and the fourth directly towards the first. The four persons will meet after a time equal to

a) d/V b) $2d/3V$ c) $2d/\sqrt{3}\,V$ d) $d/\sqrt{3}\,V$

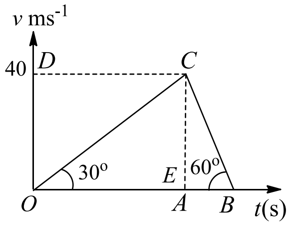
82. The displacement-time graph of a moving particle is shown in Fig. The instantaneous velocity of the

particle is negative at the point



a) D b) F c) C d) E

83. The velocity-time graph of a body is shown in Fig. The ratio of average acceleration during the intervals OA and AB is



a) 1 b) 1/2 c) 1/3 d) 3

84. A body travels 200 cm in the first 2 s and 220 cm in the next 4 s with deceleration. The velocity of the body at the end of the 7th second is

a) 5 cms^{-1} b) 10 cms^{-1} c) 15 cms^{-1} d) 20 cms^{-1}

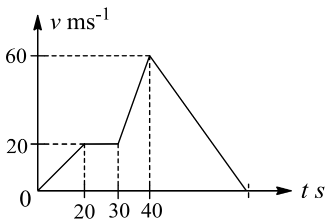
85. The relation between time t and distance x is

$t = \alpha x^2 + \beta x$

Where α and β are constant. The retardation is

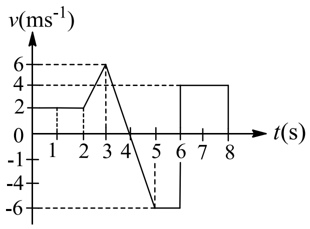
a) $2\alpha v^3$ b) $2\beta v^3$ c) $2\alpha\beta v^3$ d) $2\beta^2 v^3$

86. The velocity-time graph of a body is given in Fig. The maximum acceleration in ms^{-2} is



a) 4 b) 3 c) 2 d) 1

87. The velocity-time graph of a body is shown in Fig. The displacement of the body in 8 s is



a) 9 m b) 12 m c) 10 m d) 28 m

88. A particle moves along the x-axis in such a way that its position coordinate (x) varies with time (t) according to the expression $x = 2 - 5t + 6t^2$. Its initial velocity is

a) $-3\ \text{ms}^{-1}$ b) $-5\ \text{ms}^{-1}$ c) $2\ \text{ms}^{-1}$ d) $3\ \text{ms}^{-1}$

89. A particle is moving along the x-axis whose instantaneous speed is given by $v^2 = 108 - 9x^2$. The acceleration of the particle is

a) $-9x\ \text{ms}^{-2}$ b) $-18x\ \text{ms}^{-2}$ c) $\frac{-9x}{2}\ \text{ms}^{-2}$ d) None of these

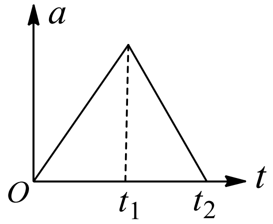
90. If x denotes displacement in time t and $x = a\cos t$, then acceleration is

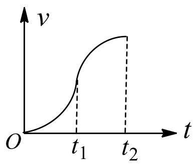
a) $a\cos t$ b) $-a\cos t$ c) $a\sin t$ d) $-a\sin t$

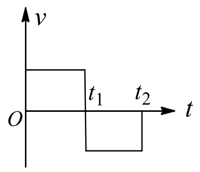
91. A person travels along a straight road for the first half of total time with a velocity v_1 and the second half of total time with a velocity v_2. Then the mean velocity $\bar{v}$ is give by

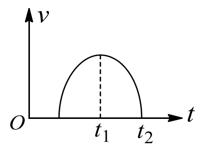
a) $\bar{v} = \dfrac{v_1 + v_2}{2}$ b) $\dfrac{2}{\bar{v}} = \dfrac{1}{v_1} + \dfrac{1}{v_2}$ c) $\bar{v} = \sqrt{v_1 v_2}$ d) $\bar{v} = \sqrt{\dfrac{v_2}{v_1}}$

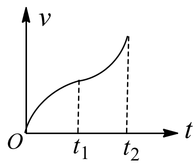
92. The acceleration versus time graph of a particle is shown in Fig. The respective $v - t$ graph of the particle is



a) 

b) 

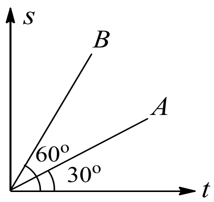
c) 

d) 

93. A police party is chasing a dacoit in a jeep which is moving at a constant speed v. The dacoit is on a motorcycle. When he is at a distance x from the jeep, he accelerates from rest at a constant rate? Which of the following relations is true if the police is able to catch the dacoit?

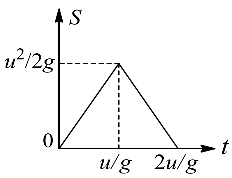
a) $v^2 \leq \alpha x$ b) $v^2 \leq 2\alpha x$ c) $v^2 \geq 2\alpha x$ d) $v^2 \geq \alpha x$

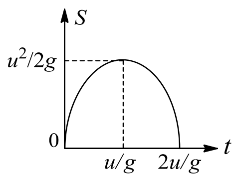
94. The displacement—time graph of two bodies A and B is shown in Fig. The ratio of the velocity of A (v_A) to the velocity of B (v_B) is

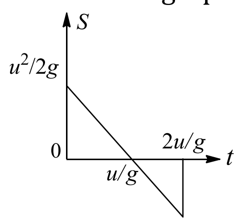


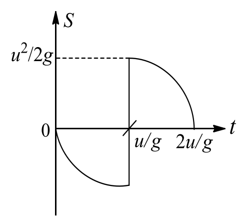
a) $1/\sqrt{3}$ b) $\sqrt{3}$ c) $1/3$ d) 3

95. An object is vertically thrown upwards. Then the displacement-time graph for the motion is as shown in

a) 

b) 

c) 

d) 

96. Taxies leave station X for station Y every 10 min. Simultaneously, a taxi also leaves station Y for station X every 10 min. The taxies move at the same constant speed and go from X and Y or vice-versa in 2 h. How many taxies coming from the other side will meet each taxi enroute from Y and X?

a) 24 b) 23 c) 12 d) 11

97. The displacement s of a particle is proportional to the first power of time t, i.e.,$s \propto t$; then the acceleration of the particle is

a) Infinite b) Zero c) A small finite value d) A large finite value

98. A moving car possesses average velocities of $5\ \mathrm{ms^{-1}}$, $10\ \mathrm{ms^{-1}}$ and $15\ \mathrm{ms^{-1}}$ in the first, second, and third seconds, respectively. What is the total distance covered by the car in these 3 s?

a) 15 m b) 30 m c) 55 m d) None of these

99. A body falls freely from rest. It covers as much distance in the last second of its motion as covered in the first three seconds. The body has fallen for a time of

a) 3 s b) 5 s c) 7 s d) 9 s

100. A person travels along a straight road for half the distance with velocity v_1 and the remaining half distance with velocity v_2. Then average velocity is given by

a) $v_1 v_2$ b) $\frac{v_2^2}{v_1^2}$ c) $\frac{(v_1+v_2)}{2}$ d) $\frac{2v_1v_2}{(v_1+v_2)}$

101. A 2 m wide truck is moving with a uniform speed $v_0 = 8\ \mathrm{ms}^{-1}$ along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is

a) $2.62\ \mathrm{ms}^{-1}$ b) $4.6\ \mathrm{ms}^{-1}$ c) $3.57\ \mathrm{ms}^{-1}$ d) $1.414\ \mathrm{ms}^{-1}$

102. A person moves 30 m north and then 20 m towards east and finally $30\sqrt{2}$ m in south-west direction. The displacement of the person from the origin will be

a) 10 m along north b) 10 m along south c) 10 m along west d) Zero

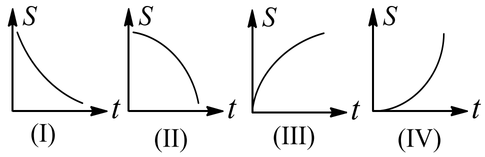
103. A body is projected upwards with a velocity u. It passes through a certain point above the ground after t_1. The time after which the body passes through the same point during the return journey is

a) $\left(\frac{u}{g}-t_1^2\right)$ b) $2\left(\frac{u}{g}-t_1\right)$ c) $3\left(\frac{u^2}{g}-t_1\right)$ d) $3\left(\frac{u^2}{g^2}-t_1\right)$

104. The velocity acquired by a body moving with uniform acceleration is $30\ \mathrm{ms}^{-1}$ in 2 s and $60\ \mathrm{ms}^{-1}$ in 2 s. The initial velocity is

a) Zero b) $2\ \mathrm{ms}^{-1}$ c) $3\ \mathrm{ms}^{-1}$ d) $10\ \mathrm{ms}^{-1}$

105. The acceleration will be positive in



a) (I) and (III) b) (I) and (IV) c) (II) and (IV) d) None of these

106. The angle between velocity and acceleration during retarded motion is

a) 180° b) 40° c) 45° d) 0°

107. Two trains A and B, 100 m and 60 m long, are moving in opposite directions on parallel tracks. The velocity of the shorter train is 3 times that of the longer one. If the trains take 4 s to cross each other, the velocities of the trains are

a) $V_A = 10\ \mathrm{ms}^{-1}, V_B = 30\ \mathrm{ms}^{-1}$ b) $V_A = 2.5\ \mathrm{ms}^{-1}, V_B = 7.5\ \mathrm{ms}^{-1}$

c) $V_A = 20\ \mathrm{ms}^{-1}, V_B = 60\ \mathrm{ms}^{-1}$ d) $V_A = 5\ \mathrm{ms}^{-1}, V_B = 15\ \mathrm{ms}^{-1}$

108. A body covers one-third of the distance with a velocity v_1, the second one-third of the distance with a velocity v_2, and the remaining distance with a velocity v_3. The average velocity is

a) $\frac{v_1+v_2+v_3}{3}$ b) $\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$ c) $\frac{v_1v_2+v_2v_3+v_3v_1}{3}$ d) $\frac{v_1v_2v_3}{3}$

109. A ball is thrown upwards with speed v from the top of a tower and it reaches the ground with speed $3v$. What is the height of the tower?

a) $\frac{v^2}{g}$ b) $\frac{2v^2}{g}$ c) $\frac{4v^2}{g}$ d) $\frac{8v^2}{g}$

110. Two cars A and B are travelling in the same direction with velocities V_A and V_B $(V_A > V_B)$. When the car A is at a distance s behind car B, the driver of the car A applies the brakes producing a uniform retardation a; there will be no collision when

a) $s < \frac{(V_A-V_B)^2}{2a}$ b) $s = \frac{(V_A-V_B)^2}{2a}$ c) $s \geq \frac{(V_A-V_B)^2}{2a}$ d) $s \leq \frac{(V_A-V_B)^2}{2a}$

111. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is

a) $\left(\frac{\alpha t+\beta^2}{\alpha\beta}\right)t$ b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$ c) $\frac{(\alpha+\beta)t}{\alpha\beta}$ d) $\frac{\alpha\beta t}{\alpha+\beta}$

Multiple Correct Answers Type

112. A lead ball is dropped into a lake from a diving board 5m above the water. If hits the water with a certain velocity and then sinks to the bottom with the same constant velocity. It reaches the bottom 5.0s after it is dropped. If $g = 10ms^{-2}$.

a) The depth of lake in 40m

b) The depth of lake in 50m

c) The average velocity of ball is $5ms^{-1}$

d) The average velocity of ball is $9ms^{-2}$

113. A car accelerates from rest at a constant rate of $2\ ms^{-2}$ for some time. Then it retards at a constant rate of $4\ ms^{-2}$ and comes to rest. It remains in motion for 6 s

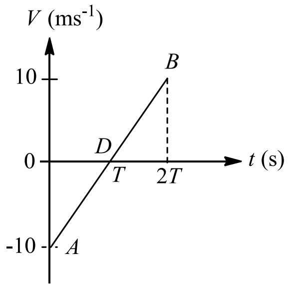
a) Its maximum speed is $8\ ms^{-1}$

b) Its maximum speed is $6\ ms^{-1}$

c) It travelled a total distance of 24 m

d) It travelled a total distance of 18 m

114. The figure shows the velocity (v) of a particle plotted against time (t)



a) The displacement of the particle in time $2T$ is zero

b) The initial and final speeds of the particle are the same

c) The acceleration of the particle remains constant throughout the motion

d) The particle changes its direction of motion at same point

115. Which of the following statements is/are correct?

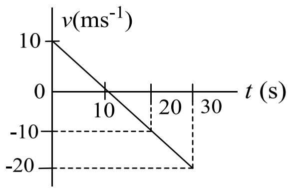
a) If the velocity of a body changes, it must have some acceleration

b) If the speed of a body changes, it must have some acceleration

c) If the body has acceleration, its speed must change

d) If the body has acceleration, its speed may change

116. The velocity-time plot for a particle moving on a straight line is shown in Fig



a) The particle has a constant acceleration

b) The particle has never turned around

c) The particle has zero displacement

d) The average speed in the interval 0 to 10 s is the same as the average speed in the interval 10 s to 20 s

117. The body will speed up if

a) Velocity and acceleration are in the same direction

b) Velocity and acceleration are in opposite directions

c) Velocity and acceleration are in perpendicular direction

d) Velocity and acceleration are acting at acute angle w.r.t. each other

118. A particle moving in a straight line with initial velocity u and retardation a, v, where v is the velocity at any time t

a) The particle will cover a total distance u/a

b) The particle will come to rest after time $1/a$

c) The particle will continue to move for a very long time

d) The velocity of the particle will becomes $u/2$ after time $1/a$

119. If the velocity of a particle is zero at $t = 0$,then

a) The acceleration at $t = 0$, must be zero
b) If the acceleration is zero from $t = 0$ to $t = 5$ s, the speed is also zero in this interval
c) If the acceleration is zero from $t = 0$ to $t = 5$ s, the displacement is also zero in this interval
d) If speed is zero from $t = 0$ to $t = 5$ s, the acceleration is also zero in this interval

120. A balloon starts rising from the ground with an acceleration of 2.5ms^{-2}. After 4 s, a stone is released from the balloon. If $\text{g} = 10\text{ms}^{-2}$, the stone will
a) Have a displacement of 25m
b) Cover a total distance of 30m
c) Reach the ground in 3.2s
d) Begin to move down after being released

121. A block slides down a smooth inclined plane when released from the top, while another falls freely from the same point
a) Sliding block will reach the ground first
b) Freely falling block will reach the ground first
c) Both the blocks will reach the ground with different speeds
d) Both the blocks will reach the ground with same speed

122. Which of the following statements are true for a moving body?
a) If its velocity changes, its speed must change and it must have some acceleration
b) If its velocity changes, its speed may or may not change, and it must have some acceleration
c) If its speed changes but direction of motion does not change, its velocity may remain constant
d) If its speed changes, its velocity must change and it must have some acceleration

123. If a body is accelerating
a) It may speed up
b) It may speed down
c) It may move with same speed
d) It may move with same velocity

124. At $t = 0$ an arrow is fired vertically upwards with a speed of $100\ \text{ms}^{-1}$. A second arrow is fired vertically upwards with the same speed at $t = 5$ s. Then
a) The two arrows will be at the same height above the ground at $t = 12.5$ s
b) The two arrows will reach back their starting points at $t = 20$ s and $t = 25$ s
c) The ratio of the speeds of the first and second arrows at $t = 20$ s will be 2 : 1
d) The maximum height attained by either arrow will be 1000 m

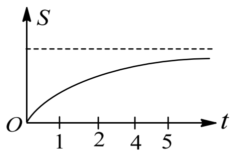
125. A boy starting from rest is moving with a uniform acceleration 5ms^{-2} for time 10 s, and after that with uniform acceleration 10ms^{-2} for time 15s, then
a) Average acceleration of the body is $7.5\ \text{ms}^{-2}$
b) Average acceleration of the body is $8.0\ \text{ms}^{-2}$
c) Total distance travelled by body is 1875 m
d) Total distance travelled by body is 2125 m

126. A particle of mass m moves on the x-$axis$ as follows : it starts from rest at $t = 0$ from the point $x = 0$ and comes to rest at $t = 1$ at the point $x = 1$. No other information is available about its motion at intermediate time ($0 < t < 1$). If α denotes the instantaneous acceleration of the particle, then
a) α cannot remain positive for all t in the interval $0 \le t \le 1$
b) $|\alpha|$ cannot exceed 2 at any point in its path
c) $|\alpha|$ must be ≥ 4 at some point or points in its path
d) α must change sign during the motion but no other assertion can be made with the information given

127. The motion of a body is given by the equation $\frac{dv(t)}{dt} = 6.0 - 3v(t)$.where $v(t)$ is speed in m/s and t in sec. If the body was at rest at $t = 0$
a) The terminal speed is 2.0 m/s
b) The speed varies with the time as $v(t) = 2(1 - e^{-3t})m/s$
c) The speed is $0.1 m/s$ when the acceleration is half the initial value

d) The magnitude of the initial acceleration is $6.0 m/s^2$

128. The displacement of a particle as a function of time is shown in Fig. It indicates



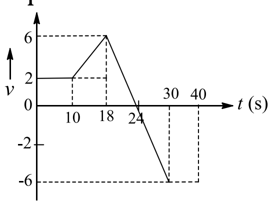
a) The particle starts with a certain velocity, but the motion is retarded and finally the particle stops
b) The velocity of the particle decreases
c) The acceleration of the particle is in opposite direction to the velocity
d) The particle starts with a constant velocity, the motion is accelerated and finally the particle moves with another constant velocity

129. The motion of a body falling from rest in a resisting medium is described by the equation

$$\frac{dv}{dt} = A - Bv$$

Where A and B are constants. Then
a) Initial acceleration of the body is A
b) The velocity at which acceleration becomes zero is A/B
c) The velocity at any time t is $\frac{A}{B}(1 - e^{Bt})$
d) All the above are wrong.

130. A particle moves in a straight line with the velocity as shown in Fig. At $t = 0, x = -16$ m



a) The maximum value of the position coordinate of the particle is 54 m
b) The maximum value of the position coordinate of the particle is 36 m
c) The particle is at the position of 36 m at $t = 18$ s
d) The particle is at the position of 36 m at $t = 30$ s

131. A particle is projected vertically upward with velocity u from a point A, when it returns point of projection
a) Its average speed is $u/2$
b) Its average velocity is zero
c) Its displacement is zero
d) Its average speed is u

132. A particle moves with an initial velocity v_0 and retardation βv, where v is its velocity at any time t
a) The particle will stop shortly
b) The particle will cover a total distance of v_0/β
c) The particle will continue moving for a very long time
d) The velocity of particle will become $v_0/2$ after time$1/\beta$.

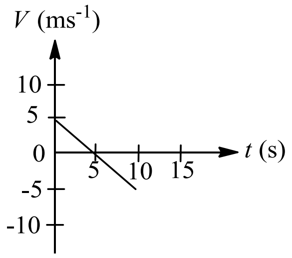
133. A particle moves along a straight line and its velocity depends on time as $v = 4t - t^2$. Then for first 5 s:
a) Average velocity is $25/3$ ms^{-1}
b) Average speed is 10 ms^{-1}
c) Average velocity is $5/3$ ms^{-1}
d) Acceleration is 4 ms^{-2} at $t = 0$

134. A particle is moving with a uniform acceleration along a straight line AB. Its speed at A and B are 2ms^{-1} and 14ms^{-1} respectively. Then
a) Its speed at mid-point of AB is 10 ms^{-1}
b) Its speed at a point P such that $AP: PB = 1: 5$ is 4 ms^{-1}
c) The time to go from A to mid-point of AB is double of that to go from mid-point to B
d) None of the above

135. Check up the only correct statements in the following:
a) A body having a constant velocity still can have varying speed
b) A body having a constant speed can have varying velocity
c) A body having constant speed can have an acceleration

d) If velocity and acceleration are in the same direction, then distance is equal to displacement

136. Suppose $\vec{a}$ and $\vec{v}$ denote the acceleration and velocity respectively of a body in one dimensional motion, then
   a) Speed must increase when $\vec{a} > 0$
   b) Speed will increase when $\vec{v}$ and $\vec{d}$ are >0
   c) Speed must decreases when $\vec{a}<0$
   d) Speed will decrease when $\vec{v}<0$ and $\vec{a} > 0$
137. A particle is projected vertically upwards in vacuum with a speed v.
   a) The time taken to rise to half its maximum height is half the time taken to reach its maximum height
   b) The time taken to rise to three-fourth of its maximum height is half the time taken to reach its maximum height.
   c) When it rises to half its maximum height, its speed becomes $v/\sqrt{2}$
   d) When it rises to half its maximum height, its speed becomes $v/2$
138. A mass throws a stone, vertically up with a speed of 20 ms^{-1} from top of a high rise building. Two seconds later, an identical stone is thrown vertical downward with the same speed $20\mathrm{ms}^{-1}$. Then (use, $\mathrm{g} = 10\mathrm{ms}^{-2}$)
   a) The relative acceleration between the two is equal to zero
   b) The time interval between their hitting the ground is 2s
   c) Both will have the same KE, when they hit the ground
   d) The relative velocity between the two stones remains constant till one hits the ground.
139. From the top of a tower of heights 200 m, a ball A is projected up with 10 ms^{-1}, and 2 s later another ball B is projected vertically down with the same speed. Then
   a) Both A and B will reach the ground simultaneously
   b) Both A will hit the ground 2 s later than B hitting the ground
   c) Both the balls will hit the ground with the same velocity
   d) Both the balls will hit the ground with the different velocity
140. The figure shows the velocity (v) of a particle moving on a straight line plotted against time (t)



   a) The particle has zero displacement
   b) The particle has never turned around
   c) The particle has constant acceleration
   d) The average speed in the interval 0 to 5s is the same as the average speed in the interval 5 to 10 s
141. A body starts from rest and then moves with uniform acceleration. Then
   a) Its displacement is directly proportional to the square of the time
   b) Its displacement is inversely proportional to the square of the time
   c) It may move along a circle
   d) It always moves in a straight line
142. Select this correct statements
   a) The average speed of the particle in a given time is never less than the magnitude of the average velocity.
   b) The average velocity of a particle is zero in a time interval. It is possible that the instantaneous velocity is never zero in an interval.
   c) The average speed of a particle moving on a straight line is zero in a time interval. It is possible that the instantaneous velocity is never zero in the interval.

d) It is possible to have a case in which the instantaneous speed of particle may be zero but the acceleration is not zero.

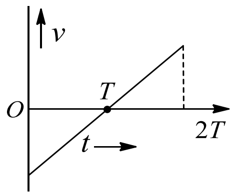
143. A particle of mass m moves on the x-axisas follow: it starts from rest at $t = 0$ from the point $x = 0$ and comes to rest at $t = 1$ at the point $x = 1$. No other information is available about its motion at intermediate times (0< $t < 1$). If a denotes the instantaneous acceleration of the particle, then
a) α cannot remain positive for all t in the interval $0 \leq t \leq 1$
b) $|a|$ cannot exceed 2 at any point in its path
c) $|a|$ must be ≥ 4 at same point or point in its path
d) α must change sign during the motion but no other assertion can be made with the information given

144. Average acceleration is in the direction of
a) Initial velocity
b) Final velocity
c) Change in velocity
d) Final velocity if initial velocity is zero

145. Two bodies of masses m_1 and m_2 are dropped from heights h_1 and h_2, respectively. They reach the ground after time t_1 and t_2 and strike the ground with v_1 and v_2, respectively. Choose the correct relations from the following
a) $\frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}$
b) $\frac{t_1}{t_2} = \sqrt{\frac{h_2}{h_1}}$
c) $\frac{v_1}{v_2} = \sqrt{\frac{h_1}{h_2}}$
d) $\frac{t_1}{t_2} = \frac{h_2}{h_1}$

146. The motion of a body is given by the equation $\frac{dv(t)}{dt} = 6.0 - 3v(t)$.where $v(t)$ is speed in m/s and t in sec. If the body was at rest at $t = 0$
a) The terminal speed is 2.0 m/s
b) The speed varies with the time as $v(t) = 2(1 - e^{-3t})m/s$
c) The speed is $0.1 m/s$ when the acceleration is half the initial value
d) The magnitude of the initial acceleration is $6.0 m/s^2$

147. Figure show the velocity (v) of a particle plotted against time (t)



a) The particle changes its direction of motion at some point
b) The acceleration of the particle remains constant
c) The displacement of the particle is zero
d) The initial and final speeds of the particle are the same

148. The motion of a body is given by the equation $\frac{dv(t)}{dt} = 6.0 - 3v(t)$, where $v(t)$ is speed in ms^{-1} and t in second. If body was at rest at $t = 0$
a) The terminal speed is 2.0 ms^{-1}
b) The speed varies with the times as $v(t)=2(1-e^{-3t})\text{ms}^{-1}$
c) The speed is 1.0 ms^{-1} when the acceleration is half the initial value
d) The magnitude of the initial acceleration is 6.0ms^{-2}.

149. The displacement (x) of a particle depends on time (t) as $x = \alpha t^2 - \beta t^3$.
a) The particle will come to rest after time $2\alpha/3\beta$
b) The particle will return to its starting point after time α/β
c) No net force will act on the particle at $t = \alpha/3\beta$.
d) The initial velocity of the particle was zero but its initial acceleration was not zero

150. A particle of mass m moves on the x-$axis$ as follows : it starts from rest at $t = 0$ from the point $x = 0$ and comes to rest at $t = 1$ at the point $x = 1$. No other information is available about its motion at intermediate time (0< $t < 1$). If α denotes the instantaneous acceleration of the particle, then
a) α cannot remain positive for all t in the interval $0 \leq t \leq 1$
b) $|\alpha|$ cannot exceed 2 at any point in its path

c) $|\alpha|$ must be ≥ 4 at some point or points in its path

d) α must change sign during the motion but no other assertion can be made with the information given

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 151 to 150. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

151

Statement 1: A body is dropped from a height of 40.0m. After it falls by half the distance, the acceleration due to gravity ceases to act. The velocity with which it hits the ground is 20ms^{-1}(Take $\text{g} = 10\text{ms}^{-2}$)

Statement 2: $v^2 = u^2 + 2as$

152

Statement 1: Retardation is directed opposite to the velocity

Statement 2: Retardation is equal to the time rate of decrease of velocity

153

Statement 1: The position-time graph of a uniform motion in one dimension of a body can have negative slope

Statement 2: When the speed of body decreases with time, the position-time graph of the moving body can have negative slope

154

Statement 1: Displacement of a body may be zero when distance travelled by it is not zero

Statement 2: The displacement is the longest distance between initial and final position

155

Statement 1: The average velocity of the object over an interval of time is either smaller than or equal to the average speed of the object over the same interval

Statement 2: Velocity is vector quantity and speed is a scalar quantity

156

Statement 1: A positive acceleration of a body can be associated with a '*slowing down*' of the body

Statement 2: Acceleration is vector quantity

157

Statement 1: Position-time graph of a stationary object is a straight line parallel to time axis

Statement 2: For a stationary object, position does not change with time

158

Statement 1: The average and instantaneous velocities have same value in a uniform motion

Statement 2: In uniform motion, the velocity of an object increases uniformly

159

Statement 1: Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis

Statement 2: In uniform motion of an object velocity increases as the square of time elapsed

160

Statement 1: A body may be accelerated even when it is moving uniformly

Statement 2: When direction of motion of the body is changing then body may have acceleration

161

Statement 1: Displacement of a body may be zero when distance travelled by it is not zero

Statement 2: The displacement is the longest distance between initial and final position

162

Statement 1: The position-time graph of a body moving uniformly is a straight line parallel to position axis

Statement 2: The slope of position-time graph in a uniform motion gives the velocity of an object

163

Statement 1: Displacement of a body is vector sum of the area under velocity-time graph

Statement 2: Displacement is a vector quantity

164

Statement 1: A body having non-zero acceleration can have a constant velocity

Statement 2: Acceleration is the rate of change of velocity

165

Statement 1: A body falling freely may do so with constant velocity

Statement 2: The body falls freely, when acceleration of a body is equal to acceleration due to gravity

166

Statement 1: The equation of motion can be applied only if acceleration is along the direction of velocity and is constant

Statement 2: If the acceleration of a body is constant then its motion is known as uniform motion

167

Statement 1: Two balls of different masses are thrown vertically upwards with the same speed. They will pass through their point of projection in the downward direction with the same speed

Statement 2: The height and the downward velocity attained at the point of projection are independent of the mass of ball

168

Statement 1: A bus moving due north takes a turn and starts moving towards east with same speed. There will be no change in the velocity of bus

Statement 2: Velocity is a vector-quantity

169

Statement 1: A body can have acceleration even if its velocity is zero at a given instant

Statement 2: A body is momentarily at rest when it reverses its direction of velocity

170

Statement 1: The position-time graph of a uniform motion in one dimension of a body can have negative slope

Statement 2: When the speed of body decreases with time, the position-time graph of the moving body can have negative slope

171

Statement 1: Position-time graph of a stationary object is a straight line parallel to time axis

Statement 2: For a stationary object, position does not change with time

172

Statement 1: A body, whatever its motion is always at rest in a frame of reference which is fixed to the body itself

Statement 2: The relative velocity of a body with respect to itself is zero

173

Statement 1: A bus moving due north takes a turn and starts moving towards east with same speed. There will be no change in the velocity of bus

Statement 2: Velocity is a vector-quantity

174

Statement 1: An object can have constant speed is a scalar quantity

Statement 2: Speed is a scalar but velocity is a vector quantity

175

Statement 1: A body, whatever its motion is always at rest in a frame of reference which is fixed to the body itself

Statement 2: The relative velocity of a body with respect to itself is zero

176

Statement 1: An object can have constant speed is a scalar quantity

Statement 2: Speed is a scalar but velocity is a vector quantity

177

Statement 1: A negative acceleration of a body can be associated with a '*speeding up*' of the body

Statement 2: Increase in speed of a moving body is independent of its direction of motion

178

Statement 1: The slope of displacement-time graph of a body moving with high velocity is steeper than the slope of displacement-time graph of a body with low velocity

Statement 2: Slope of displacement-time graph = Velocity of the body

179

Statement 1: The position-time graph of a body moving uniformly is a straight line parallel to position axis

Statement 2: The slope of position-time graph in a uniform motion gives the velocity of an object

180

Statement 1: A negative acceleration of a body can be associated with a '*speeding up*' of the body

Statement 2: Increase in speed of a moving body is independent of its direction of motion

181

Statement 1: At any instant, the acceleration of a body can change its direction without any change in the direction of velocity

Statement 2: At any instant, the direction of acceleration is same as that of the direction of change in velocity vector is same as that of the direction of change in velocity vector at that instant

182

Statement 1: A body falling freely may do so with constant velocity

Statement 2: The body falls freely, when acceleration of a body is equal to acceleration due to gravity

183

Statement 1: A positive acceleration of a body can be associated with a '*slowing down*' of the body

Statement 2: Acceleration is vector quantity

184

Statement 1: The equation of motion can be applied only if acceleration is along the direction of velocity and is constant

Statement 2: If the acceleration of a body is constant then its motion is known as uniform motion

185

Statement 1: The relative velocity between any two bodies moving in opposite direction is equal to sum of the velocities of two bodies

Statement 2: Sometimes relative velocity between two bodies is equal to difference in velocities of the two

186

Statement 1: The average velocity of the object over an interval of time is either smaller than or equal to the average speed of the object over the same interval

Statement 2: Velocity is vector quantity and speed is a scalar quantity

187

Statement 1: For an observer looking out through the window of a fast moving train, the nearby objects appear to move in the opposite direction to the train, while the distant objects appear to be stationary

Statement 2: If the observer and the object are moving at velocities $\vec{V}_1$ and $\vec{V}_2$ respectively with reference to a laboratory frame, the velocity of the object with respect to the observer is $\vec{V}_2 - \vec{V}_1$

188

Statement 1: For an observer looking out through the window of a fast moving train, the nearby objects appear to move in the opposite direction to the train, while the distant objects appear to be stationary

Statement 2: If the observer and the object are moving at velocities $\vec{V}_1$ and $\vec{V}_2$ respectively with reference to a laboratory frame, the velocity of the object with respect to the observer is $\vec{V}_2 - \vec{V}_1$

189

Statement 1: The magnitude of average velocity is equal to average speed if velocity is constant

Statement 2: If velocity is constant, then there is no change in the direction of motion

190

Statement 1: Displacement of a body is vector sum of the area under velocity-time graph

Statement 2: Displacement is a vector quantity

191

Statement 1: A body having non-zero acceleration can have a constant velocity

Statement 2: Acceleration is the rate of change of velocity

192

Statement 1: A body may be accelerated even when it is moving uniformly

Statement 2: When direction of motion of the body is changing then body may have acceleration

193

Statement 1: The average and instantaneous velocities have same value in a uniform motion

Statement 2: In uniform motion, the velocity of an object increases uniformly

194

Statement 1: The slope of displacement-time graph of a body moving with high velocity is steeper than the slope of displacement-time graph of a body with low velocity

Statement 2: Slope of displacement-time graph = Velocity of the body

195

Statement 1: The velocity of a particle may vary even when its speed is constant

Statement 2: Such a body may move along a circular path

196

Statement 1: Rocket in flight is not an illustration of projectile

Statement 2: Rocket takes flight due to combustion of fuel and does not move under the gravity effect alone

197

Statement 1: The speedometer of an automobile measure the average speed of the automobile

Statement 2: Average velocity is equal to total displacement per total time taken

198

Statement 1: Distance-time graph of the motion of a body having uniformly accelerated motion is a straight line inclined to the time axis

Statement 2: Distance travelled by a body having uniformly accelerated motion is directly proportional to the square of the time taken

199

Statement 1: Distance-time graph of the motion of a body having uniformly accelerated motion is a straight line inclined to the time axis

Statement 2: Distance travelled by a body having uniformly accelerated motion is directly proportional to the square of the time taken

200

Statement 1: The position-time graph of a uniform motion in one dimension of a body can have negative slope.

Statement 2: When the speed of body decreases with time, the position-time graph of the moving body has negative slope.

201

Statement 1: Distance and displacement are different physical quantities

Statement 2: Distance and displacement have same dimension

202

Statement 1: The average velocity of the body may be equal to its instantaneous velocity

Statement 2: For a given time interval of a given motion, average velocity is single valued while average speed can have many values

203

Statement 1: Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis

Statement 2: In uniform motion of an object velocity increases as the square of time elapsed

204

Statement 1: Rocket in flight is not an illustration of projectile

Statement 2: Rocket takes flight due to combustion of fuel and does not move under the gravity effect alone

205

Statement 1: A car moving with a speed of 25ms^{-1} takes U turn in 5 s, without changing its speed. The average acceleration during these 5 s is 5ms^{-2}.

Statement 2: Acceleration$=\frac{\text{change in velocity}}{\text{time taken}}$.

206

Statement 1: The speedometer of an automobile measure the average speed of the automobile

Statement 2: Average velocity is equal to total displacement per total time taken

207

Statement 1: A body moving with a uniform velocity is in equilibrium.

Statement 2: A boy can move with a uniform velocity if a constant force is acting on it.

208

Statement 1: An object can posses acceleration even at a time when it has uniform speed

Statement 2: It is possible when the direction of motion keeps changing

209

Statement 1: The relative velocity between any two bodies moving in opposite direction is equal to sum of the velocities of two bodies

Statement 2: Sometimes relative velocity between two bodies is equal to difference in velocities of the two

210

Statement 1: The displacement of a body may be zero, though its distance can be finite

Statement 2: If the body moves such that finally it arrives at the initial point, then displacement is zero while distance is finite

211

Statement 1: The relative velocity between any two bodies may be equal to sum of the velocities of two bodies.

Statement 2: Some times, relative velocity between two bodies may be equal to difference in velocities of the two.

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

212. For a body projected vertically up with a velocity $\vec{v}_0$ from the ground, match the following

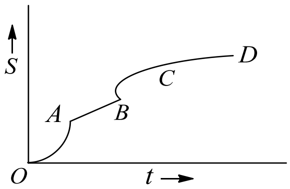
Column-I **Column- II**

(A)	$\vec{v}_{av}$ (Average velocity)	(p)	Zero for round trip
(B)	u_{av} (average speed)	(q)	$\frac{\vec{v}_1+\vec{v}_2}{2}$ over any time interval
(C)	T_{ascent}	(r)	$\frac{v_0}{2}$ over the total time of its flight
(D)	$T_{descent}$	(s)	$\frac{v_0}{g}$

CODES :

	A	B	C	D
a)	A,b	c	d	d
b)	c	d	a	b
c)	b	c	d	a
d)	a,d	b	a	c

213. The displacement versus time curve is given Fig. Sections OA and BC are parabolic. CD is parallel to the time axis



	Column-I		Column- II
(A)	OA	(p)	Velocity increases with time linearly
(B)	AB	(q)	Velocity decreases with time
(C)	BC	(r)	Velocity is independent of time
(D)	CD	(s)	Velocity is zero

CODES :

	A	B	C	D
a)	a	c	b	d
b)	c	a	d	b
c)	d	c	b	a
d)	b	d	a	c

214. A particle moves along a straight line such that its displacement S varies with time t as $S = \alpha + \beta t + \gamma t^2$

	Column-I		Column- II
(A)	Acceleration at $t = 2$ s	(p)	$\beta + 5\gamma$
(B)	Average velocity during 3rd sec	(q)	2γ
(C)	Velocity at $t = 1$ s	(r)	a

(D) Initial displacement	(s)	$\beta = 2\gamma$

CODES :

	A	B	C	D
a)	a	d	c	b
b)	b	a	d	c
c)	d	c	b	a
d)	c	a	b	d

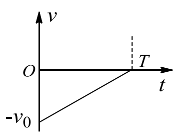
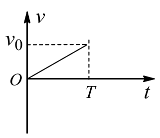
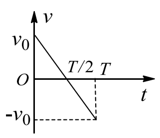
215. A ball is thrown vertically upwards from the top of a cliff. Take starting position of motion as origin and upward direction as positive. Column I specifies the position, velocity, and/or acceleration of the particle at any instant. Column II gives their sign, $(+)$ or $(-)$, at that moment. Match the columns:

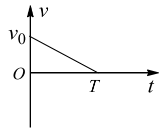
	Column-I		Column- II
(A)	When the ball is above the point of projection, its displacement is	(p)	Always positive
(B)	When the ball is above the point of projection, its velocity is	(q)	Always negative
(C)	When the ball is above the point of projection, its acceleration is or may be negative	(r)	May be positive
(D)	When the ball is below the point of projection, its acceleration is	(s)	May be zero

CODES :

	A	B	C	D
a)	b	a	d	c
b)	a,d	b	c	a
c)	a	c,d	b	b
d)	c,d	b	a	c

216. Study the following $v - t$ graphs in Column I carefully and match approximately with the statement given in Column II. Assume that motion takes place from time 0 to T

	Column-I		Column- II
(A)		(p)	Net displacement is positive, but not zero
(B)		(q)	Net displacement is negative, but not zero
(C)		(r)	Particle returns to its initial position again

(D) 

(s) Acceleration is positive

CODES :

	A	B	C	D
a)	a	b,d	c	b
b)	a,d	b	a	c
c)	b	c	d	a,d
d)	b,d	a,d	c	a

Linked Comprehension Type

This section contain(s) 23 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 217 to -217

When two bodies A and B are moving with velocity $\vec{v}_A$ and $\vec{v}_B$then relative velocity of A w.r.t B is $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$.
Relative velocity of B w.r.t. A is
$\vec{v}_{AB} = \vec{v}_B - \vec{v}_A = \vec{v}_B + (-\vec{v}_A)$
When body C is moving with velocity $\vec{v}_C$ on a body A, which is moving with velocity $\vec{v}_A$, then velocity of C w.r.t. ground is $\vec{v}_C + \vec{v}_A$.
Suppose two parallel rail tracks run north-south. Train A moves north with a speed of 54 kmh^{-1} and train B moves south with a speed of 90 kmh^{-1}.

217. Relative velocity of ground w.r.t. B is
a) 25 ms^{-1}due north b) 25 ms^{-1}due south c) 40 ms^{-1}due north d) 40 ms^{-1}due south

Paragraph for Question Nos. 218 to - 218

There is a balloon containing a stone at a height 300 m from the ground.
(Take g $= 10\text{ms}^{-2}$)

218. A stone is dropped from the balloon, when balloon is stationary at height 300m. How long will the stone take to reach the ground?
a) 7.12 s b) 7.75 s c) 7.82 s d) 8.12 s

Paragraph for Question Nos. 219 to - 219

The displacement of a body is given by $4s = M + 2Nt^4$, where M and N are constants

219. The velocity of the body at any instant is
a) $\dfrac{M+2Nt^4}{4}$ b) $2N$ c) $\dfrac{M+2N}{4}$ d) $2Nt^3$

Paragraph for Question Nos. 220 to - 220

A body is dropped from the top of the tower and falls freely

220. The distance covered by it after n second is directly proportional to

a) n^2 b) n c) $2n - 1$ d) $2n^2 - 1$

Paragraph for Question Nos. 221 to - 221

A body at rest is acted upon by a constant force (it means acceleration of the body will be constant)

221. What is the nature of the displacement-time graph?

a) Straight line
b) Parabola
c) Asymmetric parabola
d) Rectangular hyperbola

Paragraph for Question Nos. 222 to - 222

A car accelerates from rest at a constant rate α for some time and then decelerates at a constant rate β to come to rest. The total time elapsed is t

222. The maximum velocity attained by the car is

a) $\frac{\alpha\beta}{2(\alpha+\beta)}t$ b) $\frac{\alpha\beta}{\alpha+\beta}t$ c) $\frac{2\alpha\beta}{\alpha+\beta}t$ d) $\frac{4\alpha\beta}{\alpha+\beta}t$

Paragraph for Question Nos. 223 to - 223

A body is moving with uniform velocity of 8 ms^{-1}. When the body just crossed another body, the second one starts and moves with uniform acceleration of 4 ms^{-2}

223. The time after which two bodies meet will be

a) 2 s b) 4 s c) 6 s d) 8 s

Paragraph for Question Nos. 224 to - 224

A body is allowed to fall from a height of 100 m. If the time taken for the first 50 m is t_1 and for the remaining 50 m is t_2

224. Which is correct?

a) $t_1 = t_2$
b) $t_1 > t_2$
c) $t_1 < t_2$
d) Depends upon the mass

Paragraph for Question Nos. 225 to - 225

A body is dropped from a balloon moving up with a velocity of 4 ms^{-1} when the balloon is at a height of 120.5

m from the ground

225. The height of the body after 5 s from the ground is ($g = 9.8\ m/s^{-2}$)
a) 8 m b) 12 m c) 18 m d) 24 m

Paragraph for Question Nos. 226 to - 226

A bus starts moving with acceleration 2 ms^{-2}. A cyclist 96 m behind the bus starts simultaneously towards the bus at a constant speed of 20 ms^{-1}

226. After what time will he be able to overtake the bus?
a) 4 s b) 8 s c) 12 s d) 16 s

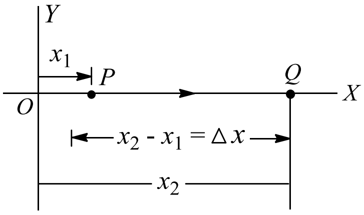
Paragraph for Question Nos. 227 to - 227

A car is moving towards south with a speed of 20 ms^{-1}. A motorcyclist is moving towards east with a speed of 15 ms^{-1}. At a certain instant, the motorcyclist is due south of the car and is at a distance of 50 m from the car

227. The shortest distance between the motorcyclist and the car is
a) 20 m b) 10 m c) 40 m d) 30 m

Paragraph for Question Nos. 228 to - 228

Consider a particle moving along the x-axis as shown in Fig. Its distance from the origin O is described by the coordinate x which varies with time. At a time t_1, the particle is at point P, where its coordinate is x_1, and at time t_2 it is at point Q, where its coordinate x_2. The displacement during the time interval from t_1 and t_2 is the vector from P to Q the x −component of this vector is $(x_2 - x_1)$ and all other component are zero
It is convenient to represent the quantity $x_2 - x_1$, the change in x, by means of a notation using the Greek letter Δ (capital delta) to designate a change in any quantity. Thus we write $\Delta x = x_2 - x_1$ in which Δx is not a product but is to be interpreted as a single symbol representing the change in the quantity x. Similarly, we denote the time interval from t_1 to t_2 as $t = t_2 - t_1$



The average velocity of the particle is defined as the ratio of the displacement Δx to the time interval Δt. We represent average velocity by the letter v with a bar ($\bar{v}$) to signify average value. Thus

$$\bar{v} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$

228. A particle moves half the time of its journey with velocity u. The rest of the half time it moves with two velocities v_1 and v_2 such that half the distance it covers with v_1 and the other half with v_2. Find the net average velocity assume straight line motion
a) $\frac{u(v_1 + v_2) + 2v_1v_2}{2(v_1 + v_2)}$ b) $\frac{2u(v_1 + v_2)}{2u + v_1 + v_2}$ c) $\frac{u(v_1 + v_2)}{2v_1}$ d) $\frac{2v_1v_2}{u + v_1 + v_2}$

Paragraph for Question Nos. 229 to - 229

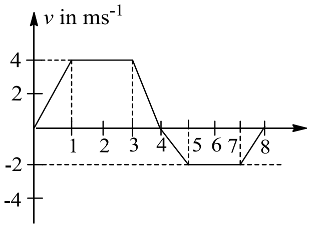
Two particles A and B are initially 40 m apart, A is behind B. Particle A is moving with uniform velocity of 10 ms^{-1} towards B. Particle B starts moving away from A with constant acceleration of 2 ms^{-2}

229. The time at which there is a minimum distance between the two is

a) 2 s   b) 4 s   c) 5 s   d) 6 s

Paragraph for Question Nos. 230 to - 230

The velocity-time graph of a particle in straight line motion is shown in Fig. The particle starts its motion from origin

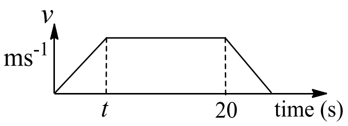


230. The distance travelled by the particle in 8 s is

a) 18 m   b) 16 m   c) 8 m   d) 6 m

Paragraph for Question Nos. 231 to - 231

The velocity-time graph of a particle moving along a straight line is shown in Fig. The rate of acceleration and deceleration is constant and it is equal to 5 ms^{-2}. If the average velocity during the motion is 20 ms^{-2}, then

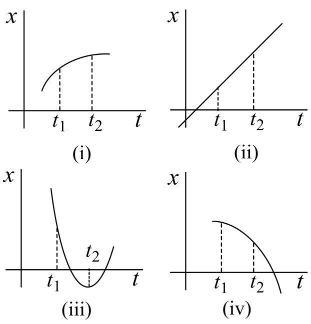


231. The value of t is

a) 5 s   b) 10 s   c) 20 s   d) $5\sqrt{2}$ s

Paragraph for Question Nos. 232 to - 232

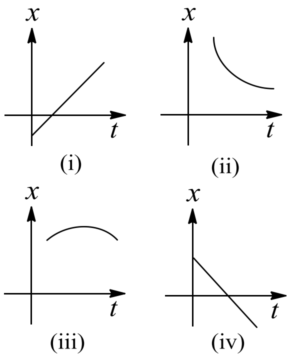
Study the four graphs given below. Answer the following questions on the basis of these graphs



232. In which of the graphs, the particle has more magnitude of velocity at t_1 than at t_2
a) (i), (iii) and (iv) b) (i) and (iii) c) (ii) and (iii) d) None of the above

Paragraph for Question Nos. 233 to - 233

Study the following graphs



233. The particle is moving with constant speed
a) In graphs (i) and (iii) b) In graphs (i) and (iv) c) In graphs (i) and (ii) d) In graphs (i)

Integer Answer Type

234. A body is thrown up with a velocity 100 ms^{-1}. It travels 5 m in the last second of its journey. If the same body is thrown up with a velocity 200 ms^{-1}, how much distance (in metre will it travel in the last second ($\mathrm{g} = 10\ \mathrm{ms}^{-2}$)?
235. A balloon rises from rest on the ground with constant acceleration 1 ms^{-2}. A stone is dropped when the balloon has risen to a height of 39.2 m. Find the time taken by the stone to reach the ground
236. A train starts from station A with uniform acceleration a_1 for some distance and then goes with uniform retardation a_2 for some more distance to come to rest at station B. The distance between stations A and B is 4 km and the train takes 1/15 h to complete this journey. If acceleration are in km per minute unit, then show that $\frac{1}{a_1} + \frac{1}{a_2} = x$. Find the value of x
237. In quick succession, a large number of balls are thrown up vertically in such a way that the next ball is thrown up when the previous ball is at the maximum height. If the maximum height is 5 m, then find the number of the thrown up per second ($\mathrm{g} = 10\ \mathrm{ms}^{-2}$)
238. From a lift moving upward with a uniform acceleration $a = 2\ \mathrm{ms}^{-2}$, a man throws a ball vertically upward with a velocity $v = 12\ \mathrm{ms}^{-1}$ relative to the lift. The ball comes back to the man after a time t. Find the value of t in second
239. In a car race, car A takes 4 s less than car B at the finish and passes the finishing point with a velocity v more than the car B. Assuming that the cars start form rest and travel with constant acceleration $a_1 = 4\mathrm{ms}^{-2}$ and $a_2 = 1\ \mathrm{ms}^{-2}$ respectively, find the velocity of v in ms^{-1}
240. On a two-lane road, car A is travelling with a speed of 36 kmh^{-1}. Two cars B and C approach car A in opposite directions with a speed of 54 kmh^{-1} each. At a certain instant, when the distance AB is equal to AC, both being 1 km, B decides to overtakes A before C does. What minimum acceleration of car B is required to avoid an accident?
241. A police jeep is chasing a culprit going on a motorbike. The motorbike crosses a turning at a speed of 72 kmh^{-1}. The jeep follows it at a speed of 90 kmh^{-1}, crossing the turning 10 s later than the bike Assuming that they travel at constant speeds, how far from the turning will the jeep catch up with the

bike? (In km)

242. A cat, on seeing a rat at a distance $d = 5$ m, starts with velocity $u = 5\ \text{ms}^{-1}$ and moves with acceleration $\alpha = 2.5\ \text{ms}^{-2}$ in order to catch it, while the rate with acceleration β starts from rest. For what value of β will the cat overtake the rat? (in ms^{-2})

: ANSWER KEY :

1)	a	2)	d	3)	c	4)	a
5)	d	6)	b	7)	c	8)	b
9)	b	10)	a	11)	a	12)	a
13)	b	14)	d	15)	a	16)	a
17)	d	18)	d	19)	a	20)	c
21)	c	22)	c	23)	d	24)	c
25)	d	26)	b	27)	c	28)	a
29)	d	30)	b	31)	c	32)	a
33)	c	34)	d	35)	c	36)	d
37)	b	38)	c	39)	c	40)	d
41)	a	42)	d	43)	b	44)	c
45)	b	46)	a	47)	a	48)	a
49)	d	50)	b	51)	c	52)	b
53)	d	54)	b	55)	c	56)	a
57)	c	58)	a	59)	c	60)	a
61)	b	62)	d	63)	a	64)	c
65)	d	66)	a	67)	c	68)	a
69)	d	70)	a	71)	b	72)	b
73)	d	74)	a	75)	c	76)	c
77)	a	78)	b	79)	a	80)	a
81)	a	82)	d	83)	c	84)	b
85)	a	86)	c	87)	c	88)	b
89)	a	90)	b	91)	a	92)	a
93)	c	94)	c	95)	a	96)	b
97)	b	98)	b	99)	b	100)	d
101)	c	102)	c	103)	b	104)	a
105)	b	106)	a	107)	a	108)	b
109)	c	110)	c	111)	d	1)	
	a,d	2)	a,c	3)	a,b,c,d	4)	
	a,b,d						
5)	a,d	6)	a,d	7)	a,c	8)	
	b,d						
9)	b,c	10)	b,d	11)	b,d	12)	
	a,b,c						
13)	a,b,c	14)	b,d	15)	a,c,d	16)	
	a,b,d						
17)	a,b,c	18)	a,b,c	19)	a,c,d	20)	

	a,b,c						
21)	b,c	22)	c,d	23)	a,c	24)	
	b,c,d						
25)	b,d	26)	b,c	27)	a,b,c,d	28)	
	a,c						
29)	c,d	30)	a,d	31)	a,b,d	32)	
	a,d						
33)	c,d	34)	a,c	35)	a,b,d	36)	
	a,b,c,d						
37)	b,c,d	38)	a,b,c,d	39)	a,c,d	1)	a
	2)	a	3)	c	4)	c	
5)	a	6)	b	7)	a	8)	c
9)	c	10)	e	11)	c	12)	e
13)	a	14)	e	15)	e	16)	d
17)	a	18)	e	19)	a	20)	c
21)	a	22)	a	23)	e	24)	a
25)	a	26)	a	27)	b	28)	a
29)	e	30)	b	31)	b	32)	e
33)	b	34)	d	35)	b	36)	a
37)	b	38)	b	39)	a	40)	a
41)	e	42)	e	43)	c	44)	a
45)	b	46)	a	47)	e	48)	e
49)	e	50)	c	51)	b	52)	c
53)	c	54)	a	55)	d	56)	e
57)	c	58)	a	59)	b	60)	a
61)	b	1)	a	2)	a	3)	b
	4)	c					
5)	d	1)	a	2)	b	3)	d
	4)	a					
5)	b	6)	b	7)	b	8)	b
9)	c	10)	b	11)	d	12)	a
13)	c	14)	a	15)	a	16)	b
17)	b	1)	5	2)	4	3)	2
	4)	1					
5)	2	6)	8	7)	1	8)	1
9)	5						

: HINTS AND SOLUTIONS :

1 **(a)**

Relative velocity of overtaking $= 40 - 30 = 10\ \text{ms}^{-1}$. Total relative distance covered with this relative velocity during overtaking $= 100 + 200 = 300$ m

So time taken $= 300/10 = 30$ s

2 **(d)**

By the time 5th water drop starts falling, the first water drop reaches the ground

$u = 0, h = \frac{1}{2}gt^2 \Rightarrow 5 = \frac{1}{2} \times 10 \times t^2 \Rightarrow t = 1$ s

Hence, the interval of falling of each water drop is $\frac{1\text{ s}}{4} = 0.25$ s

When the 5th drop starts its journey towards ground, the third drop travels in air for $0.25 + 0.25 = 0.5$

Therefore, height (distance) covered by 3rd drop in air is

$h_1 = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times (0.5)^2 = 5 \times 0.25 = 1.25$ m

The third water drop will be at a height of $5 - 1.25 = 3.75$ m

3 **(c)**

$x = at^2 - bt^3$

Velocity $= \frac{dx}{dt} = 2at - 3bt^2$

and acceleration $= \frac{d^2x}{dt^2} = 2a - 6bt$

Acceleration will be zero if

$2a - 6bt = 0 \Rightarrow t = \frac{2a}{6b} = \frac{a}{3b}$

4 **(a)**

$u = 0, v = 27.5\ \text{ms}^{-1}, t = 10$ s

$a = \frac{v-u}{t} = \frac{27.5}{10} = 2.75\ \text{ms}^{-2}$

In first 10 s, distance travelled:

$s_1 = 0 \times 10 + \frac{1}{2} \times 2.75 \times 10^2 = 137.5$m

In first 20 s, distance travelled

$s_2 = 0 \times 20 + \frac{1}{2} \times 2.75 \times 20^2 = 550$m

Required distance $= 550 - 137.5 = 412.5$ m

5 **(d)**

Before the second ball is dropped, the first ball would have travelled some distance say $S_0 = \frac{1}{2}gt_0^2$. After dropping the second ball, the relative acceleration of both balls becomes zero. So distance between them increases linearly. After some time, the first ball will collide with the ground and the distance between them will start decreasing and the magnitude of relative velocity will be increasing for this time. Option (d) represents all these clearly

6 **(b)**

When a body slides on an inclined plane, component of weight along the plane produces an acceleration

$a = \frac{mg\sin\theta}{m} = g\sin\theta =$ constant

If s is the length of the inclined plane, then

$s = 0 + \frac{1}{2}at^2 = \frac{1}{2}g\sin\theta \times t^2$

$\frac{s'}{s} = \frac{t'^2}{t^2}$ or $\frac{s}{s'} = \frac{t^2}{t'^2}$

Given $t = 4$ s and $s' = \frac{s}{4}$

$t' = t\sqrt{\frac{s'}{s}} = 4\sqrt{\frac{s}{4s}} = \frac{4}{2} = 2$ s

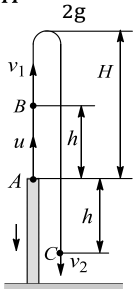
7 **(c)**

$H = \frac{u^2}{2g}$; given $v_2 = 2v_1$ ...(i)

A to B: $v_1^2 = u^2 - 2gh$ ...(ii)

A to C: $v_2^2 = u^2 - 2g(-h)$ ...(iii)

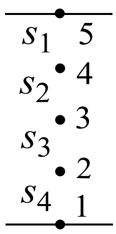
Solving (i), (ii) and (iii), we get the value of u^2 as $10gh/3$ and then we get the value of H by using $H = \frac{u^2}{2g}$



8 **(b)**

$S_1 + S_2 + S_3 + S_4 = 16$ m, $S_1 : S_2 : S_3 : S_4 = 1 : 3 : 5 : 7$

Solve to get $S_1 = 1$ m, $S_2 = 3$ m, $S_3 = 5$ m, $S_4 = 7$ m



9 **(b)**

In options (a), (c) and (d), we can find from the graphs that more than one velocity can be possible at a single time, which is not possible practically

10 **(a)**

Since the last five steps covering 5 m land the drunkard fell into the pit, the displacement prior to this as $(11-5)\ m = 6$ m

Time taken for first eight steps (displacement in first eight steps $= 5-3 = 2$ m) =8 s. Then time taken to cover first 6 m of journey $= \frac{6}{2} \times 8 = 24$ s

Time taken to cover last 5 m = 5 s

Total time $= 24 + 5 = 29$ s

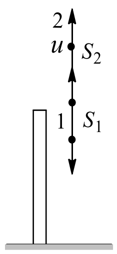
11 **(a)**

At time t, let displacement of first stone be $S_1 = \frac{1}{2}gt^2$ and that of second stone be

$S_2 = ut - \frac{1}{2}gt^2$

Distance between two stones at time t:

$S = S_1 + S_2 = ut \Rightarrow S = ut$



So the graph should be a straight line passing through origin as shown in option (a)

12 **(a)**

$t = \sqrt{x} + 3$

Differentiating will respect to t, we get

$1 = \frac{1}{2\sqrt{x}}\frac{dx}{dt} + 0$ or $\frac{dx}{dt} = 2\sqrt{x}$

When velocity is zero, $2\sqrt{x} = 0$ or $x = 0$

13 **(b)**

$a_x = \frac{d^2x}{dt^2} = 8$ and $a_y = \frac{d^2y}{dt^2} = 0$

Hence, net acceleration is $\sqrt{a_x^2 + a_y^2} = 8\ \text{ms}^{-2}$

14 **(d)**

$2ax = (50)^2 - (10)^2$ and $2(-a)(-x) = v^2 - (50)^2$

This given $v^2 - (50)^2 = (10)^2$ i.e., $v = 70\ \text{ms}^{-1}$

15 **(a)**

Uniform motion involves equal distances covered in equal time intervals or the velocity is constant

16 **(a)**

$$S = ut + \frac{1}{2}at^2$$

$$\Rightarrow -76 = u \times 6 - \frac{1}{2} \times 10 \times (6)^2 \Rightarrow u = \frac{52}{3}\ \text{ms}^{-1}$$

17 **(d)**

$$s = kt^{1/2} \Rightarrow a = \frac{d^2s}{dt^2} = -\frac{1}{4}kt^{-3/2}$$

As t increases, retardation decreases

18 **(d)**

Displacement in 12 s = area under $v - t$ graph

$$= \frac{1}{2} \times (12 + 5)4 = 34\ \text{m}$$

$$V_{av} = \frac{\text{Displacement}}{\text{Time}} = \frac{34}{12} = \frac{17}{6}\ \text{ms}^{-1}$$

Hence (a) is incorrect; (b) is incorrect because during first 3 seconds, velocity increases from 0 to 4 ms^{-1} option; (c) is incorrect, because in part AB velocity is constant

19 **(a)**

For 0 to 5 s, acceleration is positive, for 5 to 15 s acceleration is negative, for 15 to 20 s acceleration is positive

20 **(c)**

Here $h = \frac{1}{2} \times 10 \times (5)^2 = 125$ m

In 3 s it falls through: $h_1 = \frac{1}{2} \times 10 \times (3)^2 = 45$ m

Rest 80 m is covered in 4 s. Hence, total time taken is 3 s + 4 s = 7 s

21 **(c)**

Maximum height attained $\propto u^2$

22 **(c)**

$h = \frac{1}{2}gt^2$ and $h - 20 = \frac{1}{2}g\,(t-1)^2$

solving them, we get $t = 2.5$ s and h = 31.25 m

23 **(d)**

Velocity given by $OA = \tan 60° = \sqrt{3}\ \text{ms}^{-1}$

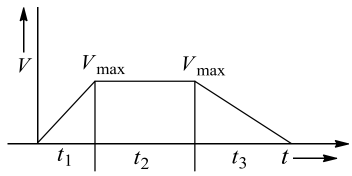
Velocity give by $AB = -\tan 30° = -\frac{1}{\sqrt{3}}\ \text{ms}^{-1}$

Required ratio $= \frac{\sqrt{3}}{1/\sqrt{3}} = 3:1$

24 **(c)**

Graphically, the area of $v - t$ curve represents displacement:

$S = \frac{1}{2}v_{\max}t_1$ or $t_1 = \frac{2S}{v_{\max}}$



$2S = v_{\max}t_2$ or $t_2 = \frac{2S}{v_{\max}}$

$5S = \frac{1}{2}v_{\max}t_3$ or $t_3 = \frac{10S}{v_{\max}}$

$$v_{av} = \frac{\text{Total displacement}}{\text{Total time}} = \frac{S + 2S + 5S}{\frac{2S}{v_{\max}} + \frac{2S}{v_{\max}} + \frac{10S}{v_{\max}}}$$

$$\frac{v_{av}}{v_{\max}} = \frac{8\,S}{14\,S} = \frac{4}{7}$$

Alternative:

$$\frac{v_{av}}{v_{\max}} = \frac{\text{Total displacement}}{2\begin{pmatrix}\text{Total displacement}\\ \text{during acceleration}\\ \text{and retardation}\end{pmatrix} + \begin{pmatrix}\text{Displacement}\\ \text{during uniform}\\ \text{velocity}\end{pmatrix}}$$

$$= \frac{8S}{2(S+5S)+2S} = \frac{8}{14} = \frac{4}{7}$$

25 **(d)**

Distance covered by the object in first 2 s

$$h_1 = \frac{1}{2}\,gt^2 = \frac{1}{2} \times 10 \times 2^2 = 20 \text{ m}$$

Similarly, distance covered by the object in next 2 s will also be 20 m, hence the required height $= H - 20 - 20 = H - 40$ m

26 **(b)**

The required ratio is 1 : 3 : 5:… so on

27 **(c)**

$x^2 = 1 + t^2$ or $x = (1+t^2)^{1/2}$

$$\frac{dx}{dt} = \frac{1}{2}\,(1+t^2)^{-1/2}2t = t(1+t^2)^{-1/2}$$

$$a = \frac{d^2x}{dt^2} = (1+t^2)^{-1/2} + t\left(-\frac{1}{2}\right)(1+t^2)^{-3/2}2t$$

$$= \frac{1}{x} - \frac{t^2}{x^3}$$

28 **(a)**

At $t = 0$ slope of the $x - t$ graph is zero; hence, velocity is zero at $t = 0$. As time increases, slope increases in negative direction; hence, velocity increases, slope increases in negative direction. At point '1' , slope changes suddenly from negative to positive value; hence, velocity changes suddenly from negative to positive and then velocity starts decreasing and becomes zero at '2'. Option (a) represents all these clearly

29 **(d)**

$v^2 - u^2 = 2as, v = 0$

$s \propto u^2$

When the initial velocity is made n times, the distance over which it can be stopped becomes n^2 times

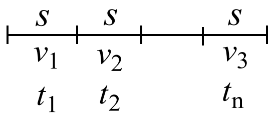
30 **(b)**

When a body possesses constant velocity, both its magnitude (i.e., speed) and direction must remain constant. On the other hand, if the speed of a body is constant. For example, in uniform circular motion, though the speed of a body remains constant, velocity changes from point to point due to a change in direction. A body moving with a constant speed along a circular path constantly experiences a centripetal acceleration

31 **(c)**

$$t_1 = \frac{s}{v_1}, t_2 = \frac{s}{v_2}, \dots, t_n = \frac{s}{v_n}$$

Average speed =(Total distance)/(Total time)



$$\Rightarrow \bar{V} = \frac{ns}{t_1 + t_2 + \ldots + t_n}$$

$$= \frac{ns}{\frac{s}{v_1} + \frac{s}{v_2} + \ldots + \frac{s}{v_n}} = \frac{n}{\frac{1}{v_1} + \frac{1}{v_2} + \ldots + \frac{1}{v_n}}$$

Taking reciprocal, we get $\frac{1}{\bar{V}} = \frac{1}{n}\left(\frac{1}{v_1} + \frac{1}{v_2} + \ldots + \frac{1}{v_n}\right)$

32 **(a)**

If the location of a particle changes, then both distance and displacement must have some value

33 **(c)**

We have $h = \frac{1}{2}gT^2$

In $T/3$ second, distance fallen $= \frac{1}{2}g\left(\frac{T}{3}\right)^2 = \frac{h}{9}$

So position of the ball from the ground is

$$h - \frac{h}{9} = \frac{8h}{9}\text{m}$$

34 **(d)**

From 0 to t_1, velocity is positive and constant as indicated by positive and constant slope

From t_1 to t_3, slope is zero, hence velocity is zero

From t_3 to t_4, velocity is negative and constant as indicated by negative and constant as indicated by negative and constant slope

Option (d) satisfies all these observations

35 **(c)**

To have distance equal to magnitude of displacement, the particle has to move in the same direction. The velocity may or may not be constant

36 **(d)**

Relative velocity of policeman w.r.t. the thief is $10 - 9 = 1 \text{ ms}^{-1}$. Since the relative separation between them is 100 m, the time taken will be = relative separation relative velocity =100/1 = 100 s

37 **(b)**

At any instant, the magnitudes of velocity and speed will be equal

38 **(c)**

Suppose the body be projected vertically upwards from A with a speed u_0

Using equation $s = ut + \left(\frac{1}{2}\right)at^2$, we get

For first case: $-h = u_0t_1 - \left(\frac{1}{2}\right)gt_1^2$ (i)

For second case: $-h = -u_0 t_2 - \left(\frac{1}{2}\right) gt_2^2$ (ii)

(i)—(ii) $\Rightarrow 0 = u_0(t_2 + t_1) + \left(\frac{1}{2}\right) g(t_2^2 - t_1^2)$

$\Rightarrow u_0 = \left(\frac{1}{2}\right) g(t_1 - t_2)$ (iii)

Putting the value of u_0 in (ii), we get

$-h = -\left(\frac{1}{2}\right) g(t_1 - t_2)t_2 - \left(\frac{1}{2}\right) gt_2^2$

$\Rightarrow h = \frac{1}{2} gt_1 t_2$ (iv)

For third case: $u = 0, t = ?$

$-h = 0 \times t - \left(\frac{1}{2}\right) gt^2$ or $h = \left(\frac{1}{2}\right) gt^2$ (v)

Combining Eq. (iv) and Eq. (v), we get

$\frac{1}{2} gt^2 = \frac{1}{2} gt_1 t_2$ or $t = \sqrt{t_1 t_2}$

39 **(c)**

Maximum height will be attained at 110 s. Because after 110 s, velocity becomes negative and rocket will start coming down. Area from 0 to 110 s is

$\frac{1}{2} \times 110 \times 1000 = 55{,}000 \text{ m} = 55 \text{ km}$

40 **(d)**

Here relative velocity of the train w.r.t. other train is $V - v$. Hence, $0 - (V - v)^2 = 2ax$

or $a = -\frac{(V-v)^2}{2x}$ Minimum retardation $= \frac{(V-v)^2}{2x}$

41 **(a)**

The only force acting on both will be gravity which will produce same acceleration g in both. Further, both the balls are dropped simultaneously from same height, hence both will come together on the ground

42 **(d)**

Let the car accelerate at rate α for time t_1 then maximum velocity attained,

$v = 0 + at_1 = at_1$

Now, the car decelerates at a rate β for time $(t - t_1)$ and finally comes to rest. Then,

$0 = v - \beta(t - t_1) \Rightarrow 0 = \alpha t_1 - \beta t + \beta t_1$

$\Rightarrow t_1 = \frac{\beta}{\alpha + \beta} t$

$\therefore v = \frac{\alpha\beta}{\alpha + \beta} t$

43 **(b)**

Given $v_{av} = \frac{v+u}{2} = 0.34$ and $v - u = 0.18$

Solving these two equations, we get

$u = 0.25 \text{ ms}^{-1}, v = 0.43 \text{ ms}^{-1}$. Given $s = 3.06$ m

Now use $v^2 - u^2 = 2as$ to find $a = 0.02 \text{ ms}^{-2}$

44 **(c)**

Relative acceleration of both will be zero w.r.t. each other

So, $s_{\text{rel}} = u_{\text{rel}} t$ or $100 = 100t$ or $t = 1$ s

45 **(b)**

Area under acceleration-time graph gives the change in velocity. Hence,

$$v_{\max} = \frac{1}{2} \times 10 \times 11 = 55 \text{ ms}^{-1}$$

Therefore, the correct option is (b).

46 **(a)**

The $v - x$ equation from the given graph can be written as,

$$v = \left(-\frac{v_0}{x_0}\right) x + v_0 \qquad \ldots \text{(i)}$$

$$\therefore \qquad a = \frac{dv}{dt} = \left(-\frac{v_0}{x_0}\right) \frac{dx}{dt} = \left(-\frac{v_0}{x_0}\right) v$$

Substituting v from Eq. (i), we get

$$a = \left(-\frac{v_0}{x_0}\right) \left[\left(-\frac{v_0}{x_0}\right) x + v_0\right]$$

$$a = \left(\frac{v_0}{x_0}\right)^2 x - \frac{v_0^2}{x_0}$$

Thus, $a - x$ graph is a straight line with positive slope and negative intercept.

47 **(a)**

If t_1 and $2t_2$ are the time taken by particle to cover first and second half distance respectively

$t_1 = \frac{x/2}{3} = \frac{x}{6}$ ...(i)

$x_1 = 4.5\, t_2$ and $x_2 = 7.5\, t_2$

So, $x_1 + x_2 = \frac{x}{2} \Rightarrow 4.5\, t_2 + 7.5\, t_2 = \frac{x}{2}$

$t_2 = \frac{x}{24}$ ...(ii)

Total time $t = t_1 + 2t_2 = \frac{x}{6} + \frac{x}{12} = \frac{x}{4}$

So, average speed $= 4\, m/sec$

48 **(a)**

Magnitude of displacement can't exceed distance

49 **(d)**

Relative speed of trains $= 37.5 + 37.5 = 75 \text{ kmh}^{-1}$

Time taken by the trains to meet $= 90/75 = 6/5$ h

Since speed of bird $= 60 \text{ kmh}^{-1}$, distance travelled by the bird $= 60 \times 6/5 = 72$ km

50 **(b)**

Given $v = 3x^2 - 2x$; differentiating v, we get

$\frac{dv}{dt} = (6x - 2)\frac{dx}{dt} = (6x - 2)v$

$\Rightarrow a = (6x-2)(3x^2-2x)$ Now put $x = 2$ m

$\Rightarrow a = (6\times 2 - 2)(3(2)^2 - 2\times 2) = 80$ ms^{-2}

51 **(c)**

$v^2 - u^2 = 2as$

Suppose velocity when middle part passes $= v_m$

Then $v_m^2 - u^2 = 2as \times \frac{1}{2} = as$

or $v_m^2 = u^2 + as = u^2 + \frac{v^2-u^2}{2} = \frac{u^2+v^2}{2}$

$$\Rightarrow v_m = \sqrt{\frac{u^2+v^2}{2}}$$

52 **(b)**

Given $7x = \frac{g}{2}(2n-1)$ and $x = \frac{1}{2}g(1)^2$

Solving these two equations, we get $n = 4$ s

53 **(d)**

Here $\frac{dv}{dt} = -kv^3$

or $\frac{dv}{v^3} = -kdt$ or $\int_{v_0}^{v}\frac{dv}{v^3} = \int_0^t -k\,dt$

or $\left[-\frac{1}{2v^2}\right]_{v_0}^{v} = -kt$ or $-\frac{1}{2v^2} + \frac{1}{2v_0^2} = -kt$

or $v^2 = \frac{v_0^2}{1+2v_0^2kt}$ or $v = \frac{v_0}{\sqrt{2v_0^2kt+1}}$

54 **(b)**

Let the initial relative velocity, relative acceleration and relative displacement of the coin with respect to the floor of the lift be u_r, a_r, and s_r, then

$s_r = u_rt + (1/2)a_rt^2$

and $u_r = u_c - u_\ell = 10 - 10 = 0$

$a_r = a_c - a_\ell = (-9.8) - 0 = -9.8$ ms^{-2}

$s_r = s_c - s_\ell = -2.45$ m

$-2.45 = 0(t) + (1/2)(-9.8)t^2$

or $t^2 = 1/2$ or $t = 1/\sqrt{2}s$

55 **(c)**

Since maximum velocity is more than average velocity, ratio of the average velocity to maximum velocity has to be less than one

56 **(a)**

If t_1 and $2t_2$ are the time taken by particle to cover first and second half distance respectively

$t_1 = \frac{x/2}{3} = \frac{x}{6}$ ...(i)

$x_1 = 4.5\,t_2$ and $x_2 = 7.5\,t_2$

So, $x_1 + x_2 = \frac{x}{2} \Rightarrow 4.5\,t_2 + 7.5\,t_2 = \frac{x}{2}$

$t_2 = \frac{x}{24}$ ...(ii)

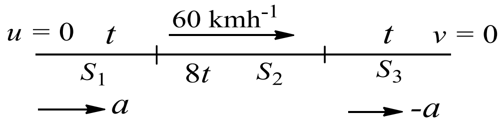
Total time $t = t_1 + 2t_2 = \frac{x}{6} + \frac{x}{12} = \frac{x}{4}$

So, average speed $= 4\, m/sec$

57 **(c)**

$$S_1 = \frac{1}{2}at^2 = \frac{1}{2}(at)t = \frac{60t}{2} = 30t$$

$S_2 = 60 \times 8\,t = 480\,t, S_3 = S_1 = 30t$



$$v_{\text{av}} = \frac{S_1 + S_2 + S_3}{t + 8t + t} = 54 \text{ km h}^{-1}$$

58 **(a)**

Suppose v be the velocity of the body after falling through half the distance. Then

$s = \frac{39.2}{2} = 19.6$ m, $u = 0$ and g $= 9.8$ ms^{-2}

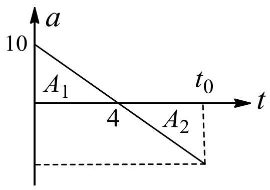
$v^2 = u^2 + 2gh = 0^2 + 2 \times 9.8 \times 19.6$ v

$= 19.6$ ms^{-1}

When the acceleration due to gravity ceases to act, the body travels with the uniform velocity of 19.6 ms^{-1}. So it hits ground with velocity 19.6 ms^{-1}

59 **(c)**

Particle will acquire the initial velocity when areas A_1 and A_2 are equal. For this, $t_0 = 8$ s



60 **(a)**

We know that for a body thrown up, its displacement is given as $S = ut - \frac{1}{2}gt^2$. So the $s - t$ graph is parabolic downwards.

Also the ball collides inelastically, so it will rebound to less height every time as shown in the graph

t_1, t_2, t_3 are the instants when the ball collides with ground. Here slope of the $s - t$ graph is suddenly changing from negative to positive. It means velocity before collision is negative (downwards) and after collision is positive (upwards)

61 **(b)**

Time taken by the same ball to return to the hands of the juggler is $\frac{2u}{g} = \frac{2\times 20}{10} = 4$ s. So he is throwing the balls after 1 s each. Let at some instant he throws ball number 4. Before 1 s of throwing it, he throws ball 3. So the height of ball 3 is

$$h_3 = 20 \times 1 - \frac{1}{2}10(1)^2 = 15 \text{ m}$$

Before 2 s, he throws ball 2. So the height of ball 2 is

$$h_2 = 20 \times 2 - \frac{1}{2}10(2)^2 = 20 \text{ m}$$

Before 3 s, he throws ball 1. So the height of ball 1 is

$$h_1 = 20 \times 3 - \frac{1}{2}10(3)^2 = 15 \text{ m}$$

62 **(d)**

We know that average velocity $= \frac{\text{Displacement}}{\text{time}}$ and average speed $= \frac{\text{Distance}}{\text{time}}$

Since displacement can be less than or equal to distance, average velocity can be less than or equal to average speed

63 **(a)**

Time of fall $= \sqrt{\frac{2h}{g}}$

Time taken by the sound to come out $= \frac{h}{c}$

Total time $= \sqrt{\frac{2h}{g}} + \frac{h}{c} = h\left[\sqrt{\frac{2}{gh}} + \frac{1}{c}\right]$

64 **(c)**

Near B velocity decreases with time. Hence, there is retardation or there is opposing force acting on the body

65 **(d)**

At $t = 0$, velocity is positive and maximum. As the particle goes up, velocity decreases and becomes zero at the highest point. When the particle starts coming down, velocity increases in the negative direction

66 **(a)**

Area from 0 to 10 s $= \frac{1}{2}[10 + 4]5 = 35$ m

Area from 10 to 12 s $= \frac{1}{2} \times 2 \times (-2.5) = -2.5$ m

Distance travelled $= 35 + 2.5 = 37.5$ m

67 **(c)**

Distance travelled by first train

$$s_1 = \frac{u^2}{2a} = \frac{(15)^2}{2 \times 1} = 112.5 \text{ m}$$

Distance travelled by second train

$$s_2 = \frac{(20)^2}{2 \times 1} = 200 \text{ m}$$

Total distance travelled $= 112.5 + 200 = 312.5$ m

Distance of separation $= 500 - 312.5 = 187.5$ m

68 **(a)**

The velocity v acquired by the parachutist after 10 s:

$v = u + gt = 0 + 10 \times 10 = 100 \text{ ms}^{-1}$

Then, $s_1 = ut + \frac{1}{2}gt^2 = 0 + \frac{1}{2} \times 10 \times 10^2 = 500$ m

The distance travelled by the parachutist under retardation is

$s_2 = 2495 - 500 = 1995$ m

Let v_g be the velocity on reaching the ground.

Then $v_g^2 - v^2 = 2as_2$

or $v_g^2 - (100)^2 = 2 \times (-2.5) \times 1995$ or

$v_g = 5 \text{ ms}^{-1}$

69 **(d)**

$$t = \frac{S_{rel}}{v_{rel}} \Rightarrow \frac{4}{60} = \frac{5}{30 + v_2} \quad \Rightarrow \quad v_2 = 45 \text{ kmh}^{-1}$$

70 **(a)**

Suppose h be the height of each storey, then

$25h = 0 + \frac{1}{2} \times 10 \times t^2 = \frac{1}{2} \times 10 \times 5^2$ or $h = 5$ m

In first second, let the stone passes through n storey. So

$n \times 5 = \frac{1}{2} \times 10 \times (1)^2$ or $n = 1$

71 **(b)**

Suppose u be the initial velocity,

Velocity after time t_1: $v_{11} = u + at_1$

Velocity after time $t_1 + t_2$: $v_{22} = u + a(t_1 + t_2)$

Velocity after time $t_1 + t_2 + t_3$:

$v_{33} = u + a(t_1 + t_2 + t_3)$

Now $v_1 = \frac{u+v_{11}}{2} = \frac{u+u+at_1}{2} = u + \frac{1}{2}at_1$

$$v_2 = \frac{v_{11} + v_{22}}{2} = u + at_1 + \frac{1}{2}at_2$$

$$v_3 = \frac{v_{22} + v_{33}}{2} = u + at_1 + at_2 + \frac{1}{2}at_3$$

So $v_1 - v_2 = -\frac{1}{2}a(t_1 + t_2)$

$$v_2 - v_3 = -\frac{1}{2}a(t_2 + t_3)$$

$(v_1 - v_2) : (v_2 - v_3) = (t_1 + t_2) : (t_2 + t_3)$

72 **(b)**

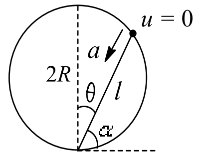
If the displacement is zero, the distance moved may or may not be zero. For example, if a particle returns to its initial position after moving through a distance, displacement will be zero but distance covered will not be zero

73 **(d)**

$a = g \sin \alpha = g \sin(90° - \theta)$

$= g \cos \theta$

$l = 2R \cos \theta$



Now using $s = ut + \frac{1}{2}at^2$, we get

$$l = 0t + \frac{1}{2}g \cos \theta t^2$$

$$\Rightarrow 2R \cos \theta = \frac{1}{2}g \cos \theta t^2 \Rightarrow t = 2\sqrt{\frac{R}{g}}$$

This is independent of θ

74 **(a)**

In option (a), there is some part of the graph which is perpendicular to t axis. It indicates infinite acceleration, which is not possible practically

75 **(c)**

Acceleration between 8 to 10 s (or at $t = 9$ s):

$$a = \frac{v_2 - v_1}{t_2 - t_1} = \frac{5 - 15}{10 - 8} = -5 \text{ ms}^{-2}$$

76 **(c)**

Time taken to cover first n metre is given by

$$n = \frac{1}{2} g t_n^2 \text{ or } t_n = \sqrt{\frac{2n}{g}}$$

Time taken to cover first $(n+1)$ m is give by

$$t_{n+1} = \sqrt{\frac{2(n+1)}{g}}$$

So time taken to cover $(n+1)^{\text{th}}$ m is given by

$$t_{n+1} - t_n = \sqrt{\frac{2(n+1)}{g}} - \sqrt{\frac{2n}{g}}$$

$$= \sqrt{\frac{2}{g}}\left[\sqrt{n+1} - \sqrt{n}\right]$$

This given the required ratio as $\sqrt{1}, (\sqrt{2} - \sqrt{1}), (\sqrt{3} - \sqrt{2})$,...etc (starting from $n = 0$)

77 **(a)**

Given that $u = 0$ (the electron starts from rest), at any time t: $v = kt = 2t$

$a = \frac{dv}{dt} = 2 \text{ ms}^{-2}$ (constant acceleration)

Now $s = ut + \frac{1}{2}at^2 = 0 \times 3 + \frac{1}{2} \times 2 \times (3)^2 = 9$ m

78 **(b)**

$$a = -\frac{4}{2}t + 4 \Rightarrow a = -2t + 4$$

$$v = \int a\,dt + C = \int (-2t + 4)dt + C$$

$$= -t^2 + 4t + C$$

Hence, graph will be parabolic

79 **(a)**

Time of ascent $= 1$ s $\Rightarrow \frac{u}{g} = 1 \Rightarrow u = 10 \text{ ms}^{-1}$

Maximum height attained $= \frac{u^2}{2g} = \frac{10^2}{2 \times 10} = 5$ m

80 **(a)**

Bomb B_1 will have less velocity upward on dropping, so it will reach ground first

81 **(a)**

From considerations of symmetry, the four persons meet at the centre of the square. The displacement from the corner to the centre of the square for each person is give by

$$S_r = \frac{\sqrt{d^2 + d^2}}{2} = \frac{d}{\sqrt{2}}$$

The speed of each person can be resolved into two components: the radial component and the perpendicular component. Throughout the journey, the radial component of velocity towards the centre is given by

$V_r = V\cos 45° = \frac{V}{\sqrt{2}}$, Time $= \frac{S_r}{V_r} = \frac{d/\sqrt{2}}{V/\sqrt{2}} = \frac{d}{V}$

82 **(d)**

The slope of the graph is negative at this point

83 **(c)**

During OA, acceleration $= \tan 30° = \frac{1}{\sqrt{3}} \text{ ms}^{-2}$

During AB, acceleration $= -\tan 60° = -\sqrt{3} \text{ ms}^{-2}$

Required ratio $= \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

84 **(b)**

$200 = u \times 2 - (1/2)a(2)^2$

or $u - a = 100$ ...(i)

$200 + 220 = u(2+4) - (1/2)(2+4)^2 a$

or $u - 3a = 70$ ...(ii)

Solving Eqs. (i) and (ii), we get $a = 15 \text{ cms}^{-2}$ and $u = 115 \text{ cms}^{-1}$

Further, $v = u - at = 115 - 15 \times 7 = 10 \text{ cms}^{-1}$

85 **(a)**

$t = \alpha x^2 + \beta x$

Differentiating: $1 = 2\alpha \frac{dx}{dt}.x + \beta \frac{dx}{dt}$

$$v = \frac{dx}{dt} = \frac{1}{\beta + 2\alpha x}; \frac{dv}{dt} = \frac{-2\alpha v}{(\beta + 2\alpha x)^2} = -2\alpha v^3$$

86 **(c)**

Maximum acceleration will be from 30 to 40 s, because slope in this interval is maximum

$$a = \frac{v_2 - v_1}{t_2 - t_1} = \frac{60 - 20}{40 - 30} = 4 \text{ ms}^{-2}$$

87 **(c)**

Displacement = area under graph

$$= 2 \times 2 + \frac{1}{2}(2+6) \times 1 + \frac{1}{2} \times 1 \times 6 - \frac{1}{2} \times 1 \times 6 - 1 \times 6 + 2 \times 4$$

$= 10$ m

88 **(b)**

$$x = 2 - 5t + 6t^2 \Rightarrow v = \frac{dx}{dt} = -5 + 12t$$

$v_{t=0} = -5 + 12 \times 0 = -5 \text{ ms}^{-1}$

89 **(a)**

$v^2 = 108 - 9x^2$

$$a = \frac{dv}{dt} = \frac{dv}{dx} \cdot \frac{dx}{dt} = \frac{d\left(\sqrt{108 - 9x^2}\right)}{dx} \cdot \frac{dx}{dt}$$

$$a = \frac{1(-18x)}{2\sqrt{108 - 9x^2}} \cdot \sqrt{108 - 9x^2} = -9x \text{ ms}^{-2}$$

Alternative: Differentiating w.r.t. x, we get

$2v\dfrac{dv}{dx} = -18x$

$\Rightarrow \dfrac{vdv}{dx} = -9x \Rightarrow a = -9x \quad \left(\because v\dfrac{dv}{dx} = a\right)$

90 **(b)**

$x = a\cos t, \dfrac{dx}{dt} = -a\sin t; \dfrac{d^2x}{dt^2} = -a\cos t$

91 **(a)**

$V_{\text{av}} = \dfrac{v_1(t/2) + v_2(t/2)}{t} = \dfrac{v_1 + v_2}{2}$

92 **(a)**

From 0 to t_1, acceleration is increasing linearly with time; hence, $v - t$ graph should be parabolic upwards. From t_1 to t_2, acceleration is decreasing linearly with time; hence, the $v - t$ graph should be parabolic downwards

93 **(c)**

If police is able to catch the dacoit after time t, then

$vt = x + \frac{1}{2}\alpha t^2$. This gives $\frac{\alpha}{2}t^2 - vt + x = 0$

or $t = \frac{v \pm \sqrt{v^2 - 2\alpha x}}{\alpha}$

For t to be real, $v^2 \geq 2\alpha x$

94 **(c)**

We know that slope of displacement-time graph is equal to velocity. So $v_A = \tan 30° = 1/\sqrt{3}$,

$v_B = \tan 60° = \sqrt{3}$ Hence, $v_A/v_B = 1/3$

95 **(a)**

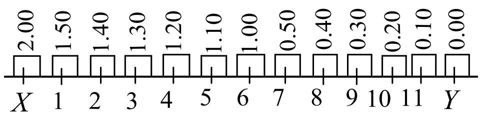
Let the particle be thrown up with initial velocity u

Displacement (s) at any time t is $S = ut - \frac{1}{2}gt^2$

The graph should be parabolic downwards as shown in option (b)

96 **(b)**

Because one taxi leaves every 10 min, at any instant there will be 11 taxies on the way towards each station, one will be arriving and another leaving the other station. Figure shows the location of taxies going from X and Y at the instant 2.00 PM. The taxi which leaves the station X at 0.00 PM has just arrived at the station Y. Consider the taxi leaving the station Y at 2.00 PM



It will meet all the 11 taxies marked 1 to 11 as well as 12 other taxies which would leave the station X from 2.00 PM to 3.50 PM. When it arrives at the station X at 4.00 PM, there will be one more taxi leaving that station. However, it will not be counted among the taxies crossed by taxi under consideration. That is, it will cross 23 taxies leaving the station X from 0.10 PM to 3.50 PM

97 **(b)**

$s = kt$. Differentiating s twice to get acceleration, we see that acceleration comes out to be zero

98 **(b)**

Distance covered $= S = v_{av} \times$ time

For first second: $S_1 = 5 \times 1 = 5$ m

For second: $S_2 = 10 \times 1 = 10$ m

For third second: $S_3 = 15 \times = 15$ m

Total distance travelled

$S = S_1 + S_2 + S_3 = 5 + 10 + 15 = 30$ m

99 **(b)**

Distance covered in first three seconds = Distance covered in last second, i.e.,

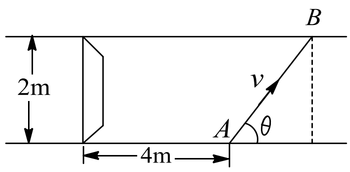
$\dfrac{1}{2}g(3)^2 = \dfrac{g}{2}(2t - 1) \Rightarrow t = 5\text{s}$

100 **(d)**

$t_1 = \dfrac{S/2}{v_1}, t_2\dfrac{S/2}{v_2}, v_{\text{av}} = \dfrac{S}{t_1 + t_2} = \dfrac{2v_1v_2}{v_1 + v_2}$

101 **(c)**

Let the man start crossing the road at an angle θ with the roadside. For safe crossing, the condition is that the man must cross the road by the time the truck describes the distance $(4 + 2\cot\theta)$



So, $\frac{4 + 2\cot\theta}{8} = \frac{2/\sin\theta}{v}$ or $v = \frac{8}{2\sin\theta + \cos\theta}$

For minimum $v, \frac{dv}{d\theta} = 0$

or $\frac{-8(2\cos\theta - \sin\theta)}{(2\sin\theta + \cos\theta)^2} = 0$ or $2\cos\theta - \sin\theta = 0$

or $\tan\theta = 2$, so $\sin\theta = \frac{2}{\sqrt{5}}, \cos\theta = \frac{1}{\sqrt{5}}$

$v_{\min} = \dfrac{8}{2\left(\frac{2}{\sqrt{5}}\right) + \frac{1}{\sqrt{5}}} = \dfrac{8}{\sqrt{5}} = 3.57 \text{ ms}^{-1}$

102 **(c)**

$AB = 30$ m, $BC = 20$ m, $CD = 30\sqrt{2}$

$DBCE$ is isosceles (Fig), so

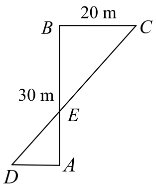
$BE = BC = 20$ m

$AE = AB - BE = 30 - 20 = 10$ m

$EC = 20\sqrt{2}$ m

$ED = CD - EC = 30\sqrt{2} - 20\sqrt{2} = 10\sqrt{2}$ m

$DADE$ is isosceles, so $AD = AE = 10$ m



103 **(b)**

Suppose v be the velocity attained by the body after time t_1. Then $v = u - gt_1$ (i)

Let the body reach the same point at time t_2. Now velocity will be downwards with same magnitude v, then $-v = u - gt_2$ ...(ii)

(i) − (ii) $\Rightarrow 2v = g(t_2 - t_1)$

or $t_2 - t_1 = \frac{2v}{g} = \frac{2}{g}(u - gt_1) = 2\left(\frac{u}{g} - t_1\right)$

104 **(a)**

$30 = u + a \times 2, 60 = u + a \times 4$

Solve to get $u = 0$

105 **(b)**

In (I), slope is negative and its magnitude is decreasing with time. It means slope is increasing numerically. So velocity is increasing towards right, and so acceleration is positive.

In (IV), slope is positive and its magnitude is increasing with time. So velocity is increasing towards right, and so acceleration is positive.

106 **(a)**

During retarded motion, acceleration and velocity are in opposite directions

107 **(a)**

$3V_A = V_B, S_{\text{rel}} = n_{\text{rel}}t \Rightarrow 100 + 60$
$= (V_A + V_B) \times 4$

Solve to get $V_A = 10\text{ ms}^{-1}$ and $V_B = 30\text{ ms}^{-1}$

108 **(b)**

$t_1 = \frac{S/3}{v_1}, t_2 = \frac{S/3}{v_2}, t_3\frac{S/3}{v_3}$

$v_{\text{av}} = \frac{S}{t_1 + t_2 + t_3} = \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$

109 **(c)**

According to the third equation of motion,

$v^2 - u^2 = 2as$

Given $v = 3v, u = v$ and $a = g$

or $(3v)^2 - v^2 = 2gs$ or $s = \frac{4v^2}{g}$

110 **(c)**

For no collision, the speed of car A should be reduced to v_B before the cars meet, i.e., final relative velocity of car A with respect to car B is zero, i.e., $V_r = 0$

Here u_r =initial relative velocity $= V_A - V_B$

Relative acceleration $= a_r = -a - 0 = -a$

Let relative displacement $= s_r$

Then using the equation, $v_r^2 = u_r^2 + 2a_rs_r$

$0^2 = (V_A - V_B)^2 - 2as_r$ or $s_r = \frac{(V_A - V_B)^2}{2a}$

For no collision, $s_r \leq s$ i.e., $\frac{(V_A - V_B)^2}{2a} \leq s$

111 **(d)**

Let the car accelerate at rate α for time t_1 then maximum velocity attained,

$v = 0 + \alpha t_1 = \alpha t_1$

Now, the car decelerates at a rate β for time $(t - t_1)$ and finally comes to rest. Then,

$0 = v - \beta(t - t_1) \Rightarrow 0 = \alpha t_1 - \beta t + \beta t_1$

$\Rightarrow t_1 = \frac{\beta}{\alpha + \beta}t$

$\therefore v = \frac{\alpha\beta}{\alpha + \beta}t$

112 **(a,d)**

If s is the height of ball from surface of lake and $t_1$is the time taken by ball to reach the water surface, then

$t_1 = \sqrt{\frac{2s}{g}} = \sqrt{\frac{2 \times 5}{10}} = 1\text{s}$

The velocity of ball, when it strikes the water surface,

$v = \sqrt{2gs} = \sqrt{2 \times 10 \times 5} = 10\text{ms}^{-1}$

Time taken by ball to travel depth h of the lake with uniform velocity v is

$t_2 = h/v = h/10$

Given, $t_1 + t_2 = 5$ or $1 + \frac{h}{10} = 5$ or $h = 40\text{m}$

Displacement $= 5 + 40 = 45\text{m}$

Total time = 5 s

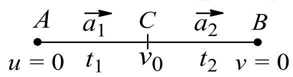
Average velocity $= \frac{45}{5} = 9\text{ms}^{-1}$

113 **(a,c)**

$a_1 = 2\text{ ms}^{-2}, a_2 = -4\text{ ms}^{-2}$

$v_0 = a_1t_1 = 2t_1, v_0 = a_2t_2 = 4t_2$

$t_1 + t_2 = 6 \Rightarrow \frac{v_0}{2} + \frac{v_0}{4} = 6 \Rightarrow v_0 = 8\text{ ms}^{-1}$



Total distance travelled

$S = AC + CB = \frac{1}{2}v_0t_1 + \frac{1}{2}v_0t_2$

$= \frac{1}{2} \times 8 \times 6 = 24\text{ m}$

114 **(a,b,c,d)**

Displacement = velocity ×time. In time 0 to 2 the displacement $= -$Area of ΔOAB +Area of ΔOAD +Area of $\Delta DBC = 0$. Since $OA = BC$, so initial and final speeds are the same.

The slope of velocity-time graph represents acceleration. Here, the velocity-time graphs AB is a straight line inclined to time axis hence has equal acceleration throughout. The particle changes its direction of motion after time T.

115 **(a,b,d)**

$a=\frac{dv}{dt}$, if velocity changes, definitely there will be acceleration. If speed changes, then velocity also changes, so definitely there will be acceleration

Acceleration may be due to change in the direction of velocity only and not magnitude

If body has acceleration, its speed may change if acceleration is due to change in magnitude of velocity

116 **(a,d)**

Since the graph is a straight line, its slope is constant, it means acceleration of the particle is constant

Velocity of the particle changes from positive to negative at $t=10$ s, so particle changes direction at this time

The particle has zero displacement up to 20 s, but not for the entire motion

The average speed in the interval of 0 to 10 s is the same as the average speed in the interval of 10 s to 20 s because distance covered in both time intervals is same

117 **(a,d)**

The body will speed up if the angle between velocity and acceleration is acute

118 **(a,c)**

Average negative acceleration when particle moves from initial position to highest position is

$$a=\frac{\alpha u+0}{2}=\frac{\alpha u}{2}$$

Distance covered, $s=\frac{u^2}{2a}=\frac{u^2}{2\times\alpha u/2}=\frac{u}{\alpha}$

Retardation $=\frac{-dv}{dt}=\alpha v$ or $\frac{dv}{v}=-\alpha dt$

Integrating it, $\int_u^v \log_e v=\int_0^t -\alpha t$ or $v=ue^{-\alpha t}$

When, $t=\frac{1}{\alpha}$, then $v=ue^{-1}=\frac{u}{e}$

When, $t=\infty$, then $v=0$.

119 **(b,d)**

When initial velocity of a body is zero, its acceleration may not be zero.

If initial velocity is zero and acceleration is zero, then the boy will not move *ie*, displacement is zero.

If speed is zero in an interval of time, the acceleration is zero in this interval.

120 **(b,c)**

Taking upward motion of the balloon for 4s, we have, $u=0; a=2.50\text{ms}^{-2}$;

$t=4\text{s}; v=?; s=?$

$v=u+at=0+2.5\times 4=10\text{ms}^{-1}$

$$s=ut+\frac{1}{2}at^2=10\times 4-\frac{1}{2}\times 2.5\times 4^2$$

When stone is released from the balloon at the height of 20m, it retains the velocity of balloon *ie*, 10ms^{-1} upwards but not its acceleration.

Taking downward motion of stone, when released from balloon to ground, we have

$u=-10\text{ms}^{-1}; a=10\text{ms}^{-2}, s=20\text{m}, t=?$

As $s=ut+\frac{1}{2}at^2; so, 20=-10t+\frac{1}{2}\times 10t^2$

or $5t^2-10t-20=0$. On solving $t=3.2$ s

Distance covered by stone after being released from balloon up to highest point of its path is

$v^2=u^2+2as$

$0=10^2+2(-10)s$ or $s=5\text{m}$.

∴ Total distance travelled = 5 +5 +20=30 m

121 **(b,d)**

Freely falling block will reach the ground first, because it has to travel less distance and with greater acceleration in comparison to the other block

Both the blocks will reach the ground with the same speed, because the potential energies of both decreases by the same amount, which gets converted into KE

122 **(b,d)**

Velocity = speed + direction. If velocity changes, the direction of motion of body may change, the speed of body may or may not change. The change in velocity must produce acceleration. If speed changes, then velocity of body must change and hence there must be an acceleration.

123 **(a,b,c)**

If the initial velocity of the body is zero or positive, then for an accelerating body, its speed may increase. If the initial velocity of the body is negative, then for an accelerating body, its speed may decrease. When a body is having a uniform circular motion, it is having centripetal acceleration and uniform speed.

124 **(a,b,c)**

Let they meet at height h after time t

$h=100t-\frac{1}{2}\text{g}t^2\rightarrow$ for first arrow

$=100(t-5)-\frac{1}{2}\text{g}(t-5)^2\rightarrow$ for second arrow

$\Rightarrow t=-12.5$ s (after solving) So (a) is correct

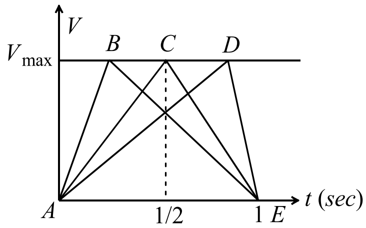
Time of flight of first arrow: $T=\frac{2u}{\text{g}}=\frac{2\times 100}{10}=20$ s

Second arrow will reach after 5 s of reaching first. So (b) is correct

$v_1 = 100 - 10 \times 20 = -100 \text{ ms}^{-1}$
$v_2 = 100 - 10 \times 15 = -50 \text{ ms}^{-1}$
Ratio: $\frac{v_1}{v_2} = 2 : 1$ So (c) is correct
Maximum height attained
$H = \frac{u^2}{2g} - \frac{(100)^2}{2\times10} = 500$ m. Hence (d) is incorrect

125 **(b,d)**
Average acceleration $a = \frac{a_1t_1 + a_2t_2}{t_1 + t_2}$
$= \dfrac{5 \times 10 + 10 \times 15}{10 + 15} = 8\text{ms}^{-2}$
Total distance travelled, $s = s_1 + s_2$
$= \left(\frac{1}{2}a_1t_1^2\right) + \left(a_1t_1 \times t_2 + \frac{1}{2}a_2t_2^2\right)$
$= \frac{1}{2} \times 5 \times 10^2 + 5 \times 10 \times 15 + \frac{1}{2} \times 10 \times 15^2$
$= 2125$m.

126 **(a,c,d)**
The body is at rest initially and again comes to rest at $t = 1$ second at position $x = 1$
Thus, firstly acceleration will be positive then negative
Thus, (α) have to change the direction so that body may finally come to rest in the interval $0 \le t \le 1$
If we plot $v - t$ graph



Now, $\frac{1}{2} . v_{\max} t = s \quad \Rightarrow U_{\max} = \frac{2\times s}{t}$
$v_{\max} = \dfrac{2 \times 1}{1} = 2m/s$
Thus, maximum velocity $= 2m/s$
Now, just see the $v - t$ diagram,
For ABE, $\left|\begin{matrix} During\ AB \\ During\ BE \end{matrix}\right| \begin{matrix} \alpha > 4m/s^2 \\ \alpha < -4m/s^2 \end{matrix}$
For ACE $\left|\begin{matrix} During\ AC \\ During\ CE \end{matrix}\right| \begin{matrix} \alpha = 4m/s^2 \\ \alpha = -4m/s^2 \end{matrix}$
For ADF $\left|\begin{matrix} During\ AD \\ During\ DE \end{matrix}\right| \begin{matrix} \alpha < 4m/s^2 \\ \alpha > -4m/s^2 \end{matrix}$
Thus, $\alpha \ge 4$ at some point or points in its path

127 **(a,b,d)**
$\dfrac{dv}{dt} = 6 - 3v \Rightarrow \dfrac{dv}{6 - 3v} = dt$
Integrating both sides, $\int \frac{dv}{6-3v} = \int dt$
$\Rightarrow \dfrac{\log_e(6 - 3v)}{-3} = t + K_1$
$\Rightarrow \log_e\ (6 - 3v) = -3t + K_2$ Let $[-3K_1 = K_2]$ ...(i)
At $t = 0, v = 0\ \therefore \log_e 6 = K_2$
Substituting the value of K_2in equation (i)
$\log_e(6 - 3v) = -3t + \log_e 6$
$\Rightarrow \log_e\left(\dfrac{6 - 3v}{6}\right) = -3t \Rightarrow e^{-3t} = \dfrac{6 - 3v}{6}$
$\Rightarrow 6 - 3v = 6e^{-3t} \Rightarrow 3v = 6(1 - e^{-3t})$
$\Rightarrow v = 2(1 - e^{-3t})$
$\therefore v_{\text{terminal}} = 2m/s$ (When $t = \infty$)
Acceleration $a = \frac{dv}{dt} = \frac{d}{dt}[2(1 - e^{-3t})] = 6e^{-3t}$
Initial acceleration $= 6\ m/s^2$

128 **(a,b,c)**
Initially at origin, slope is not zero, so the particle has some initial velocity but with time we see that slope is decreasing and finally the slope becomes zero, so the particle stops finally
As the magnitude of velocity is decreasing, velocity and acceleration will be in opposite directions

129 **(a,b,c)**
Given acceleration, $\frac{d}{v} = A - bv$
(a) When $t = 0, v = 0$; therefore initial acceleration,$\left(\frac{dv}{dt}\right)_{t=0} = A$

(b)When acceleration is zero, then $\frac{dv}{dt} = 0$. Hence, $A - Bv = 0$ or $v = A/B$.

(c)$\frac{dv}{A-Bv} = dt$

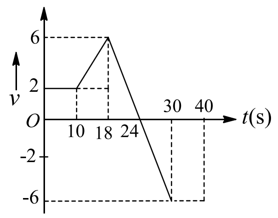
Integrating it within the limits of motion *ie*, as time changes 0 to t, velocity changes 0 to v, we have

$-\left[\dfrac{\log_e(A - Bv)}{B}\right]_0^v = (t)_0^t$

$\log_e(A - Bv) - \log_e A = -Bt$

or $\frac{A-Bv}{A} = e^{-Bt}$ or $v = \frac{A}{B}(1 - e^{-Bt})$

130 **(a,c,d)**
Maximum value of position coordinate= initial coordinate + area under the graph up to $t = 24$ s (As up to $t = 24$ s, the displacement of the particle will be positive



Maximum value of position coordinate

$$-16+\left[(2\times 10)+\left(\frac{2+6}{2}\right)\times(18-10)+\frac{1\times 6}{2}\times(24-18)\right]$$

$=-16+[20+32+18]=54$ m

At time $t=18$ s

Position $=-16+$ Area of graph up to $t=18$ s

$=-16+[20+32]=36$ m

At time $t=30$ s

Position $=-16+$ Area of graph up to $t=30$ s

$$=-16+\left[70-\frac{1}{2}\times 6\times 6\right]=36 \text{ m}$$

131 **(a,b,c)**

For vertically projected body, if it returns to the starting point, displacement and average velocity become zero. As acceleration is constant average speed during upward or downward motion is $(u+0)/2=u/2$. The same will be the average speed for the whole motion

132 **(b,c)**

Given that, $\frac{dv}{dt}=-\beta v$ or $\frac{dv}{v}=-\beta dt$ ...(i)

Integrating it within the conditions of motion, we have

$\int_{v_0}^{v}\frac{dv}{v}=-\beta\int_0^t dt$ or $v=v_0e^{-\beta t}$ ...(ii)

From Eq.(i) we not that as $t\to\infty, v=0$. Hence the particle will continue moving for a very long time.

Further, $\frac{dv}{dt}=-\beta\frac{dx}{dt}$

or $dv=-\beta dx$

Integrating it within the conditions of motion we have

$$\int_{v_0}^{0}dv=-\beta\int_0^{x_0}dx$$

On solving we get, $v_0=\beta x_0$

or $x_0=v_0/\beta$.

So, the particle will cover a total distance of v_0/β.

133 **(c,d)**

Average velocity $\vec{v}=\frac{\int_0^5 v\,dt}{\int_0^5 dt}=\frac{\int_0^5(4t-t^2)dt}{\int_0^5 dt}$

$$=\frac{\left[2t^2-\frac{t^3}{3}\right]_0^5}{5}=\frac{50-\frac{125}{3}}{5}=\frac{25}{3\times 5}=\frac{5}{3}$$

For average speed, let us put $v=0$, which gives $t=0$ and $t=4$ s

$$\therefore \text{ average speed}=\frac{\left|\int_0^4 v\,dt\right|+\left|\int_4^5 v\,dt\right|}{\int_0^5 dt}$$

$$=\frac{\left|\int_0^4(4t-t^2)dt\right|+\left|\int_4^5 v\,dt\right|}{5}$$

$$=\frac{\left[2t^2-\frac{t^3}{3}\right]_0^4+\left[2t^2-\frac{t^3}{3}\right]_4^5}{5}$$

$$=\frac{\left|\left[2t^2-\frac{t^3}{3}\right]_0^4\right|+\left|\left[2t^2-\frac{t^3}{3}\right]_4^5\right|}{5}=\frac{13}{5}\text{ ms}^{-1}$$

For acceleration: $a=\frac{dv}{dt}=\frac{d}{dt}(4t-t^2)=4-2t$

At $t=0, a=4$ ms^{-2}

Therefore, Options (c) and (d) are correct, and options (a) and (b) are wrong

134 **(a,c)**

Here, $u=2\text{ms}^{-1}, v=14\text{ms}^{-1}$

Distance between A and $B=$ s

A C B

Then acceleration, $a=\frac{v^2-u^2}{2s}=\frac{14^2-2^2}{2s}=\frac{194}{2s}=\frac{97}{s}$

The speed at mid point C, $v^2=u^2+2\alpha\frac{s}{2}$

$$=2^2+2\times\frac{97}{s}\times\frac{s}{2}=101$$

$v=\sqrt{101}=10\text{ms}^{-1}$

As per question, $AP=\frac{1}{6}[AB]=\frac{1}{6}s$

When, $s=s/6, v^2=2^2+2\times\frac{97}{s}\times\frac{s}{6}$

$$=3+2\times\frac{97}{3}=36.3\text{ms}^{-1}$$

$v=\sqrt{36.3}\approx 6\text{ms}^{-1}$

Since velocity at mid point C is 10ms^{-1}

$\therefore$ Taking motion from A to C, we have

$10=2+a\times t_1$ or $t_1=\frac{10-2}{a}=\frac{8}{a}$

Taking motion from C to B, we have

$14=10+a\times t_2$ or $t_2=\frac{14-10}{a}=\frac{4}{a}$

$\therefore \frac{t_1}{t_2}=2$ or $t_2=\frac{t_1}{2}$

135 **(b,c,d)**

A body having a constant speed can have a varying velocity due to change in the direction of velocity. Thus a body having constant speed can have an acceleration.

If velocity and acceleration are in the same direction, then distance is equal to displacement, because then there is no change in direction of motion. The body will continuously travel in one direction only

136 **(b,d)**

If the initial velocity is negative ($ie, \vec{v} < 0$) and $\vec{a}$ is a positive, ie, ($\vec{a} > 0$) then speed will decrease. The speed will increase when $\vec{v}$ and $\vec{d}$ are both positive.

137 **(b,c)**

Maximum height reached, $s_m = \frac{v^2}{2g}$.

Time taken to reach the maximum height, $T_m = \frac{v}{g}$

Height s reached in time t is $s = ut - \frac{1}{2}gt^2$

If $t = \frac{T}{2} = \frac{v}{2g}$

Then $s = \frac{v \times v}{2g} - \frac{1}{2}g\left(\frac{v}{2g}\right)^2$

$= \frac{v^2}{2g} - \frac{v^2}{8g} = \frac{3v^2}{8g} = \frac{3}{4}s_m$

Speed at height s is $v^2 = u^2 - 2gs$

When $s = \frac{s_m}{2} = \frac{v^2}{4g}$

then $v'^2 = v^2 - 2g \times v^2/4g = \frac{v^2}{2}$ or $v' = \frac{v}{\sqrt{2}}$

138 **(a,b,c,d)**

A stone thrown vertically up with velocity $20 ms^{-1}$ from top of building will go up and return to the point of projection with downward velocity$20 ms^{-1}$.

So both will strike the ground with same speed and hence same KE. Acceleration of each stone is acceleration due to gravity acting downwards. So the relative acceleration of two stones is zero.

Time of ascent of the first stone from point of projection is $t = \frac{u}{g} = \frac{20}{10} = 2s$. Time of descent up to point of projection= 2s. Total time =2+2=4s.

Since the second stone is thrown after 2s, so the two stones will strike the ground with time interval $= 4 - 2 = 2$s. Relative velocity between the two stones remains constant till one stone strikes the ground.

139 **(a,c)**

Ball A will returns to the top of tower after

$T = \frac{2u}{g} = \frac{2 \times 10}{10} = 2$ s

With speed of $10\ ms^{-1}$ downward

And this time, B is also projected downward with $10\ ms^{-1}$. So both reach ground simultaneously.

Also they will hit the ground with same speed

140 **(c,d)**

The displacement is the area which the velocity-time graphs encloses with time axis for a given interval of time. Since the area of velocity time graph for time 0 to 5s is the same as area of the velocity-time graph for time 5s to 10s, hence average speed in these intervals is the same.

141 **(a,d)**

From $s = \frac{1}{2}at^2, u = 0$

$s \propto t^2$, since the particle starts from rest and acceleration is constant, so there is no change in the direction of velocity and the particle moves in a straight line always

142 **(a,b,d)**

Average speed is never less than average velocity.

Average velocity of a particle moving once around a circle can be zero but instantaneous velocity is never zero in the interval.

Average velocity of a particle moving on a straight line never zero.

When a particle is in vertical motion, then at the highest point, the instantaneous velocity of the particle is zero.

143 **(a,d)**

The body starts from rest at $x = 0$ and then again comes to rest at $x = 1$. It means initially acceleration is positive and then negative.

So we can canclude that α cannot remains positive for all t in the interval $0 \leq t \leq 1$ ie, α must change sign during the motion.

144 **(c,d)**

Since average acceleration = change in velocity/time, so average acceleration is in the direction of change in velocity. Also if initial velocity is zero, then the final velocity and change in velocity will be in the same direction

145 **(a,c)**

$t = \sqrt{\frac{2h}{g}}, v = \sqrt{2gh}$

146 **(a,b,d)**

$\frac{dv}{dt} = 6 - 3v \Rightarrow \frac{dv}{6 - 3v} = dt$

Integrating both sides, $\int \frac{dv}{6-3v} = \int dt$

$\Rightarrow \frac{\log_e(6 - 3v)}{-3} = t + K_1$

$\Rightarrow \log_e\ (6 - 3v) = -3t + K_2$ Let $[-3K_1 = K_2]$ ...(i)

At $t = 0, v = 0\ \therefore \log_e 6 = K_2$

Substituting the value of K_2in equation (i)

$\log_e(6 - 3v) = -3t + \log_e 6$

$\Rightarrow \log_e\left(\frac{6 - 3v}{6}\right) = -3t \Rightarrow e^{-3t} = \frac{6 - 3v}{6}$

$\Rightarrow 6 - 3v = 6e^{-3t} \Rightarrow 3v = 6(1 - e^{-3t})$

$\Rightarrow v = 2(1 - e^{-3t})$

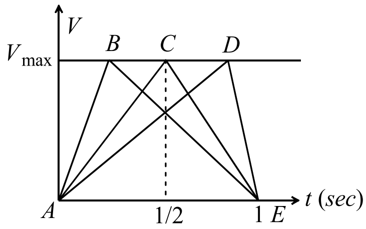
$\therefore v_{\text{terminal}} = 2m/s$ (When $t = \infty$)
Acceleration $a = \frac{dv}{dt} = \frac{d}{dt}[2(1 - e^{-3t})] = 6e^{-3t}$
Initial acceleration $= 6\ m/s^2$

147 **(a,b,c,d)**
Particle changes direction of motion at $t = T$.
Acceleration remains constant, because the velocity-time graph is a straight line.
Displacement is zero, because net area is zero.
Initial and final speeds are equal

148 **(b,c,d)**
Given, $\frac{dv}{dt} = 6 - 3\text{v}$ ...(i)
or $\frac{dv}{6-3v} = dt$
Integrating it, we have
$\left[-\frac{1}{3}\log(6 - 3v)\right] = t + K$ ...(ii)
At $t = 0, v = 0$
$\therefore k = -\frac{1}{3}\log 6$
Putting this value in Eq.(ii), we have
$-\frac{1}{3}\log(6 - 3v) = t - \frac{1}{3}\log 6$
or $\log\left(\frac{6-3v}{6}\right) = -3t$
or $\frac{6-3v}{6} = e^{-3t}$ or $1 - \frac{v}{2} = e^{-3t}$
or $v = 2, (1 - e^{-3t})$
When t=0, $v = 2(1 - e^{-3t})$
Initially , $v = 0$, From Eq. (i) acceleration, $a_0 = \frac{dv}{dt}$ $= 6 - 3 \times 0 = 6\text{ms}^{-2}$
When $a = a_0/2 = 6/2 = 3$ then from Eq. (i);
$3 = 6 - 3v$
or $3v = 6 - 3 = 3$ or $v = 1\text{ms}^{-1}$

149 **(a,b,c,d)**
$x = at^2 = \beta t^3$
$v = \frac{dx}{dt} = 2\alpha t - 3\beta t^2$ ...(i)
Acceleration, $a = \frac{dv}{dt} = 2\alpha - 6\beta\ t$ ...(ii)
The particle will come to rest, if $v = 0$
From Eq.(i), $0 = 2\alpha t - 3\beta t^2$ or $t = 2\alpha/3\beta$
The particle when returns to its starting point, then $x = 0$
Now, $0 = \alpha t^2 - \beta t^3$ or $t = \alpha/\beta$.
Force on particle is zero when $a = 0$. From Eq.(ii)
$0 = 2\alpha - 6\beta t$ or $t = \alpha/3\beta$
When $t = 0$, from (i) $v = 0$ and from Eq.(ii)
$a \neq 0$, has $a = 2\alpha$

150 **(a,c,d)**
The body is at rest initially and again comes to rest at $t = 1$ second at position $x = 1$
Thus, firstly acceleration will be positive then negative
Thus, (α) have to change the direction so that body may finally come to rest in the interval $0 \leq t \leq 1$
If we plot $v - t$ graph



Now, $\frac{1}{2}.v_{\max}t = s \quad \Rightarrow U_{\max} = \frac{2\times s}{t}$
$v_{\max} = \frac{2 \times 1}{1} = 2m/s$
Thus, maximum velocity $= 2m/s$
Now, just see the $v - t$ diagram,
For ABE, $\left|\begin{matrix} During\ AB \\ During\ BE \end{matrix}\right| \begin{matrix} \alpha > 4m/s^2 \\ \alpha < -4m/s^2 \end{matrix}$
For ACE $\left|\begin{matrix} During\ AC \\ During\ CE \end{matrix}\right| \begin{matrix} \alpha = 4m/s^2 \\ \alpha = -4m/s^2 \end{matrix}$
For ADF $\left|\begin{matrix} During\ AD \\ During\ DE \end{matrix}\right| \begin{matrix} \alpha < 4m/s^2 \\ \alpha > -4m/s^2 \end{matrix}$
Thus, $\alpha \geq 4$ at some point or points in its path

151 **(a)**
Here, $u = 0, a = 10\text{ms}^{-2}, s = 40/2 = 20\text{m}$

Using the relation $v^2 = u^2 + 2as = 0 + 2 \times 10 \times 20 = 400$ or $v = 20\text{ms}^{-1}$. Thus both the Assertion and Reason are correct and Reason is the correct explanation of Assertion.

152 **(a)**
When there is retardation, velocity decreases. So retardation is equal to the time rate of decrease of velocity. This retardation will be oppositely directed to velocity

153 **(c)**
Negative slope of position time graph represents that the body is moving towards the negative direction and if the slope of the graph decrease with time then it represents the decrease in speed $i.e.$ retardation in motion

154 **(c)**
The displacement is the shortest distance between initial and final position. When final position of a body coincides with its initial position, displacement is zero, but the distance travelled is not zero

156 **(b)**
A body having positive acceleration can be

associated with slowing down, as time rate of change of velocity decreases, but velocity increases with time, from graph it is clear that slope with time axis decreases in speed $i.e.$ retardation in motion

157 **(a)**
Position- time graph for a stationary object is a straight line parallel to time axis showing that no change in position with time

158 **(c)**
An object is said to be in uniform motion if it undergoes equal displacement in equal intervals if time

$$\therefore v_{av} = \frac{s_1 + s_2 + s_3 + \cdots}{t_1 + t_2 + t_3 + \cdots} = \frac{s + s + s + \cdots}{t + t + t + \cdots} = \frac{ns}{nt} = \frac{s}{t}$$

and $v_{ins} = \frac{s}{t}$

thus, in uniform motion average and instantaneous velocities have same value and body moves with constant velocity

159 **(c)**
In uniform motion the object moves with uniform velocity, the magnitude of its velocity at different instant $i.e.$ at $t = 0, t = 1sec, t = 2\ sec$, ….will always be constant. Thus velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to time axis

160 **(e)**
The uniform motion of a body means that the body is moving with constant velocity, but if the direction of motion is changing (such as in uniform circular motion), its velocity changes and thus acceleration is produced in uniform motion

161 **(c)**
The displacement is the shortest distance between initial and final position. When final position of a body coincides with its initial position, displacement is zero, but the distance travelled is not zero

162 **(e)**
If the position-time graph of a body moving uniformly is a straight line parallel to position axis, it means that the position of body is changing at constant time. The statement is abrupt and shows that the velocity of body is infinite

163 **(a)**
According to definition, displacement= velocity × time

Since displacement is a vector quantity so its value is equal to the vector sum of the area under velocity-time graph

164 **(e)**
As per definition, acceleration is the rate of change of velocity, $i.e.\ \vec{a} = \frac{d\vec{v}}{dt}$.

If velocity is constant $d\vec{v}/dt = 0, \therefore \vec{a} = 0$

Therefore, if a body has constant velocity it cannot have non zero acceleration

165 **(e)**
When a body falling freely, only gravitational force acts on it in vertically downward direction. Due to this downward acceleration the velocity of a body increases and will be maximum when the body touches the ground

166 **(d)**
Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero

167 **(a)**
In kinematical equations, mass does not appear

168 **(e)**
As velocity is a vector quantity, its value changes with change in direction. Therefore when a bus takes a turn from north to east its velocity will also change

169 **(a)**
When the body reverses the direction of motion it is momentarily at rest, but it still possesses acceleration. Velocity zero does not mean that acceleration is also zero

170 **(c)**
Negative slope of position time graph represents that the body is moving towards the negative direction and if the slope of the graph decrease with time then it represents the decrease in speed $i.e.$ retardation in motion

171 **(a)**
Position- time graph for a stationary object is a straight line parallel to time axis showing that no change in position with time

172 **(a)**
A body has no relative motion with respect to itself. Hence if a frame of reference of the body is fixed, then the body will be always at relative rest in this frame of reference

173 **(e)**
As velocity is a vector quantity, its value changes with change in direction. Therefore when a bus takes a turn from north to east its velocity will also change

174 **(a)**
Since velocity is a vector quantity, hence as its direction changes keeping magnitude constant, velocity is said to be changed. But for constant speed in equal time interval distance travelled should be equal

175 **(a)**
A body has no relative motion with respect to itself. Hence if a frame of reference of the body is fixed, then the body will be always at relative rest in this frame of reference

176 **(a)**
Since velocity is a vector quantity, hence as its direction changes keeping magnitude constant, velocity is said to be changed. But for constant speed in equal time interval distance travelled should be equal

177 **(b)**
A body having negative acceleration can be associated with a speeding up, if object moves along negative X-direction with increasing speed

178 **(a)**
Since slope of displacement-time graph measures velocity of an object

179 **(e)**
If the position-time graph of a body moving uniformly is a straight line parallel to position axis, it means that the position of body is changing at constant time. The statement is abrupt and shows that the velocity of body is infinite

180 **(b)**
A body having negative acceleration can be associated with a speeding up, if object moves along negative X-direction with increasing speed

181 **(b)**
Acceleration depends upon the force applied

182 **(e)**
When a body falling freely, only gravitational force acts on it in vertically downward direction. Due to this downward acceleration the velocity of a body increases and will be maximum when the body touches the ground

183 **(b)**
A body having positive acceleration can be associated with slowing down, as time rate of change of velocity decreases, but velocity increases with time, from graph it is clear that slope with time axis decreases in speed *i*. *e*. retardation in motion

184 **(d)**
Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero

185 **(b)**
When two bodies are moving in opposite direction, relative velocity between them is equal to sum of the velocity of bodies. But if the bodies are moving in same direction their relative velocity is equal to difference in velocity of the bodies

187 **(b)**
Statement 1 is based on visual experience. Statement 2 is formula of relative velocity. But it does not explains Statement 1. The correct explanation of Statement 1 is due to visual perception of motion (due angular velocity). The object appears to be faster when its angular velocity is greater w.r.t. observer

188 **(b)**
Statement 1 is based on visual experience. Statement 2 is formula of relative velocity. But it does not explains Statement 1. The correct explanation of Statement 1 is due to visual perception of motion (due angular velocity). The object appears to be faster when its angular

velocity is greater w.r.t. observer

189 **(a)**
If velocity is constant, then displacement and distance will be equal and the magnitude of average velocity is equal to average speed

190 **(a)**
According to definition, displacement= velocity × time

Since displacement is a vector quantity so its value is equal to the vector sum of the area under velocity-time graph

191 **(e)**
As per definition, acceleration is the rate of change of velocity, $i.e.\ \vec{a} = \frac{d\vec{v}}{dt}$.

If velocity is constant $d\vec{v}/dt = 0, \therefore \vec{a} = 0$

Therefore, if a body has constant velocity it cannot have non zero acceleration

192 **(e)**
The uniform motion of a body means that the body is moving with constant velocity, but if the direction of motion is changing (such as in uniform circular motion), its velocity changes and thus acceleration is produced in uniform motion

193 **(c)**
An object is said to be in uniform motion if it undergoes equal displacement in equal intervals if time

$$\therefore v_{av} = \frac{s_1 + s_2 + s_3 + \cdots}{t_1 + t_2 + t_3 + \cdots} = \frac{s + s + s + \cdots}{t + t + t + \cdots} = \frac{ns}{nt} = \frac{s}{t}$$

and $v_{ins} = \frac{s}{t}$

thus, in uniform motion average and instantaneous velocities have same value and body moves with constant velocity

194 **(a)**
Since slope of displacement-time graph measures velocity of an object

195 **(b)**
Such a body can move along any curved path including circular path

196 **(a)**
Motion of rocket is based on action reaction phenomena and is governed by rate of fuel burning causing the change in momentum of ejected gas

197 **(e)**
Speedometer measures instantaneous speed of automobile

198 **(e)**
For distance-time graph, a straight line inclined to tome axis measures uniform speed for which acceleration is zero and for uniformly accelerated motion $S \propto t^2$

199 **(e)**
For distance-time graph, a straight line inclined to tome axis measures uniform speed for which acceleration is zero and for uniformly accelerated motion $S \propto t^2$

200 **(c)**
The position-time graph of a moving body in one dimension can have negative slope if its velocity in negative

201 **(b)**
Two different physical quantities may have same dimensions

202 **(c)**
The average velocity of the body may be equal to its instantaneous velocity, because instantaneous velocity can take any value

For a given time interval of a given motion, both average velocity and average speed can have only one value as displacement and distance will have single values

203 **(c)**
In uniform motion the object moves with uniform velocity, the magnitude of its velocity at different instant $i.e.$ at $t = 0, t = 1sec, t = 2\ sec$, ...will always be constant. Thus velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to time axis

204 **(a)**
Motion of rocket is based on action reaction phenomena and is governed by rate of fuel burning causing the change in momentum of

ejected gas

205 **(d)**
Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

$$=\frac{25-(-25)}{5}=10\text{ms}^{-2}.$$

Hence assertion is wrong but Reason is correct.

206 **(e)**
Speedometer measures instantaneous speed of automobile

207 **(c)**
Here Assertion is correct but Reason is wrong because a constant force on body will produce a constant acceleration in the body.

208 **(a)**
If the direction of velocity changes (magnitude may or may not change), we say that velocity changes. If velocity changes, then definitely there will be acceleration

209 **(b)**
When two bodies are moving in opposite direction, relative velocity between them is equal to sum of the velocity of bodies. But if the bodies are moving in same direction their relative velocity is equal to difference in velocity of the bodies

210 **(a)**
When the body returns to its initial point, its displacement is zero, but distance travelled is not zero

211 **(b)**
When two bodies are moving in opposite directions, relative velocity between them is equal to sum of the velocities of two bodies.

212 **(a)**
For a round trip, displacement is zero; hence $\vec{v}_{av}=0$. Also $\vec{v}_{av}=\frac{\vec{v}_1+\vec{v}_2}{2}$, when $\vec{v}_1$ is initial, $\vec{v}_2$ is final. Hence **i** → **a**, **b**

Average speed $(v_{\text{av}})=\frac{\text{Total distance}}{\text{Time of flight}}=\frac{2(v_0^2/2\text{g})}{2\,v_0/\text{g}}=\frac{v_0}{2}$

Hence **ii** → **c**

$T_{\text{ascent}}=T_{\text{descent}}=\frac{v_0}{\text{g}}$ Hence **iii** → **d**, **iv** → **d**

213 **(a)**
In $OA, S\propto t^2, v=\frac{dS}{dt}\propto 2t$
i.e., $v\propto t$
i.e., velocity increases with time
In $AB, S\propto t, v=\frac{dS}{dt}\propto 1$
i.e., velocity is uniform, i.e., constant or independent of time. In BC, body is retarded, i.e., velocity decreases with time. In CD, $S\propto t^0$ i.e., v =zero i.e., body is at rest

214 **(b)**
$v=\frac{dS}{dt}=\beta+2\gamma t, a=\frac{dv}{dt}=2\gamma$ So, **i** → **b**
$(v)=\frac{\int_2^3 v dt}{\int_2^3 dt}=\frac{\beta(3-2)+\gamma(9-4)}{1}=\beta+5\gamma$ So, **ii** → **a**
Velocity at $t=1$ s: $v=\beta+2\gamma\times 1=\beta+2\gamma$, So **iii** → **d**
Initial displacement i.e., $t=0, S=a$ So, **iv** → **c**

215 **(c)**
When the ball is above the point of projection, its displacement is always positive, but its velocity may be positive (when moving up), zero (at top point), or negative (when coming down)
Acceleration is always directed downward, so it is always negative

216 **(d)**
a. Area of $v-t$ graph lies below the time axis, so displacement is negative, but slope is positive, so acceleration is positive
b. Area of $v-t$ graph lies above the time axis, so displacement is positive, and slope is positive, so acceleration is also positive
c. Displacement is zero, because half area is above time axis and half below. Slope is negative, so acceleration is negative
d. Area of $v-t$ graph lies above the time axis, so displacement is positive, and slope is negative, so acceleration is also negative

217 **(a)**
$\vec{\text{v}}_{\text{GB}}=\vec{\text{v}}_{\text{G}}+(-\vec{\text{v}}_{\text{B}})=0+(-25\text{ms}^{-1})$
$=25\text{ms}^{-1}$ due north

218 **(b)**
$$t=\sqrt{\frac{2s}{\text{g}}}=\sqrt{\frac{2\times 300}{10}}=7.75\text{s}$$

219 **(d)**
$$s=\frac{M+2Nt^4}{4}\Rightarrow v=\frac{ds}{dt}=2\,Nt^3$$
Putting $t=1$ s, we get $v=2$ N

220 **(a)**

$S = \frac{1}{2}gn^2 \Rightarrow S \propto n^2$

$S = \frac{a}{2}(2n-1) \Rightarrow S \propto (2n-1)$

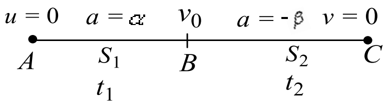
$V = gn \Rightarrow v \propto n$

221 **(b)**

Here acceleration is constant. So we can use

$s = ut + \frac{1}{2}at^2, s - t$ graph will be parabolic

222 **(b)**



From A to B, applying $v = u + at$, we get

$v_0 = 0 + at_1 \Rightarrow t_1 = v_0/a$

From B to C, again applying $v = u + at$, we get

$0 = v_0 - bt_2 \Rightarrow t_2 = v_0/b$

Given $t_1 + t_2 = t \Rightarrow \frac{v_0}{\alpha} + \frac{v_0}{\beta} = t \Rightarrow v_0 \frac{\alpha\beta t}{\alpha+\beta}$

v_0 is the maximum velocity attained

223 **(b)**

Let they meet after time t, then the distance travelled by both in time t should be same

$s = 8t = \frac{1}{2}4t^2 \Rightarrow t = 4$ s

224 **(b)**

$s = \frac{1}{2}gt_1^2$ or $t_1^2 = \frac{50\times2}{g} = \frac{100}{g}$ or $t_1 = \frac{10}{\sqrt{g}}$

and $100 = \frac{1}{2}gt^2$ or $t = \frac{10\sqrt{2}}{\sqrt{g}}$

$t_2 = t - t_1 = \frac{10}{\sqrt{g}}(\sqrt{2}-1) = 0.4t_1$

$t_1 > t_2$

225 **(c)**

$s = ut + \frac{1}{2}at^2 = 4\times5 - \frac{1}{2}\times9.8\times5^2$

$= 20 - 122.5 = -102.5$ m

This shows that the body is 102.5 m below the initial position, i.e., height of the body

$= 120.5 - 102.5 = 18$ m

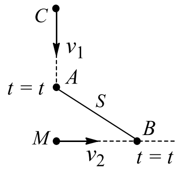
226 **(b)**

Let at time t, the cyclist overtake the bus, then 96+ (distance travelled by bus in time t)= (distance travelled by cyclist in time t)

$\Rightarrow \frac{1}{2}\times2\times t^2 + 96 = 20\times t \Rightarrow t^2 - 20t + 96 = 0$

This gives $t = 8$ s or 12 s. Hence, the cyclist will overtake the bus at 8 s

227 **(d)**



CM = 50 m

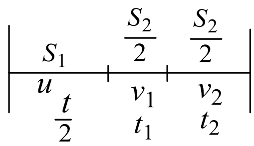
$v_1 = 20\text{ ms}^{-1}, v_2 = 15\text{ ms}^{-1}, AC = v_1t, MB = v_2t$

$S = \sqrt{MA^2 + MB^2} = \sqrt{(50 - v_1t)^2 + (v_2t)^2}$

From $\frac{ds}{dt} = 0$ (for minima), find t and put t in s

228 **(a)**

$S_1 = \frac{ut}{2}, \frac{S_2}{2} = v_1t_1 = v_2t_2$ (i)



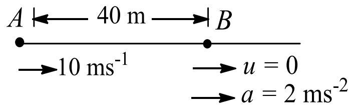
$\frac{t}{2} = t_1 + t_2$

From (i) and (ii) $\Rightarrow t_1 = \frac{v_2t}{2(v_1+v_2)}$

$v_{av} = \frac{S}{t} = \frac{S_1 + S_2}{t} = \frac{\frac{ut}{2} + 2v_1t_1}{t}$

Put the value of t_1 and get $v_{\text{av}} = \frac{u(v_1+v_2)+2v_1v_2}{2(v_1+v_2)}$

229 **(c)**



Distance between the particles will be minimum when velocity of B becomes equal to that of A, i.e., 10 ms^{-1}

Apply $v = u + at \Rightarrow 10 = 0 + 2t \Rightarrow t = 5$ s

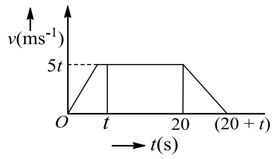
230 **(a)**

Distance covered = area of speed – time graph

$= \frac{1}{2}\times(4+2)\times4 + \frac{1}{2}(4+2)\times2 = 18$ m

231 **(a)**

Average speed $= 20\text{ ms}^{-1}$



$\frac{\text{Total distance}}{\text{Total time}} = 20 \Rightarrow \frac{\text{Area of graph}}{20 + t} = 20$

$\Rightarrow \frac{1}{2}(20 + t + 20 - t)\times5t = 20(20 + t) \Rightarrow t$

$= 5$ s

232 **(b)**

In graph (i) and (iii), magnitude of slope is greater at t_1 than that at t_2

233 **(b)**

For the graph (i) and (iv), slope is constant, hence the velocity is constant

234 **(5)**

$s = u + \frac{a}{2}(2n - 1)$

$u = 100\ \text{ms}^{-1}, a = -10\ \text{ms}^{-2}$ and $s = 5$ m

$5 = 100 - 5(2n - 1)$ gives $n = 10$ s

Body when thrown up with velocity 200 ms^{-1} will take 20 s to reach the highest point. Distance travelled in 20th second is $200 - 5(200 \times 2 -$ $1 = 5$ m

In the last second of upward journey, the bodies will travel same distance

235 **(4)**

$h = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2h}{a}} = \sqrt{\frac{2 \times 40 \times 8}{10}} = 8$ s

Velocity after 8 s, $v = 0 + 1 \times 8 = 8\ \text{ms}^{-1}$

$40 = -10t + \frac{1}{2}10t^2$

$10t^2 - 2 \times 10t - 2 \times 40 = 0$

$t^2 - 2t - 8 = 0$

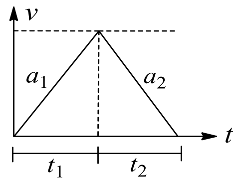
$t - 4t + 2t - 8 = 0$

$t = 4$ s

236 **(2)**

$t_1 + t_2 = 4$ min, $v = a_1t_1 = a_2t_2$

$S = \frac{1}{2} \times 4v \Rightarrow 4 = 2v \Rightarrow v = 2$



$t_1 + t_2 = v\left[\frac{1}{a_1} + \frac{1}{a_2}\right] \Rightarrow 4 = 2\left[\frac{1}{a_1} + \frac{1}{a_2}\right] \Rightarrow \frac{1}{a_1} + \frac{1}{a_2} = 2$

237 **(1)**

$v^2 = u^2 - 2\text{g}s$

$0 = u^2 - (2)(10)$ will give $u = 10\ \text{ms}^{-1}$

Further, $v = u - \text{g}t$

$0 = 10 - (10)t$ gives $t = 1$s

238 **(2)**

Taking upward direction as positive, let us work in the frame of lift. Acceleration of ball relative to lift $= (\text{g} + a)$ downward, so $a_{\text{real}} = -(\text{g} + a)$, initial velocity: $u_{\text{rel}} = v$, final velocity: $v_{\text{rel}} = -v$ as the ball will reach the man with same speed w.r.t lift

Apply $v_{\text{rel}} = u_{\text{rel}} + a_{\text{rel}}t \Rightarrow -v = v + (-\text{g} - a)t \Rightarrow t = 2$ s

239 **(8)**

$t_1 = t_2 - t, v_1 = v_2 = v, S = \frac{1}{2}a_1t_2^1, S = \frac{1}{2}a_2t_2^2$

$v_1 = a_1t_1, v_2 = a_2t_2 \Rightarrow v_2 + v = a_1t_1$

$\Rightarrow a_2t_2 + v = a_1t_1 = a_1t_2 \Rightarrow t_2 = \frac{v + a_1t}{a_1 - a_2}$

$\sqrt{\frac{a_2}{a_1}} = \frac{t_1}{t_2} = 1 - \frac{t}{t_2} \Rightarrow \sqrt{\frac{a_2}{a_1}} = 1 - \frac{t(a_1 - a_2)}{(v + a_1t)}$

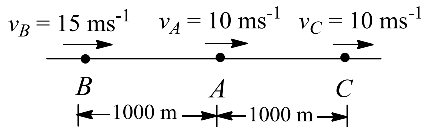
$\Rightarrow \frac{\sqrt{a_2}}{\sqrt{a_1}} = \frac{v + a_2t}{v + a_1t} \Rightarrow \sqrt{a_2}\,v + a_1\sqrt{a_2}\,t$

$= v\sqrt{a_1} + a_2\sqrt{a_1}t$

$\Rightarrow v = \left(\sqrt{a_1a_2}\right)t = 8\ \text{ms}^{-1}$

240 **(1)**

The situation can be roughly shown in the figure. Let C take time t to overtake A



$d_{\text{rel}} = 1000$ m, $v_{\text{rel}} = (10 + 15) = 25\ \text{ms}^{-1}$

Here $t = \frac{d_{\text{rel}}}{v_{\text{rel}}} = \frac{1000}{25} = 40$ s

Let acceleration of B be a for overtaking

$d_{\text{rel}} = 1000$ m; $v_{\text{rel}} = 15 - 10 = 5\ \text{ms}^{-1}$

$d_{\text{rel}} = a$ and $t = 40$ s

Using $d_{\text{rel}} = u_{\text{rel}}t + \frac{1}{2}a_{\text{rel}}t^2$

$1000 = 5 \times 40 + \frac{1}{2}a(40)^2 \Rightarrow a = 1\ \text{ms}^{-2}$

241 **(1)**

$V_p = 90\ \text{kmh}^{-1} = 25\ \text{ms}^{-1}$

$V_c = 72\ \text{kmh}^{-1} = 20\ \text{ms}^{-1}$

In 10 s culprit reaches point B from A. Distance covered by culprit, $S = vt = 20 \times 10 = 200$ m

At time $t = 10\ s$, the police jeep is 200 m behind the culprit. Relative velocity between jeep and culprit is $25 - 20 = 5\ \text{ms}^{-1}$

Time $= \frac{S}{V} = \frac{200}{5} = 40$ s (Relative velocity is considered)

In 40 s, the police jeep will move from A to a distance S. Where $S = vt = 25 \times 40 = 1000$ m $=$ 1.0 km away

The jeep will catch up with the bike 1 km far from the turning

242 **(5)**

For rat $S = \frac{1}{2}\beta t^2$ (i)

For cat $S = d = ut + \frac{1}{2}\alpha t^2 0$ (ii)

Putting the value of S from Eq.(i) in Eq.(ii),

$(a - b)t^2 + 2ut - 2d = 0$

$t = \frac{2u \pm \sqrt{4u^2 - 8d(\beta - \alpha)}}{2(\beta - \alpha)}$

For t to be real, $\frac{u^2}{2d} \geq (\beta - \alpha)$

$$\therefore\ \beta = \alpha + \frac{u^2}{2d}$$

Substituting a, d and u we get

$$\beta = 2.5 + \frac{5^2}{2 \times 5} = 2.5 + 2.5 = 5\ \mathrm{ms}^{-2}$$