Topicwise Questions

POSITION, DISTANCE AND DISPLACEMENT

1. A Body moves 6 m north. 8 m east and 10m vertically upwards, what is its resultant displacement from initial position

(*a*) $10\sqrt{2}$ (*b*) 10m

(*c*) $\frac{10}{\sqrt{2}}$m (*d*) 10×2m

2. A man goes 10m towards North, then 20m towards east then displacement is

(*a*) 22.5m (*b*) 25m

(*c*) 25.5m (*d*) 30m

SPEED AND VELOCITY

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

(*a*) v_1v_2 (*b*) $\frac{v_2^2}{v_1^2}$

(*c*) $\frac{v_1+v_2}{2}$ (*d*) $\frac{2v_1v_2}{v_1+v_2}$

4. A car travels the first half of a distance between two places at a speed of 30 km/hr and the second half of the distance at 50 km/hr. The average speed of the car for the whole journey is

(*a*) 42.5 km/hr (*b*) 40.0 km/hr

(*c*) 37.5 km/hr (*d*) 35.0 km/hr

5. A person travels along a straight road for the first half time with a velocity v_1 and the next half time with a velocity v_2. The mean velocity V of the man is

(*a*) $\frac{2}{V}=\frac{1}{v_1}+\frac{1}{v_2}$ (*b*) $V=\frac{v_1+v_2}{2}$

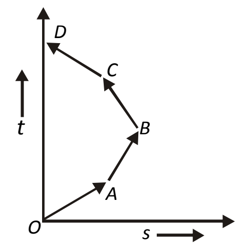
(*c*) $V=\sqrt{v_1v_2}$ (*d*) $V=\sqrt{\frac{v_1}{v_2}}$

6. If a car covers $2/5^{th}$ of the total distance with v_1 speed and $3/5^{th}$ distance with v_2 then average speed is

(*a*) $\frac{1}{2}\sqrt{v_1v_2}$ (*b*) $\frac{v_1+v_2}{2}$

(*c*) $\frac{2v_1v_2}{v_1+v_2}$ (*d*) $\frac{5v_1v_2}{3v_1+2v_2}$

7. Which of the following options is correct for the object having a straight line motion represented by the following graph



(*a*) The object moves with constantly increasing velocity from O to A and then it moves with constant velocity.

(*b*) Velocity of the object increases uniformly

(*c*) Average velocity is zero

(*d*) The graph shown is impossible

ACCELERATION, EQUATION OF KINEMATICS: CONSANT ACCELERATION

8. A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then

(*a*) $S_1 = S_2$ (*b*) $S_1 = S_2/3$

(*c*) $S_1 = S_2/2$ (*d*) $S_1 = S_2/4$

9. A body is moving from rest under constant acceleration and let S_1 be the displacement in the first (p – 1) sec and S_2 be the displacement in the first P sec. The displacement in $(p^2 - p + 1)^{th}$ sec. will be

(*a*) $S_1 + S_2$ (*b*) $S_1 S_2$

(*c*) $S_1 - S_2$ (*d*) S_1 / S_2

10. A body starts from the origin and moves along the X-axis such that the velocity at any instant is given by $(4t^3 - 2t)$, where t is in sec and velocity is in m/s. What is the acceleration of the particle, when it is 2 m from the origin?

(*a*) 28 m/s^2 (*b*) 22 m/s^2

(*c*) 12 m/s^2 (*d*) 10 m/s^2

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

12. A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10m Its acceleration is

(*a*) 20 m/sec^2 (*b*) –20 m/sec^2
(*c*) –40 m/sec^2 (*d*) +2m/sec^2

13. Which of the following four statements is false

(*a*) A body can have zero velocity and still be accelerated
(*b*) A body can have a constant velocity and still have a varying speed
(*c*) A body can have a constant speed and still have a varying velocity
(*d*) The direction of the velocity of a body can change when its acceleration is constant

14. A car moving with a velocity of 10 m/s can be stopped by the application of a constant force F in a distance of 20 m. If the velocity of the car is 30 m/s, it can be stopped by this force in

(*a*) $\frac{20}{3}$m (*b*) 20m
(*c*) 60m (*d*) 180m

15. The position of a particle moving along the x-axis at certain times is given below:

t(s)	0	1	2	3
x(m)	–2	0	6	16

Which of the following describes the motion correctly

(*a*) Uniform, accelerated
(*b*) Uniform, decelerated
(*c*) Non-uniform, accelerated
(*d*) There is not enough data for generalization

16. A car starts from rest and moves with uniform acceleration a on a straight road from time t = 0 to t = T. After that, constant deceleration brings it to rest. In this process the average speed of the car is

(*a*) $\frac{aT}{4}$ (*b*) $\frac{3aT}{2}$
(*c*) $\frac{aT}{2}$ (*d*) aT

17. If the velocity of a particle is given by $v = (180 - 16x)^{1/2}$ m/s, then its acceleration will be

(*a*) Zero (*b*) 8 m/s^2
(*c*) – 8 m/s^2 (*d*) 4 m/s^2

18. The displacement x of a particle varies with time $t, x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(*a*) Go on decreasing with time
(*b*) Will be independent of α and β
(*c*) Drop to zero when $\alpha = \beta$
(*d*) Go on increasing with time

19. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S, then

(*a*) $S = \frac{1}{2}ft^2$ (*b*) $S = \frac{1}{4}ft^2$
(*c*) $S = \frac{1}{72}ft^2$ (*d*) $S = \frac{1}{6}ft^2$

20. A body is starts from rest with acceleration 2 m/s^2 till it attains the maximum velocity then retards to rest with 3 m/s^2. If total time taken is 10 second then maximum speed attained is

(*a*) 12 m/s (*b*) 8 m/s
(*c*) 6 m/s (*d*) 4 m/s

MOTION UNDER GRAVITY

21. A stone falls from a balloon that is descending at a uniform rate of 12 m/s. The displacement of the stone from the point of release after 10 sec is

(*a*) 490 m (*b*) 510m
(*c*) 610m (*d*) 725m

22. Two bodies of different masses m_a and m_b are dropped from two different heights a and b. The ratio of the time taken by the two to cover these distances are

(*a*) a : b (*b*) b : a
(*c*) $\sqrt{a} : \sqrt{b}$ (*d*) $a^2 : b^2$

23. A ball P is dropped vertically and another ball Q is thrown horizontally with the same velocities from the same height and at the same time. If air resistance is neglected, then

(*a*) Ball P reaches the ground first
(*b*) Ball Q reaches the ground first
(*c*) Both reach the ground at the same time
(*d*) The respective masses of the two balls will decide the time

24. A stone dropped from the top of the tower touches the ground in 4 sec. The height of the tower is about

(*a*) 80m (*b*) 40m
(*c*) 20m (*d*) 160m

25. A body is released from the top of a tower of height h. It takes t sec to reach the ground. Where will be the ball after time t/2 sec

(*a*) At h/2 from the ground
(*b*) At h/4 from the ground
(*c*) Depends upon mass and volume of the body
(*d*) At 3h/4 from the ground

26. A body is slipping from an inclined plane of height h and length l. If the angle of inclination is θ, the time taken by the body to come from the top to the bottom of this inclined plane is

(*a*) $\sqrt{\frac{2h}{g}}$ (*b*) $\sqrt{\frac{2l}{g}}$

(*c*) $\frac{1}{\sin\theta}\sqrt{\frac{2h}{g}}$ (*d*) $\sin\theta\sqrt{\frac{2h}{g}}$

27. A man in a balloon rising vertically with an acceleration of 4.9 m/sec^2 releases a ball 2 sec after the balloon is let go from the ground. The greatest height above the ground reached by the ball is (g = 9.8m/sec^2)

(*a*) 14.7 m (*b*) 19.6 m
(*c*) 9.8 m (*d*) 24.5 m

28. A rocket is fired upward from the earth's surface such that it creates an acceleration of 19.6 m/sec^2. If after 5 sec its engine is switched off, the maximum height of the rocket from earth's surface would be

(*a*) 245 m (*b*) 490 m
(*c*) 980 m (*d*) 735 m

29. A ball of mass m_1 and another ball of mass m_2 are dropped from equal height. If time taken by the balls are t_1 and t_2 respectively, then

(*a*) $t_1 = \frac{t_2}{2}$ (*b*) $t_1 = t_2$

(*c*) $t_1 = 4t_2$ (*d*) $t_1 = \frac{t_2}{4}$

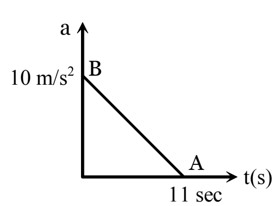
30. Three different objects of masses m_1, m_2 and m_3 are allowed to fall from rest and from the same point 'O' along three different frictionless paths. The speeds of the three objects, on reaching the ground, will be in the ratio of

(*a*) $m_1 : m_2 : m_3$ (*b*) $m_1 : 2m_2 : 3m_3$

(*c*) 1 : 1 : 1 (*d*) $\frac{1}{m_1} : \frac{1}{m_2} : \frac{1}{m_3}$

VARIABLE ACCELERATION

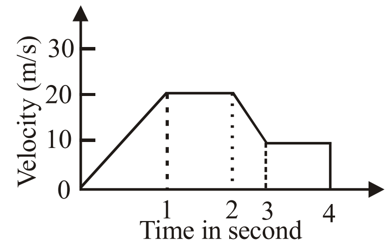
31. A particle starts from rest. Its acceleration (a) versus time (t) is as shown in the figure. The maximum speed of the particle will be



(*a*) 110 m/s (*b*) 55 m/s
(*c*) 550 m/s (*d*) 660 m/s

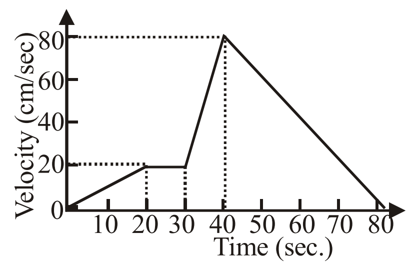
GRAPHS

32. The variation of velocity of a particle with time moving along a straight line is illustrated in the following figure. The distance travelled by the particle in four seconds is



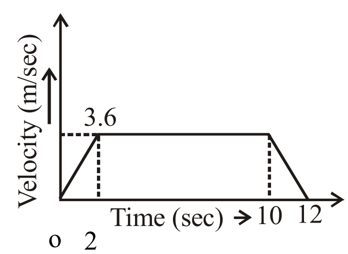
(*a*) 60 m (*b*) 55 m
(*c*) 25 m (*d*) 30 m

33. The v – t graph of a moving object is given in figure. The maximum acceleration is



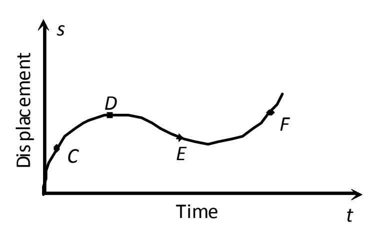
(*a*) 1cm/sec^2 (*b*) 2 cm/sec^2
(*c*) 3 cm/sec^2 (*d*) 6 cm/sec^2

34. A lift is going up. The variation in the speed of the lift is as given in the graph. What is the height to which the lift takes the passengers?



(*a*) 3.6 m
(*b*) 28.8 m
(*c*) 36.0 m
(*d*) Cannot be calculated from the above graph

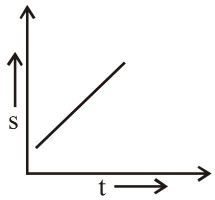
35. The displacement-time graph of moving particle is shown below

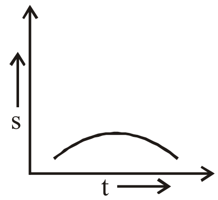


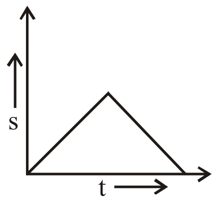
The instantaneous velocity of the particle is negative at the point

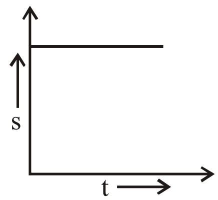
(*a*) D (*b*) F
(*c*) C (*d*) E

36. Which of the following graph represents uniform motion

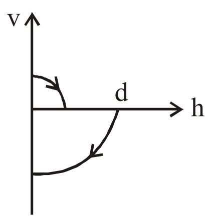
(*a*) 

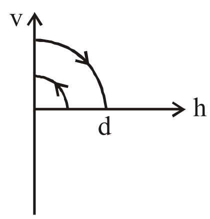
(*b*) 

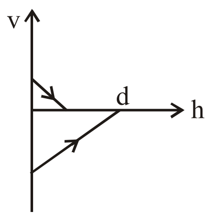
(*c*) 

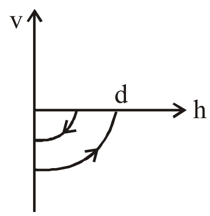
(*d*) 

37. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground is

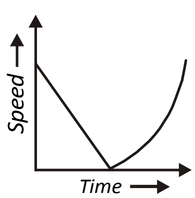
(*a*) 

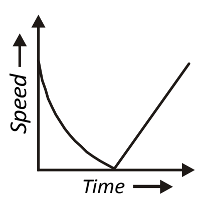
(*b*) 

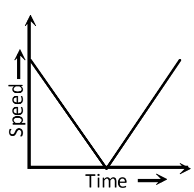
(*c*) 

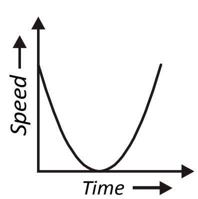
(*d*) 

38. A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its height if the air resistance (constent) is not ignored

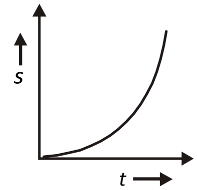
(*a*) 

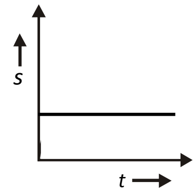
(*b*) 

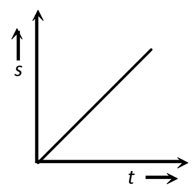
(*c*) 

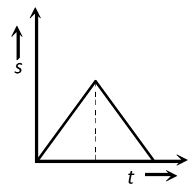
(*d*) 

39. Which graph represents the uniform acceleration

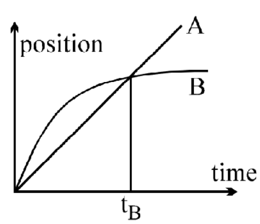
(*a*) 

(*b*) 

(*c*) 

(*d*) 

40. The graph shows position as a function of time for two trains running on parallel tracks. Which one of the following statements is true?



(*a*) At time t_B, both trains have the same velocity.

(*b*) Both trains have the same velocity at some time after t_B

(*c*) Both trains have the same velocity at some time before t_B.

(*d*) Somewhere on the graph, both trains have the same acceleration.

Learning Plus

1. A particle covers half of the circle of radius r. Then the displacement and distance of the particle are respectively-

(*a*) $2\pi r, 0$ (*b*) $2r, \pi r$

(*c*) $\frac{\pi r}{2}, 2r$ (*d*) $\pi r, r$

2. A car travels from A to B at a speed of 20 km h^{-1} and returns at a speed of 30 km h^{-1}. The average speed of the car for the whole journey is

(*a*) 5 km h^{-1} (*b*) 24 km h^{-1}

(*c*) 25 km h^{-1} (*d*) 50 km h^{-1}

3. A car runs at constant speed on a circular track of radius 100 m taking 62.8 s on each lap. What is the average speed and average velocity on each complete lap ?

(*a*) velocity 10 m/s speed 10 m/s

(*b*) velocity zero, speed 10 m/s

(*c*) velocity zero, speed zero

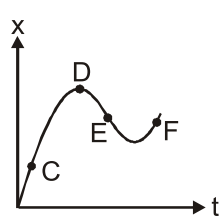
(*d*) velocity 10 m/s, speed zero

4. The displacement of a body is given by $2s = gt^2$ where g is a constant. The velocity of the body at any time t is

(*a*) gt (*b*) gt/2

(*c*) $gt^2/2$ (*d*) $gt^3/3$

5. The displacement-time graph of a moving particle is shown below. The instantaneous velocity of the particle is zero at the point



(*a*) C (*b*) D

(*c*) E (*d*) F

6. A body starts from rest and is uniformly accelerated for 30 s. The distance travelled in the first 10s is x_1, next 10 s is x_2 and the last 10 s is x_3. Then $x_1 : x_2 : x_3$ is the same as

(*a*) 1 : 2 : 4 (*b*) 1 : 2 : 5

(*c*) 1 : 3 : 5 (*d*) 1 : 3 : 9

7. A body starts from rest with constant acceleration, the ratio of distances travelled by the body during 4^{th} and 5^{th} seconds is:

(*a*) 7/5 (*b*) 7/9

(*c*) 7/3 (*d*) 3/7

8. A particle, after starting from rest , experiences, constant acceleration for 20 seconds. If it covers a distance of S_1, in first 10 seconds and distance S_2 in next 10 sec, then

(*a*) $S_2 = S_1/2$ (*b*) $S_2 = S_1$

(*c*) $S_2 = 2S_1$ (*d*) $S_2 = 3S_1$

9. A body sliding on a smooth inclined plane requires 4sec to reach the bottom after starting from rest at the top. How much time does it take to cover one fourth the distance starting from the top

(*a*) 1sec (*b*) 2 sec

(*c*) 0.4sec (*d*) 1.6 sec

10. A body is dropped from a height h under acceleration due to gravity g. If t_1 and t_2 are time intervals for its fall for first half and the second half distance, the relation between them is

(*a*) $t_1 = t_2$ (*b*) $t_1 = 2t_2$

(*c*) $t_1 = 2.414\, t_2$ (*d*) $t_1 = 4t_2$

11. A body is thrown upward and reaches its maximum height. At that position-

(*a*) its velocity is zero and its acceleration is also zero

(*b*) its velocity is zero but its acceleration is maximum

(*c*) its acceleration is minimum

(*d*) its velocity is zero and its acceleration is the acceleration due to gravity

12. A particle is moving so that its displacement s is given as $s = t^3 - 6t^2 + 3t + 4$ meter. Its velocity at the instant when its acceleration is zero will be -

(*a*) 3 m/s (*b*) –12 m/s

(*c*) 42 m/s (*d*) –9 m/s

13. 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 body was at rest at t = 0 find the wrong option.

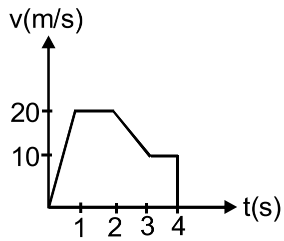
(*a*) The terminal speed is 2.0 m/s

(*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

14. The variation of velocity of a particle moving along straight line is shown in the figure. The distance travelled by the particle in 4 s is

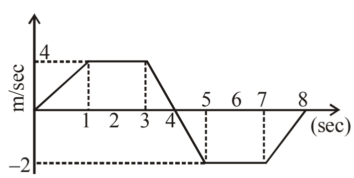


(*a*) 25m (*b*) 30m
(*c*) 55m (*d*) 60m

15. The displacement time graphs of two particles A and B are straight lines making angles of respectively 30º and 60º with the time axis. If the velocity of A is v_A and that of B is v_B then the value of $\frac{v_A}{v_B}$ is

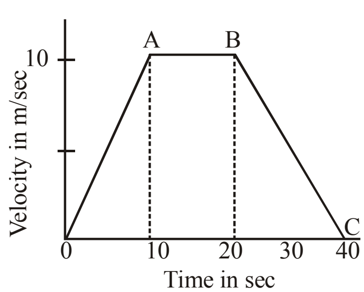
(*a*) 1/2 (*b*) $1/\sqrt{3}$
(*c*) $\sqrt{3}$ (*d*) 1/3

16. The v-t graph of a linear motion is shown in adjoining figure. The distance from origin after 8 seconds is-



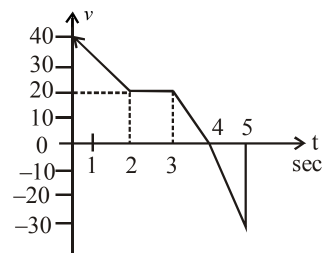
(*a*) 18 meters (*b*) 16 meters
(*c*) 8 meters (*d*) 6 meters

17. The adjoining curve represents the velocity-time graph of a particle, its acceleration values along OA, AB and BC in metre/sec^2 are respectively-



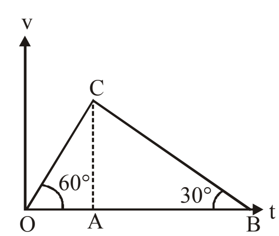
(*a*) 1, 0, -0.5 (*b*) 1, 0, 0.5
(*c*) 1, 1, 0.5 (*d*) 1, 0.5, 0

18. In the following velocity-time graph of a body, the distance and displacement travelled by the body in 5 second in meters will be -



(*a*) 75,115 (*b*) 105, 75
(*c*) 45, 75 (*d*) 95, 55

19. The velocity-time graph of body is shown in figure. The ratio of the .... during the intervals OA and AB is .... which of the following statement is wrong



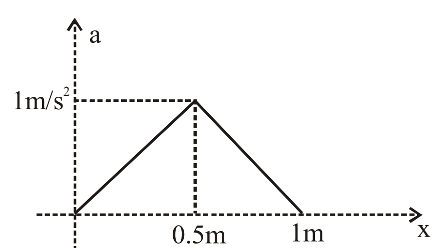
(*a*) magnitude of average velocities, 1

(*b*) $\frac{OA}{AB}, \frac{1}{4}$

(*c*) magnitude of average accelerations, inverse of ratio of distances covered

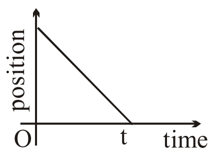
(*d*) distance covered, 1 : 3

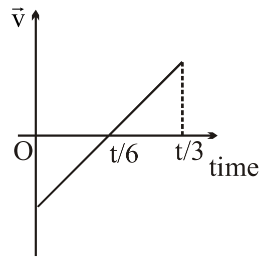
20. A body initially at rest, starts moving along x-axis in such a way so that its acceleration vs displacement plot is as shown in figure. The maximum velocity of particle is

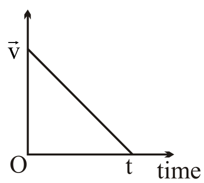


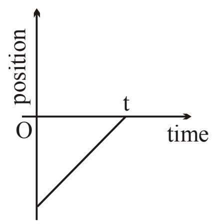
(*a*) 1 m/s (*b*) 6 m/s
(*c*) 2 m/s (*d*) none

21. For which of the following graphs the average velocity of a particle moving along a straight line for time interval (0, t) must be negative.

(*a*) 

(*b*) 

(*c*) 

(*d*) 

22. Each of four particles move along x-axis. Their coordinates (in meters) as functions of time (in seconds) are given by

particle 1 : $x(t) = 3.5 - 2.7t^3$

particle 2 : $x(t) = 3.5 + 2.7t^3$

particle 3 : $x(t) = 3.5 + 2.7t^2$

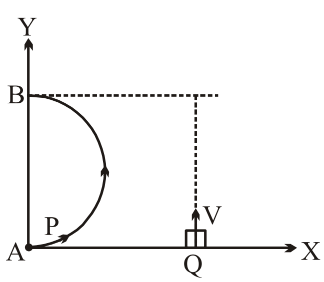
particle 4 : $x(t) = 3.5 - 3.4t - 2.7t^2$

Which of these particles have constant acceleration ?

(*a*) All four (*b*) Only 1 and 2

(*c*) Only 2 and 3 (*d*) Only 3 and 4

23. A particle P starts from origin as shown and moves along a circular path. Another particle Q crosses x-axis at the instant particle P leaves origin. Q moves with constant speed v parallel to y-axis and is all the time having y-coordinate same as that of P. When P reaches diametrically opposite at point B, its average speed is



(*a*) πV (*b*) $\frac{\pi V}{2}$

(*c*) $\frac{V}{2}$ (*d*) None of these

24. A particle is projected up from ground with initial speed v_0. Starting from time $t = 0$ to $t = t_1$,

(*a*) Distance travelled and magnitude of displacement are not equal if $t_1 < \frac{v_0}{g}$

(*b*) Distance travelled and magnitude of displacement are equal if $\frac{v_0}{g} < t_1 < \frac{2v_0}{g}$

(*c*) Distance travelled and magnitude of displacement may not be equal if $0 < t_1 < \frac{2v_0}{g}$

(*d*) The magnitude of displacement is greater than the distance travelled if $\frac{v_0}{g} < t_1 < \frac{2v_0}{g}$

25. Two bodies P and Q have to move equal distances starting from rest. P is accelerated with 2a for first half distance then its acceleration becomes a for last half, where as Q has acceleration a for firsthalf and acceleration 2a for last half, then for whole journey.

(*a*) Average speed of P is more than that of

(*b*) Average speed of both will be same.

(*c*) Maximum speed during the journey is more for P.

(*d*) Maximum speed during the journey is more for

26. A particle moves along the x axis from x_i to x_f. Of the following values of the initial and final coordinates, which results in a negative displacement?

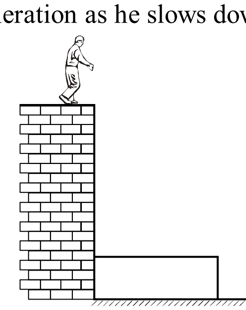
(*a*) $x_i = 4m, x_f = 6m$

(*b*) $x_i = -4m, x_f = -8m$

(*c*) $x_i = -4m, x_f = 2m$

(*d*) $x_i = -4m, x_f = -2m$

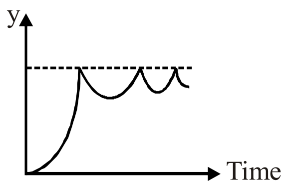
27. Suppose that a man jumps off a building 202 m high onto cushions having a total thickness of 2m. If the cushions are crushed to a thickness of 0.5 m, what is the man's acceleration as he slows down?



(*a*) $10 \, m/s^2$ (*b*) $\frac{4000}{3} \, m/s^2$

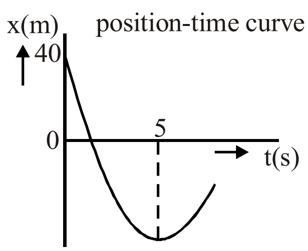
(*c*) $50 \, m/s^2$ (*d*) $20 \, m/s^2$

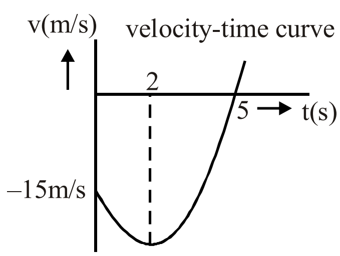
28. The graph below describes the motion of a ball rebounding from a horizontal surface being released from a point above the surface. The quantity represented on the y-axis is the ball's

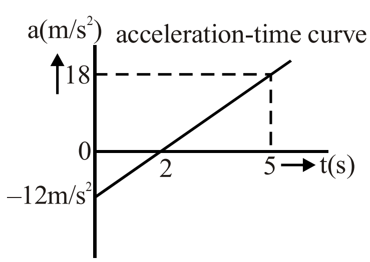


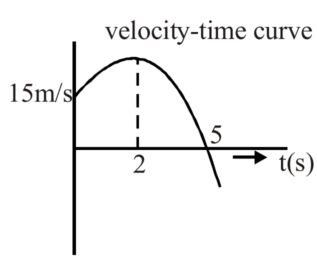
(*a*) displacement (*b*) velocity
(*c*) acceleration (*d*) momentum

29. The position of a particle which moves along a straight line is defined by the relation $x = t^3 - 6t^2 - 15t + 40$, where x is expressed in meters and t in seconds. Which of the graph does not represent the motion of the particle?

(*a*)


(*b*)


(*c*)


(*d*)


30. A Trolley is moving away from a stop with an acceleration $a = 0.2\ m/s^2$. After reaching the velocity $u = 36\ km/h$, it moves with a constant velocity for the time of 2 min. Then, it uniformly slows down, and stops after further travelling a distance of 100 m. Find the average speed all the way between stops.

(*a*) $\frac{76}{17}$ m/s (*b*) $\frac{208}{21}$ m/s

(*c*) $\frac{85}{12}$ m/s (*d*) $\frac{155}{19}$ m/s

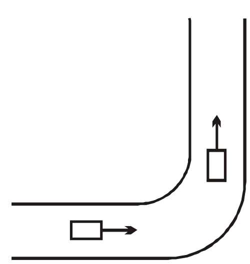
31. Two cars start to move simultaneously with the same speed from point A to point B. The first moves in a straight line connecting A and B, uniformly, and the second - on the bypass road, made as a half-circle connecting the same points. The speed of the second uniformly increases so that at the end of the path its speed is doubled. Which car will arrive earlier at point B?

(*a*) 1st car
(*b*) 2nd car
(*c*) both will reach simultaneously
(*d*) depends on values of R and v

32. A particle is dropped from rest. The particle first covers a distance x_1 in time t_1 and then a distance x_2 in further time t_2. If ratio of time $\frac{t_1}{t_2} = \frac{1}{(\sqrt{2}-1)}$, find the correct option:

(*a*) $x_1 = x_2$ (*b*) $x_1 > x_2$
(*c*) $x_1 < x_2$ (*d*) Unpredictable

33. A car is moving with $20\ ms^{-1}$ from west to east and takes left turn in 5 sec without changing its speed. Find average acceleration of the car during this period of 5 sec.



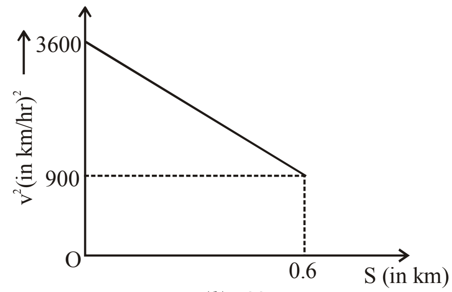
(*a*) $4\sqrt{2}\ ms^{-2}$ N–E

(*b*) $4\sqrt{2}\ ms^{-2}$ N–W

(*c*) $4\ ms^{-2}$ N – E

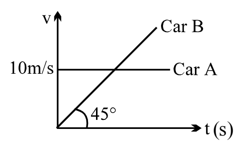
(*d*) Zero

34. A graph between the square of the velocity of a particle and the distance 'S' moved by the particle is shown in the figure. The acceleration of the particle in kilometer per hour square is



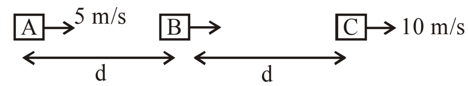
(*a*) 2250 (*b*) 225
(*c*) –2250 (*d*) –225

35. Initially car A is 10.5 m ahead of car B. Both start moving at time t = 0 in the same direction along a straight line. The velocity time graph of two cars is shown in figure. The time when the car B will catch the car A, will be



(*a*) t = 21 sec (*b*) t = $2\sqrt{5}$ sec
(*c*) 20 sec (*d*) none

36. Three persons A, B, C are moving along a straight line as shown with constant and different speeds. When B catches C, the seperation between A & C becomes 4d, then the speed of B is



(*a*) 15 m/s
(*b*) 10 m/s
(*c*) 12.5 m/s
(*d*) not possible

37. Two balls are projected simultaneously with the same speed from the top of a tower, one vertically upwards and the other vertically downwards. If the first ball strikes the ground with speed 20 m/s then speed of second ball when it strikes the ground is.
(*a*) 10 m/s
(*b*) 20 m/s
(*c*) 40 m/s
(*d*) Data insufficient

Advanced Level Multiconcept Questions

MCQ/COMPREHENSION/MATCHING/NUMERICAL

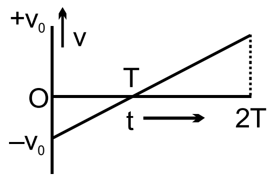
1. Mark the correct statements for a particle going on a straight line
(*a*) if the velocity is zero at any instant, the acceleration should also be zero at that instant
(*b* if the velocity is zero for a time interval, the acceleration is zero at any instant within the time interval
(*c*) if the velocity and acceleration have opposite sign, the object is slowing down
(*d*) if the position and velocity have opposite sign, the particle is moving towards the origin.

2. Let $\vec{v}$ and $\vec{a}$ denote the velocity and acceleration respectively of a body in one-dimensional motion
(*a*) $|\vec{v}|$ must decrease when $\vec{a} < 0$
(*b*) Speed must increase when $\vec{a} > 0$
(*c*) Speed will increase when both $\vec{v}$ and $\vec{a}$ are < 0
(*d*) Speed will decrease when $\vec{v} < 0$ and $\vec{a} > 0$

3. A particle has intial velocity 10 m/s. It moves due to constant retarding force along the line of velocity which produces a retardation of 5 m/s^2. Then -
(*a*) the maximum displacement in the direction of initial velocity is 10 m
(*b*) the distance travelled in first 3 seconds is 7.5 m
(*c*) the distance travelled in first 3 seconds is 12.5 m
(*d*) the distance travelled in first 3 seconds is 17.5 m

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

5. The figure shows 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

6. A particle moves with constant speed v along a regular hexagon ABCDEF in the same order. Then the magnitude of the average velocity for its motion from A to -
(*a*) F is v/5 (*b*) D is v/3
(*c*) C is v $\sqrt{3}/2$ (*d*) B is v

Comprehension Type Questions – 1 (No. 7 to 9)

A boy is standing on a open truck. Truck is moving with an acceleration 2 m/s^2 on horizontal road. When speed of truck is 10 m/s and reaches to a electric pole, boy projected a ball with a velocity 10 m/s in vertical upward direction relative to himself (take g = 10 m/s^2). Neglect the height of boy and truck.

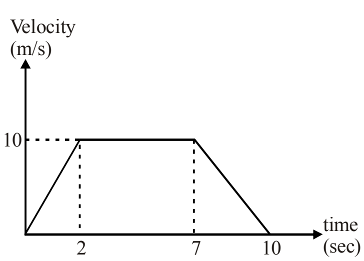
7. The distance of ball from pole where ball land is
(*a*) 20m (*b*) 10m
(*c*) 30m (*d*) 40m

8. Maximum height of ball from ground is -
(*a*) 5m (*b*) 7.5m
(*c*) 2.5m (*d*) 10m

9. Speed of truck at the instant when boy see that ball is moving backward horizontally is -
(*a*) 14 m/s (*b*) 10 m/s
(*c*) 12 m/s (*d*) Data is insufficient

Comprehension Type Questions – 2(No. 10 to 12)

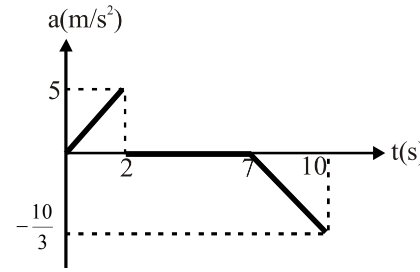
The velocity-time graph of a car moving on a straight track is given below. The car weighs 1000 kg.
(Use F = ma)

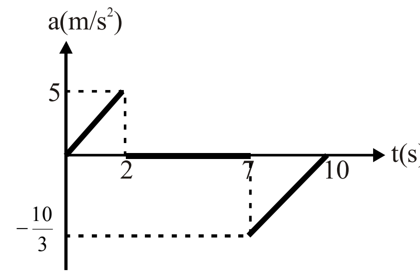


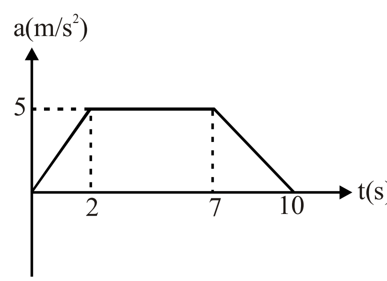
10. The distance travelled by the car during the whole motion is:
(*a*) 50m (*b*) 75m
(*c*) 100m (*d*) 150m

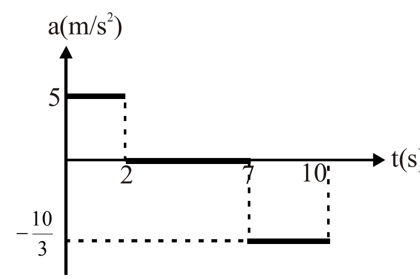
11. The braking force required to bring the car to a stop with in one second from the maximum speed is:
(*a*) $\frac{10000}{3}$ N
(*b*) 5000 N
(*c*) 10000 N
(*d*) $\frac{5000}{3}$ N

12. Correct acceleration-time graph representing the motion of car is:

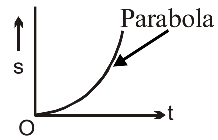
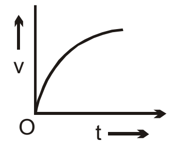
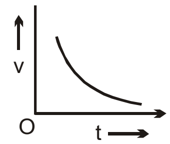
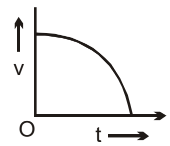
(*a*)


(*b*)


(*c*)


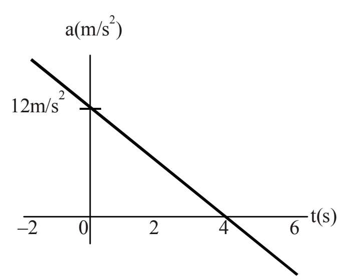
(*d*)


13. Match list **I** with List **II** and select the correct answer using the codes given below the lists.

Column-I		**Column-II**
(*a*) Dacceleration decreasing with time	(P)	
(*b*) Velocity increasing with time	(Q)	
(*c*) Magnitude of acceleration increasing with time	(R)	
(*d*) Body going farther away from the starting point with time	(S)	

NUMERICAL VALUE BASED

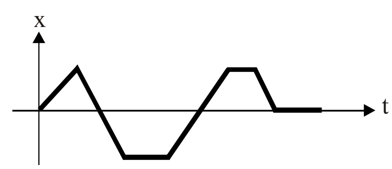
14. Figure gives the acceleration a versus time t for a particle moving along an x-axis. At t = –2.0s, the particle's velocity is 7.0 m/s. What is its velocity (in m/s) at t = 6.0 s?



15. A particle moves in xy-plane according to the equation x = 3t, y = 25 – 4t. What is the minimum distance of the particle (in m) from the origin ? Both x & y are in m.

16. A rocket rises vertically up from the surface of earth so that it's distance from the earth's surface is $l = ct^2$ where c is a constant. After 10 sec. the rocket has travelled 2 km. Determine it's speed (in m/s) at that moment.

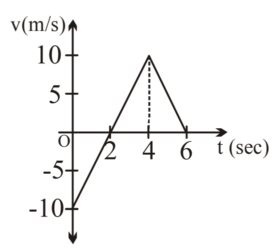
17. Consider a particle moving on a straight line with varying velocity. Its position time graph is as shown.



Find the number of times its velocity changes during motion.

18. Acceleration of particle moving rectilinearly is $a = 4 - 2x$ (where x is position in metre and a in m/s^2). It is at instantaneous rest at $x = 0$. At what position x (in metre) will the particle again come to instantaneous rest?

19. The figure shows the graph of velocity-time for a particle moving in a straight line. If the average speed for 6 sec is 'b' and the average acceleration from 0 sec to 4 sec is 'c' find magnitude of bc (in m^2/s^3).



Topicwise Questions

1. (*a*) $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \quad \therefore r = \sqrt{x^2 + y^2 + z^2}$

$r = \sqrt{6^2 + 8^2 + 10^2} = 10\sqrt{2}m$

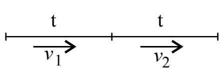
2. (*a*) $\vec{r} = 20\hat{i} + 10\hat{j}$

$\therefore r = \sqrt{20^2 + 10^2} = 22.5m$

3. (*d*) As the total distance is divided into two equal parts therefore distance average speed $= \dfrac{2v_1v_2}{v_1 + v_2}$.

4. (*c*) Distance average speed $= \dfrac{2v_1v_2}{v_1 + v_2}$

$= \dfrac{2 \times 30 \times 50}{30 + 50} = \dfrac{75}{2} = 37.5\,km/hr.$

5. (*b*) 

$V_{Ar} = \dfrac{S}{T} = \dfrac{v_1t + v_2t}{2t} = \dfrac{v_1 + v_2}{2}$

6. (*d*) Average speed $= \dfrac{\text{Total distance travelled}}{\text{Total time taken}}$

$= \dfrac{x}{\dfrac{2x/5}{v_1} + \dfrac{3x/5}{v_2}} = \dfrac{5v_1v_2}{3v_1 + 2v_2}$.

7. (*c*) From given figure, it is clear that the net displacement is zero. So average velocity will be zero.

8. (*b*) As $S = ut + \dfrac{1}{2}at^2 \therefore S_1 = \dfrac{1}{2}a(10)^2 = 50a$ .....(i)

As $v = u + at$

velocity acquired by particle in 10 sec $v = a \times 10$

For next 10 sec, $S_2 = (10a) \times 10 + \dfrac{1}{2}(a) \times (10)^2$

$S_2 = 150a$ .....(ii)

From (i) and (ii) $S_1 = S_2/3$

9. (*a*) From $S = ut + \dfrac{1}{2}at^2$

$S_1 = \dfrac{1}{2}a(P-1)^2$ and $S_2 = \dfrac{1}{2}aP^2\,[\text{As } u = 0]$

From $S_n = u + \dfrac{a}{2}(2n-1)$

$S_{(P^2-P+1)^{th}} = \dfrac{a}{2}\left[2\left(P^2 - P + 1\right) - 1\right] = \dfrac{a}{2}\left[2P^2 - 2P + 1\right]$

It is clear that $S_{(P^2-P+1)^{th}} = S_1 + S_2.$

10. (*b*) $v = 4t^3 - 2t$ (given) $\therefore a = \dfrac{dv}{dt} = 12t^2 - 2$

and $x = \int_0^t v\,dt = \int_0^t \left(4t^3 - 2t\right)dt = t^4 - t^2$

When particle is at 2m from the origin $t^4 - t^2 = 2$

$\Rightarrow t^4 - t^2 - 2 = 0\ \left(t^2 - 2\right)\left(t^2 + 1\right) = 0 \Rightarrow t = \sqrt{2}$ sec

Acceleration at $t = \sqrt{2}$ sec given by,

$a = 12t^2 - 2 = 12 \times 2 - 2 = 22m/s^2$.

11. (*b*) Let u_1, u_2, u_3 and u_4 be velocities at time $t = 0, t_1, (t_1 + t_2)$ and $(t_1 + t_2 + t_3)$ respectively and acceleration is a then

$v_1 = \dfrac{u_1 + u_2}{2}, v_2 = \dfrac{u_2 + u_3}{2}$ and $v_3 = \dfrac{u_3 + u_4}{2}$

Also $u_2 = u_1 + at_1, u_3 = u_1 + a\left(t_1 + t_2\right)$

and $u_4 = u_1 + a\left(t_1 + t_2 + t_3\right)$

By solving, we get $\dfrac{v_1 - v_2}{v_2 - v_3} = \dfrac{\left(t_1 + t_2\right)}{\left(t_2 + t_3\right)}$..

12. (*b*) From $v^2 = u^2 + 2aS$

$\Rightarrow 0 = u^2 + 2aS$

$\Rightarrow a = \dfrac{-u^2}{2S} = \dfrac{-(20)^2}{2 \times 10} = -20m/s^2.$

13. (*b*) Constant velocity means constant speed as well as same direction throughout.

14. (*d*) $S \propto u^2$ If u becomes 3 times then S will become 9 times i.e. $9 \times 20 = 180m$.

15. (*c*) Instantaneous velocity $v = \dfrac{\Delta x}{\Delta t}$

By using the data from the table

$$v_1 = \frac{0-(-2)}{1} = 2\text{m/s}, \quad v_2 = \frac{6-0}{1} = 6\text{m/s}$$

$$v_3 = \frac{16-6}{1} = 10\text{m/s}.$$

16. (*c*) For First part,

u = 0, t = T and acceleration = a

$$\therefore v = 0 + aT = aT \text{ and } S_1 = 0 + \frac{1}{2}aT^2 = \frac{1}{2}aT^2$$

For Second part,

u = aT, retardation = a_1, v = 0 and time taken = T_1 (let)

$$\therefore 0 = u - a_1T_1 \Rightarrow aT = a_1T_1$$

and from $v^2 = u^2 - 2aS_2$

$$\Rightarrow S_2 = \frac{u^2}{2a_1} = \frac{1}{2}\frac{a^2T^2}{a_1} \quad (v = aT)$$

$$S_2 = \frac{1}{2}aT \times T_1 \left(\text{As } a_1 = \frac{aT}{T_1}\right)$$

$$V_{Av} = \frac{S_1 + S_2}{T + T_1} = \frac{aT}{2}$$

17. (*c*) $v = (180 - 16x)^{1/2}$

As $a = \dfrac{dv}{dt} = \dfrac{dv}{dx}.\dfrac{dx}{dt}$

$$\therefore a = \frac{1}{2}(180-16x)^{-1/2} \times (-16)\left(\frac{dx}{dt}\right)$$

$$= -8(180-16x)^{-1/2} \times v$$

$$= -8(180-16x)^{-1/2} \times (180-16x)^{1/2} = -8\text{m/s}^2.$$

18. (*d*) $x = ae^{-\alpha t} + be^{\beta t}$

Velocity $v = \dfrac{dx}{dt} = \dfrac{d}{dt}\left(ae^{-at} + be^{\beta t}\right)$

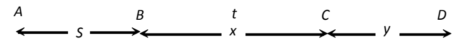
$$= a.e^{-\alpha t}\left(-\alpha + be^{\beta t}.\beta\right) = -a\,\alpha e^{-\alpha t} + b\,\beta e^{\beta t}$$

Acceleration $= -a\,\alpha e^{\alpha t}(\alpha) + b\,\beta e^{bt}.\beta$

$$= a\,\alpha^2\ e^{-\alpha t} + b\beta^2\ e^{\beta t}$$

Acceleration is positive so velocity goes on increasing with time.

19. (*c*) Let car starts from point A from rest and moves up to point B with acceleration f.



Velocity of car at point B, $v = \sqrt{2fS}$

[As $v^2 = u^2 + 2as$]

Car moves distance BC with this constant velocity in time t

$x = \sqrt{2fS}.t$ ......(i) [As s = ut]

So the velocity of car at point C also will be $\sqrt{2fs}$ and finally car stops after covering distance y.

$$\text{Distance CD} \Rightarrow y = \frac{\left(\sqrt{2fS}\right)^2}{2(f/2)} = \frac{2fS}{f} = 2S \text{ ....(ii)}$$

$$[\text{As } v^2 = u^2 - 2as \Rightarrow s = u^2/2a]$$

So, the total distance AD = AB + BC + CD = 15S (given)

$\Rightarrow$ S + x + 2S = 15S $\Rightarrow$ x = 12S

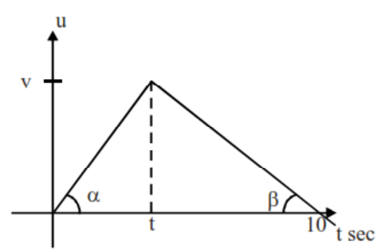
Substituting the value of x in equation (i) we get

$$x = \sqrt{2fS}.t \Rightarrow 12S = \sqrt{2fS}.t$$

$$\Rightarrow 144S^2 = 2fS.t^2$$

$$\Rightarrow S = \frac{1}{72}ft^2.$$

20. (*a*)



tan α = 2, tan β = 3

$$2 = \frac{v}{t}, \qquad 3 = \frac{v}{10-t}$$

v = 2t, v = 30 – 3t

30 – 3t = 2t $\Rightarrow$ t = 6 sec

v = 12 m/s

21. (*c*) u = 12 m/s, g = 9.8 m/sec², t = 10 sec

Displacement $= ut + \dfrac{1}{2}gt^2$

$$= 12 \times 10 + \frac{1}{2} \times 9.8 \times 100 = 610\text{m}.$$

22. (*c*) $h = \dfrac{1}{2}gt^2 \Rightarrow t = \sqrt{2h/g}$

$$t_a = \sqrt{\frac{2a}{g}} \text{ and } t_b = \sqrt{\frac{2b}{g}} \Rightarrow \frac{t_a}{t_b} = \sqrt{\frac{a}{b}}$$

23. (*c*) Vertical component of velocities of both the balls are same and equal to zero. So $t = \sqrt{\frac{2h}{g}}$.

24. (*a*) $h = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times (4)^2 = 80m.$

25. (*d*) Let the body after time t/2 be at x from the top, then

$$x = \frac{1}{2}g\frac{t^2}{4} = \frac{gt^2}{8} \qquad \ldots(i)$$

$$h = \frac{1}{2}gt^2 \qquad \ldots(ii)$$

Eliminate t from (i) and (ii), we get $x = \frac{h}{4}$

$\therefore$ Height of the body from the ground $= h - \frac{h}{4} = \frac{3h}{4}$.

26. (*c*) Force down the plane = mg sin θ

$\therefore$ Acceleration down the plane = g sin θ

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

$$\therefore t^2 = \frac{2l}{g\sin\theta} = \frac{2h}{g\sin^2\theta} \Rightarrow t = \frac{1}{\sin\theta}\sqrt{\frac{2h}{g}}.$$

27. (*a*) Height travelled by ball (with balloon) in 2 sec

$$h_1 = \frac{1}{2}at^2 = \frac{1}{2} \times 4.9 \times 2^2 = 9.8m$$

Velocity of the balloon after 2 sec

$v = at = 4.9 \times 2 = 9.8 m/s$

Now if the ball is released from the balloon then it acquire same velocity in upward direction.

Let it move up to maximum height h_2

$v^2 = u^2 - 2gh_2 \Rightarrow 0 = (9.8)^2 - 2 \times (9.8) \times h_2 \therefore h_2 = 4.9m$

Greatest height above the ground reached by the ball $= h_1 + h_2 = 9.8 + 4.9 = 14.7$ m.

28. (*d*) Given a = 19.6 m/s² = 2g

Resultant velocity of the rocket after 5 sec

v = 2g × 5 = 10g m/s

Height achieved after 5 sec, $h_1 = \frac{1}{2} \times 2g \times 25 = 245m$

On switching off the engine it goes up to height h_2 where its velocity becomes zero.

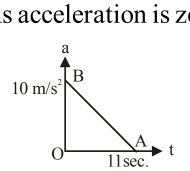
$0 = (10g)^2 - 2gh_2 \Rightarrow h_2 = 490$ m

$\therefore$ Total height of rocket = 245 + 490 = 735 m.

29. (*b*) The time of fall is independent of the mass.

30. (*c*) Speed of the object at reaching the ground $v = \sqrt{2gh}$.

31. (*b*) The area under acceleration time graph gives change in velocity. As acceleration is zero at the end of 11 sec

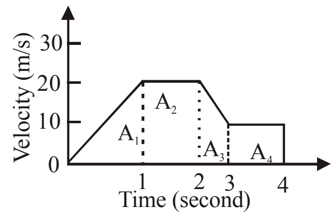


i.e. v_{max} = Area of ΔOAB

$$= \frac{1}{2} \times 11 \times 10 = 55 m/s$$

32. (*b*) Distance = Area under

v -– t graph = $A_1 + A_2 + A_3 + A_4$



$$= \frac{1}{2} \times 1 \times 20 + (20 \times 1) + \frac{1}{2}(20 + 10) \times 1 + (10 \times 1)$$

$$= 10 + 20 + 15 + 10 = 55m.$$

33. (*d*) Maximum acceleration means maximum change in velocity in minimum time interval.

In time interval t = 30 to t = 40 sec

$$a = \frac{\Delta v}{\Delta t} = \frac{80 - 20}{40 - 30} = \frac{60}{10} = 6 cm/sec^2 .$$

34. (*c*) Area of trapezium $= \frac{1}{2} \times 3.6 \times (12 + 8) = 36.0m.$.

35. (*d*) Slope of displacement time graph is negative only at point E.

36. (*a*) This graph shows uniform motion because line having a constant slope.

37. (*a*) For the given condition initial height h = d and velocity of the ball is zero. When the ball moves downward its velocity increases and it will be maximum when the ball hits the ground & just after the collision it becomes half and in opposite direction. As the ball moves upward its velocity again decreases and becomes zero at height d/2. This explanation match with graph (*a*).

38. (*d*) For upward motion

Effective acceleration = – (g + a)

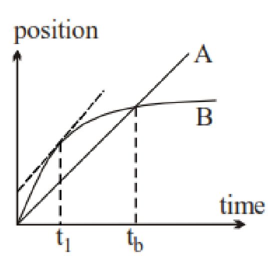
and for downward motion

Effective acceleration = (g – a)

But both are constants. So the slope of speed-time graph will be constant.

39. (*a*) Since slope of graph remains constant for velocity-time graph.

40. (*c*)

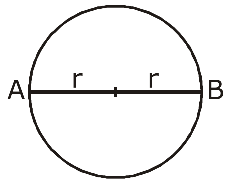


(*c*) Both have same velocity at some time before t_b at time t_1

Learning Plus

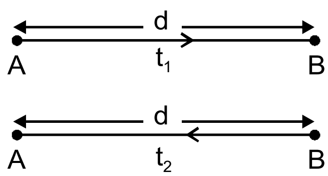
JEE-MAIN
OBJECTIVE QUESTIONS

1. (*b*)



Displacement $= 2r$
distance $= \pi r$

2. (*b*) From A to B $t_1 = \frac{d}{20}$ hr $\Rightarrow$ From B to A $t_2 = \frac{d}{30}$ hr



$\therefore$ Average Speed $= \frac{\text{Total Distance}}{\text{Total Time}}$

$$= \frac{2d}{t_1 + t_2} = \frac{2d}{\frac{d}{20} + \frac{d}{30}} \Rightarrow v = 24 \text{ km/hr}$$

3. (*b*) $t = 62.8$ sec

in each lap car travel a distance $= 2\pi R$

$= 2 \times 3.14 \times 100 = 628$ m

In each lap displacement of the car = 0

Average speed

$$= \frac{\text{Total Distance}}{\text{Total Time}} = \frac{628}{62.8} = 10 \text{ m/s}$$

Average Velocity $= \frac{\text{Total Displacement}}{\text{Total Time}} = 0$

4. (*a*) $2s = gt^2 \Rightarrow s = \frac{1}{2} gt^2$

$$v = \frac{ds}{dt} = gt$$

5. (*c*) $V_{inst} = \frac{dx}{dt}$ (slop of x-t graph)

At C $\tan\theta$ =+ve At E $\theta > 90^o(-\text{ve slop})$

At D $\theta = 0^o$ At F $\theta < 90^o(+\text{ve slope})$

$\therefore$ At D, V = 0 As ten $\theta = 0$

6. (*c*) let the acceleration of the body is a and $u = 0$

then $x_1 = \frac{1}{2}at^2 = \frac{1}{2}a(10)^2$

$$x_2 = \frac{1}{2}a(20)^2 - x_1 \Rightarrow x_2 = \frac{1}{2}a\,(20)^2 - \frac{1}{2}a\,(10)^2$$

$$= \frac{1}{2}a(10)(30) \Rightarrow x_3 = \frac{1}{2}a(30)^2 - \frac{1}{2}a\,(20)^2$$

$$= \frac{1}{2}a(10)(50) \Rightarrow \therefore\ x_1 : x_2 : x_3 = 1:3:5$$

7. (*b*) $S_2 = \frac{1}{2} \times a \times 4$

$S_3 = \frac{1}{2} \times a \times 9$

$S_4 = \frac{1}{2} \times a \times 16$

$S_5 = \frac{1}{2} \times a \times 25$

distance travelled by body in 4[th] sec $= \frac{1}{2}a[7]$

distance travelled by body in 5[th] sec $= \frac{1}{2}a[9]$

ratio = 7 : 9

8. (*d*) Let constant acceleration = a

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

$S_1 = \frac{1}{2}a \times 10^2 = 50a$

$S_2 = \frac{1}{2}a \times 20^2 - \frac{1}{2}a \times 10^2 = 150a$

$S_2 = 3S_1$

9. (*b*) In inclined initial u = 0

$S = \frac{1}{2}at^2$ and $a = g\sin\theta$

$l = \frac{1}{2} g \sin\theta \times (4)^2$ ...(i)

$\frac{\ell}{4} = \frac{1}{2} g \sin\theta\, t^2$ ...(ii)

From (i) and (ii)

t = 2 sec

10. (*c*) $\frac{h}{2} = \frac{1}{2} g t_1^2$ ....(*a*)

$h = \frac{1}{2} g (t_1 + t_2)^2$ ....(*b*)

From equation (*a*) and (*b*)

$2t_1^2 = (t_1 + t_2)^2$

$\sqrt{2} t_1 = t_1 + t_2$

$(\sqrt{2} - 1) t_1 = t_2$

$t_1 = \frac{t_2}{\sqrt{2} - 1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1}$

$t_1 = \left(\sqrt{2} + 1\right) t_2$

11. (*d*) At H_{max}, $v = 0$

Acceleration constant & it is due to gravity

$|a| = g$

12. (*d*) $v = \frac{ds}{dt} = 3t^2 - 12t + 3$

$a = \frac{dv}{dt} = 6t - 12$

$a = 0 \Rightarrow t = 2 sec$

$V_{2sec} = 3(2)^2 - 12(2) + 3 = +12 - 24 + 3$

$= -9$ m/s

13. (*c*) $\frac{dv}{dt} = 6 - 3v \Rightarrow \frac{dv}{6-3v} = dt$

Integrating both sides, $\int \frac{dv}{6-3v} = \int dt$

$\Rightarrow \frac{\log_e (6-3v)}{-3} = t + K_1$

$\Rightarrow \log_e(t - 3v) = -3t + K_2$ …(i)

At t = 0, v = 0 \ $\log_e 6 = K_2$

Substituting the value of K_2 in equation (i)

$\log_e(t - 3v) = -3t + \log_e 6$

$\Rightarrow \log_e \left(\frac{6-3v}{6}\right) = -3t$ Þ $e^{-3t} = \frac{6-3v}{6}$

$\Rightarrow t - 3v = 6e^{-3t}$ Þ $3v = 6(1 - e^{-3t})$

$\Rightarrow v = 2(1 - e^{-3t})$

$\therefore$ $v_{trminal} = 2$ m/s (When t = ¥)

Acceleration $a = \frac{dv}{dt} = \frac{d}{dt}\left[2\left(1 - e^{-3t}\right)\right] = 6e^{-3t}$

Initial acceleration = 6 m/s².

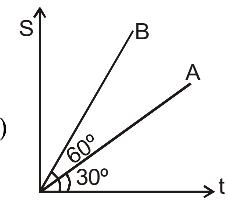
14. (*c*) From graph it is clear that velocity is always positive during its motion

so displacement = distance

displacement = Area under V-t curve

$= \frac{1}{2} \times 20 \times 1 + 20 \times 1 + \frac{1}{2} \times 1 \times 30 + 1 \times 10 \Rightarrow 55$ m

15. (*d*)



$\frac{V_A}{V_B} = \frac{\tan 30^o}{\tan 60^o} \Rightarrow \therefore \frac{V_A}{V_B} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

16. (*d*) Total Distance = Area under the curve (Position + Negative)

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

$= 2 + 8 + 2 - 1 - 4 - 1 = 6$ meter

17. (*a*) (acceleration) = Slope $= \frac{\Delta v}{\Delta t}$

$OA \rightarrow \frac{10}{10} = 1$

$AB \rightarrow 0 = 0$

$BC \rightarrow \frac{-10}{20} = -0.5$

18. (*b*) Distance = Total Area = 105 m

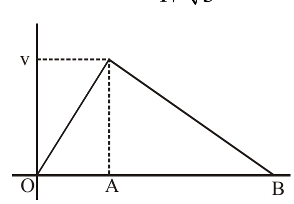
Displacement = 90 - 15 = 75m

(–ve y asxis area) – (–ve y axis area)

19. (*b*) Avg. velocity = for OA = $\frac{O + v}{2}$

For OB = $\frac{v + O}{2}$ constant acceleration

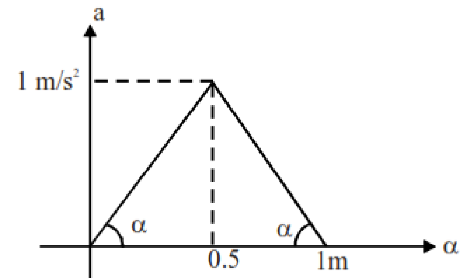
$\frac{\text{Area OAC}}{\text{Area ABC}} = \frac{\sqrt{3}}{1/\sqrt{3}} = 3$



Distance coverd in (OA) = $\frac{1}{2}\left(\sqrt{3}\right)\left(t_{OA}\right)^2$

Distance covered in (AB) = $\frac{1}{2}\left(\frac{1}{\sqrt{3}}\right)\left(t_{AB}\right)^2$

20. (*a*) $\int a dx = \frac{v_2^2 - v_1^2}{2} = \frac{v_2^2}{2}$



as $v_1 = 0$

$\frac{1}{2} \times 1 \times 1 = \frac{v_2^2}{2}$

$\Rightarrow v_2 = 1 m/s$

21. (*a*) $< \vec{v} > = \frac{\vec{s}}{t} = \frac{\Delta \vec{x}}{t}$

(*a*) +ve disp., +ve velocity
(*b*) zero disp.
(*c*) slope is +ve, so velocity is +ve.
(*d*) slope is –ve, so velocity is –ve.

22. (*d*) $a = \frac{d^2x}{dt^2}$ is constant for 3 and 4

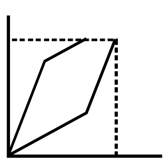
23. (*b*) Avg. speed $= \frac{\text{dist}}{\text{time}} = \frac{\pi R}{2R / v} = \frac{nV}{2}$

24. (*c*) 

At t_1. disp $\neq$ distance

where $0 < t_1 < \frac{2r_0}{g}$

25. (*a*) for P : $v^2_{max} = 2 \times 2a \times \frac{L}{2} + 2 \times a \times \frac{L}{2}$

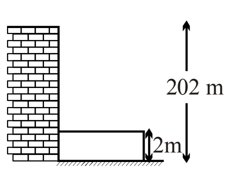


for Q : $v^2_{max} = 2 \times a \times \frac{L}{2} + 2 \times 2a \times \frac{L}{2}$

from velocity time graph time taken by P will be less. So average speed greater than

26. (*b*) Δx is negative for (2)

27. (*b*) Use basic kinematics,



$v_2 - v_0 = 2a (x - x_0)$

$v = v = \sqrt{2ax} = \sqrt{2(9.8)200} = 62.61$ m/s

$v^2 - v_0^2 = 2a (x - x_0)$

$0^2 - 62.61^2 = 2a(0.5 - 2)$

$a = 1307$ m/s^2

$a = 133$ g

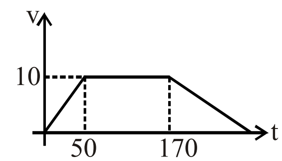
28. (*a*) Acceleration is constant except during collision. So displacement time graph is parabolic.

29. (*d*) $x = t^3 - 6t^2 - 15t + 40$

$v = t^2 - 12t - 15 = 0$at $t = 5$

$\therefore$ A is wrong

30. (*d*)



$v = 36 \times \frac{5}{18} = 10$ m/s

$v = at$

$10 = 0.2 \times t$

$t = 50$

$\frac{1}{2} \times t \times 10 = 100$

$t = 20$ sec.

dist. $= \frac{1}{2} \times (190 + 120) \times 10 = 1550$ m

$v_{av} = \frac{1550}{190} = \frac{155}{19}$ m/s

31. (*a*) $t_1 = \frac{2R}{v}$

for 2nd car, $v_{av} = \frac{v + 2v}{2} = \frac{\pi R}{t_2}$

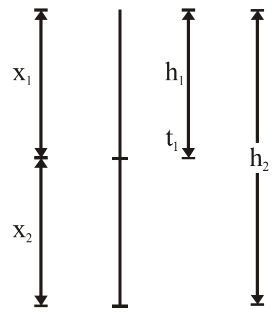
$\Rightarrow t_2 = \frac{2\pi R}{3v} > t_1$

32. (*a*) $t_1 : t_2 = 1 : \left(\sqrt{2} - 1\right)$

So, $t_1 = 1$ and $t_1 + t_2 = \sqrt{2}$

$x_1 = h_1 = \frac{1}{2} g t_1^2 = \frac{1}{2} g$

$h_2 = \frac{1}{2} g (t_1 + t_2)^2$



$= \frac{1}{2} g \times 2 = g$

$x_2 = (h_2 - h_1) = \frac{1}{2} g$

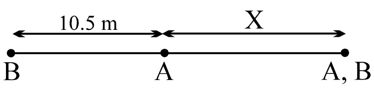
$x_1 = x_2$

33. (*b*) avg. $a = \frac{20\sqrt{2}}{5} = 4\sqrt{2}\,ms^{-2} N - W$

34. (*c*) Since, $V_f^2 - V_i^2 = 2aS$

$a = -2250\,kmh^{-2}$

35. (*a*)



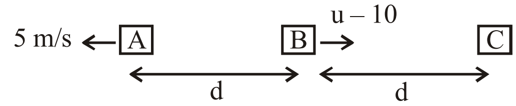
$X = 10\,t$

$10.5 + X = \frac{1}{2} \times 1 \times t^2$

$\Rightarrow t^2 - 20t - 21 = 0$

$\Rightarrow t = -1, 21$ sec

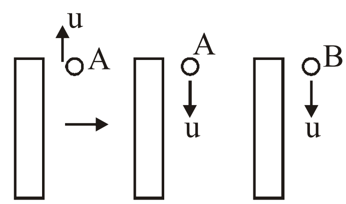
36. (*c*) with respect to C



$\frac{d}{u-10} = \frac{2d}{5}$

$\Rightarrow u = 12.5$ m/s

37. (*b*)



Ball A has the same speed u when its crosses the top end of the tower while going down which is the intital speed of B.

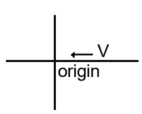
As both have same initial velocities, so their velocities are same upon reaching the ground.

Advanced Level Multiconcept Questions

1. (*b,c,d*) (*b*) $\Rightarrow a = \frac{dv}{dt}$

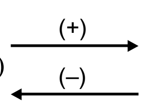
(*c*) $\vec{v}$ $\overleftarrow{a}$ Object is slowing down.

(*d*)



the particle is moving towards origin.

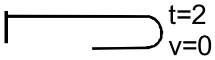
2. (*c,d*)



$\vec{v}, \vec{a}$ • (v)↑ $\overleftarrow{v}, \overleftarrow{a}$ • (v)↑

$\vec{v}, \overleftarrow{a}$ • (v)↓ $\overleftarrow{v}, \vec{a}$ • (v)↓

3. (*a,c*) $v = 10 - 5t$



When v = 0 at t = 2 sec.

Max displacement $= 10t - \frac{5t^2}{2}$

put $t = 2 \Rightarrow 20 - 10 = 10m$

Distance traveled in first 3 seconds

$= 10 + \left(0 + \frac{1}{2} \times 5 \times (1)^2\right) \Rightarrow = 12.5\,m$

4. (*a,b,c,d*) $X = \alpha T^2 - \beta t^3$

(*a*) $0 = \alpha t^2 - \beta t^3 \Rightarrow t = \frac{\alpha}{\beta}$

(*b*) $v = \frac{dx}{dt} = 2\alpha t - 3\beta t^2 \Rightarrow v = 0 \Rightarrow t = \frac{2\alpha}{3\beta}$

(*c*) $a = \frac{d^2x}{dt^2} = 2\alpha - 6\beta t$

when $t = 0 \Rightarrow a = 2\alpha$; $v = 0$

(*d*) Acceleration at $t = \frac{\alpha}{3\beta}$; $a = 0$

$\therefore$ net force = 0

5. (*a,b,c,d*)

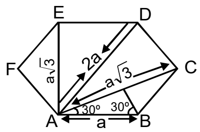
(a) At T (velocity changes its direction)

(b) slope constant

(c) Upper area = Lower area

(d) Initial speed = final speed.

6. (*a,c,d*)



(*a*) A to F

$$\text{Average velocity} = \frac{\text{Total Displacement}}{\text{Total time}}$$

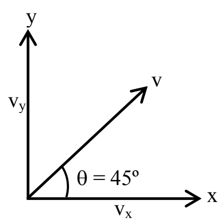
$$= \frac{a}{5a/v} = \frac{v}{5}$$

(*b*) $\text{A to D} = \dfrac{2a}{3a/v} = \dfrac{2}{3}v$

(*c*) $\text{A to C} = \dfrac{a\sqrt{3}}{2a/v} = \dfrac{v\sqrt{3}}{2}$

(*d*) $\text{A to B} = \dfrac{a}{a/v} = v$

7. (*a*)



Take x-axis along motion of truck and y-axis vertically upward

$\vec{v}_{ball/boy} = (10\,\hat{j})$ m/s

$\vec{v}_{boy/g} = (10\,\hat{i})$ m/s

$\vec{v}_{ball/g} = (10 + 10)$

Distance of ball from pole

$$= \frac{u^2 \sin 2\theta}{g} = \frac{(10\sqrt{2})^2 \times \sin 90}{g}$$

$= 20$ m

8. (*a*) Maximum height $= \dfrac{10^2}{2g} = 5$ m

9. (*c*) At maximum height, velocity of ball is horizontal. Time taken by ball to reach maximum height

$$t_H = \frac{u_y}{g} = \frac{10}{10} = 1 \text{ sec}$$

Velocity of truck is

$v = u + at$

$= 10 + 2 \times 1 = 12$ m/s

10. (*b*) Distance travelled = Are $= \dfrac{1}{2} \times (10 + 5) \times 10 = 75$ m

11. (*c*) $ma = |-(10)(1000)\text{kg}|$

$= 10000$ N

12. (*d*)

13. (*a*) R ; (*b*)-P,Q ; (*c*)-S ; (*d*)-P,Q,R,S

(*a*) $v > 0$ and $\dfrac{dv}{dt} < 0$ or

$v > 0$ and $\dfrac{dv}{dt} > 0$

(*b*) $\dfrac{ds}{dt} > 0$ or

$v > 0$ and $\dfrac{dv}{dt} > 0$ or

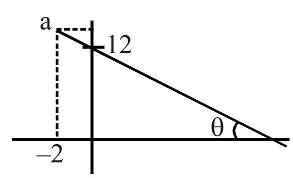
$v < 0$ and $\dfrac{dv}{dt} < 0$

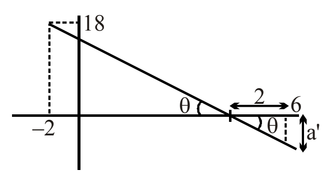
(*c*) $\left|\dfrac{dv}{dt}\right|$ is increasing

(*d*) $x > 0$, and $v > 0$ or

$x < 0$ and $v < 0$

14. [0055] ΔV = area under graph





$$\tan\theta = \frac{12}{4} = 3$$

$$\frac{a}{6} = 3 \Rightarrow a = 18$$

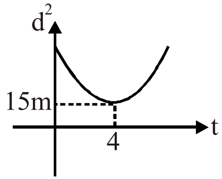
$$\frac{a'}{2} = \tan\theta \Rightarrow a' = 6$$

$$\text{Area} = \frac{1}{2} \times 18 \times 6 - \frac{1}{2} \times 6 \times 2$$

$V_6 - 7 = 54 - 6 = 48$

$V_6 = 55$ m/s

15. [0015] $d^2 = x^2 + y^2 = (3t)^2 + (25-4t)^2$



$= 625 - 200\,t + 25t^2$

$d^2 = 625 - 200 \times 4 + 25 \times 16 = 1025 - 800 = 225$

$d = 15$ m

16. [0400] $\ell = ct^2$

$2000 = c \times 10^2$

$c = 20$ m/s^2

$$v = \frac{d\ell}{dt} = 2ct = 2 \times 20 \times 10 = 400 \text{ m/s}$$

17. [0006] g x –t graphs

Every change in shape is a change in velocity

18. [0004] $$\frac{vdv}{dx} = 4 - 2x$$

$$\int_0^v vdv = \int_0^x (4-2x)dx$$

$$\Rightarrow \frac{v^2}{2} = 4x - x^2$$

when $v = 0$, $4x - x^2 = 0$

$x = 0, 4$

$\therefore$ At $x = 4$, the particle will again come to rest.

19. [0025] Average speed $= \dfrac{\text{distance travelled}}{\text{time taken}}$

$$b = \frac{\text{total area}}{\text{total time}} = \frac{10+20}{6} = \frac{30}{6} = 5 \text{ m/s}$$

Average acceleration $= \dfrac{\text{change in velocity}}{\text{time taken}}$

$$C = \frac{10-(-10)}{4} = \frac{20}{4} = 5 \text{ m/s}^2$$

$bc = (5)\,(5) = 25$ m^2/s^3