KATTAR NEET 2026

Physics by MR Sir

Motion in a straight line

Q1 A particle has a velocity $\boldsymbol{u}$ towards east at $\boldsymbol{t} = 0$. Its acceleration is towards west and is constant. Let $\boldsymbol{x_A}$ and $\boldsymbol{x_B}$ be the magnitudes of displacement in the first 10 seconds and the next 10 seconds then:

(A) $x_A < x_B$

(B) $x_A = x_B$

(C) $x_A > x_B$

(D) The information is insufficient to decide the relation of x_A with x_B.

Q2 A body travelling along a straight line traversed one third of the total distance with a velocity 4m/s. The remaining part of the distance was covered with a velocity 2m/s for half the time & with velocity 6m/s for the other half of time. The mean velocity averaged over the whole time of motion is .

(A) 5m/s (B) 4m/s

(C) 4.5m/s (D) 3.5m/s

Q3 The accelerations of a particle as seen from two frames $\boldsymbol{S_1}$ and $\boldsymbol{S_2}$ have equal magnitude, as 4 m/s^2

(A) The frames must be at rest with respect to each other.

(B) The frames may be moving with respect to each other but neither should be accelerated with respect to the other

(C) The acceleration of $\boldsymbol{S_2}$ with respect to $\boldsymbol{S_1}$ may either be zero or 8 m/s^2.

(D) The acceleration of $\boldsymbol{S_2}$ with respect to $\boldsymbol{S_1}$ may be anything between zero and 8 m/s^2.

Q4 A train passes an observer standing on a platform. The first carriage of the train passes the observer in time t_1 = 1 s and the second carriage in t_2 = 1.5 s. Find its acceleration assuming it to be constant. The length of each carriage is: 12 m.

(A) 3.3 m/s^2

(B) –3.2 m/s^2

(C) 24 m/s^2

(D) –24 m/s^2

Q5 A particle moves along a straight line OX. At a time t , (in second) the distance x of the particle from O is given by $x = 40 + 12t - t^3$ How long would the particle travel before coming to rest?

(A) $24m$ (B) $40m$

(C) $56m$ (D) $16m$

Q6 A particle starts from rest at A and moves with a uniform acceleration $\boldsymbol{a}$ m/s^2 in a straight line. After 1/$\boldsymbol{a}$ second, a second particle starts from A and moves with uniform velocity u in the same line and same direction. If u > 2m/s, then during the entire motion, the second particle remains ahead of first particle for a duration:

(A) $2\frac{\sqrt{u(u-2)}}{a}$

(B) $\frac{a}{2}\sqrt{u(u-2)}$

(C) $\frac{2}{a} \times 2\sqrt{u(u-2)}$

(D) $\sqrt{u(u-2)}$

Q7 The displacement of a particle, starting from rest (at $t = 0$) is given by $s = 6t^2 - t^3$. The time in seconds at which the particle will obtain zero velocity again is:

(A) 2 (B) 4

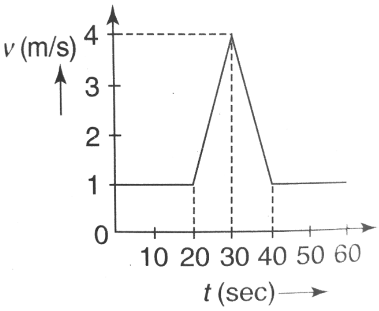
(C) 6 (D) 8

Q8 Two cars start off to race with velocity 4 m/s and 2 m/s & travel in a straight line with uniform acceleration 1 m/s^2 and 2 m/s^2 respectively. If they reach the final point at the same instant, then the length of the path is:

(A) 30 m (B) 32 m

(C) 20 m (D) 24 m

Q9 Velocity-time $(v - t)$ graph for a moving object is shown in the figure. Total displacement of the object during the time interval when there is non-zero acceleration and retardation is



(A) 60 m

(B) 50 m

(C) 30 m

(D) 40 m

Q10 An open lift is coming down from the top of a building at a constant speed $v = 10$ m/s. A boy standing on the floor of lift throws a stone vertically upwards at a speed of 30 m/s w.r.t. himself. The time after which he will catch the stone is: (Given g = 10 m/s^2)

(A) 4 sec (B) 6 sec

(C) 8 sec (D) 10 sec

Q11 Three points A, B, C are located in a straight line with AB = a and $AC = b$. Two particles start from points B and C and move with uniform velocities V_1 and V_2 respectively such that angle between $\vec{V}_1$ and line ABC is θ and $\vec{V}_2$ and line ABC is also θ. If point A and both the particles are always in a straight line then :

(A) $aV_1 = bV_2$ (B) $aV_1^2 = bV_2^2$

(C) $a^2V_1 = b^2V_2$ (D) $aV_2 = bV_1$

Q12 A block is kept on the floor of an elevator. The elevator starts descending with an acceleration of 12 m/s^2. The displacement of the block during 1[st] one second with respect to elevator is: (Given g = 10 m/s^2)

(A) 1 m downwards

(B) 1 m upwards

(C) 5 m downwards

(D) Zero meter

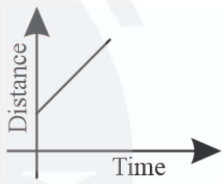
Q13 A point moves rectilinearly. Its displacement x at time t is given by $x^2 = t^2 + 1$. Its acceleration at time t is:

(A) $\frac{1}{x^3}$ (B) $\frac{1}{x} - \frac{1}{x^2}$

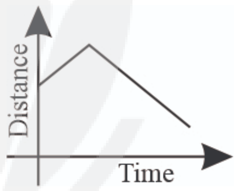
(C) $-\frac{1}{x^2}$ (D) $-\frac{t^2}{x^3}$

Q14 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 between distance between the particles and time before either hits the ground is

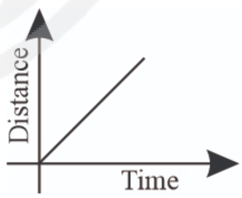
(A)



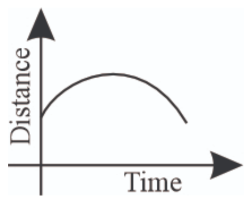
(B)



(C)

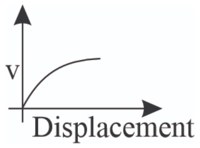


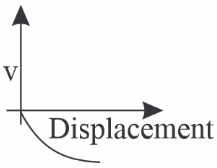
(D)

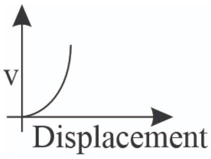


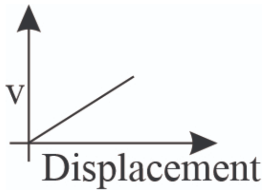
Q15 A particle moves with constant acceleration in the positive x-axis. At $t = 0$, the particle is at origin and is at rest, then correct graph between velocity and displacement is:

(A)

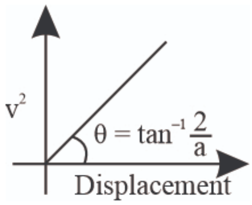


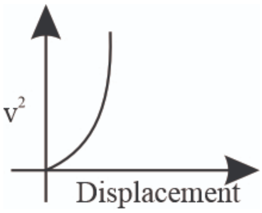
(B)


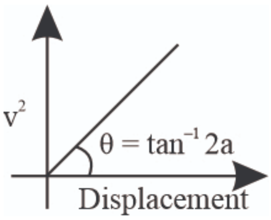
(C)


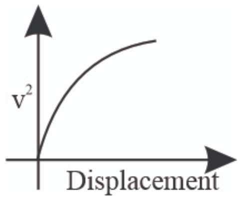
(D)


Q16 A particle moves with constant acceleration ***a*** in the positive *x*-axis, at $t = 0$, the particle is at origin at rest, then correct graph between $(\text{velocity})^2$ and displacement is:

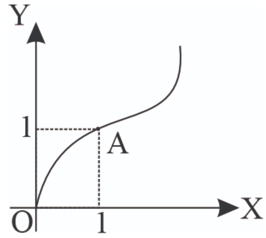
(A)


(B)


(C)


(D)


Q17 Trajectory of a particle is as shown here and it follows the equation $y = (x - 1)^3 + 1$. Find co-ordinates of the point *A* on the curve such that direction of instantaneous velocity at *A* is same as direction of average velocity for the motion *O* to *A*:



(A) (3/2, 9/8)
(B) (2, 2)
(C) (3, 9)
(D) (5/2, 35/8)

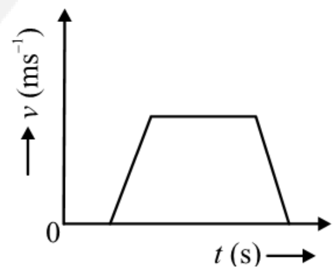
Q18 If the initial speed of a particle is *u* and its acceleration is given as $a = At^3$, where *A* is constant and *t* is time, then its final speed *v* will be given as:

(A) $u + At^4$
(B) $u + \frac{At^4}{4}$
(C) $u + At^3$
(D) $u + \frac{At^3}{3}$

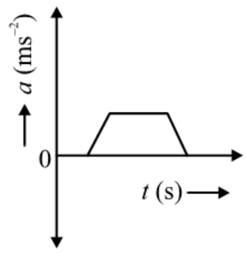
Q19 The position *x* of a particle varies with time, (*t*) as $x = at^2 - bt^3$. The acceleration will be zero at time *t* is equal to:

(A) $a/3b$
(B) zero
(C) $2a/3b$
(D) a/b

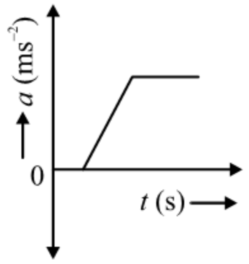
Q20 The velocity (*v*) - time (*t*) plot of the motion of a body is shown below:

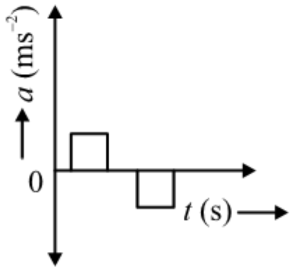


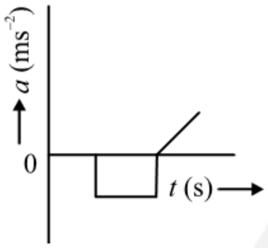
The acceleration (*a*) - time (*t*) graph that best suits this motion is:

(A)


(B)



(C)


(D)


Q21 A balloon rises up with constant net acceleration of 10 m/s^2. After 2 s, a particle dropped from the balloon. After further 2 s, match the following, lists (Take $g = 10\ m/s^2$)

List-I		List-II (S.I. unit)	
A.	Height of particle from ground	I.	Zero
B.	Speed of particle	II.	10
C.	Displacement of particle	III.	40
D.	Acceleration of particle	IV.	20

(A) A-III, B-I, C-IV, D-II
(B) A-I, B-II, C-III, D-IV
(C) A-III, B-IV, C-I, D-II
(D) A-II, B-I, C-IV, D-III

Q22 A bird flies to and fro between two cars which move with velocities v_1 and v_2 respectively. If the speed of the bird is v_3 and the initial distance of separation between the cars is d, find the total distance covered by the bird till the cars meet.

(A) $\frac{d}{v_2+v_3}v_1$
(B) $\frac{dv_3}{v_1+v_2}$
(C) $\frac{d}{v_1+v_3}v_2$
(D) $\frac{d}{v_1-v_2}v_3$

Q23 Suppose you are riding a bike with a speed of 10 ms^{-1} due east relative to a person A, who is walking on the ground towards east. If your friend B walking on the ground due west measures your speed as 15 ms^{-1}, find the relative velocity between two reference frames A and B.
(A) $v_{AB} = 10\ ms^{-1}$ towards east
(B) $v_{AB} = 15\ ms^{-1}$ towards east
(C) $v_{AB} = 20\ ms^{-1}$ towards east
(D) $v_{AB} = 5\ ms^{-1}$ towards east

Q24 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 (g is acceleration due to gravity)
(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) $h\left[\frac{2}{g}-\frac{1}{c}\right]$

Q25 A body travels 200 cm in the first 2 s with deceleration ***a*** and 220 cm in the next 4 s with deceleration ***a***. The velocity of the body at the end of the seventh second is:
(A) 5 $cm\ s^{-1}$
(B) 10 $cm\ s^{-1}$
(C) 15 $cm\ s^{-1}$
(D) 20 $cm\ s^{-1}$

Q26 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

Q27 A metro train starts from rest and in five seconds achieves $108 \mathrm{kmh}^{-1}$. After that it moves with constant velocity and comes to rest after travelling $45\ \mathrm{m}$ with uniform retardation. If total distance travelled is $395\ \mathrm{m}$, find total time of travelling

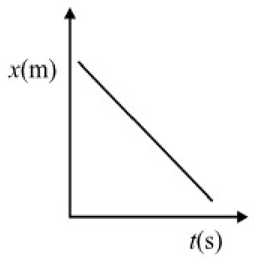
(A) $12.2\ \mathrm{s}$

(B) $15.3\ \mathrm{s}$

(C) $9\ \mathrm{s}$

(D) $17.2\ \mathrm{s}$

Q28 The position-time (x-t) graph of an object in uniform motion is shown below, the velocity of object is;



(A) Positive

(B) Negative

(C) Zero

(D) Maybe positive or negative

Q29 A body accelerates from rest at a constant rate and then decelerates at a constant rate to come to the rest. The ratio of times of acceleration to deceleration is 1/3. It achieves a maximum velocity of 3 m/sec. If total time elapsed is $4\sqrt{3}$ seconds, find the rate of deceleration:

(A) $\sqrt{3}\ \mathrm{m/sec^2}$

(B) $\frac{1}{\sqrt{3}}\ \mathrm{m/sec^2}$

(C) $2\sqrt{3}\ \mathrm{m/sec^2}$

(D) $\frac{\sqrt{3}}{2}\ \mathrm{m/sec^2}$

Q30 The position of a particle moving rectilinearly is given by $x = t^3 - 3t^2 - 10$. Find the distance travelled by the particle in the first 4 seconds starting from $t = 0$.

(A) 24 units (B) 36 units

(C) 15 units (D) 50 units

Q31 A particle moves along the x-axis with its x coordinate varying with time 't' as $x = t^2 - 5t + 6$ (where x is in meter and t is in second). At $t = 2$ s;

(A) Magnitude of velocity > magnitude of acceleration

(B) Magnitude of acceleration > magnitude of velocity

(C) Acceleration vector is in the direction of velocity vector

(D) Both (B) and (C)

Q32 A ball is thrown vertically upwards with speed 40 m/s. It is at height h above the ground when moving upwards at $t = 3$ s. From this location how much time is required by ball to again reach the same height h when moving downwards. ($g = 10$ m/s^2)

(A) 2 s (B) 5 s

(C) 4 s (D) 3 s

Q33 A football is moving towards north in the horizontal plane at constant speed u. After experiencing a kick, it moves with same speed towards west. What is the direction of average acceleration of the football?

(A) Along north-east

(B) Along south-west

(C) Towards south

(D) Towards east

Q34 A body travelling along a straight line with a uniform acceleration has velocities 5 m/s at a point A and 15 m/s at a point B respectively. If M is the mid point of AB, then choose **incorrect** statement.

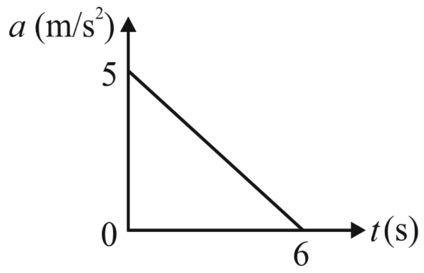
(A) The ratio of times taken by the body to cover distance MB and AM is $\left[\frac{\sqrt{5}-1}{2}\right]$

(B) The velocity at M is $5\sqrt{5}\ \mathrm{m/s}$

(C) Average velocity over AM is $\frac{5(\sqrt{5}+1)}{2}\mathrm{m/s}$

(D) The product of the acceleration and the distance AB is 200 m^2/s^2.

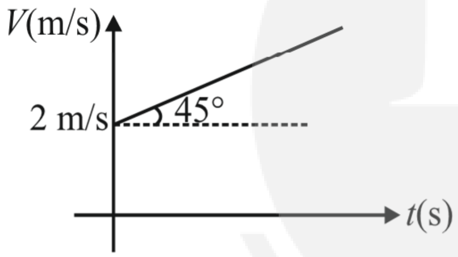
Q35 A particle starts from rest. Its acceleration at time $t = 0$ is 5 m/s^2 which varies with time as shown in the figure. The maximum speed of the particle will be;



(A) 7.5 m/s (B) 15 m/s
(C) 30 m/s (D) 37.5 m/s

Q36 The x coordinate (in m) of a particle moving in a straight line along x-axis varies with time t (in s) as $x(t) = 3t^2 - 4t + 5$. Find the average velocity of the particle in the interval from $t = 2$ s to $t = 4$ s.
(A) 14 m/s (B) 6 m/s
(C) 22 m/s (D) 8 m/s

Q37 The velocity time graph of a particle moving on a straight line is shown below. What is the distance covered by the particle in 5th second of the motion?

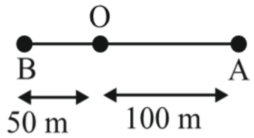


(A) 13.0 m (B) 6.5 m
(C) 4.0 m (D) 2.0 m

Q38 Position of a particle moving along x-axis is given by $x = (2 + 8t - 4t^2)$ m. The distance travelled by the particle from $t = 0$ s to $t = 2$ s is;
(A) 0 m (B) 8 m
(C) 12 m (D) 16 m

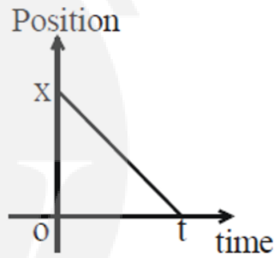
Q39 Two particles, A and B, are initially positioned vertically one above the other. Particle A is at a height of 20 m above Particle B. At the instant Particle A is released from rest, Particle B is simultaneously projected vertically upwards with an initial speed u. Assuming negligible air resistance and g = 10 m/s^2, determine the minimum value of u for which the two particles will collide in mid-air.
(A) 30 m/s (B) 10 m/s
(C) 40 m/s (D) 20 m/s

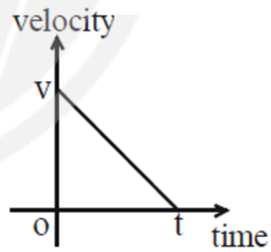
Q40 A particle moves 100 m from point O towards east direction with a speed 10 m/s to reach point 'A'. Then it takes a U turn and moves towards west direction with a speed 5 m/s such that it is at distance of 50 m from the starting point to reach point 'B'. Find the average speed for entire journey.

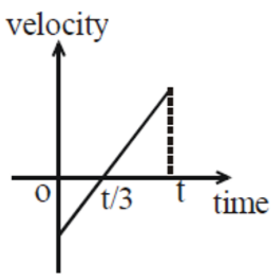


(A) 1.25 m/s (B) 7.5 m/s
(C) 6.25 m/s (D) 12.5 m/s

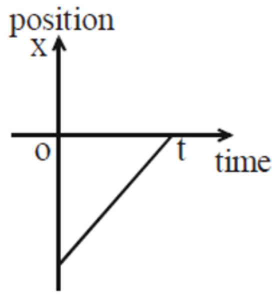
Q41 For which of the following graphs the average velocity of a particle moving along a straight line for time interval 0 to t must be negative:

(A)


(B)


(C)


(D)



Q42 **Statement I:** Two trains each of length 100 m and moving in opposite directions with equal speed of 10 m/s will completely cross each other in a time of 5 s.

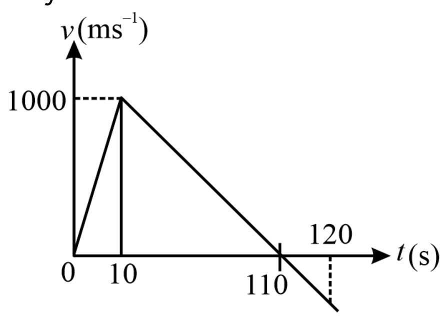
Statement II: For two objects moving in a straight line with same speed v in opposite directions, their relative speed is $2v$.

(A) Statement I and Statement II both are correct.
(B) Statement I is correct but Statement II is incorrect.
(C) Statement I is incorrect but Statement II is correct.
(D) Statement I and Statement II both are incorrect.

Q43 A tennis ball is dropped on the floor from a height of 20 m. It rebounds to a height of 5 m. The ball was in contact with the floor for 0.01 *s*. What was its average acceleration during the contact? ($g = 10 m/s^2$)

(A) 3000 m/s^2 (B) 2000 m/s^2
(C) 1000 m/s^2 (D) 500 m/s^2

Q44 The 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) 33 km

Q45 A particle moves along a straight line such that its displacement at any time t is given by $S = (t^3 - 6t^2 + 2t + 4)$ metres. The velocity when the acceleration is zero is:

(A) 2 ms^{-1}
(B) –12 ms^{-1}
(C) 42 ms^{-1}
(D) –10 ms^{-1}

Q46 Ball *A* is dropped from the top of a building. At the same instant ball. *B* is thrown vertically upwards from the ground. When the balls collide, they are moving in opposite directions and the speed of *A* is twice the speed of *B*. At what fraction of the height of the building from ground did the collision occur.

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) $\frac{1}{4}$ (D) $\frac{2}{5}$

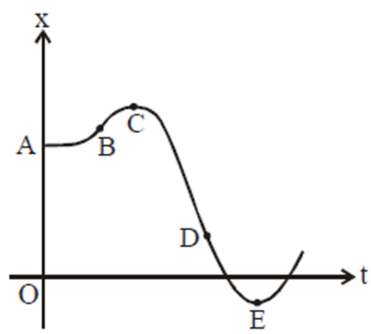
Q47 A body dropped from top of a tower falls through 40 m during the last two seconds of its fall. The height of tower is; ($g = 10 m/s^2$)

(A) 60 m (B) 45 m
(C) 80 m (D) 50 m

Q48 The velocity of a particle moving in a straight line varies with time as $v(t) = t^2 - 5t + 6$ m/s. Which of the following is correct for $\frac{5}{2} < t < 3$?

(A) The particle is speeding up
(B) The particle is slowing down
(C) The speed is constant
(D) None of these

Q49 For the position (x) time (t) graph shown of a particle in one-dimensional motion. Choose the **correct** alternatives from below:

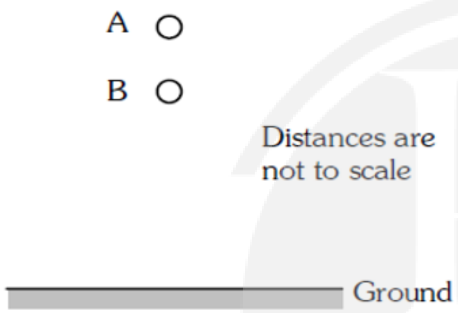


(a) Particle was released from rest at t=0.

(b) At C particle will reverse its direction of motion.
(c) Average velocity for motion between B and D is positive.
(d) At E, velocity = 0 and acceleration > 0

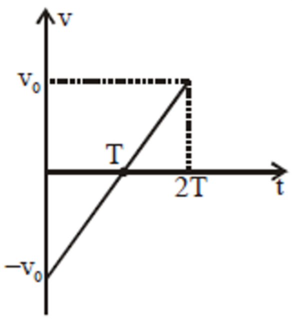
(A) a, b only (B) a, b, d only
(C) a, d only (D) b, c, d only

Q50 Two identical metal spheres are held above the ground as shown. The separation between them is small compared to their distance above the ground. Both the spheres are released simultaneously. If effects of air drag is negligible, the separation of the spheres before any one of them hits ground will:



(A) remain constant.
(B) decrease continuously.
(C) increase continuously.
(D) increase initially and then remain constant.

Q51 Figure shows the velocity (v) of particle plotted against time 't':



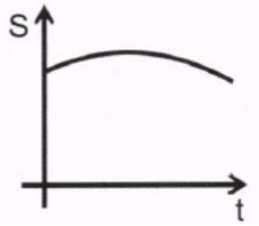
(A) Particle changes its direction of motion at some point
(B) Acceleration of particle remains constant
(C) Displacement is zero
(D) All of these

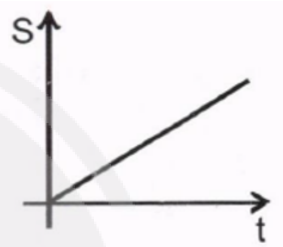
Q52

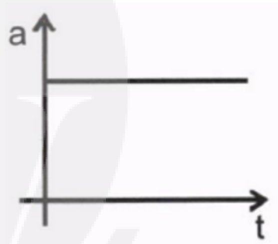
The acceleration 'a' in m/s^2 of a particle is given by $a = 3t^2 + 2t + 2$ where t is the time. If the particle starts with a velocity u = 2 m/s at t = 0, then the velocity at the end of 2 second is:

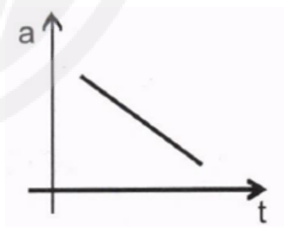
(A) 12 m/s (B) 18 m/s
(C) 27 m/s (D) 36 m/s

Q53 Which of the following graphs represents motion with uniform velocity?

(A)


(B)


(C)


(D)


Q54 The displacement of a body is given by $4s = M + 2Nt^4$, where M and N are constants. The velocity of the body at any instant is:

(A) $\frac{M+2Nt^4}{4}$ (B) $2N$
(C) $\frac{M+2N}{4}$ (D) $2Nt^3$

Q55 From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is:

(A) $2gH = n^2u^2$
(B) $gH = (n-2)^2u^2$
(C) $2gH = nu^2(n-2)$
(D) $gH = (n-2)^2u^2$

Q56 A particle is moving with speed $v = b\sqrt{x}$ along positive *x*-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at $t = 0$).

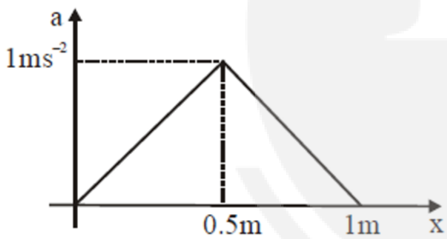
(A) $\frac{b^2\tau}{4}$

(B) $\frac{b^2\tau}{2}$

(C) $b^2\tau$

(D) $\frac{b^2\tau}{\sqrt{2}}$

Q57 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) 5 m/s

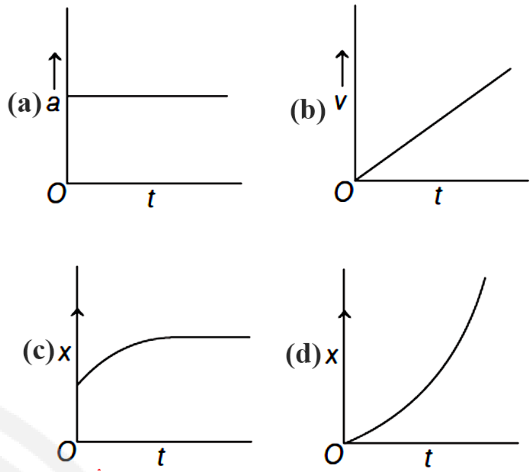
Q58 A stone is thrown vertically upward with an initial velocity (v_0). The distance travelled in time $\frac{4v_0}{3g}$ is:

(A) $\frac{2v_0^2}{g}$ (B) $\frac{v_0^2}{2g}$
(C) $\frac{4v_0^2}{3g}$ (D) $\frac{5v_0^2}{9g}$

Q59 Two particles are released from the same height at an interval of 1 s. How long after the first particle begins to fall will the two particles be 10 m apart. ($g = 10$ m/s^2)

(A) 1.5 s (B) 2 s
(C) 1.25 s (D) 2.5 s

Q60 A particle starts from origin *O* from rest and moves with a uniform acceleration along the positive *X*-axis. Identify all figures that correctly represent the motion qualitatively. (*a* = acceleration, *v* = velocity, *x* = displacement, *t* = time)



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

Answer Key

Q1	(D)
Q2	(B)
Q3	(D)
Q4	(B)
Q5	(C)
Q6	(A)
Q7	(B)
Q8	(D)
Q9	(B)
Q10	(B)
Q11	(D)
Q12	(B)
Q13	(A)
Q14	(C)
Q15	(A)
Q16	(C)
Q17	(A)
Q18	(B)
Q19	(A)
Q20	(C)
Q21	(A)
Q22	(B)
Q23	(D)
Q24	(A)
Q25	(B)
Q26	(B)
Q27	(D)
Q28	(B)
Q29	(B)
Q30	(A)
Q31	(B)
Q32	(A)
Q33	(B)
Q34	(D)
Q35	(B)
Q36	(A)
Q37	(B)
Q38	(B)
Q39	(B)
Q40	(C)
Q41	(A)
Q42	(C)
Q43	(A)
Q44	(C)
Q45	(D)
Q46	(B)
Q47	(B)
Q48	(B)
Q49	(B)
Q50	(A)
Q51	(D)
Q52	(B)
Q53	(B)
Q54	(D)
Q55	(C)
Q56	(B)
Q57	(A)
Q58	(D)
Q59	(A)
Q60	(D)

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

Let magnitude of acceleration be a. Also let west to east be positive direction. Hence

$x_A = \left|u\left(10\right) - \frac{1}{2}\left(a\right)\left(10\right)^2\right| = \left|10u - 50a\right|$

$x_B = \left|\left(u - 10a\right)\left(10\right) - \frac{1}{2}\left(a\right)\left(10\right)^2\right|$

$= |10u - 150a|$

Let $(10u - 50a) = l_1$

$\therefore\ x_A = |l_1|,\ x_B = |l_1 - 100a|$

Hence x_A may be less than equal to or greater than x_B depending on l_1 and a.

[for example: If $0 < 100a < 2l_1$ then $x_A > x_B$, if $100a = 2l_1$ then $x_A = x_B$, if $100a > 2l_1$ then $x_A < x_B$; under the condition l_1 is a positive quantity. How ever if l_1 is a negative quantity then $x_A < x_B$]

Q2 Text Solution:

Suppose the total distance be d.

$T_1 = \frac{d}{3\times4} = \frac{d}{12}\text{sec}$

Let body travels for next T sec then

$\frac{T}{2}\times2 + \frac{T}{2}\times6 = \frac{2d}{3} \Rightarrow T = \frac{d}{6}$

So average velocity $= \frac{d}{\frac{d}{12}+\frac{d}{6}} = 4\ \text{m/s}$

Q3 Text Solution:

Let $\vec{a}_p, \vec{a}_{s_1}, \vec{a}_{s_2}$ be accelerations of the particle, frame S_l and frame S_2 with respect to ground. Hence

$\vec{a}_p - \vec{a}_{s_1} = 4\hat{n}_1$ ....(i)

$\vec{a}_p - \vec{a}_{s_2} = 4\hat{n}_2$ ....(i)

where $\hat{n}_1$ and $\hat{n}_2$ are unit vectors.

Subtracting (ii) from (i)

$\vec{a}_{s_2} - \vec{a}_{s_1} = 4\hat{n}_1 - 4\hat{n}_2$

$\Rightarrow \left|\vec{a}_{s_2} - \vec{a}_{s_1}\right| = \sqrt{4^2 + 4^2 + 2\left(4\right)\left(4\right)\cos\theta}$

$= \left(4\sqrt{2}\right)\sqrt{1+\cos\theta} = 8\cos\frac{\theta}{2}$

$\Rightarrow\ 0 \le \left|\vec{a}_{s_2} - \vec{a}_{s_1}\right| \le 8$

Here θ is the angle between $\hat{n}_2$ and $-\hat{n}_1$.

Q4 Text Solution:

$12 = u\left(1\right) + \frac{1}{2}\left(a\right)\left(1\right)^2 = u + \frac{a}{2} \ldots \left(i\right)$

$12 = \left(u + a\right)\left(\frac{3}{2}\right) + \frac{1}{2}\left(a\right)\left(\frac{3}{2}\right)^2$

$12 = \frac{3u}{2} + \frac{21}{8}a \qquad \ldots\left(ii\right)$

Solving a = –3.2 m/s^2

Q5 Text Solution:

- The particle's journey distance is

$$x = 40 + 12t - t^3$$
$$v = \frac{dx}{dt} = 12 - 3t^2$$

- However, the final velocity is $v = 0$.

$$12 - 3t^2 = 0$$
$$t^2 = \frac{12}{3} = 4$$
$$t = 2s$$

- Now put the value of $t = 2s$ in above equation
- Then we get,

$$x = 40 + 12(2) - 8$$
$$= 56m$$

Q6 Text Solution:

Let at any time t, the displacement of first particle be S_1 and that of second particle be S_2.

$S_1 = \frac{1}{2}at^2 \text{ and } S_2 = u\left(t - \frac{1}{a}\right)$

For required condition $S_2 > S_1$

$\Rightarrow u\left(t - \frac{1}{a}\right) > \frac{1}{2}at^2 \Rightarrow t^2 - \frac{2u}{a}t + \frac{2u}{a^2} < 0$

$\Rightarrow \frac{1}{a}\left(u - \sqrt{u^2 - 2u}\right) < t$

$< \frac{1}{2}\left(u - \sqrt{u^2 - 2u}\right)$

Hence the duration for which particle 2 remains ahead of particle 1

$\Rightarrow \frac{1}{a}\left[\left(u + \sqrt{u^2 - 2u}\right) - \left(u - \sqrt{u^2 - 2u}\right)\right]$

$= \frac{2}{a}\sqrt{u(u-2)}$

Q7 Text Solution:

(B)

$S = 6t^2 - t^3$

$\Rightarrow \frac{ds}{dt} = \frac{d}{dt}\left(6t^2 - t^3\right)$

$\Rightarrow v = 6\left(2t\right) - 3t^2$

$\Rightarrow v = 12t - 3t^2$

$\therefore \quad 3t(4-t) = 0$

$t = 0, 4$

[New NCERT Class 11th Page No. 14, 15]

Q8 Text Solution:

$s = 4t + \frac{1}{2}(1)t^2 = 2t + \frac{1}{2}(2)t^2$

$4t + 0.5t^2 = 2t + t^2$

Solving we get, t = 0 and t = 4s.

So, $s = 4 \times 4 + \frac{1}{2}(1)t^2 = 24\ \text{m}$

Q9 Text Solution:

From the graph it is clear that, between time interval $20s\ to\ 30s$, the slope shows the acceleration and decelation. Hence, distance travelled during this interval,

$=$Area between this interval 20s to 40s

$= \frac{1}{2} \times 20 \times 3 + 20 \times 1 = 50m$

Therefore option B is Correct.

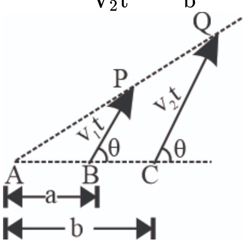
Q10 Text Solution:

$0 = 30t + \frac{1}{2}(-10)t^2 \Rightarrow t = 6\ \text{s}$

Q11 Text Solution:

ABP and ACQ are similar triangles.

Hence $\frac{V_1 t}{V_2 t} = \frac{a}{b}$



$\Rightarrow bV_1 = aV_2$

The result holds good for general θ as long sin $\theta \neq 0$.

Q12 Text Solution:

With respect to elevator, the initial velocity of the block is zero and the block starts accelerating upwards with an acceleration of 2 m/s^2. Hence

$S = 0(1) + \frac{1}{2} \times 2 \times 1^2 = 1\text{m upwards.}$

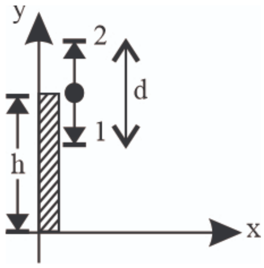
Q13 Text Solution:

$x^2 = t^2 + 1 \Rightarrow \frac{dx}{dt} = \frac{t}{\sqrt{t^2+1}}$

$\Rightarrow \frac{d^2x}{dt^2} = \frac{1}{(t^2+1)^{3/2}} = \frac{1}{x^3}$

Q14 Text Solution:

At any time t, the distance d between the stones is:



Stone 1 (dropped from height)

$y_1 = \frac{1}{2}gt^2$ (y_1 is distance from top)

Stone 2 (y_2 is distance from top)

$\text{from ground } y_2 = ut + \frac{1}{2}gt^2$

$\text{from ground } y_1 = H - \frac{1}{2}gt^2; y_2 = H + ut - \frac{1}{2}gt^2$

distance between stones (d) = $|y_2 - y_1|$ $|(-u)t|$ =ut

Q15 Text Solution:

$v^2 = 2as \Rightarrow v = \pm\sqrt{2\,as}$

Q16 Text Solution:

$v^2 = 0^2 + 2(a)s \Rightarrow v^2 = 2\,as$

Q17 Text Solution:

Clearly A is the point such that OA is tangent to curve = $(x-1)^3 + 1$ at the point A. Let point A be (x_1, y_1).

$\therefore \quad y = (x-1)^3 + 1$

$\Rightarrow \left[\frac{dy}{dx}\right]_{x=x_1} = 3(x_1-1)^2$

Hence equation of tangent (x_1, y_1) is

$(y - y_1) = 3(x_1-1)^2(x - x_1)$

But this tangent passes through origin. Hence

$-y_1 = -3x_1(x_1-1)^2 \Rightarrow y_1 = 3x_1(x_1-1)^2$

$\Rightarrow (x_1-1)^3 + 1 = 3x_1(x_1-1)^2$

$\Rightarrow (2x_1+1)(x_1-1)^2 = 1$

$\Rightarrow 2x_1^3 - 3x_1^2 + 1 = 1 \Rightarrow x_1^2(2x_1 - 3) = 0$

$\Rightarrow x_1 = \frac{3}{2}$

$\Rightarrow y_1 = (x_1-1)^3 + 1 = \left(\frac{3}{2}-1\right)^3 + 1 = \frac{1}{8} + 1 = \frac{9}{8}$

$\therefore A\ is\ \left(\frac{3}{2}, \frac{9}{8}\right)$

Q18 Text Solution:

(B)

$\int_u^v dv = \int_0^t At^3 dt$

$\therefore \quad v - u = \frac{At^4}{4}$

[New NCERT Class 11th Page No. 16]

Q19 Text Solution:

(A)

$x = at^2 - bt^3$

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

$v = 2at - 3bt^2$

$\frac{dv}{dt} = 2a - 6bt$

acceleration = $(2a - 6bt) = 0$

$2a - 6bt = 0$

$t = \frac{2a}{6b}$ $\boxed{t = \frac{a}{3b}}$

[New NCERT Class 11th Page No. 16]

Q20 Text Solution:

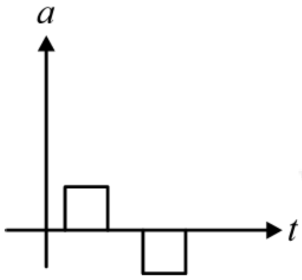
(C)

Initially, the body has zero velocity and zero slope.

Hence the acceleration would be zero intially.

After that, the slope of *v-t* curve is constant and positive.

After that, the slope of *v-t* courve is constant and negative.



[New NCERT Class 11th Page No. 18]

Q21 Text Solution:

Balloon at t=2s (when particle drops): H_{bal} = $\frac{1}{2}\left(10\right)(2)^2 = 20m$; V_{bal} = (10)(2) = 20 m/s.

Particle (for further 2s, t_p = 2s): u_p = 20m/s (up), y_0 = 20m (initial height), a_p = –10 m/s^2.

- A. Height of particle from ground (at t_p = 2s): $y_p = 20 + 20(2) - \frac{1}{2}\left(10\right)(2)^2$=20 + 40 – 20 = 40m. (Matches III)
- B. Speed of particle (at t_p = 2s): v_p = 20 – 10(2) = 0 m/s. (Matches I)
- C. Displacement of particle (in these 2s): $\Delta_p = 20\left(2\right) - \frac{1}{2}\left(10\right)(2)^2$= 40 – 20 = 20m. (Matches IV).
- D. Acceleration of particle: –g = –10 m/s^2. Magnitude is 10 SI units. (Matches II)

Q22 Text Solution:

$V_{12} = V_1 + V_2$

Time taken to cover distance 'd'

$t = \frac{d}{v_{12}} = \frac{d}{v_1+v_2}$

Since the speed of bird is v_3, therefore, distance covered by bird in time t

$v_3 \times t = \frac{d}{v_1+v_2}v_3$

Q23 Text Solution:

Taking east direction as positive (positive x)

$\vec{v}_{you.A} = 10\,ms^{-1}$

$\vec{v}_{A.B} = \vec{v}_{A.you} + \vec{v}_{you.B}$ ....(i)

$\vec{v}_{you} = \vec{v}_{you.A} + \vec{v}_{A}$ ....(ii)

As the direction of $\vec{v}_{you.A}$ and $\vec{v}_{A}$ is both towards east. Hence, your direction should be toward east.

$\vec{v}_{you.B} = \vec{v}_{you} - \vec{v}_{B}$ ....(iii)

As B is moving toward west and you are moving towards east.

Hence, your direction w.r.t B should be toward east.

$\vec{v}_{you.B} = 15\ ms^{-1}$ (towards east)

Now from (i), $\vec{v}_{A.B} = -10 + 15 = 5\ ms^{-1}$

Hence, velocity of A w.r.t B will be 5 ms^{-1} toward east.

Q24 Text Solution:

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

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

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

Q25 Text Solution:

200 = u × 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 cm^{-2} and u = 115 cms^{-1}.

Further, v = u – at = [115 – (15 × 7)] = 10 cm s^{-1}.

Q26 Text Solution:

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

$a = \frac{\mathrm{mgsin}\theta}{\mathrm{m}} = \mathrm{gsin}\theta = \mathrm{Constant}$

If s is the length of the inclined plabne, then

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

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

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

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

Q27 Text Solution:

Acceleration phase (first 5 s):

Final speed after 5 s: $108\,\mathrm{km/h} = 30\,\mathrm{m/s}$.

Acceleration: $a = \frac{30-0}{5} = 6\,\mathrm{m/s}^2$.

Distance covered:

$s_1 = \frac{1}{2}\,a\,t^2 = \frac{1}{2} \times 6 \times 5^2 = 75\,\mathrm{m}$.

Deceleration phase over 45 m:

Initial speed: $30\,\mathrm{m/s}$, final speed: $0\,\mathrm{m/s}$, distance $45\,\mathrm{m}$.

Deceleration: $\frac{0^2-30^2}{2\,(-45)} = -10\,\mathrm{m/s}^2$.

Time of deceleration: $\frac{30}{10} = 3\,\mathrm{s}$.

Constant-velocity phase:

Total distance is $395\,\mathrm{m}$. Thus the distance in this phase is $395 - 75 - 45 = 275\,\mathrm{m}$.

Speed is $30\,\mathrm{m/s}$. Time $= \frac{275}{30} \approx 9.17\,\mathrm{s}$.

Total time $= 5 + 9.17 + 3 \approx 17.2\,\mathrm{s}$.

Q28 Text Solution:

(2)

x-t graph is straight line.

$\Rightarrow$velocity is constant.

The slope is negative

$\therefore$ velocity is negative.

Q29 Text Solution:

Given $\frac{t_1}{t_2} = \frac{1}{3}$

$t = t_1 + t_2$

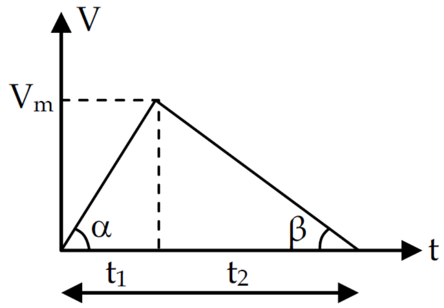
$= 4\sqrt{3}$

So, $t_1 = \sqrt{3}$

and $t_2 = 3\sqrt{3}$

Rate of deceleration

$= \tan\beta = \frac{V_m}{t_2} = \frac{3}{3\sqrt{3}} = \frac{1}{\sqrt{3}}\frac{m}{s^2}$



Q30 Text Solution:

We needed total distance:

fist let calculate X at $t = 0$.

$X = 0 + 0 - 10 = -10m.$

If the particle will change it direction of motion, the velocity must first become zero.

$\frac{dx}{dt} = V = 3t^2 - 6t = 0$

$t = 2\ sec$

$(here\ the\ velocity\ will\ change\ its\ direction)$

let's see the position of particle at $t = 2$.

$X = 8 - 12 - 10 = -14$m

so,

$X_{t=0} = -10m,\ X_{t=2} = -14m\ and\ X_{t=4} = +6m$

On a number line particle will move from $-14\ to\ -10(means\ 4m\ )$ and then returns from $-14\ to\ -10(means\ 4m)$and the further reaches to $+6\ from\ -10\ (\ means16\ m)$

Adding $4m\ + 4m + 16m\ = 24m$

Option A is the correct answer.

Video Solution:

Q31 Text Solution:

Given: $x = t^2 - 5t + 6$

At $t = 2$

$v = 2t - 5 = -1$ m/s

$a = 2\ \mathrm{m/s^2}$

So, $|a| > |v|$ and they are in opposite directions.

Q32 Text Solution:

$u = 40$m/s, $g = 10$ m/s^2

At $t = 3$s, ball is going **up**

Time to top = 4s → time from $t = 3$ to top = 1s

Same time to return to same height while coming down = 1s

Total time: 1 + 1 = 2s

Q33 Text Solution:

Average acceleration is along the direction of change in velocity.

$\Delta \vec{V} = \vec{V}_f - \vec{V}_i$

$\vec{V}_f$ is along west and $-\vec{V}_i$ is along south so their resultant with be along southwest.

Q34 Text Solution:

Given:

$v_A = 5$ m/s, $v_B = 15$ m/s

Uniform acceleration

M is midpoint of AB

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

$15^2 - 5^2 = 2a \cdot AB \Rightarrow 200 = 2a \cdot AB \Rightarrow a \cdot AB = 100$

But Option D says **200**, so it's **incorrect**

Q35 Text Solution:

Maximum speed is reached when the acceleration becomes zero. From the graph, the acceleration $a(t)$ is zero at t=6s. Since the particle starts from rest, the speed at any time is the integral of acceleration over time, which geometrically represents the area under the acceleration-time graph.

The area under the acceleration-time graph up to t = 6s is the area of a triangle with a base of 6s and a height of 5 m/s^2.

Calculating this area gives the maximum speed:

Maximum speed $= \frac{1}{2} \times \text{base} \times \text{height}$

$= \frac{1}{2} \times 6\text{s} \times 5\ \text{m/s}^2 = 15\ \text{m/s}$

Thus, the maximum speed of the particle is 15 m/s.

Q36 Text Solution:

The position function is $x(t) = 3t^2 - 4t + 5$

At t = 2s, the position is $x(2) = 3(2)^2 - 4(2) + 5 = 9\ \text{m}$

At t = 4s, the position is $x(4) = 3(4)^2 - 4(4) + 5 = 37\ \text{m}$

The displacement is $\Delta x = x(4) - x(2) = 37 - 9 = 28\ \text{m}$

The time interval is $\Delta t = 4\ \text{s} - 2\ \text{s} = 2\ \text{s}$

The average velocity is $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{28}{2} = 14\ \text{m/s}$

Q37 Text Solution:

Initial speed = 2 m/s

Slope = acceleration = 1 m/s^2

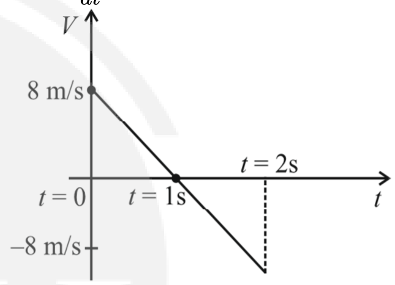
$S_5 = u + \frac{a}{2}(2n - 1)$

$= 2 + \frac{1}{2}(9) = \frac{13}{2}$ m

= 6.5 m

Q38 Text Solution:

$V = \frac{dx}{dt} = 8 - 8t$



Distance = Area under the curve

$= \frac{1}{2} \times 1 \times 8 \times 2$

= 8 m

Q39 Text Solution:

Time taken by upper ball to reach the ground

$= \sqrt{\frac{2 \times 20}{10}} = 2$ s

Total time of flight of lower ball should be greater than 2s

$\frac{2u}{g} = 2$

$u \geq 10$ m/s.

Q40 Text Solution:

Average speed = $\frac{\text{total distance}}{\text{total time}} = \frac{250}{\frac{100}{10} + \frac{150}{5}}$

$= \frac{250}{10+30} = \frac{250}{40}$

= 6.25 m/s

Q41 Text Solution:

Average velocity = displacement/time

And displacement = final position − initial position

As, displacement is negative in option 1), average velocity must be negative in this case.

Q42 Text Solution:

Relative speed of trains = 10 m/s + 10 m/s = 20m/s.

Total distance to cover = 100m + 100m = 200m.

Time to cross = $\frac{200\text{m}}{20\text{ m/s}}$=10 s. (Statement I is incorrect).

Relative speed of objects moving in opposite directions with same speed v is $v-(-v) = 2v$. (Statement II is correct).

The final answer is *C*.

Q43 Text Solution:

$a_{avg} = \frac{\Delta v}{t} = \frac{\sqrt{2g\times20}+\sqrt{2g(5)}}{0.01}$
$= \frac{20+10}{0.01}$
$= \frac{30}{0.01}$
= 3000 m/s^2

Q44 Text Solution:

Maximum height is the area under the v-t graph until v = 0 (t = 110s).

Area = Area of first triangle + Area of second triangle

Area =
$\frac{1}{2}\times 10\times 1000+\frac{1}{2}\times(110-10)\times 1000$

Area = $5000+\frac{1}{2}\times 100\times 1000$
$= 5000 + 50000\,\text{m} = 55\text{ km}.$

The final answer is 55 km.

Q45 Text Solution:

Velocity: $v\left(t\right) = \frac{dS}{dt} = 3t^2-12t+2$

Acceleration: $a\left(t\right) = \frac{dv}{dt} = 6t-12$

Zero acceleration: $6t-12=0 \Rightarrow t=2\,\text{s}.$

Velocity at t = 2s: $v\left(2\right) = 3(2)^2-12\left(2\right)+2$
$= 12-24+2 = -10\,\text{m/s}$

The final answer is –10 ms^{-1}

Q46 Text Solution:

Let t be the time until collision.

$v_A = gt, v_B = u_B - gt.$

Given $v_A = 2v_B \Rightarrow gt$
$= 2\left(u_B - gt\right) \Rightarrow 3gt = 2u_B.$

Heights: $H-h=\frac{1}{2}gt^2, h = u_Bt-\frac{1}{2}gt^2$

$H = (H-h)+h = \frac{1}{2}gt^2+u_Bt-\frac{1}{2}gt^2$
$= u_Bt$

Substitute $u_B = \frac{3}{2}gt : H = \left(\frac{3}{2}gt\right)t$
$= \frac{3}{2}gt^2 \Rightarrow gt^2 = \frac{2}{3}H$
$H-h = \frac{1}{2}gt^2 = \frac{1}{2}\cdot\frac{2}{3}H = \frac{1}{3}H$
$h = H-(H-h) = H-\frac{1}{3}H = \frac{2}{3}H$

Fraction of height from ground $= \frac{h}{H} = \frac{2}{3}.$

Q47 Text Solution:

Using Galileo's Law, the distance in one second each for first three seconds is;

5 m, 15 m, 25 m

Total duration of fall is 3 s

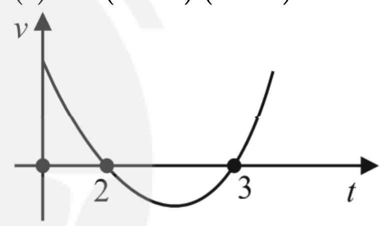
$H = \frac{1}{2}gt^2 = 5\times 9 = 45$ m

Q48 Text Solution:

$v\left(t\right) = t^2-5t+6$

$v\left(t\right) = t^2-2t-3t+6$

$v\left(t\right) = (t-2)(t-3)$



At $t=\frac{5}{2}s$ it has nonzero speed and at t = 3s it has zero speed i.e. it is slowing down.

Q49 Text Solution:

(a) Slope at A (velocity at t = 0) is zero. **correct.**

(b) Slope changes sign at C (+ve → 0 → –ve), so direction reverses. **Correct.**

(c) Displacement from B to D ($x_D - x_B$) is negative. Average velocity is negative. **Incorrect.**

(d) Slope at E is zero (velocity zero). Graph is concave up (positive acceleration). **Correct.**

Correct alternatives are (b) and (a), (d).

The final answer is B.

Q50 Text Solution:

Both spheres experience the same gravitational acceleration. Their relative acceleration is zero. Since their initial relative velocity is also zero (released simultaneously), their relative position (separation) will remain constant throughout their fall until one hits the ground.

The answer is remain constant.

Q51 Text Solution:

A. Velocity changes sign at $t = T$. **Correct.**

B. Slope of v-t graph (acceleration) is constant. **Correct.**

C. Area under v-t graph (displacement) from where it starts at $-v_0$ to $2T$ is zero (equal positive and negative areas). **Correct.**

D. Since A, B, and C are correct, **All of these** is correct.

Q52 Text Solution:

Integrate acceleration to get velocity:

$v(t) = \int(3t^2 + 2t + 2)dt$

$= t^3 + t^2 + 2t + C$

Use initial condition $v(0) = 2$ to find C:

$2 = 0^3 + 0^2 + 2(0) + C \Rightarrow C = 2.$

Velocity function: $v(t) = t^3 + t^2 + 2t + 2$

Velocity at

$t = 2s : v(2) = (2)^3 + (2)^2 + 2(2) + 2$

= 8 + 4 + 4 + 2 = 18 m/s.

Q53 Text Solution:

Uniform velocity means constant velocity (both magnitude and direction).

A. S-t graph with changing slope (velocity). Non-uniform velocity.

B. S-t graph with constant slope (velocity). **Uniform velocity.**

C. a-t graph with constant non-zero acceleration. Uniformly changing velocity.

D. a-t graph with changing acceleration. Non-uniformly changing velocity.

Graph B shows uniform velocity.

Q54 Text Solution:

Express displacement $s(t)$:

$s(t) = \frac{M}{4} + \frac{N}{2}t^4$

Differentiate $s(t)$ with respect to t to find velocity $v(t)$:

$v(t) = \frac{ds}{dt} = \frac{d}{dt}\left(\frac{M}{4} + \frac{N}{2}t^4\right)$

$= 0 + \frac{N}{2}(4t^3) = 2Nt^3.$

Q55 Text Solution:

Time taken to reach the maximum height,

$t_1 = \frac{u}{g}$

If t_2 is the time taken to hit the ground, then

i.e. $\quad -H = ut_2 - \frac{1}{2}gt_2^2$

But $\quad t_2 = nt_1$

So, $\quad -H = u\frac{nu}{g} - \frac{1}{2}g\frac{n^2u^2}{g^2}$

$-H = \frac{nu^2}{g} - \frac{1}{2}\frac{n^2u^2}{g}$

$\Rightarrow \quad 2gH = nu^2(n-2)$

Q56 Text Solution:

Given,

speed $v = b\sqrt{x}$

Now, differentiating it with respect to time, we get

$\frac{dv}{dt} = \frac{d}{dt}b\sqrt{x}$

$\Rightarrow \quad a = \frac{b}{2\sqrt{x}}.\frac{dx}{dt} \quad \left[\because \frac{dv}{dt} = a\right]$

$\Rightarrow \quad a = \frac{b}{2\sqrt{x}}.v = \frac{b}{2\sqrt{x}}.b\sqrt{x} = \frac{b^2}{2}$

As acceleration is constant, we use

$v = u + at$ .... (i)

Now, it is given that $x = 0$ at $t = 0$.

So, initial speed of particle is

$u = b\sqrt{x}|_{x=0} = b \times 0 = 0$

Hence, when time $t = \tau$, speed of the particle using Eq. (i) is

$v = u + at = 0 + \frac{b^2}{2}.\tau = \frac{b^2}{2}.\tau$

Q57 Text Solution:

Max velocity occurs when the area under the $a - x$ graph from 0 to x is maximum.

Area = $\int adx = \frac{1}{2}v^2$.

The velocity will be maximum when the acceleration becomes zero. Looking at the graph, acceleration becomes zero at $x = 1$ m. So, we need to find the velocity at $x = 1$m.

The area under the $a - x$ graph from $x = 0$ to $x = 1$ m is the area of the entire triangle.

$\frac{v_f^2}{2} - \frac{v_i^2}{2} = \text{Area}$

Since $v_i = 0$:

$\frac{v_f^2}{2} - 0 = 0.5$

$\frac{v_f^2}{2} = 0.5$

$v_f^2 = 0.5 \times 2 = 1$

$v_f = \sqrt{1} = 1 \text{ m/s}$

Maximum velocity is 1m/s.

Q58 Text Solution:

Time to reach max height $t_{up} = \frac{v_0}{g}$

Total time $t = \frac{4v_0}{3g}$ > t_{up}, so stone goes up and then down.

Time falling $t_{down} = t - t_{up} = \frac{v_0}{3g}$

Height reached $H = \frac{v_0^2}{2g}$

$\text{Distance}_{up} = H = \frac{v_0^2}{2g}$

Distance down

$= \frac{1}{2}g\left(t_{down}\right)^2 = \frac{1}{2}g\left(\frac{v_0}{3g}\right)^2 = \frac{v_0^2}{18g}$

$\text{Total distance} = \frac{v_0^2}{2g} + \frac{v_0^2}{18g} = \frac{9v_0^2+v_0^2}{18g} = \frac{10v_0^2}{18g}$

$= \frac{5v_0^2}{9g}$

Q59 Text Solution:

Let *t* be time after first particle falls.

Distance by first particle: $s_1 = 5t^2$.

Distance by second particle: $s_2 = 5(t-1)^2$.

Separation: $|s_1 - s_2| = 10$

$5t^2 - 5\left(t^2 - 2t + 1\right) = 10$

$t^2 - \left(t^2 - 2t + 1\right) = 2$

2t – 1 = 2.

2t = 3.

t = 1.5 s.

Q60 Text Solution:

a = constant

v = *at* and $x = \frac{1}{2}at^2$