PRACTICE EXERCISES

SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. A particle has an initial velocity of 9 ms^{-1} due east and a constant acceleration of 2 ms^{-2} due west. The distance covered by the particle in the fifth second of its motion is
   (A) 0 m (B) 0.5 m
   (C) 2 m (D) 20 m

2. The velocity of a car travelling on a straight road is given by the equation $v = 9 + 8t - t^2$ where v is in metre per second and t in second. The instantaneous acceleration when $t = 5$ s is
   (A) 2 ms^{-2} (B) 1 ms^{-2}
   (C) –1 ms^{-2} (D) –2 ms^{-2}

3. A racing car travelling at a constant speed has to pass through a horizontal turn where the radius of curvature of the road is 200 m. If the normal acceleration of the car cannot exceed 0.8 g where $g = 10\ ms^{-2}$, the maximum speed of the car without sliding can be
   (A) 36 kmh^{-1} (B) 72 kmh^{-1}
   (C) 144 kmh^{-1} (D) 174 kmh^{-1}

4. Ball A is dropped from the top of a tower of height H. 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. The height from the ground where the collision happens is
   (A) $\frac{H}{4}$ (B) $\frac{H}{3}$
   (C) $\frac{2H}{5}$ (D) $\frac{2H}{3}$

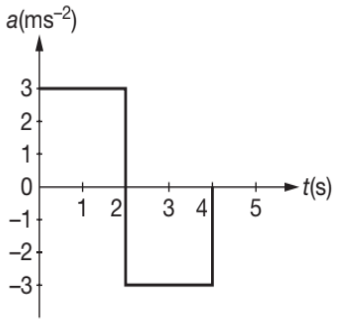
5. Wind is blowing at a harbour with a speed of 72 kmh^{-1} and the flag on the mast of a boat anchored at harbour flutters along the North-East direction. If the boat starts moving at a speed of 51 kmh^{-1} due North, the direction of the flag is (in approximation)
   (A) towards east (B) towards west
   (C) towards north (D) towards south

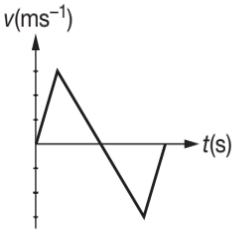
6. Two bodies begin to fall freely from the same height but the second falls T second after the first. The time (after which the first body begins to fall) when the distance between the bodies equals L is
   (A) $\frac{T}{2}$ (B) $\frac{T}{2} + \frac{L}{gT}$
   (C) $\frac{L}{gT}$ (D) $T + \frac{2L}{gT}$

7. A particle is dropped from point A at a certain height from ground. It falls freely and passes through three points B, C and D with $BC = CD$. The time taken by the particle to move from B to C is 2 seconds and from C to D is 1 second. The time taken to move from A to B is
   (A) 0.25 s (B) 0.5 s
   (C) 0.75 s (D) 1.5 s

8. A juggler maintains four balls in motion, making each of them to rise a height of 20 m from his hand. The time interval that he should maintain, for the proper distance between them $g = 10\ ms^{-2}$ is
   (A) 0.5 s (B) 1 s
   (C) 2 s (D) 3 s

9. A particle starts from rest at time $t = 0$ and undergoes acceleration a as shown. The velocity as function of time during the interval 0 to 4 second is indicated in



(A)


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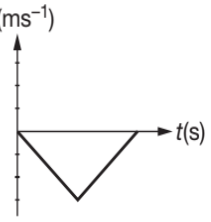

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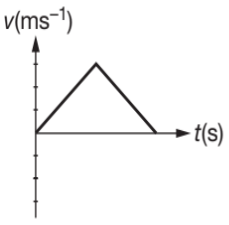

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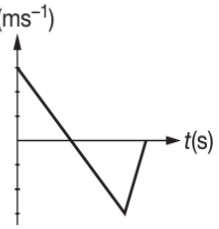


10. The slopes of the windscreen of two motor cars are $\beta_1 = 30°$ and $\beta_2 = 15°$ respectively. The cars have velocities v_1 and v_2 in the horizontal direction. If the hailstones appear to the drivers to be bounced by the windscreen of their respective cars in the vertical direction then $\frac{v_1}{v_2}$ (assuming that hailstones were falling on the cars vertically) is

(A) 3 (B) 1

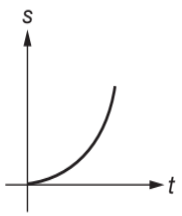
(C) $\frac{1}{3}$ (D) $\frac{1}{9}$

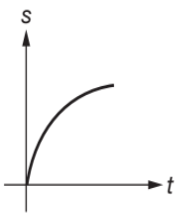
11. A person walks up a stationary escalator in time t_1. If he remains stationary on the escalator, then he reaches up in time t_2. The time it would take him to walk up the moving escalator is

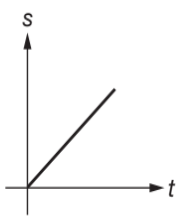
(A) $\frac{t_1 + t_2}{2}$ (B) $t_1 + t_2$

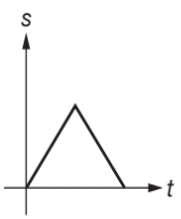
(C) $\sqrt{t_1 t_2}$ (D) $\frac{t_1 t_2}{t_1 + t_2}$

12. One stone is dropped from a tower from rest and simultaneously another stone is projected vertically upwards from the tower with some initial velocity. The graph of the distance, s between the two stones varies with time (t) as (before either stone hits the ground)

(A) 

(B) 

(C) 

(D) 

13. Wind is blowing from the south at $10\ \text{ms}^{-1}$ but to a cyclist it appears to be blowing from the east at $10\ \text{ms}^{-1}$. The cyclist has a velocity

(A) $10\hat{i} - 10\hat{j}$ (B) $10\hat{i} + 10\hat{j}$

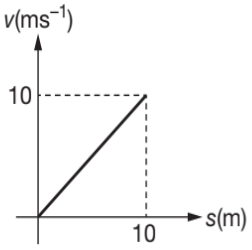
(C) $-10\hat{i} + 10\hat{j}$ (D) $-10\hat{i} - 10\hat{j}$

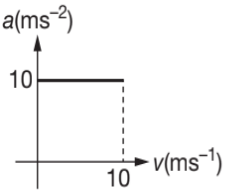
14. If a particle takes t second less and acquires a velocity of $v\ \text{ms}^{-1}$ more in falling through the same distance on two planets where the accelerations due to gravity are $2g$ and $8g$ respectively then

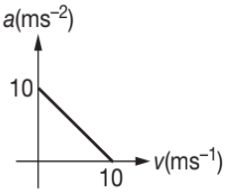
(A) $v = 4gt$ (B) $v = 5gt$

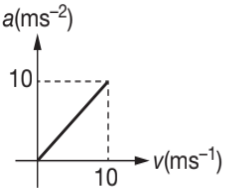
(C) $v = 2gt$ (D) $v = 16gt$

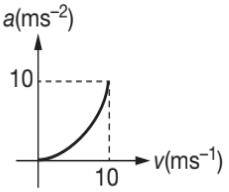
15. Velocity versus displacement graph of a particle moving in a straight line is shown in figure. Corresponding acceleration versus velocity graph will be



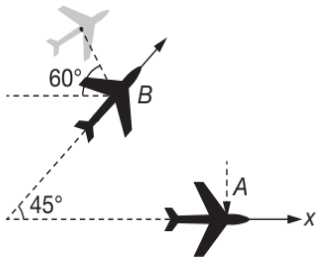
(A) 

(B) 

(C) 

(D) 

16. Passengers in the jet transport A flying east at a speed of $800\ \text{kmh}^{-1}$ observe a second jet plane B that passes under the transport in horizontal flight. Although the nose of B is pointed in the $45°$ north east direction, plane B appears to the passengers in A to be moving away from the transport at the $60°$ angle as shown. The true velocity of B is



(A) $586\ \text{kmh}^{-1}$ (B) $400\sqrt{2}\ \text{kmh}^{-1}$

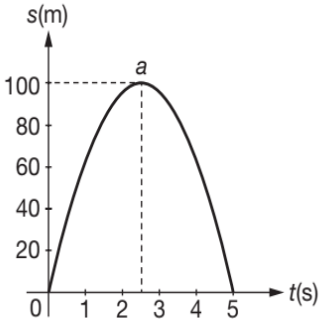
(C) $717\ \text{kmh}^{-1}$ (D) $400\ \text{kmh}^{-1}$

17. A body falling freely from a tower of height h covers a distance of $\frac{7}{16}h$ during the last second of its motion. Then the height of tower is (Take $g = 10\ \text{ms}^{-2}$)

(A) 60 m (B) 70 m

(C) 80 m (D) 90 m

18. The figure shows the displacement-time graph (a parabola) of a body. This graph indicates that the initial velocity, in ms^{-1} and acceleration, in ms^{-2} respectively are



(A) 80, 40 (B) 40, 80
(C) 80, 32 (D) 32, 16

19. Acceleration of a particle is a for a time t. It is followed immediately by a retardation of a for time $\frac{t}{2}$. Consider this as one cycle. If initial velocity of particle is zero, then the displacement of the particle after n such cycles in succession is

(A) $\frac{n(3n+4)}{8}at^2$ (B) $\frac{n(n+1)}{2}at^2$
(C) $\frac{(n^2+n+1)}{4}at^2$ (D) nat^2

20. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at the lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal is

(A) $\sqrt{u^2-2gL}$ (B) $\sqrt{2gL}$
(C) $\sqrt{u^2-gL}$ (D) $\sqrt{2\left(u^2-gL\right)}$

21. For a particle moving rectilinearly the displacement x depends on time t as $x=at^3+bt^2+ct+d$. The ratio of its initial acceleration to its initial velocity depends
(A) only on a and b (B) only on b and c
(C) only on a and c (D) only on a

22. A self-propelled vehicle of mass m whose engine delivers constant power P has an acceleration $a=\frac{P}{mv}$ (assume that there is no friction). In order to increase its velocity from v_1 to v_2, the distance it has to travel will be

(A) $\frac{m}{3P}\left(v_2-v_1\right)$ (B) $\frac{m}{3P}\left(v_2^2-v_1^2\right)$
(C) $\frac{m}{3P}\left(v_2^3-v_1^3\right)$ (D) $\frac{3P}{m}\left(v_2^2-v_1^2\right)$

23. The motion of a body falling from rest in a resisting medium is described by the equation $\frac{dv}{dt}=a-bv$ where a and b are constants. The velocity at any time t is

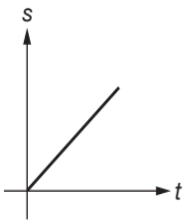
(A) $v_t=\frac{a}{b}\left(1-e^{-bt}\right)$ (B) $v_t=\frac{b}{a}e^{-bt}$
(C) $v_t=\frac{a}{b}\left(1+e^{-bt}\right)$ (D) $v_t=\frac{b}{a}e^{bt}$

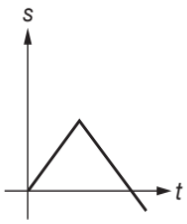
24. A parachutist drops freely from an airplane for 10 s before the parachute opens. He then descends with a uniform retardation of 2.5 ms^{-2}. If he bails out of the plane at a height of 2495 m and g is 10 ms^{-2}, his velocity on reaching the ground will be
(A) 5 ms^{-1} (B) 10 ms^{-1}
(C) 15 ms^{-1} (D) 20 ms^{-1}

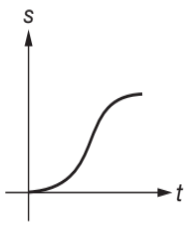
25. The nucleus of a helium atom travels along the axis of a straight hollow tube 4 m long. The tube is part of a particle accelerator. If the particle enters the tube with a speed of 1000 ms^{-1} and leaves at 9000 ms^{-1}, and assuming that the acceleration is uniform, the time the particle remains inside the tube is
(A) 4×10^{-3} s (B) 8×10^{-4} s
(C) 1×10^{-4} s (D) 8×10^{-3} s

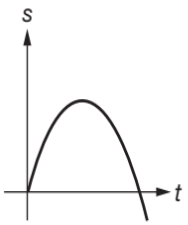
26. Two cars A and B start off to race with velocities 8 ms^{-1} and 4 ms^{-1} and travel in straight line with uniform accelerations 2 ms^{-2} and 4 ms^{-2} respectively. If they reach the final point at the same instant, then the length of the path is
(A) 24 m (B) 32 m
(C) 48 m (D) 16 m

27. A particle is moving in x-y plane with $y=\frac{x}{2}$ and $v_x=4-2t$. The displacement versus time graph of the particle would be

(A)


(B)


(C) 

(D) 

28. A ball is thrown vertically upwards. It was observed at a height h twice with a time interval Δt. The initial velocity of the ball is

(A) $\sqrt{8gh+g^2(\Delta t)^2}$ (B) $\sqrt{8gh+\left(\frac{g\Delta t}{2}\right)^2}$

(C) $\frac{1}{2}\sqrt{8gh+g^2(\Delta t)^2}$ (D) $\sqrt{8gh+4g^2(\Delta t)^2}$

29. A point moves in x-y plane according to the law $x=5\sin(6t)$ and $y=5(1-\cos(6t))$, where x and y are in metre. The distance traversed by the particle in $t=4$ s is

(A) 24 m (B) 48 m

(C) 96 m (D) 120 m

30. A particle moving with uniform acceleration along a straight line covers distances a and b in successive intervals of p and q second. The acceleration of the particle is

(A) $\frac{pq(p+q)}{2(bp-aq)}$ (B) $\frac{2(aq-bp)}{pq(p+q)}$

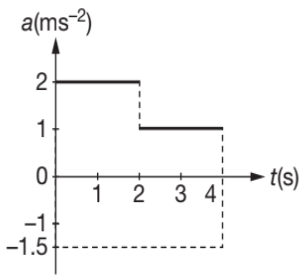
(C) $\frac{2(ap-bq)}{pq(p+q)}$ (D) $\frac{2(bp-aq)}{pq(p+q)}$

31. The motion of a particle is defined by $x=a\cos(\omega t)$ and $y=a\sin(\omega t)$. The acceleration of the particle is

(A) $a\omega$ (B) $a^2\omega$

(C) $a\omega^2$ (D) $\frac{a\omega^2}{2}$

32. The figure shows the acceleration versus time graph of a train. If it starts from rest, the distance it travels before it comes to rest is



(A) 30 metre (B) 26 metre

(C) 13 metre (D) 40 metre

33. A car A is going north east at 80 kmh^{-1} and another car B is going south east with a velocity of 60 kmh^{-1}. The velocity of A relative to B makes an angle with the north equal to

(A) $\tan^{-1}\left(\frac{2}{7}\right)$ (B) $\tan^{-1}\left(\frac{7}{2}\right)$

(C) $\tan^{-1}(7)$ (D) $\tan^{-1}\left(\frac{1}{7}\right)$

34. A particle is moving along a circular path of radius 3 metre in such a way that the distance travelled measured along the circumference is given by $s=\frac{t^2}{2}+\frac{t^3}{3}$. The acceleration of the particle when $t=2$ second is

(A) 1.3 ms^{-2} (B) 3 ms^{-2}

(C) 10 ms^{-2} (D) 13 ms^{-2}

35. A lead ball is dropped into a lake from the diving board 5 m above the water. In hits the water with a certain velocity and then sinks to the bottom with this same constant velocity. It reaches the bottom 5 s after it is dropped. The depth of the lake is $\left(\text{take } g=10\ \text{ms}^{-2}\right)$

(A) 10 m (B) 20 m

(C) 25 m (D) 40 m

36. A balloon starts rising from the ground with an acceleration of 1.25 ms^{-2}. After 8 s, a stone is released from the balloon. The stone will

(A) cover a distance of 40 m
(B) have a displacement of 50 m
(C) reach the ground in 4 s
(D) begin to move down after being released

37. The velocity acquired by a body when it falls through a height h is v. If it further falls through a height x $(x \ll h)$, the increase in velocity is approximately

(A) $\frac{vx}{2h}$ (B) $\frac{2v}{xh}$

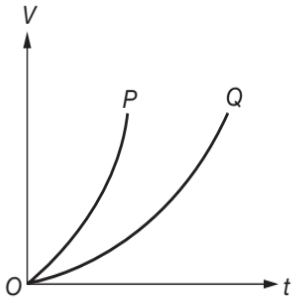
(C) $\frac{2vx}{h}$ (D) $\frac{v}{2xh}$

38. An armoured car 2 m long and 3 m wide is moving at 10 ms^{-1} when a bullet hits it in a direction making an angle $\tan^{-1}\left(\frac{3}{4}\right)$ with the length of the car as seen

by a stationary observer. The bullet enters one edge of the car at the corner and passes out at the diagonally opposite corner. Neglecting any interaction between the car and the bullet, the time for the bullet to cross the car is

(A) 0.20 s (B) 0.15 s
(C) 0.10 s (D) 0.50 s

39. A time-velocity graph of two vehicles P and Q starting from rest at the same time is given in the figure. The statement that can be deduced correctly from the graph is



(A) velocity of Q is greater than that of P
(B) acceleration of P is increasing at a slower rate than that of Q
(C) acceleration of Q is greater than that of P
(D) acceleration of P is greater than that of Q

40. A stone takes time t to fall through a height h. The increment in time when it falls further through a distance x $(x \ll h)$ is

(A) $\frac{xth}{2}$ (B) $\frac{xt}{2}$
(C) $\frac{xt}{2h}$ (D) $\frac{2h}{xt}$

41. The speed of an aeroplane at the instant it lands on a runway is $60\ \text{ms}^{-1}$. If the deceleration of the aeroplane is given as $a = -0.6 - 0.001\,v^2$, the distance that it covers on the runway before coming to a stop is

(A) 98 metre (B) 450 metre
(C) 973 metre (D) 1800 metre

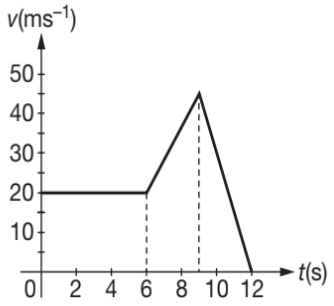
42. In a 100 metre race, a runner accelerates uniformly from the start to his maximum velocity in a distance of 4 m and runs the remaining distance at that velocity. If he finishes the race in 10.4 second, then his maximum velocity was

(A) $10\ \text{ms}^{-1}$ (B) $15\ \text{ms}^{-1}$
(C) $20\ \text{ms}^{-1}$ (D) $25\ \text{ms}^{-1}$

43. The position of a particle is given by $\vec{r} = a\cos(\omega t)\hat{i} + a\sin(\omega t)\hat{j} + bt\hat{k}$ where $\omega = \frac{2\pi}{T}$ and T is time period for one revolution of the particle following a helical path. The distance moved by the particle in one full turn of the helix is

(A) $\frac{4\pi}{\omega}\sqrt{a^2 + b^2\omega^2}$ (B) $\frac{2\pi}{\omega}\sqrt{a^2\omega^2 + b^2}$
(C) $\frac{2\pi}{\omega}\sqrt{a^2 + b^2\omega^2}$ (D) $\frac{4\pi}{\omega}\sqrt{a^2\omega^2 + b^2}$

44. The graph in the figure shows the velocity of a body plotted as a function of time. The distance covered by the body in the first 12 s is

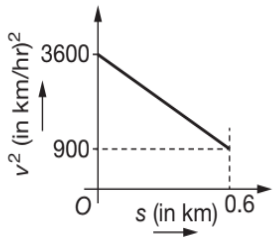


(A) 360 m (B) 240 m
(C) 285 m (D) 500 m

45. A horizontal wind is blowing with a velocity v towards north-east. A man starts running towards north with acceleration a. The time after which man will feel the wind blowing towards east is

(A) $\frac{v}{a}$ (B) $\frac{\sqrt{2}v}{a}$
(C) $\frac{v}{\sqrt{2}a}$ (D) $\frac{2v}{a}$

46. 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 kilometre per hour square is



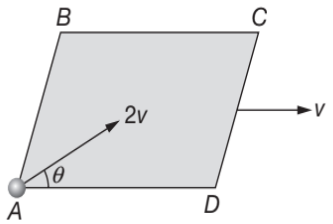
(A) 2250 (B) 225
(C) –2250 (D) –225

47. The speed of a body moving in a straight line changes from $25\ ms^{-1}$ to $10\ ms^{-1}$ in $3\ s$ at a constant rate.
(A) during this time it travels 52.5 metre.
(B) its acceleration is $5\ ms^{-2}$.
(C) its acceleration is greatest at the beginning because it is going fastest at that time.
(D) the distance travelled during an interval of 3 second cannot be calculated from the given data.

48. A car covers the first half of the distance between two places at a speed of $40\ kmh^{-1}$ and the second half at $60\ kmh^{-1}$. The average speed of the car is
(A) $50\ kmh^{-1}$ (B) $42\ kmh^{-1}$
(C) $35\ kmh^{-1}$ (D) $48\ kmh^{-1}$

49. Rain, pouring down at an angle α with the vertical has a speed of $10\ ms^{-1}$. A girl runs against the rain with a speed of $8\ ms^{-1}$ and sees that the rain makes an angle β with the vertical, then relation between α and β is
(A) $\tan\alpha = \dfrac{8+10\sin\beta}{10\cos\beta}$ (B) $\tan\beta = \dfrac{8+10\sin\alpha}{10\cos\alpha}$
(C) $\tan\alpha = \tan\beta$ (D) $\tan\alpha = \cot\beta$

50. A smooth square platform $ABCD$ is moving towards right with a uniform speed v. A particle is projected from A with speed $2v$ making an angle θ with AD so that it strikes the point B. Then θ equals



(A) $30°$ (B) $45°$
(C) $60°$ (D) $90°$

51. An express elevator can accelerate or decelerate with values whose magnitudes are limited to $0.4g$. The elevator attains a maximum vertical speed of 400 metre per minute. The minimum time required by the elevator to start from rest from the 10th floor and to stop at the 30th floor, a distance 100 m apart is
(A) $1.67\ s$ (B) $16.7\ s$
(C) $167\ s$ (D) $1670\ s$

52. A swimmer crosses a flowing stream of width d to and fro in time t_1. The time taken to cover the same distance up and down the stream is t_2. If t_3 is the time the swimmer would take to swim a distance $2d$ in still water, then
(A) $t_3 = t_1 + t_2$ (B) $t_3^2 = t_1 t_2$
(C) $t_2^2 = t_1 t_3$ (D) $t_1^2 = t_2 t_3$

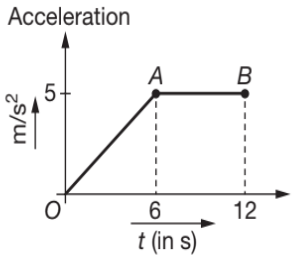
53. A bullet loses $\dfrac{1}{20}$ of its velocity in passing through a plank. The least number of planks required to stop the bullet is
(A) 10 (B) 11
(C) 12 (D) 23

54. A motorboat going down stream overcame a raft at a point A. 60 minute later it turned back and after some time passed the raft at a distance of 6 km from the point A. Assuming the duty of the engine to be constant, the flow velocity is
(A) $3\ kmh^{-1}$ (B) $4\ kmh^{-1}$
(C) $5\ kmh^{-1}$ (D) $6\ kmh^{-1}$

55. A glass wind screen whose inclination with the vertical can be changed is mounted on a car. The car moves horizontally with a speed of $2\ ms^{-1}$. The angle α with the vertical at which the wind must screen be placed so that the rain drops, falling vertically downwards with velocity $6\ ms^{-1}$, strike the wind screen normally is
(A) $\sin^{-1}\left(\dfrac{1}{3}\right)$ (B) $\cos^{-1}(3)$
(C) $\tan^{-1}\left(\dfrac{1}{3}\right)$ (D) $\tan^{-1}(3)$

56. A train travelling at $72\ kmh^{-1}$ is checked by track repairs. It retards uniformly for 200 m covering next 400 m at constant speed and accelerates to $72\ kmh^{-1}$ in a further distance of 600 m. If the time at constant lower speed is equal to the sum of the times taken in retarding and accelerating, the total time taken is
(A) 140 s (B) 160 s
(C) 120 s (D) 100 s

57. For an airplane to take-off it accelerates according to the graph shown and takes 12 s to take-off from the rest position. The distance travelled by the airplane is



(A) 21 m (B) 210 m
(C) 2100 m (D) 120 m

58. A body with constant acceleration travels 2 metre in the first 2 second and 2.2 m in the next 4 second. The velocity at the end of the seventh second from the start shall be

(A) $0.1\ \text{ms}^{-1}$ (B) $0.2\ \text{ms}^{-1}$
(C) $0.5\ \text{ms}^{-1}$ (D) $1\ \text{ms}^{-1}$

59. A particle is released from rest from a tower of height $3h$. The ratio of times to fall equal heights h, i.e., $t_1 : t_2 : t_3$ is

(A) $3:2:1$
(B) $\sqrt{3}:\sqrt{2}:1$
(C) $1:(\sqrt{2}-1):(\sqrt{3}-\sqrt{2})$
(D) $9:4:1$

60. Two particles A and B are thrown up simultaneously from the edge of a cliff with initial speeds v and $2v$. Assuming that the particle A comes to rest immediately after striking the ground, the variation in relative position of the particle B with respect to the particle A with time, till both the stones strike the ground is plotted. This variation plot is
(A) only linear
(B) only parabolic
(C) first parabolic then linear
(D) first linear then parabolic

61. A dog is chasing a cat who is running along a straight line at constant speed u. The dog moves with a constant speed v, always heading towards the cat. Initially i.e. at $t = 0$, the velocities of dog and cat are perpendicular and the initial perpendicular distance between them is l. The dog catches the cat at

(A) $t = \dfrac{lv}{v^2 - u^2}$ for $v > u$

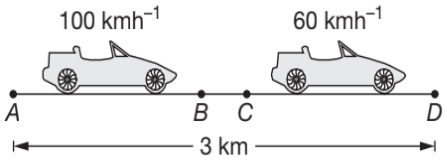
(B) $t = \dfrac{lv}{u^2 - v^2}$ for $u > v$

(C) $t = \dfrac{lv^2}{\sqrt{v^2 - u^2}}$ for $v > u$

(D) $t = \dfrac{lv^2}{\sqrt{u^2 - v^2}}$ for $u > v$

62. The acceleration is constant when the relationship between the
(A) position coordinate s and the square of the velocity v is linear
(B) position coordinate s and the velocity v is linear
(C) position coordinate and the reciprocal of the velocity v is linear
(D) square of the position coordinate s and the velocity v is linear

63. In travelling a distance of 3 kilometre between points A and D, a car is driven at $100\ \text{kmh}^{-1}$ from A to B for t second and at $60\ \text{kmh}^{-1}$ from C to D for t second. If the brakes are applied for 4 second between B and C to give the car a uniform deceleration, the value of t is



(A) 75.5 second (B) 45.5 second
(C) 65.5 second (D) 56.5 second

64. A car is travelling on a straight road. The maximum velocity the car can attain is $24\ \text{ms}^{-1}$. The maximum acceleration and deceleration it can attain are $1\ \text{ms}^{-2}$ and $4\ \text{ms}^{-2}$ respectively. The shortest time the car takes to start from rest and come to rest in a distance of 200 metre is

(A) 22.4 second (B) 33.6 second
(C) 11.2 second (D) 5.6 second

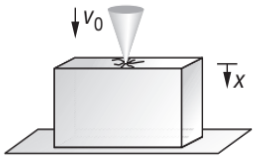
65. A person walks up a stalled escalator in 90 s. When standing on the same escalator, now moving, he is carried in 60 s. The time it would take him to walk up the moving escalator will be

(A) 36 s (B) 18 s
(C) 72 s (D) 27 s

66. Two particles, A and B move with constant velocities $\vec{v}_A$ and $\vec{v}_B$. Initially their radius vectors are $\vec{r}_A$ and $\vec{r}_B$. For the particles to collide the four vectors must be interrelated as

(A) $\vec{v}_A - \vec{v}_B = \vec{r}_A - \vec{r}_B$
(B) $\vec{v}_A = \vec{v}_B$ and $\vec{r}_A = \vec{r}_B$
(C) $\dfrac{\vec{v}_A + \vec{v}_B}{|\vec{v}_A + \vec{v}_B|} = \dfrac{\vec{r}_A + \vec{r}_B}{|\vec{r}_A + \vec{r}_B|}$
(D) $\dfrac{\vec{v}_B - \vec{v}_A}{|\vec{v}_B - \vec{v}_A|} = \dfrac{\vec{r}_A - \vec{r}_B}{|\vec{r}_A - \vec{r}_B|}$

67. The cone falling with a speed v_0 strikes and penetrates the block of packing material. The acceleration of the cone after impact is $a = g - cx^2$, where c is a positive constant and x is the penetration distance. If the maximum penetration depth is x_m. Then c equals



(A) $\frac{2gx_m + v_0^2}{x_m^2}$ (B) $\frac{2gx_m - v_0^2}{x_m^2}$

(C) $\frac{6gx_m - 3v_0^2}{2x_m^3}$ (D) $\frac{6gx_m + 3v_0^2}{2x_m^3}$

68. Water drops fall at regular intervals from a roof. At an instant when a drop is about to leave the roof, the separations between 3 successive drops below the roof are in the ratio

(A) 1: 2 : 3 (B) 1 : 4 : 9

(C) 1 : 3 : 5 (D) 1 : 5 : 13

69. A particle has an initial velocity $\vec{u} = \left(6\hat{i} + 8\hat{j}\right)$ ms^{-1} and an acceleration of $\vec{a} = \left(0.8\hat{i} + 0.6\hat{j}\right)$ ms^{-2}. Its speed after 10 s is

(A) 20 ms^{-1} (B) 14 ms^{-1}

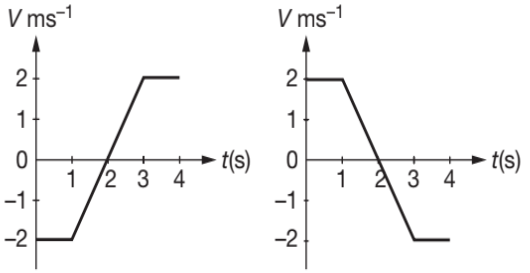
(C) $14\sqrt{2}$ ms^{-1} (D) 17 ms^{-1}

70. A car moves rectilinearly for 6 s with a velocity that varies with time as $|t-3|$ ms^{-1} where t is in second. The total distance moved by the car is

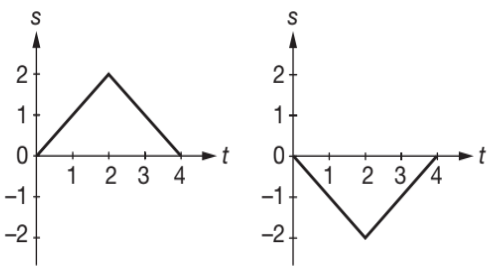
(A) 3 m (B) 6 m

(C) 9 m (D) 12 m

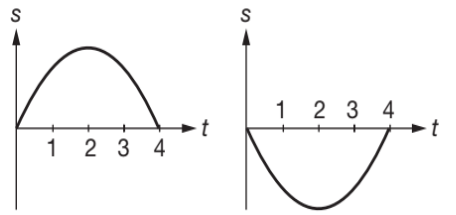
71. The V-t curves for two different particle motions are shown. The corresponding displacement time curves, taking $S = 0$ when $t = 0$ for both instances will be



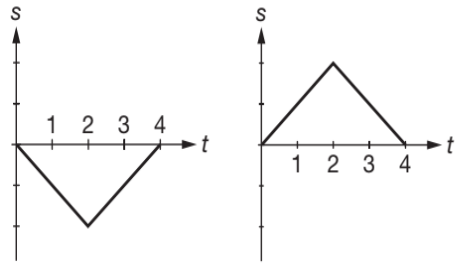
(A)



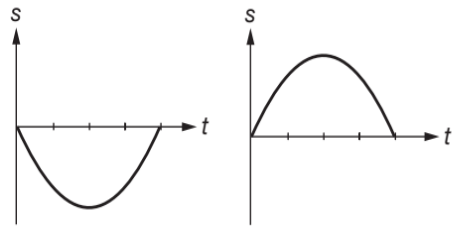
(B)



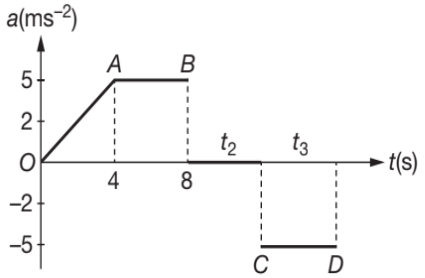
(C)



(D)



72. The acceleration of a train between two stations 2 kilometre apart is shown in the figure. The maximum speed of the train is



(A) 30 ms^{-1} (B) 60 ms^{-1}

(C) 90 ms^{-1} (D) 120 ms^{-1}

73. The acceleration is constant when the relationship between

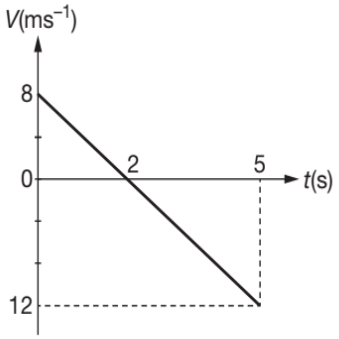
(A) the square of the position coordinate x and the velocity v is linear

(B) the position coordinate x and the reciprocal of the velocity is linear

(C) the position coordinate x and velocity v is linear

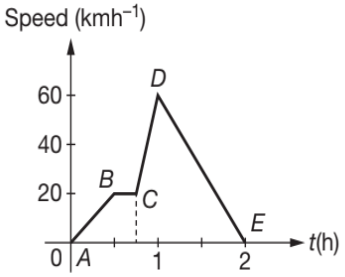
(D) the position coordinate x and the square of the velocity v is linear

74. A particle moves along a horizontal straight line with a velocity-time relationship as shown in figure. The total distance moved by the particle is



(A) 39 m (B) 13 m
(C) 26 m (D) 2.6 m

75. A train moves from one station to another in 2 hour, and its speed during the motion is shown in the graph. The maximum acceleration during the journey is



(A) 80 kmh^{-2} (B) 160 kmh^{-2}
(C) 40 kmh^{-2} (D) 60 kmh^{-2}

76. The wind appears to blow from the north to a man moving in the north-east direction. When he doubles his velocity the wind appears to move in the direction $\cot^{-1}(2)$ east of north. The actual direction of the wind is

(A) $\sqrt{2}v$ towards east (B) $\frac{v}{\sqrt{2}}$ towards west
(C) $\sqrt{2}v$ towards west (D) $\frac{v}{\sqrt{2}}$ towards east

77. A man drives a car from Y towards X at speed 60 kmh^{-1}. A car leaves station X for station Y every 10 min. The distance between X and Y is 60 km. The car travels at speed 60 kmh^{-1}. A man drives a car from Y towards X at speed 60 kmh^{-1}. If he starts at the moment when first car leaves station X. The number of cars he would meet on route is
(A) 5 (B) 7
(C) 10 (D) 20

78. A body falls from rest, in the last second of its fall, it covers half of the total distance. If g is 9.8 ms^{-2}, then the total time of its fall is (in second)
(A) 2 (B) $2+\sqrt{2}$
(C) $2-\sqrt{2}$ (D) $2\pm\sqrt{2}$

79. The motion of a body falling from rest in a resisting medium is described by the equation $\frac{dv}{dt} = A - Bv$ where A and B are constants. The velocity at any time t is
(A) $A(1-e^{Bt})$ (B) $ABte^{-t}$
(C) $\frac{A}{B}(1-e^{-Bt})$ (D) $AB^2(1-e^{-Bt})$

80. In a car race, car A takes t_0 time less to finish than car B and passes the finishing point with a velocity v_0 more than car B. The cars start from rest and travel with constant accelerations a_1 and a_2. Then the ratio $\frac{v_0}{t_0}$ is equal to
(A) $\frac{a_1+a_2}{2}$ (B) $\frac{a_2^2}{a_1}$
(C) $\frac{a_1^2}{a_2}$ (D) $\sqrt{a_1a_2}$

81. A 2 m wide car is moving with a uniform speed of 8 ms^{-1} along the edge of a straight horizontal road. A pedestrian starts to cross the road with a speed v when the car is 12 m away from him. The minimum value of v for the pedestrian to cross the road safely is
(A) $\frac{4}{3}$ ms^{-1} (B) $\frac{3}{4}$ ms^{-1}
(C) $\frac{1}{2}$ ms^{-1} (D) $\frac{1}{6}$ ms^{-1}

82. In PROBLEM 81, if θ is the angle made by the velocity of the pedestrian with the road then
(A) $\tan\theta = 2$ (B) $\tan\theta = \frac{1}{6}$
(C) $\tan\theta = 6$ (D) $\tan\theta = \frac{1}{2}$

83. In PROBLEM 81, the time to cross the moving vehicle safely is
(A) $\frac{24}{37}$ s (B) $\frac{37}{24}$ s
(C) $\frac{24}{49}$ s (D) $\frac{3}{2}$ s

84. A proton in a cyclotron moves in a circle of radius 0.8 metre at a speed of 10^7 ms^{-1}. The acceleration of the proton and acceleration due to gravity have a ratio of approximately

(A) 10^{10} (B) 10^{11}

(C) 10^{13} (D) 10^{14}

85. 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. $(g = 10\ \text{ms}^{-2})$

(A) 1.25 s (B) 1.5 s

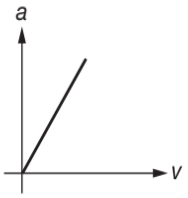
(C) 2 s (D) 2.5 s

86. A particle thrown down from the top of a tower takes time t_1 to reach the ground. It takes time t_2 if thrown from the same point with the same speed in the upward direction. The time taken by it to fall freely to the ground from the top of tower is

(A) $\frac{1}{2}(t_1 + t_2)$ (B) $\frac{1}{2}(t_1 - t_2)$

(C) $\frac{t_1 t_2}{t_1 + t_2}$ (D) $\sqrt{t_1 t_2}$

87. The acceleration-velocity graph of a particle moving rectilinearly is as shown in figure. Then slope of velocity-displacement graph must be



(A) increasing linearly
(B) decreasing linearly
(C) a constant
(D) increasing parabolically

88. Two particles start simultaneously from the same point and move along two straight lines, one with uniform velocity v and other with a uniform acceleration a. If α is the angle between the lines of motion of two particles then the least value of relative velocity will be at time given by

(A) $\frac{v}{a}\sin\alpha$ (B) $\frac{v}{a}\cos\alpha$

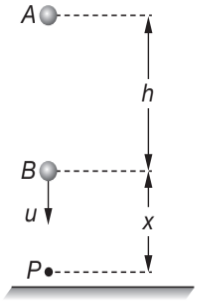
(C) $\frac{v}{a}\tan\alpha$ (D) $\frac{v}{a}\cot\alpha$

89. In PROBLEM 88, the least value of relative velocity is

(A) $v\sin\alpha$ (B) $v\cos\alpha$

(C) $v\tan\alpha$ (D) $v\cot\alpha$

90. A body dropped from a certain height attains the same velocity as another falling with an initial velocity u from a height h below the first body. If g is the acceleration due to gravity, then



(A) $u = \sqrt{gh}$ (B) $u = 2\sqrt{gh}$

(C) $u = \sqrt{2gh}$ (D) $u = \sqrt{\frac{gh}{2}}$

91. Two objects move uniformly toward each other. They get closer by 4 metre each second but when they move uniformly in the same direction, with the same speeds, they get 4 metre closer every 10 second. The speeds of the two objects are

(A) 2.2 ms^{-1} and 1.8 ms^{-1}

(B) 1.1 ms^{-1} and 1.8 ms^{-1}

(C) 22 ms^{-1} and 18 ms^{-1}

(D) 1.7 ms^{-1} and 2.1 ms^{-1}

92. A body falls freely under gravity. The distance travelled by it in the last second of its journey equals the distance travelled by it in the first three second of its free fall. The total time taken by the body to reach the ground is

(A) 5 s (B) 8 s

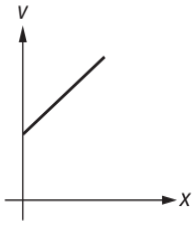
(C) 12 s (D) 15 s

93. Six persons are initially at the six corners of a hexagon of side a. Each person now moves with a uniform speed v in such a manner that 1 is always directed towards 2, 2 towards 3, 3 towards 4 and so on. The time after which they meet is

(A) $\frac{2a}{v}$ (B) $\frac{a}{v}$

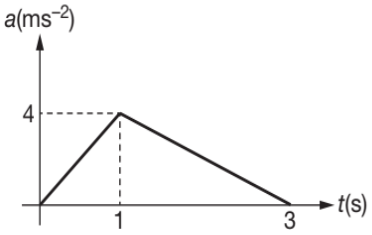
(C) $\frac{2a}{3v}$ (D) $\frac{a}{2v}$

94. Velocity versus displacement graph of a particle moving in a straight line is as shown in figure. The acceleration of the particle is



(A) constant
(B) increases parabolically with x
(C) increases linearly with x^2
(D) increases linearly with x

95. The acceleration time graph of a particle moving in a straight line is as shown in figure. The velocity of the particle at time $t = 0$ is $2\ \text{ms}^{-1}$. The velocity after 2 second will be



(A) $2\ \text{ms}^{-1}$ (B) $4\ \text{ms}^{-1}$
(C) $6\ \text{ms}^{-1}$ (D) $8\ \text{ms}^{-1}$

96. A ball is thrown vertically up with a speed of $20\ \text{ms}^{-1}$. It is caught on its way down 5 m above the point from where it was thrown. The time lapse between the throw and the catch is

(A) 1.9 s (B) 3.8 s
(C) 8.3 s (D) 1.2 s

97. Two particles start moving from the same point along the same straight line. The first moves with constant velocity $2v$ and the second with constant acceleration a. During the time that elapses before the second catches the first, the greatest distance between the particles is

(A) $\frac{v^2}{a}$ (B) $\frac{v^2}{2a}$
(C) $\frac{2v^2}{a}$ (D) $\frac{v^2}{4a}$

98. Starting from rest a particle moves in a straight line with acceleration $a = [2 + |t - 2|]\ \text{ms}^{-2}$. Velocity of particle at the end of 4 s will be

(A) $8\ \text{ms}^{-1}$ (B) $12\ \text{ms}^{-1}$
(C) $16\ \text{ms}^{-1}$ (D) $20\ \text{ms}^{-1}$

99. A body moving rectilinearly traversed one third of the total distance with a velocity $4\ \text{ms}^{-1}$. The remaining part of the distance was covered with a velocity $2\ \text{ms}^{-1}$ for half the time and with velocity $6\ \text{ms}^{-1}$ for the other half of time. The mean velocity averaged over the whole time of motion is

(A) $5\ \text{ms}^{-1}$ (B) $4.5\ \text{ms}^{-1}$
(C) $3.5\ \text{ms}^{-1}$ (D) $4\ \text{ms}^{-1}$

100. A, B, C and D are four collinear points such that $AB = BC = CD$. If the average value of velocities between A and B, C and D are $12\ \text{ms}^{-1}$ and $20\ \text{ms}^{-1}$ respectively, then the value of average velocity between B and C if the body moves with uniform acceleration throughout is

(A) $16\ \text{ms}^{-1}$ (B) $14\ \text{ms}^{-1}$
(C) $\left(1+\sqrt{241}\right)\text{ms}^{-1}$ (D) $8\ \text{ms}^{-1}$

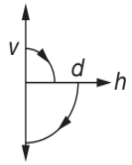
101. A target is made of two plates, one of wood and the other of iron. The thickness of the wooden plate is 4 cm and that of iron plate is 2 cm. A bullet fired goes through the wood first and then penetrates 1 cm into iron. A similar bullet fired with the same velocity from opposite direction goes through iron first and then penetrates 2 cm into wood. If a_1 and a_2 be the retardations offered to the bullet by wood and iron plates respectively then

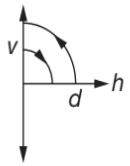
(A) $a_1 = 2a_2$ (B) $a_2 = 2a_1$
(C) $a_1 = a_2$ (D) Data Insufficient

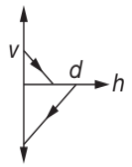
102. A ball is thrown from the top of a tower of height 80 metre with a horizontal velocity of $30\ \text{ms}^{-1}$. The velocity with which it strikes the level ground is

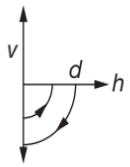
(A) $20\ \text{ms}^{-1}$ (B) $50\ \text{ms}^{-1}$
(C) $80\ \text{ms}^{-1}$ (D) $100\ \text{ms}^{-1}$

103. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height $\frac{1}{2}d$. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as

(A)


(B)


(C)


(D)


104. A ball is dropped from the roof of a tower of height h. The total distance covered by it in the last second of its motion is equal to the distance covered by it in first three second. The value of h in meters is $\left(g = 10\ \text{ms}^{-2}\right)$

(A) 80 (B) 100
(C) 125 (D) 200

105. A stone falls freely from a point O. It passes through the points P, Q, R,.....such that OP, OQ, OR, ... are in geometric progression. Then velocities of stone at P, Q, R, ...are in

(A) arithmetic progression
(B) geometric progression
(C) harmonic progression
(D) logarithmic mean

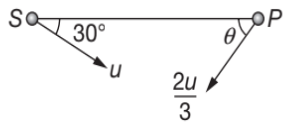
106. A particle projected vertically upwards attains a maximum height H. If the ratio of the times to attain a height h $(h < H)$ is $\frac{1}{3}$ then

(A) $4h = 3H$ (B) $3h = 4H$
(C) $3h = H$ (D) $4h = H$

107. The velocity of a boat in still water is η times less than the velocity of flow of the river $(\eta > 1)$. The angle with the stream direction at which the boat must move to minimise drifting is

(A) $\sin^{-1}\left(\frac{1}{\eta}\right)$ (B) $\cot^{-1}\left(\frac{1}{\eta}\right)$
(C) $\frac{\pi}{2} + \sin^{-1}\left(\frac{1}{\eta}\right)$ (D) $\frac{\pi}{2} + \cot^{-1}\left(\frac{1}{\eta}\right)$

108. Sachin (S) hits a ball along the ground with a speed u in a direction which makes an angle $30°$ with the line joining him and the fielder Prem (P). Prem runs to intercept the ball with a speed $\frac{2u}{3}$. At what angle θ should he run to intercept the ball?



(A) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (B) $\sin^{-1}\left(\frac{2}{3}\right)$
(C) $\sin^{-1}\left(\frac{3}{4}\right)$ (D) $\sin^{-1}\left(\frac{4}{5}\right)$

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. A particle moves with an initial velocity v_0 and retardation αv, where v is its velocity at any time t. If $\log_e(2) = 0.7$, then which of the following statement(s) is/are correct?

(A) The particle will cover a total distance $\frac{v_0}{\alpha}$.

(B) The particle will come to rest after time $\frac{1}{\alpha}$.

(C) The particle will continue to move for a very long time.

(D) The velocity of the particle will become $\frac{v_0}{2}$ after time $\frac{7}{10\alpha}$.

2. Average velocity of a particle moving in a straight line, with constant acceleration a and initial velocity u and final velocity v in first t second is

(A) $\frac{u+v}{2}$ (B) $u + at$
(C) $\frac{1}{2}(u + at)$ (D) $u + \frac{1}{2}at$

3. The velocity of a particle moving along a straight line increases according to the linear law $v = v_0 + kx$, where k is a constant. Then

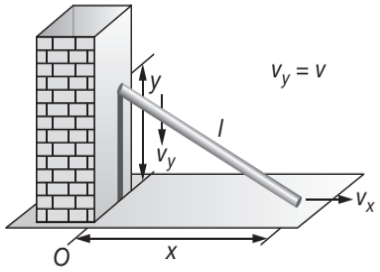
(A) the acceleration of the particle is $k(v_0 + kx)$.

(B) the particle takes a time $\frac{1}{k}\log_e\left(\frac{v_1}{v_0}\right)$ to attain a velocity v_1.

(C) velocity varies linearly with displacement with slope of velocity displacement curve equal to k.

(D) data is insufficient to arrive at a conclusion.

4. A rod of length l leans by its upper end against a smooth vertical wall, while its other end leans against the floor. The end that leans against the wall moves uniformly downward . Then the



(A) other end moves uniformly forward with speed v.

(B) other end moves with a speed whose value decreases with increase in y and vanishes at $y = 0$.

(C) other end moves with a speed whose value decreases with decrease in y and vanishes at $y = 0$.

(D) other end moves such that the ratio $\frac{v_x}{v}$ equals $\frac{y}{\sqrt{l^2 - y^2}}$.

5. For a particle moving in a plane, if $\vec{v}$ and $\vec{a}$ be the instantaneous velocity and acceleration, then rate of change of speed, $\frac{dv}{dt}$, of the particle equal(s)

(A) $|\vec{a}|$

(B) the component of $\vec{a}$ perpendicular to $\vec{v}$

(C) $\frac{\vec{a} \cdot \vec{v}}{v}$

(D) the projection of $\vec{a}$ along $\vec{v}$

6. The position of a particle travelling along x-axis is given by $x_t = t^3 - 9t^2 + 6t$ where x_t is in cm and t is in second. Then

(A) the body comes to rest firstly at $(3 - \sqrt{7})$ s and then at $(3 + \sqrt{7})$ s.

(B) the total displacement of the particle in travelling from the first zero of velocity to the second zero of velocity is zero.

(C) the total displacement of the particle in travelling from the first zero of velocity to the second zero of velocity is –74 cm.

(D) the particle reverses its velocity at $(3 - \sqrt{7})$s and then at $(3 + \sqrt{7})$ s and has a negative velocity for $(3 - \sqrt{7}) < t < (3 + \sqrt{7})$

7. A particle, starting from rest is first accelerated for time t_1 with constant acceleration a_1 and then stops in time t_2 with constant retardation a_2. Let v_1 be the average velocity in this case and s_1 the total displacement. Now, the same particle, starting again from rest is accelerated for the same time t_1 with constant acceleration $2a_1$ and finally comes to rest with constant retardation a_2 in time t_3. If v_2 is the average velocity in this case and s_2 the total displacement. Then

(A) $s_2 = 2s_1$ (B) $2s_1 < s_2 < 4s_1$

(C) $v_2 = 2v_1$ (D) $2v_1 < v_2 < 4v_1$

8. A particle moves with an initial velocity v_0 and retardation αv, where v is velocity at any instant t. Then

(A) the particle will cover a total distance $\frac{v_0}{\alpha}$.

(B) the particle continues to move for a long time span.

(C) the particle attains a velocity $\frac{1}{2}v_0$ at $t = \frac{1}{\alpha}$.

(D) the particle comes to rest at $t = \frac{1}{\alpha}$.

9. A particle moving along a straight line with uniform acceleration has velocities 7 ms^{-1} at A and 17 ms^{-1} at B. C is the mid-point of AB. Then

(A) the average velocity between C and B is 15 ms^{-1}

(B) the ratio of time to go from A to C and that from C to B is 3 : 2

(C) the velocity at C is 10 ms^{-1}

(D) the average velocity between A and C is 10 ms^{-1}

10. An aeroplane flies along a straight line from A to B with a speed v_0 and back again with the same speed v_0. A steady wind v is blowing. If $AB = l$ then

(A) total time for the trip is $\frac{2v_0 l}{v_0^2 - v^2}$, if wind blows along the line AB.

(B) total time for the trip is $\frac{2l}{\sqrt{v_0^2 - v^2}}$, if wind blows perpendicular to the line AB.

(C) total time for the trip decreases because of the presence of wind.

(D) total time for the trip increases because of the presence of wind.

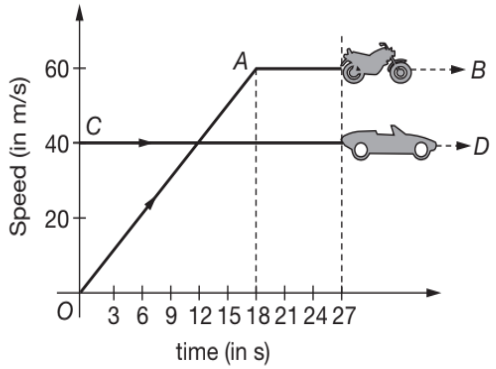
11. Acceleration of a particle which is at rest at $x = 0$ is $\vec{a} = (4 - 2x)\hat{i}$. Select the correct alternative(s)

(A) maximum speed of particle is 4 units

(B) particle further comes to rest at $x = 4$

(C) particle oscillates about $x = 2$
(D) all of the above

12. At the instant a motor bike starts from rest in a given direction, a car overtakes the motor bike, both moving in the same direction.



The speed time graphs for motor bike and car are represented by OAB and CD respectively. Then

(A) at $t = 18$ s the motor bike and car are 180 m apart.
(B) at $t = 18$ s the motor bike and car are 720 m apart.
(C) the relative distance between motor bike and car reduces to zero at $t = 27$ s and both are 1080 m far from origin.
(D) the relative distance between motor bike and car always remains same.

13. A car is moving rectilinearly on a horizontal path with acceleration a_0. A person sitting inside the car observes that an insect S is crawling up the screen with an acceleration a. If θ is the inclination of the screen with the horizontal, then the acceleration of the insect

(A) perpendicular to screen is $a_0 \tan\theta$
(B) perpendicular to screen is $a_0 \sin\theta$
(C) along the horizontal is $a_0 - a\cos\theta$
(D) parallel to screen is $a + a_0 \cos\theta$

14. A particle having a velocity $v = v_0$ at $t = 0$ is decelerated at the rate $|a| = \alpha\sqrt{v}$, where α is a positive constant.

(A) The particle comes to rest at $t = \dfrac{2\sqrt{v_0}}{\alpha}$.
(B) The particle will come to rest at infinity.
(C) The distance travelled by the particle is $\dfrac{2v_0^{3/2}}{\alpha}$.
(D) The distance travelled by the particle is $\dfrac{2}{3}\dfrac{v_0^{3/2}}{\alpha}$.

15. A car starts moving rectilinearly (initial velocity zero) first with an acceleration of $5\ \text{ms}^{-2}$ then uniformly and finally decelerating at the same rate till it stops. Total time of journey is 25 s and average velocity during the journey is $72\ \text{kmh}^{-1}$. Then

(A) total distance travelled by the car is 500 m.
(B) maximum speed attained during the journey is $25\ \text{ms}^{-1}$.
(C) car travels with uniform speed for 15 s.
(D) car accelerates for 5 s and decelerates also for 5 s.

16. For a moving body, which of the following statement(s) is/are true?

(A) If its speed changes but direction of motion does not change, its velocity may remain constant.
(B) If its speed changes, its velocity must change and it must have some acceleration.
(C) If its velocity changes, its speed must change and it must have some acceleration.
(D) If its velocity changes, its speed may or may not change, and it must have some acceleration.

17. A body is moving along a straight line. Its distance x_t from a point on its path at a time t after passing that point is given by $x_t = 8t^2 - 3t^3$, where x_t is in metre and t is in second.

(A) Average speed during the interval $t = 0$ s to $t = 4$ s is $20.21\ \text{ms}^{-1}$.
(B) Average velocity during the interval $t = 0$ s to $t = 4$ s is $-16\ \text{ms}^{-1}$.
(C) The body starts from rest and at $t = \dfrac{16}{9}$ s it reverses its direction of motion at $x_t = 8.43$ m from the start.
(D) It has an acceleration of $-56\ \text{ms}^{-2}$ at $t = 4$ s.

18. Let $\vec{r}$ be the radius vector of a particle in motion about some reference point and r its modulus. Similarly $\vec{v}$ be the velocity vector and v its modulus, then

(A) $|d\vec{r}| \neq dr$ (B) $v \neq \dfrac{dr}{dt}$
(C) $v = \dfrac{dr}{dt}$ (D) $v = \left|\dfrac{d\vec{r}}{dt}\right|$

19. Two particles P and Q move in a straight line AB towards each other. P starts from A with velocity u_1 and an acceleration a_1. Q starts from B with velocity u_2 and acceleration a_2. They pass each other at the midpoint of AB and arrive at the other ends of AB with equal velocities.

(A) They meet at midpoint at time $t=\dfrac{2(u_2-u_1)}{(a_1-a_2)}$.

(B) The length of path specified i.e. AB is $l=\dfrac{4(u_2-u_1)(a_1u_2-a_2u_1)}{(a_1-a_2)^2}$.

(C) They reach the other ends of AB with equal velocities if $(u_2+u_1)(a_1-a_2)=8(a_1u_2-a_2u_1)$.

(D) They reach the other ends of AB with equal velocities if $(u_2-u_1)(a_1+a_2)=8(a_2u_1-a_1u_2)$.

20. Consider a body moving rectilinearly under the influence of constant acceleration $\vec{a}$. Let $\vec{v}$ denote the velocity of the body at any instant of time. Which of the following argument(s) is/are correct?

(A) Speed must decrease when $\vec{a}$ is negative.

(B) Speed must increase when $\vec{a}$ is negative for the body that starts from rest initially.

(C) Speed will increase when both $\vec{v}$ and $\vec{a}$ are both negative.

(D) Speed will decrease when $\vec{v}$ is negative and $\vec{a}$ positive.

21. The co-ordinate of the particle in x-y plane are given as $x=2+2t+4t^2$ and $y=4t+8t^2$. The motion of the particle is

(A) along a parabolic path

(B) non-uniformly accelerated

(C) along a straight line

(D) uniformly accelerated

22. Two particles A and B are located in x-y plane at points $(0,0)$ and $(0,4\text{ m})$. They simultaneously start moving with velocities $\vec{v}_A=2\hat{j}\ \text{ms}^{-1}$ and $\vec{v}_B=2\hat{i}\ \text{ms}^{-1}$. Select the correct alternative(s)

(A) the distance between them is constant

(B) the distance between them first decreases and then increases

(C) time after which they are at minimum distance is 1 s

(D) the shortest distance between them is $2\sqrt{2}$ m

23. Consider a body moving rectilinearly with velocity v under the influence of an acceleration a. Which of the following statement(s) is/are correct?

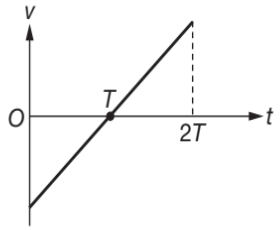
(A) The direction of a must have some correlation with the direction of v.

(B) a can be non-zero when $v=0$

(C) a must be zero when $v=0$

(D) a may be zero when $v\neq 0$

24. For a particle moving rectilinearly, the velocity-time $(\vec{v}\text{-}t)$ graph is plotted. Which of the following argument(s) is/are correct to explain the facts about its motion?



(A) The acceleration of the particle remains constant.

(B) The particle changes its direction of motion at some point.

(C) The initial and final speeds of the particle are the same.

(D) The displacement of the particle is zero.

25. Two stationary objects when seen by an observer that moves with a constant speed along the line joining them (the stationary objects) will

(A) move in the same direction

(B) move in opposite directions

(C) have the same velocity

(D) have the same speed

26. A particle moving along x-axis has its velocity (v) varying with x co-ordinate (x) as $v=\sqrt{x}$. Then

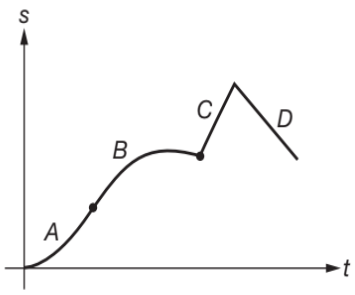
(A) initial velocity of particle is zero

(B) motion is uniformly accelerated

(C) acceleration of particle at $x=2$ m is $\dfrac{1}{2}\ \text{ms}^{-2}$

(D) acceleration of particle at $x=4$ m is $1\ \text{ms}^{-2}$

27. Displacement time graph of a particle moving in a straight line is as shown in figure



(A) in region A acceleration is positive

(B) in region B acceleration is negative

(C) in region C motion is uniform

(D) in region D acceleration is negative

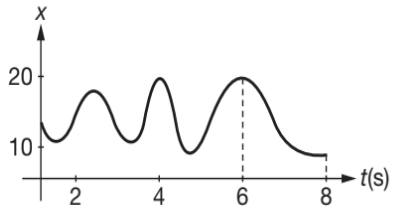
28. A particle moves on a straight line position at any time t is given by $x=x_0e^{-kt}$, where k is a constant. Select the correct statement(s).

(A) Distance moved is infinite.
(B) Distance moved during total motion is finite
(C) Average speed for total motion is zero.
(D) Average speed for total motion is infinite.

29. The motion of the body starting from rest is governed by the relation $\frac{dv}{dt} = -v^2 + 2v - 1$, where v is speed in ms^{-1} and t is time in second, then select the correct statement(s).

(A) Terminal velocity is $1\ ms^{-1}$.
(B) The magnitude of initial acceleration is $1\ ms^{-2}$.
(C) Instantaneous speed is $v = -\frac{1}{1+t}$.
(D) The speed is $1.5\ ms^{-1}$ when acceleration is one fourth of its initial value

30. In the figure is shown the position of a particle moving on the x-axis as a function of time. Then

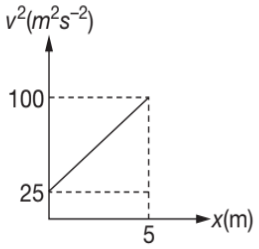


(A) the particle has come to rest for 6 times
(B) the maximum speed is at $t = 6$ s
(C) the velocity remain positive for $t = 0$ to $t = 6$ s
(D) the average velocity for the total period shown is negative

31. A particle moves with an initial velocity v_0 and retardation αv, where v is its velocity at any time t. Select the correct statement(s).

(A) The particle will cover a total distance $\frac{v_0}{\alpha}$
(B) The particle comes to rest after a time $\frac{1}{\alpha}$
(C) The particle will continue to move for a very long time
(D) The velocity of the particle will become $\frac{v_0}{2}$ after a time $\frac{1}{\alpha}$

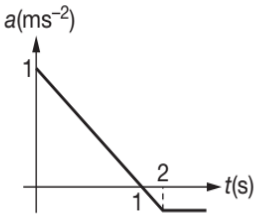
32. A particle starts moving rectilinearly from the origin along the x-axis. The graph between the square of speed and position of the particle is given in the figure. Select the correct statement(s).

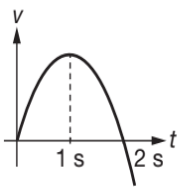


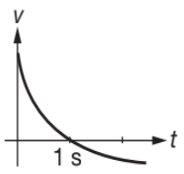
(A) Acceleration of the particle is $15\ ms^{-1}$ at $t = \frac{1}{2}$ s
(B) Acceleration of the particle is $7.5\ ms^{-1}$ at $t = 1$ s
(C) Acceleration of the particle is constant
(D) At $t = 1$ s, velocity of particle is $12.5\ ms^{-1}$

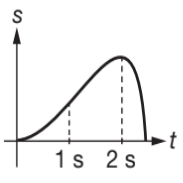
33. Mark the correct statement for a particle going on a straight line
(A) If the velocity and acceleration have opposite sign, the object is slowing down.
(B) If the position and velocity have opposite sign, the particle is moving towards the origin.
(C) If the velocity is zero at an instant, the acceleration should also be zero at that instant.
(D) If the velocity is zero for a time interval, the acceleration is zero at any instant within the time interval.

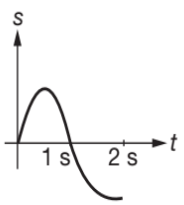
34. Acceleration vs time graph for a particle moving in straight line is as shown in figure. If particle starts from rest at $t = 0$, then which of the following curve is true for the same particle



(A) 

(B) 

(C) 

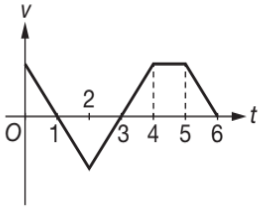
(D) 

35. A train accelerates from rest for time t_1, at a constant acceleration α for distance x. Then it decelerates to rest at constant retardation β in time t_2 for distance y. Then

(A) $\frac{x}{y} = \frac{\beta}{\alpha}$ (B) $\frac{\beta}{\alpha} = \frac{t_1}{t_2}$

(C) $\frac{x}{y} = \frac{t_1}{t_2}$ (D) $x = y$

36. From v-t graph shown in figure. We can draw the following conclusion



(A) between $t = 1$ is to $t = 2$ s speed of particle is decreasing

(B) between $t = 2$ s to $t = 3$ s speed of particle is increasing

(C) between $t = 5$ to $t = 6$ s acceleration of particle is negative

(D) between $t = 0$ to $t = 4$ s particle changes, its direction of motion twice

37. Which of the following statement(s) is/are incorrect ?

(A) Distance and speed can never be negative

(B) Distance and speed may decrease or increase

(C) Distance is always greater than magnitude of displacement

(D) Speed is always greater than magnitude of velocity

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

(A) Its maximum speed is $8\ \text{ms}^{-1}$

(B) Its maximum speed is $6\ \text{ms}^{-1}$

(C) It travelled a total distance of 24 m

(D) It travelled a total distance of 18 m

39. A particle moves along a straight line and its velocity depends on time as $v = 4t - t^2$. Then for first 5 s, the

(A) Average velocity is $\frac{25}{3}\ \text{ms}^{-1}$

(B) Average speed is $10\ \text{ms}^{-1}$

(C) Average velocity is $\frac{5}{3}\ \text{ms}^{-1}$

(D) Acceleration is $4\ \text{ms}^{-2}$ at $t = 0$

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** In a uniformly accelerated motion, acceleration time graph is straight line with positive slope.
Statement-2: Acceleration is rate of change of velocity.

2. **Statement-1:** A body having non-zero acceleration can have a constant velocity.
Statement-2: Acceleration is the rate of change of velocity.

3. **Statement-1:** Irrespective of the kind of motion possessed by a body, the body will always stay at rest in a reference frame attached to the body itself.
Statement-2: The relative velocity of a body with respect to itself is always zero.

4. **Statement-1:** The instantaneous velocity does not depend on instantaneous position vector.
Statement-2: The instantaneous velocity and average velocity of a particle are always same.

5. **Statement-1:** A balloon ascends from the surface of earth with constant speed. When it was at a height 50 m above the ground, a packet is dropped from it. To an observer on the balloon, the displacement of the packet, from the moment it is dropped to the moment it reaches the surface of earth, is 50 m.
Statement-2: Displacement (vector) depends upon the reference frame used to measure it.

6. **Statement-1:** A man who can swim at a speed v relative to water wants to cross the river of width d, flowing with speed u. He cannot reach a point P just opposite to him across the river, if $u > v$.
Statement-2: The time to reach the opposite point P across the river is $\frac{d}{\sqrt{v^2-u^2}}$ and if $u > v$ time will come out to be imaginary.

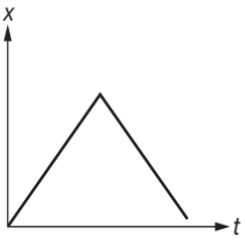
7. **Statement-1:** When a particle moves along a straight line magnitude of its average velocity is equal to its average speed over any time interval.
Statement-2: For one dimensional motion displacement and distance may or may not be equal.

8. **Statement-1:** If two particles, moving with constant velocities are to meet, the relative velocity must be along the line joining the two particles.
Statement-2: Relative velocity means motion of one particle as viewed from the other.

9. **Statement-1:** Two balls are dropped one after the other from a tall tower. The distance between them increases linearly with time (that elapses after the second ball is dropped and before the first hits ground).
Statement-2: Relative acceleration is zero, whereas relative velocity non-zero in the above situation.

10. **Statement-1:** $\left|\frac{d\vec{v}}{dt}\right| = \frac{d}{dt}|\vec{v}|$, where $\vec{v}$ has its usual meaning.
Statement-2: Acceleration is the rate of change of velocity.

11. **Statement-1:** $x-t$ graph, for a particle undergoing rectilinear motion, can be as shown in the figure.



Statement-2: Infinitesimal changes in velocity are physically possible only in infinitesimal time.

12. **Statement-1:** Area under velocity-time graph gives displacement.
Statement-2: Area under acceleration-time graph gives average velocity.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension 1

Two particles A and B start from rest at the origin $x = 0$ and move along a straight line such that $a_A = (6t - 3)\ \text{ms}^{-2}$ and $a_B = (12t^2 - 8)\ \text{ms}^{-2}$, where t is in seconds. Based on the above facts, answer the following questions.

1. Total distance travelled by A at $t = 4$ s is
(A) 40 m (B) 41 m
(C) 42 m (D) 43 m

2. Total distance travelled by B at $t = 4$ s is
(A) 192 m (B) 184 m
(C) 196 m (D) 200 m

3. The distance between them at $t = 4$ s is
(A) 144 m (B) 148 m
(C) 152 m (D) 156 m

Comprehension 2

A particle initially at $x = 10$ m, starts moving along the positive x-axis with an initial velocity of 40 ms^{-1} under the influence of an acceleration of 10 ms^{-2} directed along the negative x direction. Based on this information, answer the following questions.

4. The particle reverses its direction of motion at time t_0 from the start. Then
(A) $t_0 = 2$ s (B) $t_0 = 4$ s
(C) $t_0 = 6$ s (D) $t_0 = 8$ s

5. The maximum x-coordinate of the particle is
(A) 30 m (B) 60 m
(C) 90 m (D) 120 m

6. The velocity of the particle (in ms^{-1}) at the origin of the coordinate system is
(A) $30\sqrt{2}$ along $+x$ direction
(B) $30\sqrt{2}$ along $-x$ direction
(C) $10\sqrt{7}$ along $+x$ direction
(D) $10\sqrt{7}$ along $-x$ direction

7. The time at which the particle crosses the origin is

(A) $(4-3\sqrt{2})$ s (B) $(4+3\sqrt{2})$ s

(C) $(4-\sqrt{7})$ s (D) $(4+\sqrt{7})$ s

Comprehension 3

Starting from rest, a particle moves rectilinearly along x-axis, under the influence of acceleration a which varies with time t (in second) as $a=(2t-4)$ ms^{-2}. Based on this information answer the following questions.

8. The particle comes to rest at time equal to

(A) 1 s (B) 2 s

(C) 3 s (D) 4 s

9. The maximum velocity of the particle is v_{max} at time t_0 (say). Then

(A) $v_{max}=2$ ms^{-1}, along $+x$ axis at time $t_0=2$ s

(B) $v_{max}=4$ ms^{-1}, along $-x$ axis at time $t_0=2$ s

(C) $v_{max}=2$ ms^{-1}, along $-x$ axis at time $t_0=4$ s

(D) $v_{max}=4$ ms^{-1}, along $+x$ axis at time $t_0=4$ s

10. The velocity-time graph of the particle is a

(A) Straight line passing through $(0, 0)$

(B) Straight line passing through $(2, 0)$

(C) Parabola having origin at $(4, 2)$

(D) Parabola having origin at $(2, 4)$

Comprehension 4

The motion of a body falling initially from rest in a resistive medium is described by the differential equation

$$\frac{dv}{dt}=6-3v$$

where v is the velocity of the body at any instant (in ms^{-1}). Based on the above facts, answer the following questions.

11. The initial acceleration is of the body is

(A) 6 ms^{-2} (B) 3 ms^{-2}

(C) 2 ms^{-2} (D) 18 ms^{-2}

12. The terminal velocity i.e., the velocity at which acceleration becomes zero is given by

(A) 6 ms^{-1} (B) 3 ms^{-1}

(C) 2 ms^{-1} (D) 18 ms^{-1}

13. The velocity at any time t is given by

(A) $v=e^{-3t}$ (B) $v=1-e^{-3t}$

(C) $v=\frac{1}{2}(1-e^{-3t})$ (D) $v=2(1-e^{-3t})$

14. The acceleration (a) of the body as the function of time is

(A) $a=2e^{-3t}$ (B) $a=3e^{-2t}$

(C) $a=6e^{-3t}$ (D) $a=6e^{-2t}$

Comprehension 5

A particle moves in the xy plane, such that at any instant t, its x and y coordinates are given by

$$x=a\sin(\omega t)$$

and

$$y=a[1-\cos(\omega t)]$$

where a and ω are constants. Based on the above facts, answer the following questions.

15. The magnitude of the velocity of the particle is

(A) $a\omega$

(B) $a\omega\sin(\omega t)$

(C) $a\omega\cos(\omega t)$

(D) $a\omega[\sin(\omega t)+\cos(\omega t)]$

16. The equation of trajectory followed by the particle is

(A) $x=\sqrt{2ay}$ (B) $x=\sqrt{2ay}\sqrt{1-\frac{y}{2a}}$

(C) $x=4ay^2$ (D) None of these

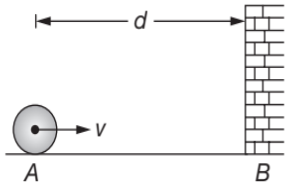
17. The magnitude of the acceleration of the particle is

(A) $a\omega$ (B) $a\omega^2$

(C) $\frac{a\omega^2}{2}$ (D) $\frac{a\omega^2}{3}$

Comprehension 6

A small ball is pushed with a speed v from A. It moves on a smooth surface and collides with the wall at B at distance d from A. During impact loses one third of its velocity.



Based on the above facts, answer the following questions.

18. The average velocity of the ball during its motion from A to B and back to A will be

(A) zero (B) $\frac{v}{2}$

(C) $\frac{v}{3}$ (D) $\frac{2v}{3}$

19. The total time taken by the ball in moving from A to B and back to A is T. Then T equals

(A) $\frac{2d}{v}$ (B) $\frac{3d}{v}$

(C) $\frac{4d}{v}$ (D) $\frac{5d}{2v}$

20. The average speed during the journey from A to B and back to A is

(A) $\frac{v}{5}$ (B) $\frac{2v}{5}$

(C) $\frac{3v}{5}$ (D) $\frac{4v}{5}$

Comprehension 7

A car accelerates from rest with $2\ \text{ms}^{-2}$ on a straight track and then it comes to rest applying its brakes. The total distance travelled by the car is 100 m in 20 s. Based on the above facts, answer the following questions.

21. The maximum speed attained by the car is

(A) $5\ \text{ms}^{-1}$ (B) $10\ \text{ms}^{-1}$

(C) $15\ \text{ms}^{-1}$ (D) $20\ \text{ms}^{-1}$

22. The duration for which the brakes were applied is

(A) 10 s (B) 5 s

(C) 15 s (D) 16 s

23. The maximum retardation given to the car is

(A) $2\ \text{ms}^{-2}$ (B) $\frac{2}{3}\ \text{ms}^{-2}$

(C) $\frac{4}{3}\ \text{ms}^{-2}$ (D) $\frac{5}{3}\ \text{ms}^{-2}$

24. The average speed of the car for the entire tenure of motion is

(A) $5\ \text{ms}^{-1}$ (B) $6\ \text{ms}^{-1}$

(C) $8\ \text{ms}^{-1}$ (D) $8.2\ \text{ms}^{-1}$

25. The distance covered during acceleration is

(A) 25 m (B) 15 m

(C) 10 m (D) 5 m

26. The distance covered during retardation is

(A) 85 m (B) 75 m

(C) 50 m (D) 25 m

Comprehension 8

A body falling from a height H hits an inclined plane in its path at a height $h(<H)$. As a result of this impact, the direction of the velocity of the body becomes horizontal. Based on the above facts, answer the following questions.

27. The value of $\frac{h}{H}$ for which the body will take the maximum time to reach the ground is

(A) $\frac{1}{\sqrt{2}}$ (B) $\sqrt{2}$

(C) $\frac{1}{2}$ (D) 2

28. The time taken by the body to hit the ground is

(A) $T=2\sqrt{\frac{H}{g}}$ (B) $T=4\sqrt{\frac{H}{g}}$

(C) $T=\sqrt{\frac{2H}{g}}$ (D) $T=\sqrt{\frac{3H}{g}}$

Comprehension 9

A body is projected from the ground vertically upwards. The body is observed to be at height h above the ground at two times t_1 and t_2 while ascending and descending respectively. Based on the above facts, answer the following questions.

29. The height h in terms of t_1 and t_2 is

(A) $h=gt_1t_2$ (B) $h=2gt_1t_2$

(C) $h=\frac{1}{2}gt_1t_2$ (D) $h=\frac{1}{4}gt_1t_2$

30. The velocity of projection (u) must be

(A) $u=\frac{1}{2}g(t_1+t_2)$ (B) $u=\frac{1}{4}g(t_1+t_2)$

(C) $u=2g(t_1+t_2)$ (D) $u=4g(t_1+t_2)$

31. The maximum height (H) reached by the body is

(A) $H=\frac{1}{2}gt_1^2$ (B) $H=\frac{1}{2}gt_2^2$

(C) $H=\frac{1}{8}g(t_1+t_2)^2$ (D) $H=\frac{1}{4}g(t_1+t_2)^2$

32. The velocity (v) of the body at height $\frac{h}{2}$ is

(A) $v=\frac{1}{4}gt_1$ (B) $v=\frac{1}{4}gt_2$

(C) $v=\frac{1}{2}g\sqrt{t_1^2+t_2^2}$ (D) $v=\frac{1}{4}g\sqrt{t_1t_2}$

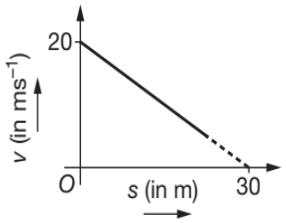
33. The velocity of the particle at half the maximum height.

(A) $\frac{g}{2}\sqrt{t_1^2+t_2^2}$ (B) $\frac{g}{4}\left(t_1^2+t_2^2\right)$

(C) $\frac{g}{2\sqrt{2}}\left(t_1+t_2\right)$ (D) $\frac{g}{\sqrt{2}}\left(t_1+t_2\right)$

Comprehension 10

If the velocity v of a particle moving along a straight line decreases linearly with its displacement s from 20 ms^{-1} to a value approaching zero at $s = 30$ m. Based on the above facts, answer the following questions.



34. Acceleration of the particle at $s = 15$ m is

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

(C) $\frac{20}{3}$ ms^{-2} (D) $-\frac{20}{3}$ ms^{-2}

35. The time taken by the particle to reach the 30 m position is

(A) 1.5 s (B) 3 s

(C) 6 s (D) Infinite

Comprehension 11

Buses are going from one city to other and vice-versa. The buses start at regular interval of 5 minutes each from station A to B and station B to A each with same speed 60 kmh^{-1}. The distance between two stations is 30 km. A bus marked A starts from city A and finds buses approaching from opposite direction.

Based on the above facts, answer the following questions.

36. The time interval after which bus A will meet two buses coming from opposite side is

(A) 5 min (B) 2.5 min

(C) 1.25 min (D) 10 min

37. The distance travelled by bus A to meet two buses from opposite side is

(A) 2.5 km (B) 5 km

(C) 10 km (D) None of these

38. How many buses the bus A will meet on way from city A to city B?

(A) 6 (B) 5

(C) 12 (D) 11

Comprehension 12

A particle moves in positive x-direction according to law $x = 12t - t^2$ m. where t time in second. (Take +ve x-direction as +ve).

Based on the above facts, answer the following questions.

39. Average velocity from $t = 0$ to $t = 8$ s is

(A) 4 ms^{-1} (B) 6 ms^{-1}

(C) 8 ms^{-1} (D) –4 ms^{-1}

40. Average speed from $t = 0$ to $t = 8$ s is

(A) 4 ms^{-1} (B) 5 ms^{-1}

(C) 6 ms^{-1} (D) 8 ms^{-1}

41. Average acceleration from $t = 0$ s to $t = 8$ s is

(A) $-\frac{1}{4}$ ms^{-2} (B) $+\frac{1}{4}$ ms^{-2}

(C) $-\frac{1}{2}$ ms^{-2} (D) –2 ms^{-2}

Comprehension 13

A particle starts from rest from the origin with a time varying acceleration $a = (2t - 4)$, where t is in seconds and a in ms^{-2}. Assuming the particle to move rectilinearly.

Based on the above facts, answer the following questions.

42. Particle comes to rest (after a time) at

(A) 1 s (B) 4 s

(C) 3 s (D) 2 s

43. The speed of the particle moving in negative direction is maximum at time t. Then t equals

(A) 3 s (B) 4 s

(C) 2 s (D) 1 s

44. The distance travelled by the particle from the start to the moment when it comes to rest is

(A) $\frac{16}{3}$ m (B) 2 m

(C) 3 m (D) None of these

Comprehension 14

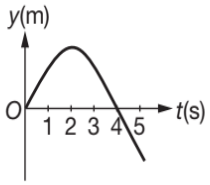
A person standing on the roof of a building throws a ball vertically upward at an instant $t = 0$. The ball leaves his

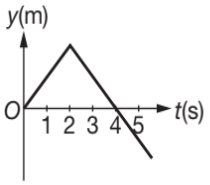
hand with an upward speed $20\ \text{ms}^{-1}$ and it is then in free fall. The ball rises to a certain height and then moves down. On its way down, the ball just misses to hit the roof of the building and keeps falling towards the earth. The ball hits earth at $t = 5$ s. Considering that

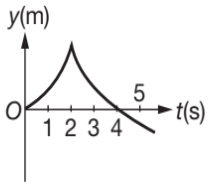
(i) the vertically upward direction is the positive y-direction
(ii) the position of ball at $t = 0$ is the origin
(iii) the ball does not rebound and comes to rest at the same place where it hits earth and
(iv) air resistance is negligible, answer these questions. $\left(\text{Take } g = 10\ \text{ms}^{-2}\right)$

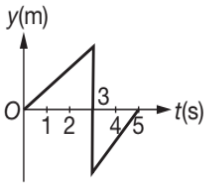
Based on the above facts, answer the following questions.

45. Position-time graph for the given motion of the ball is

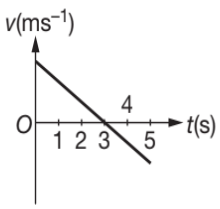
(A) 

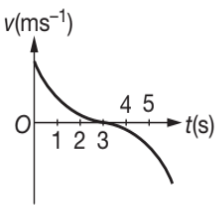
(B) 

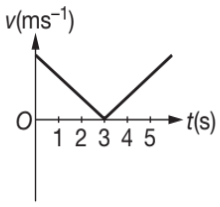
(C) 

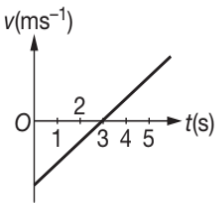
(D) 

46. Velocity of the ball will vary with time as

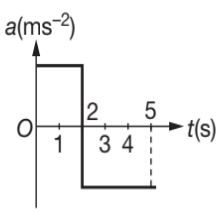
(A) 

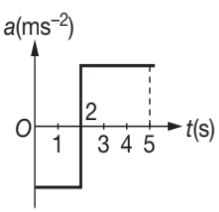
(B) 

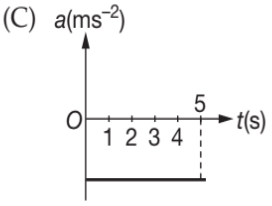
(C) 

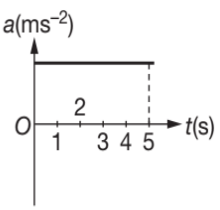
(D) 

47. Acceleration of the ball will vary with time as

(A) 

(B) 

(C) 

(D) 

Comprehension 15

The position of a particle is moving along the x-axis depends on the time according to the equation $x = 6t^2 - t^3$, where x is in metre and t in seconds.

Based on the above facts, answer the following questions.

48. Time at which velocity of the particle is maximum along positive direction of x-axis is
(A) 1 s (B) 2 s
(C) 3 s (D) 4 s

49. Distance travelled by the particle during time interval $t = 3$ s to $t = 5$ s is
(A) 2 m (B) 5 m
(C) 12 m (D) 10 m

50. Average speed of the particle during time interval $t = 0$ s to $t = 6$ s is
(A) $2\ \text{ms}^{-1}$ (B) Zero
(C) $4\ \text{ms}^{-1}$ (D) None of these

Comprehension 16

A particle is moving along x-axis and its initial velocity is $27\ \text{ms}^{-1}$. The acceleration of particle is given by the relation $a = (-6t)\ \text{ms}^{-2}$, where t is in seconds. At $t = 0$ particle is at $x = 0$.

Based on the above facts, answer the following questions.

51. The velocity of particle, when it travels 26 m is
(A) $21\ \text{ms}^{-1}$ (B) $15\ \text{ms}^{-1}$
(C) $24\ \text{ms}^{-1}$ (D) $18\ \text{ms}^{-1}$

52. Maximum value of velocity along positive x-direction is
(A) $35\ \text{ms}^{-1}$ (B) $33\ \text{ms}^{-1}$
(C) $27\ \text{ms}^{-1}$ (D) $30\ \text{ms}^{-1}$

53. Maximum value of displacement along positive x-direction is
(A) 54 m (B) 27 m
(C) 120 m (D) None of these

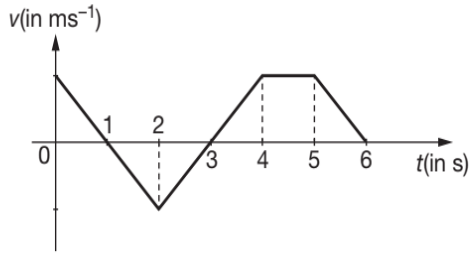
MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	(p)	(q)	(r)	(s)	(t)
B	(p)	(q)	(r)	(s)	(t)
C	(p)	(q)	(r)	(s)	(t)
D	(p)	(q)	(r)	(s)	(t)

1. From the v-t graph shown in figure, match the quantities in **COLUMN-I** to their respective conclusions in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) between $t=0$ and $t=1$ s	(p) $v=0$
(B) between $t=1$ s and $t=2$ s	(q) $a=0$
(C) between $t=2$ s and $t=3$ s	(r) $v\neq 0$
(D) between $t=3$ s and $t=4$ s	(s) $a\neq 0$
(E) between $t=4$ s and $t=5$ s	(t) accelerated
(F) between $t=5$ s and $t=6$ s	(u) decelerated
(G) at $t=1$ s and at $t=3$ s	

2. For a particle moving rectilinearly, the x varies with t as per the equation $x=-5t^2+20t+10$, where x is in metre and t is in second.

COLUMN-I	COLUMN-II
(A) Average speed, in ms^{-1}, from $t=0$ to $t=4$ s	(p) 20
(B) Average velocity, in ms^{-1}, from $t=0$ to $t=4$ s	(q) 10
(C) Acceleration, in ms^{-2}, at $t=4$ s	(r) Zero
(D) Speed, in ms^{-1}, at $t=4$ s	(s) -4
	(t) None of these

(*Continued*)

3. Match the quantities in **COLUMN-I** with the corresponding expressions in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Velocity	(p) $\frac{d\vec{v}}{dt}$
(B) Tangential acceleration	(q) $\frac{d\vec{r}}{dt}$
(C) Acceleration	(r) $\frac{d\lvert\vec{v}\rvert}{dt}$
(D) Instantaneous speed	(s) $\frac{d^2\vec{r}}{dt^2}$
	(t) $\left\lvert\frac{d\vec{v}}{dt}\right\rvert$
	(u) None of these

4. A particle moves such that its x coordinate is related to the time t by the relation $t=\sqrt{x}+3$, where x is in metre, t is in second. Based on this information, match the values in **COLUMN-I** (in SI units) to their respective quantities for the particles motion given in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 0	(p) Acceleration at $t = 5$ s.
(B) 2	(q) Average speed from $t = 0$ to $t = 6$ s.
(C) 3	(r) Velocity at the point of reversal of motion.
(D) 18	(s) Total distance travelled from $t = 0$ to $t = 6$ s.
	(t) Displacement from $t = 0$ to $t = 6$ s.

5. A man can row a boat with 4 kmh^{-1} in still water. The man wishes to cross the river of width 4 km having a water current of 2 $kmhr^{-1}$. To cross the river with zero drift he swims making at an angle α degree with the current flow taking a time t_1 minutes to cross the river.

Now he wishes to cross the river in the shortest time t_2 minutes making an angle β degree with the river flow.

Further he takes a time t_3 minutes to row 2 km upstream and then downstream back to the start point. Assuming all the cases to be independent of each other, the man to start from the river bank from the same point in the first two cases and from the mid-point of the river in the third case, match the quantities in **COLUMN-I** to the values in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) α	(p) $40\sqrt{3}$
(B) β	(q) 60
(C) t_1	(r) 80
(D) t_2	(s) 90
(E) t_3	(t) 120
	(u) Zero

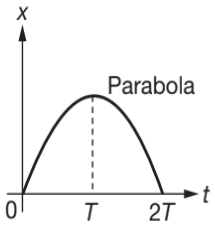
6. For one dimensional motion if v_{av} be the average speed, $\vec{v}_{av}$ be the average velocity, v_{inst} be the instantaneous speed, $\vec{v}_{inst}$ be the instantaneous velocity and v be the speed, then match the following

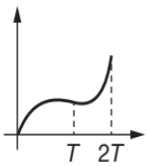
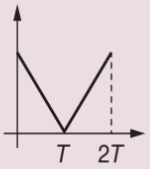
COLUMN-I	COLUMN-II
(A) $\vec{v}_{inst} = \vec{v}_{av}$	(p) for uniform motion in any direction
(B) $\lvert\vec{v}_{inst}\rvert = v$	(q) for uniform motion in given direction
(C) $v_{inst} = v_{av}$	(r) Always true
(D) $\lvert\vec{v}_{inst}\rvert < v$	(s) Never true

7. Match the following

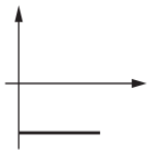
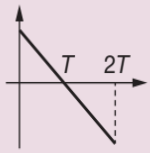
COLUMN-I	COLUMN-II
(A) Motion of dropped ball	(p) Two dimensional motion
(B) Motion of a snake	(q) Three dimensional motion
(C) Motion of a bird	(r) One dimensional motion
(D) Earth	(s) Absolute rest

8. The displacement-time graph of a body moving on a straight line is given by

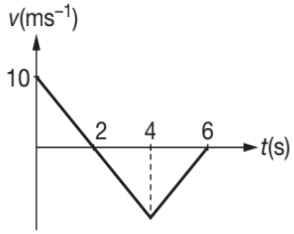


COLUMN-I	COLUMN-II
(A) Velocity – time graph	(p) 
(B) Acceleration-time graph	(q) 

(*Continued*)

COLUMN-I	COLUMN-II
(C) Distance – time graph	(r) 
(D) Speed – time graph	(s) 

9. For the velocity-time graph shown in figure, in a time interval from $t = 0$ to $t = 6$ s, match the following



COLUMN-I	COLUMN-II
(A) Change in velocity	(p) $-\frac{5}{3}$ SI unit
(B) Average acceleration	(q) –20 SI unit
(C) Total displacement	(r) –10 SI unit
(D) Acceleration at $t = 3$ s	(s) –5 SI unit

10. A balloon rises up with constant net acceleration of $10\ \text{ms}^{-2}$. After 2 s a particle drops from the balloon. After further 2 s match the following $\left(\text{Take } g = 10\ \text{ms}^{-2}\right)$

COLUMN-I	COLUMN-II
(A) Height of particle ground	(p) Zero
(B) Speed of particle	(q) 10 SI units
(C) Displacement of particle	(r) 40 SI units
(D) Acceleration of particle	(s) 20 SI units

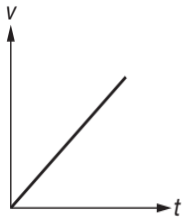
11. A body accelerates from rest for time t_1 at a constant rate α for distance x then it decelerates at constant rate β for time t_2 and covers distance y in this time and come at rest. If all quantities are in SI units, then match the following columns.

COLUMN-I	COLUMN-II
(A) $\frac{x}{y}$	(p) $\frac{t_1}{t_2}$
(B) $\frac{\alpha}{\beta}$	(q) $\frac{t_2}{t_1}$
(C) average speed for whole journey	(r) $\sqrt{\frac{2\alpha\beta}{\alpha+\beta}(x+y)}$
(D) Maximum speed attained in it whole journey	(s) $\sqrt{\frac{\alpha\beta}{\alpha+\beta}\left(\frac{x+y}{2}\right)}$

12. The equation of one dimensional motion of particle is described in **COLUMN-I.** At $t = 0$, particle is at origin and at rest. Match the **COLUMN-I** with the statements in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) $x = (3t^2 + 2)$ m	(p) velocity of particle at $t = 1$ s is 8 ms^{-1}
(B) $v = 8t\ \text{ms}^{-1}$	(q) particle moves with uniform acceleration
(C) $a = 16t$	(r) particle moves with variable acceleration
(D) $v = 6t - 3t^2$	(s) particle will change its direction some time

13. v-t graph of a particle moving along positive direction x is shown in figure. Match the items in **COLUMN-I** with the respective answers in **COLUMN-II**.

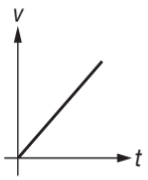
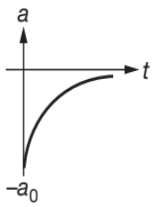
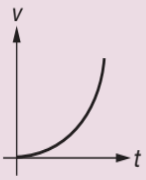
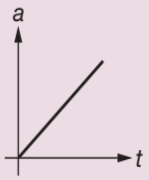
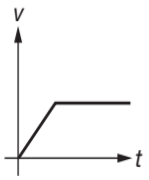
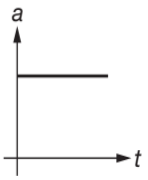
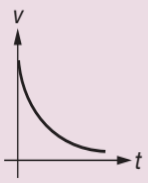
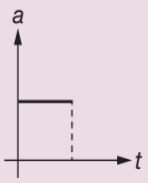


COLUMN-I	COLUMN-II
(A) a-x graph	(p) Parabola

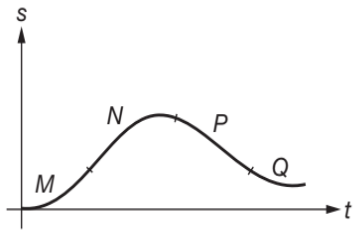
(*Continued*)

COLUMN-I	COLUMN-II
(B) v-x graph	(q) Circle
(C) a-t graph	(r) Straight line
(D) a-v graph	(s) Ellipse

14. Match the v-t graphs in **COLUMN-I** with the respective a-t graphs in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 	(p) 
(B) 	(q) 
(C) 	(r) 
(D) 	(s) 

15. Let us call a motion, A when velocity is positive and increasing. A^{-1} when velocity is negative and increasing. R when velocity is positive and decreasing and R^{-1} when velocity is negative and decreasing. Now match the following two tables for the given s-t graph

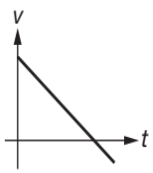
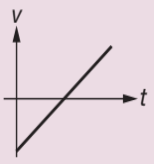
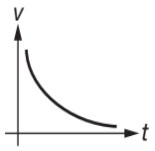
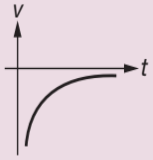


COLUMN-I	COLUMN-II
(A) M	(p) A^{-1}
(B) N	(q) R^{-1}
(C) P	(r) A
(D) Q	(s) R

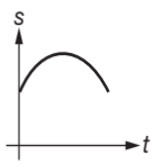
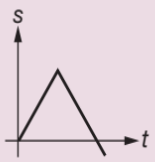
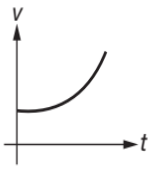
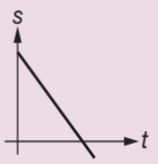
16. In the s-t equation $(s = 10 + 20t - 5t^2)$ match the following

COLUMN-I	COLUMN-II
(A) Distance travelled in 3 s	(p) –20 unit
(B) Displacement in 1 s	(q) 15 unit
(C) Initial acceleration	(r) 25 unit
(D) Velocity at 4 s	(s) –10 unit

17. The velocity time graphs for a particle moving along a straight line is given in each situation of **COLUMN–I**. Match the graph in **COLUMN–I** with corresponding statements in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 	(p) Speed of particle is continuously decreasing.
(B) 	(q) Magnitude of acceleration of particle is decreasing with time.
(C) 	(r) Direction of acceleration of particle does not change.
(D) 	(s) Magnitude of acceleration of particle does not change.
	(t) Acceleration is always opposite to the direction of velocity.

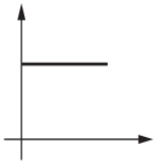
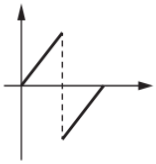
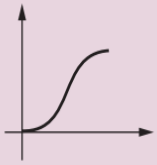
18. Match the statements in **COLUMN–I** with corresponding graphs in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Particle moving with constant speed.	(p) 
(B) Particle moving with increasing acceleration.	(q) 
(C) Particle moving with constant negative acceleration.	(r) 
(D) Particle moving with zero acceleration.	(s) 

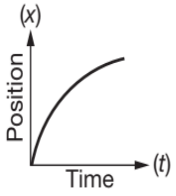
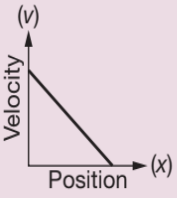
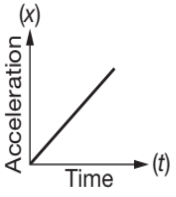
19. The motion of an object over time can often be communicated by graphs of its distance, velocity or acceleration with time. Different features of these graphs correspond to quantities of the motion. Match each quantity in the **COLUMN-I** with its graphical manifestation in the **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Distance travelled Δd	(p) Slope of a distance-time graph
(B) Velocity change Δv	(q) Slope of velocity-time graph
(C) Velocity v	(r) Area under a velocity-time graph
(D) Acceleration a	(s) Area under an acceleration-time graph.

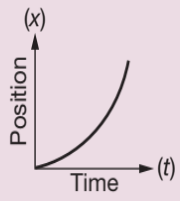
20. A particle is dropped vertically downward under gravity. Consider the downward direction as positive and the collision of the ball with the ground to be elastic, match the statements in **COLUMN–I** with corresponding graphs in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) The distance travelled by particle varies with time as	(p) 
(B) Velocity of particle changes with time as	(q) 
(C) Displacement of particle depends on time as	(r) 
(D) Dependency of acceleration on time is given by	(s) 

21. A particle is moving along x-direction in four ways. Different graphs is plotted in **COLUMN-I**.

COLUMN-I	COLUMN-II
(A) 	(p) Variable velocity
(B) 	(q) Positive acceleration
(C) 	(r) Negative acceleration

(*Continued*)

COLUMN-I	COLUMN-II
(D) 	(s) Constant speed

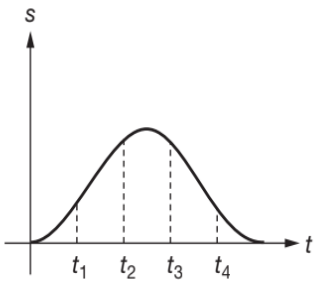
22. Match the following

COLUMN-I	COLUMN-II
(A) Constant positive acceleration	(p) Speed may increase
(B) Constant negative acceleration	(q) Speed may decrease
(C) Constant displacement	(r) Speed is zero
(D) Constant slope of a-t graph	(s) Speed must increase

23. Two ships A and B are 10 km apart on a line running from south to north. A is towards north of B and moving west with a speed of 20 kmh^{-1} while B is moving towards north with 20 kmh^{-1}. The distance of their closest approach in metres is l and the time in second taken to reach this position is t.

COLUMN-I	COLUMN-II
(A) l	(p) North-West
(B) t	(q) 7071
(C) $\vec{V}_{AB}$	(r) 900
(D) $\vec{V}_{BA}$	(s) South-East

24. A particle is moving in straight line and its displacement versus time graph is as shown in figure. **COLUMN-I** contains different instant and **COLUMN-II** contains values of acceleration and velocities at those instants. Match them



COLUMN-I	COLUMN-II
(A) t_1	(p) $a>0$
(B) t_2	(q) $a<0$
(C) t_3	(r) $v>0$
(D) t_4	(s) $v<0$
	(t) None

25. A particle is moving along x-axis. Its x-coordinate is varying with time as $x=-20t+5t^2$. For the given equation, match the following columns.

COLUMN-I	COLUMN-II
(A) At what time particle changes its direction of motion	(p) 1 s
(B) At what time magnitude of velocity and acceleration are equal	(q) 2 s
(C) In how much time, distance travelled by the particle becomes 25 m	(r) 3 s
(D) In how much time the displacement of the particle becomes 15 m	(s) 4 s
	(t) None of the above

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

1. If the body covers equal displacements in successive intervals of time t_1, t_2 and t_3 then show that $\frac{1}{t_1}-\frac{1}{t_2}+\frac{1}{t_3}=\frac{k}{t_1+t_2+t_3}$. Find k.

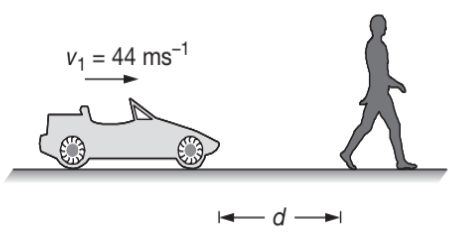
2. Between two stations a train accelerates uniformly at first, then moves with a constant speed and finally retards uniformly. If the ratios of the time taken are $1:8:1$ and the greatest speed attained by the train is $60\ \text{kmh}^{-1}$, find the average speed, in ms^{-1}, over the whole journey.

3. A sphere is fired downwards into a medium with an initial speed of $27\ \text{ms}^{-1}$. If it experiences a deceleration of $a=(-6t)\ \text{ms}^{-2}$, where t is in seconds, determine the distance, in metre, travelled before it stops.

4. A particle travels along a straight line such that in 2 s it moves from an initial position $x_A=+0.5$ m to a position $x_B=-1.5$ m. Then in another 4 s it moves from x_B to $x_C=+2.5$ m. Determine the particle's average speed, in ms^{-1}, during the 6 s time interval.

5. A particle moving with constant acceleration along a straight line covers the distance between two points 80 m apart in 10 s. Its speed as at passes second point is $18\ \text{ms}^{-1}$.
(a) What is its speed, in ms^{-1}, at the first point?
(b) What is its acceleration in ms^{-2}?
(c) At what prior distance, in m and time, in s from first point, the particle reverses its direction of motion?
(d) What is the total distance travelled, in m, during this 10 s?

6. Tests reveal that a normal driver takes about 0.75 s before he or she can react to a situation to avoid a collision. It takes about 3 s for a driver having 0.1% alcohol in his system to do the same. If such drivers are travelling on a straight road at $44\ \text{ms}^{-1}$ and their cars can decelerate at $2\ \text{ms}^{-2}$, determine the shortest stopping distance (d) for each, in metre, from the moment they see the pedestrians.



7. A bus starts from rest with a constant acceleration of $5\ \text{ms}^{-2}$. At the same time a car travelling with a constant velocity of $50\ \text{ms}^{-1}$ overtakes and passes the bus. Find
(a) at what distance, in metre, will the bus overtake the car?
(b) how fast, in ms^{-1}, will the bus be travelling then?

8. A truck travelling along a straight road at a constant speed of $72\ \text{kmh}^{-1}$ passes a car at time $t=0$ moving much slower. At the instant the truck passes the car, the car starts accelerating at constant $1\ \text{msec}^{-2}$ and overtake the truck 0.6 km further down the road, from where the car moves uniformly. Find the distance between them, in metre, at time $t=50$ s from the start.

9. A train travelling at $72\ \text{kmh}^{-1}$ is checked by track repairs. It retards uniformly for 200 m, covering the next 400 m at constant speed and accelerates uniformly to $72\ \text{kmh}^{-1}$ in a further 600 m. If the time at the constant lower speed is equal to the sum of the times taken in retarding and accelerating, find the total time, in minutes, taken.

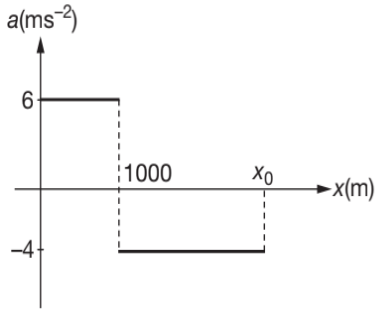
10. At the instant the traffic light turns green, a car starts with a constant acceleration of $2\ \text{ms}^{-2}$. At the same instant a truck travelling with a constant speed of $10\ \text{ms}^{-1}$, overtakes and passes the car. How far beyond the starting point, in m, with the car overtake the truck? How fast, in ms^{-1}, will the car be travelling at that instant?

11. A bullet fired into a fixed target looses half of its velocity after penetrating 3 cm. How much further, in cm, it will penetrate before coming to rest assuming that it faces constant resistance to motion.

12. A body travels 200 cm in the first two second and 220 cm in the next four second. What will be the velocity, in cms^{-1} at the end of seventh second from the start?

13. A particle moves with uniform acceleration a. If v_1, v_2 and v_3 be the average velocities in three successive intervals of time t_1, t_2 and t_3 respectively, then find the value of $\frac{(v_1-v_2)(t_3+t_2)}{(v_2-v_3)(t_2+t_1)}$.

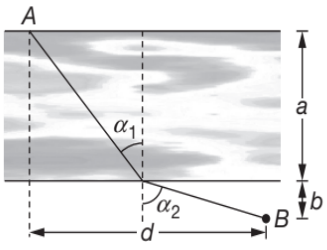
14. A sports car travels along a straight road with an acceleration-deceleration described by the graph. If the car starts from rest, determine the distance x_0, in m, the car travels until it stops.



15. A balloon rises from rest on the ground with constant acceleration $\frac{g}{8}$. A stone is dropped when the balloon has risen to a height H metre. The time taken by the stone to reach the ground is given by $x\sqrt{\frac{H}{g}}$. Find x.

16. As a train accelerates uniformly it passes successive kilometre marks while travelling at velocities of $2\ \text{ms}^{-1}$ and then $10\ \text{ms}^{-1}$. Determine the train's velocity, in ms^{-1}, when it passes the next kilometre mark and the time it takes, in s, to travel the 2 km distance.

17. From a point A on bank of a channel with still water a person must get to a point B on the opposite bank. All the distances are shown in figure. The person uses a boat to travel across the channel and then walks along the bank to point B. The velocity of the boat is v_1 and the velocity of the walking person is v_2. If $v_1 = 3\sqrt{3}\ \text{ms}^{-1}$, $\alpha_1 = 30°$ and $\alpha_2 = 60°$, then for what value of v_2, in ms^{-1}, the person takes a minimum time to go from A to B.



18. A person walks up a stationary 15 m long escalator in 90 s. When standing on the same escalator, now moving, the person is carried up in 60 s. How much time, in seconds, would it take that person to walk up the moving escalator? Does the answer depend on the length of the escalator?

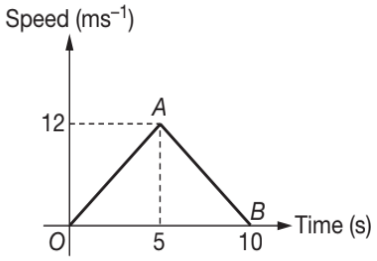
19. The driver of the train A moving with a speed of $144\ \text{kmh}^{-1}$ sights another train B 1 km ahead of him. The train B is moving with a uniform speed of $108\ \text{kmh}^{-1}$. The driver of the train A immediately applies brakes producing a constant retardation and just manages to avoid a collision. What is the retardation of the train A, in cms^{-2}? For how long is this retardation produced?

20. A sailor in a boat, which is going due east with a speed of $8\ \text{ms}^{-1}$ observes that a submarine is heading towards north at a speed of $12\ \text{ms}^{-1}$ and sinking at a rate of $2\ \text{ms}^{-1}$. The commander of submarine observes a helicopter ascending at a rate of $5\ \text{ms}^{-1}$ and heading towards west with $4\ \text{ms}^{-1}$. Find the actual speed of the helicopter and its speed with respect to boat, both in ms^{-1}.

21. The speed-time graph of a particle moving along a fixed direction is shown in figure. Obtain the distance travelled by the particle, in metre and the average speed of the particle in ms^{-1} between

(a) $t = 0$ to 10 s

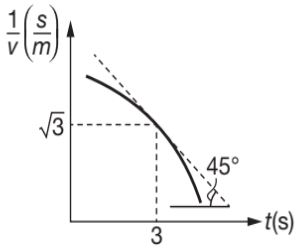
(b $t = 2$ to 6 s.



22. At the moment $t = 0$, a particle leaves the origin and moves in the positive direction of the x-axis. Its velocity varies with time as $v = v_0\left(1 - \frac{t}{5}\right)$ where $v_0 = 10\ \text{cms}^{-1}$ is the initial speed of the particle. The particle will be at the distance of 10 cm from the origin at three different instants. Find out the approximate time interval between the second and the third instant.

23. An athlete takes 2 s to reach his maximum speed of $36\ \text{kmh}^{-1}$. The magnitude of his average acceleration (in ms^{-2}) is .....

24. The diagram shows variation of $\frac{1}{v}$ with respect to time (where v is in ms^{-1}).



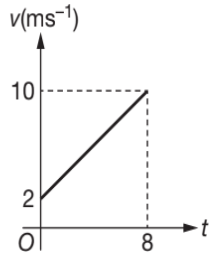
Find the instantaneous acceleration $\left(\text{in } \frac{m}{s^2}\right)$ of body at $t = 3$ s.

25. A ball is thrown upwards from the foot of a tower. The ball crosses the top of tower twice after an interval of 4 seconds and the ball reaches ground after 8 seconds, then the height of tower in meters is $(g = 10\ \text{ms}^{-2})$

26. An insect moves with a constant velocity v from one corner of a room to other corner which is opposite of the first corner along the largest diagonal of room. If the insect cannot fly and dimensions of room is $a \times a \times a$, then the minimum time in which the insect can move is $\frac{a}{v}$ times the square root of a number n, then n is equal to?

27. A body moves with constant acceleration covers 16 m and 24 m in successive intervals of 4 s and 2 s. Then its acceleration in ms^{-2} is .....

28. Figure shows the graph of velocity versus time for a particle going along x-axis. Initially at $t = 0$, particle is at $x = 3$ m. The position of the particle at $t = 2$ s (in m) is .....



29. A swimmer jumps from a bridge over a canal and swims 1 km up stream. After that first km, he passes a floating cork. He continues swimming for half an hour and then turns around and swims back to the bridge. The swimmer and the cork reach the bridge at the same time. Assuming the swimmer had been swimming at a constant speed, calculate how fast does the water in the canal flow in kmh^{-1}.

30. A car travelling at 60 kmh^{-1} over takes another car travelling at 42 kmh^{-1}. Assuming each car to be 5 m long. Find the time taken during the over take. (in sec)

31. A particle is moving on a straight line with constant retardation of 1 ms^{-2}. What is the average speed of the particle on the last two meters before it stops? (in ms^{-1})

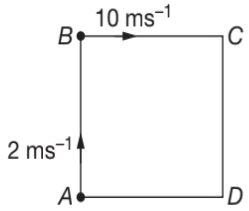
32. A bullet going with speed 16 ms^{-1} enters a concrete wall and penetrates a distance of 0.4 m before coming to rest. Then the time taken during the retardation is $x \times 10^{-2}$ s. Find x.

33. A baseball is moving at 25 ms^{-1} when it is struck by a bat and moves off in the opposite direction at 35 ms^{-1}. If the impact lasted 0.010 s, find the baseball's acceleration during the impact. (in kms^{-2})

34. A point moves with uniform acceleration and its initial speed and final speed are 2 ms^{-1} and 8 ms^{-1} respectively then, the space average of velocity (in ms^{-1}) over the distance moved is .....

35. A man is running with a speed 8 ms^{-1} constant in magnitude and direction passes under a lantern hanging at a height 10 m above the ground. Find the velocity which the edge of the shadow of the man's head moves over the ground with if his height is 2 m.

36. Two men P and Q are standing at corners A and B of square $ABCD$ of side 8 m. They start moving along the tank with constant speed 2 ms^{-1} and 10 ms^{-1} respectively. Find the time, in second, when they will meet for the first time.

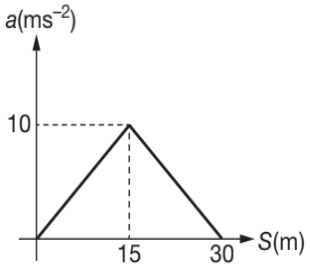


37. A particle starting from rest undergoes acceleration given by $a = |t - 2|\ \text{ms}^{-2}$ where t is time in sec. Velocity of particle after 4 sec is .....

38. A ball is thrown upward from the edge of a cliff with an initial velocity of 6 ms^{-1}. How fast is it moving half second later? $(g = 10\ \text{ms}^{-2})$

39. A car goes from 20 to 30 kmh^{-1} in 1.5 s. At the same acceleration, how long will it take the car to go from 30 to 36.7 kmh^{-1}? (in sec)

40. The particle moves with rectilinear motion given the acceleration-displacement $(a\text{-}S)$ curve is shown in figure. If the initial velocity is 10 ms^{-1} then velocity of particle after particle has travelled 30 m divided by 5 is equal to.

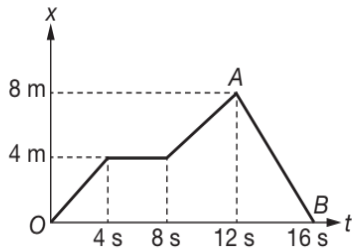


41. A police jeep is chasing a culprit going on a motor bike. The motor bike crosses a turning at a speed of $72\ \text{kmh}^{-1}$. The jeep follows it a speed of $90\ \text{kmh}^{-1}$ crossing the turning ten seconds later than the bike. Assuming that they travel at constant speeds, how far from the turning will the jeep catch up with the bike? (in km)

42. A boy standing on a long railroad car throws a ball straight upwards. The car is moving on the horizontal road with an acceleration of $1\ \text{ms}^{-2}$ and projection velocity in the vertical direction is $9.8\ \text{ms}^{-1}$. How far behind the boy will the ball fall on the car? (in m)

43. The speed of a motor launch with respect to the water is $v = 5\ \text{ms}^{-1}$, the speed of stream $u = 3\ \text{ms}^{-1}$. When the launch began travelled 3.6 km up stream, turned about and caught up with the float. How long is it before the launch reaches the float again? (Find answer in hour).

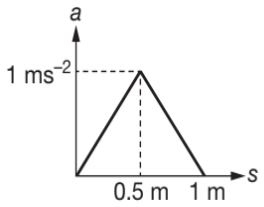
44. Figure shows the graph of the x-coordinate of a particle going along the x-axis as function of time.



The speed of particle at $t = 12.5$ s (in ms^{-1}) is .....

45. A particle moving in a straight line covers half the distance with speed of $3\ \text{ms}^{-1}$. The other half of the distance is covered in two equal time intervals with a speeds of $4.5\ \text{ms}^{-1}$ and $7.5\ \text{ms}^{-1}$, respectively. Find the average speed of the particle during this motion.

46. A body initially at rest moving along x-axis in such a way so that its acceleration displacement plot is as shown in figure. What will be the maximum velocity of particle in ms^{-1}.



ARCHIVE: JEE MAIN

1. **[Online April 2019]**

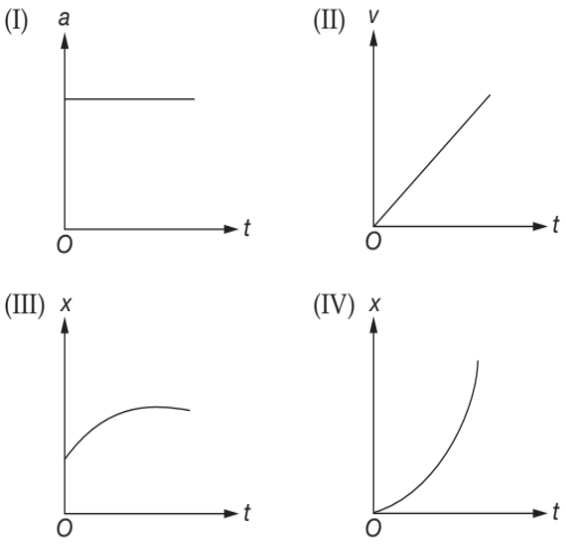
Ship A is sailing towards north-east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}\ \text{kmhr}^{-1}$ where $\hat{i}$ points east and $\hat{j}$, north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at $10\ \text{kmhr}^{-1}$. A will be at minimum distance B in

(A) 2.2 hr (B) 4.2 hr

(C) 3.2 hr (D) 2.6 hr

2. **[Online April 2019]**

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

3. [Online April 2019]
The stream of a river is flowing with a speed of 2 kmh^{-1}. A swimmer can swim at a speed of 4 kmh^{-1}. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight?

(A) 60° (B) 90°
(C) 150° (D) 120°

4. [Online April 2019]
The position vector of a particle changes with time according to the relation $\vec{r}(t)=15t^2\hat{i}+(4-20t^2)\hat{j}$. What is the magnitude of the acceleration at $t=1$?

(A) 50 (B) 100
(C) 40 (D) 25

5. [Online April 2019]
The position of a particle as a function of time t, is given by $x(t)=at+bt^2-ct^3$ where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be

(A) $a+\frac{b^2}{4c}$ (B) $a+\frac{b^2}{3c}$
(C) $a+\frac{b^2}{2c}$ (D) $a+\frac{b^2}{c}$

6. [Online April 2019]
A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to

(A) 0.4 ms^{-1} (B) 0.7 ms^{-1}
(C) 0.3 ms^{-1} (D) 0.1 ms^{-1}

7. [Online April 2019]
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) $b^2\tau$ (B) $\frac{b^2\tau}{4}$
(C) $\frac{b^2\tau}{2}$ (D) $\frac{b^2\tau}{\sqrt{2}}$

8. [Online January 2019]
A particle is moving with a velocity $\vec{v}=k\left(y\hat{i}+x\hat{j}\right)$, where K is a constant. The general equation for its path is

(A) $y^2=x+\text{constant}$ (B) $y=x^2+\text{constant}$
(C) $y^2=x^2+\text{constant}$ (D) $xy=\text{constant}$

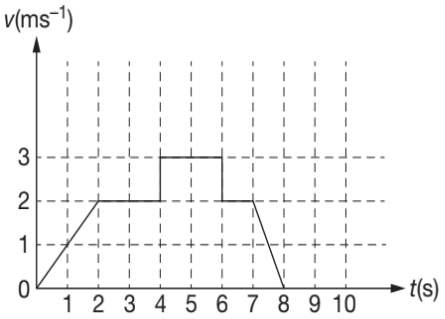
9. [Online January 2019]
In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed v more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then v is equal to

(A) $\frac{a_1+a_2}{2}t$ (B) $\frac{2a_1a_2}{a_1+a_2}t$
(C) $\sqrt{2a_1a_2}t$ (D) $\sqrt{a_1a_2}t$

10. [Online January 2019]
The position co-ordinates of a particle moving in a 3-D coordinate system is given by $x=a\cos(\omega t)$, $y=a\sin(\omega t)$ and $z=a\omega t$. The speed of the particle is

(A) $2a\omega$ (B) $\sqrt{2}a\omega$
(C) $\sqrt{3}a\omega$ (D) $a\omega$

11. [Online January 2019]
A particle starts from the origin at time $t=0$ and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position of the particle time $t=5$ s ?



(A) 9 m (B) 6 m
(C) 10 m (D) 3 m

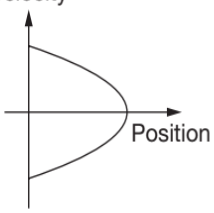
12. [Online January 2019]
A passenger train of length 60 m travels at a speed of 80 km/hr. Another freight train of length 120 m travels at a speed of 30 km/hr. The ratio of times taken by the passenger train to completely cross the freight train when : (i) they are moving in the same direction and (ii) in the opposite directions is

(A) $\frac{25}{11}$ (B) $\frac{5}{2}$
(C) $\frac{11}{5}$ (D) $\frac{3}{2}$

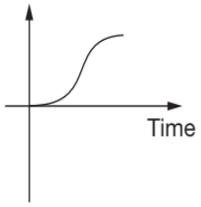
13. [2018]

All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up

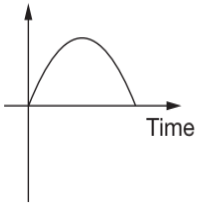
(A) Velocity



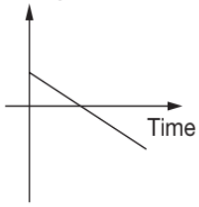
(B) Distance



(C) Position

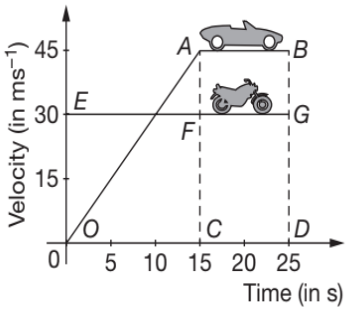


(D) Velocity



14. [Online 2018]

The velocity-time graphs of a car and a scooter are shown in the figure. (i) The difference between the distance travelled by the car and the scooter in 15 s and (ii) the time at which the car will catch up with the scooter are, respectively



(A) 112.5 m and 15 s (B) 337.5 m and 25 s
(C) 225.5 m and 10 s (D) 112.5 m and 22.5 s

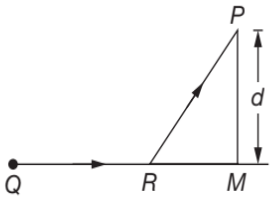
15. [Online 2018]

An automobile, travelling at 40 kmh^{-1}, can be stopped at a distance of 40 m by applying brakes. If the same automobile is travelling at 80 kmh^{-1}, the minimum stopping distance, in metres, is (assume no skidding)

(A) 100 m (B) 75 m
(C) 160 m (D) 150 m

16. [Online 2018]

A man in a car at location Q on a straight highway is moving with speed v. He decides to reach a point P in a field at a distance d from the highway (point M) as shown in the figure. Speed of the car in the field is half to that on the highway. What should be the distance RM, so that the time taken to reach P is minimum?

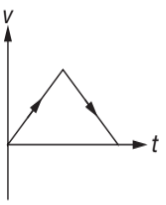


(A) $\frac{d}{2}$ (B) $\frac{d}{\sqrt{3}}$
(C) $\frac{d}{\sqrt{2}}$ (D) d

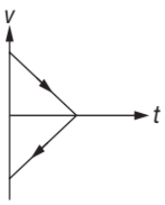
17. [2017]

A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity versus time?

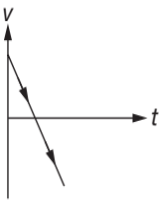
(A)



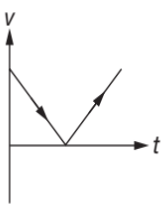
(B)



(C)



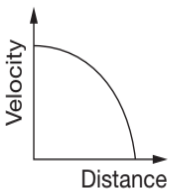
(D)



18. [Online 2017]

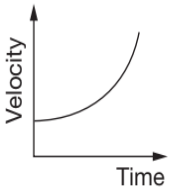
Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

(A)

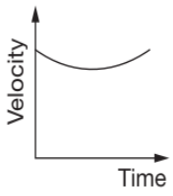


(B)

(C)

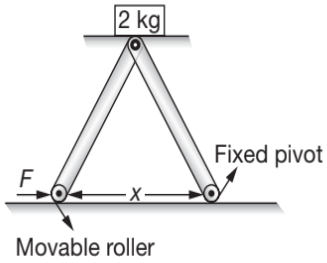


(D)



19. [Online 2017]

The machine as shown has 2 rods of length 1 m connected by a pivot at the top. The end of one rod is connected to the floor by a stationary pivot and the end of the other rod has a roller that rolls along the floor in a slot. As the roller goes back and forth, a 2 kg weight moves up and down. If the roller is moving towards right at a constant speed, the weight moves up with a

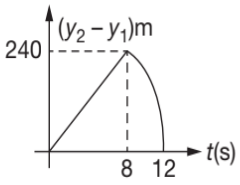


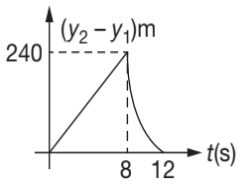
(A) speed which is $\frac{3}{4}^{\text{th}}$ of that of the roller when the weight is 0.4 m above the ground.
(B) constant speed.
(C) decreasing speed.
(D) increasing speed.

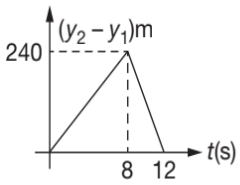
20. [Online 2017]
A car is standing 200 m behind a bus, which is also at rest. The two start moving at the same instant but with different forward accelerations. The bus has acceleration $2\ \text{ms}^{-2}$ and the car has acceleration $4\ \text{ms}^{-2}$. The car will catch up with the bus after a time of

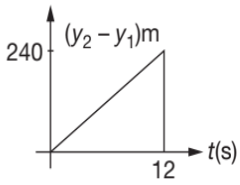
(A) $\sqrt{120}$ s (B) 15 s
(C) $10\sqrt{2}$ s (D) $\sqrt{110}$ s

21. [2015]
Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of $10\ \text{ms}^{-1}$ and $40\ \text{ms}^{-1}$ respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first?
(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ \text{ms}^{-2}$)
(The figures are schematic and not drawn to scale)

(A) 

(B) 

(C) 

(D) 

22. [2014]
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) $gH = (n-2)u^2$ (B) $2gH = n^2u^2$
(C) $gH = (n-2)^2u^2$ (D) $2gH = nu^2(n-2)$

23. [2011]
An object moving with a speed of $6.25\ \text{ms}^{-1}$, is decelerated at a rate given by $\frac{dv}{dt} = -2.5\sqrt{v}$, where v is the instantaneous speed. The time taken by the object, to come to rest, would be

(A) 1 s (B) 2 s
(C) 4 s (D) 8 s

24. [2010]
A particle is moving with velocity $\vec{v} = K\left(y\hat{i} + x\hat{j}\right)$, where K is a constant. The general equation for its path is

(A) $y^2 = x^2 + \text{constant}$ (B) $y = x^2 + \text{constant}$
(C) $y^2 = x + \text{constant}$ (D) $xy = \text{constant}$

25. [2009]
A particle has an initial velocity $3\hat{i} + 4\hat{j}$ and an acceleration of $0.4\hat{i} + 0.3\hat{j}$. Its speed after 10 s is

(A) 10 units (B) $7\sqrt{2}$ units
(C) 7 units (D) 8.5 units

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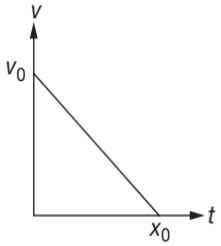
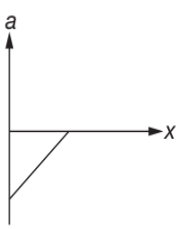
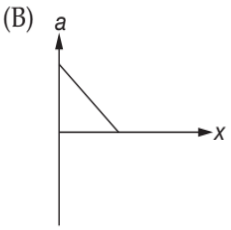
Single Correct Choice Type Problems

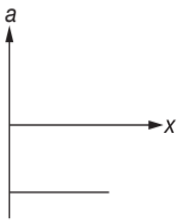
In this section each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

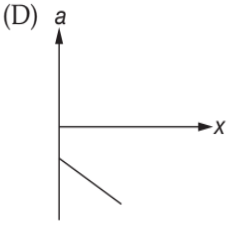
1. [IIT-JEE 2005]
The given graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement?



(A) 

(B) 

(C) 

(D) 

2. [IIT-JEE 2004]

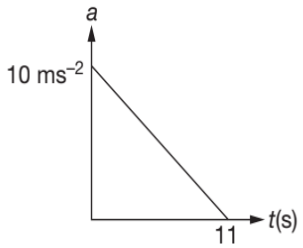
A small block slides without friction down an inclined plane starting from rest. Let S_n be the distance travelled from time $t = n-1$ to $t = n$. Then $\frac{S_n}{S_{n+1}}$ is

(A) $\frac{2n-1}{2n}$ (B) $\frac{2n+1}{2n-1}$

(C) $\frac{2n-1}{2n+1}$ (D) $\frac{2n}{2n+1}$

3. [IIT-JEE 2004]

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

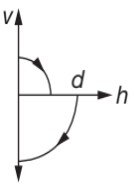


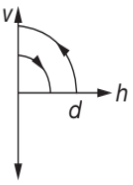
(A) 110 ms^{-1} (B) 55 ms^{-1}

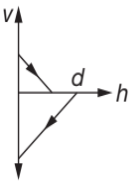
(C) 550 ms^{-1} (D) 660 ms^{-1}

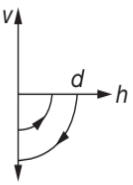
4. [IIT-JEE 2000]

A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height $\frac{1}{2}d$. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as

(A) 

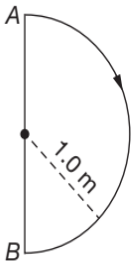
(B) 

(C) 

(D) 

5. [IIT-JEE 1999]

In 1.0 second a particle goes from point A to point B moving in a semi-circle of radius 1.0 metre (figure). The magnitude of the average velocity is

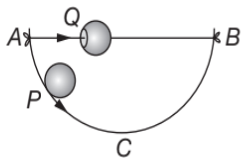


(A) 3.14 ms^{-1} (B) 2.0 ms^{-1}

(C) 1.0 ms^{-1} (D) ZERO

6. [IIT-JEE 1993]

A particle P is sliding down a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time, the horizontal component of its velocity is v. A bead Q of same mass as P is ejected from A at $t = 0$ along the horizontal string AB, with a speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q be the respective times taken by P and Q to reach the point B, then



(A) $t_P < t_Q$

(B) $t_P = t_Q$

(C) $t_P > t_Q$

(D) $\frac{t_P}{t_Q} = \frac{\text{length of arc } ACB}{\text{length of chord } AB}$

7. [IIT-JEE 1988]

A boat which has a speed of 5 kmh^{-1} in still water crosses a river of width 1 km along the shortest possible path in 15 minute. The velocity of the river water in kmh^{-1} is

(A) 1 (B) 3

(C) 4 (D) $\sqrt{41}$

8. [IIT-JEE 1983]

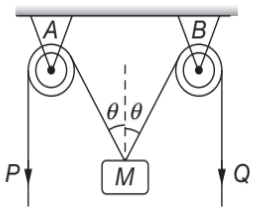
A river is flowing from west to east at a speed of 5 m per minute. A man on the south bank of the river, capable of swimming at 10 m per minute in still water wants to swim across the river to a point directly opposite in the shortest time. He should then swim in a direction

(A) 60° west of north (B) 30° east of north

(C) 30° west of north (D) 60° east of north

9. [IIT-JEE 1982]

In the arrangement shown in the figure, the ends P and Q of an unstretchable string move downwards with uniform speed U. Pulleys A and B are fixed. Mass M moves upwards with a speed



(A) $2U\cos\theta$ (B) $\dfrac{U}{\cos\theta}$

(C) $\dfrac{2U}{\cos\theta}$ (D) $U\cos\theta$

10. [IIT-JEE 1982]

A particle is moving Eastwards with a velocity of 5 ms^{-1}. In 10 s, the velocity changes to 5 ms^{-1} Northwards. The average acceleration in this time is

(A) zero

(B) $\dfrac{1}{\sqrt{2}}$ ms^{-2} towards North-East

(C) $\dfrac{1}{\sqrt{2}}$ ms^{-2} towards North-West

(D) $\dfrac{1}{2}$ ms^{-2} towards North

Multiple Correct Choice Type Problems

In this section each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. [IIT-JEE 1999]

The co-ordinates of a particle moving in a plane are given by $x = a\cos(pt)$ and $y = b\sin(pt)$ where a, $b(<a)$ and p are positive constants of appropriate dimensions. Then

(A) the path of the particle is an ellipse.

(B) the velocity and acceleration of the particle are normal to each other at $t = \dfrac{\pi}{2p}$.

(C) the acceleration of the particle is always directed towards the focus.

(D) the distance travelled by the particle in time interval $t = 0$ to $t = \dfrac{\pi}{2p}$ is a.

2. [IIT-JEE 1993]

A particle of mass m moves on the x-axis as follows: it starts from rest at $t = 0$ from the point $x = 0$ and comes to rest at $t = 1$ at the point $x = 1$. No other information is available about its motion at intermediate time $(0 < t < 1)$. If α denotes the instantaneous acceleration of the particle, then

(A) α cannot remain positive for all t in the interval $0 \le t \le 1$

(B) $|\alpha|$ cannot exceed 2 at any point in its path

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

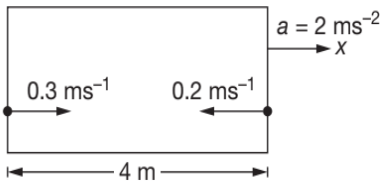
(D) α must change sign during the motion but no other assertion can be made with the information given

Integer/Numerical Answer Type Questions

In this section, the answer to each question is a numerical value obtained after series of calculations based on the data provided in the question(s).

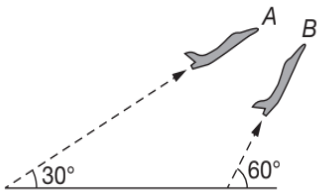
1. [JEE (Advanced) 2014]

A rocket is moving in a gravity free space with a constant acceleration of 2 ms^{-2} along $+x$ direction (shown in figure). The length of a chamber inside the rocket is 4 m. A ball is thrown from the left end of the chamber in $+x$ direction with a speed of 0.3 ms^{-1} relative to the rocket. At the same time, another ball is thrown in $-x$ direction with a speed of 0.2 ms^{-1} from its right end relative to the rocket. The time in seconds when the two balls hit each.



2. [JEE (Advanced) 2014]

Airplanes A and B are flying with constant velocity in the same vertical plane at angles $30°$ and $60°$ with respect to the horizontal respectively as shown in figure. The speed of A is $100\sqrt{3}$ ms^{-1}. At time $t = 0$ s, an observer in A finds B at a distance of 500 m. This observer sees B moving with a constant velocity perpendicular to the line of motion of A. If at $t = t_0$, A just escapes being hit by B, t_0 in seconds is



Assertion and Reasoning Type Problems

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.

Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.

Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.

Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. [JEE (Advanced) 2008]

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

Statement-II: If the observer and the object are moving at velocities v_1 and v_2, respectively with reference to a laboratory frame, the velocity of the object with respect to the observer is $v_2 - v_1$.

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on Displacement, Velocity, Acceleration, Average Speed and Velocity)

1. $32\ \text{ms}^{-1}$, 67 m, 66 m
2. $\sqrt{\frac{as}{2}}$
3. $2\ \text{ms}^{-1}$
4. 30 m, $15\ \text{ms}^{-1}$
5. (a) ms^{-2}, ms^{-3}
   (b) 1 s
   (c) 82 m, –80 m
   (d) at $t = 0$, $v = 0$ and $a = 6\ \text{ms}^{-2}$
   at $t = 1$ s, $v = 0$ and $a = -6\ \text{ms}^{-2}$
   at $t = 2$ s, $v = -12\ \text{ms}^{-1}$ and $a = -18\ \text{ms}^{-2}$
   at $t = 3$ s, $v = -36\ \text{ms}^{-1}$ and $a = -30\ \text{ms}^{-2}$
   at $t = 4$ s, $v = -72\ \text{ms}^{-1}$ and $a = -42\ \text{ms}^{-2}$
6. $135\ \text{ms}^{-1}$, $42\ \text{ms}^{-2}$
7. $20.6\ \text{ms}^{-1}$, 76°
8. $0.222\ \text{ms}^{-1}$, $2.22\ \text{ms}^{-1}$
9. (a) 14.125 m
   (b) $1.75\ \text{ms}^{-1}$, $4.03\ \text{ms}^{-1}$
10. –27 m, 69 m
11. $-30\ \text{ms}^{-2}$

Test Your Concepts-II (Based on Constant Acceleration)

2. (a) $\left(\frac{\alpha\beta}{\alpha+\beta}\right)t$
   (b) $\frac{1}{2}\left(\frac{\alpha\beta}{\alpha+\beta}\right)t^2$
3. $3x$
6. (a) $5\ \text{ms}^{-1}$
   (b) $1.67\ \text{ms}^{-2}$
   (c) 7.5 m
8. 0.74 s, $6.2\ \text{ms}^{-2}$
9. $3.45t_0$
10. 8 m
11. $\frac{3}{5}$
12. 4×10^{-4} s, $2\times10^{7}\ \text{ms}^{-2}$
13. (a) 80 s
    (b) $90\ \text{kmh}^{-1}$
    (c) 37 s
14. (a) 33.7 min
    (b) 44.53 min
15. 24.5 s, 600 m
16. 89 m
17. $\frac{3}{4}$ h, $\frac{3}{2}$ h, No overtaking
18. $v_{av} = \frac{3v_0(v_1+v_2)}{4v_0+v_1+v_2}$
19. 2.27 s
20. 2280 m, Car A
21. $22.3\ \text{ms}^{-1}$, 1500 m
22. 20.6 s
23. (a) 15.8 s
    (b) 391 m
    (c) $29.5\ \text{ms}^{-1}$
24. $4\ \text{ms}^{-1}$ opposite to the direction of motion of the train.
25. $0.2\ \text{ms}^{-2}$, $0.8\ \text{ms}^{-1}$

Test Your Concepts-III (Based on Variable Acceleration)

1. $5\log_e\left(\frac{5}{4}\right)$ s
2. $v = \pm\sqrt{2}s$
3. $x = \frac{v_0}{k}(1-e^{-kt})$, $a = -kv_0e^{-kt}$
4. $s = 2v_0$
5. $\pm2\sqrt{6}\ \text{ms}^{-1}$, 4 m, $\pm4\sqrt{2}$ m
6. $v = \sqrt{v_0^2+2kt}$
7. $v = \frac{A}{B}(1-e^{-Bt})$
8. $v = -\frac{16}{(8t+1)^2}$, $a = \frac{256}{(8t+1)^3}$
9. (a) $\frac{5}{6}\ \text{ms}^{-1}$
   (b) $-\frac{55}{6}\ \text{ms}^{-1}$
10. $v = 5(e^t-1)$, $x = 5(e^t-t-1)$

11. $80\ \text{kms}^{-2}$, $6.93\ \text{ms}$

12. $\left(4\hat{i}+8\hat{j}\right)\ \text{ms}^{-1}$

13. $h_{\max}=\frac{1}{2k}\log_e\left(\frac{g+kv_0^2}{g}\right)$

14. $-\frac{20}{3}\ \text{ms}^{-2}$

15. $v=\left(6t^2-2t^{3/2}\right)$, $x=\left(2t^3-\frac{4}{5}t^{5/2}+15\right)$

Test Your Concepts-IV (Based on Graph)

4. 114 m

5. 400 m

8. $46.47\ \text{ms}^{-1}$

10. $12.7\ \text{ms}^{-1}$, $22.8\ \text{ms}^{-1}$, $36.1\ \text{ms}^{-1}$

11. (a) $v=t^2-2t$

(b) 6.67 m

12. $10\ \text{ms}^{-1}$

Test Your Concepts-V (Based on Motion Under Gravity)

2. $\sqrt{2g_0R}$

3. $|v|=\frac{gt}{2}$

4. $10\sqrt{50}\ \text{ms}^{-1}$

7. $\frac{gn^2}{8}\left(\frac{gn-2u}{gn-u}\right)^2$

8. $\frac{u_0}{\sqrt{1+\frac{cu_0^2}{mg}}}$

9. $1.26\times10^3\ \text{ms}^{-2}$

10. (a) 216,000 metre

(b) 447.8 sec

11. $5\sqrt{13}\ \text{ms}^{-1}$

(a) 16.25 m

(b) 1.8 s

12. 73.302 metre

13. $\frac{v_0}{g}+\frac{t_0}{2}$

14. 45 m

15. (a) 75 m

(b) 4.1 s

16. $14.7\ \text{ms}^{-1}$, 19.6 metre

17. 1.5 s

Test Your Concepts-VI (Based on Planar Motion)

1. (a) 48 m

(b) $16\sqrt{2}\ \text{ms}^{-1}$

2. 4 m, $37.8\ \text{ms}^{-2}$

3. $k\omega t$

4. (a) $y=x-\alpha\frac{x^2}{k}$

(b) $v=k\sqrt{1+(1-2\alpha t)^2}$, $\vec{a}=-(2\alpha k)\hat{j}$

6. $201.25\ \text{ms}^{-1}$, $405\ \text{ms}^{-2}$

7. $\left(10\hat{i}+7\hat{j}\right)\ \text{ms}^{-1}$, $\left(12\hat{i}+10\hat{j}\right)\ \text{m}$

8. $32\ \text{ms}^{-1}$

Test Your Concepts-VII (Based on Relative Velocity)

1. (a) 40 s

(b) 80 m

2. 60°

4. (a) 28°

(b) 1.48 hour

5. $3\ \text{kmhr}^{-1}$

6. (a) 0.7 s

(b) 1.3 m

7. $2v\sin(20°)$

8. $5\sqrt{2}$ km, 15 minutes

9. $2\sqrt{5}\ \text{ms}^{-2}$ at an angle of $\alpha=\tan^{-1}(2)$ NW

10. 3200 m

11. $a=\frac{2u-gt}{t}$

12. $\frac{u}{\sqrt{2}}$, at 45° perpendicular to stream flow

13. $8\ \text{ms}^{-1}$, 12°

14. (a) He should row at an angle $90°+\sin^{-1}\left(\frac{3}{5}\right)$ upstream.

(b) 160 s

15. (a) 3.65 s, 12.3 m

(b) 19.8 ms^{-1}

16. (a) 0.8 ms^{-1}

(b) 1.79 ms^{-1}

(c) 120° upstream

18. (a) $\frac{10}{\sin\theta}$ minute

(b) 10 minute

(c) $\frac{2}{3}$ km

19. $\tan^{-1}(3)$

20. Infinite, $\frac{3d}{2}$

Single Correct Choice Type Questions

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

Multiple Correct Choice Type Questions

1. A, C, D	**2.** A, D	**3.** A, B, C	**4.** C, D	**5.** C, D
6. A, C, D	**7.** B, C	**8.** A, B	**9.** A, B, D	**10.** A, B, D
11. B, C	**12.** A, C	**13.** B, C	**14.** A, D	**15.** A, B, C, D
16. B, D	**17.** A, B, C, D	**18.** A, B, D	**19.** A, B, C	**20.** B, C, D
21. C, D	**22.** B, C, D	**23.** B, D	**24.** A, B, C, D	**25.** A, C, D
26. A, B, C	**27.** A, B, C	**28.** B, C	**29.** A, B, D	**30.** A, D
31. A, C	**32.** B, C, D	**33.** A, B, D	**34.** A, C	**35.** A, B, C
36. C, D	**37.** B, C, D	**38.** A, C	**39.** C, D	

Reasoning Based Questions

1. D	**2.** D	**3.** A	**4.** C	**5.** D	**6.** A	**7.** D	**8.** A	**9.** A	**10.** D
11. D	**12.** C								

Linked Comprehension Type Questions

1. B	**2.** D	**3.** C	**4.** B	**5.** C	**6.** B	**7.** B	**8.** D	**9.** B	**10.** D
11. A	**12.** C	**13.** D	**14.** C	**15.** A	**16.** B	**17.** B	**18.** A	**19.** D	**20.** D
21. B	**22.** C	**23.** B	**24.** A	**25.** A	**26.** B	**27.** C	**28.** A	**29.** C	**30.** A

31. C	**32.** C	**33.** C	**34.** D	**35.** D	**36.** B	**37.** A	**38.** D	**39.** A	**40.** B
41. C	**42.** B	**43.** C	**44.** D	**45.** A	**46.** A	**47.** C	**48.** B	**49.** C	**50.** B
51. C	**52.** C	**53.** A							

Matrix Match/Column Match Type Questions

1. A → (s, u)	B → (s, t)	C → (s, u)	D → (s, t)	E → (q, r)	F → (s, u)	G → (p, s)
2. A → (q)	B → (r)	C → (s)	D → (p)			
3. A → (q)	B → (r)	C → (p, s)	D → (t)			
4. A → (r, t)	B → (p)	C → (q)	D → (s)			
5. A → (t)	B → (s)	C → (p)	D → (q)	E → (r)		
6. A → (q)	B → (r)	C → (p, q)	D → (s)			
7. A → (r)	B → (p)	C → (q)	D → (p)			
8. A → (s)	B → (r)	C → (p)	D → (q)			
9. A → (r)	B → (p)	C → (r)	D → (s)			
10. A → (r)	B → (p)	C → (s)	D → (q)			
11. A → (p)	B → (q)	C → (s)	D → (r)			
12. A → (q)	B → (p, q)	C → (p, r)	D → (r, s)			
13. A → (r)	B → (p)	C → (r)	D → (r)			
14. A → (r)	B → (q)	C → (s)	D → (p)			
15. A → (r)	B → (s)	C → (p)	D → (q)			
16. A → (r)	B → (q)	C → (s)	D → (p)			
17. A → (r, s)	B → (r, s)	C → (p, q, r, t)	D → (p, q, r, t)			
18. A → (q, s)	B → (r)	C → (p)	D → (s)			
19. A → (r)	B → (s)	C → (p)	D → (q)			
20. A → (s)	B → (r)	C → (q)	D → (p)			
21. A → (p, r)	B → (p, r)	C → (p, q)	D → (p, q)			
22. A → (p, q)	B → (p, q)	C → (r)	D → (p, q)			
23. A → (q)	B → (r)	C → (s)	D → (p)			
24. A → (p, r)	B → (q, r)	C → (q)	D → (q, s)			
25. A → (q)	B → (r)	C → (r)	D → (p, r)			

Integer/Numerical Answer Type Questions

1. 3	**2.** 15	**3.** 54	**4.** 1	**5.** (a) 2 (b) 2 (c) 1, 1 (d) 82
6. 517, 616	**7.** (a) 1000 (b) 100	**8.** 300	**9.** 2	**10.** 100, 20
11. 1	**12.** 10	**13.** 1	**14.** 2500	**15.** 2
16. 14, 250	**17.** 9	**18.** 36	**19.** 5, 200	**20.** 13, 13
21. (a) 60, 6 (b) 10.8, 9	**22.** 2	**23.** 5	**24.** 3	**25.** 60
26. 5	**27.** 4	**28.** 9	**29.** 1	**30.** 2
31. 1	**32.** 5	**33.** 6	**34.** 5.6	**35.** 10
36. 3	**37.** 4	**38.** 1	**39.** 1	**40.** 4
41. 1	**42.** 2	**43.** 1	**44.** 2	**45.** 4
46. 1				

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1. D	**2.** C	**3.** D	**4.** A	**5.** B	**6.** B	**7.** C	**8.** C	**9.** D	**10.** B
11. A	**12.** C	**13.** B	**14.** D	**15.** C	**16.** B	**17.** C	**18.** A	**19.** C	**20.** C
21. A	**22.** D	**23.** B	**24.** A	**25.** B					

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Single Correct Choice Type Problems

1. A	**2.** C	**3.** B	**4.** A	**5.** B	**6.** A	**7.** B	**8.** C	**9.** B	**10.** C

Multiple Correct Choice Type Problems

1. A, B, C	**2.** A, D

Integer/Numerical Answer Type Questions

1. 2 or 8	**2.** 5

Assertion and Reasoning Type Problems

1. B