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PHYSICS

TARGET : JEE- Advanced 2023

CAPS-1

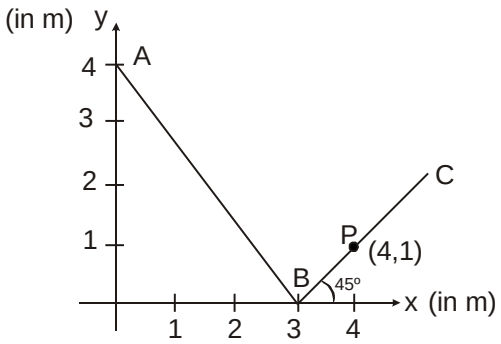
RECTILINEAR MOTION

SCQ (Single Correct Type) :

1. A stone is dropped from the top of a tall cliff and n seconds later another stone is thrown vertically downwards with a velocity u. Then the second stone overtakes the first, below the top of the cliff at a distance given by

(A) $\frac{g}{2}\left[\frac{n(gn/2-u)}{(gn-u)}\right]^2$ (B) $\frac{g}{2}\left[\frac{n(gn-u/2)}{(gn-u)}\right]^2$ (C) $g\left[\frac{(gn-u)}{(gn-u/2)}\right]^2$ (D) None

2. A particle moves in x-y plane, starting from A, along straight line paths AB and then BC, as shown in the graph. When it is at point P, angle between directions of its average velocity and instantaneous velocity is : [tan 37º = 3/4]



(A) 90º (B) 82º (C) 98º (D) 74º

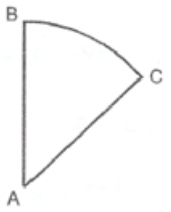
3. The displacement 'x' and time of travel 't' for a particle moving on a straight line are related as $t = \sqrt{(x+1)(x-1)}$. Its acceleration at a time t is

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

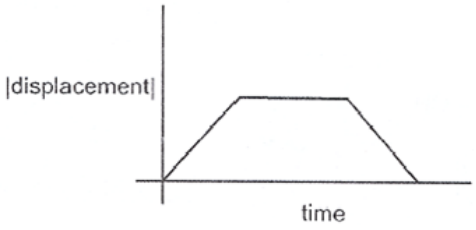
4. Drops of water fall from the roof of a building 9m. high at regular intervals of time, the first drop reaching the ground at the same instant fourth drop starts to fall. What are the distances of the second and third drops from the roof ?

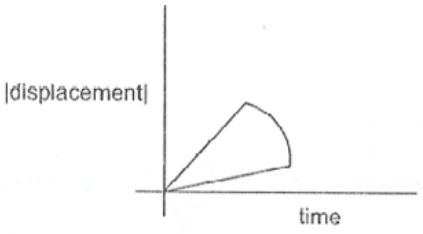
(A) 6 m and 2 m (B) 6 m and 3 m (C) 4 m and 1 m (D) 4 m and 2 m

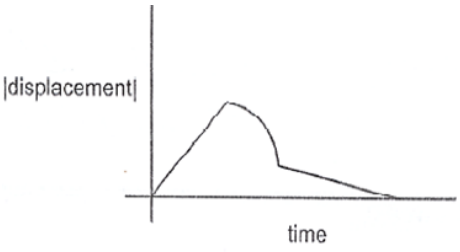
5. A particle moves along the path ABCA with a constant speed. Part BC is circular with center at A

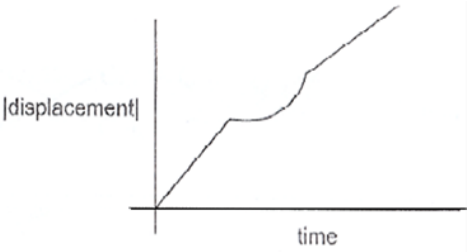


The modulus of its displacement (from A) versus time graph will be:

(A) 

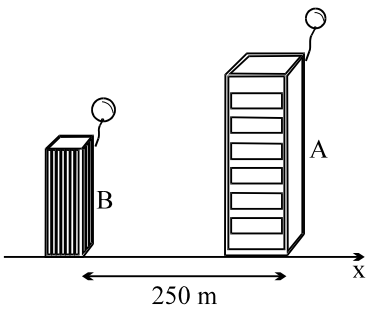
(B) 

(C) 

(D) 

MCQ (One or more than one correct) :

6. Two balloons are simultaneously released from two buildings A and B. Balloon from A rises with constant velocity 10 ms^{-1}, While the other one rises with constant velocity of 20 ms^{-1}. Due to wind the balloons gather horizontal velocity V_x = 0.5 y, where 'y' is the height from the point of release. The buildings are at a distance of 250 m & after some time 't' the balloons collide.



(A) t = 5 sec.

(B) difference in height of buildings is 100 m

(C) difference in height of buildings is 500

(D) t = 10 sec

7. An air India flight made an emergency landing with its wheel locked, due to locked wheels, horizontal component of acceleration is $a = -B_0 + B_1t$ from touch down at t = 0, until the plane comes to rest at $t = t_0$, $B_0 > 0$ and $B_1 > 0$. Then which of following options is/are correct ?

(A) Horizontal speed of plane at t = 0 when it first touched down is B_0t_0

(B) Horizontal speed of plane at t = 0 when it first touched down is $B_0t_0 - \frac{B_1t_0^2}{2}$

(C) Distance traveled by plane from t = 0 to $t = t_0$ is $\frac{B_0t_0^2}{2} - \frac{B_1t_0^3}{3}$

(D) Distance traveled by plane from t = 0 to $t = t_0$ is $B_0t_0^2 - \frac{B_1t_0^3}{3}$

8. A person, standing on the roof of a 40 m high tower, throws a ball vertically upwards with speed 10 m/s. Two seconds later, he throws another ball again in vertical downward direction (use g = 10 m/s^2). If both the balls hit the ground simultaneously, then choose the correct option(s).

(A) The first ball hits the ground after 4 seconds.

(B) The second ball was projected vertically downwards with speed 5 m/s.

(C) The distance travelled by the first ball is 10 m greater than the distance travelled by the seconds ball.

(D) Both balls hit the ground with same velocities.

Comprehension Type Question:

A physics tutor launches a home-built model rocket straight up into the air. At t = 0, the rocket is at y = 0 with $V_y(t = 0) = 0$. The acceleration of the rocket is given by

$$a_y = \begin{cases} -g + \alpha g - \beta t^4 & ;0 < t < t_b \\ \\ -g & ;t > t_b \end{cases}$$

where $t_b = \left(\frac{\alpha g}{\beta}\right)^{1/4}$ is the time at which fuel burns out. α is a positive dimensionless number (>1).

9. The expression for the velocity $V_y(t)$ valid at all times in the interval $0 < t < t_b$ is

(A) $V_y = (\alpha - 1)gt + \frac{1}{5}\beta t^5$ (B) $V_y = (\alpha - 1)gt - \frac{1}{5}\beta t^5$

(C) $V_y = (\alpha + 1)gt + \frac{1}{5}\beta t^5$ (D) $V_y = (\alpha + 1)gt - \frac{1}{5}\beta t^5$

10. The expression for the velocity $V_y(t)$ valid for the time interval $t > t_b$ is

(A) $V_y = \frac{1}{5}\alpha g t_b + gt$ (B) $V_y = -g(t - t_b)$ (C) $V_y = g(t - t_b)$ (D) $V_y = \frac{4}{5}\alpha g t_b - gt$

11. The time taken for rocket to reach its maximum height is

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

Numerical based Questions :

12. A bus is driving through a green light at t = 0 with initial speed of 12 m/sec. The acceleration of bus as a function of time is given by :

$$a = \begin{cases} 0 & \text{when } 0 \le t \le 1 \\ -6(t-1) & \text{when } t \ge 1 \end{cases}$$

All units are in S.I. Find the speed (in m/sec) of bus at time t = 2 second.

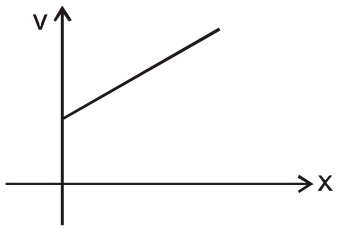
13. A particle moves in straight line with constant acceleration 'a'. The displacements of particle from origin at $t = t_1$, $t = t_2$ and $t = t_3$ are s_1, s_2 and s_3 respectively. If t_1, t_2, t_3 are in A.P. with common difference d and displacements are in G.P. Find the value of n (any number) if $a = \frac{(\sqrt{s_3} - \sqrt{s_1})^2}{nd^2}$

14. A parachutist jumps from height 100 m. He wants to reach at ground with zero velocity. For this purpose he switches on a parachute propeller after falling freely for certain height. Given that after the parachute propeller is switched on total acceleration of the man varies with velocity as a = –2v, where v is the instantaneous velocity of the man. Find the time after falling freely man should switch on parachute propeller for this purpose. (use $g = 10 m/s^2$).

15. The maximum possible acceleration of a train starting from the rest and moving on straight track is 10 m/s^2 and maximum possible retardation is 5 m/s^2. The maximum speed that train can achieve is 70 m/s. Minimum time in which the train can complete a journey of 1000m ending at rest is $\frac{347}{2\alpha}$ sec .Where α is an intger . Find α .

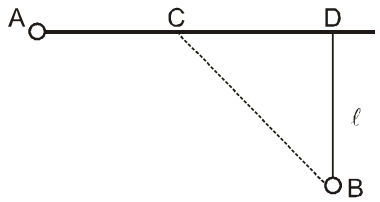
16. A train stopping at two stations 2 kms apart on a straight line takes 4 minutes for the journey. Assuming that its motion is first uniformly accelerated and then uniformly retarded. Prove that $\frac{1}{x} + \frac{1}{y} = 4$, where x and y' are the magnitude of the acceleration and retardation respectively in (km/min^2).

17. A particle moves along x-axis in positive direction. Its acceleration 'a' is given as a = cx + d, where x denotes the x-coordinate of particle, c and d are positive constants. For velocity-position graph of particle to be of type as shown in figure, find the value of speed (in m/s) of particle at x = 0. Take $c = 1\ s^{-2}$ and $d = 3\ ms^{-2}$



18. The two ends of a train moving with a constant acceleration pass a certain point with velocities u and v. Show that the velocity with which the middle point of the train passes the same point is $\sqrt{\frac{u^2 + v^2}{2}}$.

19. From point A located on a highway (Fig.) one has to get by car as soon as possible to point B located in the field at a distance ℓ from the highway. It is known that the car moves in the field η times slower than on the highway. At what distance from point D one must turn off the highway?



20. The velocity of a particle moving in the positive direction of the x axis varies as $v = \alpha\sqrt{x}$ where α is a positive constant. Assuming that at the moment t = 0 the particle was located at the point x = 0, find:

(a) the time dependence of the velocity and the acceleration of the particle;

(b) the mean velocity of the particle averaged over the time that the particle takes to cover the first s metres of the path.

Matrix Match Type :

21. **Column I**

(A) Zero acceleration

(B) Infinite acceleration

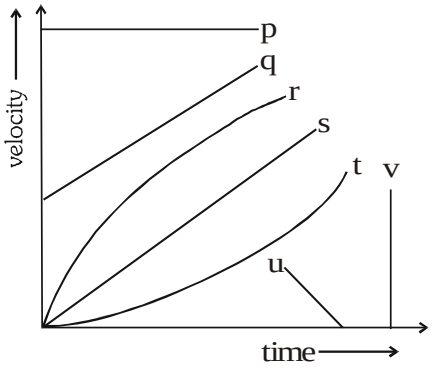
(C) Constant positive acceleration, with zero initial velocity

(D) Constant positive acceleration, with non–zero initial velocity

(E) Constant Negative acceleration

(F) Increasing acceleration

Column II



22. The position of a particle along x-axis is given by $x = (2t^3 - 21t^2 + 60t)$m. Then match the column I with column II.

	Column-I		**Column-II**
(A)	Velocity of particle is zero	(P)	2 sec
(B)	Acceleration of particle is zero	(Q)	3 sec
(C)	Acceleration of particle is negative	(R)	3.5 sec
(D)	Velocity of particle is towards the origin	(S)	4 sec
		(T)	5 sec

Subjective Type Questions :

23. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 km h^- in the direction A to B notices that a bus goes past him every 18 min. in the direction of his motion, and every 6 min. in the opposite direction. What is the period T of the bus service and with what speed (assumed constant) do the buses ply on the road ?

24. A passenger who just missed the train stands on the platform, sadly watching the last two boggies of the train. The second last boggy takes time 3 sec. to pass by the passenger, and the last one takes time 2 sec. to pass by. How late is the passenger for the departure of the train? Assume that the train accelerates at constant rate

25. A block of mass m is fired horizontally along a level surface that is lubricated with oil. The oil provides a viscous resistance that varies as the 3/2 power of the speed. If the initial speed of the block is v_0 at x = 0, find the maximum distance reached by the block. Assume no resistance to motion other than that provided by the oil.