AVIRAL CLASSES
IIT-JEE | NEET | FOUNDATIONS

PHYSICS
CRASH COURSE

LECTURE - 04

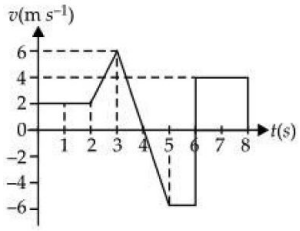
TOPICS : Kinematics Motion- 1D

1. A person walks up a stationary escalator in time t_1. If he remains stationary on the escalator, then it can take him up in time t_2. How much time would it take him to walk up the moving escalator ?

(a) $\frac{t_1 + t_2}{2}$ (b) $\sqrt{t_1 t_2}$

(c) $\frac{t_1 t_2}{t_1 + t_2}$ (d) $t_1 + t_2$

2. The velocity-time graph of a body is shown in figure. The displacement covered by the body in 8 s is



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

3. A streamer moves with velocity 3 km h^{-1} in and against the direction of river water whose velocity is 2 km h^{-1}. Calculate its total time for total journey if the boat travels 2 km in direction of the stream and then back to his place.

(a) 2 h (b) 2.5 h
(c) 2.4 h (d) 3 h

4. A particle is projected vertically upwards from a point A on the ground. It takes time t_1 to reach a point B, but it still continues to move up. If it takes further time t_2 to reach the ground from point B. Then height of point B from the ground is

(a) $\frac{1}{2}g(t_1 + t_2)^2$ (b) gt_1t_2

(c) $\frac{1}{8}g(t_1 + t_2)^2$ (d) $\frac{1}{8}gt_1t_2$

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

(a) $\frac{(\alpha + \beta^2)t}{\alpha\beta}$ (b) $\frac{\alpha\beta}{t(\alpha+\beta)}$

(c) $\frac{\alpha\beta}{(\alpha+\beta)}$ (d) $\frac{(\alpha+\beta)t}{\alpha\beta}$

6. Two particles move in the same straight line starting from the same position. The first moves with constant velocity u and the second with constant acceleration f. During the time elaapses before the second catches the first greatest distance between the particle is

(a) $\frac{u}{f}$ (b) $\frac{u^2}{2f}$

(c) $\frac{f}{2u^2}$ (d) $\frac{f}{u^2}$

7. A body falling from a high minaret travels 40 m in the last 2 s of its fall to ground. Height of minaret is [Take g = 10 ms^{-2}]

(a) 60 m (b) 45 m
(c) 80 m (d) *50* m

8. A stone falls freely from rest and the total distance covered by it in the last second of its motion equals the distance covered by it in the first three seconds of its motion. The stone remains in the air for

(a) 6 s (b) 5s
(c) 7s (d) 4s

9. A body is fired vertically upwards. At half the maximum height, the velocity of the body is 10 ms^{-1}. The maximum height raised by the body is [Take g = 10 ms^{-2}]

(a) 5 m (b) 10 m
(c) 15 m (d) 20 m

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

(a) 24 m (b) 40 m
(c) 12 m (d) 16 m

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TOPICS : Kinematics Motion- 1D (SOLUTION)

1. **(c)** : Let L be the length of escalator.

Speed of man w.r.t. escalator is $v_{mc} = \frac{L}{t_1}$

Speed of escalator is $v_c = \frac{L}{t_2}$

$\therefore$ Speed of man with respect to ground would be

$$v_m = v_{mc} + v_c = L\left(\frac{1}{t_1} + \frac{1}{t_2}\right)$$

$\therefore$ The desired time is $t = \frac{L}{v_m} = \frac{t_1 t_2}{t_1 + t_2}$

2. **(c)** : Displacement in 8 s = Algebraic sum of the area under velocity-time graph

$$= 2\times 2 + \frac{1}{2}\times 1\times 4 + 1\times 2 + \frac{1}{2}\times 1\times 6 - \frac{1}{2}\times 16 - 6\times 1 + 2\times 4$$

$$= 4 + 2 + 2 + 3 - 3 - 6 + 8 = 10 \text{ m},$$

3. **(c)** : The velocity of streamer while moving down-stream = 3 km h^{-1} + 2 km h^{-1} = 5 km h^{-1} and while moving upstream = 3 km h^{-1} – 2 km h^{-1} = 1 km h^{-1}.

Total time taken $= \frac{2\text{ km}}{5\text{ km h}^{-1}} + \frac{2\text{ km}}{1\text{ km h}^{-1}} = 0.4\text{ h} + 2\text{ h} = 2.4\text{ h}$

4. **(d)** : Time taken for the particle to reach the highest point is $\frac{t_1 + t_2}{2}$.

As $v = u - gt$

At highest point, $v = 0$

Therefore, initial velocity of the particle is

$$u = g\left(\frac{t_1 + t_2}{2}\right) \qquad \text{...(i)}$$

Therefore, height of point B from the ground is

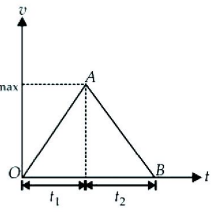
$$h = ut_1 - \frac{1}{2}gt_1^2 = g\left(\frac{t_1 + t_2}{2}\right)t_1 - \frac{1}{2}gt_1^2 \qquad \text{(Using (i))}$$

or $\quad h = g\left(\frac{t_1^2}{2} + \frac{t_1 t_2}{2}\right) - \frac{1}{2}gt_1^2 \quad$ or $\quad h = \frac{1}{2}gt_1 t_2$

5. **(c) :** Let the car accelerates for time t_1 and decelerates for time t_2. Then,

$t = t_1 + t_2$ ...(i)

and corresponding velocity-time graph will be as shown in figure.



From the graph,

α = slope of line $OA = \frac{v_{max}}{t_1}$

or $t_1 = \frac{v_{max}}{\alpha}$ ...(ii)

6. **(b) :** The greatest distance is, when velocities of both are equal.

or $ft = u$

$\therefore \quad t = \frac{u}{f}$

$S_1 = ut = \frac{u^2}{f}$ and $S_2 = \frac{1}{2} ft^2 = \frac{u^2}{2f}$

$\therefore \quad S_{max} = S_1 - S_2 = \frac{u^2}{2f}$

7. **(b) :** Let h be total height and t be the total time of flight. Then,

$h = \frac{1}{2} \times 10 \times t^2 = 5t^2$ ...(i)

and $h - 40 = \frac{1}{2} \times 10 \times (t-2)^2 = 5(t^2 + 4 - 4t)$

Using (i), we get

$5t^2 - 40 = 5(t^2 + 4 - 4t)$ or $5t^2 - 40 = 5t^2 + 20 - 20t$

or $20t = 60$ or $t = 3$ s

$\therefore \quad h = 5(3)^2 = 45$ m

8. **(b) :** Let the stone remains in air for n s.

$D_n = u + \frac{g}{2}(2n-1) = 0 + \frac{g}{2}(2n-1)$ (... $u = 0$)

Distance travelled in first three seconds

$S_3 = 0 \times 3 + \frac{1}{2} \times g \times 3^2 = \frac{9}{2}g$ (... $u = 0$)

As $D_n = S_3$ (Given)

$\therefore \quad \frac{g}{2}(2n-1) = \frac{9}{2}g$ or $2n - 1 = 9, n = 5$ s

9. **(b) :** Let h be maximum height reached by the body. Taking motion of the body from half the maximum height upto the highest point, we have

$u = 10 \text{ m s}^{-1}$, $a = -g = -10 \text{ m s}^{-2}$, $v = 0$, $S = \frac{h}{2}$

As $v^2 = u^2 + 2aS$

$\therefore \quad 0 = 10^2 + 2(-10) \times \frac{h}{2}$ or $h = 10 \text{ m}$

10. **(d) :** Given: $x = 40 + 12t - t^3$

$\therefore$ Velocity, $v = \frac{dx}{dt} = \frac{d}{dt}(40 + 12t - t^3) = 12 - 3t^2$

When particle comes to rest, $v = 0$

$\therefore \quad 0 = 12 - 3t^2$ or $t = 2 \text{ s}$

When $t = 0$, $x_0 = 40 + 12 \times 0 - 0^3 = 40 \text{ m}$

When $t = 2 \text{ s}$, $x_2 = 40 + 12 \times 2 - 2^3 = 56 \text{ m}$

$\therefore$ Distance travelled before coming to rest

$S = x_2 - x_0 = 56 \text{ m} - 40 \text{ m} = 16 \text{ m}$