AVIRAL CLASSES
IIT-JEE | NEET | FOUNDATIONS

PHYSICS
CRASH COURSE

LECTURE - 02

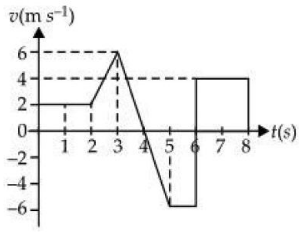
TOPICS : Kinematics

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

5. 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

6. A car covers the first one-third of distance x at a speed of 10 km h^{-1}, the second one-third at a speed of 20 km h^{-1} and the last one-third at a speed of 60 km h^{-1}. Find the average speed of the car over the entire distance x.

(a) 10 km h^{-1} (b) 12 km h^{-1}

(c) 18 km h^{-1} (d) 20 km h^{-1}

7. From the top of a tower, a particle is thrown vertically downwards with a velocity of 10 ms^{-1}. The ratio of distance covered by it in the 3^{rd} and 2^{nd} seconds of the motion is (Take g = 10 ms^{-2})

(a) 5 : 7 (b) 7 : 5

(c) 3 : 6 (d) 6 : 3

8. The position x of a particle with respect to time t along x-axis is given by $x = 9t^2 - t^3$, where x is in metre and t in second. What will be the position of this particle when it achieves maximum speed along the + x direction ?

(a) 32 m (b) 54 m

(c) 81 m (d) 24 m

9. A particle initially at rest moves along the x-axis. Its acceleration a varies with time as a = 4t. If it starts from the origin, the distance covered by it in 3 second is

(a) 12 m (b) 18 m

(c) 24 m (d) 36 m

10. A ball is dropped on the floor from a height of 10 m. It rebounds to a height of 2.5 m. If the ball is in contact with the floor for 0.01 seconds, what is the average acceleration during contact ?

(Take g = 10 ms^{-2})

(a) 700 ms^{-2} (b) 1400 ms^{-2}

(c) 2100 ms^{-2} (d) 2800 ms^{-2}

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TOPICS : Kinematics (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 $v_c = \frac{L}{t_2}$

∴ Speed of man with respect to ground would be

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

∴ 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

$= 2\times2 + \frac{1}{2}\times1\times4 + 1\times2 + \frac{1}{2}\times1\times6 - \frac{1}{2}\times16 - 6\times1 + 2\times4$

$= 4 + 2 + 2 + 3 - 3 - 6 + 8 = 10$ m,

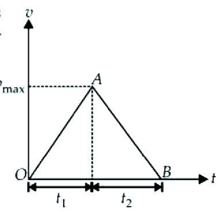
3. **(c) :** The velocity of streamer while moving down-stream = 3 km h^{-1} + 2 km h^{-1} = 5 km h^{-1} and while moving upstream = 3 km h^{-1} − 2 km h^{-1} = 1 km h^{-1}.

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. **(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)

and β = slope of line $AB = \frac{v_{max}}{t_2}$

or $t_2 = \frac{v_{max}}{\beta}$ ...(iii)

From Eqs. (i), (ii) and (iii), we get

$t = \frac{v_{max}}{\alpha} + \frac{v_{max}}{\beta}$ or $t = v_{max}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$

or $t = v_{max}\left(\frac{\alpha+\beta}{\alpha\beta}\right)$ or $v_{max} = \frac{\alpha\beta t}{\alpha+\beta}$

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

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

When particle comes to rest, $v = 0$

∴ $0 = 12 - 3t^2$ or $t = 2$ s

When $t = 0$, $x_0 = 40 + 12\times0 - 0^3 = 40$ m

When $t = 2$ s, $x_2 = 40 + 12\times2 - 2^3 = 56$ m

∴ Distance travelled before coming to rest

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

6. **(c) :** For first one-third of distance

Distance covered $= \frac{x}{3}$ km

Speed = 10 km h^{-1}.

The time taken for the journey, $t_1 = \frac{x/3}{10}\text{ h} = \frac{x}{30}\text{ h}$

For the next one-third of distance :

Distance covered $= \frac{x}{3}$ km.

Speed = 20 km h^{-1}

The time taken for travel is $t_2 = \frac{x/3}{20}\text{ h} = \frac{x}{60}\text{ h}$

For the last one-third of distance :

Distance covered $= \frac{x}{3}$ km.

Speed is 60 km h^{-1}

The time taken for travel is $t_3 = \frac{x/3}{60}\text{ h} = \frac{x}{180}\text{ h}$

∴ Average Speed $= \frac{\text{total distance}}{\text{total time}} = \frac{x}{\frac{x}{30} + \frac{x}{60} + \frac{x}{180}}$

$= \frac{180x}{10x} = 18\text{ km h}^{-1}$

7. **(b) :** Distance travelled in 3rd second

$S_3 = 10 + \frac{10}{2}(2\times3 - 1) = 35$ m

Distance travelled in 2nd second,

$S_2 = 10 + \frac{10}{2}(2\times2 - 1) = 25\text{ m} \Rightarrow \frac{S_3}{S_2} = \frac{7}{5}$

8. **(b) :** Given, $x = 9t^2 - t^3$ ...(i)

$v = \frac{dx}{dt} = 18t - 3t^2$

and $a = \frac{dv}{dt} = 18 - 6t$ ...(iii)

Now, when speed of particle is maximum, its acceleration is zero, *i.e.*, $a = 0$

$\therefore$ $18 - 6t = 0$ or $t = 3$ s

Putting in Eq. (i), we obtain position of particle at that time

$x = 9(3)^2 - (3)^3 = 54$ m

9. B

10. **(c) :** $v_1 = \sqrt{2gh} = \sqrt{2 \times 10 \times 10} = \sqrt{200}$

$v_2 = -\sqrt{2gh} = -\sqrt{2 \times 10 \times 2.5} = -\sqrt{50}$

So $\Delta v = v_1 - v_2 = \sqrt{200} + \sqrt{50} = 3\sqrt{50} = 21$

$\therefore$ Acceleration $= \frac{\Delta v}{\Delta t} = \frac{21}{0.01} = 2100$ m s^{-2}