AAQIL AHMED

JEE QUESTION: MOTION IN A LINE

1) Two bodies begin to fell freely from the same height. The second body begins to fell 'τ' sec. After the first. After what time from the beginning of first body does the distance between the bodies become equal to l?

ANSWER

Let the time of fall of the 1st body be t seconds

Time of fall of 2nd body $= t - \tau$

Distance of free fall of the bodies are

$$H_1 = \frac{gt^2}{2} \; ; \; H_2 = \frac{g(t-\tau)^2}{2}$$

Therefore, $l = H_1 - H_2 = gt\tau - \frac{1}{2}g\tau^2$

$$l = gt\left(\tau - \frac{t}{2}\right)$$

$$\Rightarrow t = \frac{l}{g\tau} + \frac{\tau}{2}$$

2) TWO PARALLEL RAIL TRACKS RUN NORTH SOUTH. TRAIN A MOVES NORTH WITH A SPEED OF 54km/h AND TRAIN B MOVES SOUTH WITH A SPEED OF 90km/h. what is

a) velocity of B wrt A

b) velocity of ground wrt B

c) velocity of monkey running on the roof of train A against its motion (with a velocity of 18km/h wrt A) as observed by a man standing on the ground

ANSWER

$v_A = +54 km/h = 15 m/s$, $v_B = -90 km/h = -25 m/s$

i) $v_{BA} = v_B - v_A = -25 - 15$

$= -40 m/s$

i.e, the train B appears to A to move with a speed of 40 m/s from north to south

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ii) $v_{GB} = v_G - v_B$

$= 0 - (-25)$

$= 25 m/s$

iii) Let the velocity of the monkey W.R.T ground be v_M. Relative velocity of the monkey W.R.T to A,

$v_{MA} = v_M - v_A$

$= -18 km/h$

$= -5 m/s$

$v_M = v_{MA} + v_A = (-5+15)$

$= 10 m/s$

3. If a freely felling body covers half of its total distance in the last second. Find its time of fall.

ANSWER

Suppose, t is the time

$h = \frac{1}{2} g t^2 - (1)$

$\frac{h}{2} = \frac{1}{2} g (t-1)^2 - (2\cdot1)$

Solving ① & ②

$\frac{1}{4} g t^2 = \frac{1}{2} g (t^2 + 1 - 2gt)$

$\frac{1}{2} t^2 = gt^2 - 2gt + g$

$t = (2+\sqrt{2}) sec$

Hazique Rizvi
2025-2026

Q1. A body projected vertically upwards with a certain speed from the top of a tower reaches the ground in t_1. If it is projected vertically downwards from the same point with the speed being same, it reaches the ground in t_2. Time required to reach the ground, if it is dropped from the top of the tower is:

A: h = height of the tower
u = intial speed of projection (same magnitude in both cases)
g = acceleration due to gravity (positive downward)
t_1 = Time taken to reach the ground when projected upwards
t_2 = Time taken to reach the ground when projected downwards
t = time taken to reach ground when simply dropped

Case:1 - Projectile thrown upwards
initial velocity = $-u$ [thrown upwards]
time taken = t_1

$$h = -ut_1 + \frac{1}{2}gt_1^2$$

Case: 2 - Projectile thrown downwards
initial velocity = u
time taken = t_2

$$h = ut_2 + \frac{1}{2}gt_2^2$$

Case:3 - Body simply dropped
$u = 0$
t = time taken

$$h = \frac{1}{2}gt^2$$

On equating the heights obtained from case 1 and 2

$$-ut_1 + \frac{1}{2}gt_1^2 = ut_2 + \frac{1}{2}gt_2^2$$

$$-ut_1 - ut_2 = \frac{1}{2}gt_2^2 - \frac{1}{2}gt_1^2$$

$$-u(t_1+t_2) = \frac{1}{2}g(t_2^2 - t_1^2)$$

$$-u(t_1+t_2) = \frac{1}{2}g(t_2-t_1)(t_2+t_1)$$

$$-u = \frac{1}{2}g(t_2-t_1)$$

$$u = \frac{1}{2}g(t_1-t_2)$$

On expressing h in terms of t_1 and t_2

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

$$h = \frac{1}{2}gt_1t_2$$

equate the height for dropped case:

$$h = \frac{1}{2}gt^2 \quad [\text{dropped case}]$$

$$\frac{1}{2}gt^2 = \frac{1}{2}gt_1t_2$$

$$t^2 = t_1t_2$$

$$t = \sqrt{t_1t_2}$$

∴ The time required for the body to reach the ground when dropped is the geometric mean of t_1 and t_2

Q2. The position of a particle related to time is given by $x = (5t^2 - 4t + 5)$m. The magnitude of velocity of the particle at $t = 2$s will be:

A: The position of a particle as a function of time is given by

$$x = (5t^2 - 4t + 5)m$$

to find magnitude of the velocity of the particle at $t = 2$s, we first need to find the velocity of the particle as a function of time.

The velocity v is the time derivative of the position 'x'

$$v = \frac{dx}{dt} \Rightarrow v = \frac{dx}{dt} = 10t - 4 \text{ m/s}$$

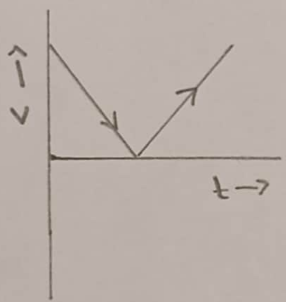
Now we can find the velocity of the particle at $t=2s$
by plugging $t=2$

$v(2s) = 10(2) - 4\,m/s = 16\,m/s$

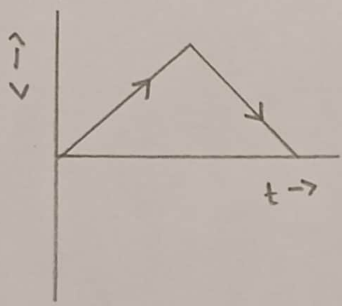
$\therefore$ The magnitude of the velocity of the particle at $t=2s$
is: $|v(2s)| = 16\,m/s$

Q3. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time

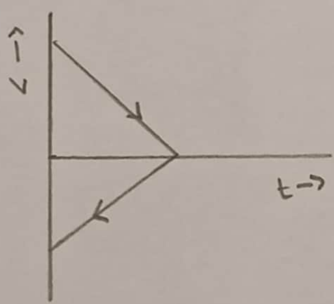
a)



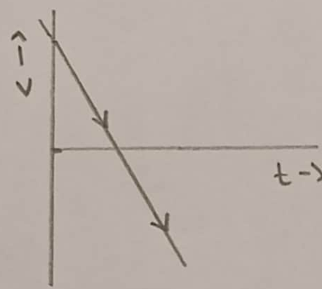
b)



c)



d)



A: Initially the speed of particle is maximum (V_0) and at height h velocity will become zero, then particle will move downward and velocity will increase gradually and become maximum when it reaches the ground and acceleration in this entire motion will be $-g$, so slope of $v-t$ will be same and negative

$\therefore$ Option d) is correct

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XI - A
30

Batch:- 2025-26

JEE Questions

Motion In A Straight Line

Q.1) A particle is moving in a straight line. The variation of position 'x' as a function of time 't' is given as $x = (t^3 - 6t^2 + 20t + 15)$ m. The velocity of the body when its acceleration becomes zero is. [JEE Mains 2025]

Ans:- $x = (t^3 - 6t^2 + 20t + 15)$ m

$$\frac{d(x)}{dt} = \frac{d}{dt}(3t^2 - 12t + 20 + 0)\,m \quad -①$$

$$\frac{dv}{dt} = \frac{d}{dt}(6t - 12)\,m$$

$a = 6t - 12 \; [\because a = 0]$

$\therefore t = \frac{12}{6} \Rightarrow \underline{2sec}$ - ②

Sub. $t = 2$ sec in ①;

$\Rightarrow 3t^2 - 12t + 20$

$\Rightarrow 3(2)^2 - 12(2) + 20$

$\Rightarrow 12 - 24 + 20$

$\Rightarrow -12 + 20$

$\Rightarrow$ 8 m/s

Q.2) The distance travelled by an object in time t is given by $s=(2.5)t^2$. The instantaneous speed of the object at $t=5s$ will be :- [JEE Mains 2024]

(A) 5 m/s
(B) 12.5 m/s
(C) 62.5 m/s
(D) 25 m/s

Ans :- $s=(2.5)t^2$

Differentiate;

$\Rightarrow 2\times 2.5\times t$

$\Rightarrow \cancel{2}\times\frac{5}{\cancel{2}}\times t$

$s=5t \; [t=5s]$

$\therefore s=(5)(5) \Rightarrow \underline{\underline{25 \text{ m/s}}}$ (D)

Q.3) A ball is thrown vertically upward with an initial velocity of 150 m/s. The ratio of velocity after 3s and 5s is $\frac{x+1}{x}$. The value of x is . [$g=10 \text{ m/s}^2$]. [JEE Mains 2024]

$v=u-gt$

$v_1=150-10(3) \Rightarrow 120 \text{ m/s}$

$v_2=150-10(5) \Rightarrow 100 \text{ m/s}$

$\frac{v_1}{v_2} \Rightarrow \frac{120}{100} \Rightarrow \frac{12}{10} \Rightarrow \frac{6}{5} \times \frac{x+1}{x}$

$6x=5x+5$

$\therefore \underline{\underline{x=5}}$

Chp:- Motion in a Straight Line

Q1. A particle is moving in a straight line with an initial velocity of 2 m/s. It undergoes a constant acceleration of $3 \, m/s^2$ for 4 seconds. Find the distance travelled by the particle in the last second of its motion.

Ans. Calculating the velocity ~~after~~ after 4 seconds using the equation $v = u + at$, where v is the final velocity, u is the initial velocity, a is the acceleration, and t is the time.

$$v = 2 + 3(4)$$
$$= 2 + 12$$
$$= 14 \, m/s$$

Calculate the velocity at the start of the last second:

The particle accelerates for 4 seconds, so the start of the last second is at $t = 3$ seconds. Using $v = u + at$ again:

$$v_{3s} = 2 + 3(3)$$
$$= 2 + 9$$
$$= 11 \, m/s$$

Calculate the distance traveled in the last second.

The distance traveled in the last second can be calculated using the equation $s = ut + \frac{1}{2}at^2$, but

since we're considering only 1 second, it's easier to use $s = v_{avg} \times t$, where v_{avg} is the average velocity during that second.

$$V_{avg} = \frac{V_{3s} + V_{1s}}{2} = \frac{11+14}{2} = \frac{25}{2} = \underline{12.5\ m/s}$$

Distance traveled in the last second =

$V_{avg} \times t = 12.5 \times 1$

$= \underline{12.5\ meters}$

Final answer = $\underline{12.5\ meters}$

Q2. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β to come at rest. If the total time elapsed is t seconds, find the maximum velocity acquired by the car.

Ans. Let t_1 be the time the car accelerates, and t_2 be the time it decelerates. The total time is $t = t_1 + t_2$

The maximum velocity v_{max} is acquired at the end of the acceleration phase. Using $v = u + at$ for the acceleration phase:

$v_{max} = 0 + at_1 = at_1$

Use the deceleration phase to relate t_1 and t_2.

During deceleration, the car comes to rest, so $v=0$.

Using $v = u + at$ for the deceleration phase:

$0 = v_{max} - \beta t_2$

$v_{max} = \beta t_2$

Now,

$at_1 = \beta t_2$

Use the total time to find a relation between t_1 and t_2

$t = t_1 + t_2$

$t_2 = t - t_1$

Solving for t_1

$\alpha t_1 = \beta (t - t_1)$

$\alpha t_1 = \beta t - \beta t_1$

$\alpha t_1 + \beta t_1 = \beta t$

$t_1 (\alpha + \beta) = \beta t$

$t_1 = \dfrac{\beta t}{\alpha + \beta}$ $t_1 = \dfrac{\beta t}{\alpha + \beta}$

CamScanner

Now, Find v_{max}

$$v_{max} = \alpha t_1 = \alpha \frac{\beta t}{\alpha + \beta}$$

$$v_{max} = \frac{\alpha \beta t}{\alpha + \beta}$$

$\therefore$ The final answer is $= \dfrac{\alpha \beta t}{\alpha + \beta}$

Q3. A particle moves in a straight line with a velocity given by $v(t) = 3t^2 - 2t + 1$ m/s. Find the displacement of the particle from $t = 0$s to $t = 2$s

Ans. We are given the velocity of a particle as a function of time, $v(t) = 3t^2 - 2t + 1$ m/s, and we need to find the displacement of the particle from $t = 0$s to $t = 2$s.

The displacement of an object can be found by integrating its velocity function with respect to time.

The displacement s from $t = 0$s to $t = 2$s is given by the integral:

$$s = \int_0^2 v(t)\,dt = \int_0^2 (3t^2 - 2t + 1)\,dt$$

Evaluating the integral, we get:

$$s = \left[\frac{3t^3}{3} - \frac{2t^2}{2} + t\right]_0^2$$

∴ The final answer is : 6

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Q.1 A person travelling on a straight line moves with a uniform velocity v_1 for a distance x and with a uniform velocity v_2 for next $\frac{3}{2}x$ distance. The average velocity in this motion is $\frac{50}{7}$ m/s. If v_1 is 5 m/s then $v_2 =$ ______ m/s.

Ans. Distance 'x' at velocity $v_1 = 5$ m/s
Distance '$\frac{3x}{2}$' at velocity v_2

Average Velocity $= V_{avg} = \frac{\text{Total Distance}}{\text{Total Time}} = \frac{50}{7}$ m/s [Given]

Total Distance $= x + \frac{3x}{2} = \frac{5x}{2}$

Time for x: $t_1 = \frac{x}{v_1} = \frac{x}{5}$

Time for $\frac{3x}{2}$: $t_2 = \frac{\frac{3x}{2}}{v_2} = \frac{3x}{2v_2}$

$$\Rightarrow \frac{50}{7} = \frac{\frac{5x}{2}}{\frac{x}{5} + \frac{3x}{2v_2}} = \frac{5/2}{\frac{1}{5} + \frac{3}{2v_2}}$$

$$\Rightarrow \frac{50}{7} = \frac{5/2}{\frac{1}{5} + \frac{3}{2v_2}}$$

$$\Rightarrow \frac{1}{5} + \frac{3}{2v_2} = \frac{7}{20}$$

$$\Rightarrow \frac{3}{2v_2} = \frac{3}{20}$$

$$\Rightarrow \underline{\underline{v_2 = 10 \text{ m/s}}}$$

Q.2. A body moves on a frictionless plane starting from rest. If S_n is distance moved between $t = n-1$ and $t = n$ and S_{n-1} is distance moved between $t = n-2$ and $t = n-1$, then the ratio $\frac{S_{n-1}}{S_n}$ is $(1 - 2/x)$ for $n = 10$. The value of $x =$ ____ ?

Ans.

$$S = ut + \frac{1}{2}at^2 \qquad \left[S = \frac{1}{2}at^2 \text{ as } u = 0\right]$$

The distance moved between $t = n-1$ & $t = n$ (S_n) can be found by calculating distance covered by end of time n & subtracting the distance covered by end of time $(n-1)$. Let's denote total distance covered by time n as $S(n)$, which, acc. to formula :- $S(n) = \frac{1}{2}an^2$

$$\Rightarrow S_n = S(n) - S(n-1)$$

$$\Rightarrow S_n = \frac{1}{2}an^2 - \frac{1}{2}a(n-1)^2 = \frac{1}{2}a(n^2 - (n^2 - 2n + 1))$$

$$\Rightarrow S_n = \frac{1}{2}a(2n+1)$$

Similarly $S_{n-1} = \frac{1}{2}a((n-1)^2 - (n-2)^2) = \frac{1}{2}a((n-1)^2 - (n^2 - 4n + 4))$

$$\Rightarrow S_{n-1} = \frac{1}{2}a(\cancel{n^2} - 2n + 1 - \cancel{n^2} + 4n - 4)$$

$$\Rightarrow S_{n-1} = \frac{1}{2}a(2n-3)$$

$$\Rightarrow \frac{S_{n-1}}{S_n} = \frac{\frac{1}{2}a(2n-3)}{\frac{1}{2}a(2n-1)} = \frac{2n-3}{2n-1}$$

For $n = 10$, $\frac{S_{n-1}}{S_n} = \frac{17}{19}$

Given, ratio is represented by $1 - 2/x \Rightarrow \frac{17}{19} = 1 - 2/x$

$$\Rightarrow 2/x = \frac{2}{19} \Longrightarrow x = 19$$

Q3 A car starts from rest and accelerates uniformly to a speed of 72 km/hr in 10s. It then moves with a uniform speed for 20s and is finally brought to rest in 5s with constant retardation. Find the total distance covered by the car.

Ans. $72 \text{ km/hr} = 72 \times \frac{5 \text{ m/s}}{18} = \underline{20 \text{ m/s}}$

$\text{Acceleration} = \frac{v-u}{t} = \frac{20}{10} = \underline{2 \text{ m/s}^2}$

Distance covered during acceleration $= S_1 = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(2)(100) = \underline{100 \text{ m}}$

Distance covered during uniform motion $= S_2 = vt = 20 \times 20 = \underline{400 \text{ m}}$

Retardation of car $= \frac{v-u}{t} = \frac{-20}{5} = \underline{-4 \text{ m/s}^2}$

$\Rightarrow$ Distance covered during retardation $= S_3 = ut + \frac{1}{2}at^2$

$= 20(5) + \frac{1}{2}(-4)(25)$

$= 100 - 50 = \underline{50 \text{ m}}$

$\therefore$ Total Distance $= 100 + 400 + 50$

$= \underline{550 \text{ m}}$

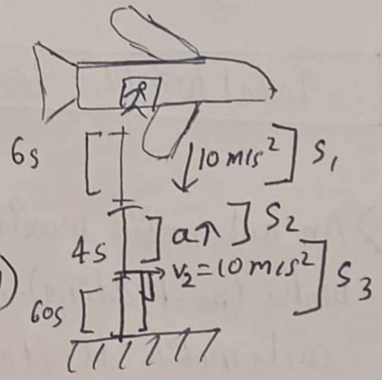
Sarthak B. Shinde XI-A

Motion In A Straigt line

Q1) Parchutist jumps out of plane and accelerates with gravity for 6 sec. He then pulls parachute chord and after 4s deceleration period, descends at 10 m/s for 60 seconds, reaching ground. From what height did parachutist jump? Assume acceleration due to gravity to be $10 m/s^2$ throughout motion.

Solution:

Ist motion: Person jumped for 6 seconds with gravity.



So,

$a = g = 10 m/s^2$

$u = 0$ {no initial velocity as plane moved horizotal)

$t = 6s$

$s = ut + \frac{1}{2}at^2$

$s = 0 \times 6 + \frac{1}{\cancel{2}} \times 10 \times \cancel{6}^{3} \times 6$

$\boxed{S_1 = 0 + 180 = 180m}$

$v = u + at$

$v = 0 + 10 \times 6$

$\boxed{V_1 = 60 m/s}$

IInd motion: person opened paruchute and descend for 4 ~~m/s~~ second:

So,

$a = ?$

$u = 60 m/s$ (peron was at $v = 60 m/s$ before oppening parachute)

$V_2 = 10 m/s$ (after 4 seconds of descension, he moved with uniform $v = 10 m/s$)

$t = 4s$

$v = u + at$

$10 = 60 + a \times 4$

$4a = 10 - 60 = -50 \Rightarrow a = \frac{-25}{2} m/s^2$

$s = ut + \frac{1}{2}at^2$

$s_2 = 60 \times 4 - \frac{1}{\cancel{2}} \times \frac{25}{\cancel{2}} \times \cancel{4} \times 4$

$\boxed{S_2 = 240 - 100 = 140 m}$

III^{rd} motion: Person moving with uniform velocity for 60 seconds

$V = 10\,m/s$

$t = 60s$

$S = Vt$ (uniform velocity)

$S_3 = 60 \times 10$

$\boxed{S_3 = 600\,m}$

Total height $H = S_1 + S_2 + S_3 = (140 + 180 + 600)\,m$
$= 920\,m$

$\boxed{\therefore \text{ total height} = 920\,m}$

Q) An automobile moving at 40 km/h can be stopped in 40 m using brakes (no skidding). At what minimum distance can same automobile be stopped if its moving at 80 km/h? (JEE Main-2018)

(a) 75m (b) 100m (c) 150m (d) 160m

(A) At $u = 40$ km/h, $v = 0$ (body comes to rest) $S = 40m = 0.04$ km

$2aS = v^2 - u^2$

$2 \times a \times 0.04 = 0 - (40)^2$

$a = \dfrac{-1600}{0.08} = \dfrac{-160000}{8} = -20{,}000\,km/h^2$

At $u = 80$ km/h, $V = 0$ (body come to rest), $a = -20{,}000\,k/h^2$ (uniform acceleration)

$2aS = v^2 - u^2$

$2 \times -20{,}000 \times S = 0^2 - (80)^2$

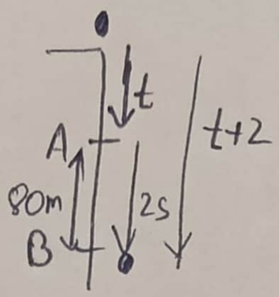
$S = \dfrac{+\cancel{6400}^{16}}{+\cancel{40000}} = \dfrac{16}{100} = 0.16\,km = 160\,m$

$\boxed{\therefore \text{ minimum distance} = 160\,m}$

$\boxed{(d)\ 160m}$

Q> A body falling under gravity covers two points A and B seprated by 80 m in 2s. The distance of upper point A from starting point is ______ m (use $g = 10\ m\ s^{-2}$)

Sol:



t = time taken to reach point A

$u = 0$ {body dropped from rest}

$a = g = 10 m/s^2$

$S_t = ut + \frac{1}{2} \times a \times t^2$

$S_t = 0 + \frac{1}{2} \times 10 \times t \times t$

$S_t = 5t^2$

$t+2 \rightarrow$ {time taken to reach point B}

$a = g = 10 m/s$

$u = 0$ {body dropped}

$S = ut + \frac{1}{2} at^2$

$S_{t+2} = 0 + \frac{1}{2} \times 10 \times (t+2)^2$

$S_{t+2} = 5(t^2 + 2t + 4)$

$S_{t+2} = 5t^2 + 20t + 20$

$S_{t+2} - S_t = S_2$ {displacement in 2 sec = $S_2 = 80m$}

$5t^2 + 20t - 20 - 5t^2 = 80$

$20t + 20 = 80$

$t + 1 = 4$

$\boxed{t = 3s}$

At time $t = 3s$, body reaches A

$S_A = ut + \frac{1}{2} at^2$

$S_A = 0 + \frac{1}{2} \times 10 \times 3 \times 3$

$\boxed{S_A = 45 m}$

Ans: 45 m

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Motion in a Straight Line

Q1) A particle moves along the X-axis and has its displacement x varying with time t according to the equation:

$$x = C_0(t^2 - 2) + C(t-2)^2$$

[where, C_0 and C are constant of appropriate dimension.]

Then, which of the following statements is correct?

(A) The acceleration of the particle is $2(C+C_0)$
(B) The acceleration of the particle is $2C_0$.
(C) The acceleration of the particle is $2C$.
(D) The initial velocity of the particle is $4C$.

Ans:- Given,

$x = C_0(t^2-2) + C(t-2)^2$ [$x \rightarrow$ displacement]

$\therefore v = \frac{dx}{dt} = \frac{d}{dt}\left[C_0(t^2-2) + C(t-2)^2\right]$

$= \frac{d}{dt}\{C_0(t^2-2)\} + \frac{d}{dt}\{C(t-2)^2\}$

$= C_0(2t) + C(2t-2) \Rightarrow v = C_0(2t) + C(2t-2)$

$\therefore a = \frac{dv}{dt} = \frac{d}{dt}\{C(2t) + C(2t-2)\} = 2C_0 + 2C$

$\Rightarrow a = 2(C_0 + C)$

$\therefore$ Accerelartion is $2(C_0+C)$ [(A)]

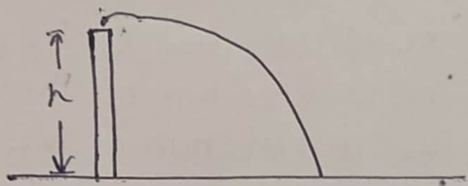
② A body projected vertically upwards with a certain speed from the top of a tower reaches the ground in t_1. If it is projected verticle downwards from the same point with the same speed, it reaches the ground in t_2. Time required to reach the ground, if it is dropped from the top of the tower is:

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

Ans:-

CASE 1:-

$h = -ut_1 + \frac{1}{2}gt_1^2$ ---- (i)



CASE 2:-

$h = ut_2 + \frac{1}{2}gt_2^2$ ---- (ii)

$\therefore$ from (i), (ii), we get,

$-ut_1 + \frac{1}{2}gt_1^2 = ut_2 + \frac{1}{2}gt_2^2$

$\Rightarrow -u(t_1+t_2) = \frac{1}{2}g(t_2^2 - t_1^2)$

$\Rightarrow -u = \frac{1}{2}g(t_2-t_1)$

$\Rightarrow u = \frac{1}{2}g(t_1-t_2)$ ---- (iii)

Substituting (iii) in (i), we get,

$\Rightarrow h = -\{\frac{1}{2}g(t_1-t_2)\}t_1 + \frac{1}{2}gt_1^2$

$= \frac{1}{2}g(t_2t_1 - t_1^2) + \frac{1}{2}gt_1^2$

$\Rightarrow h = \frac{1}{2}g(t_2t_1) - \cancel{\frac{1}{2}gt_1^2} + \cancel{\frac{1}{2}gt_1^2}$

$\Rightarrow h = \frac{1}{2}g(t_2-t_1)$ ---- (iv)

CASE 3:-

$h = \frac{1}{2}gt^2$ ---- (v)

[$\because$ free fall]

so, $u=0$

$\therefore \frac{1}{\cancel{2}}\cancel{g}t^2 = \frac{1}{\cancel{2}}\cancel{g}(t_2-t_1)$

$\Rightarrow t = \sqrt{t_2-t_1}$ [(D)]

$\therefore$ Required time is,

$t = \sqrt{t_2-t_1}$ [(D)]

Abhishek Kr. Singh
XII-A Roll No. -3
2025-26

(3) A train starting from rest first accelerated uniformly up to a speed of 80 kmph, for time t then it moves with a constant speed of time 3t. The avg. speed of the train for this duration of journey (kmph):

(A) 70 (B) 40 (C) 30 (D) 80

Ans:-

$u_1 = 0$; $v_1 = 80$ kmph ; $t_1 = t$.

$v_1 = u_1 + at_1$

$\Rightarrow 80 = 0 + at_1 \Rightarrow t_1 = \frac{80}{a}$ ---(i)

$S_1 = u_1t_1 + \frac{1}{2}at_1^2 \Rightarrow S_1 = 0 + \frac{1}{2} \cdot \cancel{a} \cdot \frac{80}{\cancel{a}} \cdot \frac{80}{a} \Rightarrow S_1 = \frac{3200}{a}$ ---(ii)

$\therefore u_2 = 80$ kmph ; $v_2 = ?$; $a = 0$; $t_2 = 3t$

$\therefore t_2 = 3 \times \frac{80}{a} \Rightarrow t_2 = \frac{240}{a}$

$\therefore u_2 + at_2 = v_2$

$\Rightarrow u_2 + 0 = v_2 \Rightarrow v_2 = u_2 = 80$ kmph

$\therefore S = ut + \frac{1}{2}at^2 \Rightarrow S_2 = 80(3t) \Rightarrow 240t = S_2$

$\Rightarrow S_2 = 240 \times \frac{80}{a} \Rightarrow S_2 = \frac{19200}{a}$ --- (iii)

$\text{Avg. Speed} = \frac{S_1 + S_2}{t_1 + t_2} = \frac{3200 + 19200}{\cancel{a}} \times \frac{\cancel{a}}{80 + 240}$

$\Rightarrow$ Avg. Speed $= 70$ kmph $\boxed{A}$

KOUSHIK BASKARAN
2025-2026

1. A body moves 6m north, 8m east and 10m vertically upwards what is its resultant displacement from initial position (only magnitude) (a) $10\sqrt{2}$m (b) 10m (c) $10/\sqrt{2}$ m (d)

Answer :- $d_x = 8m$ (east) $d_y = 6m$ (north) $d_z = 10m$ (upward)

$$|\vec{d}| = \sqrt{d_x^2 + d_y^2 + d_z^2}$$

$$\sqrt{8^2 + 6^2 + 10^2}$$

$$\Rightarrow \sqrt{64 + 36 + 100}$$

$$\Rightarrow \sqrt{200}$$

$$= 10\sqrt{2}m$$

2. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s the distance travelled by the toy in next t s will be

Answer :- $S = ut + \frac{1}{2}at^2$, $u = 0$

$S_1 = 10m$ $\quad S_1 = \frac{1}{2}at^2$

$10 = \frac{1}{2}at^2 = at^2 = 20$ - ①

$S_2 = \frac{1}{2}a(2t)^2 = \frac{1}{2}a(4t^2) = 2at^2$

$S_2 = 2 \times 20 = 40m$

$S = S_2 - S_1 = 40 - 10 = 30m$

3. A ball of mass 0.5kg is dropped from the height of 10m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is ______ m ($g = 10 m/s^2$)

Answer :- $m = 0.5kg$ $h_0 = 10m$ $g = 10 m/s^2$ $v = 10$

$v^2 = u^2 + 2gs$

$(+10)^2 = 0^2 + 2(10)s$

$100 = 20s$

$s = \frac{100}{20} = 5m$

Arun Sam Isac

2025-2026

Q.1 A ball is dropped from the top of a 100m high tower on a planet. In the last $\frac{1}{2}$ s before hitting the ground, It covers, a distance of 19m. Acceleration due to gravity (g) (in ms^{-2}) near the surface on that planet is.

Ans: Let the ball takes time t to reach the ground.

Using, $S = ut + \frac{1}{2} gt^2$

$S = 0 + \frac{1}{2} gt^2$

$S = \frac{1}{2} gt^2$

$200 = gt^2$

$t = \sqrt{\frac{200}{g}}$

In last, $\frac{1}{2}$ s body travels a distance of 19m, so in $(t - \frac{1}{2})$

Distance travelled = 81

$\frac{1}{2} g \left(t - \frac{1}{2}\right)^2 = 81$

$g \left(t - \frac{1}{2}\right) = 81 \times 2$

$\frac{1}{2} = \frac{1}{\sqrt{g}} (\sqrt{200} - \sqrt{81 \times 2}$

$\sqrt{g} = 2(10\sqrt{2} - 9\sqrt{2})$

$\sqrt{g} = 2\sqrt{2}$

$g = 8 m/s^2$

Q.2 The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is $x = 0$ and $t = 0$, then its displacement after unit time ($t = 1$) is

Ans: We know that $v = \frac{dx}{dt}$

$dx = v\,dt$

Integrating $\int_0^x dx = \int_0^t v\,dt$ or $x \int_0^t (v_0 + gt + ft)^2\,dt = \left[v_0 t + \frac{gt^2}{2} + \frac{ft}{3}\right]$

or $x = v_0 t + \frac{gt^2}{2} + \frac{ft^3}{3}$

At $t = 1$, $x = v_0 + \frac{g}{2} + \frac{f}{3}$

Q.3 A particle located at $x = 0$ and time $t = 0$, starts moving along with the positive x-direction with a velocity 'v' that varies as $v = a\sqrt{x}$. The displacement of the particle varies with time as.

Ans: $v = a\sqrt{x}$ or $\frac{dx}{dt} = a\sqrt{x}$ or $\frac{dx}{\sqrt{x}} = a\,dt$

Integrating both sides, $\int_0^x \frac{dx}{\sqrt{x}} = a\int_0^x dt$; $\left[\frac{2\sqrt{x}}{1}\right]^x = a[t]_0^t$

$= 2\sqrt{x} = at = x = \frac{a^2}{4} t^2$

Zaid Shamsheeri
XI-A.

Motion in a straight line.

Q1. Two cars travel towards each other at 20m/s each when they are 300m apart, both apply breaks and retard at 2m/s. The distance between when they come at rest.

Sol:

Relative speed = 20+20 = 40m/s.

Relative retardation = 2+2 = 4m/s.

Stopping distance : $S = \frac{v^2}{2a} = \frac{40^2}{2\times4} = \frac{1600}{8} = 200m$

Remaining gap = 100m

Q2. Particle covers half the distance at speed 6m/s the remaining half is covered in two equal time intervals at speeds 9m/s and 15m/s. avg speed = ?

Sol:

first half : $T_1 = \frac{D/2}{6} = \frac{D}{12}$

Distance = $9T + 15T = 24T = \frac{D}{2}$.

$T = \frac{D}{48}$, $t_2 = 2T = \frac{D}{24}$.

Total time. $\frac{D}{12} + \frac{D}{24} = \frac{D}{8}$.

Avg speed = $\frac{D}{D/18}$ = 8m/s

Q3. for a particle, the relation between T and x given by $T = \alpha x^2 + \beta x$.

find relation between accelaration "a" and velocity "v"

Solu:

$$\frac{dt}{dx} = 2\alpha x + \beta \Rightarrow v = \frac{dx}{dt} = \frac{1}{2\alpha x + \beta}.$$

$$\frac{dv}{dx} = \frac{-2\alpha}{(2\alpha x + \beta)^2}.$$

$$a = \frac{v\,dv}{dx} = \frac{1}{2\alpha x + \beta} \times \frac{2\alpha}{(2\alpha x+\beta)^2} = \frac{-2\alpha}{(2\alpha x+\beta)^3}$$

$$a = -2\alpha v^3$$

Q=

D.S.HARINI, XI-A
2025-2026 Motion in a Straight line

Q. A person of h = 1.6m is walking away from a lamp post 4m along a straight path on the flat ground. The lamp post & the person are always perpendicular to the ground. If the speed of the person is 60 cm s⁻¹, the speed of the tip of the person's shadow on the ground with respect to the person is — cm s⁻¹.

Sol: $\frac{dx_1}{dt}$ = speed of person = 60 cm/s

$\frac{dx_2}{dt}$ = speed of tip's of persons shadow

Apply ~Δ rule in ΔABE & ΔDCE,

$$\frac{4}{x_2} = \frac{1.6}{x_2 - x_1}$$

$$4x_2 - 4x_1 = 1.6x_2$$

$$2.4x_2 = 4x_1$$

Differenting both sides:

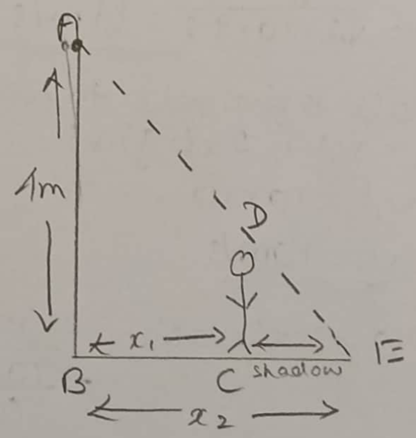
$$2.4\frac{dx_2}{dt} = 4\frac{dx_1}{dt}$$

$$\frac{dx_2}{dt} = \frac{4}{2.4}(60) = 100\ \text{cm/s}$$

$$\vec{V}_{SP} = \vec{V}_{SG} - \vec{V}_{PG}$$

$$V_{SP} = 100 - 60$$

$$= \underline{\underline{40\ \text{cm s}^{-1}}}$$



Q. A force of 40N is responsible for the motion of a body governed by the eq. $s = 2t + 2t^2$ where S is in meters & t in sec. What is the momentum of the body at $t = 2$ sec?

Sol: $P = ?$ at $t = 2$ secs $F = 40N$, $s = 2t + 2t^2$

(i) $v = \frac{d}{dt}(s)$ $v = \frac{d}{dt}(2t + 2t^2)$

$v = 2 + 4t$

$a = \frac{d}{dt}(2+4t)$ $\therefore$ $a = 4 m/s^2$

$F = ma$, $F = 40$

$40 = ma$

$m = F/a$ $m = 40/4 = \boxed{10 kg}$

$v = 2 + 4t$

At $t = 2$ secs

$v = 2 + 4(2)$

$v = 10 m/s$

P at $t = 2$ secs

$P = 10 \times 10$

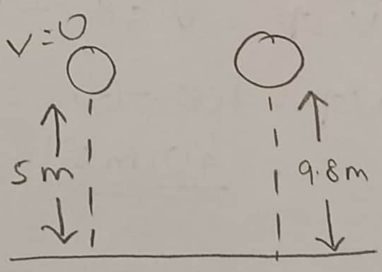
$\boxed{P = 100 \text{ kg m/s}}$

Q. A tennis ball dropped on to the floor from a height of 9.8m. It rebounds to a height 5m. Ball comes in contact with the floor for 0.2secs. The avg. acceleration during contact is:

$v^2 = 2gh$

$v = \sqrt{2gh}$

$v = \sqrt{2 \times 10 \times 9.8} = 14 m/s$



Ball rebounds to $h = 5m$

$0 = v_1^2 + 2 \times (-g) \times 5$

$v_1^2 = 10 \times 10$

$v_1 = 10 m/s$

Avg acceleration $= v_1 - (v)/t$

$= \frac{10+14}{0.2} = \frac{24}{0.2} = 120 m/s^2$

RAYAN

Motion in ~~plane~~ St line

Q.) A body projected vertically upwards with a certain speed from top of a tower reaches the ground in t_1. If it's projected vertically downwards from the same point with the same speed, it reaches the ground t_2. Time required to reach the ground, if it is dropped from top of the tower is:

(A) $\sqrt{t_1 t_2}$ (B) $\sqrt{t_1+t_2}$

(C) $\sqrt{t_1-t_2}$ (d) $\sqrt{t_1/t_2}$

Ans → $t_1 = \dfrac{u+\sqrt{u^2+2gh}}{g}$

$t_2 = \dfrac{-u+\sqrt{u^2+2gh}}{g}$

$t = \dfrac{\sqrt{2gh}}{g}$

$t_1 t_2 = \dfrac{(u^2+2gh)-u^2}{g^2} = \dfrac{2gh}{g^2} = t^2$

$\boxed{t=\sqrt{t_1 t_2}}$

Q.) The velocity of a particle is given $\vec{v} = -x\hat{i} + 2y\hat{j} - z\hat{k}$ m/s

The magnitude of $\vec{a}$ at (1, 2, 4) is ___ ms^{-2}.

(A) $\sqrt{6}$

(B) $\sqrt{33}$

(C) 9

(d) 0

$$\vec{V} = V_x\hat{i} + V_y\hat{j} + V_z\hat{k} = -x\hat{i} + 2y\hat{j} - z\hat{k}$$

$$a_x = (-x)(-1) = x$$

$$a_y = 2y(2) = 4y$$

$$a_z = -z(-1) = z$$

$$\vec{a} = \hat{i} + 8\hat{j} + 4\hat{k}$$

$$\boxed{|a| = 9ms^{-2}}$$

Q.) A particle moves in a straight line so that its displacement 'x' at any time 't' is given by $x^2 = 1 + t^2$. It's acceleration at any time 't' is x^{-n} where n = ___

Ans →

$$x^2 = 1 + t^2$$

$$2x\frac{dx}{dt} = 2t$$

$$xv = t$$

$$x\frac{dv}{dt} + v\frac{dx}{dt} = 1$$

$$xa + v^2 = 1$$

$$a = \frac{1}{x^3} = x^{-3}$$

SAANVI PATEL
2025-26

CH-2 MOTION IN A STRAIGHT LINE

Q1 A train is moving in a straight line with constant acceleration a. A boy standing inside throws a ball forward at speed 10 m/s at angle of 60° to the horizontal. The boy has to move forward by 1.15m inside the train in order to catch the ball back at same height. Find acc. of ~~the~~ train (in m/s^2) [JEE Adv. 2011].

$\Rightarrow$ Given : $u = 10\ m/s$; $\theta = 60°$

Hori. component :

$u_x = u \cos\theta$
$= 10 \cos(60°)$
$= 5\ m/s$

Vertical component :

$u_y = u \sin\theta$
$= 10 \times \frac{\sqrt{3}}{2}$
$= 5\sqrt{3}\ m/s.$

$T = \frac{2u}{g} = \frac{2(5\sqrt{3})}{10} = \sqrt{3}$

Disp. of ball : $V_0 \Rightarrow$ initial velo. of train

hori. dist covered by ball at $T = \sqrt{3}$:

$x_{ball} = (V_0 + 5) \cdot \sqrt{3}$

Disp of boy :

$$x_{boy} = \cancel{x_0}\ ut + \frac{1}{2}at^2$$

$$= V_0 \cdot \sqrt{3} + \frac{1}{2}a(\sqrt{3})^2$$

$$= V_0 \cdot \sqrt{3} + \frac{3}{2}a$$

Now Relative disp = 1.15

$$\therefore \quad x_{ball} - x_{boy} = 1.15$$

$$= (V_0 + 5)\sqrt{3} - V_0 \cdot \sqrt{3} + \frac{3a}{2} = 1.5$$

$$= 5\sqrt{3} - \frac{3a}{2} = 1.15$$

Acc = $\quad -\frac{3a}{2} = 1.15 - 5\sqrt{3}$

$$= \cancel{+}\frac{3a}{2} = \cancel{+}7.51$$

$$a = \frac{2(7.51)}{3}$$

$$a = 5.006\ m/s^2$$

$$\boxed{a = 5\ m/s^2}$$

Q2 A particle moves in a straight line such that it's disp. is given by

$$x = t^3 - 4t^2 + 3t$$

Find the acceleration of the particle at the times when its displacement is zero.

$\Longrightarrow$ $\frac{d}{dx}(t^3 - 4t^2 + 3t)$

$= 3t^2 - 8t + 3$ velo.

$\frac{d}{dx}(3t^2 - 8t + 3)$

~~dt~~ acc

$= 6t - 8 \longrightarrow (1)$

Factor of $t^3 - 4t^2 + 3t$

$= t(t^2 - 4t + 3)$

$= t[(t-1)(t-3)]$

$\therefore t = 0 ; t = 3 \longrightarrow (2)$
$t = 1$

(2) in 1

$t = 0 \longrightarrow a = -8$

$t = 1 \longrightarrow a = -2$

$t = 3 \longrightarrow a = 10$

Q. A particle starts from rest and moves in a straight line with acc :

$$a(t) = 6t - 12$$

(a is m/s^2 and t = sec)

a) find time at which particle comes to rest.

b) find total dist. travelled by particle in first 4 sec.

c) find the displacement is first 4 sec.

$\Rightarrow$ $$a(t) = \frac{dv}{dt} = 6t - 12$$

$$\int a(t).dt \Rightarrow \int (6t-12).dt$$

$$\Rightarrow 3t^2 - 12t + C$$

as we start from rest $\Rightarrow$ $v = 0$
$\therefore C = 0$

$$v(t) = 3t^2 - 12t$$

$$v(t) = 0 \Rightarrow 3t^2 - 12t = 0$$

$$3t(t-4) = 0$$

$$t = 0 \mid t = 4$$

$\therefore$ particle comes at rest again at

$t = 4$ sec $\longrightarrow$ (a) $\rightarrow$ Ans

Total distance is first 4 sec

$v(t) = 3t(t-4)$

$v(t) > 0$ when $0 < t < 4$

$v(0) = 0$; $v(4) = 0$

veloc. is positive.

$$s(t) = \int (v(t))\, dt$$

$$= \int 3t^2 - 12t \,.dt$$

$$= t^3 - 6t^2 + C$$

$$s(t) = t^3 - 6t^2$$

Now,

$t = 4$

$$S(4) = (4)^3 - 6(4)^2$$

$$= 64 - 96$$

$$= -32m$$

$\therefore$ dist. traveled in first 4 sec $= \underline{32m}$

$\hookrightarrow$ (b) $\hookrightarrow$ Ans.

From $v(t) = 3t(t-4)$

motion is backward ~~in~~ from $t = 0$ to $t = 4$

$\therefore$ displacement $= \underline{-32m}$

$\hookrightarrow$ (c) $\longrightarrow$ Ans