

YAKEEN NEET 2.0

2026

Motion in a Straight Line

Physics

Lecture - 8

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phy \rightarrow (160+)
phy \rightarrow 180 ✓



Today's goal.

⇒ H/w discussion.

⇒ Motion with Constant acceleration.



@MRPHYSICSS

Assignment - 3

Jee advance

30

→ 10 Quora
JEE Adv
Level

A particle moves in a straight line and its position x at time t is given by $x^2 = 2 + t$. Its acceleration is given by

1 $\frac{-2}{x^3}$

2 $-\frac{1}{4x^3}$

3 $-\frac{1}{4x^2}$

4 $\frac{1}{x^2}$

Ans

$$x^2 = 2 + t$$

$$\Rightarrow \text{diff}^n \text{ w.r.t. } (x)$$

$$\frac{dx^2}{dx} = \frac{d(2+t)}{dx}$$

$$2x = \left(\frac{dt}{dx}\right)$$

$$2x = \frac{1}{V}$$

$$V = \frac{1}{2x}$$

$$V = \frac{dx}{dt}$$

$$\frac{dV}{dx} = \frac{1}{2} \frac{d x^{-1}}{dx}$$

$$= \frac{1}{2} \cdot -1 x^{-2}$$

$$\frac{dV}{dx} = -\frac{1}{2x^2}$$

$$a = V \frac{dV}{dx} = \frac{1}{2x} \left(-\frac{1}{2x^2} \right)$$

$$= -\frac{1}{4x^3}$$

Question



A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to [2010]

- 1 (velocity)^{3/2} ✓
- 2 (distance)²
- 3 (distance)⁻² ✗
- 4 (velocity)^{2/3}

options are part of question

$$x = (t + 5)^{-1}$$

$$v = \frac{dx}{dt} = -1(t + 5)^{-2}$$

$$\frac{d^2x}{dt^2} = 2(t + 5)^{-3}$$

$$a = 2(t + 5)^{-3}$$

$$= 2(t + 5)^{-\frac{3 \times 2}{2}} = v^{3/2}$$

$$x = (t + 5)^{-1}$$

$$\frac{dx}{dt} = v$$

$$\frac{dv}{dt} = a$$

$$a = \frac{d}{dt} (t + 5)^{-1}$$

$$a \propto (t + 5)^{-2}$$

$$a = v^3$$

Ans

H/W

Question



If acceleration of object $a = 2x^{3/2}$ then find velocity at x where initial at $x = 0$ is 4 m/s .

Velocity

$$a = 2x^{3/2}$$

accⁿ is
Variable

$$\frac{dv}{dx} = 2x^{3/2}$$

MR SCUM

$$v \frac{dv}{dx} = 2x^{3/2}$$

$$\int_{v=4}^v v dv = 2 \int_{x=0}^x x^{3/2} dx$$

$$\left(\frac{v^2}{2} \right)_4^v = 2 \left(\frac{x^{3/2+1}}{\frac{3}{2}+1} \right)_0^x$$

$$\left\{ \frac{v^2 - 4^2}{2} \right\} = 2 \frac{x^{5/2}}{\frac{5}{2}}$$

$$v^2 - 16 = \frac{8}{5} x^{5/2}$$

$$v = \sqrt{\frac{8x^{5/2}}{5} + 16}$$

H/W

Question

The relation between time t and distance x is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is:

- 1 $2\alpha v^3$
- 2 $2\beta v^2$
- 3 $2\alpha\beta v^2$
- 4 $2\beta^3 v^3$

MP* Jodha
dim'n option
ka check kar
Jisme ar'n
aaya wo ans

already 3-4th
Solved

$$a = v \frac{dv}{dx}$$

$$t = \alpha x^2 + \beta x$$

diff'n w.r.t (x)

$$\frac{dt}{dx} = \alpha(2x) + \beta \times 1$$

$$\frac{1}{v} = 2\alpha x + \beta$$

$$\alpha \left[v = \frac{1}{2\alpha x + \beta} \right]$$

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

division

Question



Topic as

If $a = 3t^2 + 2t$, initial velocity is 5 m/s. Find the velocity at $t = 4$ s. The motion is in straight line, a is acceleration in m/s^2 and t is time in seconds.

Soln

$$a = 3t^2 + 2t$$

$$u = 5 \text{ m/s } (t=0)$$

$$V_{t=4\text{se}} = ?$$

$$\frac{dv}{dt} = 3t^2 + 2t$$
$$\int_5^V dv = \int_0^4 3t^2 dt + \int_0^4 2t dt$$

$$[v]_5^V = 3\left(\frac{t^3}{3}\right)_0^4 + 2\left(\frac{t^2}{2}\right)_0^4$$

$$V - 5 = (64 - 0) + (16 - 0)$$

$$V = 5 + 80$$

$$V = 85 \text{ m/s}$$

Question



A particle is moving in a straight line such that its velocity is given by $v = 12t - 3t^2$, where v is in m/s and t is in seconds. If at $t = 0$, the particle is at the origin, find the velocity at $t = 3$ s.

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

Put $t = 3$ here

Question



The deceleration experienced by a moving motorboat after its engine is shut-off is given by $dv/dt = -kv^3$, where k is a constant. If v_0 is the magnitude of the velocity at shut-off, find the velocity as a function of t . initial

JEE

Soln

$$\frac{dv}{dt} = -kv^3$$

$$dv = -kv^3 dt$$

$$\int_{v_0}^v \frac{dv}{v^3} = -\int_0^t k dt$$

$$\int_{v_0}^v v^{-3} dv = -kt$$

$$\frac{v^{-3+1}}{-3+1} = -kt$$

$$\left[\frac{v^{-2}}{-2} \right]_{v_0}^v = -kt$$

$$\frac{1}{v^2} - \frac{1}{v_0^2} = 2kt$$

$$\frac{1}{v^2} = 2kt + \frac{1}{v_0^2}$$

Question

$$\int \frac{1}{x} dx = \log e^x$$



The motion of a body is given by $dv/dt = 6 - 3v$, where v is in m/s. Find

(a) the velocity in terms of t and, where initial velocity at $t=0$ is $u=0$,

(b) terminal velocity. The motion starts from rest.

JEE

after large time

given

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

$$\int_0^v \frac{dv}{6-3v} = \int_0^t dt$$

$$\left[\frac{\log(6-3v)}{-3} \right]_0^v = t$$

$$\log(6-3v) - \log 6 = -3t$$

$$\Rightarrow \log \left(\frac{6-3v}{6} \right) = -3t$$

$$\Rightarrow \frac{6-3v}{6} = e^{-3t}$$

$$\Rightarrow 1 - \frac{3v}{6} = e^{-3t}$$

$$\Rightarrow 1 - e^{-3t} = \frac{v}{2}$$

$$v = 2(1 - e^{-3t})$$

H/W
Try it
only no
need to
solve
completely

Ans

$$V = 2(1 - e^{-3t})$$

$$V_{\text{at } t=\infty} = 2(1 - e^{-\infty})$$

$$V = 2m/s(1 - 0)$$

$$V = 2m/s \text{ \textit{Terminated}}$$

Question

$$\int \frac{1}{x} dx = \log x$$



The motion of a body is given by $\frac{dv}{dt} = 6 - 3v$, where v is in m/s. Find

(a) the velocity in terms of t and, where initial velocity at $t=0$ is $u=0$,

(b) terminal velocity. The motion starts from rest.

→ after large time

JEE

given

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

Terminal velocity (Constant Velocity)

$$a = 0$$

$$a = 6 - 3v = 0$$

$$2v = 3$$

$$v = 2 \text{ m/s}$$

Ans ✓

Imp*
HWS

Motion with constant acceleration [uniform acceleration]

MR^x Box

Uniform Motⁿ $V = \text{const}^n$
Uniform Velocity $\text{acc}^n = 0$

* Uniform $\text{acc}^n = \text{const}^n \text{acc}^n$ → Ex = -5 m/s^2

Velocity = Variable
(Non-uniform motion) //

→ मोटी बॉक्स

object starts his motⁿ from initial velocity u and constant accⁿ a then find its velocity at time t & displacement in t .

Solⁿ

$$a = \frac{dv}{dt} \rightarrow \text{we know}$$

$$\int_u^v dv = \int_{t=0}^t a dt$$

$$a = 2t$$

$$\left[v \right]_u^v = a \int_0^t dt$$

$$\boxed{v - u = at}$$

✓ 1st eqn of motⁿ
for const accⁿ use this

$$\boxed{\vec{v} = \vec{u} + \vec{a}t} \quad \text{--- (i)}$$

$$\boxed{\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2} \quad \text{--- (ii)}$$

$$* \vec{v}^2 - u^2 = 2\vec{a}\vec{s} \quad \text{--- (iii)}$$

$$\vec{s} = \text{disp}^m = x_f - x_i$$

$$\vec{v} = \text{final velocity}$$

$$\vec{u} = \text{initial velocity}$$

$$\vec{a} = \text{acc}^n$$

$$t = \text{time}$$

* all are vector except time

- MR*
- (1) if time is given or asking then use (1) & (2) eqn of motion.
 - (2) if time is not given or asking then use 3rd eqn of motion ✓

(Q) object starts his motion with velocity u and after some time its velocity become v with constⁿ accⁿ a then find Avg. velocity in time t

Solⁿ

$$\text{Avg velocity} = \frac{\text{Total disp}^m}{\text{total time}}$$

We know that
 $v - u = at$

$$\text{Avg vel} = \frac{(ut + \frac{1}{2}at^2)}{t}$$

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

$$\text{Avg vel} = u + \frac{at}{2}$$

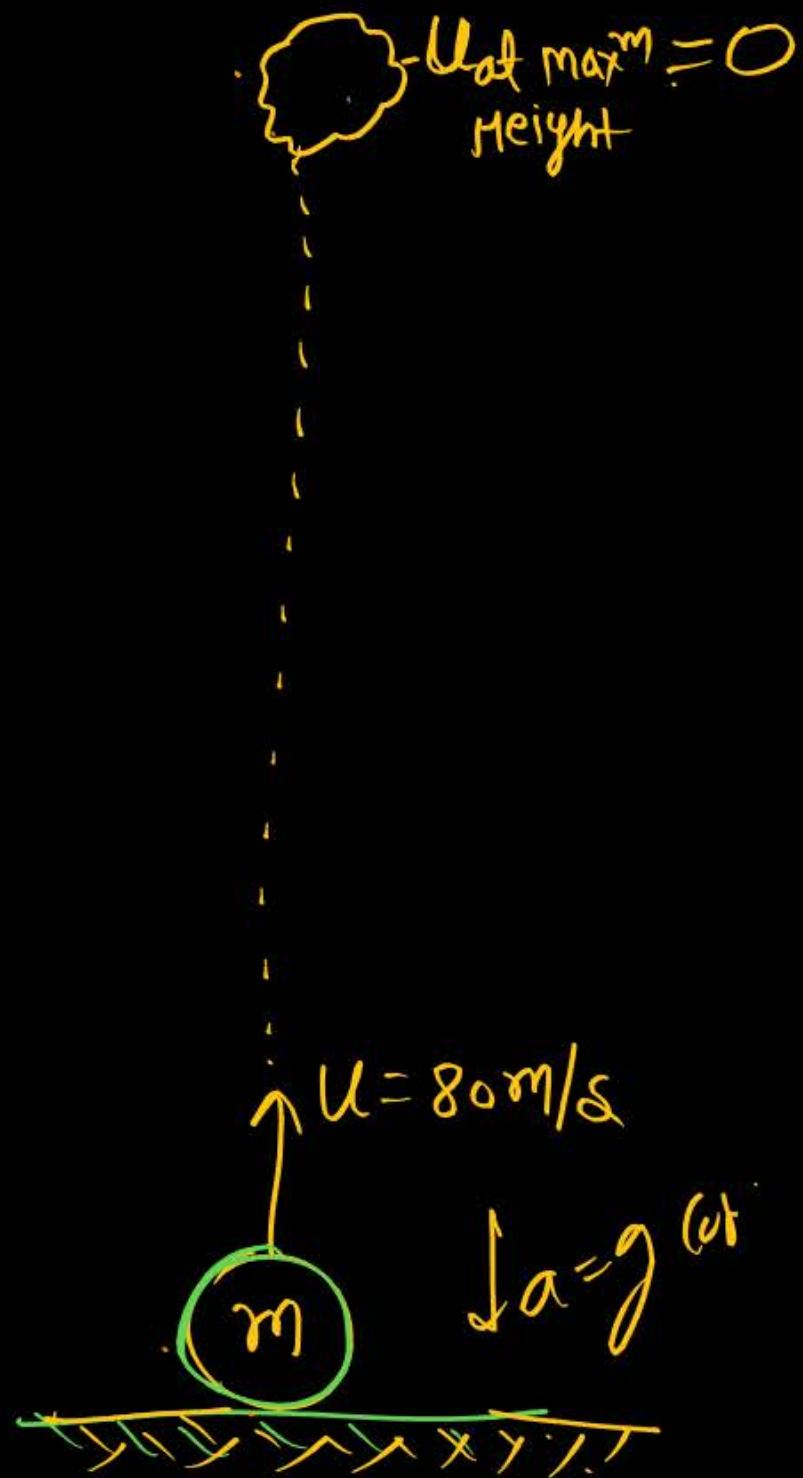
$$\text{Avg velocity} = u + \frac{v - u}{2}$$

$$= \frac{2u + v - u}{2}$$

$$\text{Avg velocity} = \frac{\vec{u} + \vec{v}}{2}$$

 for constⁿ
accⁿ

Likho →



find Avg. velocity from point of Projection to max^m Height: —

$$\textcircled{x} \text{ Avg velocity} = \frac{\vec{u} + \vec{v}}{2} = \frac{80 + 0}{2} = 40 \text{ m/s}$$

40 m/s Avg

सिद्धि

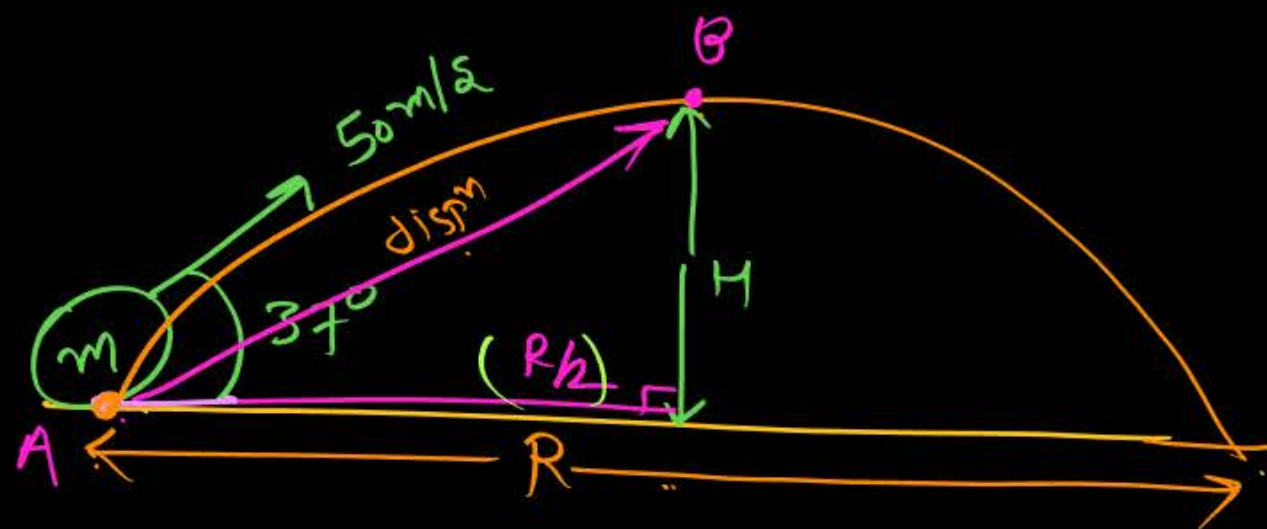
2nd method

$$\textcircled{x} H = \frac{u^2}{2g}$$

$$\textcircled{x} T_{\text{up}} = \frac{u}{g}$$

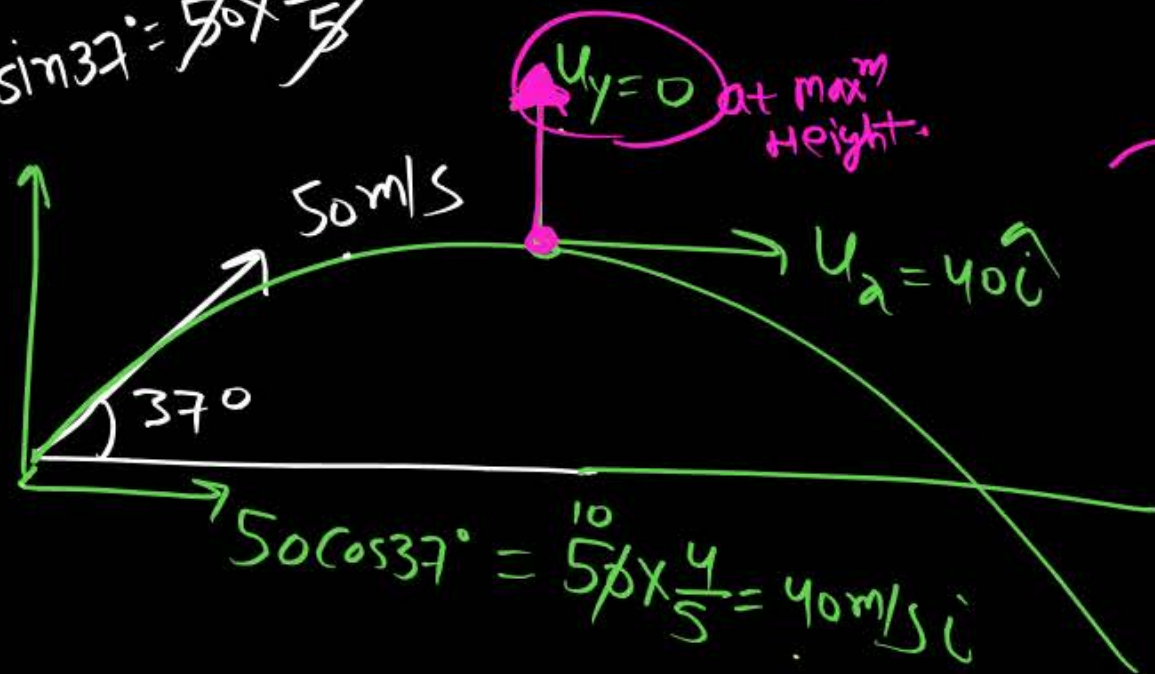
$$\text{Avg velocity} = \frac{H}{T_{\text{up}}} = \frac{\frac{u^2}{2g}}{\frac{u}{g}} = \frac{u}{2} = \frac{80}{2} = 40 \text{ m/s}$$

MRQ



$$a = g \cos \theta$$

$$u_y = 50 \sin 37^\circ = \frac{10}{5} \times \frac{3}{5} = 30 \text{ i}$$



MRQ

$$\text{Avg velocity} = \frac{u_i + u_f}{2}$$

$$\begin{aligned} \text{Avg velocity} &= \frac{40\text{i} + 30\text{j} + 40\text{i}}{2} \\ &= \frac{80\text{i} + 30\text{j}}{2} \text{ m/s} \end{aligned}$$

find Avg velocity b/w Point of Projection to max^m Height:-

Sol:

$$(\text{Avg velocity})_{A \rightarrow B} = \frac{(\text{Total disp})_{AB}}{T_{up}}$$

$$= \frac{\sqrt{(R/2)^2 + (H)^2}}{T_{up}}$$

one Page calculation

$$\vec{v} = \vec{u} + \vec{a}t \quad \text{--- (1)}$$

$$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2 \quad \text{--- (2)}$$

$$v^2 - u^2 = 2as \quad \text{--- (3)}$$

$$v_{\text{Avg}} = \frac{\vec{u} + \vec{v}}{2} = \frac{\vec{s}}{t}$$

$$\vec{s} = \left(\frac{\vec{u} + \vec{v}}{2} \right) t \quad \text{--- (4)}$$

Total displⁿ in
time t

$$s_{nth} = u + \frac{a}{2}(2n-1)$$

Δt 1 sec
Interval

\vec{u}, \vec{a} & t given hai
then use this.

\vec{u}, \vec{v} & t given

Question



Object starts his motion with velocity 10 m/sec after 8 sec its velocity becomes 24 m/sec then find total displacement in this interval. ($a = \text{constant}$)

given $\left\{ \begin{array}{l} u = 10 \text{ m/s} \\ v = 24 \text{ m/s} \end{array} \right.$

~~MR*~~ $S = \left(\frac{u+v}{2} \right) T$

$$= \left(\frac{10+24}{2} \right) \times 8$$

$$= 34 \times 4$$

$$= \underline{136 \text{ m}}$$

$u = 10 \text{ m/s}$

$v = 24 \text{ m/s}$ $t = 8 \text{ sec}$

$$v = u + at$$

$$24 = 10 + a \times 8$$

$$24 - 10 = 8a$$

$$14 = 8a$$

$$a = \frac{14}{8} = \frac{7}{4} \text{ m/s}^2$$

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

$$= 10 \times 8 + \frac{1}{2} \times \frac{7}{4} (8)^2$$

$$= 80 + \frac{7}{8} \times 64 = 80 + 56 = \underline{136 \text{ m}}$$

Question



Object starts his motion from rest and acceleration = 5 m/s^2 then find displacement in 4 sec and in 4th sec.

$u=0$

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

$$s = 0 + \frac{1}{2} \times 5 \times (4)^2$$

$$s = \frac{1}{2} \times 5 \times (4)^2$$

$$s_1 = 40 \text{ m}$$

Total \rightarrow 4 sec ka dispⁿ

$$s_2(\text{in 3 sec}) = 0 + \frac{1}{2} \times 5 \times (3)^2 = \frac{45}{2} \text{ m} = 22.5 \text{ m}$$

$$\text{dispⁿ in } n^{\text{th}} \text{ sec} = s_1 - s_2 = 40 - 22.5 = 17.5 \text{ m}$$

$$s_{nth} = s_{n \text{ sec}} - s_{(n-1) \text{ sec}} = u + \frac{a}{2}(2n-1)$$

$$s_{4th} = 0 + \frac{5}{2}(2 \times 4 - 1) = \frac{7 \times 5}{2} = \frac{35}{2} = 17.5 \text{ m}$$

1 sec \rightarrow 0 to 1 sec

2 sec \rightarrow 0 to 2 sec

3 sec \rightarrow 0 to 3 sec

4 sec \rightarrow 0 to 4 sec

all are interval of one sec.

1st sec \rightarrow 0 to 1 sec

2nd sec \rightarrow 1 to 2 sec

3rd sec \rightarrow 2 sec to 3 sec

4th sec \rightarrow 3 sec to 4 sec

5th sec \rightarrow 4 sec to 5 sec

Q) Object starts his motion from rest and constant acceleration.
 $u = 0$ then find dispm b/w $t = 2\text{sec}$ to $t = 5\text{sec}$.

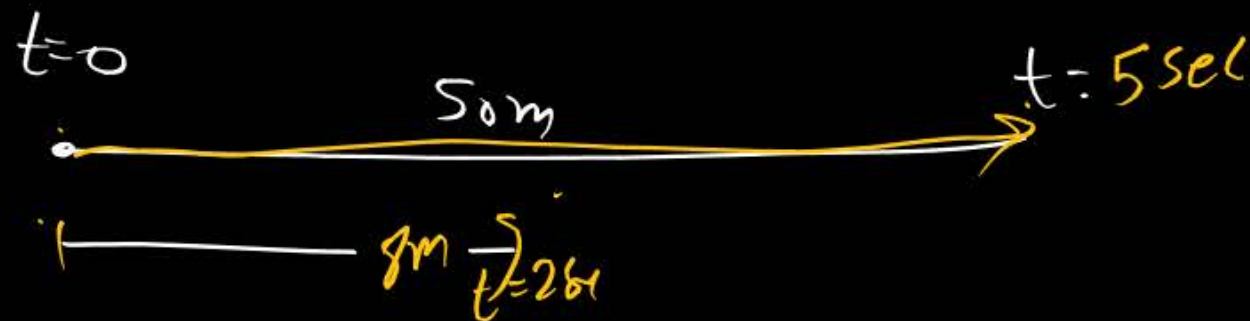
Soln

$u = 0$ $a = 4\text{m/s}^2$

$$S_{\text{in } 5\text{sec}} = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2} \times 4 \times (5)^2 = 2 \times 25 = 50\text{m}$$

$$S_{\text{in } 2\text{sec}} = ut + \frac{1}{2}at^2 = \frac{16}{2} = 8\text{m}$$



$$S_{n^{\text{th}}} = u + \frac{a}{2}(2n-1)$$

valid for 1sec
of time
interval

$$S_{\text{B/w } t=2\text{sec to } t=5\text{sec}} = 50 - 8 = 42\text{m}$$

Ans

Question



Object starts his motion with velocity u and acceleration a then find displacement in t^{th} sec.

Question



Object starts his motion from rest, constant ' a ' then find ratio of displacement in n^{th} -sec and n -sec. [IIT/NEET]

$$t = n^{\text{th}} \text{ sec}$$

$$S_{n^{\text{th}}} = u + \frac{a}{2}(2n-1)$$

$$S_{n^{\text{th}}} = \frac{a}{2}(2n-1) \quad \text{--- (1)}$$

$$t = n \text{ sec}$$

$$S_{n^{\text{th}}} = ut + \frac{1}{2}at^2$$

$$S_{na} = \frac{1}{2}an^2 \quad \text{--- (11)}$$

$$\frac{S_{n^{\text{th}}}}{S_{n\text{-sec}}} = \frac{\frac{a}{2}(2n-1)}{\frac{a}{2}n^2} = \frac{2n-1}{n^2}$$

Question



HW

Object starts his motion from rest and constant acceleration then find ratio of displacement in 6th sec and 6 sec.

- Q Object starts his from rest $u=0$ & constⁿ accⁿ then find Ratio of dispⁿ in 1sec, 2sec, 3sec & 4sec.

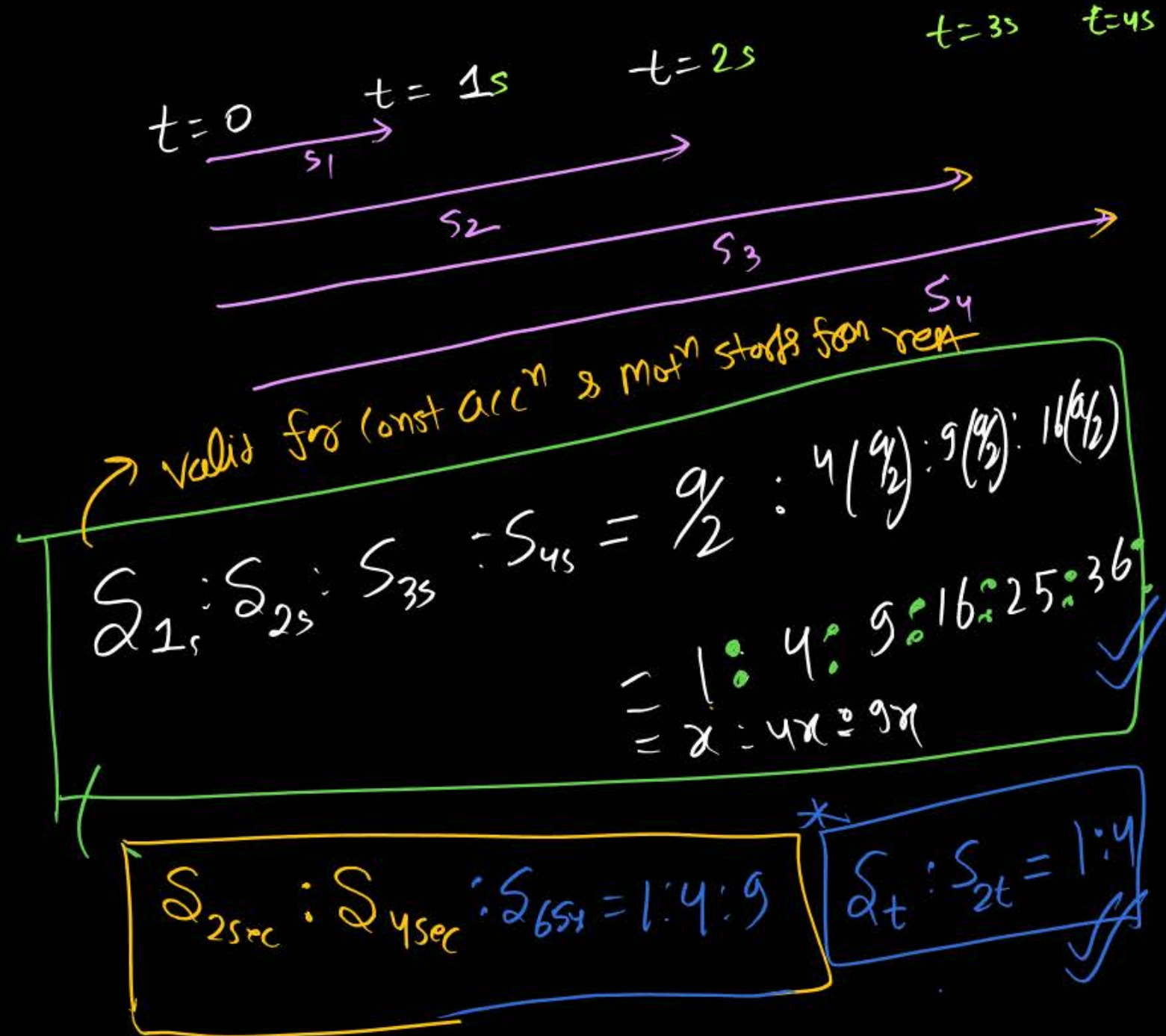
Solⁿ

$$S_{1\text{sec}} = S_1 = \frac{1}{2} a(1)^2 = a/2$$

$$\textcircled{\#} S_{2\text{sec}} = \frac{1}{2} a(2)^2 = 4 \times (a/2)$$

$$S_{3\text{sec}} = \frac{1}{2} a(3)^2 = 9 \times (a/2)$$

$$\textcircled{\#} S_{4\text{sec}} = \frac{1}{2} a(4)^2 = 16(a/2)$$



Question



$$u=0$$

Object starts from rest and constant acceleration, it moves 80 m in 6-sec then find displacement in 12-sec.

$$S_{6\text{sec}} : S_{12\text{sec}} = x : 4x$$

~~MR*~~

$$= 80 : 4 \times 80$$

$$= 80 : \textcircled{320 \text{ m}}$$



मगरी

$$\left[\begin{array}{l} u=0 \\ t=6\text{sec} \\ S=80\text{m} \end{array} \right] \rightarrow S = ut + \frac{1}{2}at^2$$

$$80 = 0 + \frac{1}{2}a(6)^2$$

$$160 = a \cdot 36$$

$$* a = \frac{160}{36} = \frac{40}{9}$$

Total dispⁿ in $t=12\text{sec}$

$$S_{\text{in } 12\text{sec}} = ut + \frac{1}{2}at^2$$

$$= \frac{1}{2} \cdot \frac{40}{9} (12)^2$$

$$= \frac{40}{2 \times 9} \times 12 \times 12$$

$$= \textcircled{320 \text{ m}}$$

Q) Object starts his motion from rest and constant acceleration, moves 90m in 1st sec then find disp^m in 2-sec.

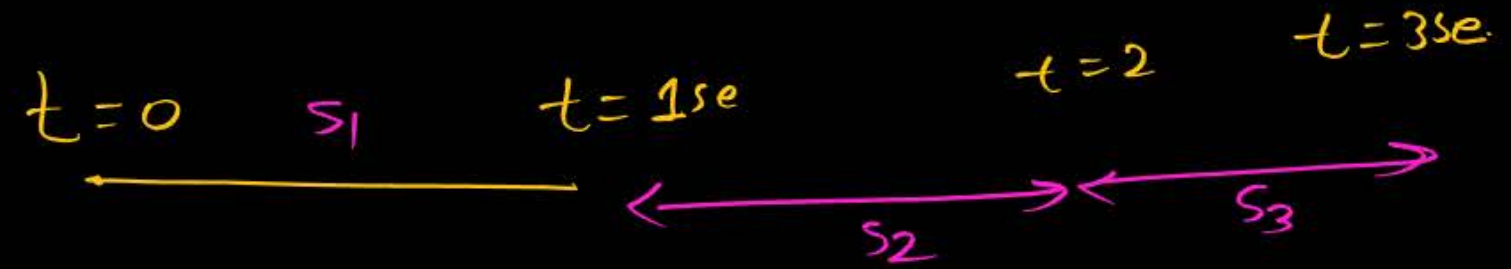
$$S_{1\text{sec}} : S_{2\text{se}} = x : 4x$$

$$= 90 : 4 \times 90$$

$$= 90 : \textcircled{360\text{m}}$$

A

Object starts from rest & constⁿ accⁿ then find
ratio of disp^m in 1st sec, 2nd sec, 3rd sec, 4th sec.



Solⁿ $S_{nth} = u + \frac{a}{2}(2n-1)$

$$S_1 = \frac{a}{2}(1)$$

$$S_{2^{nd}} = \frac{a}{2}(3)$$

$$S_{3^{rd}} = \frac{a}{2}(5)$$

$$S_{4^{th}} = \frac{a}{2}(7)$$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} : S_{4^{th}} = \frac{a}{2} : 3\left(\frac{a}{2}\right) : 5\left(\frac{a}{2}\right) : 7\left(\frac{a}{2}\right)$$

$$= 1 : 3 : 5 : 7$$

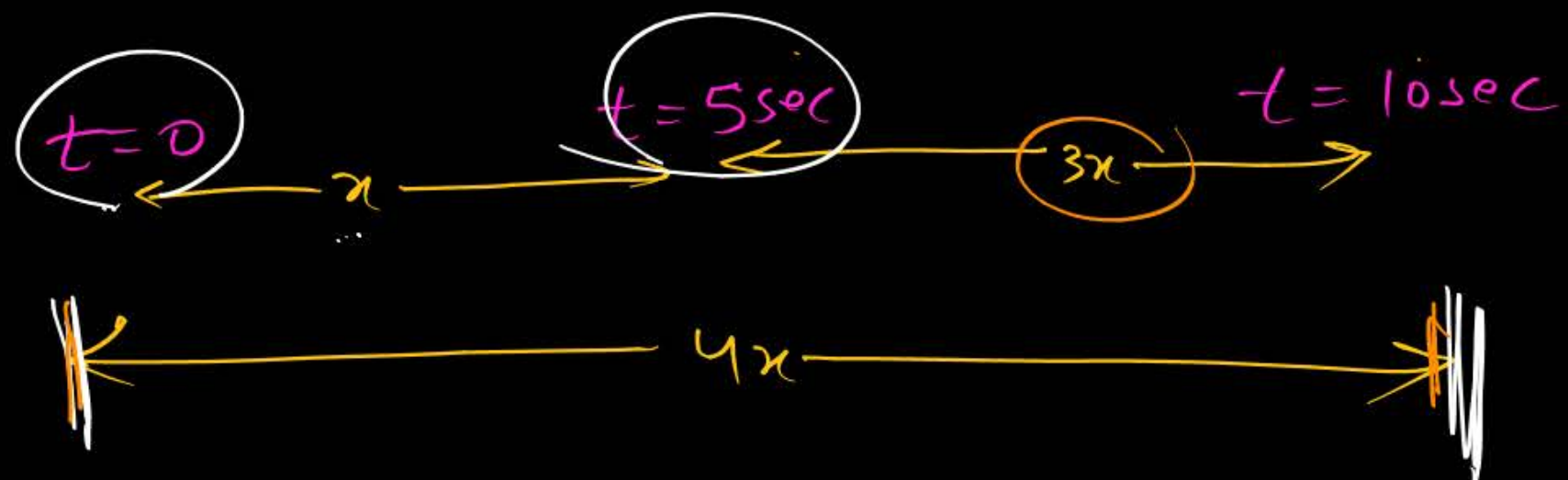
$$= n : 3n : 5n : 7n$$

ratio of odd num

~~MR*~~ $S : S = n : 3n$

5th sec next 5 sec

$t=5$ to $t=10$



Question



Object starts his motion from rest and constant acceleration and moves 100 m in 1st 5-sec then find displacement in next 5-sec.

$$u=0$$

100m

← 100m in 1st 5Sec →

→ $3 \times 100 = 300m$

$$\begin{aligned} \text{disp}^m \text{ in } 0 \text{ to } 10 \text{ sec} &= 4 \times \\ &= 4 \times 100 \\ &= \underline{\underline{400m}} \end{aligned}$$



A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then:

- 1 $S_1 = S_2$
- 2 $S_1 = S_2/3$
- 3 $S_1 = S_2/2$
- 4 $S_1 = S_2/4$

Question



A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10 m. Its acceleration is:

- 1 20 m/sec²
- 2 -20 m/sec²
- 3 -40 m/sec²
- 4 +2 m/sec²

What will be the ratio of the distance moved by a freely falling body from rest in 4th and 5th seconds of journey? **[1989]**

- 1** 4 : 5
- 2** 7 : 9
- 3** 16 : 25
- 4** 1 : 1

Question



A particle start moving from rest and constant acceleration. It travels a distance x in first 2s and y in 4s then correction relation is

1 $y = 3x$

2 $y = 4x$

3 $y = x$

4 $x = 4y$

A body starts from rest travelled a distance 120 m in the 8th sec then acceleration is:

- 1** 10
- 2** 8
- 3** 16
- 4** 4

THANK
YOU

HOME-work

assignment 2, 3

Solve Karman

has