PRAYAS 2.0 (Live)

FOR IIT - JEE 2023

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Motion in 1-D

-02

Shivendu Sir

TABLE OF CONTENT

01 GRAPHICAL VIEW

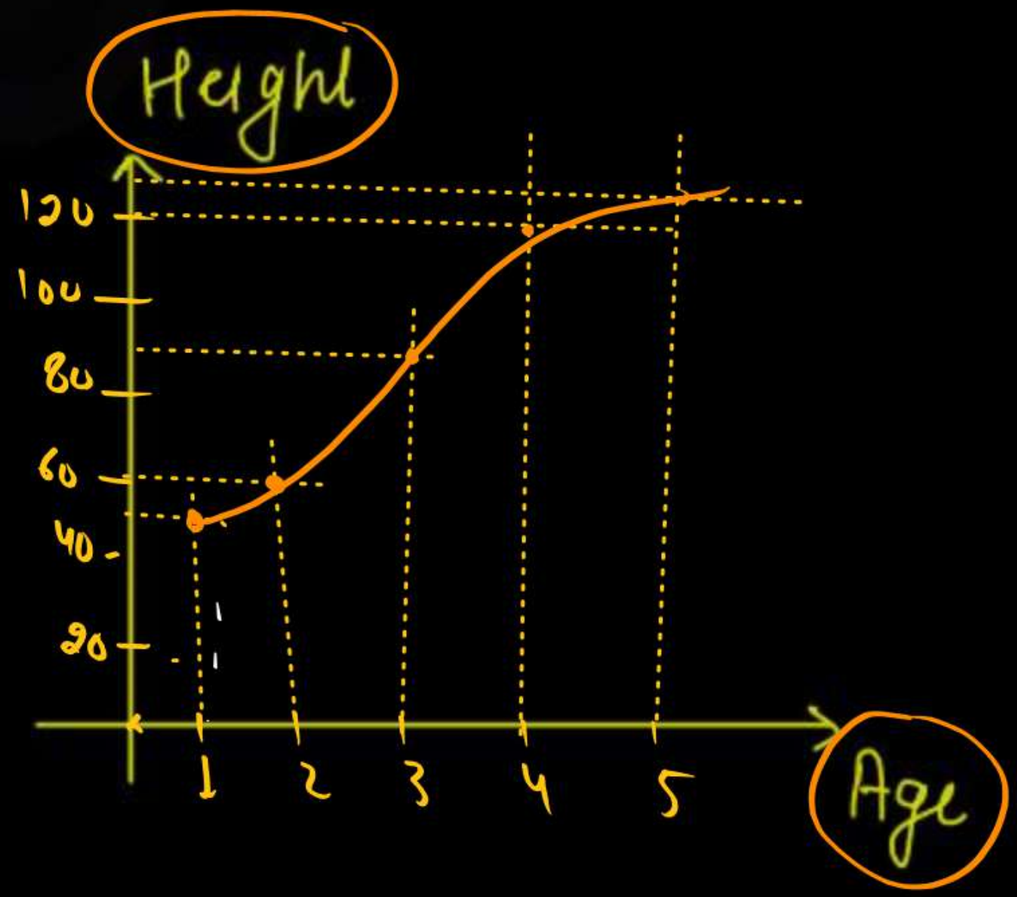
02 Instantaneous Speed and Velocity

03 Acceleration.

04

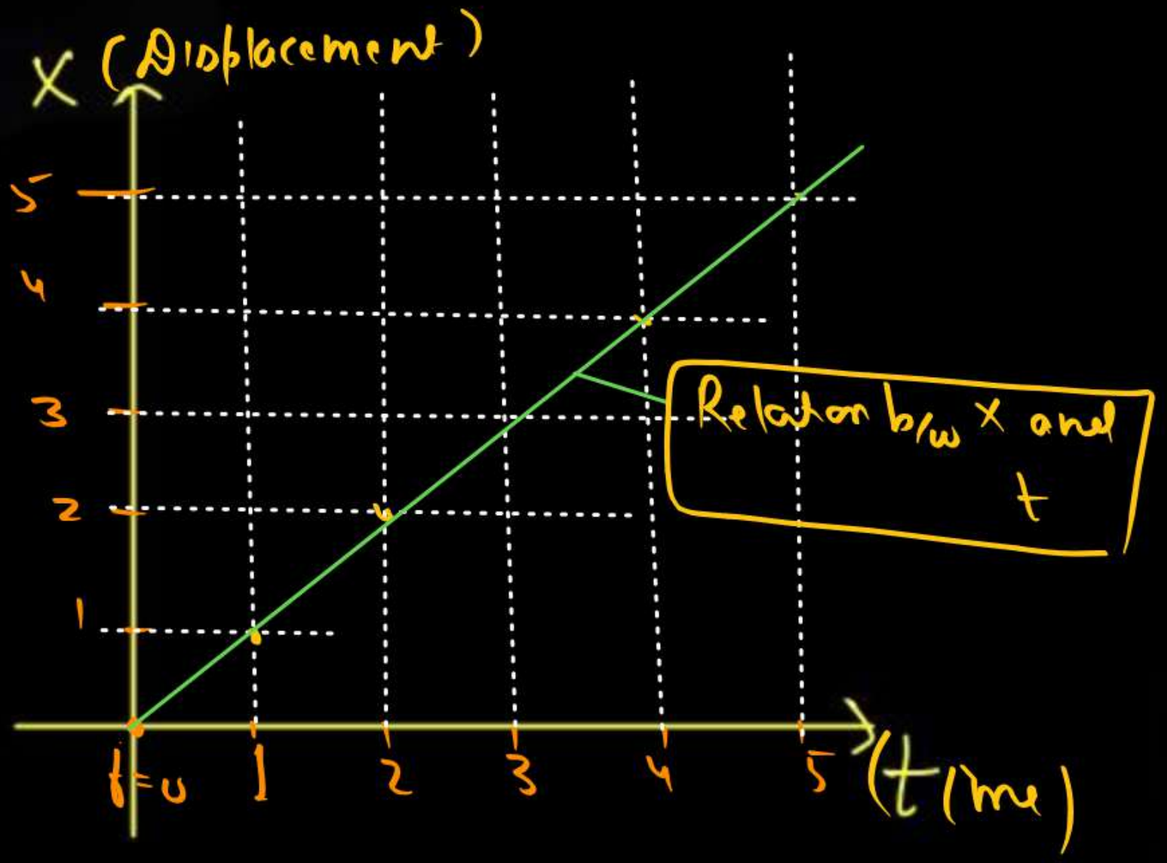
GRAPHS

⇒ GRAPH defines the relation b/w two variable



Age	Height
1 yr	50cm
2 yr	60cm
3 yr	90cm
4 yr	120cm
5 yr	130cm

Linear Graph :-



t	x
t = 0	x = 0
t = 1	x = 1
t = 2	x = 2
t = 3	x = 3
t = 4	x = 4

Kota – Patna

$$(v_{avg\ speed})_{Kota \to Pat} \Rightarrow \frac{1109}{20} \Rightarrow 55\ km/hr$$

$$\langle V \rangle_{Kota \to Kanpur} = \frac{550}{9} \Rightarrow 61\ km/hr$$

$$\langle V \rangle_{Kanpur - Varanasi} = \frac{300}{6} \Rightarrow 50\ km/hr$$

$$\langle V \rangle_{V \to P} = \frac{250}{5} = 50\ km/hr$$

$$\langle_{Kanp - Patna\rangle} = \frac{550}{11} = 50\ km/hr$$

Instantaneous

Palak Jhapalcana

dx in a straight line – T
F

$(\Delta x \to 0) \Rightarrow dx$

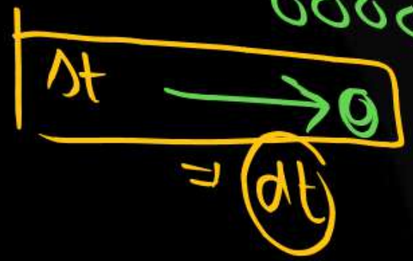
Distance and Displacement

In a instant is very very very small. thus almost a straight line. Thus

Magnitude of [Distance = Displacement] in a Instant

Instant = Bahutchoota samay

= 0.0000000000000000000000001



Inst Velocity and Speed

$$\vec{V} = \frac{d\vec{x}}{dt} = \frac{(\text{chota displacement})}{(\text{chota time})}$$

$\{ |d\vec{x}| = \text{distance imtant} \}$

Imtant

Speed = $|\vec{V}|$ ← (Magnitude of Velocity)

{ If only word "Speed or Velocity is written it means Instantan. velocity }

Differentiation :-

$$x = t^n$$

$$\frac{dx}{dt} = n\,t^{n-1}$$

→ Basic Diff.

Slope

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

Velocity is the slope of x-t curve

$$\frac{dx}{dt} = \frac{d}{dt}(x)$$

Calculation of $\frac{dx}{dt}$:-

$$x = t^n$$

$$\frac{dx}{dt} = nt^{n-1}$$

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

$$\frac{dx}{dt} = \frac{dt^2}{dt} + \frac{dt^3}{dt}$$

$$\Rightarrow 2t^{2-1} + 3t^{3-2}$$

$$v = 2t + 3t^2$$

$$x = ct^n$$

$$\frac{dx}{dt} = \frac{d(ct^n)}{dt}$$

$$= c\frac{dt^n}{dt}$$

$$\frac{dx}{dt} = cnt^{n-1}$$

The position x of a particle varies with time (t) as $x = at^2 - bt^3$. The velocity at time t of the particle will be equal to zero, where t is equal to :

(1) $\frac{2a}{3b}$ (2) $\frac{a}{b}$ (3) $\frac{a}{3b}$ (4) $\frac{a}{2b}$

$x = at^2 - bt^3$

$v = \frac{dx}{dt} \Rightarrow a\frac{dt^2}{dt} - b\frac{dt^3}{dt} \Rightarrow 2at - b3t^2 = 0$

$t(2a - b3t) = 0$

$t = 0$

$t = \frac{2a}{3b}$

A body is moving according to the equation $x = at^2 + bt - c$. Then its instantaneous speed is given by :–

(1) $a + 2b + 3ct$

(2) $a + 2bt - 3ct^2$

(3) $2b - 6ct$

(4) $2at + b$

$x = at^2 + bt - c$

$V = \frac{dx}{dt} = a\frac{dt^2}{dt} + \frac{d(bt)}{dt} - \frac{d}{dt}ct^0 \Rightarrow 2at + b|t^{1-1} - c(0)t^{-1} \to 0$

$= 2at + b$

Acceleration :- Change in velocity w.r.t time

$$a_{avg} \Rightarrow \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v_f} - \vec{v_{in}}}{\Delta t}$$

$$\vec{a}_{inst} \Rightarrow \frac{d\vec{v}}{dt} = \text{Rate of change of velocity w.r.t time}$$

$$v_{inst} = \frac{dx}{dt} = \text{Rate of change of disp. w.r.t time}$$

Gupt gyan

If $\vec{v}$ = constant

$\vec{v_f} = \vec{v_{in}}$

$\vec{a} = 0$

↳ Uniform motion

$\vec{v}$ — Direction, Magnitude

↳ If constant — Dir and Mag. Both must be Constant

Q1 If Particle is moving with constant Velocity $\neq 0$

(A) Path may be str line or curve

(B) Path must be st line

(C) Path must be curve

(D) Any path is possible

Q2 Particle is thrown upward under gravity -

→ Motion is (A) Uniform

(B) Non Uniform

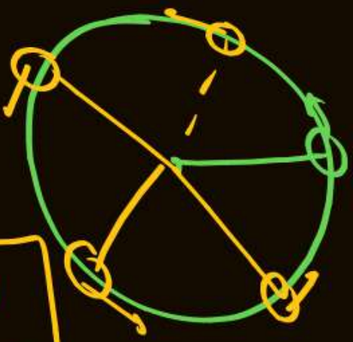
Q3 Chintu is moving with constant speed 10m/s along a circular path of Radius 100m - Motion is

(A) Velocity constant $a = 0$

(B) Velocity Variable $a \neq 0$

(C) $\vec{V}$ = const $a \neq 0$

(D) $\vec{V}$ = Variable $a = 0$



$\vec{a} =$ (A) $\frac{d\vec{v}}{dt}$ ✓

(B) $\frac{d|\vec{v}|}{dt} \Rightarrow$ Rate of change of $|\vec{v}|$ (Speed) w.r.t time

(C) $\left|\frac{d\vec{v}}{dt}\right| \Rightarrow |\vec{a}|$ = Mag. of chang in $\vec{v}$ w.r.t time

= Mag. of acceleration

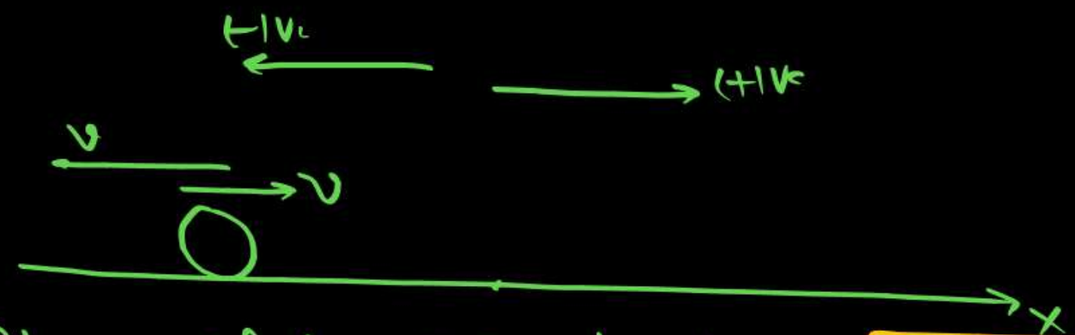
If $\vec{a} = 0$ → $\vec{V}$ = constant → 10 m/s, 0 m/s, 20 m/s

(A) $\vec{V} = 0$ must be

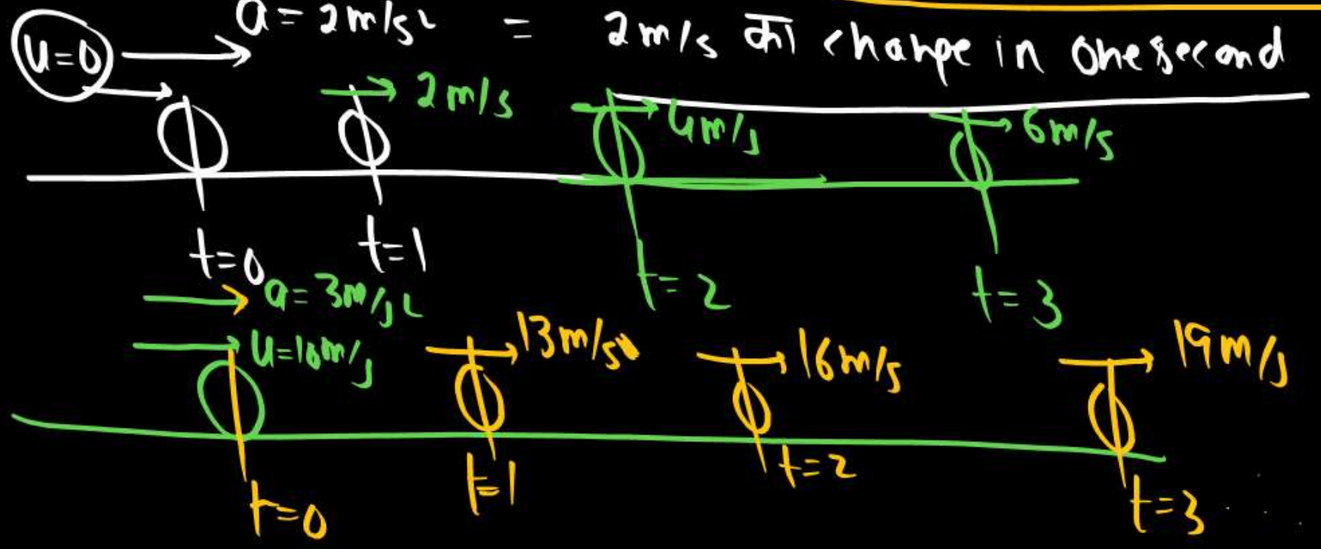
(B) $\vec{V} = 0$ maybe

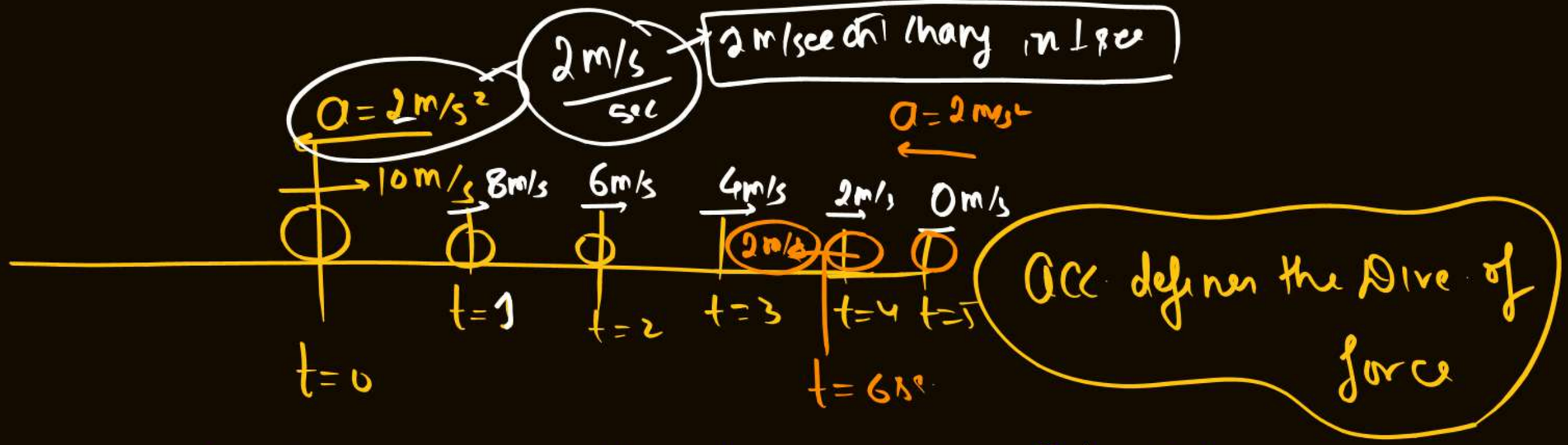
Retardation

Motion in 1-D — 1-Direction motion {motion along a straight line}



Physical feeling of acceleration : $a = \frac{dv}{dt} = \frac{m/s}{s} = m/sec^2$ $\quad LT^{-2}$

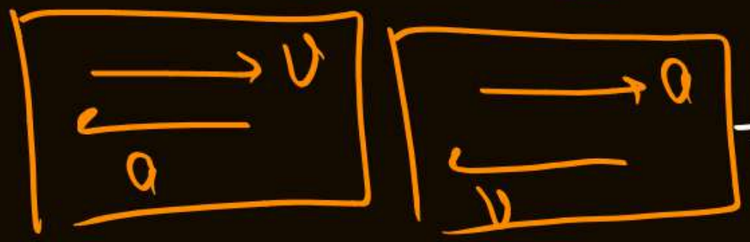




When acc and velocity is in opp dir Motion is Retardation

Motion in retarding from 0 → 5 sec

After 5 sec = Motion in accelerate



⇒ Both are Retardation

Question :-

Equation of displacement for a particle is $s = 3t^3 + 7t^2 + 14t + 8$ m. Its acceleration at time $t = 2$ sec is :-

(1) 10 m/s^2 (2) 16 m/s^2

(3) 25 m/s^2 (4) 50 m/s^2

$a_{t=2} = 36 + 14 = 50 m/s^2$

$S = 3t^3 + 7t^2 + 14t + 8$

$v = \frac{dx}{dt} = 3\frac{dt^3}{dt} + 7\frac{dt^2}{dt} + 14\frac{dt}{dt} + \frac{d8}{dt}$ (0)

$= 3.3t^2 + 7.2t + 14$

$v = 9t^2 + 14t + 14$

$a = \frac{dv}{dt} = 9\frac{dt^2}{dt} + \frac{d14t}{dt} + 0$

$a = 18t + 14$

0

a = Constant (A)

Variable (B)

$a = 18t + 14$

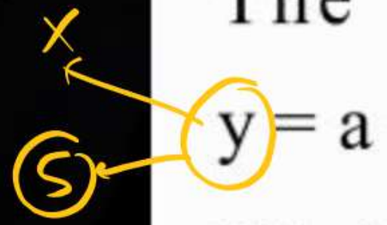
The displacement of a particle is given by $y = a + bt + ct^3$. The initial velocity and acceleration are respectively :

(1) b, 0

(2) –b, 2c

(3) b, 2c

(4) 2c, – 4d



initial velocity → $t = 0$

$y = a + bt + ct^3$

$v = \frac{dy}{dt} = 0 + b + c\,3t^2$ $\quad t=0 \Rightarrow v = b$

$a = \frac{dv}{dt} = 0 + 3c(2t) = 6t$ $\quad t=0 \Rightarrow a = 0$

$\frac{d}{dt}t^3 = 3t^2$

$\frac{dt^2}{dt} = 2t$

$\frac{d(t)}{dt} = 1$

$\frac{d(c)}{dt} = 0$

The relation $t = \sqrt{x} + 3$ describes the position of a particle where x is in meters and t is in seconds. The acceleration of particle is :–

(1) 2 m/s^2 ✓

(2) 4 m/s^2

(3) 5 m/s^2

(4) zero

$t = \sqrt{x} + 3$

$\sqrt{x} = t - 3$

$x = (t-3)^2$

$x = t^2 + 9 - 6t$

$v = \frac{dx}{dt} = 2t + 0 - 6$

$a = \frac{dv}{dt} = 2(1) - 0$

If a = 0

Uniform Motion {Motion in along a straight line}

Find Displacement in t = 10 sec

$$d = v \cdot t$$

$$\Rightarrow 10 \times 10$$

$$d = 100\,m$$

a = Constant :- Equation of Motion :-

$$\vec{v} = \vec{u} + \vec{a}t \quad \text{—(I)}$$

$$\vec{s} = \vec{u}t + \tfrac{1}{2}\vec{a}t^2 \quad \text{—(II)}$$

$$= vt - \tfrac{1}{2}at^2$$

$$= \left(\frac{\vec{v}+\vec{u}}{2}\right) \cdot t$$

$$v^2 = u^2 + 2as$$

$$u = v - at$$

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

$$= (v-at)t + \tfrac{1}{2}at^2$$

$$= vt - at^2 + \tfrac{1}{2}at^2$$

$$s = vt - \tfrac{1}{2}at^2$$

"When final velocity is given"

$$at = v - u$$

$$s = ut + \frac{1}{2}(v-u)t$$

$$s = ut + \frac{1}{2}(v-u)t$$

$$s = \left(\frac{u+v}{2}\right)t$$

If a car at rest accelerates uniformly to a speed of 144 km/h in 40 seconds, it covers a distance of :

(1) 200 m

(2) 400 m

(3) 1440 m

(4) 2980 m

$V = 144\ km/hr$ $\quad t = 40\ sec$ $\quad u = 0$

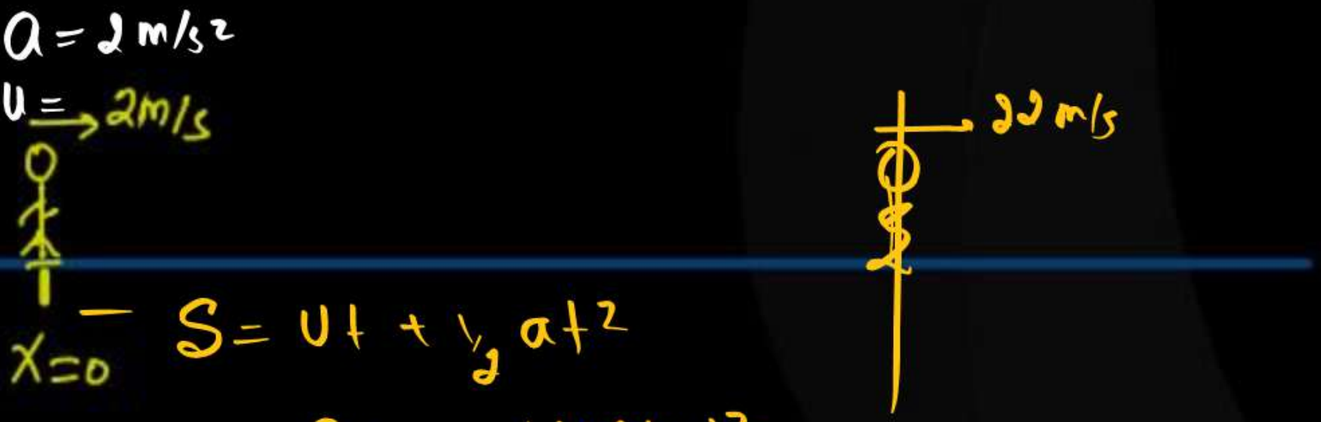
$V = 144\ km/h = 144 \times \frac{5}{18} = 40\ m/sec$

$t = 40\ sec$

$S = \left(\frac{V+u}{2}\right)t = \left(\frac{40+0}{2}\right)40$

$\Rightarrow$ 800 m Ans.

FEEL THE MOTION



Find the position of particle at $t = 10$ sec and velocity as well.

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

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

$$= 120 \text{ m}$$

$$V = u + at$$

$$V = 2 + 2(10)$$

$$\boxed{V = 22 \text{ m/s}}$$

$u = (+)\,20\ m/s$

$a = -4\ m/s^2$

(रुकने के लिए चली गयी दूरी)

Q.2 Find Stopping distance and time :-

$v_f = 0$ $\quad u = 20\ m/s$ $\quad a = -4\ m/s^2$

$v^2 = u^2 + 2as$

$0 = (20)^2 + 2(-4)\cdot s$

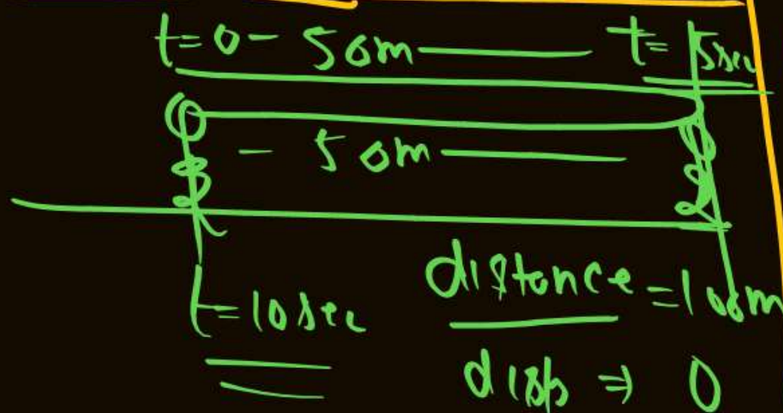
$s = \frac{(20)^2}{2\times 4} \Rightarrow 50\ m$

$v = u + at$

$0 = 20 - 4t$

$t = 5\ sec$

Q.3 Find avg-speed and avg velocity in 10 sec



distance = 100m

disp ⇒ 0

$\langle Speed \rangle = \frac{100}{10} = 10\ m/s$

$\langle Velocity \rangle = \frac{0}{10}$

Find time after which $d = 0$

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

$0 = 20t + \frac{1}{2}(-4)t^2$

$0 = t(20 - 2t)$

$t = 0$

$t = 10\ sec$

H.W

Which of the following relations representing velocity of a particle describes motion with constant acceleration ?

(1) $v = 6 - 7t$

(2) $v = 3t^2 + 5t^3 + 7$

(3) $v = 9t^2 + 8$

(4) $v = 4t^{-2} + 3t^{-1}$

If a train travelling at 72 km/h is to be brought to rest in a distance of 100 m, then its retardation should be :

(1) 20 m/s^2 (2) 2 m/s^2 (3) 10 m/s^2 (4) 1 m/s^2

H.W

The velocity acquired by a body moving with uniform acceleration is 30 m/s in 2 seconds and 50 m/s in 4 seconds. The initial velocity is :

(1) zero (2) 2 m/s (3) 4 m/s (4) 10 m/s

H.W.

A car moving with a speed of 40 km/h can be stopped by applying brakes after at least 2m. If the same car is moving with a speed of 120 km/h., what is the minimum stopping distance ?

(1) 2 m (2) 4 m (3) 6 m (4) 18 m

H.W.

HCV-Hom.Work: (1-5), 11, 12, 13, 14, 15, 16, 17.

A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 ms^{-1} to 20 ms^{-1} while passing through a distance 135 m in t second. The value of t is

(1) 12 (2) 9

(3) 10 (4) 14

H.W.

मुखड़े पर धूल लगी माना , माथा फूटा माना लेकिन ,
गालों पर थप्पड़ खाये है , जबड़ा टूटा माना लेकिन ,
माना के आंते अकड़ गई , पसलियों से लहू निकलता है ,
गिस गया है कंकर में घुटना , मिर्च सलिखे जलता है ,
माना के साँसे उखड़ रही, और धक्का लगता धड़कन से ,
लो मान लिया की काँप गया है , पूर्ण बदन अंतर्मन से ,
पर आँखों से अंगारे , नथनों से तूफ़ा लाऊंगा ,
में गिर गिर कर भी धरती पर , हर रोज़ खड़ा हो जाऊंगा ,
मुठ्ठी में बींच लिया तारा , तुम नगर में ढोल पिटादो जी ,
अँधेरे हो लाख़ घने पर अँधेरे अनन्त नहीं ,


Thank
You