

Task

①

Given that particle is starting from rest $u=0$.

Acceleration $a = \text{constant}$.

Let s be the total distance, n be the total time

Distance travelled by the body in n^{th} sec is

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

Given $s_n = \frac{9}{25} s$

$$\therefore \frac{9}{25} s = 0 + \frac{a}{2} (2n-1)$$

$$\Rightarrow \frac{9}{25} s = \frac{a}{2} (2n-1) \rightarrow \textcircled{1}$$

where $s = un + \frac{1}{2} an^2 \Rightarrow s = \frac{1}{2} an^2 \rightarrow \textcircled{2}$

$\therefore$ From $\textcircled{1}$ and $\textcircled{2}$ $\frac{9}{25} \left[\frac{1}{2} an^2 \right] = \frac{a}{2} (2n-1)$

$$\Rightarrow 9n^2 = 25(2n-1)$$

$$\Rightarrow 9n^2 = 50n - 25$$

$$\Rightarrow 9n^2 - 50n + 25 = 0$$

$$\Rightarrow 9n^2 - 45n - 5n + 25 = 0$$

$$\Rightarrow 9n(n-5) - 5(n-5) = 0$$

$$\Rightarrow (n-5)(9n-5) = 0$$

$$\Rightarrow n-5=0 \text{ or } 9n-5=0$$

$$\Rightarrow n=5 \text{ sec or } n=\frac{5}{9} \text{ sec.}$$

$\therefore$ From $\textcircled{2}$ $s = \frac{1}{2} (12) (5)^2$

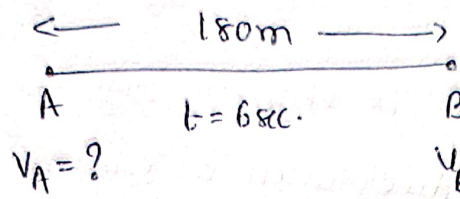
$$s = 6 \times 25 \\ = 150 \text{ cm}$$

Given body describes 6 cm in 1st sec : From $\textcircled{2}$

$$\Rightarrow 6 = \frac{1}{2} a (1)^2 \\ \Rightarrow a = 12 \text{ cm/sec}^2$$

②

let the two points be A & B



Acceleration $a = \text{constant}$

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

$$\Rightarrow 180 = V_A \times 6 + \frac{1}{2}a \times 6^2$$

$$\Rightarrow 30 = V_A + \frac{1}{2} \times 6a$$

$$\Rightarrow 30 = V_A + 3a \rightarrow \text{①}$$

From $v = u + at$

$$\Rightarrow V_B = V_A + at$$

$$\Rightarrow 45 = V_A + 6a \rightarrow \text{②}$$

By solving ① and ② we get

$$\Rightarrow V_A + 3a = 30$$

$$V_A + 6a = 45$$

$$-3a = -15$$

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

From ① sub 'a' value

we get

$$30 = V_A + 3(5)$$

$$\Rightarrow 30 = V_A + 15$$

$$\Rightarrow V_A = 15 \text{ m/s}$$

③

car is coming to rest i.e. the car is in retardation

$v = 0$ From $v^2 - u^2 = 2as$

$$\Rightarrow 0^2 - u^2 = 2(-a)s$$

$$\Rightarrow u^2 = 2as \Rightarrow s \propto u^2$$

For $u_1 = 50 \text{ kmph} \rightarrow s_1 = 6 \text{ m}$. Here $a = \text{constant}$

If $u_2 = 100 \text{ kmph} \rightarrow s_2 = ?$

$$\therefore \frac{s_2}{s_1} = \left[\frac{u_2}{u_1} \right]^2$$

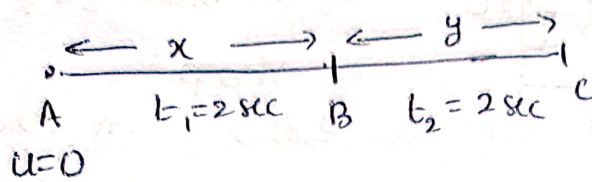
$$\Rightarrow \frac{s_2}{6} = \left[\frac{100}{50} \right]^2 \Rightarrow \frac{s_2}{6} = 2^2$$

$$\Rightarrow s_2 = 4 \times 6 = 24 \text{ m}$$

(2)

(4)

The Particle is starting from rest $u=0$ & $a=\text{constant}$



From

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

For $t_1 = 2 \text{ sec}$; $s = x$. | $t = 4 \text{ sec}$ starting from A $\rightarrow$ C

$$s = x + y$$

$$x = 0 \times 2 + \frac{1}{2} (a) (2)^2$$

$$x = 2a$$

$$\Rightarrow x + y = 0 \times 4 + \frac{1}{2} (a) (4)^2$$

$$\Rightarrow 2a + y = 0 + \frac{1}{2} a \times 16$$

$$\Rightarrow 2a + y = 8a$$

$$\Rightarrow y = 8a - 2a$$

$$\Rightarrow y = 6a$$

$$\Rightarrow y = 3(2a)$$

$$\Rightarrow y = 3x$$

(5)

Given deceleration = Negative acceleration = 5 m/s^2

Reaction time = 0.7 sec

Initial velocity $u = 8.33 \text{ m/s}$

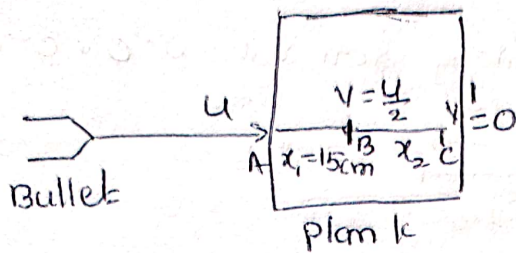
$$\therefore \text{From } s = ut + \frac{1}{2} at^2$$

$$= (8.33)(0.7) + \frac{1}{2} (-5)(0.7)^2$$

$$= 5.831 - 1.225$$

$$= 4.606 \text{ m}$$

⑥



x_2 be the distance travelled by the bullet before coming to stop.

Bullet is in retardation

(i.e) $a = -ve$.

By using $v^2 - u^2 = 2as$

For AB $v = \frac{u}{2}$; $s = 15 \text{ cm}$

For BC $v = v' = 0$; $u = \frac{u}{2}$; $s = x_2$

$$\Rightarrow \left(\frac{u}{2}\right)^2 - u^2 = 2(-a)(15)$$

$$\Rightarrow \left[0 - \left(\frac{u}{2}\right)^2\right] = 2(-a)x_2$$

$$\Rightarrow \frac{u^2}{4} - u^2 = -2a \times 15$$

$$\Rightarrow + \frac{u^2}{4} = +2a x_2$$

$$\Rightarrow + \frac{3u^2}{4} = +2a \times 15$$

$$\Rightarrow \frac{u^2}{4 \times 2a} = x_2 \rightarrow (2)$$

$$\Rightarrow \frac{u^2}{4 \times 2a} = 5 \rightarrow (1)$$

From (1) & (2) we have

$$x_2 = 5 \text{ cm}$$

⑦

Given equation $v = \sqrt{180 - 7x}$

By squaring on both sides we get

$$\Rightarrow v^2 = (\sqrt{180 - 7x})^2$$

$$\Rightarrow v^2 = 180 - 7x$$

$$\Rightarrow v^2 = (\sqrt{180})^2 - 7x$$

$$\Rightarrow v^2 - (\sqrt{180})^2 = -7x \text{ This is in}$$

the form of $v^2 - u^2 = 2as$

$\therefore$ By comparing $2a = -7$

$$\Rightarrow a = -\frac{7}{2}$$

$$\Rightarrow a = -3.5 \text{ m/s}^2$$

(3)

(8)

Given velocity $v = 60 \text{ m/s}$ Time $t = 2 \text{ sec}$

$$\begin{aligned}\therefore \text{Distance travelled} &= v \times t \\ &= 60 \times 2 \\ &= 120 \text{ m}\end{aligned}$$

(9)

Given displacement $s = t^3 - 6t^2 + 3t + 4$.

$$\text{use } \frac{d}{dt} t^n = n t^{n-1} \text{ and } \frac{d}{dt} (\text{constant}) = 0$$

$$\begin{aligned}\therefore \text{velocity} &= \frac{ds}{dt} = \frac{d}{dt} [t^3 - 6t^2 + 3t + 4] \\ &= \frac{d}{dt} t^3 - 6 \frac{d}{dt} t^2 + 3 \frac{d}{dt} t + \frac{d}{dt} (4) \\ &= 3t^{3-1} - 6(2t^{2-1}) + 3 + 0\end{aligned}$$

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

$$\text{and Acceleration } a = \frac{dv}{dt} = \frac{d}{dt} (3t^2 - 12t + 3)$$

$$\begin{aligned}&= 3 \frac{d}{dt} t^2 - 12 \frac{d}{dt} t + \frac{d}{dt} (3) \\ &= 3(2t^{2-1}) - 12 + 0\end{aligned}$$

$$a = 6t - 12$$

Given acceleration $= 0$

$$\Rightarrow 6t - 12 = 0 \Rightarrow 6t = 12$$

$$\Rightarrow t = 2 \text{ sec}$$

$$\therefore \text{velocity } v = 3(2)^2 - 12(2) + 3$$

$$= 3 \times 4 - 24 + 3$$

$$= 12 - 24 + 3$$

$$= -9 \text{ m/s}$$



10

Given that bus starts from rest $u_B = 0$
and acceleration $a_B = 5 \text{ m/s}^2$

Velocity of car $u_C = 50 \text{ m/s} = \text{constant}$ so

Acceleration of car $a_C = 0$

Here both car and Bus started at a time. After t sec they are side by side means that distance travelled by them is also same.

$\therefore$ Distance travelled by bus = Distance travelled by car

$$\Rightarrow u_B t + \frac{1}{2} a_B t^2 = u_C t + \frac{1}{2} a_C t^2$$

$$\Rightarrow 0 \times t + \frac{1}{2} \times 5 t^2 = 50 t + \frac{1}{2} (0) t^2$$

$$\Rightarrow \frac{5}{2} t^2 = 50 t$$

$$\Rightarrow \frac{t}{2} = 10$$

$$\Rightarrow t = 20 \text{ sec.}$$

$\therefore$ The speed of the bus when they are side by side is determined by using $v = u + at$

$$\Rightarrow v_B = u_B + a_B t$$

$$\Rightarrow v_B = 0 + (5)(20)$$

$$\Rightarrow v_B = 100 \text{ m/s.}$$

(13)

Given

$$x = u(t-2) + a(t-2)^2$$

Velocity $v = \frac{dx}{dt} = \frac{d}{dt} [u(t-2) + a(t-2)^2]$

$$= u \left[\frac{d}{dt}(t-2) - \frac{d}{dt}(2) \right] + a \frac{d}{dt} (t-2)^2$$

$$= u \{1-0\} + a \{2(t-2)^{2-1}\}$$

$$v = u + 2a(t-2)$$

Acceleration $a = \frac{dv}{dt} = \frac{d}{dt} [u + 2a(t-2)]$

$$= \frac{d}{dt} u + 2a \frac{d}{dt} (t-2)$$

$$= 0 + 2a \left[\frac{dt}{dt} - \frac{d}{dt}(2) \right]$$

$$= 2a \{1-0\}$$

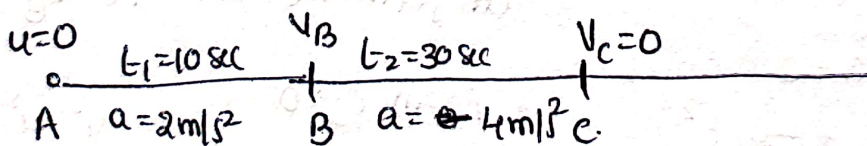
$$a = 2a$$

At $t=2 \Rightarrow x = u(t-2) + a(t-2)^2$

$$= u(2-2) + a(2-2)^2$$

$$\Rightarrow x=0 \text{ at origin.}$$

(15)



Let A be the initial point where it started from rest

After 10 sec distance travelled $AB = ut + \frac{1}{2}at^2$
 $= 0 \times 10 + \frac{1}{2} \times 2 \times (10)^2$

$$AB = 100m$$

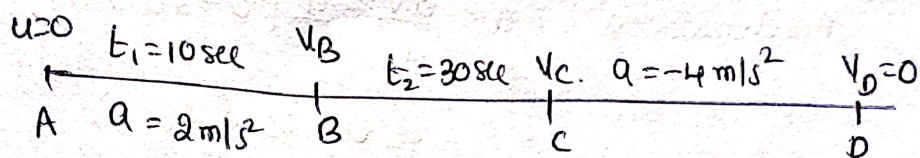
velocity at B $v_B = u + at = 0 + 2 \times 10 = 20 m/s$

Dist

15th continuation

$$\begin{aligned}\text{Distance } BC &= u_B t + \frac{1}{2} a t^2 \\ &= 20 \times 30 + \frac{1}{2} (-\frac{2}{3}) (30)^2 \\ &= 600 - 2 \times 900 \\ &= 600 - 1800 \\ &= -1200 \text{ m}\end{aligned}$$

(15)



Let A be the starting point; use $s = ut + \frac{1}{2} at^2$ to calculate distance travelled by the body.

For AB

$$s_{AB} = 0 \times 10 + \frac{1}{2} \times 2 \times 10^2$$

$$\Rightarrow s_{AB} = 0 + 100$$

$$\Rightarrow s_{AB} = 100 \text{ m}$$

Velocity at B is determined by using $v = u + at$

$$v_B = 0 + 2 \times 10 \Rightarrow v_B = 20 \text{ m/s}$$

$\therefore$ From B to C the body is in uniform motion i.e. $v_B = v_C = 20 \text{ m/s}$

For BC : $a = 0$

$$\begin{aligned}s_{BC} &= u_B t + \frac{1}{2} a t^2 \\ &= 20 \times 30 + \frac{1}{2} (0) (30)^2\end{aligned}$$

$$s_{BC} = 600 \text{ m}$$

From C to D use $v^2 - u^2 = 2as$

$$\Rightarrow v_D^2 - v_C^2 = 2a s_{CD}$$

$$\Rightarrow 0^2 - (20)^2 = 2(-4) s_{CD}$$

$$\Rightarrow -400 = -8 s_{CD}$$

$$\Rightarrow s_{CD} = 50 \text{ m}$$

$\therefore$ For entire journey total distance travelled

$$S = s_{AB} + s_{BC} + s_{CD} = 100 + 600 + 50 = 750 \text{ m}$$

(16)

(b)

Given that $v_x = \frac{1}{3} \text{ m/s} \Rightarrow \frac{dx}{dt} = \frac{1}{3} \rightarrow (1)$

and $y = 9x^2$

on differentiating w.r.t time

we get $\frac{dy}{dt} = 9 \frac{d}{dt} (x^2) \quad \left[\because \frac{d}{dt} x^n = nx^{n-1} \frac{dx}{dt} \right]$

$$\Rightarrow v_y = 9 [2x^{2-1}] \frac{dx}{dt}$$

$$\Rightarrow v_y = 18x \times v_x \rightarrow (2)$$

From (1) $\frac{dx}{dt} = \frac{1}{3} \Rightarrow dx = \frac{1}{3} dt$

on integrating both sides

$$\Rightarrow \int dx = \frac{1}{3} \int dt$$

$$\Rightarrow x = \frac{1}{3} t$$

Sub x, v value in (2) we get

$$v_y = 18 \times \frac{1}{3} t \times \frac{1}{3}$$

$$v_y = 2t$$

$\therefore$ acceleration $a = \frac{dv_y}{dt} = \frac{d}{dt} (2t)$

$$a = 2 \frac{dt}{dt} = 2 \text{ m/s}^2$$

They are asking y-component i.e. along y-axis

$\therefore a_y = 2 \hat{j} \text{ m/s}^2$ where $\hat{j}$ is unit vector

along y axis

(17), (18), (19)

Train starts from rest $u=0$, $a=2 \text{ m/s}^2$

For $t=30 \text{ sec}$, let s_1 be the

distance travelled

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

$$\Rightarrow s_1 = 0 \times (30) + \frac{1}{2}(2)(30)^2$$

$$\Rightarrow s_1 = 900 \text{ m} \rightarrow (1)$$

After $\frac{1}{2} \text{ min}$ velocity of train $v = u + at$

$$\Rightarrow v = 0 + (2)(30)$$

$$\Rightarrow v = 60 \text{ m/s} \text{ This is the}$$

maximum velocity attained by the train in its entire journey. with this velocity it travels for ~~one~~ one min and finally comes to rest [Total time = 1 min = 60 sec]

$$\text{distance } s_2 = v \times t$$

$$= 60 \times 30 \text{ sec}$$

$$= 1800 \text{ m}$$

$$\therefore \text{Total distance} = s_1 + s_2 = 900 + 1800 = 2700 = 2.7 \text{ km}$$

$$\text{For } v_1 = 60 \text{ m/s} \rightarrow s_1 = 900 \text{ m}$$

$$\text{If } v_2 = \frac{v_1}{2} = 30 \text{ m/s} \rightarrow s_2 = ?$$

$$\text{From } v^2 \propto s \Rightarrow \left[\frac{v_2}{v_1} \right]^2 = \left[\frac{s_2}{s_1} \right]$$

$$\Rightarrow s_2 = \frac{900}{4}$$

$$\Rightarrow \left[\frac{30}{60} \right]^2 = \frac{s_2}{900}$$

$$\Rightarrow s_2 = 225 \text{ m.}$$

$$= \left(\frac{1}{2} \right)^2 = \frac{s_2}{900}$$

(6)

Task

JEE mains level

(1)

length of each train $l = 50 \text{ m}$

$$v_A = 10 \text{ m/s} \quad v_B = 15 \text{ m/s}$$

when they pass each other each train travels a distance $d = l_A + l_B = 50 \text{ m} + 50 \text{ m} = 100 \text{ m}$.

velocity of one train with respect to other

$$\begin{aligned} \text{train } v &= v_A + v_B \\ &= 10 + 15 \\ &= 25 \text{ m/s} \end{aligned}$$

$$\therefore \text{time of crossing} = \frac{\text{Distance}}{\text{velocity}}$$

$$= \frac{100}{25}$$

$$= 4 \text{ sec.}$$

(2)

initial speed $u = 401 \text{ m/s}$; Final speed $v = 609 \text{ m/s}$

time $t = 5 \text{ sec.}$

$$\text{From } v = u + at$$

$$\Rightarrow 609 = 401 + a(5)$$

$$\Rightarrow 609 - 401 = 5a$$

$$\Rightarrow 5a = 208 \Rightarrow a = \frac{208}{5} = 0.56 \text{ m/s}^2$$

③

initial velocity of the body $u = v$.

After t sec the body back to its original position with same speed.

(e) Final velocity $= -v$ [Direction is reversed]

∴ From the definition of acceleration

$$a = \frac{\text{change in velocity}}{\text{time}}$$

$$\Rightarrow a = \frac{v - u}{t}$$

$$\Rightarrow a = \frac{-v - v}{t}$$

$$\Rightarrow a = \frac{-2v}{t}$$

④

let t be the correct time to reach college from house

we know that $\frac{\text{distance}}{\text{velocity}} = \text{time} \rightarrow (1)$

Apply (1) for first case. let s be the distance.

$$\frac{s}{v_1} = t + \frac{3}{60} \Rightarrow \frac{s}{2} = t + \frac{1}{20} \rightarrow (2)$$

$$\text{For second case } \frac{s}{v_2} = t - \frac{3}{60} \Rightarrow \frac{s}{3} = t - \frac{1}{20} \rightarrow (3)$$

$$\text{From (2) \& (3) } \frac{s}{2} - \frac{s}{3} = t + \frac{1}{20} - (t - \frac{1}{20})$$

$$\Rightarrow s \left[\frac{3-2}{6} \right] = t + \frac{1}{20} - t + \frac{1}{20}$$

$$\Rightarrow \frac{s}{6} = \frac{2}{20} \Rightarrow s = \frac{12}{20} = 0.6 \text{ km}$$

⑤

velocity of police car $v_1 = 30 \text{ kmph} = 30 \times \frac{5}{18} \text{ m/s} = \frac{25}{3} \text{ m/s}$

velocity of Thief's car $v_2 = 190 \text{ kmph} = 190 \times \frac{5}{18} \text{ m/s} = \frac{160}{3} \text{ m/s}$

muzzle speed of the bullet $v_B = 150 \text{ m/s}$

velocity of bullet with respect to ground

$$v_{BG} = \frac{25}{3} + v_B = \frac{25}{3} + 150$$

$$= \frac{475}{3} \text{ m/s}$$

velocity of bullet with respect to Thief's car is

$$v_{BT} = v_{BG} - v_{TG}$$

$$= \frac{475}{3} - \frac{160}{3}$$

$$= \frac{315}{3} = 105 \text{ m/s}$$

⑥

length of train 'A' is $L_A = 100 \text{ m}$

length of train 'B' is $L_B = 60 \text{ m}$

Given $v_B = 3v_A$

Time taken to cross each other is $t = 4 \text{ sec}$

$$\therefore \text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{L_A + L_B}{v_A + v_B}$$

$$\Rightarrow 4 = \frac{100 + 60}{v_A + 3v_A} \Rightarrow 4 = \frac{160}{4v_A}$$

$$\Rightarrow v_A = \frac{160}{4 \times 4} = 10 \text{ m/s} \quad ; \quad v_B = 3v_A$$

$$= 3 \times 10$$

$$= 30 \text{ m/s}$$

⑦

Use $s = ut + \frac{1}{2}at^2$ to solve this problem.

For $t = 1 \text{ sec}$; $s = 18 \text{ m}$ $\therefore 18 = u(1) + \frac{1}{2}a(1)^2$

$$\Rightarrow 18 = u + \frac{a}{2} \rightarrow (1)$$

For $t = 2 \text{ sec}$; $s = 18 + 14$ [From skimming we have to take]

$$\Rightarrow 32 = u(2) + \frac{1}{2}a(2)^2$$

$$\Rightarrow 32 = 2u + 2a \Rightarrow u + a = 16 \rightarrow (2)$$

After 2 sec. velocity $v = u + at$

$$v = u + a(2) \rightarrow (3)$$

First let us find out the values of u and a by solving (1) & (2)

$$u + \frac{a}{2} = 18$$

sub a value in (2)

$$u + a = 16$$

$$\therefore 16 = u + (-4)$$

$$\Rightarrow -\frac{a}{2} = 2$$

$$\Rightarrow u = 16 + 4$$

$$\Rightarrow a = -4 \text{ m/s}^2$$

$$\Rightarrow u = 20 \text{ m/s}$$

Here $a = \text{constant}$ i.e. change in velocity = constant.

From (3)

$$v = 20 + 3(-4) \quad (\text{Here } t = 3 \text{ sec, After } 10 \text{ m})$$

$$= 20 - 12$$

The body comes to rest

$$\Rightarrow v = 8 \text{ m/s} \quad \text{with this velocity the body}$$

continues its journey and finally comes to rest.

$$[v = 0; u = 8 \text{ m/s}]$$

$$\text{From } v^2 - u^2 = 2as$$

$$\Rightarrow 0^2 - 8^2 = 2(-4)s$$

$$\Rightarrow -64 = -8s$$

$$\Rightarrow s = \frac{64}{8} = 8 \text{ m}$$

(8)

⑧ The position of a particle $x = at^2 - bt^3$

The velocity of a particle $u = \frac{dx}{dt} = \frac{d}{dt} [at^2 - bt^3]$

Here we use the formula $\frac{d}{dx} x^n = nx^{n-1}$

$$\Rightarrow u = a \frac{d}{dt} t^2 - b \frac{d}{dt} t^3$$

$$\Rightarrow u = a [2t^{2-1}] - b [3t^{3-1}]$$

$$\Rightarrow u = 2at - 3bt^2$$

Acceleration $A = \frac{dv}{dt} = \frac{d}{dt} [2at - 3bt^2]$

$$\Rightarrow A = 2a \frac{d}{dt} t - 3b \frac{d}{dt} t^2$$

$$= 2a - 3b [2t^{2-1}]$$

$$\Rightarrow A = 2a - 6bt$$

Given acceleration is zero $\Rightarrow A = 0$

$$\Rightarrow 2a - 6bt = 0 \Rightarrow 2a = 6bt$$

$$\Rightarrow t = \frac{2a}{6b} = \frac{a}{3b}$$

%

⑨

Given relation $3t = \sqrt{3x} + 6$

$$\Rightarrow \sqrt{3x} = 3t - 6$$

on squaring both sides $(\sqrt{3x})^2 = (3t - 6)^2$

$$\Rightarrow 3x = 9t^2 + 36 - 36t$$

$$\Rightarrow x = 3t^2 + 12 - 12t \rightarrow (1)$$

$$\text{Velocity } v = \frac{dx}{dt} = \frac{d}{dt} [3t^2 - 12t + 12]$$

$$\text{Use } \frac{d}{dx} x^n = nx^{n-1} ; \frac{d}{dt} (\text{constant}) = 0$$

$$\Rightarrow v = 3 \frac{d}{dt} t^2 - 12 \frac{d}{dt} t + \frac{d}{dt} (12)$$

$$= 3(2t^{2-1}) - 12 + 0$$

$$\Rightarrow v = 6t - 12 \rightarrow (2) \text{ when velocity } v = 0$$

$$\text{we will get } \Rightarrow 6t - 12 = 0$$

$$\Rightarrow 6t = 12$$

$$\Rightarrow t = 2 \text{ sec}$$

∴ From (1) displacement

$$x = 3t^2 - 12t + 12$$

$$\Rightarrow x = 3(2)^2 - 12(2) + 12$$

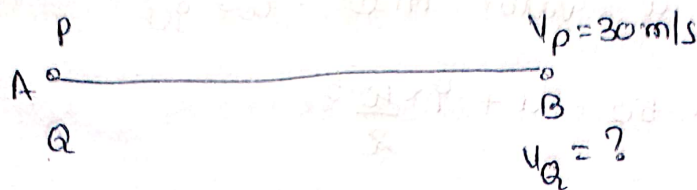
$$= 3 \times 4 - 24 + 12$$

$$= 12 - 24 + 12$$

$$\therefore x = 0$$

(19)

(10)



At A $u_P = 15 \text{ m/s}$; $u_Q = 20 \text{ m/s}$.

Given that $a_P = -a_Q$.

Use $v = u + at$

For P	For Q	$a_Q = -a_P$
$v = 30 \text{ m/s}$, $u = 15 \text{ m/s}$	$u_Q = 20 \text{ m/s}$	$v_Q = ?$

$\therefore 30 = 15 + a_P t$

$\Rightarrow a_P t = 30 - 15$
 $= 15 \text{ m/s}$

$\Rightarrow v_Q = 20 - a_P t$

$\Rightarrow v_Q = 20 - 15$
 $= 5 \text{ m/s}$

(14)

Use $s_n = u + \frac{a}{2} (2n-1)$ Formula.

For $n = 5^{\text{th}} \text{ sec}$ $s_1 = 50 \text{ m} \Rightarrow 50 = u + \frac{a}{2} (2(5)-1)$

$\Rightarrow 50 = u + \frac{a}{2} (10-1)$

$\Rightarrow 50 = u + \frac{9a}{2} \rightarrow (1)$

For $n = 7^{\text{th}} \text{ sec}$; $s_2 = 70 \text{ m} \Rightarrow 70 = u + \frac{a}{2} (2(7)-1)$

$\Rightarrow 70 = u + \frac{13a}{2} \rightarrow (2)$

By doing (2) - (1)

$\Rightarrow 20 = \frac{4a}{2} \Rightarrow a = 10 \text{ m/s}^2$

$\Rightarrow 70 - 50 = u + \frac{13a}{2} - u - \frac{9a}{2}$

$\Rightarrow 20 = \frac{13a - 9a}{2}$

14th continuation

sub 'a' value in ① we get

$$\Rightarrow 50 = u + 9 \times \frac{10^5}{2}$$

$$\Rightarrow 50 = u + 9 \times 5$$

$$\Rightarrow 50 = u + 45 \Rightarrow u = 50 - 45 = 5 \text{ m/s}$$

Distance travelled by the body in 9th sec.

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

$$= 5 + \frac{10^5}{2} (2 \times 9 - 1)$$

$$= 5 + 5 (18 - 1)$$

$$= 5 + 5 \times 17$$

$$S_n = 5 + 85 \Rightarrow 90 \text{ m}$$

(15)

From given data
graph can be drawn
as shown.

$$\therefore \frac{A}{2} + \frac{t}{4} = 1$$

$$\Rightarrow 2A + t = 4$$

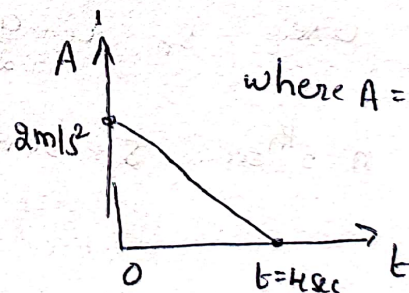
$$\Rightarrow 2A = 4 - t$$

$$\Rightarrow A = 2 - \frac{t}{2}$$

$$A \Rightarrow \frac{dv}{dt} = 2 - \frac{t}{2}$$

$$\Rightarrow dv = (2 - \frac{t}{2}) dt$$

on integrating



where A = acceleration

$$\Rightarrow \int dv = \int (2 - \frac{t}{2}) dt$$

$$\Rightarrow v = \int a dt - \frac{1}{2} \int t dt$$

$$\Rightarrow v = at - \frac{1}{2} (\frac{t^2}{2})$$

$$\Rightarrow v = at - \frac{t^2}{4}$$

$$\text{at } t = 2 \text{ sec } v = 2(2) - \frac{2^2}{4}$$

$$\Rightarrow v = 4 - 1 = 3 \text{ m/s.}$$

(11)

(16) Given $v = 2t(3-t)$

$$\Rightarrow v = 6t - 2t^2$$

$$\therefore \frac{dv}{dt} = \frac{d}{dt} [6t - 2t^2]$$

$$= 6 \frac{d}{dt} t - 2 \frac{d}{dt} (t^2) \quad \left[\because \frac{d}{dx} x^n = nx^{n-1} \right]$$

$$= 6 - 2(2t^{2-1})$$

$$= 6 - 4t$$

At maximum velocity $\frac{dv}{dt} = 0$

$$\Rightarrow 6 - 4t = 0$$

$$\Rightarrow 4t = 6$$

$$\Rightarrow t = \frac{6}{4} = \frac{3}{2} \text{ sec.}$$

(17), (18), (19)

Given the cyclist starts from rest $u = 0$ &

Acceleration $a = 0.5 \text{ m/s}^2$; Final velocity $v = 54 \text{ kmph}$

$$\Rightarrow v = 54 \times \frac{5}{18} \text{ m/s}$$

$$\Rightarrow v = 15 \text{ m/s}$$

From $v = u + at$

$$\Rightarrow 15 = 0 + 0.5 \times t$$

$$\Rightarrow 15 = 0.5t$$

$$\Rightarrow t = \frac{15}{0.5} = 30 \text{ sec.}$$