Itask

1

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

Acceleration $a=$ 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 $S_n = \frac{9}{25} S$

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

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

where $S = un + \frac{1}{2}an^2 \Rightarrow S = \frac{1}{2}an^2 \rightarrow (2)$

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

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

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

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

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

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

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

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

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

$\therefore$ From (2) $S = \frac{1}{\cancel{2}}(\cancel{12}^{6})(5)^2$

$S = 6 \times 25$

$= 150cm$

Given body describes 6cm in 1^{st} sec : From (2)

$$\Rightarrow 6 = \frac{1}{2}a(1)^2$$

$$\Rightarrow a = 12 \text{ cm/sec}^2$$

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(2)

let the two points be A & B

$\longleftarrow$ 180m $\longrightarrow$

A $\quad t = 6\,sec. \quad$ B

$V_A = ?$ $\quad\quad$ $V_B = 45\ m/s$

Acceleration a = constant

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

$\Rightarrow \cancel{180}^{30} = V_A \times \cancel{6} + \frac{1}{2} a \times 6^{\cancel{2}}$

$\Rightarrow 30 = V_A + \frac{1}{\cancel{2}}\cancel{6}^{3} a$

$\Rightarrow 30 = V_A + 3a \rightarrow (1)$

From $v = u + at$

$\Rightarrow V_B = V_A + at$

$\Rightarrow 45 = V_A + 6a \rightarrow (2)$

By solving (1) and (2) we get

$$\Rightarrow \begin{array}{r} \cancel{V_A} + 3a = 30 \\ - \cancel{V_A} \pm 6a = - 45 \\ \hline -3a = -15 \end{array}$$

$\Rightarrow a = 5\ m/s^2$

From (1) sub 'a' value we get

$30 = V_A + 3(5)$

$\Rightarrow 30 = V_A + 15$

$\Rightarrow V_A = 15\ m/s.$

(3)

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

$V = 0$ $\quad$ From $V^2 - u^2 = 2as$

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

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

For $u_1 = 50$ kmph $\rightarrow s_1 = 6m.$ $\quad$ Here a = constant

If $u_2 = 100$ kmph $\rightarrow s_2 = ?$

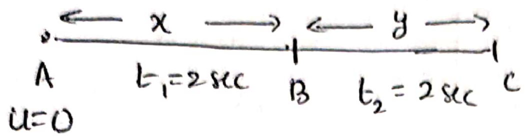
$\therefore \frac{s_2}{s_1} = \left[\frac{u_2}{u_1}\right]^2$

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

$\Rightarrow s_2 = 4 \times 6 = 24m$

(4)

The Particle is starting from rest $u=0$ & $a=$ constant



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

For $t_1=2$ sec ; $s=x$. | $t=4$ (sec) starting from A→C

$$s=x+y$$

$$x=0\times2+\frac{1}{\cancel{2}}(a)(2)^{\cancel{2}}$$

$$x=2a$$

$$\Rightarrow x+y=0\times4+\frac{1}{2}(a)(4)^2$$

$$\Rightarrow 2a+y=0+\frac{1}{\cancel{2}}a\times\cancel{16}\,8$$

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

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

$$\Rightarrow y=6a$$

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

$$\Rightarrow y=3x.$$

(5)

Given deceleration = Negative acceleration = $5\,m/s^2$

Reaction time = 0.7 sec

Initial velocity $u=8.33$ m/s.

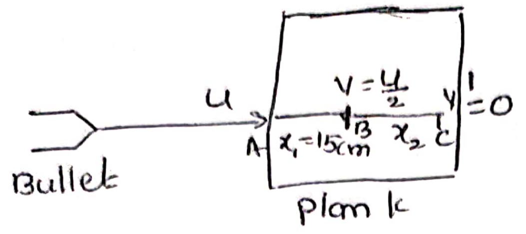
$\therefore$ From $\quad s=ut+\frac{1}{2}at^2$

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

$$=5.831-1.225$$

$$=4.606\text{ m.}$$

(6) (11)



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

Bullet is in retardation ie) $a = -ve$.

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

For AB $\quad v = \frac{u}{2}$; $S = 15\,cm$

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

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

$\Rightarrow \cancel{-}\frac{3u^2}{4} = \cancel{-}2a \times \overset{5}{\cancel{15}}$

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

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

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

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

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

From (1) & (2) we have

$x_2 = 5\,cm$

(7)

(12) Given equation $v = \sqrt{180 - 7x}$.

By squaring on both sides we get

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

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

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

$\Rightarrow v^2 - (\sqrt{180})^2 = -7x$ This is in the form of $v^2 - u^2 = 2as$

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

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

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

13 Given velocity $v = 60$ m/s

Time $t = 2$ sec

$\therefore$ Distance travelled $= v \times t$

$= 60 \times 2$

$= 120$ m

14

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

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

$\therefore$ velocity $= \frac{ds}{dt} = \frac{d}{dt}[t^3 - 6t^2 + 3t + 4]$

$= \frac{d}{dt} t^3 - 6\frac{d}{dt} t^2 + 3\frac{dt}{dt} + \frac{d}{dt}(4)$

$= 3t^{3-1} - 6(2t^{2-1}) + 3 + 0$

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

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

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

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

$a = 6t - 12$

Given acceleration $= 0$

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

$\Rightarrow t = 2$ sec

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

$= 3 \times 4 - 24 + 3$

$= 12 - 24 + 3$

$= -9$ m/s

(10) ,

(15) Given that bus starts from rest $u_B = 0$

and acceleration $a_B = 5\ m/s^2$

velocity of car $u_c = 50\ m/s$ = 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

$\Rightarrow u_B t + \frac{1}{2} a_B t^2 = u_c t + \frac{1}{2} a_c t^2$

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

$\Rightarrow \frac{\cancel{5}}{2} t^{\cancel{2}} = \overset{10}{\cancel{50}}\ \cancel{t}$

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

$\Rightarrow t = 20$ sec.

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

$\Rightarrow V_B = u_B + a_B t$

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

$\Rightarrow V_B = 100\ m/s$.

(13)

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

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

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

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

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

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

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

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

$= 2a[1-0]$

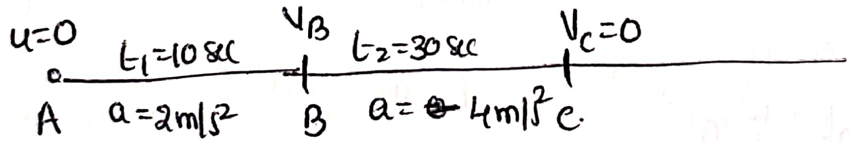
$a = 2a$

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

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

$\Rightarrow x = 0$ at origin.

(15)



let A be the initial point where it started from rest

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

$= 0\times10 + \frac{1}{2}\times2(10)^2$

$AB = 100m$

Velocity at B $V_B = u+at = 0+2\times10 = 20\,m/s$

~~Dist~~

15th continuation

Distance $BC = u_B t + \frac{1}{2} a t^2$

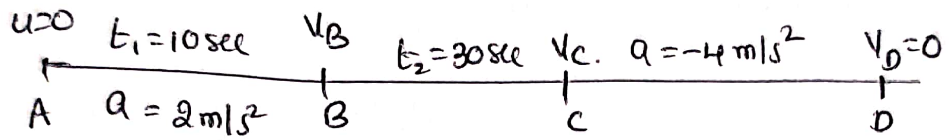
$= 20 \times 30 + \frac{1}{\cancel{2}} (-\cancel{4}^{2}) (30)^2$

$= 600 - 2 \times 900$

$= 600 - 1800$

$= -1200$ m

(15)



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

<u>For AB</u>

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

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

$\Rightarrow S_{AB} = 100m$

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

$V_B = 0 + 2 \times 10 \Rightarrow V_B = 20 m/s$

∴ From B to C the body is in uniform motion i.e $V_B = V_C = 20$ m/s

<u>For</u> <u>BC</u> : $a = 0$

$S_{BC} = u_B t + \frac{1}{2} a_B t^2$

$= 20 \times 30 + \frac{1}{2}(0)(30)^2$

$S_{BC} = 600$ m.

<u>From</u> <u>C→D</u> use $v^2 - u^2 = 2as$

$\Rightarrow V_D^2 - V_C^2 = 2a\, S_{CD}$

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

$\Rightarrow \cancel{+}400 = \cancel{+}8\, S_{CO}$

$\Rightarrow S_{CD} = 50m$

∴ For entire journey total distance travelled

$S = S_{AB} + S_{BC} + S_{CO} = 100 + 600 + 50 = 750m$

(b)

(16)

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

and $y = 9x^2$

on differentiating w.r.t time

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

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

$\Rightarrow V_y = 18\, x \times V_x \rightarrow (2)$

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

$V_y = \cancel{18}^{\cancel{6}\,2} \times \frac{1}{\cancel{3}} t \times \frac{1}{\cancel{3}}$

$V_y = 2t$

$\therefore$ acceleration $a = \frac{dV_y}{dt} = \frac{d}{dt}[2t]$

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

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

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

along y axis

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17 , 18 , 19

Train starts from rest $u=0$, & $a = 2\,m/s^2$
For $t = 30$ sec., let S_1 be the distance travelled

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

$\Rightarrow S_1 = 0\times(30) + \frac{1}{\cancel{2}}(\cancel{2})(30)^2$

$\Rightarrow S_1 = 900\,m \rightarrow (1)$

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

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

$\Rightarrow V = 60\,m/s$ This is the maximum velocity attained by the train in it's entire journey. with this velocity it travels for ~~rest~~ one min and finally comes to rest [Total time = 1 min = 60 sec]

distance $S_2 = V \times t$

$= 60 \times 30$ sec

$= 1800\,m$

$\therefore$ Total distance $= S_1 + S_2 = 900 + 1800 = 2700 = 2.7\,km$

For $V_1 = 60\,m/s \rightarrow S_1 = 900\,m$

If $V_2 = \frac{V_1}{2} = 30\,m/s \rightarrow S_2 = ?$

From $V^2 \propto S \Rightarrow \left[\frac{V_2}{V_1}\right]^2 = \left[\frac{S_2}{S_1}\right]$ $\Rightarrow S_2 = \frac{900}{4}$

$\Rightarrow \left[\frac{30}{60_2}\right]^2 = \frac{S_2}{900}$ $\Rightarrow S_2 = 225\,m.$

$= \left(\frac{1}{2}\right)^2 = \frac{S_2}{900}$

L Task

Jee mains level

(1)

length of each train $l = 50\,m$

$V_A = 10\,m/s \longrightarrow$ $\longleftarrow V_B = 15\,m/s$

when they pass each other each train travels a

distance of $= l_A + l_B = 50m + 50m = 100m.$

Velocity of one train with respect to other

train $v = V_A + V_B$

$= 10 + 15$

$= 25\,m/s$

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

$= \dfrac{100}{25}$

$= 4$ sec.

(2)

Initial speed $u = 4.1\,m/s$; Final speed $V = 6.9\,m/s$

time $t = 5$ sec.

From $V = u + at$

$\Rightarrow 6.9 = 4.1 + a(5)$

$\Rightarrow 6.9 - 4.1 = 5a$

$\Rightarrow 5a = 2.8 \Rightarrow a = \dfrac{2.8}{5} = 0.56\,m/s^2$

(3)

Initial velocity of the body $u = v$.

After 't' sec the body back to it's original position with same speed.

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

$\therefore$ From the defination 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.

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

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

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

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

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

⑦

⑤ (12)

Velocity of police car $V_1 = 30$ kmph $= 30 \times \frac{5}{18}$ m/s $= \frac{25}{3}$ m/s

velocity of thief's car $V_2 = 190$ kmph $= 190 \times \frac{5}{18}$ m/s $= \frac{160}{3}$ m/s.

Muzzle speed of the bullet $V_B = 150$ 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 theif's car is

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

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

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

⑥ (13)

length of train 'A' is $L_A = 100$ m

length of train 'B' is $L_B = 60$ m.

Given $V_B = 3V_A$

Time taken to cross each other is $t = 4$ sec

$$\therefore \text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{L_A + L_B}{V_A + V_B}$$

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

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

$$= 3 \times 10$$

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

③

(14) Use $s = ut + \frac{1}{2}at^2$ to solve this Problem.

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

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

For $t = 2$ sec ; $S = 18 + 14$ [From starting we have to take]

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

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

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)

$$u + \frac{a}{2} = 18$$
$$u + a = 16$$
$$\Rightarrow -\frac{a}{2} = 2$$
$$\Rightarrow a = -4\ m/s^2$$

sub 'a' value in (2)

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

$\Rightarrow u = 16 + 4$

$\Rightarrow u = 20$ m/s

Here a = constant (ie) change in velocity = constant.

From (3) $v = 20 + 3(-4)$ (Here $t = 3$ sec, After 10m The body comes to rest]

$= 20 - 12$

$\Rightarrow v = 8$ m/s with this velocity the body continues it's journey and finally comes to rest.

[$v = 0$; $u = 8$ m/s]

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

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

$\Rightarrow \cancel{-}64 = \cancel{-}8s$

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

8

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

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

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

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

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

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

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

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

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

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

Given acceleration is zero $\Rightarrow A = 0$

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

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

(15)

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

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

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

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

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

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

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

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

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

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

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

$\Rightarrow 6t = 12$

$\Rightarrow t = 2\,sec$

$\therefore$ From (1) displacement

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

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

$= 3\times4 - 24 + 12$

$= 12 - 24 + 12$

$\therefore x = 0$

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10

At 'A' $u_P = 15$ m/s ; $u_Q = 20$ m/s.

Given that $a_P = -a_Q$.

use $V = u + at$

For P: $V = 30$ m/s, $u = 15$ m/s

For Q: $u_Q = 20$ m/s, $a_Q = -a_P$, $V_Q = ?$

$\therefore$ $30 = 15 + a_P t$

$\Rightarrow a_P t = 30 - 15$

$= 15$ m/s

$\Rightarrow V_Q = 20 - a_P t$

$\Rightarrow V_Q = 20 - 15$

$= 5$ m/s

14

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

For $n = 5^{th}$ sec $S_1 = 50$m $\therefore \Rightarrow 50 = u + \frac{a}{2}(2(5)-1)$

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

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

For $n = 7^{th}$ sec ; $S_2 = 70$m $\Rightarrow 70 = u + \frac{a}{2}(2(7)-1)$

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

By doing (2) − (1)

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

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

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

14^{th} continuation

sub 'a' value in ① we get

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

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

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

Distance travelled by the body in 9th sec.

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

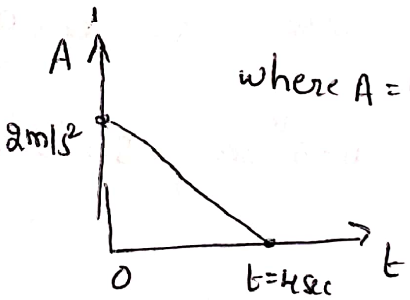
$= 5 + \frac{\cancel{10}^{5}}{\cancel{2}}(2 \times 9 - 1)$

$= 5 + 5(18-1)$

$= 5 + 5 \times 17$

$S_n = 5 + 85 \Rightarrow 90m$

(15) From given data graph can be drawn as shown.



where A = acceleration

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

$\Rightarrow 2A + t = 4$

$\Rightarrow 2A = 4 - t$

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

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

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

on integrating

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

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

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

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

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

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

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

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

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

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

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

$= 6 - 4t$

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

$\Rightarrow 6 - 4t = 0$

$\Rightarrow 4t = 6$

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

17, 18, 19

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

Acceleration $a = 0{\cdot}5\ m/s^2$; Final velocity $v = 54$ kmph

$\Rightarrow v = \cancel{54}^{3} \times \dfrac{5}{\cancel{18}}$ m/s

$\Rightarrow v = 15$ m/s

From $v = u + at$

$\Rightarrow 15 = 0 + 0{\cdot}5 \times t$

$\Rightarrow 15 = 0{\cdot}5t$

$\Rightarrow t = \dfrac{15}{0{\cdot}5} = 30$ sec.

(18) velocity of cyclist at the end of 5 sec.

is $V = u + at$

$V = 0 + (0.5)(5)$

$\Rightarrow V = 2.5\ m/s$

(19)

Velocity of cyclist at the end of 21st sec

$V_{21} = u + at$

$\Rightarrow V_{21} = 0 + (0.5)(21)$

$\Rightarrow V_{21} = 0.5 \times 21$

Velocity of cyclist at the end of 7th sec

$V_7 = u + at$

$\Rightarrow V_7 = 0 + (0.5)(7)$

$\Rightarrow V_7 = 0.5 \times 7$

$$\therefore \frac{V_{21}}{V_7} = \frac{\cancel{0.5} \times \cancel{21}^{3}}{\cancel{0.5} \times \cancel{7}} = \frac{3}{1}.$$