(1) For a Freely Falling body $u=0$

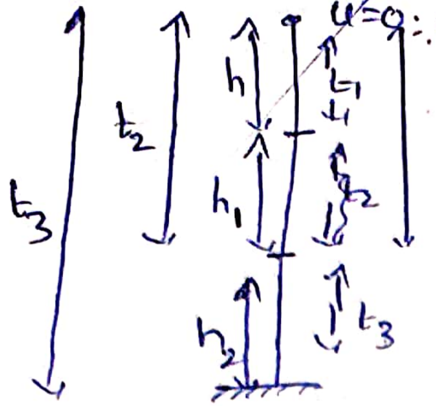
and velocity with which the body reaches ground $v^2=2gh$

$\Rightarrow v^2 \propto h$ The ratio of heights

$\Rightarrow \left(\frac{v_1}{v_2}\right)^2 = \frac{h_1}{h_2}$ $\frac{h_1}{h_2} = \frac{2}{3}$

$\Rightarrow \left[\frac{v_1}{v_2}\right]^2 = \frac{2}{3} \Rightarrow \frac{v_1}{v_2} = \frac{\sqrt{2}}{\sqrt{3}}.$

(2)



For a freely falling body Time of descent $t_d = \sqrt{\frac{2h}{g}}$

$t_1 = \sqrt{\frac{2h}{g}}$; $t_2 = \sqrt{\frac{2(2h)}{g}}$; $t_3 = \sqrt{\frac{2(3h)}{g}}$

For . .

(2) We know that $s = ut + \frac{1}{2}at^2$ Here $u=0$; $a=g$

Total distance travelled in t_1 sec

$$s_1 = \frac{1}{2} g t_1^2 \Rightarrow s_1 = h \Rightarrow h = \frac{1}{2} g t_1^2 \Rightarrow t_1 = \sqrt{\frac{2h}{g}}$$

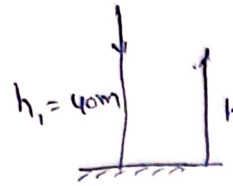
Distance travelled in t_2 & t_3 sec is $s_2 = \frac{1}{2} g (t_2+t_1)^2$; $s_3 = \frac{1}{2} g (t_3+t_2+t_1)^2$

$$s_2 = 2h \quad \therefore t_1 + t_2 = \sqrt{\frac{2(2h)}{g}} \qquad s_3 = 3h; \; t_1+t_2+t_3 = \sqrt{\frac{2(3h)}{g}}$$

$$\therefore \quad t_1 : (t_1+t_2) : (t_1+t_2+t_3) = \sqrt{\frac{2h}{g}} : \sqrt{\frac{2(2h)}{g}} : \sqrt{\frac{2(3h)}{g}} = 1 : \sqrt{2} : \sqrt{3}$$

$$\Rightarrow \quad t_1 : t_2 : t_3 = 1 : \sqrt{2}-1 : \sqrt{3}-\sqrt{2} = 1 : 0.41 : 0.32$$

(3)



let the contact time Δt or $t = 0.02s$

$\therefore \langle acceleration \rangle = \frac{v-(-u)}{t} = \frac{\sqrt{2gh_1}+\sqrt{2gh_2}}{t}$

$v = \sqrt{2gh_1}$; $u = \sqrt{2gh_2}$

$= \frac{\sqrt{2g}\,[\sqrt{h_1} - \sqrt{h_2}]}{t} = \frac{\sqrt{2\times 9.8}\,[\sqrt{40}+\sqrt{10}]}{0.02}$

v & u are in opp direction

$= \frac{\sqrt{2\times 9.8}\times\sqrt{10}\,[\sqrt{4}+1]}{2\times 10^{-2}}$

$\Rightarrow \frac{\sqrt{196}\,(2+1)}{2\times 10^{-2}} = \frac{\cancel{14}^{7}\times 3\times 10^{2}}{\cancel{2}}$

$= 2100 m/s^2$

(4)

First ball.

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

$\Rightarrow 78.4 = 0\times t + \frac{1}{2}(9.8)t^2$

$\Rightarrow 78.4 = \frac{9.8}{2}t^2$

$\Rightarrow t^2 = \frac{2\times \cancel{78.4}^{8}}{\cancel{9.8}} = 2\times 8$

$\Rightarrow t^2 = 16 \Rightarrow t = 4$ sec.

For second ball, it is thrown 2 sec later so time $t = 2$ sec

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

$\Rightarrow 78.4 = u(2) + \frac{1}{\cancel{2}}9.8(2)^{\cancel{2}}$

$\Rightarrow 78.4 = 2u + 19.6$

$\Rightarrow 2u = 78.4 - 19.6$

$\Rightarrow 2u = 58.8$

$\Rightarrow u = 29.4$ m/s

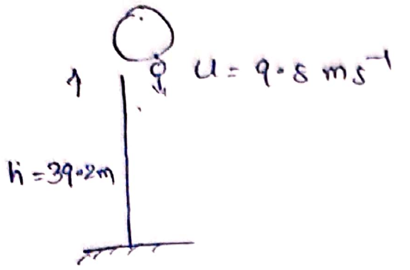
(5)

Given $t_1 = 3$ sec ; $t_2 = 13$ sec

The velocity of bullet with which it is Projected

$U = \frac{g}{2}(t_1+t_2) = \frac{10}{2}(3+13) = 5\times 16 = 80 m/s$

(6)



In this case the velocity of stone is same as that of balloon at the time of dropping.

$\therefore$ The displacement of the stone is

$$h = -ut + \frac{1}{2}gt^2$$

$$\Rightarrow 39.2 = -9.8\,t + \frac{1}{2}\,9.8\,t^2$$

$$\Rightarrow 39.2 = -9.8\,t + 4.9\,t^2$$

$$\Rightarrow 8 = -2t + t^2.$$

$\therefore$ $t^2 - 2t = 8$

$\Rightarrow t^2 - 2t - 8 = 0$

$\Rightarrow t^2 - 4t + 2t - 8 = 0$

$\Rightarrow t(t-4) + 2(t-4) = 0$

$\Rightarrow (t-4)(t+2) = 0$

(i.e) $t - 4 = 0$ (or) $t + 2 = 0$

$\Rightarrow t = 4$ sec $\quad$ $t = -2$ sec but No Negative values for time.

(7)

Given $H_{max} = 50m$; $u_1 = u$

If the velocity is doubled $u' = 2u$.

let H' be the maximum height reached.

From $H_{max} = \frac{u^2}{2g}$

$\Rightarrow H_{max} \propto u^2$

$$\Rightarrow \frac{H'}{H_{max}} = \left(\frac{u'}{u_1}\right)^2$$

$$\Rightarrow \frac{H'}{50} = \left(\frac{2\cancel{u}}{\cancel{u}}\right)^2$$

$$\Rightarrow \frac{H'}{50} = 2^2$$

$$\Rightarrow H' = 2^2 \times 50 = 200m.$$

(8)

when the lift is accelerating downwards then the relative acceleration of the lift is

$$a' = g - a$$

$$= 9.8 - 1.8$$

$$a' = 8\ m/s^2$$

$\therefore$ The time of descent

$$t = \sqrt{\frac{2h}{a'}} = \sqrt{\frac{2 \times 2}{8}}$$

$$t = \sqrt{\frac{4}{8}} = \sqrt{\frac{1}{2}}$$

$$t = \frac{1}{\sqrt{2}}\ \text{sec.}$$

(9)

let u be the velocity of Projection, $u = 39.2$ m/s

If the body reaches a point in two different intervals of time. Then the

Velocity of Projection $u = \frac{g}{2}(t_1+t_2)$

$\Rightarrow 39.2 = \frac{\cancel{9.8}^{4.9}}{\cancel{2}}(t_1+t_2)$

$\Rightarrow \frac{39.2}{8} = 4.9(t_1+t_2)$

$\Rightarrow t_1+t_2 = 8$ sec

(10)

let 'n' be the time taken by the body to reach ground $\therefore$ From $S = ut + \frac{1}{2}at^2$

For a Freely falling body $u=0$; $a=g$; $S=h$

$\therefore h = 0 \times n + \frac{1}{2}gn^2 \Rightarrow h = \frac{1}{2}gn^2$

Distance travelled by the body in the last second of fall is $S = \frac{g}{2}(2n-1)$ here $S = \frac{7h}{16}$

$\Rightarrow \frac{7h}{16} = \frac{g}{2}(2n-1)$

$\Rightarrow \frac{7}{16} \times \frac{1}{\cancel{2}}\cancel{g}n^2 = \frac{\cancel{g}}{2}(2n-1)$

$\Rightarrow \frac{7n^2}{16} = 2n-1$

$\Rightarrow 7n^2 = 32n-16$

$\Rightarrow 7n^2 - 32n + 16 = 0$

$\Rightarrow 7n^2 - 28n - 4n + 16 = 0$

$\Rightarrow 7n(n-4) - 4(n-4) = 0$

$\Rightarrow (n-4)(7n-4) = 0$

$\Rightarrow n-4 = 0$ (or) $7n-4 = 0$

$\Rightarrow n = 4$ sec

$\therefore$ From $h = \frac{1}{2}gn^2$

$= \frac{1}{\cancel{2}} \times \cancel{10}^{5} \times 4^2 = 5 \times 16$

$h = 80$m

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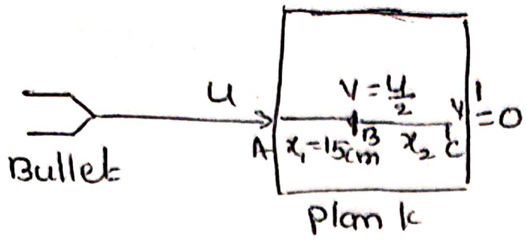


x_2 be the distance travelled by the bullet before coming to stop.
Bullet is in retardation
i.e) $a = -ve$.

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

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

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

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

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

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

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

$x_2 = 5cm$

(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 $2a = -7$

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

$\Rightarrow a = -3{\cdot}5\ m/s^2$

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

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

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

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

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

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

$= 3 \times 4 - 24 + 3$

$= 12 - 24 + 3$

$= -9 \; m/s$

(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

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

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

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

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

$$\Rightarrow t = 20\ sec.$$

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

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

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

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

16.

Given $T = 60$ sec ; $R = 120$ m.

2R

For half rotation Displacement $= 2R$

$= 2 \times 120$

$= 240$ m.

$$\langle \text{velocity} \rangle = \frac{\text{Displacement}}{\text{Time}}$$

$$= \frac{240}{60} = 4 \text{ m/s}$$

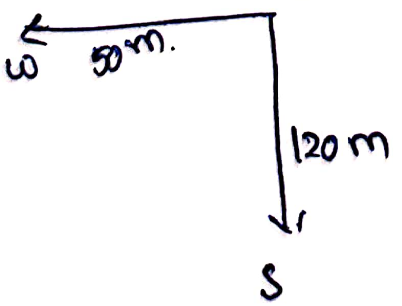
17.

Total displacement $= v_1 t_1 + v_2 t_2$

$$= \cancel{85}^{17} \times \frac{35}{\cancel{60}_{12}} + 130 \text{ km}$$

$$= 49.6 + 130 = 179.6 \text{ km}$$

20.



Distance $= 120$ m $+ 50$ m

$= 170$ m.

Displacement $= \sqrt{(120)^2 + (50)^2}$

$= 130$ m

18.

Total distance $= 2.5 + 2.5$

$= 5$ km. $= 5000$ m

Total time $= 50$ min $= 3000$ sec

$\langle speed \rangle = \dfrac{\text{Total distance}}{\text{Total time}} = \dfrac{5000}{3000} = \dfrac{5}{3}$ m/s

19.

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

velocity $= \dfrac{dx}{dt} = \dfrac{d}{dt}\left[2 - 3t + 4t^3\right]$

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

$= 0 - 3 + 4(3t^2)$

$= 12t^2 - 3$

at $t = 3$ sec

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

$= 105$ cm/s

(21)

Given that the body is projected with a velocity $u = 29.23$ m/s.

In case of vertically projected body $a = -g$

$\therefore$ From $S = u + \frac{a}{2}(2n-1) \rightarrow (1)$

let us know the time of ascent $t_a = \frac{u}{g} = \frac{29.23}{9.8}$

$t_a = 3$ sec

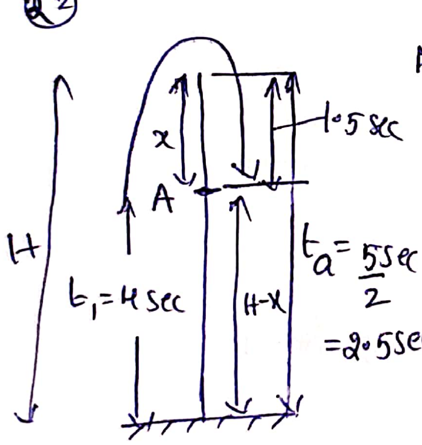
$\therefore$ In last sec $S = 29.23 - \frac{g}{2}[2\times3-1]$

$= 29.23 - 4.9[6-1]$

$= 29.23 - 24.5$

$= 4.73 \simeq 4.9$ m

(22)



Acc to Given question Time of flight $= 5$ sec

$\therefore$ time of ascent = time of descent $= 2.5$ sec

$\frac{u}{g} = 2.5 \Rightarrow u = 2.5g$.

$\therefore$ Maximum height reached by the body is $H = \frac{u^2}{2g} \Rightarrow H = \frac{(2.5g)^2}{2g}$

$\Rightarrow H = \frac{(2.5)^2 \times g^2}{2g} = \frac{6.25\times g}{2}$

$\Rightarrow H = \frac{6.25 \times 10^5}{2} = 6.25\times5$

$\Rightarrow H = 31.25$ m.

Now From Max height $u = 0$; Already 2.5 sec are over so to reach A, the body must travel 1.5 sec more.

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

$H - x = 0\times(1.5) + \frac{1}{2}\times g(1.5)^2$

$\Rightarrow 31.25 - x = 0 + \frac{1}{2}\times 10^5 \times 2.25$

$\Rightarrow 31.25 - x = 5\times 2.25$

$\Rightarrow 31.25 - x = 11.25$

$\Rightarrow x = 20$ m.

27 and 28

Given $u = 0$; $a = 2\ m/s^2$

For first $t = 30$ sec

$v = u + at$

$= 0 + 2(30)$

$v = 60\ m/s$ → maximum speed.

Distance travelled $S_1 = ut + \frac{1}{2}at^2$

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

$= 900\ m$

After this 30 sec the train is in retardation

so $a = -\cancel{\ }\ m/s^2$ v act as initial velocity

From $v = u + at$ ⇒ $0 = 60 + a(60)$

⇒ $a = -1\ m/s^2$

From $S_2 = ut + \frac{1}{2}at^2$

$= 60 \times 60 + \frac{1}{2}(-1)(60)^2$

$S_2 = 3600 - 1800 = 1800\ m$

Total distance $= S_1 + S_2 = 900 + 1800 = 2700\ m$

$= 2.7\ km$

L. Task

SA Q's

① let 'h' be the distance travelled by freely falling body in 'n' sec

$\therefore$ From $S = ut + \frac{1}{2}at^2$ [$u=0$; $a=g$]

$\Rightarrow h = 0 \times n + \frac{1}{2}gn^2$

$\Rightarrow h = \frac{g}{2}n^2 \rightarrow ①$

Distance travelled by the body in last sec is $\frac{11h}{36}$

$\therefore$ From $S = u + \frac{a}{2}(2n-1)$

$\Rightarrow \frac{11h}{36} = 0 + \frac{g}{2}(2n-1)$

1st continuation

$\therefore$ From (1)

$\Rightarrow \frac{11}{36}\left(\frac{1}{2}gn^2\right) = \frac{g}{2}(2n-1)$

$\Rightarrow \frac{11}{36}n^2 = 2n-1$

$\Rightarrow 11n^2 = 72n-36$

$\Rightarrow 11n^2-72n+36=0$

$\Rightarrow 11n^2-66n-6n+36=0$

$\Rightarrow 11n(n-6)-6(n-6)=0$

$\Rightarrow (n-6)\cancel{(11-6)}(11n-6)=0$

$\Rightarrow n-6=0$ (or) $11n-6=0$

$\Rightarrow n=6$ sec.

$\therefore$ From (1)

$h=\frac{1}{2}\times g\times 6^2$

$h=\frac{1}{\cancel{2}}\times 10\times \cancel{36}^{18} = 180m$

(2)

For a Freely falling body $u=0$; $a=g=10m/s^2$

For 4sec the $V=gt \Rightarrow V=g(4)$

$\Rightarrow V=40\ m/s$

After 4 sec, gravity ceases ie) $g=0$

$\therefore$ Distance travelled in next 3 sec is

$S=Vt = 40\times 3 = 120m$

(3) The height from which the body dropped $=125m$

$\therefore$ Time of descent $t_d=\sqrt{\frac{2h}{g}}=\sqrt{\frac{2\times 125}{10}}=\sqrt{\frac{250}{10}}=\sqrt{25}=5sec$

Distance travelled in the last sec

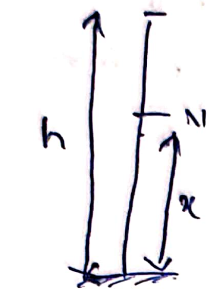
$S_n=\frac{g}{2}(2n-1)=\frac{\cancel{10}^5}{\cancel{2}}[2(5)-1]$

$S_n=5[10-1]=5\times 9=45m.$

14

5 ...... For 17 also

let 'u' be the velocity of Projection and 'h' is the maximum height reached by the body.



$a=-g$:

$H_{max} = \frac{u^2}{2g} \Rightarrow h = \frac{u^2}{2g} \Rightarrow h \propto u^2$

If the velocity of projection $v = \frac{u}{3}$ then the distance travelled is x from ground.

∴ From ~~[illegible]~~

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

$$\Rightarrow \left(\frac{u}{3}\right)^2 - u^2 = 2(-g)x$$

$$\Rightarrow \frac{u^2}{9} - u^2 = -2gx$$

$$\Rightarrow \cancel{-}\frac{8u^2}{9} = \cancel{-}2gx$$

$$\Rightarrow x = \frac{8}{9}\frac{u^2}{2g}$$

$$\Rightarrow x = \frac{8}{9}h \text{ from ground.}$$

6

let $u = 58.8$ m/s be the Velocity of Projection

After 3 sec Velocity $v = u + at$ $[a = -g = 9.8\ m/s^2]$

$$\Rightarrow v = 58.8 + (-9.8) \times 3$$

$$= 58.8 - 29.4$$

$$v = 29.4\ m/s.$$

After '3' sec acceleration due to gravity disappears

i.e, the body is moving with uniform velocity.

In next '5' sec distance $= v \times t$

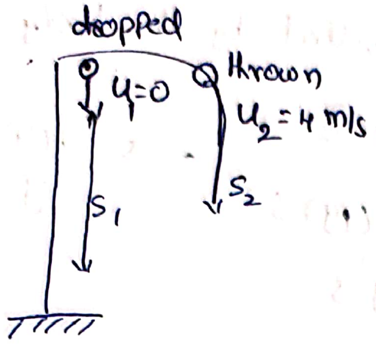
$$= 29.4 \times 5$$

$$s = 147.0\ m$$

⑤

7.

Given body is a freely falling body so: $u=0$; $a=g$



In a time 't' sec

S_1 = distance travelled by dropped body

$\therefore S_1 = u_1 t + \frac{1}{2} a t^2$

$S_1 = 0 \times t + \frac{1}{2} g t^2$

$S_1 = \frac{1}{2} g t^2$

S_2 = distance travelled by thrown body $[a=g]$

$\therefore S_2 = u_2 t + \frac{1}{2} a t^2$

$S_2 = 4t + \frac{1}{2} g t^2 \rightarrow ②$

Given $S_1 \sim S_2 = 30\ m$

$\Rightarrow \frac{1}{2} g t^2 \sim [4t + \frac{1}{2} g t^2] = 30$

$\Rightarrow 4t + \cancel{\frac{1}{2} g t^2} - \cancel{\frac{1}{2} g t^2} = 30$

$\Rightarrow 4t = 30$

$\Rightarrow t = \frac{30}{4}$

$\Rightarrow t = 7.5\ sec.$

8

let 'H' be the Max height reached by the body

$H = \frac{u^2}{2g} \rightarrow ①$

At half of Max height ; Velocity $v = 49\ m/s$

$\therefore$ From $v^2 - u^2 = 2as$ $\quad [a = -g;\ s = \frac{H}{2}]$

$\Rightarrow (49)^2 - u^2 = \cancel{2}(-g)\frac{H}{\cancel{2}}$

$\Rightarrow (49)^2 - u^2 = -g \times \frac{u^2}{2g}$

$\Rightarrow (49)^2 - u^2 = \frac{-u^2}{2}$

$\Rightarrow (49)^2 = -\frac{u^2}{2} + u^2$

$\Rightarrow (49)^2 = \frac{u^2}{2}$

$\therefore H = \frac{u^2}{2} \times \frac{1}{g}$ [From ①]

$= 49^2 \times \frac{1}{9.8} = \frac{49 \times 49}{9.8}$

$\Rightarrow H = 245\ m$

Already body is at $\frac{H}{2}$, so the further height raised by the body $= \frac{H}{2} = ~~125\ m~~$ $122.5\ m.$

(9)

Velocity of Projection = u ; Here $a = +g$

Velocity with which the body reaches ground $v = 3u$

let 's' be the distance travelled by the body

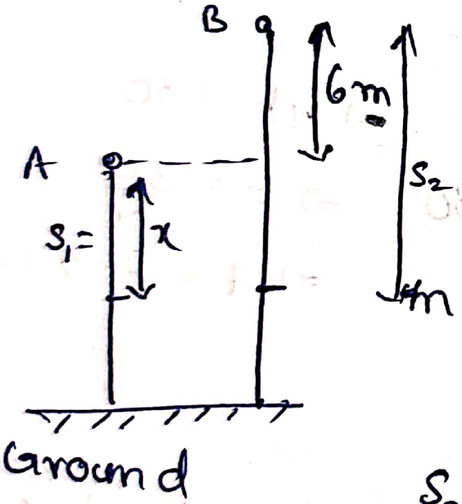
$\therefore$ From $v^2 - u^2 = 2as$

$\Rightarrow (3u)^2 - u^2 = 2(+g)s$ $\qquad \Rightarrow s = \dfrac{4u^2}{g}$

$\Rightarrow 9u^2 - u^2 = +2g\, s$

$\Rightarrow 8u^2 = +2g\, s$

(10)



Here two balls are dropped at a time and both are freely falling bodies

i.e) $u = 0$; $a = g$ [For two bodies]

$t = 2\,sec$

$S_1 = x$ = distance travelled by I^{st} body

$S_2 = 6 + x$ = distance travelled by 2^{nd} body

So after '2' sec $\quad S_2 - S_1 = 6 + x - x$

$= 6m$

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

L part

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

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

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

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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

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

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

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

$$= 3 \times 10$$

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

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

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

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

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

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(15)

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

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

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

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

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

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

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

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

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

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

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

$\Rightarrow 6t = 12$

$\Rightarrow t = 2\ sec$

$\therefore$ From (1) displacement

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

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

$= 3 \times 4 - 24 + 12$

$= 12 - 24 + 12$

$\therefore x = 0$

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L Task

16.

For first $t_1 = 2$ sec.

Displacement = 10m.

$\therefore$ $\langle \text{velocity} \rangle = \dfrac{\text{displacement}}{\text{Time}} = \dfrac{10}{2} = 5\ m/s$

For next 8 sec., displacement = 20m.

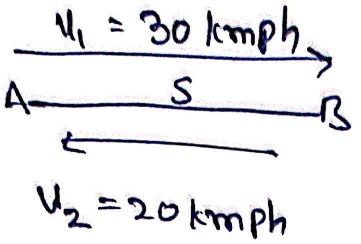
$\therefore$ $\langle \text{velocity} \rangle = \dfrac{\text{Displacement}}{\text{Time}} = \dfrac{20}{8} = 2.5\ m/s$

For total Journey $T = 10$ sec

Displacement = 20m + 10m = 30m

$\therefore$ $\langle \text{velocity} \rangle = \dfrac{\text{Displacement}}{\text{Time}} = \dfrac{30}{10} = 3\ m/s$

17.



Here total distance covered $= 2S$

First $\frac{1}{2}$ of distance speed is v_1

next half of distance speed is v_2

$$\langle velocity \rangle = \frac{2v_1 v_2}{v_1 + v_2}$$

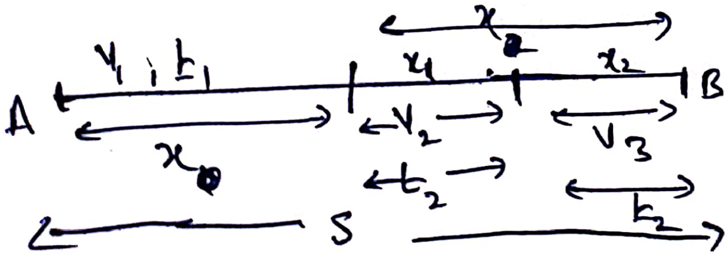
$$= \frac{2 \times 30 \times 20}{30+20} = \frac{\cancel{48}^{8} \times 3\cancel{0}}{\cancel{5}\cancel{0}} = 24 \text{ kmph.}$$

18.

If t_1 and $2t_2$ are the time taken by particle to cover first and second half distance respectively.

$t_1 = \frac{\frac{S}{2}}{3}$ Total distance $= S$

$v_1 = 3$ m/s $\quad v_2 = 4.5$ m/s



$x_1 = v_1 t_2$

$= 4.5 t_2$

$x_2 = 7.5 t_2$

$t_1 = \frac{S}{6}$

$\therefore$ Total time $= t_1 + t_2$

$= \frac{S}{6} + \frac{S}{12} = \frac{S}{4}$

$\therefore \quad x_1 + x_2 = \frac{S}{2}$

$\Rightarrow 4.5 t_2 + 7.5 t_2 = \frac{S}{2}$

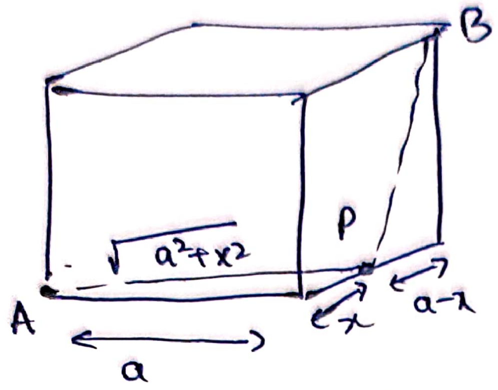
$\Rightarrow \quad 12 t_2 = \frac{S}{2}$

$\Rightarrow \quad t = \frac{S}{...}$

$$\langle speed \rangle = \frac{\text{Total distance}}{\text{Total time}}$$

$$= \frac{S}{\frac{S}{4}} = 4 \text{ m/s}$$

19



Distance = AP + PB

$$d = \sqrt{a^2+x^2} + \sqrt{(a-x)^2+a^2}$$

Time $t = \frac{d}{u}$

$$\therefore t = \frac{\sqrt{a^2+x^2} + \sqrt{(a-x)^2+a^2}}{u}$$

For minimum distance and time $\frac{dt}{dx} = 0$

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

$$= \frac{1}{u}\left[\frac{\cancel{2}x}{\cancel{2}\sqrt{a^2+x^2}} + \frac{\cancel{2}(a-x)(-1)}{\cancel{2}\sqrt{(a-x)^2+a^2}}\right] = \frac{1}{u}\left[\frac{x}{\sqrt{a^2+x^2}} - \frac{(a-x)}{\sqrt{(a-x)^2+a^2}}\right]$$

$$\frac{dt}{dx} = 0$$

$$\Rightarrow \frac{1}{u}\left[\frac{x}{\sqrt{a^2+x^2}} - \frac{(a-x)}{\sqrt{(a-x)^2+a^2}}\right] = 0$$

$$\Rightarrow \frac{x}{\sqrt{a^2+x^2}} = \frac{a-x}{\sqrt{(a-x)^2+a^2}} \qquad \text{s.o.b.s}$$

$$\Rightarrow \frac{x^2}{a^2+x^2} = \frac{(a-x)^2}{(a-x)^2+a^2}$$

$$x^2\cancel{(a-x)^2} + a^2x^2 = a^2(a-x)^2 + x^2\cancel{(a-x)^2}$$

$$\Rightarrow (ax)^{\cancel{2}} = [a(a-x)]^{\cancel{2}}$$

$$\therefore \quad x = a-x \Rightarrow 2x = a.$$

$$x = \frac{a}{2}$$

$$\therefore \quad d = \sqrt{(a^2+x^2} + \sqrt{(a-x)^2+a^2}$$

$$= \sqrt{a^2+\frac{a^2}{4}} + \sqrt{(a-\frac{a}{2})^2+a^2}$$

$$= \sqrt{\frac{5a^2}{4}} + \sqrt{\frac{a^2}{4}+a^2} = 2\sqrt{\frac{5a^2}{4}}$$

$$= \sqrt{5}\,a$$

(20)

Total displacement = $20-5 = 25$ m

$= -10$ m [Right +ve

left -ve]

Total time = 300 sec

$$\langle \text{velocity} \rangle = \frac{\text{Total displacement}}{\text{Total time}} = \frac{-10}{300}$$

$$= \frac{1}{30} = 0.33 \text{ m/s.}$$

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or $\boxed{16 \quad 17 \quad 18}$

26, 27, 28

Given $u = 50\ m/s$

Distance travelled in 6^{th} sec

$$S_n = u - \frac{g}{2}(2n-1) = 50 - \frac{10}{2}(2(6)-1)$$

$$= 50 - 5(12-1) = 50 - 5 \times 11$$

$$= 50 - 55 = -5\ m$$

ie the body is in downward motion.

and covered 5m in downward journey

Maximum height reached

$$H_{max} = \frac{u^2}{2g} = \frac{(50)^2}{2(10)} = \frac{2500}{2\times10}$$

$$= \frac{250}{2} = 125\,m$$

The time taken to reach max height

$$t_a = \frac{u}{g} = \frac{50}{10} = 5\,sec.$$

S_1 = distance travelled in Ist sec of upward motion

$$S_1 = u - \frac{g}{2}(2n-1) \quad \text{Here } n=1$$

$$= 50 - \frac{10}{2}(2(1)-1)$$

$$= 50 - 5(2-1) = 50 - 5 = 45\,m.$$

S_2 = distance travelled in Ist sec of downward motion

In this the body behaves like Freely falling body

so $u=0$; $a=+g$; $n=1$

$$\therefore S_2 = u + \frac{g}{2}(2n-1)$$

~~$S_2 = 50 + \frac{10}{2}$~~ $S_2 = 0 + \frac{\cancel{10}^{5}}{\cancel{2}}(2(1)-1)$

$$= 5(2-1)$$

$$= 5$$

$$\therefore S_1 : S_2 = 45 : 5 = 9 : 1.$$