8th advanced

WS- 5

(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 $\frac{h_1}{h_2}=\frac{2}{3}$

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

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

(2)

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

For .

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

Total distance travelled in t_1 sec

$$s_1 = \frac{1}{2}gt_1^2 \Rightarrow s_1 = h \Rightarrow h = \frac{1}{2}gt_1^2 \Rightarrow t_1 = \sqrt{\frac{2h}{g}}$$

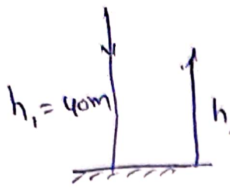
Distance travelled in t_2 & t_3 sec is $s_2 = \frac{1}{2}g(t_2+t_1)^2$; $s_3 = \frac{1}{2}g(t_3+t_2+t_1)^2$

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

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

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

(3)



let the contact time steps $t = 0.02s$.

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

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

v & u are in opp directions

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

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

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

$$= 2100 m/s^2$$

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

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

$\Rightarrow 78.4 = 2u + 19.6$

$\Rightarrow 2u = 78.4 - 19.6$

$\Rightarrow 2u = 58.8$

$\Rightarrow u = 29.4$ m/s

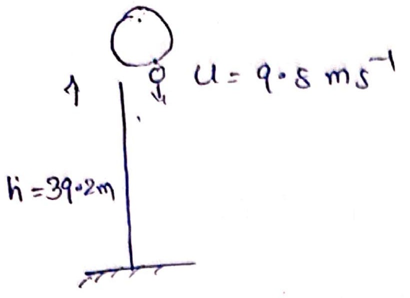
(5)

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.

∴ The displacement of the stone is

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

$$\Rightarrow 39.2 = -9.8\,t + \frac{1}{\cancel{2}} \overset{4.9}{\cancel{9.8}}\, t^2$$

$$\Rightarrow \overset{8}{\cancel{39.2}} = -\overset{2}{\cancel{9.8}}\, t + \cancel{4.9}\, t^2$$

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

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

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

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

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

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

(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 $H_{max} = \dfrac{u^2}{2g}$

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

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

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

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

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

(8)

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

$$a' = g - a$$

$$= 9.8 - 1.8$$

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

∴ 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 $S = \frac{7h}{16}$

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

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

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

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

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

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

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

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

$\Rightarrow n - 4 = 0$ (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

(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

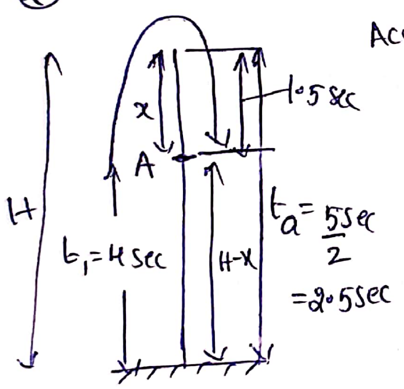
$\therefore$ In last sec $S = 29.23 - \frac{g}{2}[2 \times 3 - 1]$

$= 29.23 - 4.9[6-1]$

$= 29.23 - 24.5$

$= 4.73 \approx 4.9$ m

(22)



Acc to Given question Time of flight = 5sec

$\therefore$ 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 $H = \frac{U^2}{2g} \Rightarrow H = \frac{(2.5g)^2}{2g}$

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

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

$\Rightarrow H = 31.25$ 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 $s = ut + \frac{1}{2}at^2$

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

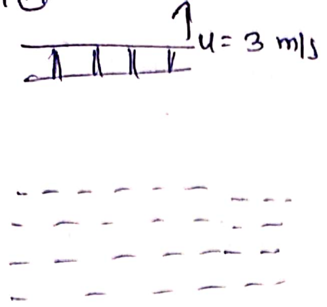
$\Rightarrow 31.25 - x = 0 + \frac{1}{\cancel{2}} \times \cancel{10}5 \times 2.25$

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

$\Rightarrow 31.25 - x = 11.25$

$\Rightarrow x = 20$m.

(17) (18), (19)



Total time taken to reach the water = 2 sec.

In this case $a = -g$

Height of the bridge is determined By using $s = ut$ $h = -ut + \frac{1}{2}gt^2$

$h = -3 \times 2 + \frac{1}{2} \times \cancel{10}^{5} \times 2^2$

$= -6 + 5 \times 4 = 20 - 6$ ~~39m~~

$= 14m$

let H_{max} = maximum height reached by the stone

$H_{max} = \frac{u^2}{2g} = \frac{3^2}{2 \times 9.8} = \frac{9}{19.6} \simeq 0.6m$

In this case displacement of the stone is nothing but height of the bridge from water.

$\therefore$ Displacement = 14m.

L Task

SAQ's

(1)

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

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

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

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

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

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

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

1st continuation

$\therefore$ From (1)

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

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

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

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

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

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

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

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

$$\Rightarrow n=6 \text{ sec.}$$

$\therefore$ From (1)

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

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

(2)

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

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

$$\Rightarrow V = 40 \text{ m/s}$$

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

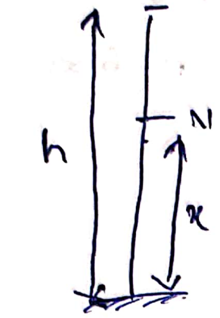
Distance travelled in the last sec

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

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

(24) (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

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

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

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

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

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

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

(6)

let $u = 58.8$ m/s be the velocity of projection

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

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

$$= 58.8 - 29.4$$

$$v = 29.4 \text{ m/s.}$$

After '3' sec acceleration due to gravity disappears

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

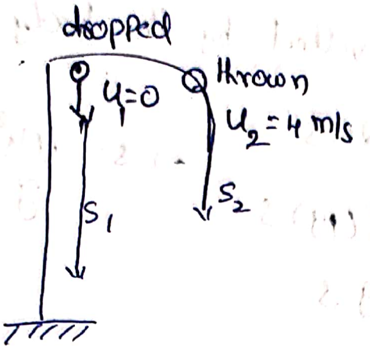
In next '5' sec distance $= v \times t$

$$= 29.4 \times 5$$

$$s = 147.0\ m$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$\therefore H = \frac{u^2}{2} \times \frac{1}{g}$ [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 $v^2 - u^2 = 2as$

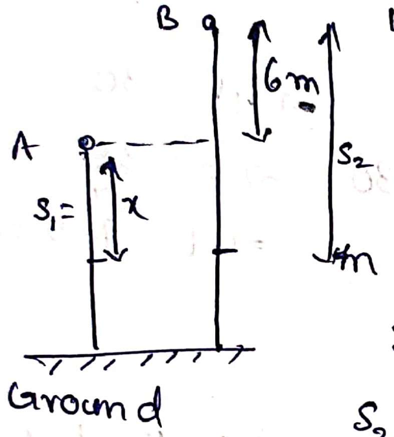
$\Rightarrow (3u)^2 - u^2 = 2(+g)s$

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

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

$\Rightarrow s = \frac{4u^2}{g}$

(10)



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

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

$t = 2sec$

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

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

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

$= 6m$

For ~~(16) (17) (18)~~ (26), (27), (28)

Given $u = 50\ m/s$

Distance travelled in 6^{th} sec

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

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

$= 50 - 55 = -5m$

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

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

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

$$= 5(2-1)$$

$$= 5$$

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

$\Rightarrow$