WS-7 vertically Projected body

Task

(1)

Given, velocity of body $= u$

It is at the same point at $t = 6s$ as was as at t...

so let $t_1 = 4s$ and $t_2 = 6s$, body is at a height h.

so $h = ut_1 - \frac{1}{2} g t_1^2 \rightarrow (1)$ and

$h = ut_2 - \frac{1}{2} g t_2^2 \rightarrow (2)$

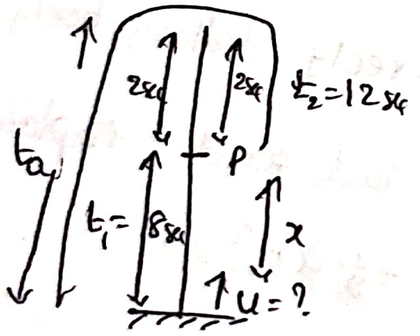
By solving $ut_1 - \frac{1}{2} g t_1^2 = ut_2 - \frac{1}{2} g t_2^2$

$\Rightarrow u(t_1 - t_2) = \frac{1}{2} g (t_1^2 - t_2^2)$

$\Rightarrow u\cancel{(t_1 - t_2)} = \frac{1}{2} g (t_1 + t_2)\cancel{(t_1 - t_2)}$

$\Rightarrow u = \frac{1}{2} \times \cancel{10}^{5} (4 + 6) = 5 \times 10 = 50 \, m/s$

(2)



$t_a = \frac{u}{g}$

$\Rightarrow u = t_a g = 10 \times 10 = 100 \, m/s$

Hence From $s = ut + \frac{1}{2} a t^2$

$\Rightarrow x = 100 \times 10 + \frac{1}{2}(-g)(10)^2$

$= 1000 - \frac{1}{2} \times 10 \times 100$

$= 500 \, m \simeq 450 m$

for $(g = 9.8 \, m/s^2)$

Given $u = 20\ m/s$; $t = 3\ sec$; $a = -g = -10\ m/s^2$

Distance travelled by the body in 3 sec

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

$$\Rightarrow s = 20 \times 3 + \frac{1}{2}(-\cancel{10}^{5})(3)^2$$

$$= 60 - 45 = 15\,m$$

(4)

Given distance covered in 5^{th} sec $= 2$ Distance covered in 6^{th} sec

$$\Rightarrow S_5 = 2S_6 \quad [\text{Here } a = -g]$$

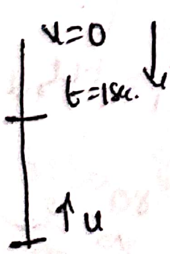
$$\Rightarrow u - \frac{g}{2}(2(5)-1) = 2\left[u - \frac{g}{2}(2(6)-1)\right]$$

$$\Rightarrow u - \frac{9g}{2} = 2u - \frac{22g}{2}$$

$$\Rightarrow 2u - u = \frac{22g}{2} - \frac{9g}{2} \Rightarrow u = \frac{13 \times g}{2} = \frac{13}{2} \times 10 = 65\,m/s$$

(5) (6)

let H be max height reached by the body $H = \frac{u^2}{2g}$



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

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

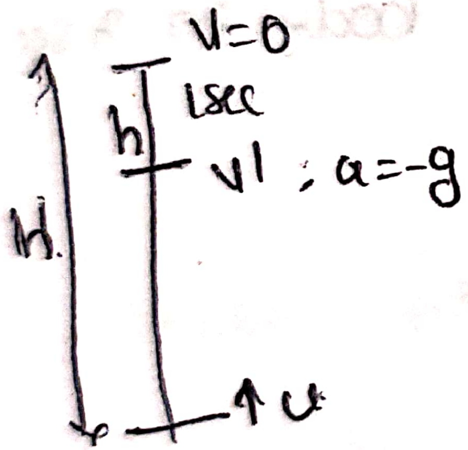
$$\Rightarrow -h = \frac{-g}{2} \Rightarrow h = \frac{g}{2} = \frac{9.8}{2} = 4.9\,m$$

The last second of vertically projected body acts as I^{st} sec of freely falling body

⑥. ⑤ continuation

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

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



h =

$\rightarrow 0^2 - v'^2 = 2(-g)h$

$\rightarrow -v'^2 = -\cancel{2}g \frac{g}{\cancel{2}}$

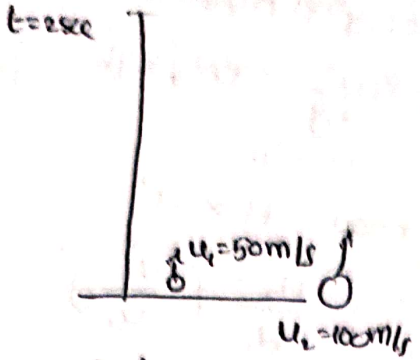
$\rightarrow v' = g$

⑦

Given $u_1 = 50$ m/s

, $u = 100$ m/s

(7)



$v_1 = u_1 - gt = 50 - 10\times 2$

$= 50 - 20 = 30\ m/s$

$u_2 = 100\ m/s$

$V_{rel} = V_{21} = 100 - 30 = 70\ m/s$

In 2 sec distance travelled by I^{st} body

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

$= 50(2) - \frac{1}{2}\times g(2)^2$

$\Rightarrow 100 - 20$

$= 80m.$

t' be the time of meeting

$t' = \frac{H}{V_{rel}} = \frac{80}{70}$

$= \frac{8}{7}$

Total time taken to meet $= 2 + t' = 2 + \frac{8}{7} = \frac{22}{7}$ sec

(8)

Given $u = 4.9\ m/s$

They are asking time taken to reach the ground

$T = \frac{2u}{g} = \frac{2\times 4.9}{9.8} = 1$ sec

(9)

After 6 sec the stone is at maximum height. In 7^{th} sec the stone act as FFB.

∴ distance travelled by the vertically projected body in last sec = Distance travelled by it in 7^{th} or Distance travelled by it in 1^{st} sec which act as FFB for return journey $\Rightarrow \frac{g}{2}$. ∴ $\frac{S_1}{S_7} = \frac{\frac{g}{2}}{\frac{g}{2}} = \frac{1}{1} = 1:1$

(10)

let 'u' be the velocity of Projection

$$H_{max} = \frac{u^2}{2g} \Rightarrow u = \sqrt{2gh} = \sqrt{2 \times 10 \times 40}$$

$u' = 3u$

we know $H \propto u^2$

$$\Rightarrow \frac{H_2}{H_1} = \left[\frac{u_2}{u_1}\right]^2$$

$$\Rightarrow \frac{H_2}{40} = \left[\frac{3u}{u}\right]^2 \Rightarrow \frac{H_2}{40} = 9$$

$\Rightarrow H_2 = 360 m.$

(12)

Scanned with OKEN Scanner

(13)

For vertically projected body

use $v^2 - u^2 = -2gs$ we know $h = \frac{u^2}{2g}$

$\Rightarrow v^2 = u^2 - 2gs$. $\Rightarrow 2gh = u^2$

(a) For $s = \frac{h}{2}$ $\Rightarrow v_1^2 = u^2 - 2g\frac{h}{2} = u^2 - \frac{u^2}{2} = \frac{u^2}{2}$

$\Rightarrow v_1 = \frac{u}{\sqrt{2}}$

(b) For $s = \frac{3h}{4}$ $\Rightarrow v_2^2 = u^2 - 2g\left(\frac{3h}{4}\right) \Rightarrow u^2 - \frac{3u^2}{4} = \frac{u^2}{4}$

$\Rightarrow v_2 = \frac{u}{2}$

(c) For $s = \frac{h}{3}$ $\Rightarrow v_3^2 = u^2 - 2g\frac{h}{3} = u^2 - \frac{u^2}{3} = \frac{2u^2}{3}$

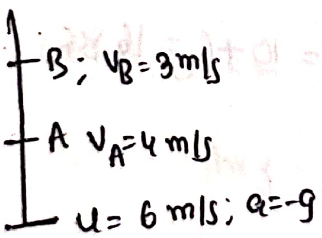
$\Rightarrow v_3 = \sqrt{\frac{2}{3}}\, u$

(d) For $s = \frac{h}{4}$. $\Rightarrow v_4^2 = u^2 - 2g\frac{h}{4} = u^2 - \frac{u^2}{4} = \frac{3u^2}{4}$

$\Rightarrow v_4 = \frac{\sqrt{3}}{2} u$.

(14)

Given $u = 6$ m/s



height of A $\Rightarrow v_A^2 - u^2 = -2g\,h_A$

$\Rightarrow 4^2 - 6^2 = -2 \times 10 \times h_A$

$\Rightarrow (10)(-2) = -20\,h_A$

$h_A = 1$ m

height of B $\Rightarrow v_B^2 - u^2 = -2g\,h_B$

$\Rightarrow 3^2 - 6^2 = -2 \times 10\, h_B$

$\Rightarrow 9 \times (-3) = -20\,h_B$

$h_B = \frac{27}{20} = 1.35$ m.

$h_B - h_A = 1.35 - 1$

$= 0.35$ m

(15)

For a vertically projected body

Time of flight

$\Rightarrow \frac{2u}{g} = 2 \Rightarrow u = g$

$H_{max} = \frac{u^2}{2g} \Rightarrow \frac{g^2}{2g} = \frac{g}{2} = \frac{9.8}{2} = 4.9m \simeq 5.$

(16)

Clearly Time of flight $T = \frac{2u}{g} = 3sec.$

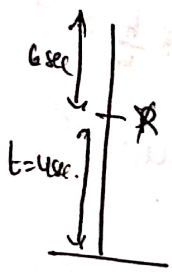
$u = \frac{3g}{2}$

$H_{max} = \frac{u^2}{2g} = \frac{(\frac{3g}{2})^2}{2g} = \frac{\frac{3g}{2} \times \frac{3g}{2}}{2g} \Rightarrow \frac{9 \times g}{8} = 45m$

(17)

Given

$u = 98 m/s$



$T_a = \frac{u}{g} = \frac{98}{g} = \frac{98}{9.8} = 10$ sec.

To reach maximum height from Ground

Time taken = 10 sec

From x to top = 6sec

From top to x → 6sec.

∴ Total time from ground to x in downward

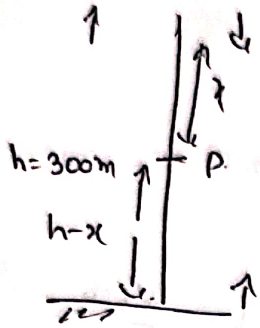
Journey = 10+6 = 16 sec

LTask

See mama

1

Given $h = 300$



$\downarrow u_1 = 0;\ a_1 = g$

$\uparrow u_2 = 150\,m/s;\ a_2 = -g$

let P is a meeting point

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

FFB

$S = x;\ u = 0;\ a = g$

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

$\Rightarrow x = \frac{1}{2} g t^2 \rightarrow (1)$

UPB

$S = 300 - x;\ u_2 = 150;\ a = -g$

$\Rightarrow 300 - x = 150t - \frac{1}{2} g t^2 \rightarrow (2)$

From (1) and (2)

$\Rightarrow 300 - \cancel{\frac{1}{2} g t^2} = 150t - \cancel{\frac{1}{2} g t^2}$

$\Rightarrow 300 = 150t \Rightarrow t = 2\ sec.$

From top height $x = \frac{1}{2} \times g t^2$

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

$= 2 \times 9.8 = 19.6\,m.$

2

Given $H_{max} = g$

From $H = \frac{u^2}{2g} \Rightarrow u^2 = 2gH \Rightarrow u^2 = 2g \times g$

$\Rightarrow u = \sqrt{2}\, g = 14.14\,m/s$

3

Given $u = 5m$

They asking maximum height reached

$H_{max} = \frac{u^2}{2g} = \frac{5^2}{2 \times 10} = \frac{25}{20} = 1.25m$

4

Given

$u = 100\,m/s$

Time of flight $T = \frac{2u}{g} = \frac{2 \times 100}{10} = 20\ sec.$

⑤

Time of ascent $= 2$ sec ; $t = 2$ sec.

$\frac{u}{g} = 2 \Rightarrow u = 2g$; $a = -g$

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

$\Rightarrow 2^2 - (2g)^2 = 2(-g)\,h$

$\Rightarrow 4 - 4g^2 = -2g\,h$

$\Rightarrow 4 - 4\times 100 = -20\,h$

$\Rightarrow -396 = -20\,h \Rightarrow h = \frac{39.6}{2}$

Given $H = a$

we

⑥

Given

$T = 4$ sec

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

$\Rightarrow u = 2g = 19.6\,m$

⑦

$H_e = 12m$: $g_e = g$.

$g_m = \frac{1}{6} g$

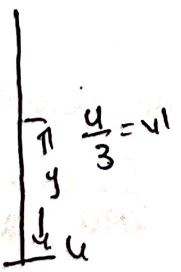
$H_{max} = \frac{u^2}{2g}$; $u =$ same

$\Rightarrow \frac{H_m}{H_e} = \frac{g_e}{g_m}$

$\Rightarrow \frac{H_m}{12} = \frac{g}{\frac{1}{6}g}$

$\Rightarrow H_m = 12\times 6 = 72m$

⑧



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

$\Rightarrow (\frac{u}{3})^2 - u^2 = 2(-g)y$

$\Rightarrow -\frac{8u^2}{9} = -2g\,y$

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

We know $H = \frac{u^2}{2g}$

$\Rightarrow y = \frac{8}{9} H$

$\Rightarrow H = \frac{9y}{8}$.

Given $H = 9.8 m.$

we know $H = \frac{u^2}{2g}$

$\Rightarrow u = \sqrt{2gH} = \sqrt{2 \times 9.8 \times 9.8} = 9.8\sqrt{2}$ m/s

Time of flight $= \frac{2u}{g} = \frac{2 \times 9.8\sqrt{2}}{9.8} = 2\sqrt{2}$ sec.

(10)

let 'u' be velocity of projection.

at $s = \frac{H}{2}$, $v = 10$ m/s, $a = -g$

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

$\Rightarrow 10^2 - u^2 = -2g\left(\frac{H}{2}\right)$

$\Rightarrow 100 - u^2 = -g\frac{u^2}{2g}$

$\Rightarrow 100 = -\frac{u^2}{2} + u^2 \Rightarrow \frac{u^2}{2} = 100$

$u^2 = 200 m$

$\therefore H = \frac{u^2}{2g} = \frac{200}{2 \times 10} = 10 m.$

(4)

(i) Given $u = 100$ m/s

Time of flight $= T = \frac{2u}{g} = \frac{2 \times 100}{10} = 20$ sec.

(ii)

Given $\frac{u_1}{u_2} = \frac{2}{3}$ $\because$ we know $H \propto u^2$.

$\frac{H_1}{H_2} = \left[\frac{u_1}{u_2}\right]^2 = \left[\frac{2}{3}\right]^2 = \frac{4}{9}$

Given $H_{max} = 45m$

$$u' = \frac{u}{2}$$

$$H_{max} = \frac{u^2}{2g} \Rightarrow u = \sqrt{2gH}$$

$$= \sqrt{2\times10\times45}$$

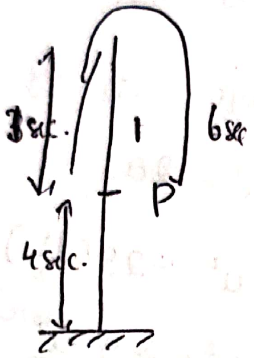
$$= 30 \text{ m/s}$$

t = Time $= \frac{u}{g} = \frac{30}{10} = 3$ sec.

$$\frac{t'}{t} = \frac{u'}{u}$$

$$\Rightarrow \frac{t'}{3} = \frac{u/2}{u} \Rightarrow t' = \frac{3}{2} = 1.5 \text{ sec}$$

(15)



total Time of ascent $T = \cancel{4\text{ sec}}\ 5$

$$\Rightarrow \frac{u}{g} = 5 \Rightarrow u = 5g$$

∴ Maximum height reached by it

$$H = \frac{u^2}{2g} = \frac{(5g)^2}{2g}$$

$$= \frac{25g^2}{2g} = \frac{25\times10}{2} = 125m.$$

(16)

Given $u = 20 m/s$

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

$a = -g$; $S = H = \frac{u^2}{2g}$

$$S = \frac{3}{4}H = \frac{3}{4}\times\frac{u^2}{2g}$$

$$= \frac{3}{4}\times\frac{20\times20}{20}$$

$$= 15m$$

$$\Rightarrow v^2 - (20)^2 = 2(-g)\left(\frac{3}{4}H\right)$$

$$\Rightarrow v^2 - 400 = -2\times10\times15$$

$$\Rightarrow v^2 - 400 = -300$$

$$\Rightarrow v^2 = 100 \Rightarrow v = 10 \text{ m/s}$$