WS-12. Vertically Projected body ~~12~~ 8th faund +

Thank

(1)

In case of vertically Projected body

Maximum height $H = \frac{u^2}{2g}$

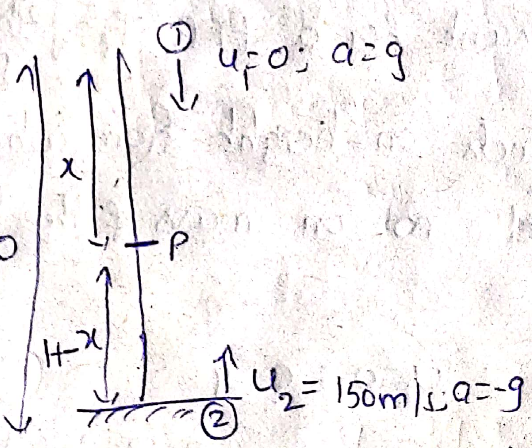
For $u_1 = u \rightarrow h_1 = 100\,m$

$u_2 = 2u \rightarrow h_2 = ?$

$$\Rightarrow \frac{h_1}{h_2} = \left[\frac{u_1}{u_2}\right]^2 \Rightarrow \frac{100}{h_2} = \left(\frac{u}{2u}\right)^2$$

$$\Rightarrow \frac{100}{h_2} = \frac{1}{4} \Rightarrow h_2 = 400\,m \rightarrow A$$

(2)



let 'p' be the meeting point

$$H_{max} = \frac{u_2^2}{2g} = \frac{(150)^2}{2 \times 10}$$

$$= \cancel{\frac{225 \times 100}{20}}$$

Here time taken by both bodies to reach P is same

For FFB (1) $\quad s = ut + \frac{1}{2}at^2$

$$x = \frac{1}{2}gt^2$$

For vertically projected body $\quad H - x = ut - \frac{1}{2}gt^2$

$$H - x = 150t - \frac{1}{2}gt^2 \qquad \therefore x = \frac{1}{2}g(2)^2$$

$$\Rightarrow 300 - \cancel{\frac{1}{2}gt^2} = 150t - \cancel{\frac{1}{2}gt^2} \qquad \underline{x = 19.6\,m}$$

$\rightarrow A$

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

(3)

Given $H_{max} = g$.

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

$\Rightarrow g = \frac{u^2}{2g} \Rightarrow u^2 = 2g^2 \Rightarrow u = \sqrt{2}\, g$

$\Rightarrow u = 1.414 \times 10 = 14.14 \text{ m/s} \rightarrow B$

(4)

let u be the initial velocity of stone = 5 m/s

It comes to rest at max height $H_{max} = \frac{u^2}{2g}$

$H = \frac{5^2}{2\times10} = \frac{25}{20} = \frac{5}{4} = 1.25 \text{ m} \rightarrow A$

(5)

Given initial velocity $u = 100$ m/s

Time of flight $= \frac{2u}{g} = \frac{2\times100}{10} = 20$ sec $\rightarrow C$.

(6)

For a VPB $u = 2$ m/s $a = -g = -9.8 \text{ m/s}^2$

Here time taken by the body to cross an observer $t = 2$ sec

Displacement/distance travelled by the body = height of tower

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

$\Rightarrow H = 2\times(2) + \frac{1}{\cancel{2}}(-9.8)(2)^{\cancel{2}}$

$= 4 - 19.6$

$= -15.6 \text{ m} \rightarrow D$

'-ve' shows direction of displacement of the body

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(7)

Here Time of flight for VPB is given by

$T = 4$ sec

$\Rightarrow \frac{2u}{g} = 4 \Rightarrow \frac{2 \times u}{9.8} = 4^{2}$

$\Rightarrow u = 2 \times 9.8 = 19.6$ m/s $\rightarrow$ (b)

(8)

Any VPB reaches the ground with same velocity as that of velocity of Projection.

So velocity on reaching ground = 100 m/s — C

(9)

Here Time of flight for VPB is $T = \frac{2u}{g}$

It is independent on mass of the body

$\therefore \frac{T_1}{T_2} = \frac{u_1}{u_2} \rightarrow$ C.

(10)

Given $u = 39.2$ m/s

$H_{max} = \frac{u^2}{2g} = \frac{(39.2)^2}{2 \times 9.8} =$

$= \frac{39.2 \times 39.2}{2 \times 9.8}$

$\Rightarrow 78.4$ m $\rightarrow$ A

Advanced

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

$$\text{Time of flight} = \frac{2u}{g} = \frac{2 \times 100}{10}$$

$$= 20\ sec$$

(ii) we know that $H_{max} = \frac{u^2}{2g}$

$$\Rightarrow H \propto u^2$$

$$\Rightarrow \frac{H_1}{H_2} = \left(\frac{u_1}{u_2}\right)^2 \Rightarrow \frac{H_1}{H_2} = \left(\frac{2}{3}\right)^2 = \frac{4}{9} \rightarrow B$$

(iii)

Maximum height $H = 45\ m.$

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

$$u^2 = 2gH = 2 \times 10 \times 45$$

$$u = \sqrt{900} = 30\ m/s$$

let t_1 be the time taken.

Acc to question New velocity $v' = \frac{u}{2} = 15\ m/s$

From $v = u + at$

$$\Rightarrow v' = u - gt$$

$$\Rightarrow 15 = 30 - 10t$$

$$\Rightarrow t = 1.5\ sec$$

(7)

Given $u = 39.2\ m/s$

$$H_{max} = \frac{u^2}{2g} = \frac{(39.2)^2}{2g} = 78.4\ m.$$

(8)

For FFB $u = 0;\ a = g$

$$\text{From } S_n = \frac{g}{2}(2n-1) = \frac{9.8}{2}(2(6)-1) = 4.9 \times 11$$

$$= 53.9\ m$$

LTask CUQ's

(4)

when the body reaches point of projection initial and final positions are same

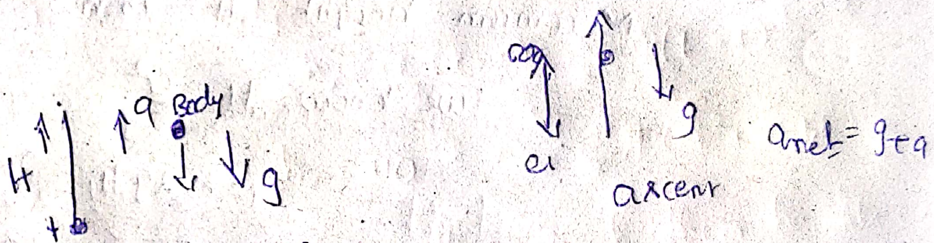
$\therefore$ displacement = Final position − initial position

$\Rightarrow$ displacement = 0

Distance = 2 times to the maximum height reached by the body.

(5)

If air resistance is considerable



Descent $a_{net} = g - a$

Since Time of ascent $= \frac{u}{g-a}$

Time of descent $= \frac{u}{g+a}$.

$\therefore$ T_{ascent} > T_{ime} of descent

(10)

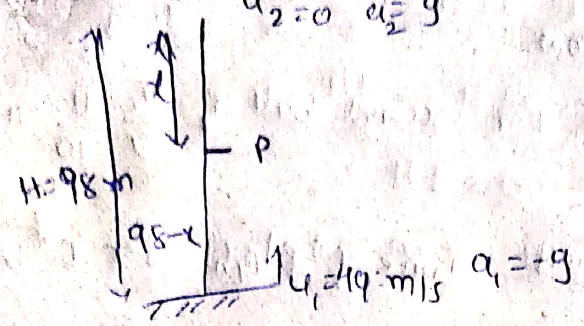
We know in case of VPB at heighest point $v = 0$

Distance travelled in last second of upward journey = Distance travelled in the first second of downward journey $= \frac{1}{2} g t^2 = \frac{1}{2}(9.8)(1)^2$
$= 4.9\,m.$

Hence distance travelled is independent on velocity of projection.

SAQ's

(1)



let 'p' be the meeting point
Time taken by the two bodies to reach p is same.

For FFB From $s = ut + \frac{1}{2}at^2$; $s = x$

$\Rightarrow x = 0 \times t + \frac{1}{2} g t^2 \Rightarrow x = \frac{1}{2} g t^2 \rightarrow (1)$

For VPB $s = 98 - x$ $u = 49$ m/s

$\Rightarrow 98 - x = 49t - \frac{1}{2} g t^2$

By sub (1) $\Rightarrow 98 - \frac{1}{2} g t^2 = 49t - \cancel{\frac{1}{2} g t^2}$

$\Rightarrow t = \frac{98}{49} = 2$ sec.

$\therefore$ At P Velocity of FFB $v = g t = 2 \times 9.8$
$= 19.6$ m/s

For VPB $v_1 = u - g t$
$= 49 - 9.8 \times 2 \Rightarrow 49 - 19.6$
$\Rightarrow 29.4$ m/s upward
$\rightarrow B$

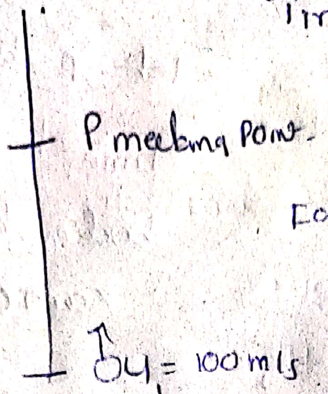
(2) For given question Time of ~~flight~~ ascent $= 6$ sec.

So 7^{th} sec. will act as I^{st} sec for downward journey. we know distance travelled by VPB in I^{st} sec of upward journey = Distance travelled by the same body in I^{st} sec of downward journey

$S_{up} = S_{down} = \frac{1}{2} g t^2 = \frac{1}{2}(9.8)(1) = 4.9$ m

$\therefore S_{up} : S_{down} = 1 : 1 \rightarrow A$

(3)



Time of flight for I^{st} ball

$$T_1 = \frac{u_1}{g} = \frac{100}{10} = 10\,sec$$

For second ball $T_2 = \frac{u_2}{g} = \frac{110}{10} = 11\,sec$

Time of flight for I^{st} body

$u_2 = 110$ m/s

$$T = 2T_1 = 20\,sec$$

The height of I^{st} body at time 't'

$$h_1 = u_1 t - \frac{1}{2} g t_1^2 = 100t - \frac{1}{2} 9.8\, t^2$$

For second body

$$h_2 = u_2 (t-2) - \frac{1}{2}(g)(t-2)^2$$

$$\rightarrow h_2 = 110(t-2) - \frac{1}{2} g (t^2 + 4 - 4t)$$

At the time of their meet their heights equal

$$h_1 = h_2$$

$$\Rightarrow 100t - \frac{1}{2} g \cancel{t^2} = 110t - 220 - \cancel{\frac{1}{2} g t^2} - \frac{1}{2} g(4) + \frac{1}{2} g(4t)$$

$$\Rightarrow 100t = 110t - 220 - 2g + 2gt$$

$$\rightarrow 100t = 110t - 220 - 20 + 20t$$

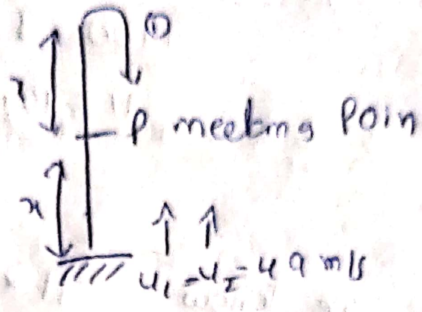
$$\rightarrow 30t = 240 \rightarrow t =$$

$$t = 8\,sec \rightarrow B$$

(4) Here two bodies Projected with a same velocity

$u_1 = u_2 = 49$ m/s

let 't' be time taken by first body to meet 2nd body



here both bodies travell same distance to meet

For I^{st} body From $s = ut + \frac{1}{2}at^2$

$\Rightarrow S = 49t - \frac{1}{2}gt^2$

For 2^{nd} body $S = 49(t-2) - \frac{1}{2}g(t-2)^2$

$49t - \frac{1}{2}gt^2 = 49(t-2) - \frac{1}{2}g(t-2)^2$

$\Rightarrow \cancel{49t} - \cancel{\frac{1}{2}gt^2} = \cancel{49t} - 98 - \cancel{\frac{1}{2}gt^2} - 2g + 2gt$

$\Rightarrow 0 = -98 - 19.6 + 2 \times 9.8 \times t$

$\Rightarrow 117.6 = 19.6t \Rightarrow t = 6$ sec. $\rightarrow$ C.

(5)

Time of ascent $= \frac{u}{g} = \frac{14.7}{9.8} \simeq 1.5$ sec $\rightarrow$ A

(6)

let H be maximum height v be the velocity $= 10$ m/s

From $v^2 - u^2 = 2as$ $S = \frac{H}{2}$

$\Rightarrow 10^2 - u^2 = -\cancel{2}g\frac{h}{\cancel{2}} \Rightarrow 100 - u^2 = -gh$ —(1)

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

$u^2 = 2gH$

$\therefore 100 - 2gH = -gH$

$\Rightarrow 100 = gH$

$H = 10m$ → A

(7)

We know $H \propto u^2$

Given $u_1 = u \rightarrow H_1 = 75m$

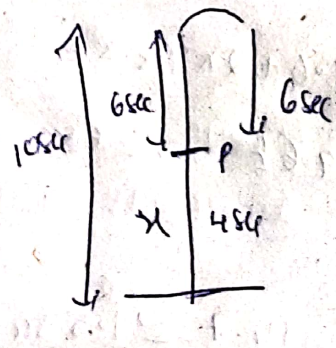
$u_2 = 2u \rightarrow H_2 = ?$

$\frac{H_1}{H_2} = \left[\frac{u_1}{u_2}\right]^2 \Rightarrow \frac{75}{H_2} = \left[\frac{u}{2u}\right]^2$

$\Rightarrow H_2 = 75 \times 4 = 300m$ → D

(8)

Given $u = 98$ m/s

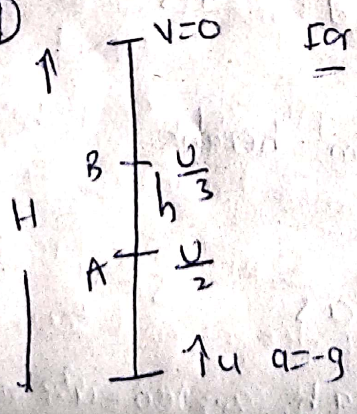


Total time of ascent $= \frac{u}{g} = \frac{98}{9.8} = 10$

$\therefore$ Again it is $t = 10$ sec

at P after 12 sec → D

(9)



For AB $s = h$ From $v^2 - u^2 = 2as$

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

$\Rightarrow \frac{u^2}{9} - \frac{u^2}{4} = -2gh$

$\Rightarrow \frac{5u^2}{36} = 2gh$

$\Rightarrow \frac{u^2}{2g} = \frac{36h}{5}$

$36h$ → A

(10) we know Max height $H = \frac{u^2}{2g}$

at a height h velocity of the body $v = \frac{u}{2}$

From $v^2 - u^2 = 2as$ $s = h;\ a = -g$

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

$\Rightarrow \frac{3}{4}u^2 = 2gh \Rightarrow \frac{u^2}{2g} = \frac{4h}{3}$

$\Rightarrow H = \frac{4h}{3} \rightarrow D$

Advanced

(1) In case of VPB direction of motion of the body and acceleration due to gravity are in opp directions so velocity decreases with 't'

From $v = u + at$ $a = -g$

$v = u - gt$

Since $K.E = \frac{1}{2}mv^2 \Rightarrow K.E \propto v^2$ so K.E decrease

~~From $v^2 - u^2 = 2(a)s$~~

~~$v^2 = u^2 + 2as \Rightarrow v^2 = u^2 - 2gs$~~

A

(2) From $v^2 = u^2 - 2gh$; $h = $ max height $= \frac{u^2}{2g}$

(a) at $\frac{h}{2} \Rightarrow v^2 = u^2 - 2g\frac{h}{2} = u^2 - \frac{u^2}{2} = \frac{u^2}{2}$

$v = \frac{u}{\sqrt{2}}$

(b) at $\frac{3}{4}h \Rightarrow v^2 = u^2 - 2g(\frac{3h}{4}) = u^2 - \frac{3u^2}{4} = \frac{u^2}{4}$

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

(c) at $\frac{1}{3}h$ $v^2 = u^2 - 2gh \Rightarrow v^2 = u^2 - 2g \frac{h}{3}$

$\Rightarrow$

$\Rightarrow v^2 = u^2 - \frac{u^2}{3} = \frac{2}{3}u^2$

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

(d) at $\frac{1}{4}h \Rightarrow v^2 = u^2 - 2g\frac{h}{4} \Rightarrow u^2 - \frac{u^2}{4}$

$v^2 = \frac{3}{4}u^2 \Rightarrow v = \frac{\sqrt{3}}{2}u$.

C.