

WS-12. Vertically Projected body 128th found +

Thank

①

In case of vertically Projected body

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

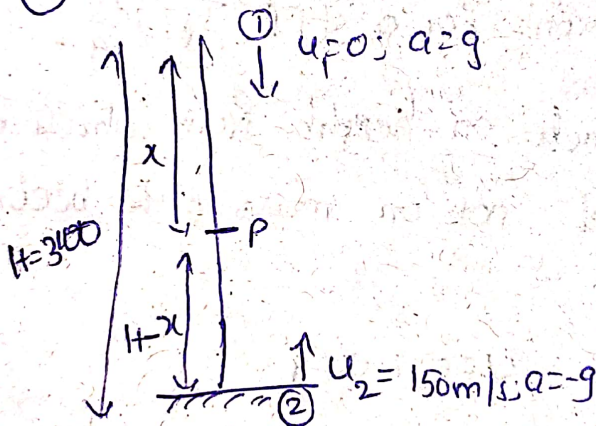
$$\text{For } u_1 = u \rightarrow h_1 = 100 \text{ m}$$

$$u_2 = 2u \rightarrow h_2 = ?$$

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

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

②



Let 'P' be the meeting point

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

$$= 1125 \times \frac{100}{200} = 562.5 \text{ m}$$

Here time taken by both bodies to reach P is same

same

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

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

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

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

$$\Rightarrow 300 - \frac{1}{2}gt^2 = 150t - \frac{1}{2}gt^2 \quad x = 19.6 \text{ m}$$

$$\Rightarrow 300 = 150t \Rightarrow t = 2 \text{ sec.} \rightarrow A$$

3

Given $H_{\max} = 9$

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

$$H = \frac{5^2}{2 \times 10} = \frac{25}{20} = \frac{5}{4} = 1.25 \text{ m} \rightarrow A$$

5

Given initial velocity $u = 100 \text{ m/s}$

$$\text{Time of flight} = \frac{2u}{g} = \frac{2 \times 100}{10} = 20 \text{ sec} \rightarrow C$$

6

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

Here time taken by the body to cross an observer $t = 2 \text{ sec}$

displacement/distance travelled by the body = height of tower

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

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

$$= 4 - 19.6$$

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

(-ve) shows direction of displacement of the body

7

Here Time of flight for VPB is given by

$$T = 4 \text{ sec}$$

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

$$\Rightarrow u = 2 \times 9.8 = 19.6 \text{ m/s} \rightarrow \text{B}$$

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

$$\text{Given } u = 39.2 \text{ m/s}$$

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

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

$$\Rightarrow 78.4 \text{ m} \rightarrow A$$

Advanced

⑥

(i) Given $u = 100 \text{ m/s}$

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

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

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

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

⑦

Maximum height $H = 45 \text{ m}$

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

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

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

Let t , be the time taken.

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

$$\text{From } v = u + at$$

$$\Rightarrow v = u - gt$$

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

$$\Rightarrow t = 1.5 \text{ sec}$$

⑧

Given $u = 39.2 \text{ m/s}$

$$H_{\text{max}} = \frac{u^2}{2g} = \frac{(39.2)^2}{2 \times 9.8} = 78.4 \text{ m}$$

⑨

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

$$\text{From } S_n = \frac{g}{2}(2n-1) = \frac{9.8}{2}(2(6)-1) = 4.9 \times 11 \\ = 53.9 \text{ m}$$

(4)

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

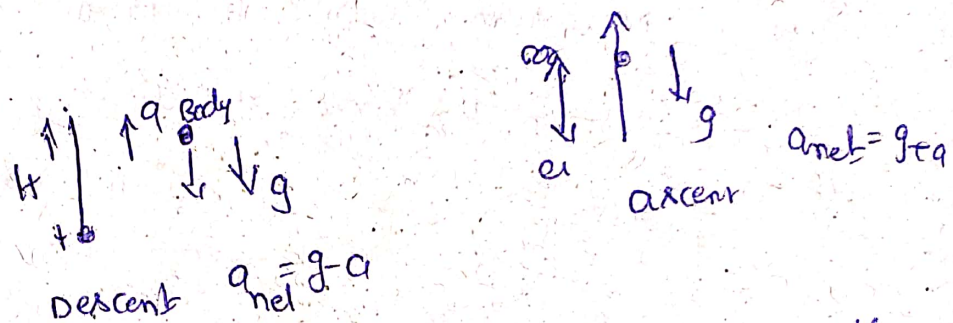
$$\therefore \text{displacement} = \text{Final position} - \text{Initial position}$$

$$\Rightarrow \text{displacement} = 0$$

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

(5)

if air resistance is considerable



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

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

$$\therefore T_{\text{ascent}} > T_{\text{descent}}$$

(16)

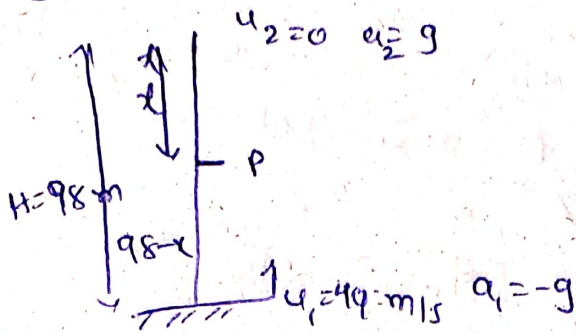
We know in case of V.P.B. at highest point

$$v = 0$$

Distance travelled in last second of
upward journey = Distance travelled in the first
second of downward journey = $\frac{1}{2}gt^2 = \frac{1}{2}(g-a)(1)^2$
= 4.9 m

Hence distance travelled is independent on velocity of
projection.

①



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

For FFB

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

$\Rightarrow x = 0 \cdot t + \frac{1}{2} g t^2 \Rightarrow x = \frac{1}{2} g t^2 \rightarrow \text{①}$

For VPB

$s = 98 - x$, $u = 49 \text{ m/s}$

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

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

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

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

For VPB

$v_1 = u - g t$

$= 49 - 9.8 \times 2 \Rightarrow 49 - 19.6$

$= 29.4 \text{ m/s upwards}$

$\rightarrow B$

② For given question Time of flight = 6 sec

So 7th sec will act as 1st sec for downward journey. we know distance travelled by VPB in 1st sec of upward journey = distance travelled by the same body in 1st sec of downward journey

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

(3)

Time of flight for 1st ball

$$T_1 = \frac{u_1}{g} = \frac{100}{10} = 10 \text{ s}$$

Meeting point

$$\text{For second ball } T_2 = \frac{u_2}{g} = \frac{110}{10} = 11 \text{ s}$$

Time of flight for 2nd body

$$u_1 = 100 \text{ m/s}$$

$$T = 2T_1 = 20 \text{ s}$$

The height of 1st body at time 't'

$$h_1 = u_1 t - \frac{1}{2} g t^2 = 100t - \frac{1}{2} \cdot 10 \cdot t^2$$

For second body

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

$$\Rightarrow h_2 = 110(t-2) - \frac{1}{2} \cdot 10 (t^2 + 4 - 4t)$$

At the time of their meet their heights equal

$$h_1 = h_2$$

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

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

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

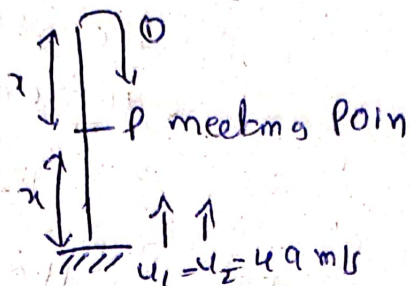
$$\Rightarrow 50t = 240 \Rightarrow t =$$

$$t = 8 \text{ s} \rightarrow B$$

(4) Here two bodies projected with a same velocity

$$u_1 = u_2 = 49 \text{ m/s}$$

let t be time taken by first body to meet 2nd body



here both bodies travel same distance

to meet

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

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

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

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

$$\Rightarrow 49t - \frac{1}{2}gt^2 = 49t - 98 - \frac{1}{2}gt^2 + 2g + 29t$$

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

$$\Rightarrow 117.6 = 19.6t \Rightarrow t = 6 \text{ sec} \rightarrow C$$

(5)

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

(6)

let H be maximum height v be the

$$\text{velocity} = 10 \text{ m/s}$$

$$\text{From } v^2 - u^2 = 2as$$

$$s = \frac{H}{2}$$

$$\Rightarrow 10^2 - u^2 = -2gh \Rightarrow 100 - u^2 = -9h \Rightarrow 0$$

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

$u^2 = 2gH$

$100 - 2gH = -gH$

$\Rightarrow 100 = gH$

$H = 10\text{m} \rightarrow A$

⑦

We know $H \propto u^2$

Given $u_1 = u \rightarrow H_1 = 75\text{m}$

$u_2 = 2u \rightarrow H_2 = ?$

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

$\Rightarrow H_2 = 75 \times 4 = 300\text{m} \rightarrow D$

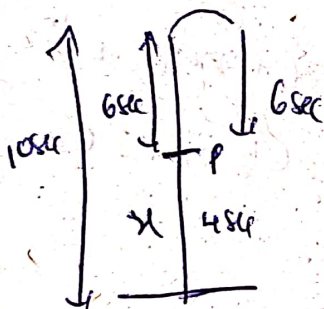
⑧

Given $u = 9.8\text{m/s}$

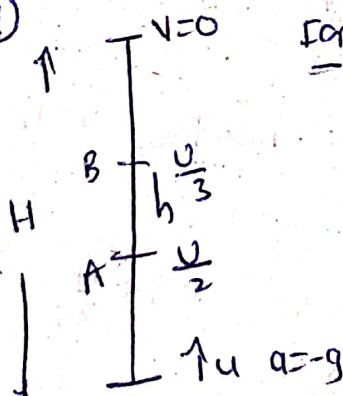
Total time of ascent $= \frac{u}{g} = \frac{9.8}{9.8}$

$\therefore$ Again it is $10\text{sec} = 10$

at P after 12 sec $\rightarrow D$



⑨



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

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

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

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

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

$\Rightarrow H = \frac{36h}{5} \rightarrow D$

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

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

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

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

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

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

Advanced

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

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

$$\underline{v = u - gt}$$

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

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

$$\underline{v^2 = u^2 - 2as \Rightarrow v^2 = u^2 - 2gs}$$

✱

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

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

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

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

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

$$\begin{aligned} \textcircled{c} \quad \text{at } \frac{1}{3} h \quad v^2 &= u^2 - 2g \frac{h}{3} \Rightarrow v^2 = u^2 - \frac{2gh}{3} \\ &\Rightarrow v^2 = u^2 - \frac{u^2}{3} = \frac{2}{3} u^2 \\ &\Rightarrow v = \sqrt{\frac{2}{3}} u \end{aligned}$$

$$\begin{aligned} \textcircled{d} \quad \text{at } \frac{1}{4} h \Rightarrow v^2 &= u^2 - 2g \frac{h}{4} \Rightarrow u^2 - \frac{u^2}{2} \\ v^2 &= \frac{u^2}{2} \Rightarrow v = \frac{\sqrt{2}}{2} u \end{aligned}$$

C.