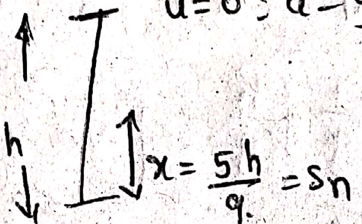
WS-11- Freely falling body 8th foundation + TTask

① let 'h' be the height of the tower.

and 'n' be the total time taken by the stone to reach ground




In $n^{th}$ sec it covers a distance $\frac{5h}{9}$

From ~~$S_n = \frac{a}{2}(2n-1)$~~

From $s=\frac{1}{2}gt^2$

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

$S_n=\frac{g}{2}(2n-1)$

$\frac{5h}{9}=\frac{g}{2}(2n-1) \rightarrow ②$

From ① & ②

$$\frac{5}{9}\times\frac{1}{\cancel{2}}\cancel{g}n^2=\frac{\cancel{g}}{\cancel{2}}(2n-1)$$

$$\Rightarrow 5n^2=9(2n-1)$$

$$\Rightarrow 5n^2=18n-9$$

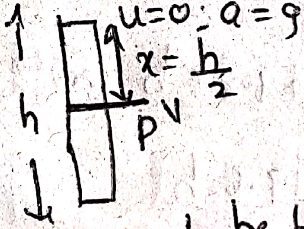
$$\Rightarrow 5n^2-18n+9=0$$

$$\Rightarrow 5n^2-15n-3n+9=0$$

$$\Rightarrow 5n(n-3)-3(n-3)=0 \Rightarrow (5n-3)(n-3)=0$$

$$\Rightarrow n=3\text{ sec.} \rightarrow B$$

②




From $v=u+at$

velocity at mid point $v=0+gt$

$\Rightarrow v=gt$

$t$ be the time taken to reach $P$

$$\therefore t=\sqrt{\frac{2x}{g}}=\sqrt{\frac{2(\frac{h}{2})}{g}}=\sqrt{\frac{h}{g}}$$

From 'P' No gravity

distance travelled $s = \frac{h}{2}$ to reach

ground, and time taken $t'$

we know time = $\frac{\text{distance}}{\text{velocity}}$

$\Rightarrow t' = \frac{\frac{h}{2}}{v} = \frac{h}{2v} = \frac{h}{2} \times \frac{1}{gt}$

$t' = \frac{h}{2} \frac{1}{g} \frac{1}{\sqrt{\frac{h}{g}}}$ $\left[ v = gt = g\sqrt{\frac{h}{g}} \right]$

$\Rightarrow t' = \frac{h}{2} \times \frac{1}{g} \times \sqrt{\frac{g}{h}}$

$= \frac{1}{2}\sqrt{\frac{h}{g}}$

Total time $= t + t' = \sqrt{\frac{h}{g}} + \frac{1}{2}\sqrt{\frac{h}{g}} = \frac{3}{2}\sqrt{\frac{h}{g}}$

$\rightarrow D$

(3)

Given

<velocity> = 7 m/s

$\frac{u+v}{2} = 7 \Rightarrow \frac{v}{2} = 7$ [u=0 For FFB

$\Rightarrow v = 14$ m/s

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

$\Rightarrow (14)^2 - 0^2 = 2 \times 9.8 \times h$ (or) $2 \times 10 \times h$

$\Rightarrow 14 \times 14 = 19.6\,h$

$\Rightarrow h = \frac{14 \times 14}{19.6} = 10m \rightarrow B$

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④ Given let 'h' be the height from which a body is released

Given $h = v$.

we know $u=0$; $a=g$ for FFB

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

$\Rightarrow h^2 - 0^2 = 2gh$

here $v \rightarrow$ final velocity $= h$

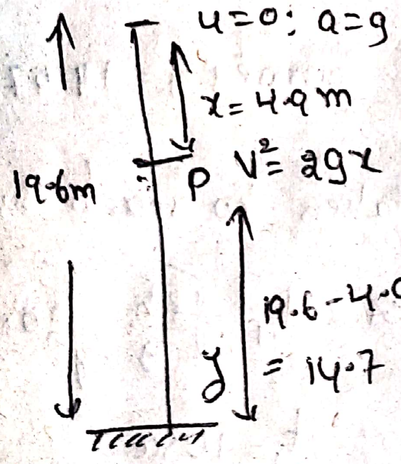
$\Rightarrow h^{\cancel{2}} = 2g\cancel{h} \Rightarrow h = 2g \rightarrow B$

⑤

let $h = 19.6m$

'p' → point from where gravity disappears

'v' be the velocity at P




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

$\Rightarrow v^2 - 0^2 = 2gx$

$\Rightarrow v^2 = 2gx$

$T_1$ be the time taken by FFB to reach 'p'

$t = \sqrt{\frac{2x}{g}} = \sqrt{\frac{2 \times 4.9}{9.8}} = 1$ sec.

$v = \sqrt{2gx}$

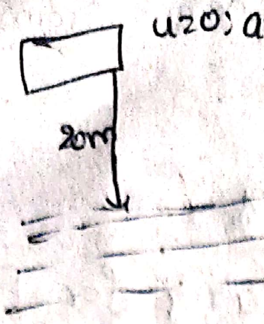
$= \sqrt{2 \times 9.8 \times 4.9}$

$= 9.8$ m/s

$T_2$ be the time taken by FFB to reach ground from P $T_2 = \frac{y}{v} = \frac{14.7}{9.8} = \frac{3}{2}$

$\therefore \frac{T_1}{T_2} = \frac{1}{\frac{3}{2}} = \frac{2}{3} \rightarrow B$

(6)




$u=0;\ a=g$

Time taken to reach the surface of water $t=\sqrt{\frac{2h}{g}}=\sqrt{\frac{2\times20}{10}}=2\,sec$

Total time of journey to reach bottom of lake $= T = 6\ sec.$

$\therefore$ The velocity with which the stone reaches surface of water $V=\sqrt{2gh}$

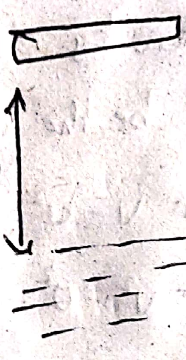
$V=\sqrt{2\times10\times20}=20\ m/s$

The time to reach bottom of lake from surface $= T-t = 4\,sec$ [ $t'$ let it be]

depth = distance $= V\times t' = 20\times4 = 80\,m$

$\rightarrow A$

(7)




Time of journey $T = 11.47\ sec.$

Time taken to reach surface of water $t_1=\sqrt{\frac{2h}{g}}=\sqrt{\frac{2\times500}{10}}$

$t_1 = 10\,sec$

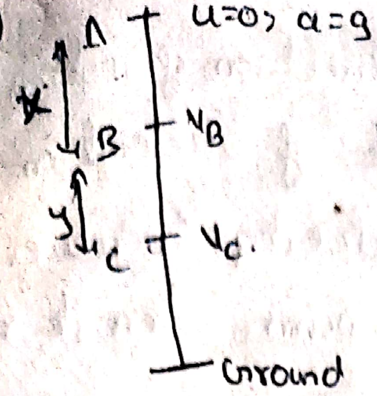
$\therefore$ Time taken by the sound of stone slashed in the pond to reach back to the top of water

$t_2 = T - t_1 = 11.47 - 10 = 1.47\ sec$

$\Rightarrow t = \frac{distance}{speed} \Rightarrow speed = \frac{500}{1.47}$

$\Rightarrow speed = 340\ m/s \rightarrow$

(8)




For AB $\quad S = x \;;\; t = 2\,sec$

From $\quad S = \frac{1}{2} g t^2$

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

$$= 2g \rightarrow B$$

(9)

If $u$ be the initial velocity, then distance covered by it 2 sec. is $\quad S = ut + \frac{1}{2}at^2 \;;\; a = g$

$$\Rightarrow S = 2u + \frac{1}{2} g (2)^2 = 2u + 20 \rightarrow (1)$$

Now distance covered in next sec (i.e) 3rd sec

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

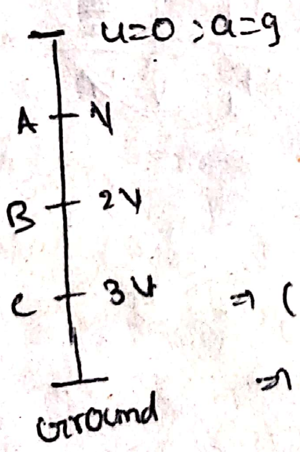
$$S' = u + \frac{g}{2}(2 \times 3 - 1)$$

$$\Rightarrow S' = u + \frac{10}{2}(6-1) = u + 25 \rightarrow (2)$$

From (1) and (2) $\quad u + 25 = 2u + 20 \Rightarrow u = 5\,m/s$

$$\therefore S = 2u + 20 = 2 \times 5 + 20 = 30m \rightarrow C$$

(10)




use $\quad v^2 - u^2 = 2as$

| AB | AC |
|---|---|
| $u = V ; V = 2V$ | $u = V ; V = 3V$ |
| $S = AB$ | $S = AC$ |

$$\Rightarrow (2V)^2 - V^2 = 2g(AB) \qquad \Rightarrow (3V)^2 - V^2 = 2g(AC)$$

$$\Rightarrow 3V^2 = 2g(AB) \qquad \Rightarrow 8V^2 = 2g\,AC$$

$$\therefore \frac{AB(2g)}{AC(2g)} = \frac{3V^2}{8V^2} \Rightarrow \frac{AB}{AC} = \frac{3}{8} \rightarrow D$$

(11) For a FFB the direction of motion of the body is same as that of acceleration due to gravity, so it's velocity increases gradually and becomes maximum when it reaches the ground.

(13), (14), (15)

Given $h = 49\,m$, $u = 0$; $a = 9.8\,m/s^2$

Time of descent $t_d = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 49}{9.8}} = \sqrt{10}$ sec.

velocity ~~u~~ with which the body reaches ground $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 49} = \frac{98}{\sqrt{10}}$

$\approx 31\,m/s$

We know $T_d = \sqrt{\frac{2h}{g}}$ $T_d \propto \sqrt{h}$

If the body reaches half of maximum height

$T_d' \propto \sqrt{\frac{h}{2}}$ $\frac{T_d'}{T_d} = \sqrt{\frac{h/2}{h}} \Rightarrow \frac{T_d'}{\sqrt{10}} = \frac{1}{\sqrt{2}}$

$\sqrt{5}$

$T_d' = \sqrt{5}$ sec $\rightarrow$ D

(17) Distance covered in the last sec of fall

$S_n = 24.5m$, let 'n' be the total

time taken

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

$a = g$ = $u = 0$

$\therefore 24.5 = 0 + \frac{g}{2}(2n-1)$

$\Rightarrow \frac{\cancel{24.5}}{5} = \frac{\cancel{9.8}\,4.9}{2}(2n-1)$

$s = \frac{1}{2}gt^2 = \frac{1}{2} \times 9.8 \times 3^2$ $\Rightarrow 5 = 2n-1 \Rightarrow 2n = 6 \Rightarrow n = 3 sec$

$= 44.1m$

(18)

Here For a FFB time of descent $t_d = \sqrt{\frac{2h}{g}}$

so time of descent depends on height not

on mass

Given $h_1 = 16m$, $h_2 = 25m$

$\therefore \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$

L Task CUQ's

(1)

Time of descent $t_d = \sqrt{\frac{2h}{g}}$

$\therefore t_d \propto \sqrt{h}$ $\therefore \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}} \rightarrow A$

(2), (3), (4)

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

distance covered in nth sec

$$S_n = u + \frac{a}{2}(2n-1)$$

$$\Rightarrow S_n = \frac{g}{2}(2n-1) \Rightarrow S_n \propto (2n-1)$$

Distance covered in 'n' sec

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

$$\Rightarrow S = 0 \times n + \frac{1}{2}g(n)^2$$

$$\Rightarrow S = \frac{g}{2}n^2 \Rightarrow S \propto n^2$$

Velocity after 'n' sec From $V = u + at$

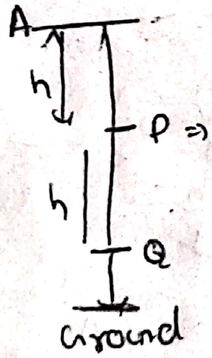
$$V = 0 + g(n)$$

$$V = gn \Rightarrow V \propto n$$

SAQ's

(1)

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




After falling through 'h' meter

Velocity $v = \sqrt{2as} = \sqrt{2gh}$

From 'A' after falling through next 'h' meter it reaches Q.

So distance $S = 2h$ ; $V = V_Q$

From $v^2 - u^2 = 2as$ $\Rightarrow$ $V_Q^2 - 0 = 2g(2h)$

$$\Rightarrow V_Q^2 = 2(2gh)$$

$$\Rightarrow V_Q = \sqrt{2}\sqrt{2gh} = \sqrt{2}\,V \rightarrow B$$

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② let 'n' be the no. of floors

and $x$ be the height of each floor.

Total height $h = nx$.

Total time $T = 3$ sec

$$\Rightarrow \sqrt{\frac{2h}{g}} = 3 \Rightarrow \sqrt{\frac{2nx}{g}} = 3 \rightarrow ①$$

Time for crossing Top most floor $t = \frac{3}{4}$ sec

$$\Rightarrow \sqrt{\frac{2x}{g}} = \frac{3}{4} \Rightarrow 2$$

From ① $\sqrt{\frac{2nx}{g}} = 3 \Rightarrow \sqrt{\frac{2x}{g}} \times \sqrt{n} = 3$

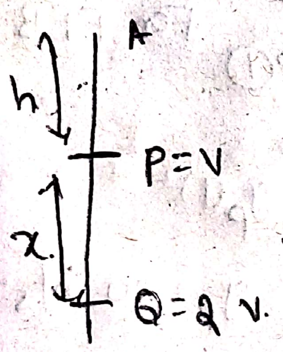
$$\Rightarrow \frac{\cancel{3}}{4} \times \sqrt{n} = \cancel{3}$$

$$\Rightarrow \sqrt{n} = 4$$

$$\Rightarrow n = 16 \rightarrow A$$

③

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




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

For AP: $\downarrow$ $u = 0$; $v$; $s = h$

$v^2 - 0^2 = 2gh$

$v^2 = 2gh$

For AQ: $u = v$; $v = 2v$; $s = x$

$(2v)^2 - v^2 = 2gx$

$\Rightarrow 3v^2 = 2gx$

$\Rightarrow 3(\cancel{2g}h) = \cancel{2g}x$

$\Rightarrow x = 3h \rightarrow A$

(4)

let 's' be the distance covered in 3 sec

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

$S = 0 \times (3) + \frac{1}{2}(g)(3)^2$

$S = \frac{g}{2} \times 9 = 4.5g$

let $s'$ be the distance covered in $n^{th}$ sec.

$S_n = u + \frac{a}{2}(2n-1)$ [u=0; a=g]

$\Rightarrow S_n = \frac{g}{2}(2n-1)$ [Given $S = S_n$]

$\Rightarrow 4.5\cancel{g} = \frac{\cancel{g}}{2}(2n-1)$

$\Rightarrow 9 = 2n-1 \Rightarrow n = 5$ sec $\rightarrow$ A

(5)

let $g_p \rightarrow$ Acceleration due to gravity

use $S = ut + \frac{1}{2}at^2$ $\rightarrow$ (1) For FFB u=0

$S_1 = 10m$, $t_1 = 1$ sec

From (1): $10 = 0 \times 1 + \frac{1}{2}g_p(1)^2$

$\Rightarrow 10 = \frac{g_p}{2} \Rightarrow g_p = 20\ m/s^2$

(7)

we know For FFB $t_d = \sqrt{\frac{2h}{g}} \Rightarrow t_d \propto \sqrt{h}$

For $h_1 = h \rightarrow$ time $t_d = t_1$

For $h_2 = \frac{h}{2} \rightarrow t_d = t_2$

$\therefore \frac{t_2}{t_1} = \sqrt{\frac{h_2}{h_1}} \Rightarrow \frac{t_2}{t} = \sqrt{\frac{\cancel{h}/2}{\cancel{h}}} = \frac{1}{\sqrt{2}}$

$\Rightarrow t_2 = \frac{t}{\sqrt{2}} \rightarrow$ B

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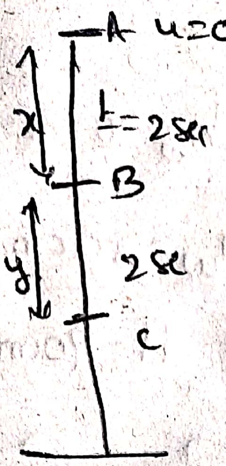
⑥




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

AB: $s = x;\ t = 2sec$

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

$x = 2g$

AC: $s = x + y$, $t = 4sec$

$x + y = 4\times 0 + \frac{1}{2}g(4)^2$

$2g + y = \frac{1}{2}g \times 16$

$2g + y = 8g$

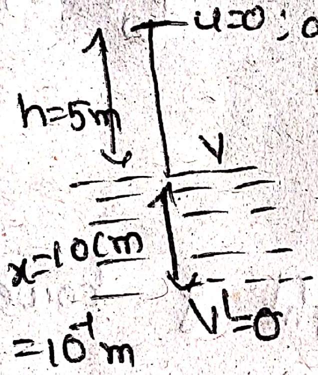
$\Rightarrow y = 8g - 2g$

$= 6g$

$= 3(2g)$

$\Rightarrow y = 3x \rightarrow D$

⑧




$v \rightarrow$ velocity with which the body reaches sand

$\therefore$ From $v^2 - u^2 = 2as \rightarrow ①$

$\Rightarrow v^2 - 0^2 = 2g(5)$

$\Rightarrow v^2 = 2\times 9.8\times 5 = 98 m/s$

(or) $\Rightarrow v = 7\sqrt{2}$ m/s

Here the sand resists motion of a body so the body is in retardation

From ① $v'^2 - v^2 = 2ax$.

$\Rightarrow 0^2 - 98 = 2a(10^{-1})$

$\Rightarrow 2a = \frac{-98}{10^{-1}} \Rightarrow a = -490 m/s^2$

-ve sign shows the body is in retardation

(9) Given

height above window $h_{\omega} = 10\text{ cm} = 0.1\text{ m}$

height of window $h_w = 80\text{ cm} = 0.8\text{ m}$

Total distance fallen $H = 90\text{cm} = 0.9\text{m}$

Time to fall 10cm is $t_1 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times 0.1}{9.8}} = \frac{1}{7}$ sec

Time to fall 90 cm is $T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2\times 0.9}{9.8}} = \frac{3}{7}$ sec

$\therefore$ Time to cross window

$t_\omega = T - t_1 = \frac{3}{7} - \frac{1}{7}$

$= \frac{2}{7}$ sec $\rightarrow$ C

(10)

let H be the height of tower

time taken to cross H $\Rightarrow T = 8$ sec

Time taken to cover $h = \frac{1}{4}H$ is t.

we know for a FFB $T_d = \sqrt{\frac{2h}{g}} \Rightarrow T_d \propto \sqrt{h}$

$$\Rightarrow \frac{t}{T} = \sqrt{\frac{h}{H}}$$

$$\Rightarrow \frac{t}{8} = \sqrt{\frac{\frac{H}{4}}{H}} = \frac{1}{\sqrt{4}} \Rightarrow$$

$$\Rightarrow \frac{t}{8} = \frac{1}{2}$$

$$\Rightarrow t = \frac{8}{2} = 4\text{ sec} \rightarrow B$$

(16)

let $h = 320$

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

$\Rightarrow t_d = \sqrt{\frac{2 \times 320}{10}} = 8$ sec.

(7)

let $h = 20m$

The velocity with which a FFB reaches the ground $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20 m/s$

(12) & (15)

Time of descent for a FFB $T_d = \sqrt{\frac{2h}{g}}$

$\therefore$ so $T_d$ depends on height from which the bodies are dropped not on mass of the bodies

(11)

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

From $v^2 - u^2 = 2as \Rightarrow v^2 - 0^2 = 2gh$

$\Rightarrow v^2 = 2gh \Rightarrow v = \sqrt{2gh}$

$\therefore v \propto \sqrt{h}$

From $s = ut + \frac{1}{2}at^2 \Rightarrow s = 0 \times t + \frac{1}{2}gt^2$

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

For 1 sec, 2 sec, 3 sec ——

$S_1 : S_2 : S_3 : \text{---} S_n = 1^2 : 2^2 : 3^2 : \text{---}$

$S_1 : S_2 : S_3 : \text{----} = 1 : 4 : 9 : \text{---}$

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