(15)

(1)

W.S. 9 →

Task

(1) From given fig $u = \frac{500}{3}$ m/s

height of the tower $h = 1500$m

Time of flight $T = \frac{u\sin\theta}{g} = \frac{500}{3} \frac{\sin 37}{10}$

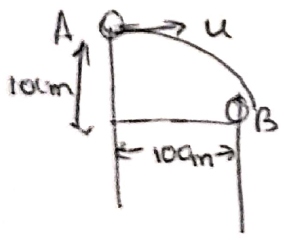
$= \frac{500}{30} \times \frac{3}{5} = 10$ sec

Range $= u_x \times T$

$= u\cos\theta \times 10$

$= \frac{500}{3} \times \cos 37 \times 10 \Rightarrow \frac{500}{3} \times \frac{4}{5} \times 10 = \frac{4000}{3}$ m

(2) According to given data



clearly as the bullet is fired from A with a velocity u

it's Range = 100 m

$h = 10$ cm
$= 10^{-1}$m

$\Rightarrow uT = 100$

$\Rightarrow u\sqrt{\frac{2h}{g}} = 100$

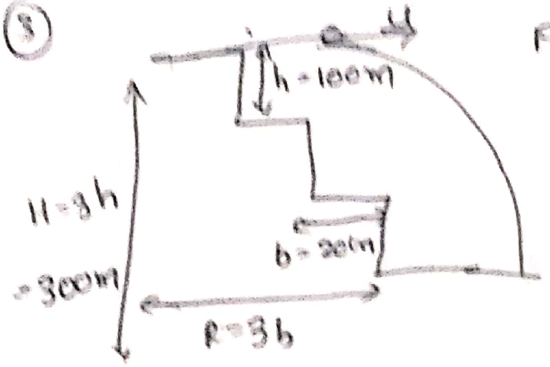
$\Rightarrow u\sqrt{\frac{2 \times 10^{-1}}{10}} = 100$

$\Rightarrow u\sqrt{\frac{2}{100}} = 100$

$\Rightarrow u = 100 \times \sqrt{\frac{100}{2}} = 100 \times \frac{10}{\sqrt{2}} = 707$ m/s

$\simeq 700$ m/s

[If $g = 9.8$ m/s^2 we get 700]

(3) 

From figure Range = 3b

$\Rightarrow u \times T_d = 3 \times 20 \times 10^{-2}$

$\Rightarrow u \times \sqrt{\frac{2H}{g}} = 60 \times 10^{-2}$

$\Rightarrow u \times \sqrt{\frac{2 \times 300}{10}} = 60 \times 10^{-2}$

$\Rightarrow u = \frac{60}{\sqrt{60}} \times 10^{-2}$

$= \sqrt{60} \times 10^{-2}$

(4)

velocity of projection $u = 12.15$ m/s

It is striking the ground 75m away from tower means

range $R = 75$m.

$\therefore$ we know that $R = u \times \sqrt{\frac{2h}{g}}$

$\therefore u\sqrt{\frac{2h}{g}} = 75$

$\Rightarrow 12.15 \sqrt{\frac{2h}{10_5}} = 75$

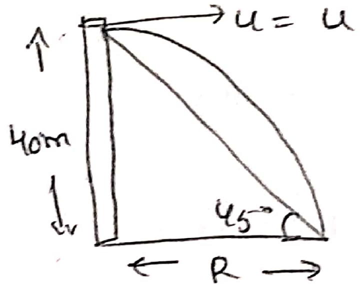
$\Rightarrow \sqrt{\frac{h}{5}} = \frac{75}{12.15}$

$\Rightarrow \sqrt{\frac{h}{5}} = 6.17$

$\Rightarrow \frac{h}{5} = 38.08$

$\Rightarrow h = 38.08 \times 5 = 190$ m

(5)



From fig $\tan 45^\circ = \frac{h}{R}$

$\Rightarrow 1 = \frac{h}{R}$

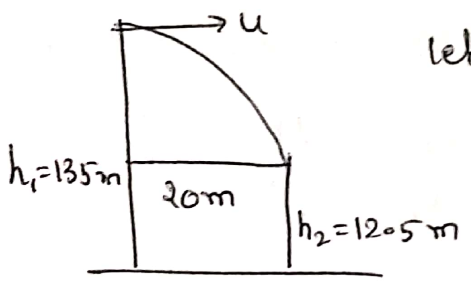
$\Rightarrow R = h$ we know $R = u\sqrt{\frac{2h}{g}}$

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

$\Rightarrow u\sqrt{\frac{2\times 4\cancel{0}}{\cancel{10}}} = 40$

$\Rightarrow u\, 2\sqrt{2} = 40 \Rightarrow u = \frac{20}{\sqrt{2}} = 10\sqrt{2} = 14\,m/s$

(7)



let 'u' be the velocity of Projection

Range = 20 m

time of descent $t_d = \sqrt{\frac{2(h_1 - h_2)}{g}}$

we know that $R = u\, t_d$

$\Rightarrow u t_d = 20m$

$\Rightarrow u\sqrt{\frac{2(135 - 12.5)}{9.8}} = 20$

$\Rightarrow u\sqrt{\frac{2\times 122.5}{9.8}} = 20$

$\Rightarrow u \times 5 = 20$

$\Rightarrow u = 4\, m/s.$

(8)

height of the tower $h = 78.4\ m$.

velocity of Projection $u = 10\ m/s$.

Velocity after 3 sec $V = u\hat{i} + gt\hat{j}$

$$\vec{V} = 10\hat{i} + 10\times 3\hat{j}$$

$$= 10\hat{i} + 30\hat{j}$$

(9)

An velocity of Projection $u = 10\ m/s$

Angle made by the velocity vector with x-axis

$$\tan\alpha = \frac{V_y}{V_x} = \frac{gt}{u} = \frac{10\times 4}{10} = 4$$

$$\Rightarrow \alpha = \tan^{-1}(4)$$

(10)

Velocity of Projection $u = 9.8\ m/s$

velocity of the stone after 1 sec $= \sqrt{u^2 + g^2t^2}$

$$V = \sqrt{(9.8)^2 + (9.8)^2 1^2}$$

$$= \sqrt{(9.8)^2 + (9.8)^2}$$

$$= (9.8)\sqrt{1+1}$$

$$= 9.8\sqrt{2}$$

14

velocity of Projection $u = u$

velocity with which stone reaches ground $v = 4u$.

$\therefore$ From $v = \sqrt{u^2+2gh}$

we have $(4u) = \sqrt{u^2+2gh}$ on squaring both sides

$\Rightarrow (4u)^2 = u^2+2gh$

$\Rightarrow 16u^2 = u^2+2gh$

$\Rightarrow h = 15\dfrac{u^2}{2g}$

Time of flight $= \sqrt{\dfrac{2h}{g}} = \sqrt{\dfrac{\cancel{2}}{g} \times \dfrac{15u^2}{\cancel{2}g}} \Rightarrow \sqrt{15}\,\dfrac{u}{g}$

Range $=$ $u \times$ Time of flight

$= u \times \sqrt{15} \times \dfrac{u}{g}$

$\Rightarrow \sqrt{15}\,\dfrac{u^2}{g}$

18, ~~16~~ ~~&~~ ~~17~~

19

velocity of Projection $u = 150$ cm/sec

height from which the ball rolledoff $= nh$

Range $R = n$width where 'n' $\rightarrow$ No. of steps

$\therefore$ $R = u\sqrt{\dfrac{2h}{g}}$

$\Rightarrow nw = u\sqrt{\dfrac{2nh}{g}}$

on squaring

$\Rightarrow n^{\cancel{2}}w^2 = u^2\,\dfrac{2\cancel{n}h}{g}$

$\Rightarrow n = \dfrac{u^2}{w^2} \times \dfrac{2h}{g}$

$= \left(\dfrac{15\cancel{0}}{2\cancel{0}}\right)^2 \times \dfrac{2 \times 2\cancel{0}}{100\cancel{0}}$

$= \dfrac{225}{\cancel{4}} \times \dfrac{\cancel{4}}{100} = 2.25$ i.e)

$n = 3$ step.

(18)

velocity of projection $u = 600$ kmph

$$= \cancel{600}^{100} \times \frac{5}{\cancel{18}_{3}} = \frac{500}{3} \text{ m/s}$$

height from which bomb dropped $h = 1960$m

In the question they are asking Range (AB)

$$R = u\sqrt{\frac{2h}{g}}$$

$$\Rightarrow R = \frac{500}{3}\sqrt{\frac{2 \times 1960}{9.8}}$$

$$= \frac{500}{3}\sqrt{\frac{2 \times 19600}{98}}$$

$$\Rightarrow \frac{500}{3}\sqrt{400} = \frac{500}{3} \times 20 = \frac{10 \times 10^3}{3} = 3.33 \text{ km}$$

(C)

Given height of the tower $h = 40$m

velocity of projection $u = 20$m/s

Angle of elevation $\theta = 30°$

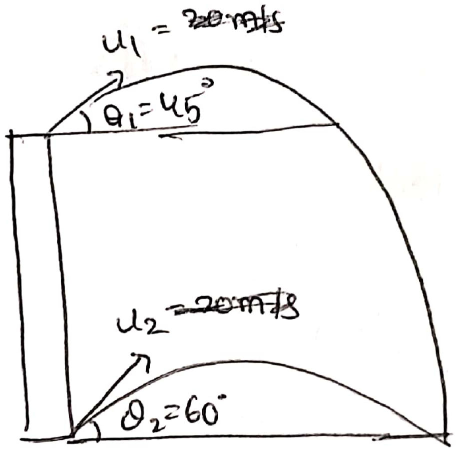
Time taken by the ball to hit the ground

$$t = \frac{\text{distance}}{u \sin\theta} = \frac{\cancel{40}\,2}{\cancel{20} \sin 30} = \frac{2}{\frac{1}{2}} = 4 \text{ sec}$$

12 , 13

when bomb is released from the plane, it's horizontal component of the velocity will remain the same as the velocity of the plan. In vertical direction the bomb will accelerate because of the acceleration due to gravity. Hence, we can say that the bomb will move in a straight line vertically downwards with respect to plane.

$\boxed{15, 16, 17}$



Time of descent is T_d = Time of flight is same

Given that Range is same for both Projectiles

$\Rightarrow R_1 = R_2$

u_1, u_2 are velocities of Projectile from Top and bottom of tower

$$R_1 = \frac{u_2^2 \sin 2\theta_2}{g} \qquad \Rightarrow u_2^2 = \frac{200}{\sin 120} \qquad T_1 = \frac{2 u_2 \sin\theta_2}{g}$$

$$\Rightarrow 20 = \frac{u_2^2 \sin 2(60)}{10} \qquad \Rightarrow u_2^2 = \frac{200}{\frac{\sqrt{3}}{2}} \qquad T_1 = \frac{2 \times 20}{\sqrt{\sqrt{3}}} \frac{\sin 60}{10}$$

$$= \frac{24}{\sqrt{\sqrt{3}}} \frac{\sqrt{3}}{2} = \frac{2}{\sqrt{3}}$$

$$\Rightarrow 20 = \frac{u_2^2 \sin 120}{10} \qquad \Rightarrow u_2 = \frac{20}{\sqrt{\sqrt{3}}}\ m/s \qquad T_1 = 2\sqrt{\sqrt{3}}\ \text{sec}$$

Speed of Projectile from bottom.

$R_p = u_1 \cos\theta_1 \, T_1$

$\Rightarrow 20 = u_1 \cos 45 \; 2\sqrt{\sqrt{3}}$

$\Rightarrow 20 = u_1 \frac{1}{\sqrt{2}} \; 2\sqrt{\sqrt{3}}$

$\Rightarrow u_1 = \frac{10\sqrt{2}}{\cancel{2}\sqrt{\sqrt{3}}}$

$\therefore \frac{u_1}{u_2} = \frac{\frac{\cancel{10}\sqrt{2}}{\cancel{2}\sqrt{\cancel{\sqrt{3}}}}}{\frac{\cancel{20}\,2}{\sqrt{\cancel{\sqrt{3}}}}} = \frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}}$

Time of flight for the Projectile

$T = 2\sqrt{\sqrt{3}} = 2(3)^{\frac{1}{4}}$ sec

LTask

CUQ's

(2), (3)

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

So Time of descent depends on height from which it is fired (or) thrown. Both bullets are fired from same Place so h = same. $\therefore$ Time of descent also same

Both will reach simultaneously

Their velocity of reaching ~~also same to the ground~~ is different because they are fired with different velocities

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(4)

For a body thrown horizontally from top of a tower

$$\text{Range} = u\sqrt{\frac{2h}{g}}$$

Time of flight $T = \sqrt{\frac{2h}{g}}$

velocity with which the body reaches ground

$$v = \sqrt{u^2+2gh} \quad (\text{or}) \quad \sqrt{u^2+g^2t^2}$$

(5)

when a stone was dropped from moving train

the velocity of stone = velocity of train. $= V_{stone}$

The velocity of person standing by the side of the track $= 0 = V_p$

$\therefore$ There is a relative velocity for the stone as seen by the observer = velocity of stone − velocity of man

$= V_{stone} - 0$

$= V_{stone}$.

so the stone follow a Parabolic Path as seen by the observer.

(6)

Here $V_{pilot} = V_{bomb}$

$\therefore$ The relative velocity of bomb as seen by the Pilot

$= V_{bomb} - V_{Pilot}$

$= 0$

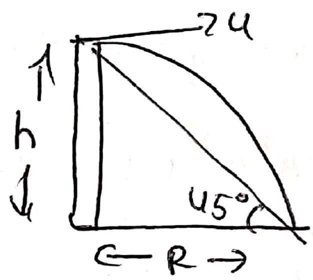
so the path followed by the bomb as seen by the Pilot is straight line

(10)

Take solution from (2) question Ans

SAQ's

(1)



Time of flight of the body = T = 4 sec

From fig $\tan 45° = \frac{h}{R}$

$\Rightarrow 1 = \frac{h}{R}$

$\Rightarrow R = h$

$T = \sqrt{\frac{2h}{g}} \Rightarrow h = \frac{1}{2} g T^2$

$\Rightarrow h = \frac{1}{2} \times 10 \times 4^2 \quad [g = 10 m/s^2]$

$= 80 m$

$\Rightarrow u \times T = 80$

$\Rightarrow u \times 4 = 80$

$\Rightarrow u = 20 m/s$

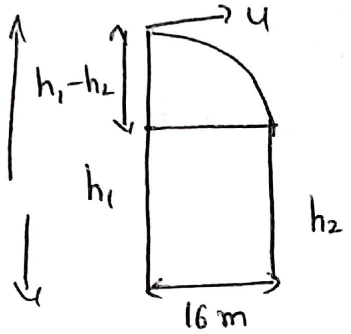
For $g = 9.8 m/s^2$ we get $u = 19.6 m/s$

2

$h_1 = 120\,m$, $h_2 = 100.4\,m$

The horizontal distance between the two cliff

$= \text{Range} = 16\,m.$



$\Rightarrow u \times T = 16$

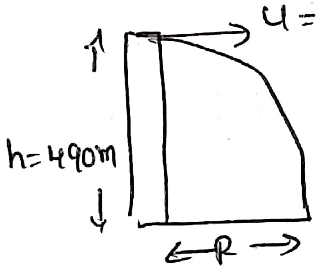
$\Rightarrow u \times \sqrt{\frac{2(h_1 - h_2)}{g}} = 16$

$\Rightarrow u\sqrt{\frac{2(120 - 100.4)}{9.8}} = 16$

$\Rightarrow u\sqrt{\frac{2 \times \cancel{19.6}^{2}}{\cancel{9.8}}} = 16 \quad \Rightarrow u\sqrt{4} = 16$

$\Rightarrow u = 8\,m/s$

3



$u = 180$ kmph

$= \cancel{180}^{10} \times \frac{5}{\cancel{18}}\,m/s$

$= 50\,m/s$

$\text{Range} = u\sqrt{\frac{2h}{g}}$

$= 50\sqrt{\frac{2 \times 490}{9.8}}$

$= 50\sqrt{\frac{2 \times 4900}{98}}$

$\Rightarrow 50\sqrt{100} = 50 \times 10 = 500\,m$

5 & 4

Time of flight $T = \sqrt{\frac{2h}{g}}$; so time depends on h but not on mass and velocity

$\frac{T_1}{T_2} = \sqrt{\frac{h_1}{h_2}} \Rightarrow \frac{t}{T_2} = \sqrt{\frac{h}{4h}} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{1}{4}} \Rightarrow \frac{t_1}{t_2} = \frac{1}{2}$

$\Rightarrow t_2 = 2t_1 = 2t$

Range of a Projectile $R = u \times T$

$R_1 = d$

$u_1 = v$

$u_2 = 3v$

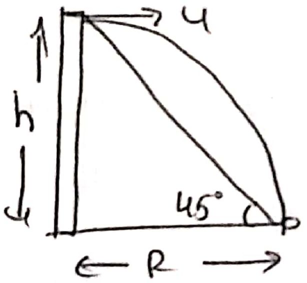
$$\therefore \frac{R_1}{R_2} = \frac{u_1}{u_2} \frac{T_1}{T_2}$$

$$\Rightarrow \frac{d}{R_2} = \frac{\cancel{v}}{3\cancel{v}} \frac{\cancel{t}}{2\cancel{t}}$$

$$\Rightarrow \frac{d}{R_2} = \frac{1}{6} \Rightarrow R_2 = 6d$$

(6)

height $h = 19.6\,m$



From fig $R = h \tan 45^\circ$

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

$$\Rightarrow u\sqrt{\frac{2 \times \cancel{19.6}^{2}}{\cancel{9.8}}} = 19.6$$

$$\Rightarrow u\sqrt{2 \times 2} = 19.6 \Rightarrow u = 9.8\ m/s$$

(7)

Given height $h = 5m$

Range $R = 10m$

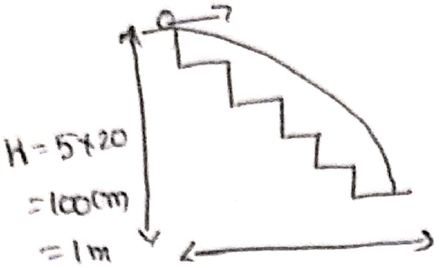
we know that $R = u\sqrt{\frac{2h}{g}}$

$$\Rightarrow 10 = u\sqrt{\frac{2 \times 5}{10}}$$

$$\Rightarrow u = 10\,m/s$$

(8)

height $h = 20cm$, width $w = 30cm$



$R = 5w$
$= 5 \times 30$
$= 150 cm$
$= 1.5m$

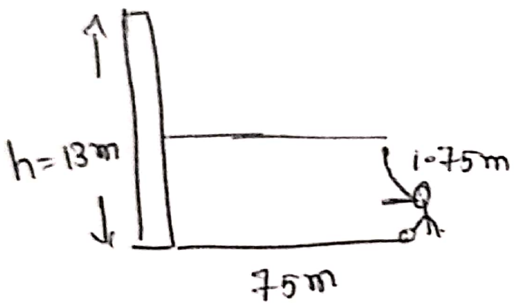
$$Range = u\sqrt{\frac{2H}{g}}$$

$$\Rightarrow 1.5 = u\sqrt{\frac{2 \times 1}{10}}$$

$$\Rightarrow 1.5 = \frac{u}{\sqrt{5}}$$

$$\Rightarrow u = 1.5\sqrt{5} \ m/s$$

(9)



If the person wants to catch a child he has to reach range point of child.

Time taken by Person = Time taken by child

Time of descent of child $T_d = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times (13 - 1.75)}{10}}$

$$T_d = \sqrt{\frac{2 \times 11.25}{10}} = \sqrt{\frac{22.5}{10}} = \sqrt{2.25} = 1.5 \ sec$$

$$Range = u \times T_d$$

$$\Rightarrow 75 = u \times 1.5$$

$$\Rightarrow u = \frac{75}{1.5} = 50 \ m/s$$

(10)

Range $R = 25\,m$

$h = 4.9\,cm$

$= 4.9 \times 10^{-2}\,m$

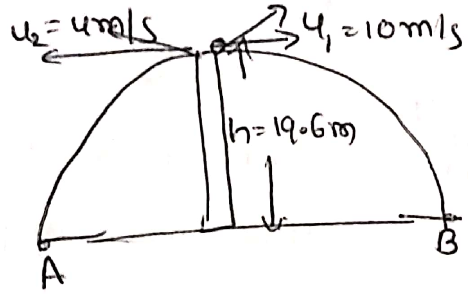
$$R = u\sqrt{\frac{2h}{g}}$$

$$\Rightarrow 25 = u\sqrt{\frac{\cancel{2}\times \cancel{4.9}\times 10^{-2}}{\cancel{9.8}\ 4.9}} \Rightarrow 25 = u\sqrt{10^{-2}}$$

$$\Rightarrow 25 = u\times 10^{-1}$$

$$\Rightarrow u = 250\ m/s$$

(17) (18), (19)



Time after which velocity vectors are Perpendicular

$$t = \sqrt{\frac{u_1 u_2}{g}} = \sqrt{\frac{10\times 4}{9.8}} \simeq 0.1\ sec$$

Seperation b/w the stones when velocity vectors are Perpendicular

$$x = (u_1 + u_2)\,t$$

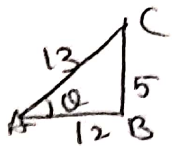
$$= (10+4)\,0.1 \Rightarrow 1.4\,m$$

Time after which their displacement vectors are Perpendicular

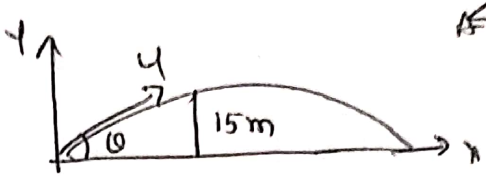
$$t = 2\sqrt{\frac{u_1 u_2}{g}} = 2\times 0.1 = 0.2\ sec$$

(20)

Velocity of ball $u = 52$ m/s



$\tan\theta = \frac{5}{12}$



$\sin\theta = \frac{5}{13}$

$\cos\theta = \frac{12}{13}$

We know that $y = u\sin\theta\, t - \frac{1}{2} g t^2$

$\Rightarrow 15 = \cancel{52}^{4} \times \frac{5}{\cancel{13}} t - \frac{1}{\cancel{2}} \times \cancel{10}^{5} \times t^2$

$\Rightarrow \cancel{15}^{3} = 4 \times \cancel{5} t - \cancel{5} t^2$

$\Rightarrow 3 = 4t - t^2 \Rightarrow t^2 - 4t + 3 = 0$

$\Rightarrow t^2 - 3t - t + 3 = 0$

$\Rightarrow t(t-3) - 1(t-3) = 0$

$t = 3$ (or) 1 sec

Required time $= 3 - 1 = 2$ sec because the ball is at a height of 15 m at $t = 1$ sec (while moving up) and $t = 3$ (while moving down)

Hence the ball is at a height > 15m in the time interval between these instants

(21)

Time taken by bullet to travel a horizontal distance of 100m is given by $t = \frac{100}{500} = \frac{1}{5}$ sec.

In this time the bullet also moves downward due to gravity

It's vertical displacement

$$h = \frac{1}{2} g t^2 = \frac{1}{2} \times 10 \times \left(\frac{1}{5}\right)^2$$

$$= \frac{1}{2} \times 10 \times \frac{1}{25} = \frac{1}{5} m = 20 cm$$