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2026
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Kinematics
PHYSICS
KPP- 17
By - Saleem Ahmed Sir
Physics Wallah

KPP Discussion

Kinematics

Question - 01

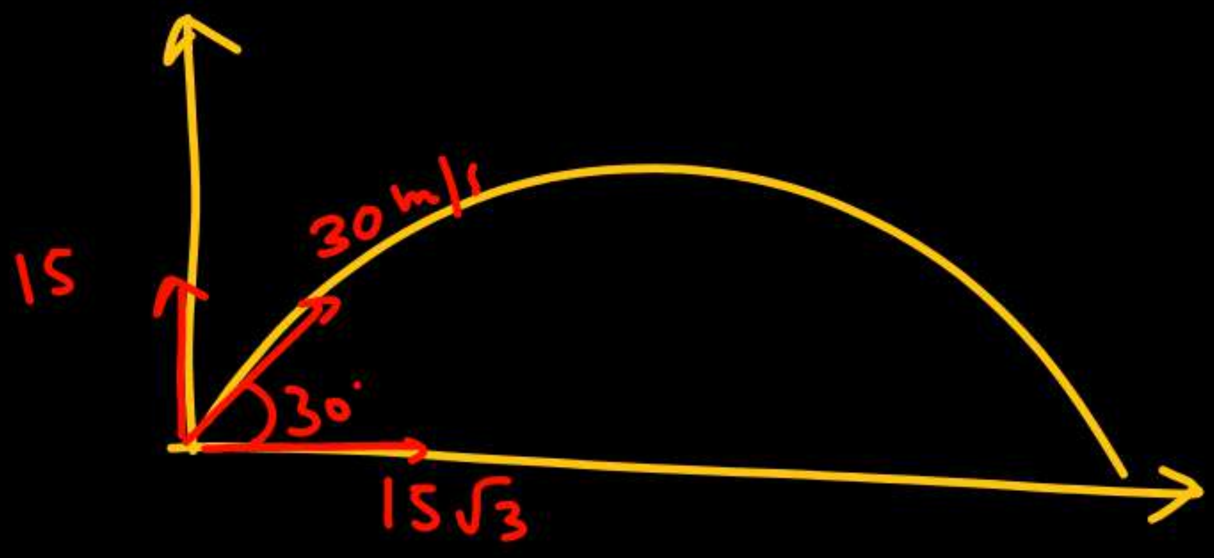
A batsman hits a ball at an angle of 30° with an initial speed of 30 ms^{-1}. Assuming that the ball travels in a vertical plane, calculate.

(a) The time at which the ball reaches the highest point

(b) The maximum height reached

(c) The horizontal range of the ball

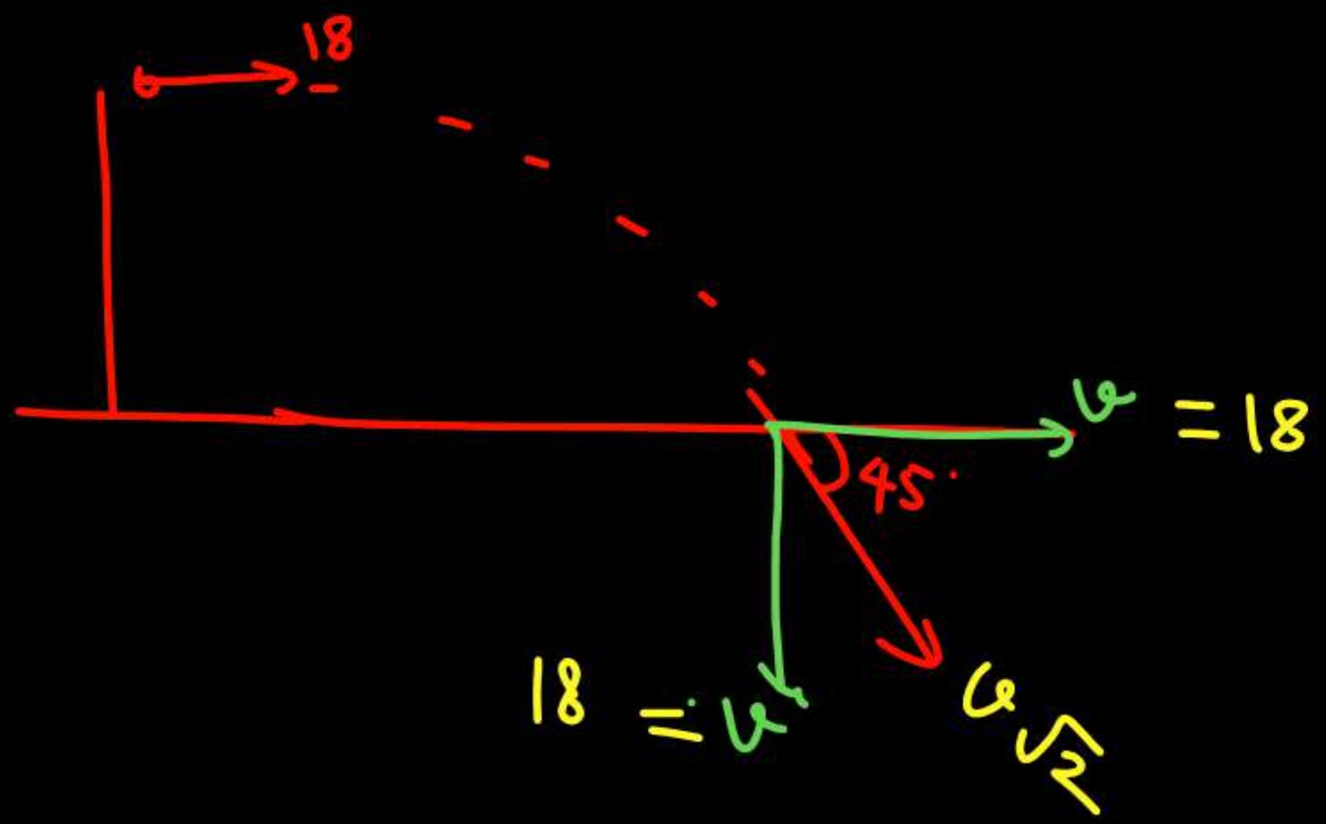
(d) The time for which the ball is in the air $= T = 3$



Ans : (a) 1.5 s, (b) 11.25 m, (c) $45\sqrt{3}$ m, (d) 3 s

Question - 02

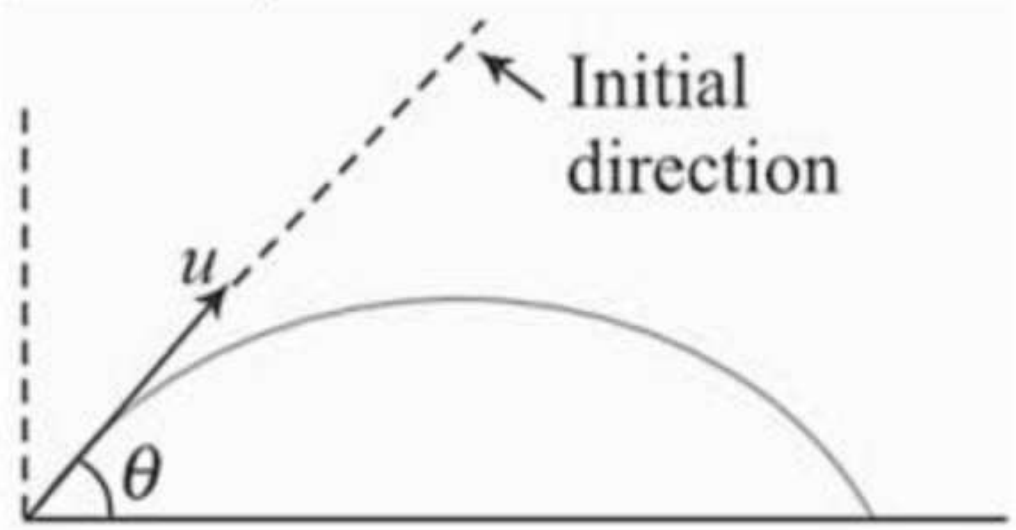
A body is projected horizontally from the top of a tower with initial velocity 18 ms^{-1}. It hits the ground at angle 45°. What is the vertical component of velocity when it strikes the ground?



Ans : (18 ms^{-1})

Question - 03

A particle is projected with relocity u at angle θ with horizontal. Calculate the time when it is moving perpendicular to initial direction. Also calculate the velocity at this position.



$$\vec{v} \cdot \vec{u}_1 = 0$$

$$\left[u\cos\theta\,\hat{i} + (u\sin\theta - gt)\,\hat{j}\right] \cdot \left(u\cos\theta\,\hat{i} + u\sin\theta\,\hat{j}\right) = 0$$

$$u^2\cos^2\theta + u\sin\theta\,(u\sin\theta - gt) = 0$$

$$u^2\cos^2\theta + u^2\sin^2\theta - u\sin\theta\, gt = 0$$

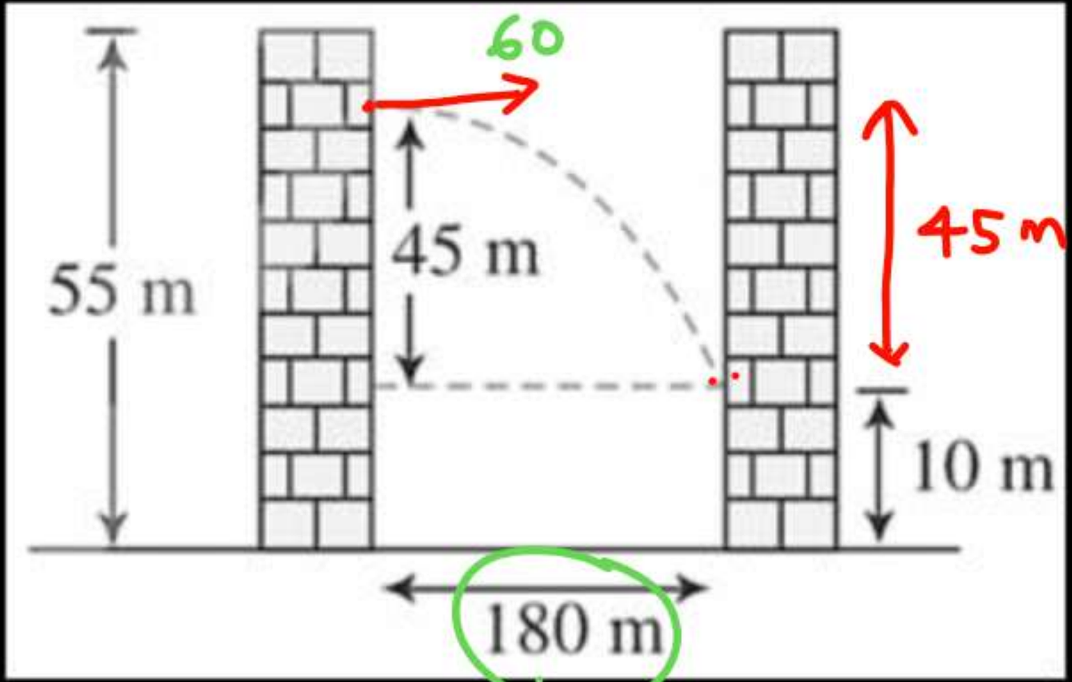
$$u^2 = u\sin\theta\, gt$$

$$t = \frac{u}{g\sin\theta}$$

Ans : $\left(t = \frac{u}{g\sin\theta}\right)$

Question - 04

An object is thrown between two tall buildings 180 m from each other. The object thrown horizontally from a window 55 m above the ground from one building strikes a window 10 m above the ground in another building. Find out the speed of projection.



$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 45}{10}} = 3$$

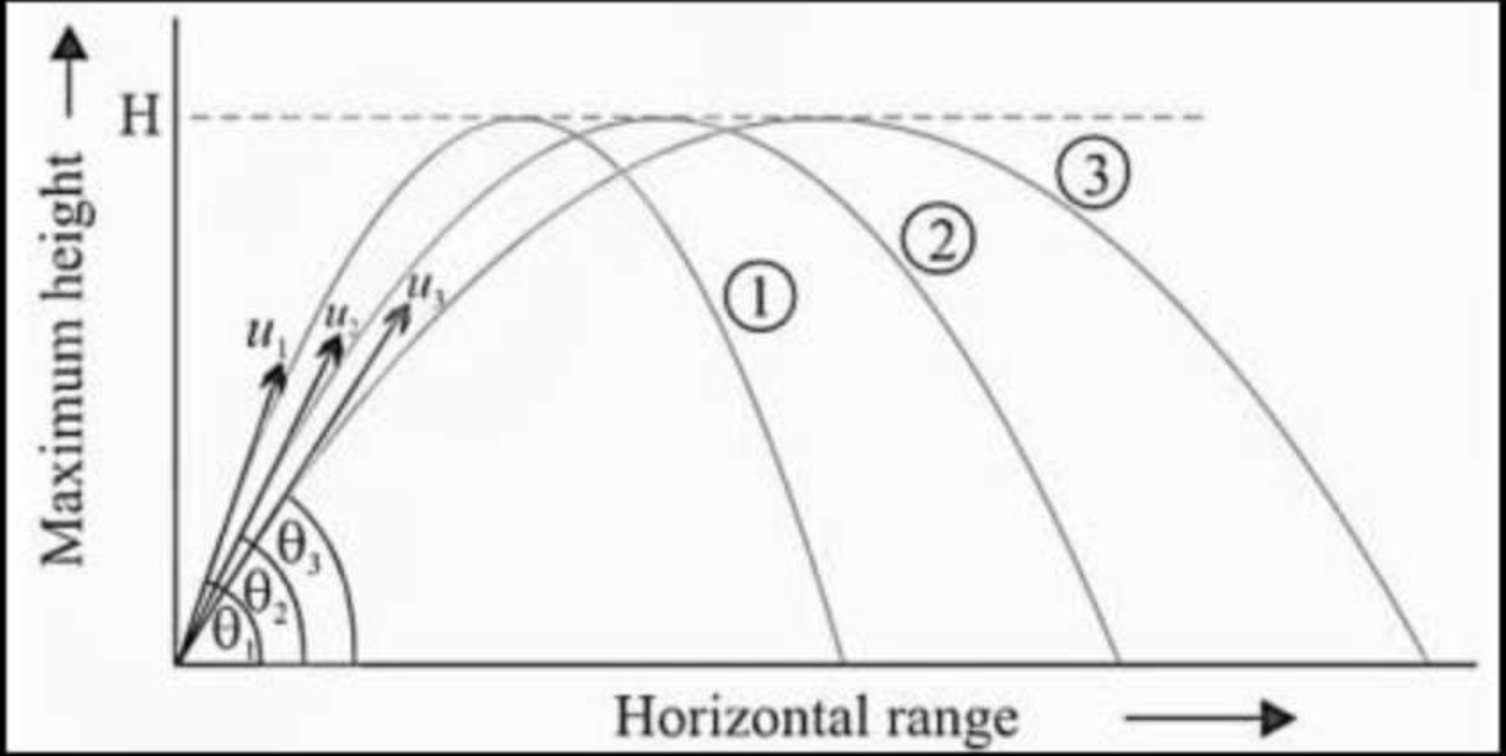
Ans : (60 ms^{-1})

Question - 05

Three projectiles are fired with velocities u_1, u_2 and u_3 at inclinations θ_1, θ_2 and θ_3, respectively, with the horizontal such that the maximum heights attained by all of them are same.

(a) Which projectile will take maximum time to reach the ground?

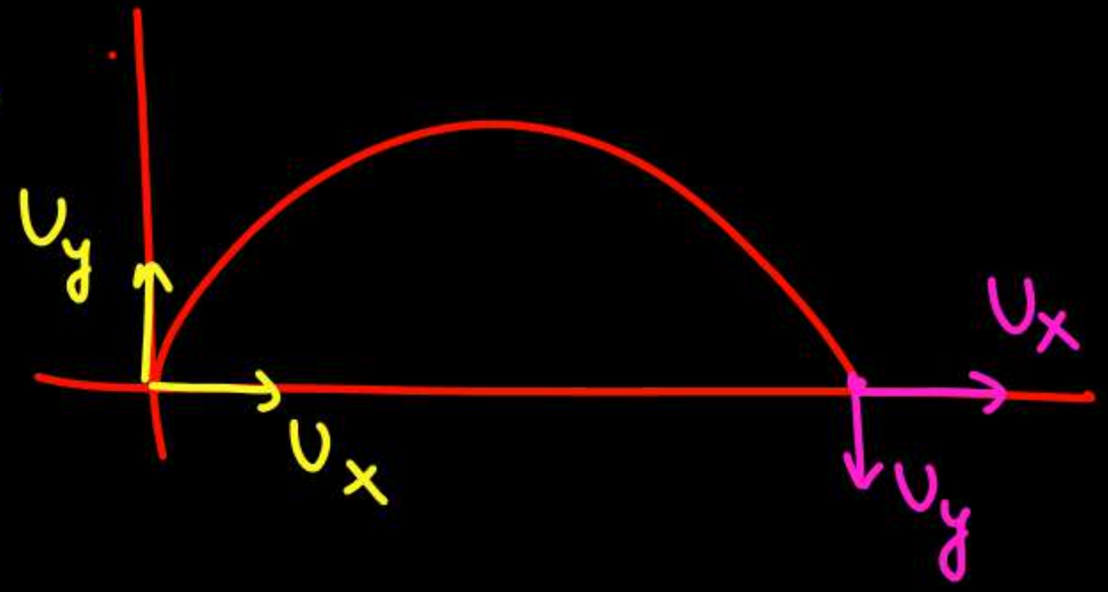
(b) Which projectile will possess the maximum speed on reaching the ground? 3



$T \rightarrow$ same

$v_y \rightarrow$ same

$v_x \equiv 3 > 2 > 1$



$v_{net} = \sqrt{v_x^2 + v_y^2}$

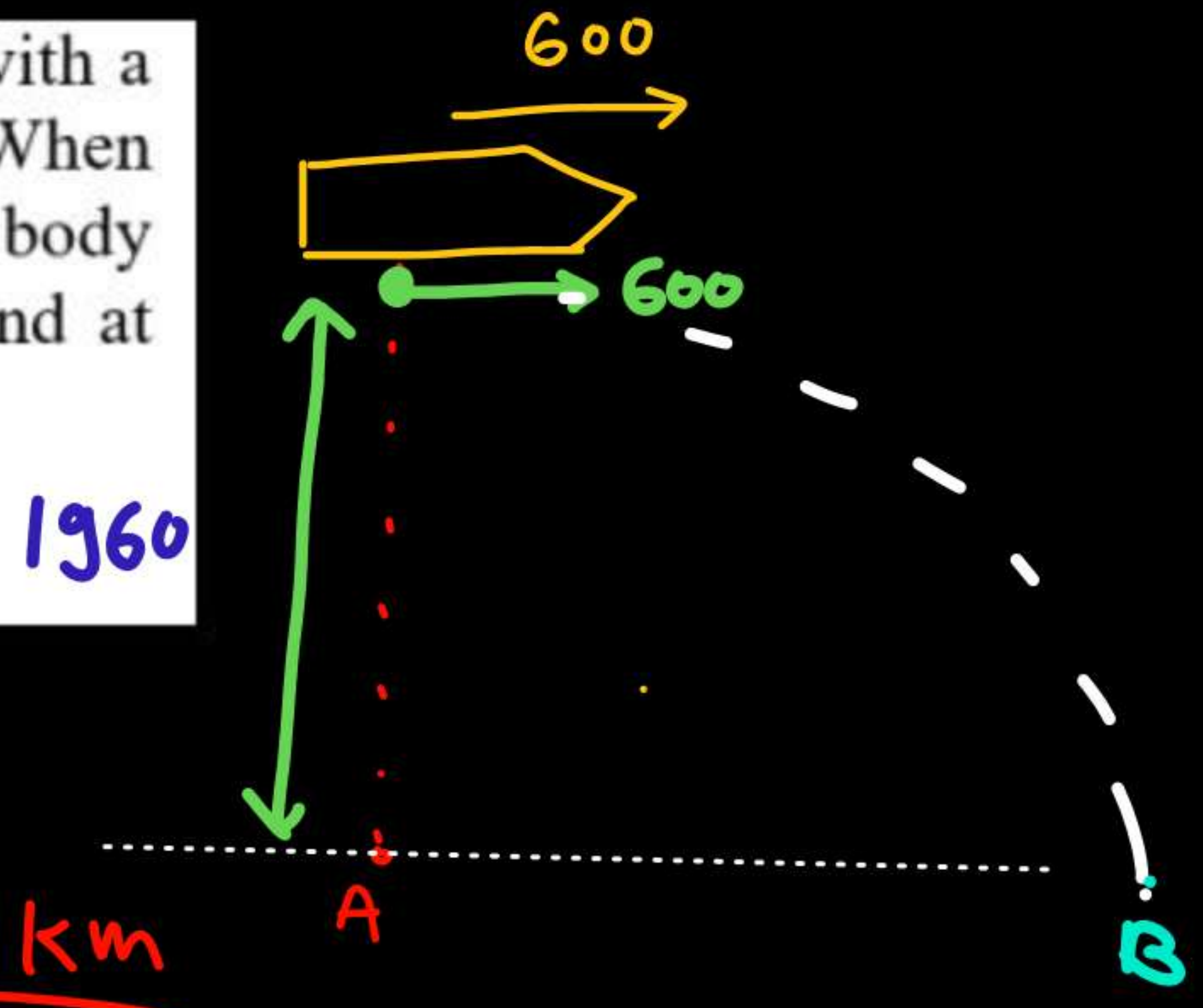
Ans : (a) The time of ascent and descent will be same and have they will reach the ground at the same time.
(b) The third projectile will reach the ground with maximum velocity i.e. u3 will be maximum.

Question - 06

$$\sqrt{\frac{2\times 19600}{9.8}}\times\frac{600}{3600}=\frac{20\times 600}{3600}=\frac{20}{6}=3.33\,km$$

An aeroplane is flying in horizontal direction with a velocity 600 km/hr and at a height of 1960 m. When it is vertically above a point A on the ground, a body is dropped from it. The body strikes the ground at point B. The distance AB equals to:

(1) 3.333 km (2) 33.33 km
(3) 333.3 km (4) 33.33 m



$$\sqrt{\frac{2\times 1960}{10}}\times\frac{600\,km}{3600\,sec}$$

$$\frac{14\sqrt{2}\times \cancel{6}}{\cancel{36}\,6}=\frac{19.6}{6}=3.26\,km$$

Ans : (1)

Question - 07

$\frac{9}{40} = \frac{\tan\theta}{4}$ $\tan\theta = \frac{9}{10}$ $\frac{H}{R} = \frac{\tan\theta}{4}$ $\frac{10}{R} = \frac{1}{4}$

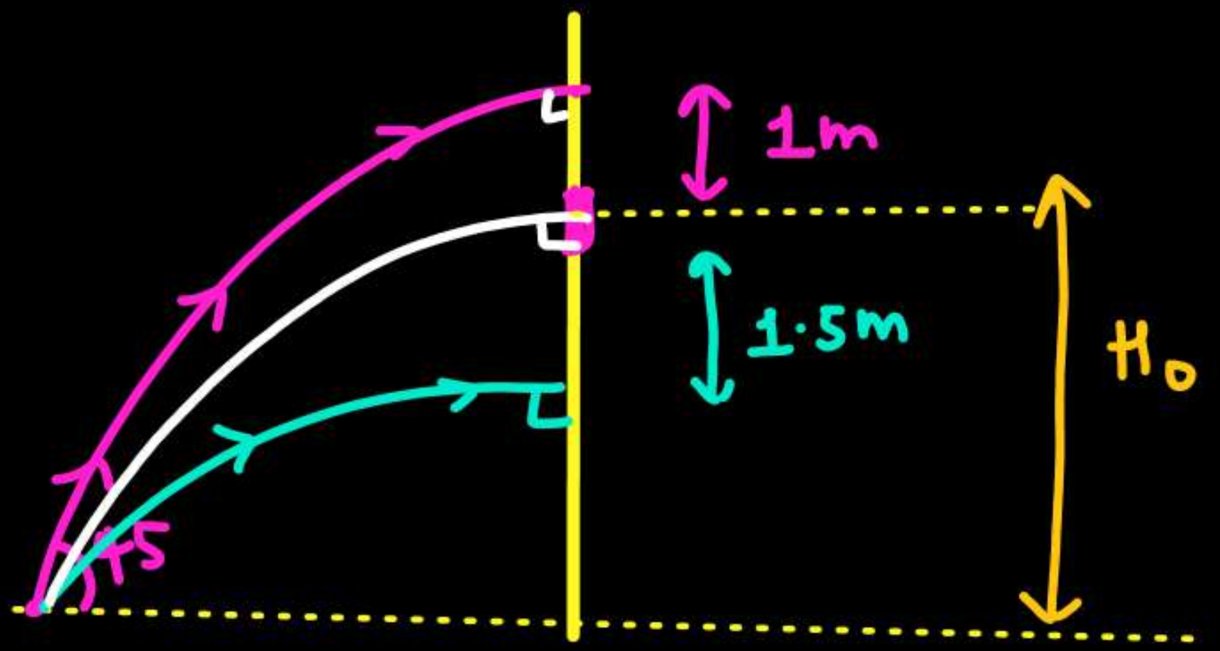
A vertical pole has a black mark at some height. A stone is projected from a fixed point on the ground. When projected at an angle of 45° it hits the pole orthogonally 1 m above the mark. When projected with a different speed at an angle of $\tan^{-1}(3/4)$, it hits the pole orthogonally 1.5 m below the mark. Find the speed and angle of projection so that it hits the mark orthogonally to the pole. [$g = 10\ \text{m/sec}^2$]

(1) $\frac{\sqrt{3620}}{3}\text{ms}^{-1}, \tan^{-1}\left(\frac{9}{10}\right)$

(2) $160\ \text{ms}^{-1}$, 30°

(3) $\frac{3620}{9}\text{ms}^{-1}, \tan^{-1}\left(\frac{9}{\sqrt{181}}\right)$

(4) None of these



$\tan^{-1}\left(\frac{3}{4}\right) = \theta$

$\theta = 37^\circ$

$\frac{H_0+1}{R} = \frac{\tan 45^\circ}{4}$ — (1)

$\frac{H_0-1.5}{R} = \frac{\tan 37^\circ}{4}$ — (2)

$\frac{H_0+1}{H_0-1.5} = \frac{4}{3}$

$3H_0+3 = 4H_0-6$

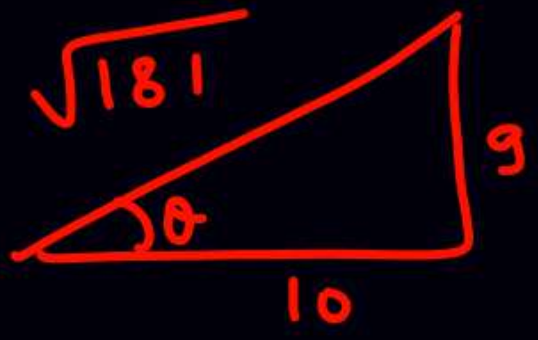
$H_0 = 9;\ R = 40$

Ans : (1)

$h_{max} = 9$

$R = 40$

$\tan\theta = \frac{9}{10}$



$$g = \frac{u^2 \sin^2\theta}{2g}$$

$$9 = \frac{u^2 \times}{2\times10} \frac{81}{181}$$

$$u^2 = \sqrt{\frac{9\times20\times181}{81}}$$

$$u = \sqrt{\frac{20\times181}{9}}$$

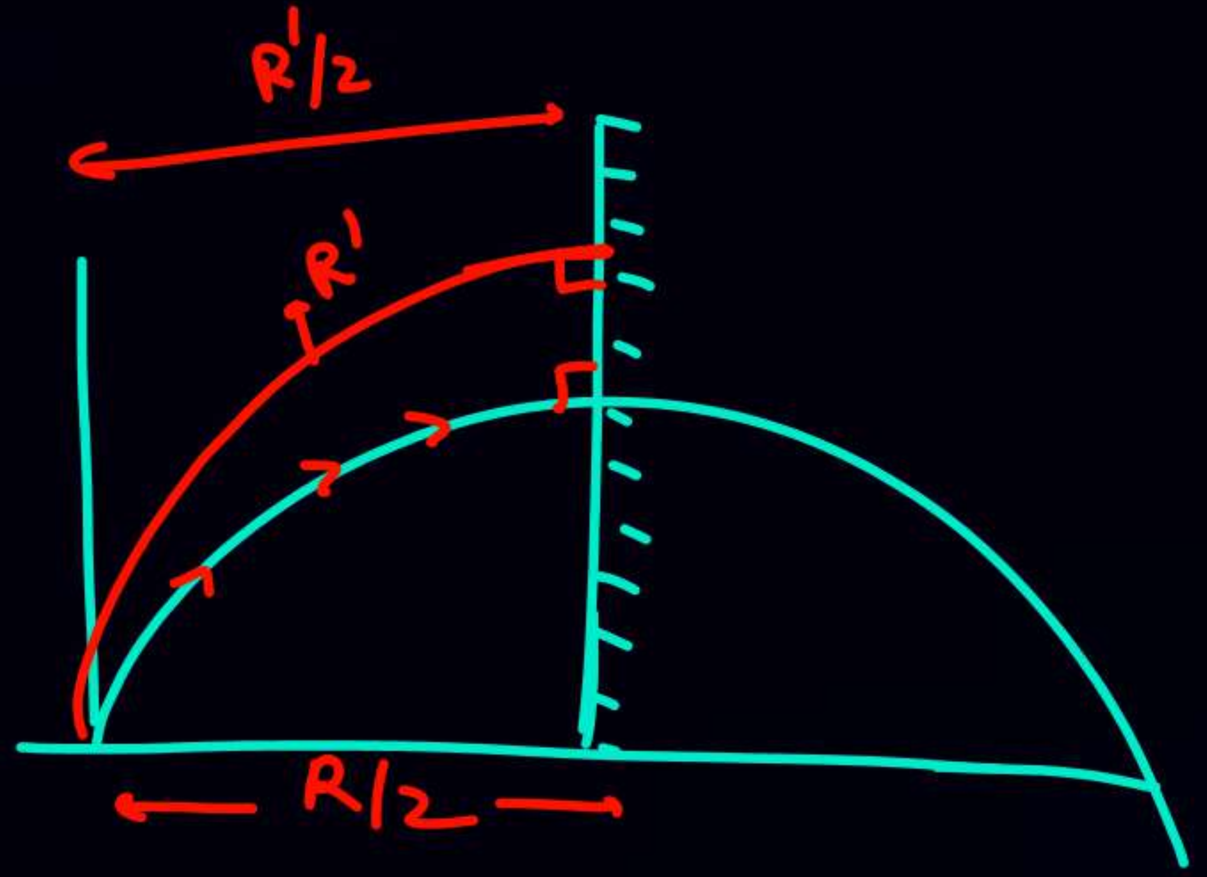
$$u = \frac{1}{3}\sqrt{3620}$$

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

$$R = \frac{u^2 \sin 2\theta}{g}$$

$$\frac{H_{max}}{R} = \frac{\sin^2\theta}{2 \times 2 \sin\theta \cos\theta}$$

$$\boxed{\frac{H}{R} = \frac{\tan\theta}{4}}$$



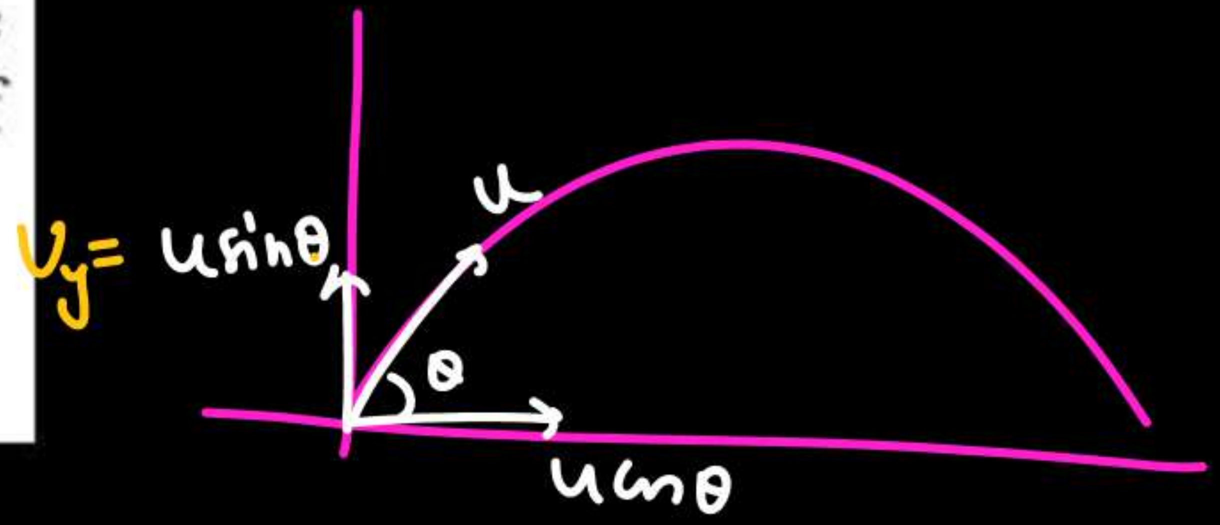
R'/2
R'
R/2

Question - 08

A projectile has a time of flight T and range R. If the time of flight is doubled, keeping the angle of projection same, what happens to the range?

(1) R/4 (2) R/2

(3) 2 R (4) 4 R



$$T = \frac{2v_y}{g} \qquad R = \frac{2v_x v_y}{g}$$

$u \longrightarrow$ double

$u\cos\theta \longrightarrow$ "

$v_y \longrightarrow$ Double

Ans : (4)

Question - 09

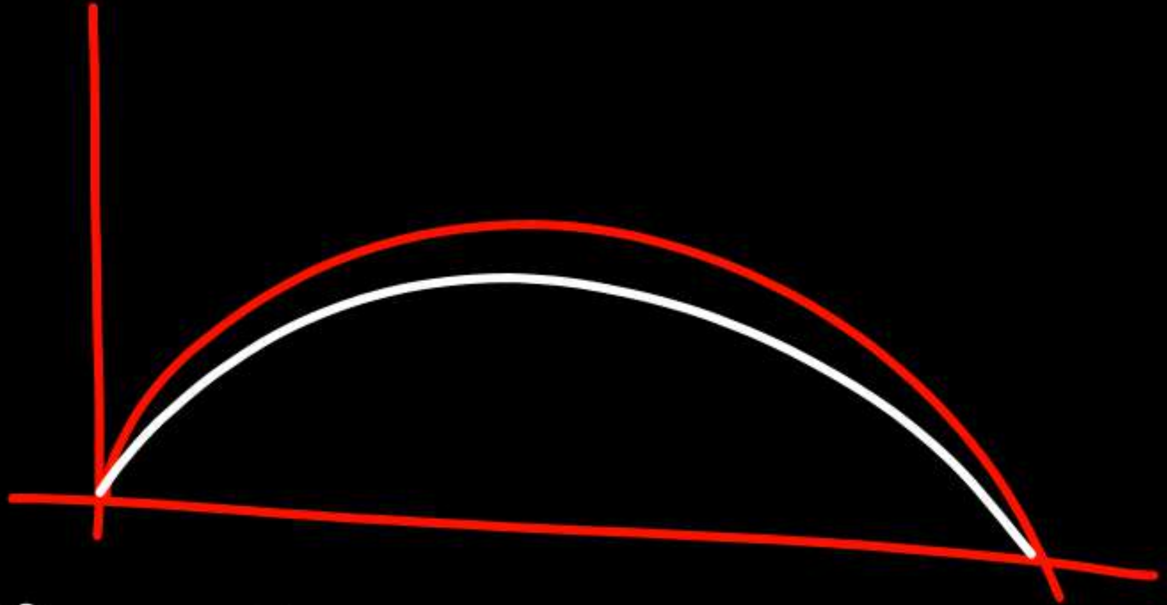
A projectile can have the same range R for two angles of projection at a given speed. If T_1 and T_2 be the times of flight in two cases, then find out relation between T_1, T_2 and R?

(1) $T_1T_2 = \frac{R}{g}$

(2) $\frac{T_1}{T_2} = \frac{R}{g}$

(3) $\frac{T_1}{T_2} = \frac{2R}{g}$

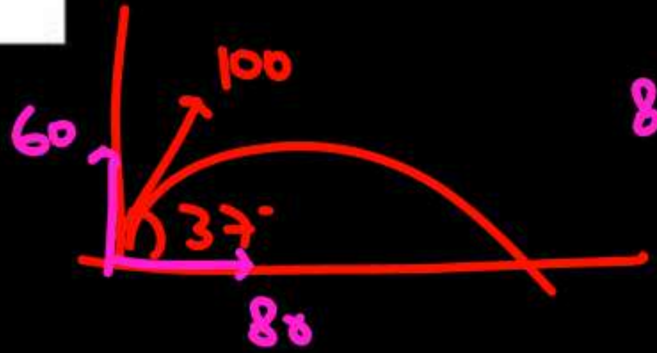
(4) $T_1T_2 = \frac{2R}{g}$



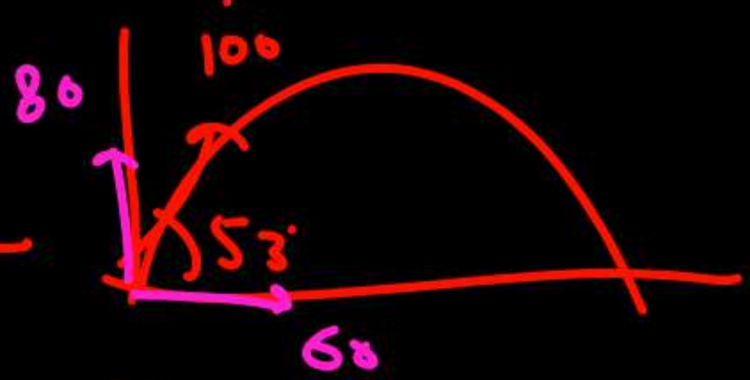
$\theta, \quad 90-\theta$

$$\frac{2u\sin\theta}{g} \cdot \frac{2u\sin(90-\theta)}{g}$$

$$\frac{2u^2\sin 2\theta}{g \; g}$$



$T_1 = 12$
$R = 960$



$T_2 = 16$
$R = 960$

Ans : (4)

Question - 10

During a projectile motion, if the maximum height equals the horizontal range, then the angle of projection with the horizontal is:

(1) $\tan^{-1}(1)$ (2) $\tan^{-1}(2)$

(3) $\tan^{-1}(3)$ (4) $\tan^{-1}(4)$

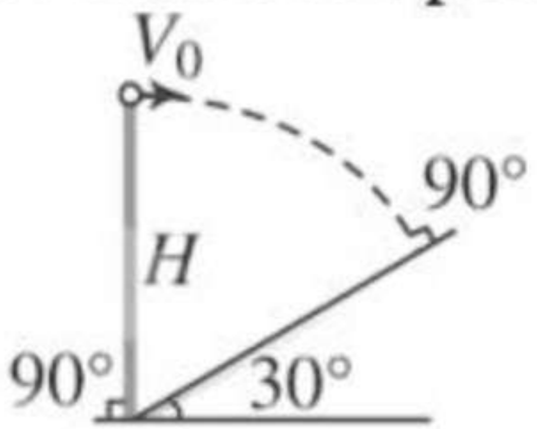
$$\frac{u^2\sin^2\theta}{2g} = \frac{u^2\sin 2\theta}{g}$$

$$\frac{\sin^{\cancel{2}}\theta}{2} = 2\cancel{\sin\theta}\cos\theta$$

Ans : (4)

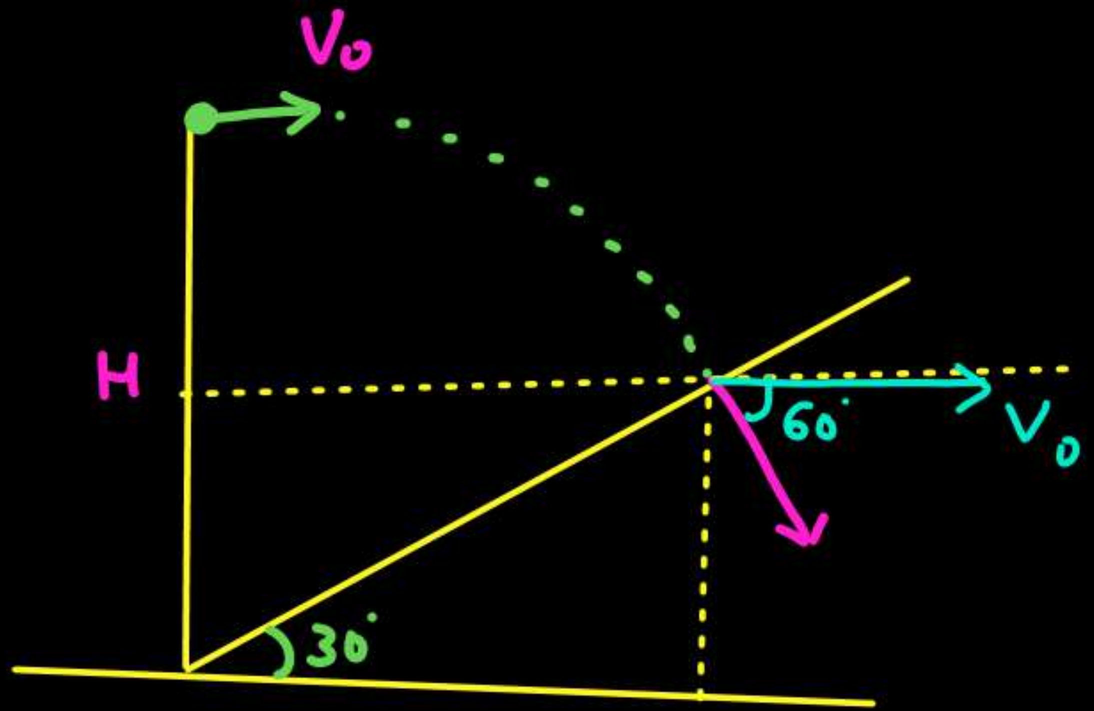
Question - 11

In the figure, the angle of inclination of the inclined plane is 30°. Find the horizontal velocity V_0 so that the particle hits the inclined plane perpendicularly.



(1) $V_0 = \sqrt{\frac{2gH}{5}}$ (2) $V_0 = \sqrt{\frac{2gH}{7}}$

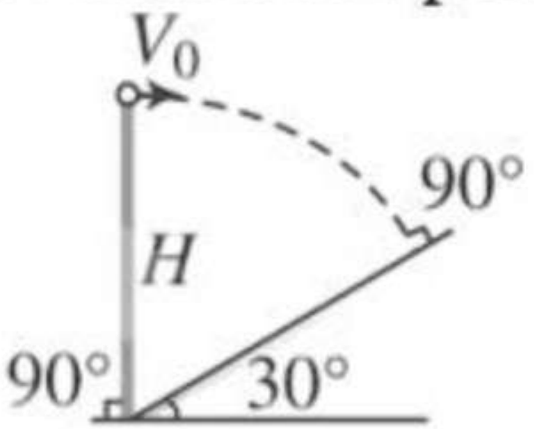
(3) $V_0 = \sqrt{\frac{gH}{5}}$ (4) $V_0 = \sqrt{\frac{gH}{7}}$



Ans : (1

Question - 11

In the figure, the angle of inclination of the inclined plane is 30°. Find the horizontal velocity V_0 so that the particle hits the inclined plane perpendicularly.



$\frac{5}{2}\frac{V_0^2}{g} = H$

$V_0 = \sqrt{\frac{2gH}{5}}$

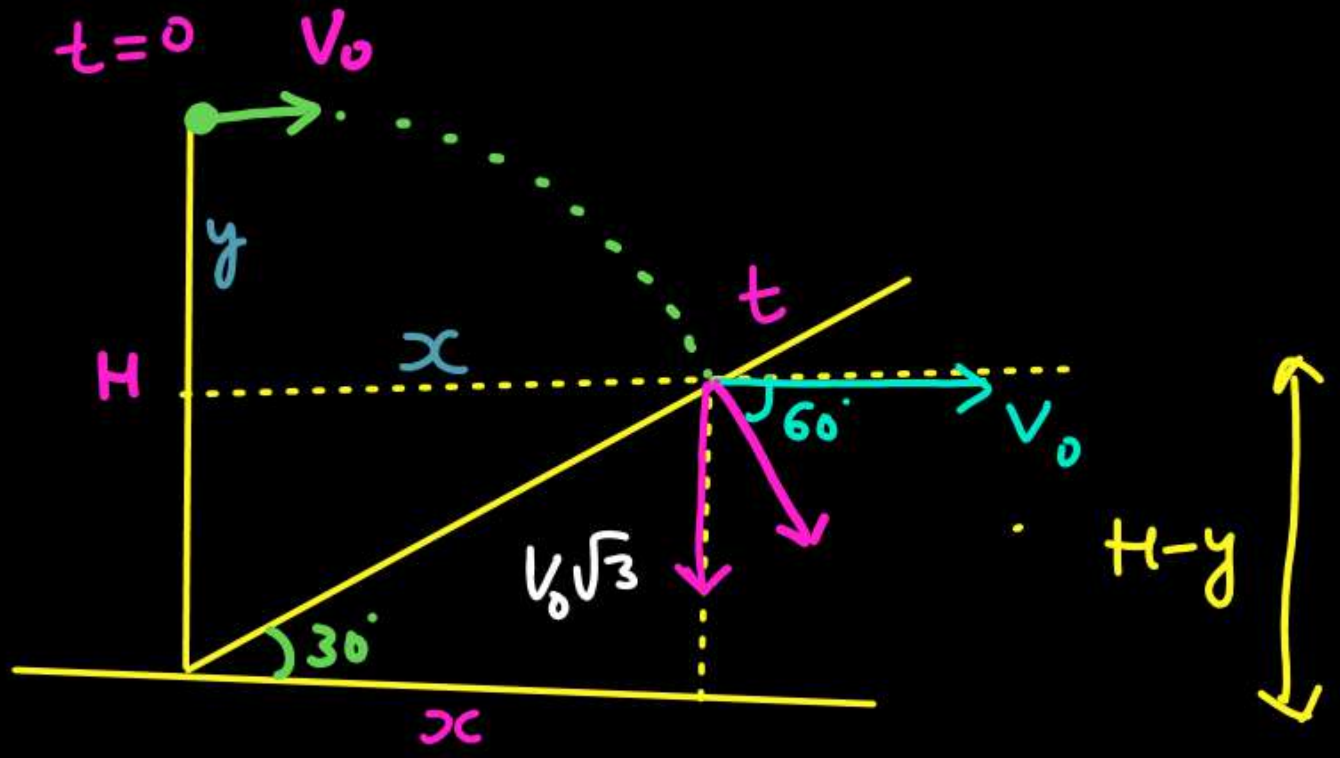
$\tan 30 = \frac{H-y}{x}$

$\frac{1}{\sqrt{3}} = \frac{H - \frac{1}{2}g\left(\frac{V_0\sqrt{3}}{g}\right)^2}{V_0\left(\frac{V_0\sqrt{3}}{g}\right)}$

(1) $V_0 = \sqrt{\frac{2gH}{5}}$ (2) $V_0 = \sqrt{\frac{2gH}{7}}$

(3) $V_0 = \sqrt{\frac{gH}{5}}$ (4) $V_0 = \sqrt{\frac{gH}{7}}$

$\frac{3}{2}\frac{V_0^2}{g} + \frac{V_0^2}{g} = H$



$x = V_0 t$

$y = 0 + \frac{1}{2}gt^2$

$V_0\sqrt{3} = 0 + gt$

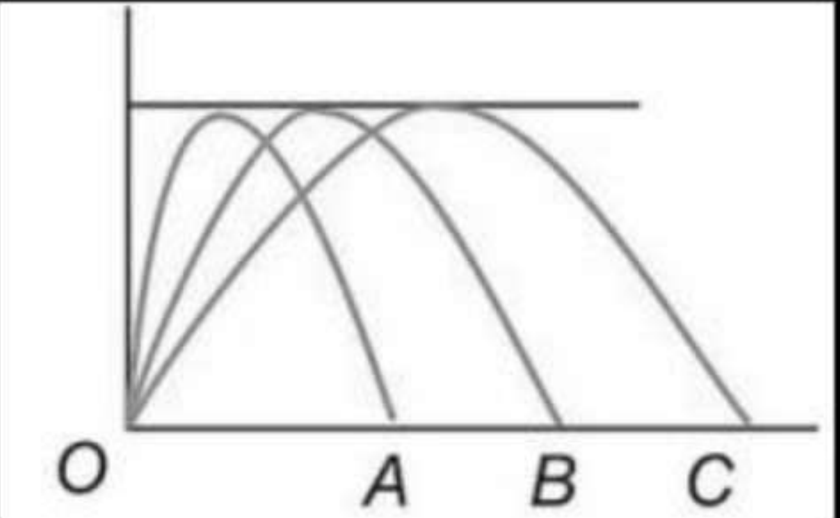
$\tan 60 = \frac{V_y}{V_0}$

$V_y = V_0\sqrt{3}$

Ans : (1

Question - 12

Three projectiles A, B and C are thrown simultaneously from the same point in the same vertical plane. Their trajectories are shown in the figure. Then which of the following statement(s) is/are correct.



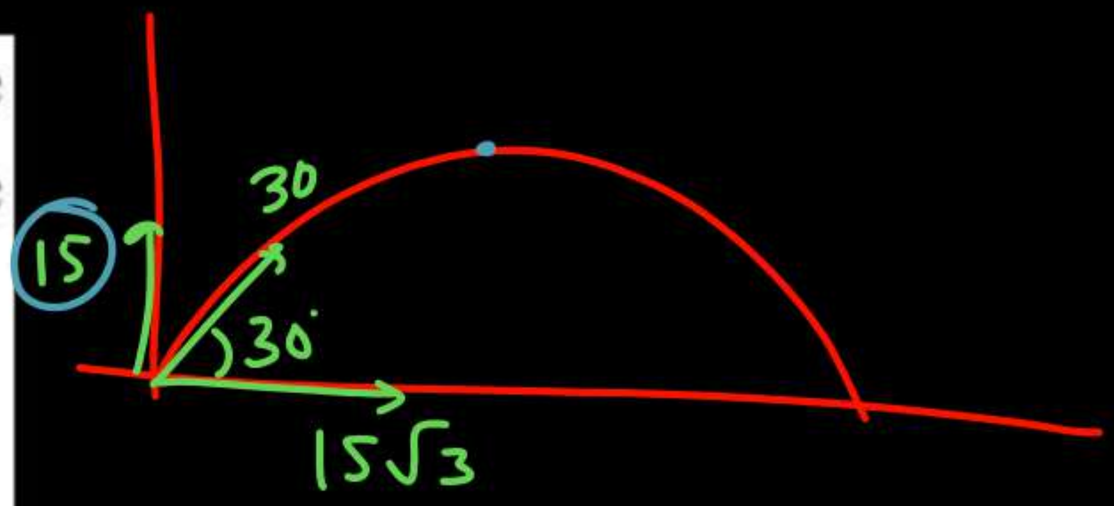
(1) The time of flight is the same for all the three.
(2) The launch speed is greatest for particle C
(3) The vertical velocity component for particle C is greater than that for the other particles
(4) Y-coordinate of all particles is always same

Ans : (1, 2, 4)

Question - 13

A body is projected at an angle of 30° with the horizontal and with a speed of 30 ms^{-1}. What is the angle with the horizontal after 1.5 s? ($g = 10\ ms^{-2}$).

(1) 0°
(2) 30°
(3) 60°
(4) 90°



Ans : (1)

Question - 14

A particle is projected from the ground with velocity u at angle θ with horizontal. The horizontal range, maximum height and time of flight are R, H and T respectively. They are given by,

$$R = \frac{u^2 \sin 2\theta}{g}, H = \frac{u^2 \sin^2\theta}{2g} \text{ and } T = \frac{2u\sin\theta}{g}$$

Now keeping u as fixed, $\boxed{\theta \text{ is varied from } 30^\circ \text{ to } 60^\circ}$. Then,

(1) R will first increase then decrease, H will increase and T will ~~decrease~~

(2) R will first increase then decrease while H and T both will increase

(3) R will decrease while H and T will increase

(4) R, H and T will increase

θ ↑ ↓

30° 45° 60°

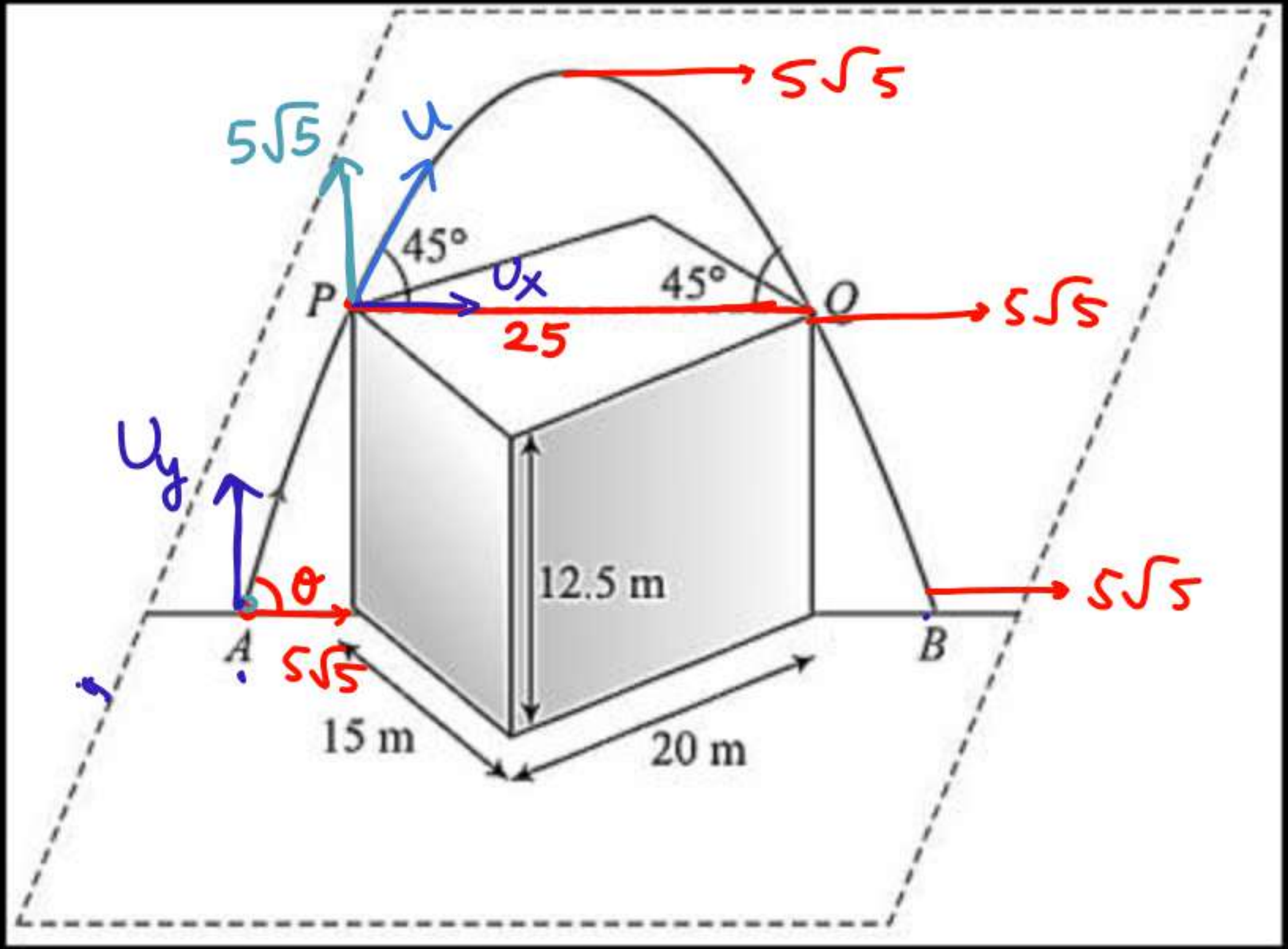
$45^\circ \rightarrow R_{max}$

Ans : (2)

Passage for questions no. 15 to 19

$(5\sqrt{5})^2 = u_y^2 - 2\times 10\times 12.5$ $\sqrt{15^2+20^2} = 25$

A particle is fired from A in the diagonal plane of a building of dimension 20 m (length) × 15 m (breadth) × 12.5 (height), just clears the roof diagonally and falls on the other side of the building at *B*. It is observed that the particle is travelling at an angle 45° with the horizontal when it clears the edges P and Q of the diagonal. Take g = 10 m/s².



$R = 25 = \dfrac{u^2 \sin 90^\circ}{g}$ $u_y = \sqrt{375}$

$\boxed{u = 5\sqrt{10}}$ $= 5\sqrt{15}$

$u_x = u\cos 45^\circ = 5\sqrt{10}\times\dfrac{1}{\sqrt{2}} = 5\sqrt{5}$

$\sqrt{(5\sqrt{5})^2 + 375}$

$\tan\theta = \dfrac{u_y}{u_x} = \dfrac{5\sqrt{15}}{5\sqrt{5}} = \sqrt{3}$

$\theta = 60^\circ$

Question - 15

The speed of the particle at point P will be:

(1) $5\sqrt{10}$ m/s (2) $10\sqrt{5}$ m/s

(3) $5\sqrt{15}$ m/s (4) $5\sqrt{5}$ m/s

Ans : (1)

Question - 16

The speed of the particle at the top of the trajectory:

(1) $5\sqrt{10}$ m/s (2) $10\sqrt{5}$ m/s

(3) $5\sqrt{15}$ m/s (4) $5\sqrt{5}$ m/s

Ans : (4)

Question - 17

The angle of projection at A will be:

(1) 30°   (2) 45°

(3) 60°   (4) 75°

Ans : (3)

Question - 18

The speed of projection of the particle at A will be:

(1) $5\sqrt{10}$ m/s
(2) $10\sqrt{5}$ m/s
(3) $5\sqrt{15}$ m/s
(4) $5\sqrt{5}$ m/s

$$\sqrt{500} = 10\sqrt{5}$$

Ans : (2)

Question - 19

The range that is AB will be:

(1) $5\sqrt{10}$ m/s (2) $25\sqrt{3}$ m/s

(3) $5\sqrt{15}$ m/s (4) $25\sqrt{5}$ m/s

$$\frac{2u_x u_y}{a_y} = \frac{2 \times 5\sqrt{5} \times \sqrt{375}}{10}$$

$$= \sqrt{375 \times 5}$$

$$= \sqrt{25 \times 15 \times 5} = 5 \times 5\sqrt{3}$$

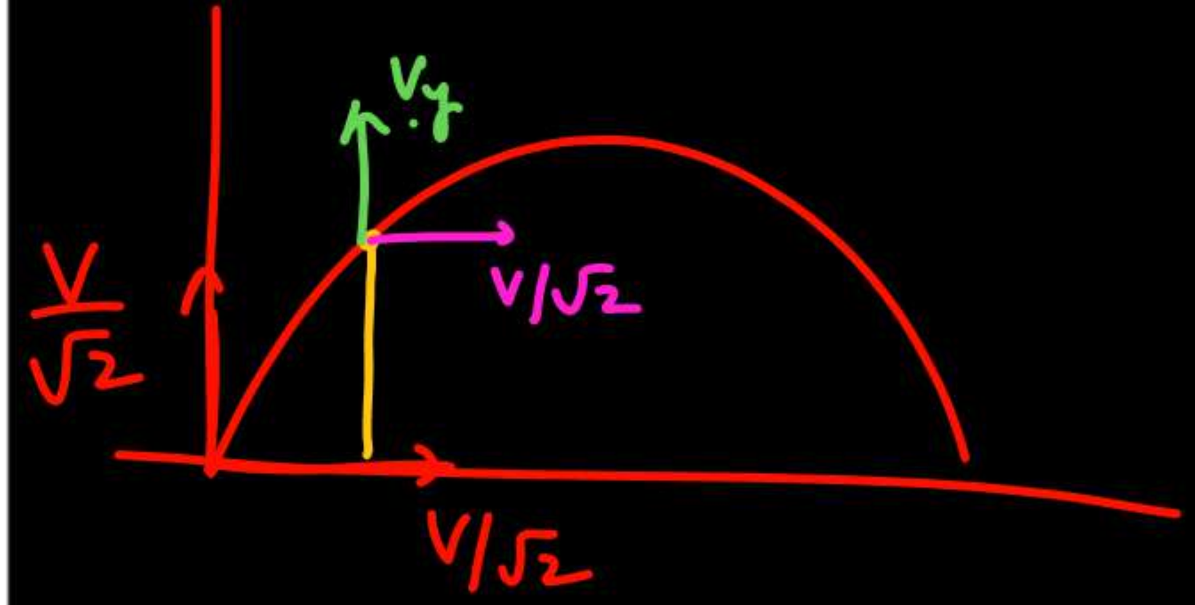
Ans : (2)

Question - 20

$$h_{max} = \frac{(v/\sqrt{2})^2}{2g} = \frac{v^2}{4g}$$

A ball is projected from the ground with velocity v such that its range is maximum. $\theta = 45^\circ$

Column-I		Column-II	
i.	Velocity at half of the maximum height (a)	a.	$\frac{\sqrt{3}v}{2}$
ii.	Velocity at the maximum height b	b.	$\frac{v}{\sqrt{2}}$
iii.	Change in its velocity when it returns to the ground c	c.	$v\sqrt{2}$
iv.	Average velocity when it reaches the maximum height	d.	$\frac{v}{2}\sqrt{\frac{5}{2}}$



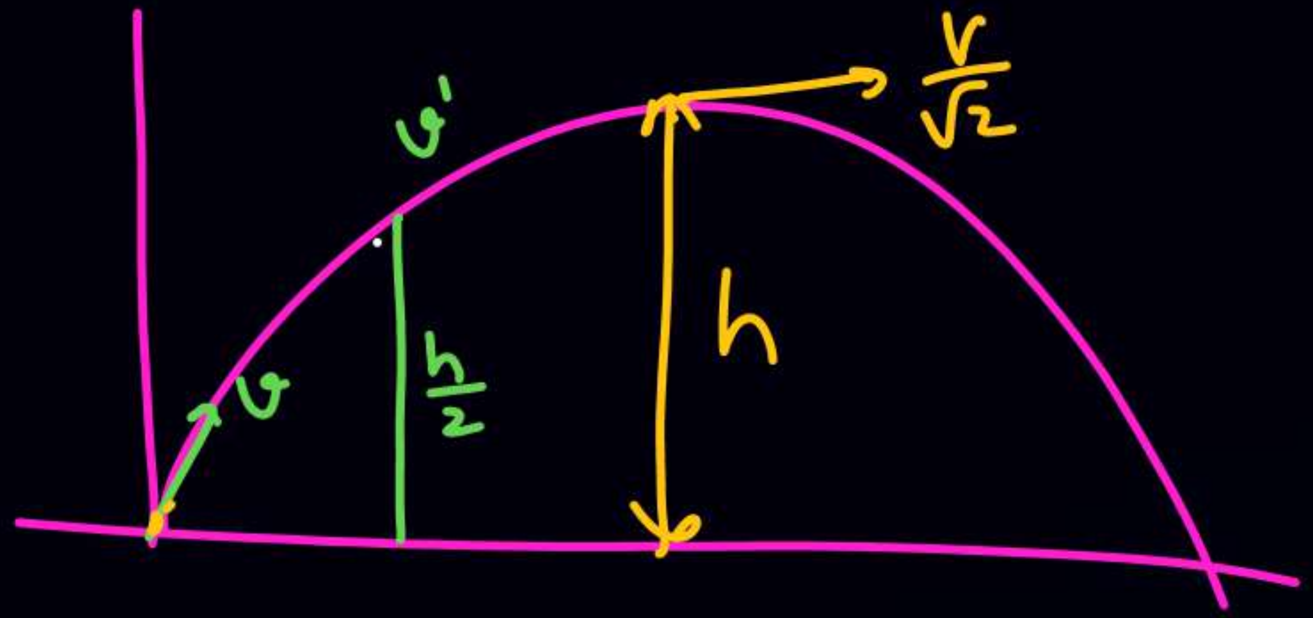
$$v_y^2 = \left(\frac{v}{\sqrt{2}}\right)^2 - 2 \times g \times \frac{v^2}{8g}$$

$$= \frac{v^2}{2} - \frac{v^2}{4} = \frac{v^2}{4}$$

$$\boxed{\vec{V} = \frac{v}{\sqrt{2}}\hat{i} + \frac{v}{2}\hat{j}}$$

$$\sqrt{\left(\frac{v}{\sqrt{2}}\right)^2 + \left(\frac{v}{2}\right)^2} = \sqrt{\frac{v^2}{2} + \frac{v^2}{4}} = \frac{v\sqrt{3}}{2}$$

$\therefore$ Ans : i → a; ii → b; iii → c; iv → d



$$\frac{1}{2}mv^2 + 0 = \frac{1}{2}m\left(\frac{v}{\sqrt{2}}\right)^2 + mgh$$

$$mgh = \frac{mv^2}{4}$$

$$\frac{1}{2}mv^2 + 0 = \frac{1}{2}mv'^2 + mg\frac{h}{2}$$

$$\frac{mv^2}{4} = \frac{1}{2}mv'^2$$

$$v' = v/2$$

THANK YOU