YAKEEN NEET 2.0

2026

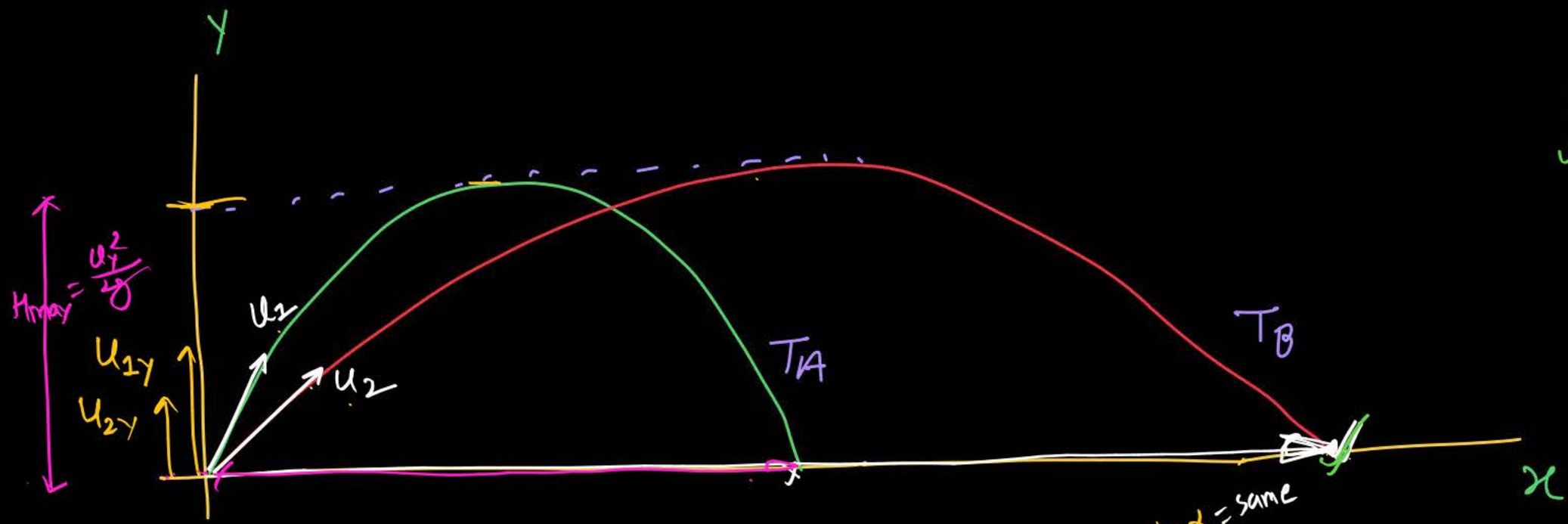
Motion in a Plane

Physics | Lecture - 3

By- Manish Raj (MR Sir)

Todays Goal

- equation of Trajectory
- Projectile on Inclined
- Horizontal Projectile motion

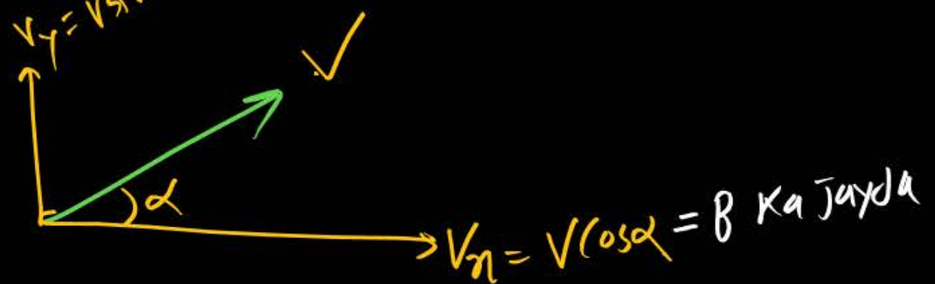


y of Projectile u_1 & u_2

(a) $u_{1y} = u_{2y}$ (Vertical vector)

(b) $T_A = T_B$

(c) $u_1 < u_2$



(#) $R = u_x T_f$

$R \propto T_f$ (if)

Ramkal scam

(a) Yes
(b) No

Ball is Projected and its position at time t is $\vec{r} = 30t\,\hat{i} + (40t - 4t^2)\hat{j}$

Then find Range :- (MR Scam)

Solution

Likho

$$\vec{r} = 30t\,\hat{i} + (40t - 4t^2)\hat{j}$$

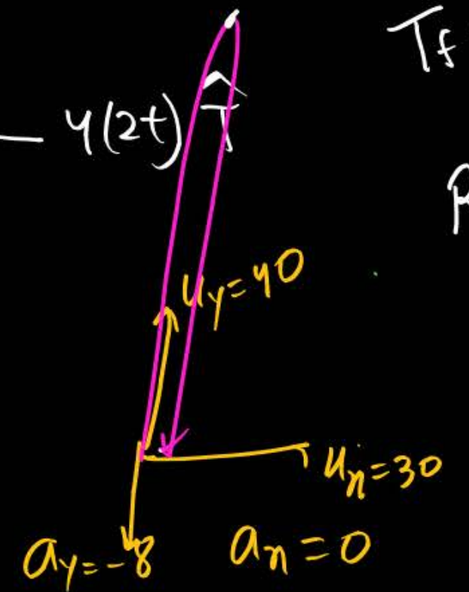
$$\vec{v} = \frac{d\vec{r}}{dt} = 30\hat{i} + (40 - 4(2t))\hat{j}$$

$$\vec{v} = 30\hat{i} + (40 - 8t)\hat{j}$$

$\vec{a} = \frac{dv}{dt} = -8\,m/s^2\,\hat{j}$

$u_x = 30$

$u_y = 40$ (at $t = 0$) ✓



$T_f = 10\,sec = \frac{2u_y}{g} = \frac{2 \times 40}{8/4} = 10\,sec$

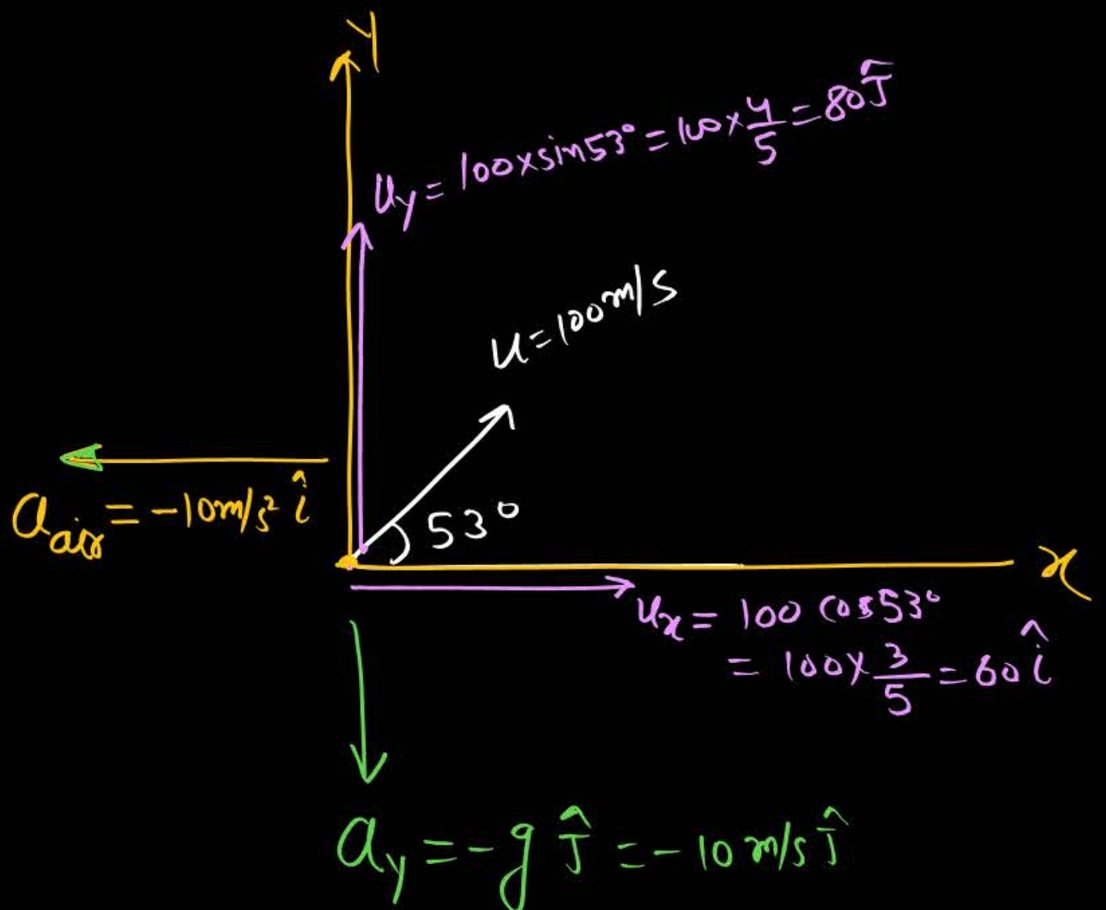
$R = u_x T_f$

$= 30 \times 10$

$= 300\,m$

$$R = \frac{2u_x u_y}{a}$$

Q



find dirn of velocity aftn 2

$t = 2$ sec, V at $t = 2$ sec.

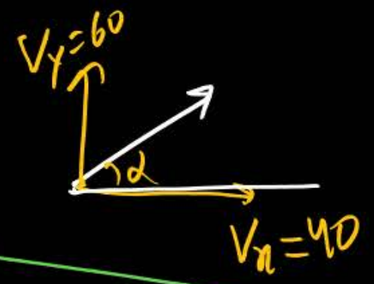
V_x at $t=2 = u_x - a_x t$

$= 60 - 10 \times 2 = 40\hat{i}$

V_y at $t=2 = u_y - a_y t$

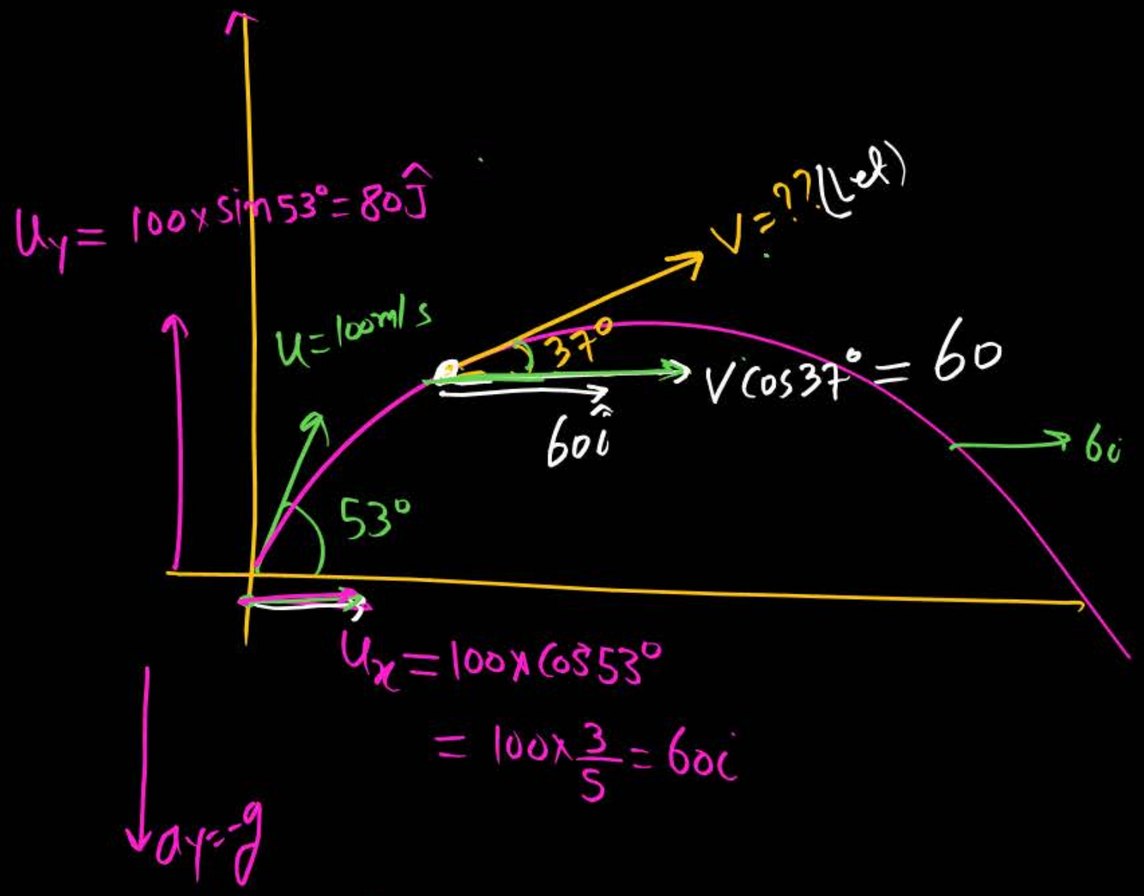
$= 80 - 10 \times 2 = 60\hat{j}$

$\tan\alpha = \frac{60}{40} = \frac{3}{2}$



$\vec{V} = 40\hat{i} + 60\hat{j}$

Ball is projected with 100m/s at 53° then find its speed when it is moving at 37° from Horizontal. (H/W) must Try



$V \times \frac{4}{5} = 60^{15}$

$V = 15 \times 5 = 75 m/s$

$u_x = \text{Const}^n$

$a_x = 0$

$\cos 37° = \frac{4}{5}$

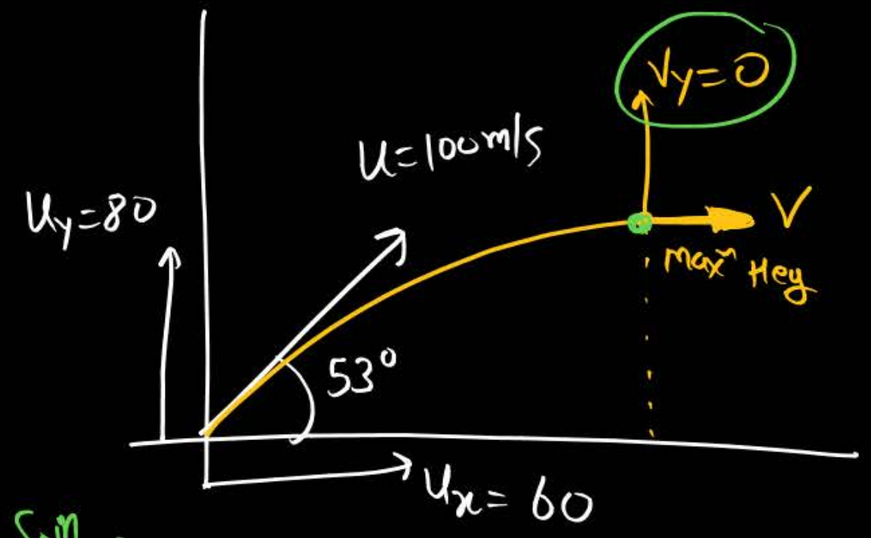
$\cos 53° = 3/5$

$\sin 53° = 4/5$

$\sin 37° = 3/5$

(8) Ball is projected with speed 100m/s at 53° then find time when its velocity Parallel to x-axis and velocity 37° from x axis.

Soln

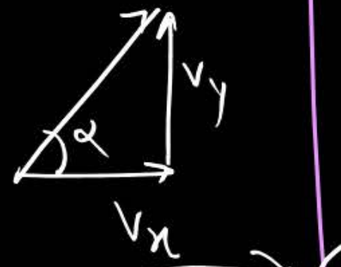


Soln ①

Motion in y

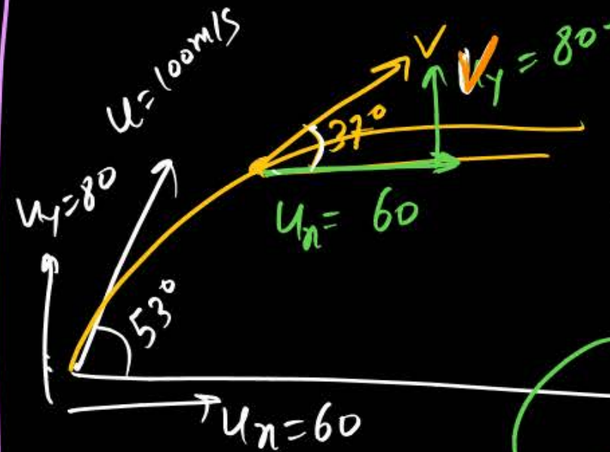
$V_y = u_y - a_y t$

$0 = 80 - 10t$ $\quad t = \frac{80}{10} = 8sec$ //



$\tan\alpha = \frac{V_y}{V_x}$

(11)



$\tan 37° = \frac{80-10t}{60}$

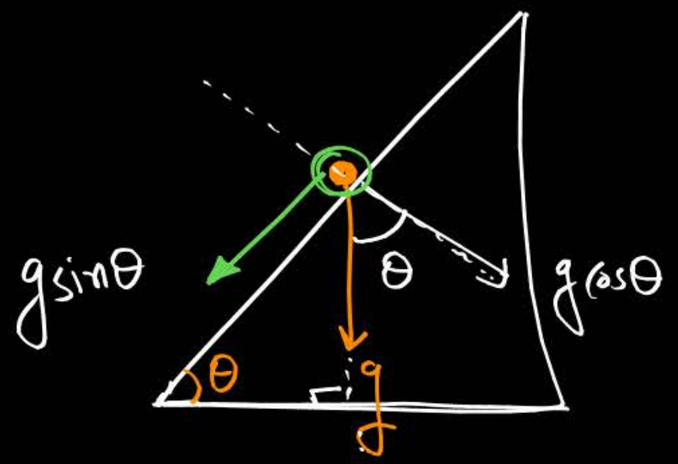
$\frac{3}{4} = \frac{80-10t}{60}$ (15)

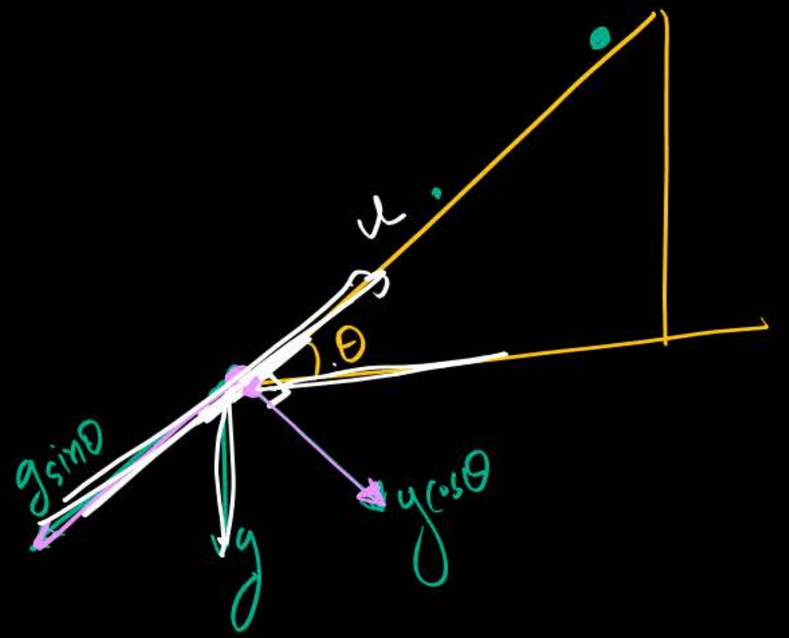
$45 = 80 - 10t$

$10t = 80 - 45$

(#) $t = \frac{35}{10} = 3.5$ sec

Basic math


$g\sin\theta$
θ
$g\cos\theta$
θ
g


u
θ
$g\sin\theta$
g
$g\cos\theta$

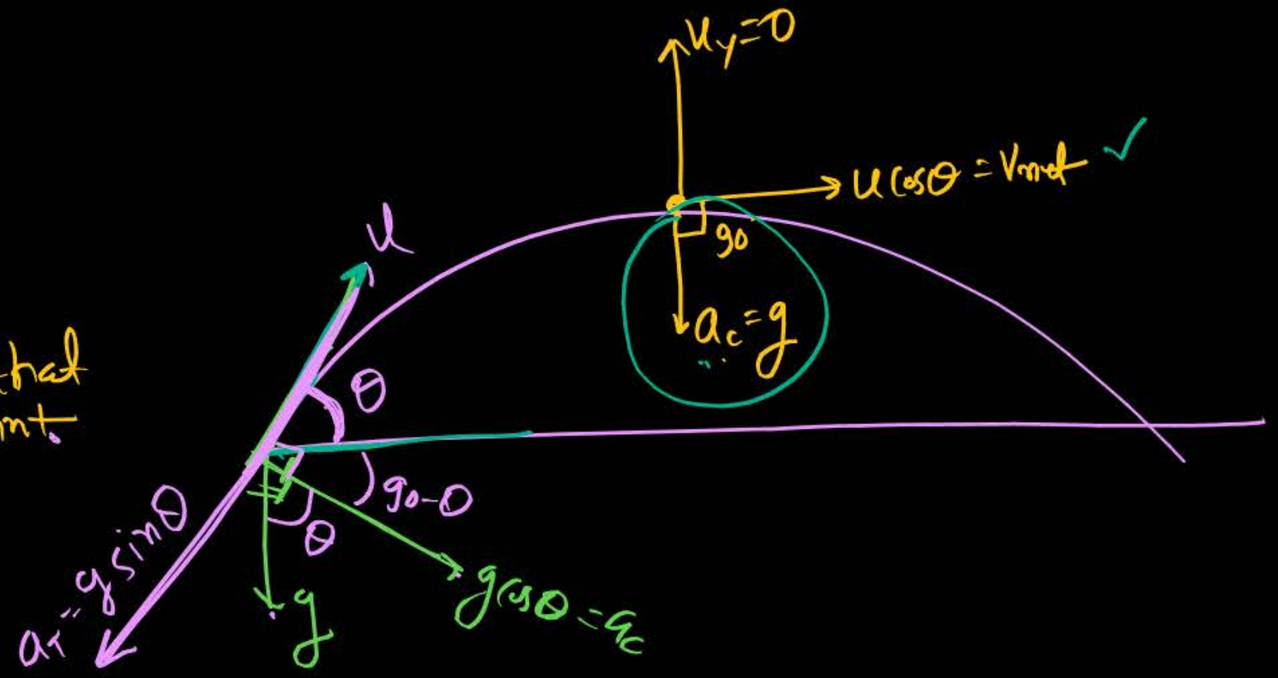
Radius of curvature

$$a_c = \frac{v^2}{R}$$ ← Radius

centripetal acc^n.

\# $R = \frac{v^2}{a_c}$ ← speed of object at that point.

← centripetal acc^n ($\vec{a} \perp \vec{v}$)



⊕ Radius of curvature at max^m Height

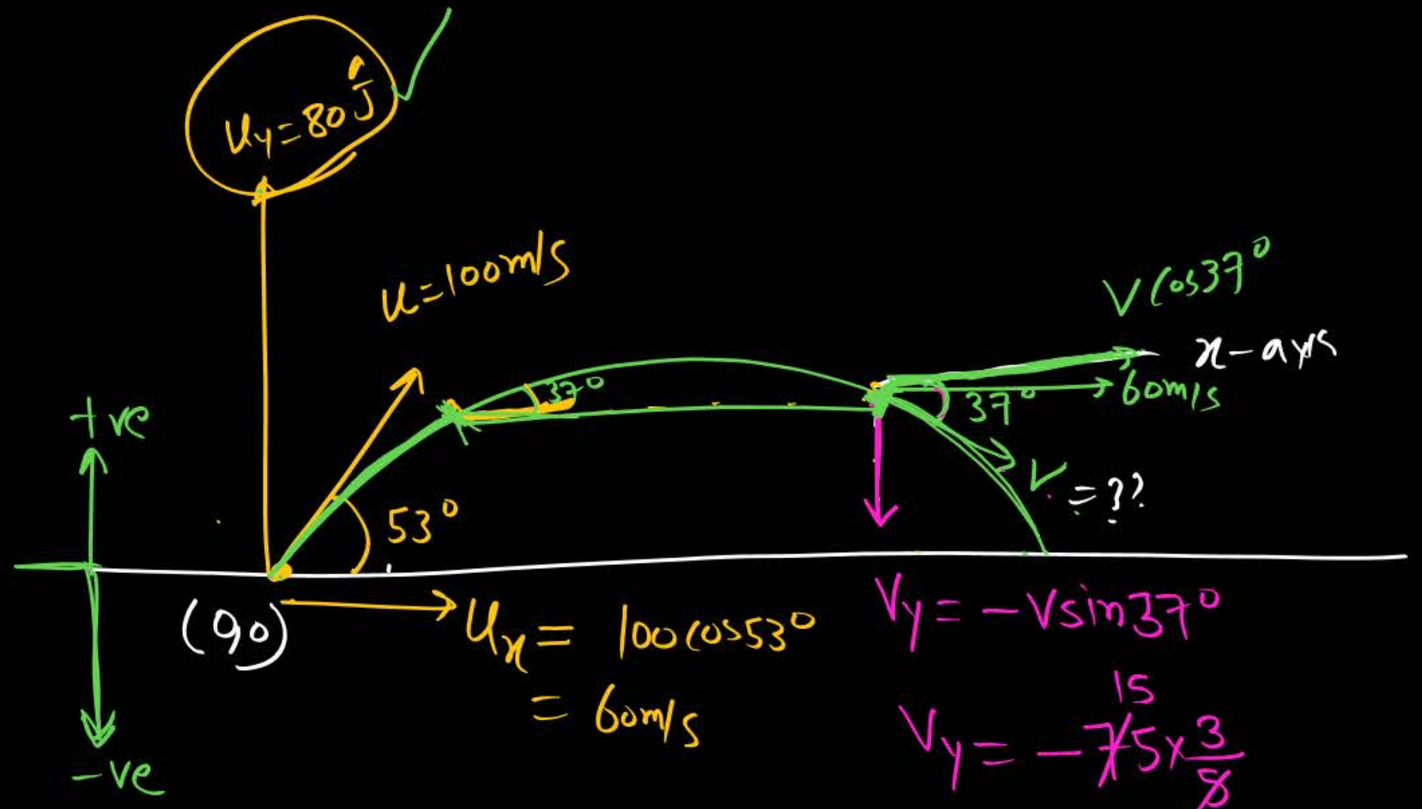
$$R_c = \frac{(u\cos\theta)^2}{g}$$

$$\boxed{R_c = \frac{u^2\cos^2\theta}{g}}$$

⊕ Radius of curvature at Point of Projecti

$$R_c = \frac{u^2}{g\cos\theta}$$ Ans.

Q)



find $v = ??$

x-axis ⇒ velocity same

$V\cos37° = 60$

$V \times \frac{4}{5} = 60$

$V = 75\ m/s$

Motⁿ in y-axis

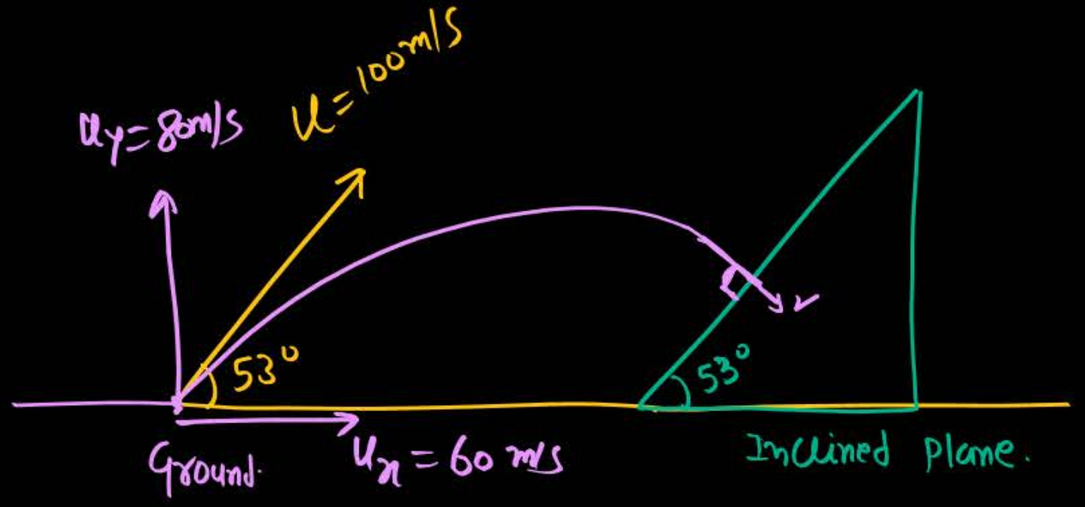
$V_y = u_y + a_y t$

$-45 = 80 - 10t$

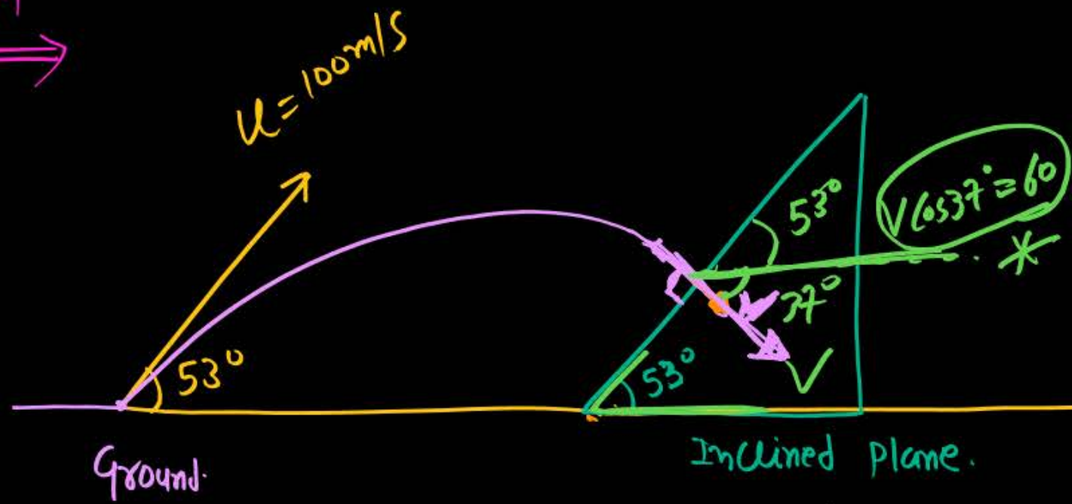
$10t = 125$

$t = 12.5$ sec

Q



Soln

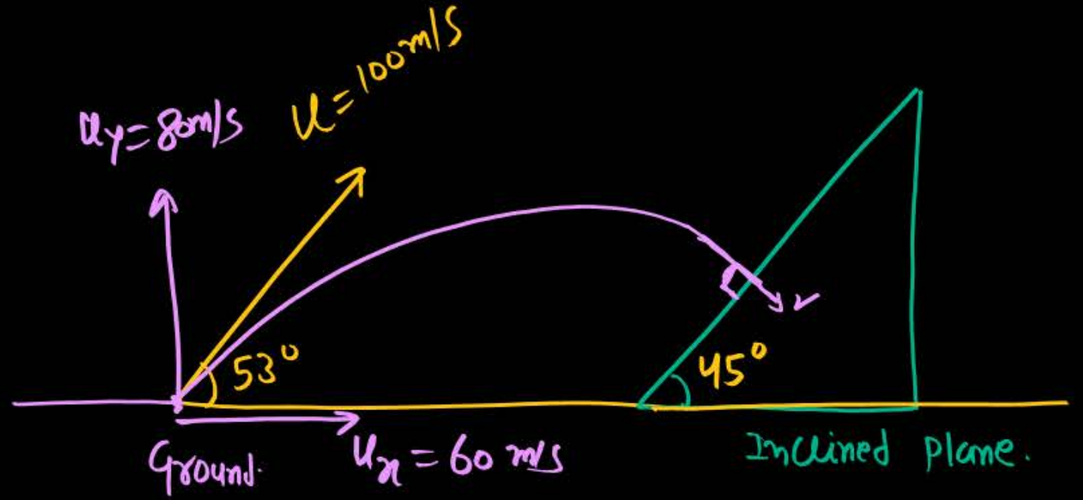


Ball is projected as shown in fig. and collide with Inclined Plane at $\perp^r$ to the plane then find speed at that Point & T_f

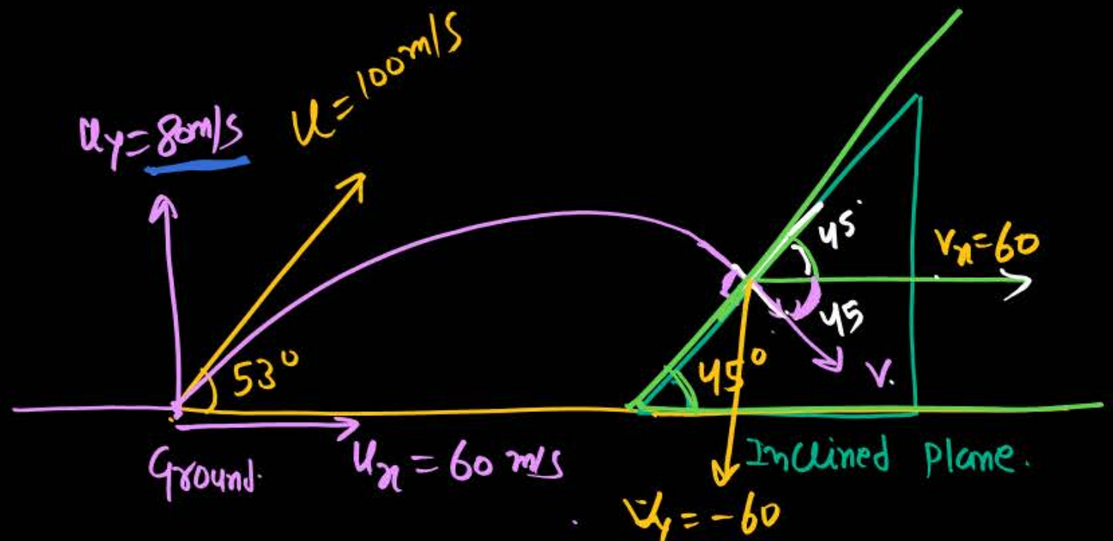
$V = 75$ m/s

$T_f = 12.5$ sec

Q



Soln



Q Ball is Projected as shown in fig. and Collide with Inclined Plane at ⊥r to the plane then find speed at that Point & T_f

$T_f = 14$ sec

total time from Projection to collision with Inclined plane.

$V\cos 45° = 60$

$V = 60\sqrt{2}$ m/s

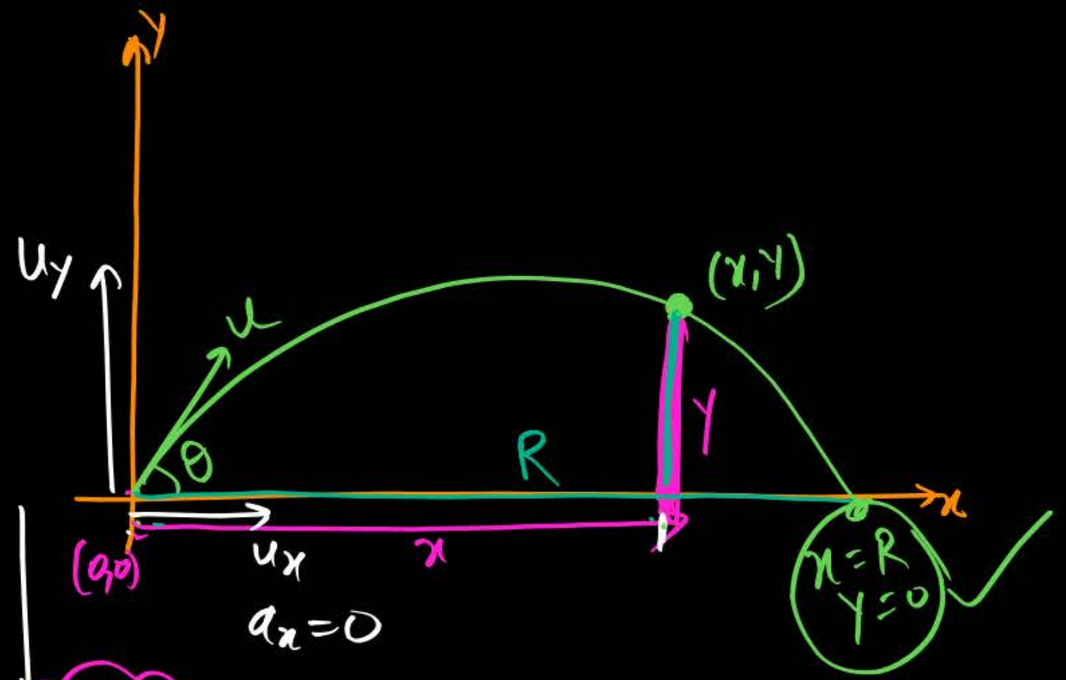
Equation of Trajectory :-

$$\tan\theta = \frac{u_y}{u_x}$$

$$x = u_x t \quad -(i)$$

$$y = u_y t - \frac{1}{2} g t^2 \quad -(ii)$$

Put Value of t from eq (i) to (ii)



$$y = u_y \frac{x}{u_x} - \frac{1}{2} g \frac{x^2}{u_x^2}$$

$$y = \tan\theta\, x - \frac{1}{2} \frac{g x^2}{u^2 \cos^2\theta}$$

→ Parabola

$$y = x\tan\theta \left[1 - \frac{x}{R}\right]$$

→ eqn of Trajectory

→ do it by Yourself

⑥ $y = \sqrt{3}x - \frac{x^2}{\sqrt{3}}$ eqn of Trajectory then find Range & angle of Projection.

Sol^n

$$y = x\tan\theta\left(1 - \frac{x}{R}\right)$$

$$y = \sqrt{3}x - \frac{x^2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

समझिए

$$\boxed{y = \sqrt{3}x\left(1 - \frac{x}{3}\right)}$$

$\tan\theta = \sqrt{3}$ $\quad R = 3m$

$\theta = 60^\circ$

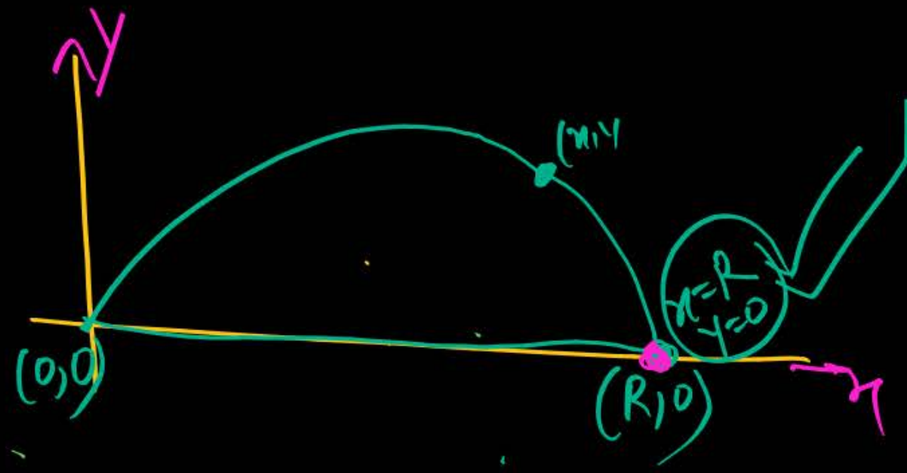
Max

$\sqrt{3} = \tan\theta \rightarrow \theta = 60^\circ$ Ans

$$y = 0 = \sqrt{3}x - \frac{x^2}{\sqrt{3}}$$

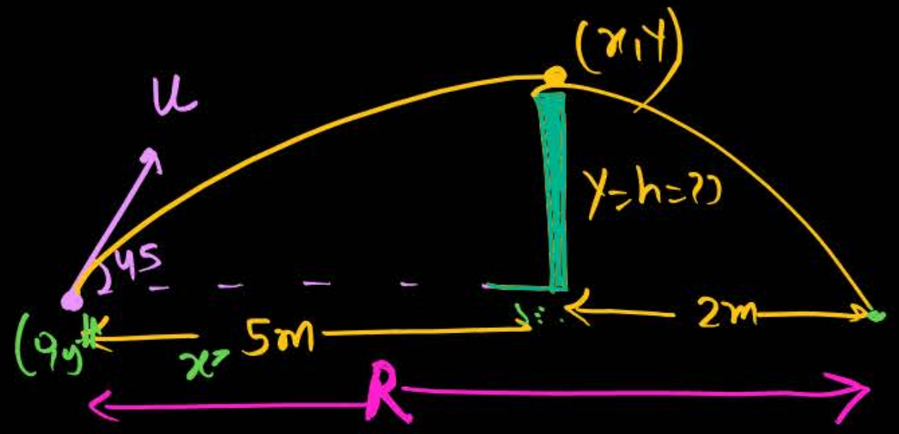
$$\sqrt{3}x = \frac{x^2}{\sqrt{3}}$$

$$x = \sqrt{3} \times \sqrt{3} = 3m = \text{Range}$$



(2) Ball is projected at angle 45° and it touches top of Pole at distⁿ 5m and fall other side at 2m from Pole then find height of Pole.

Likho



eqⁿ of trajectory

$$y = a\tan\theta\left(1-\frac{x}{R}\right)$$

$$h = 5\tan 45^\circ\left(1-\frac{5}{5+2}\right) = 5\times 1\left(1-\frac{5}{7}\right) = 5\left(\frac{2}{7}\right) = \frac{10}{7}\text{ m}$$

$\therefore$

Question JEE

Nahi likhna aa raha hai

The equation of trajectory of a projectile thrown from a level ground near the surface of earth is given by $y = ax - bx^2$, with y-axis in vertical direction and x-axis in horizontal direction, a and b are constants. Then,

(i) The range of the projectile is a/b.

(ii) At $x = a/2b$, the velocity of projectile becomes zero.

(iii) The maximum height attained by projectile is $a^2/4b$.

(iv) The angle of projectile is $\tan^{-1}(a)$.

1. (i) and (ii)
2. (ii) and (iii)
3. (i), (iii) and (iv)
4. All above

1 Mark

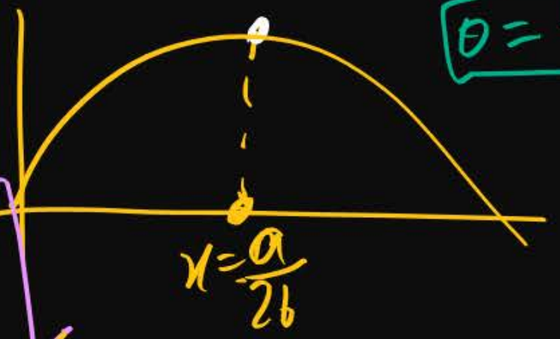
$y = ax - bx^2$

$y = 0 \quad ax = bx^2 \times x$

$R = \frac{a}{b}$

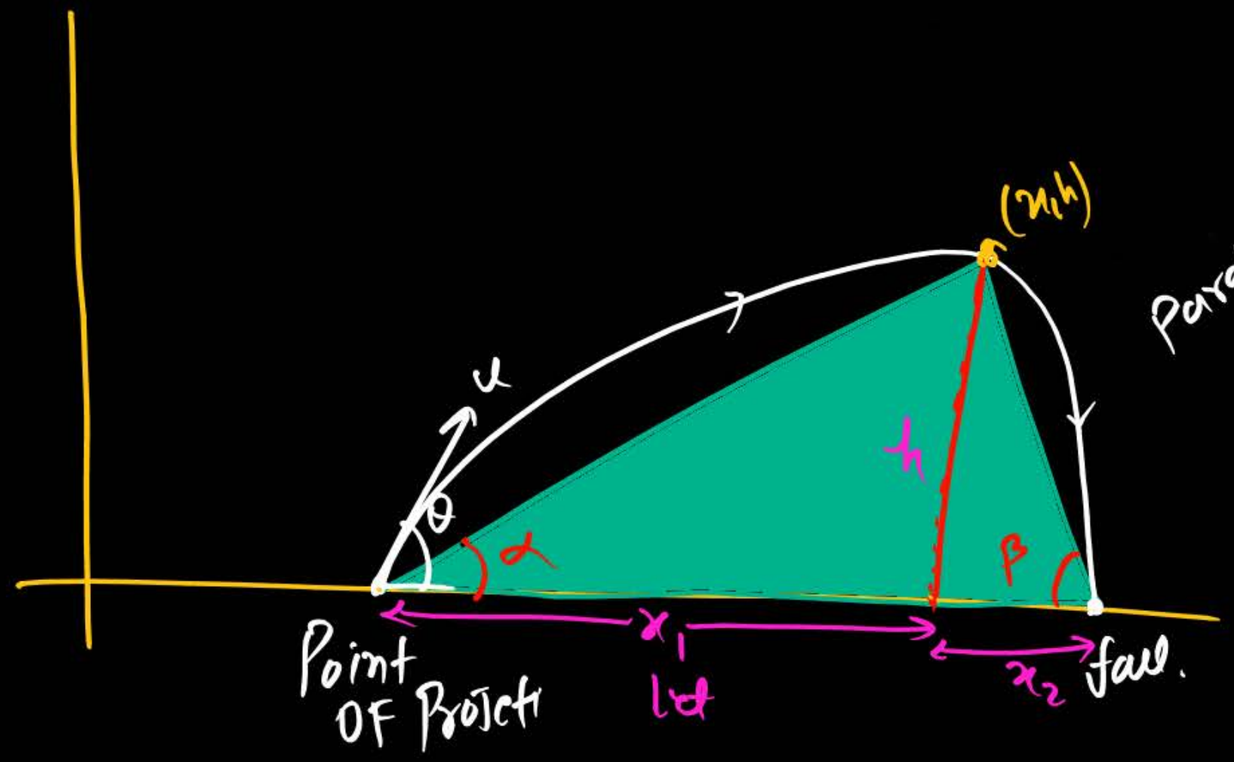
$\tan\theta = a$

$\theta = \tan^{-1}(a)$



$H = \frac{R\tan\theta}{4} = \frac{a \times a}{4b} = \frac{a^2}{4b}$

H.C.V



Parabolic Path find rel^n B/w θ, α & β

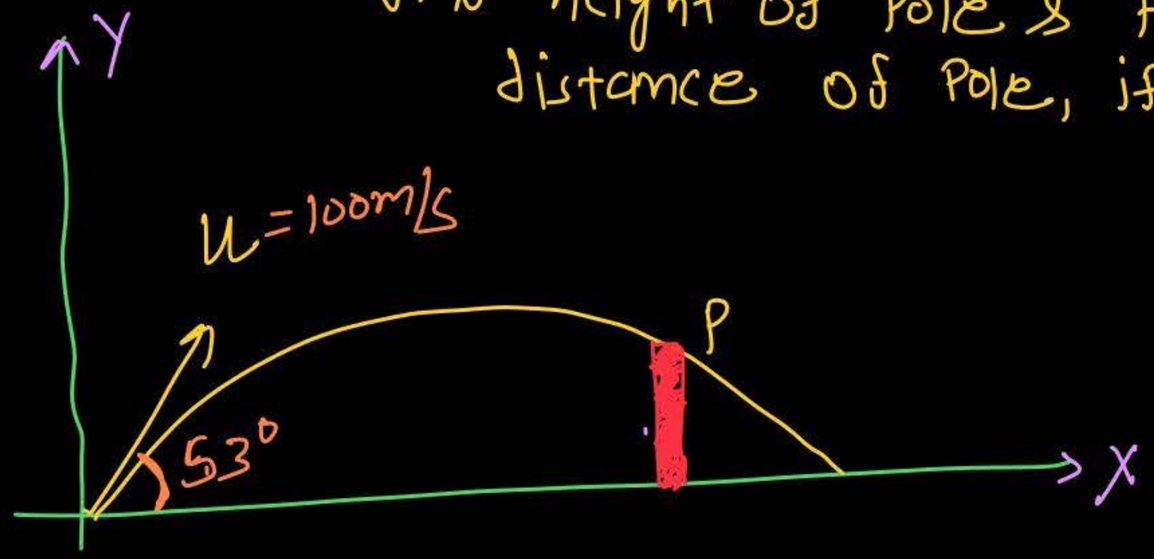
$$Y = x\tan\theta\left(1-\frac{x}{R}\right)$$

$$h = x_1\tan\theta\left(1-\frac{x_1}{x_1+x_2}\right)$$

hint

H/W

find height of Pole & Horizontal distance of Pole, if Ball touches the Pole at $t = 2\,sec$

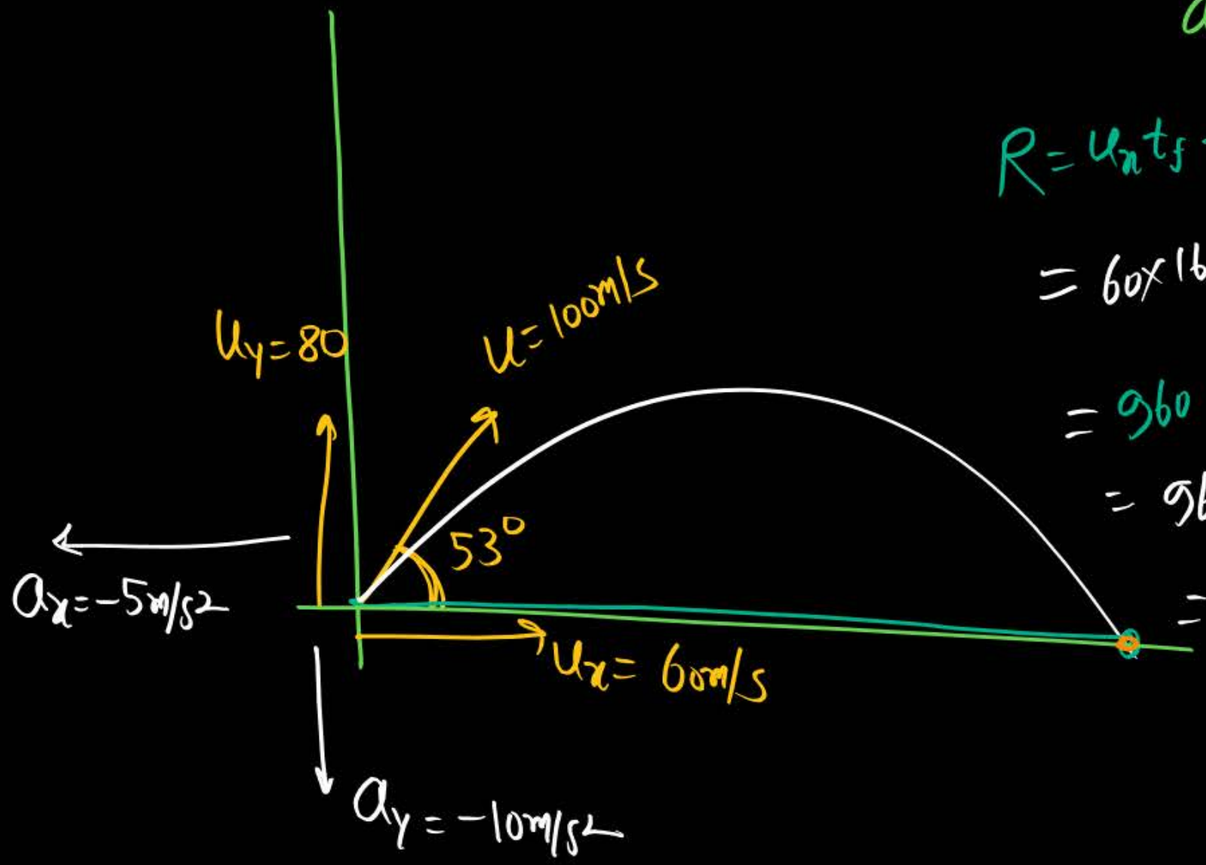


H/W

Ball is Project with 50m/s at angle 53° and constant air friction acts in x-axis which Produce retardation of $-5 m/s^2$ then find, H, T, R = ??

air friction

Ball is projected with speed 100m/s at angle 53° and const^n air friction produce retardation $-5m/s^2$ in x-axis only then find H, T, R.



$u_x = 60$ m/s

$a_x = -5 m/s^2$

$R = u_x t_f - \frac{1}{2} a_x t_f^2$

$= 60 \times 16 - \frac{1}{2} 5 (16)^2$

$= 960 - \frac{1}{2} 5 \times 16 \times 16^8$

$= 960 - 80 \times 8$

$= 960 - 640$

$= 320m$

$u_y = 80$ m/s

$u_y = -10 m/s^2$

Time of flight (Consider motion in y)

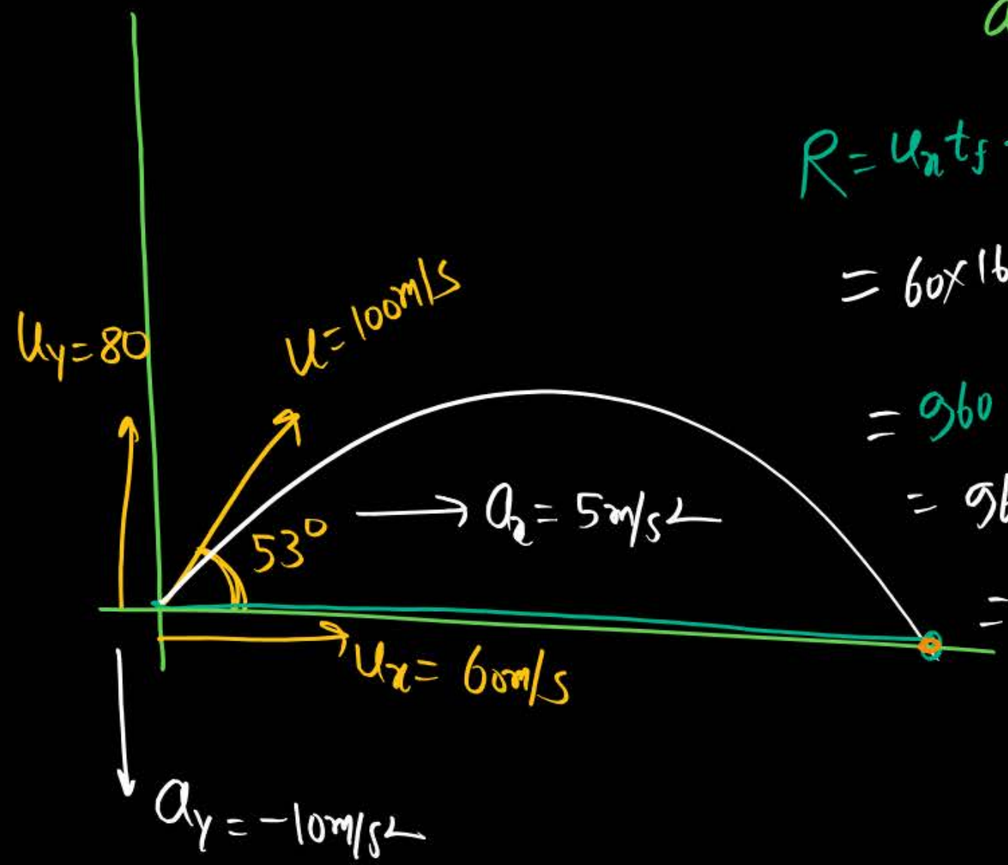
$T = \frac{2u_y}{g} = \frac{2 \times 80}{10} = 16$ sec.

$H_{max} = \frac{u_y^2}{2g} = \frac{80 \times 80^4}{2 \times 10} = 320m$

air friction

ghus पे फिसलती

(Q) Ball is projected with speed 100m/s at angle 53° and const^n air friction acts in the dir^n of motion $5m/s^2$ in x-axis only then find H, T, R.



$u_x = 60$ m/s

$a_x = -5 m/s^2$

$R = u_x t_f + \frac{1}{2} a_x t_f^2$

$= 60 \times 16 + \frac{1}{2} 5 (16)^2$

$= 960 + \frac{1}{2} 5 \times 16 \times 16$

$= 960 + 80 \times 8$

$= 960 + 640$

$= 1600m$

$u_y = 80$ m/s

$u_y = -10 m/s^2$

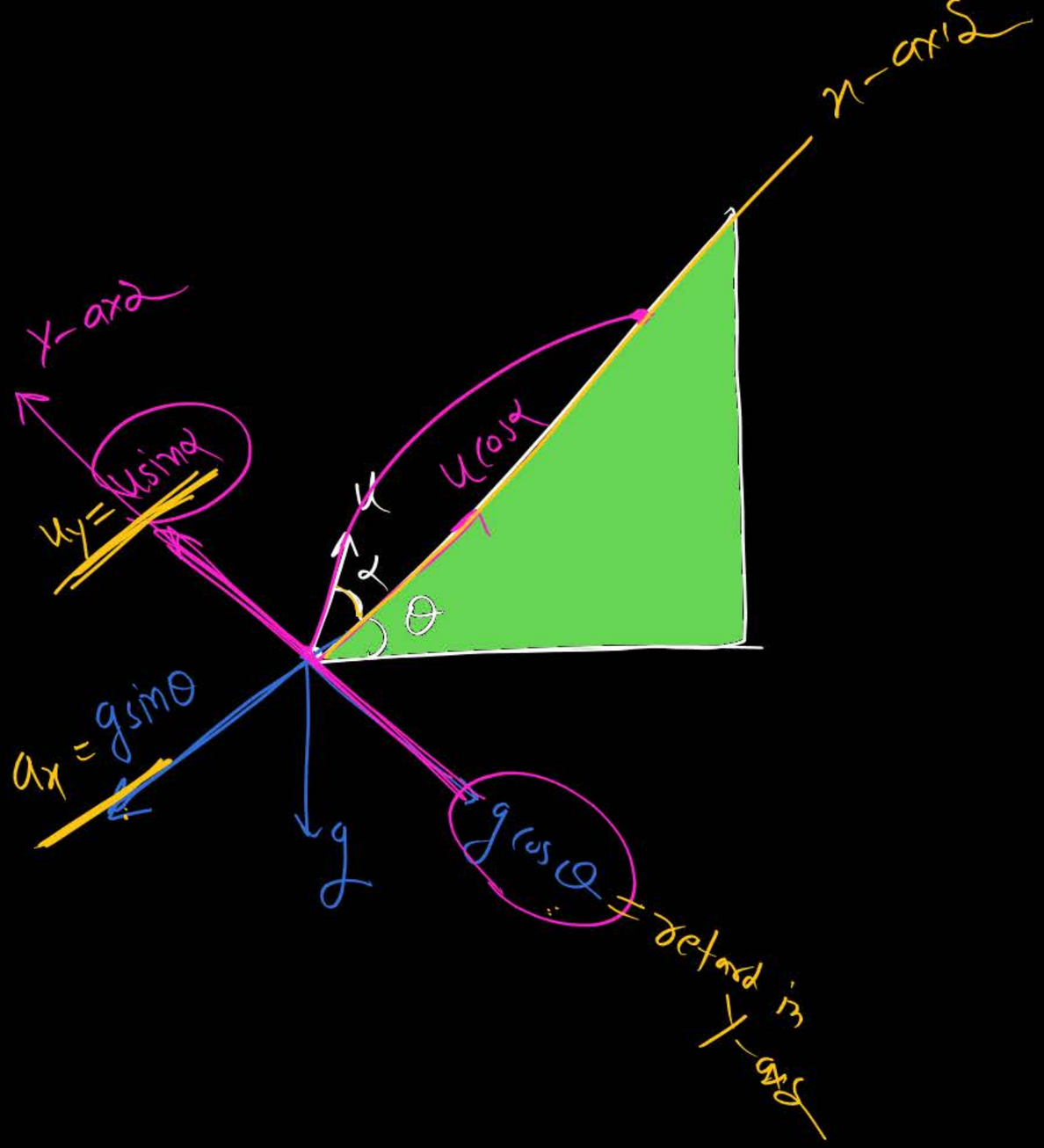
Time of flight (Consider motion in y)

$T = \frac{2u_y}{g} = \frac{2 \times 80}{10} = 16$ sec.

$H_{max} = \frac{u_y^2}{2g} = \frac{80 \times 80}{2 \times 10} = 320m$

Same

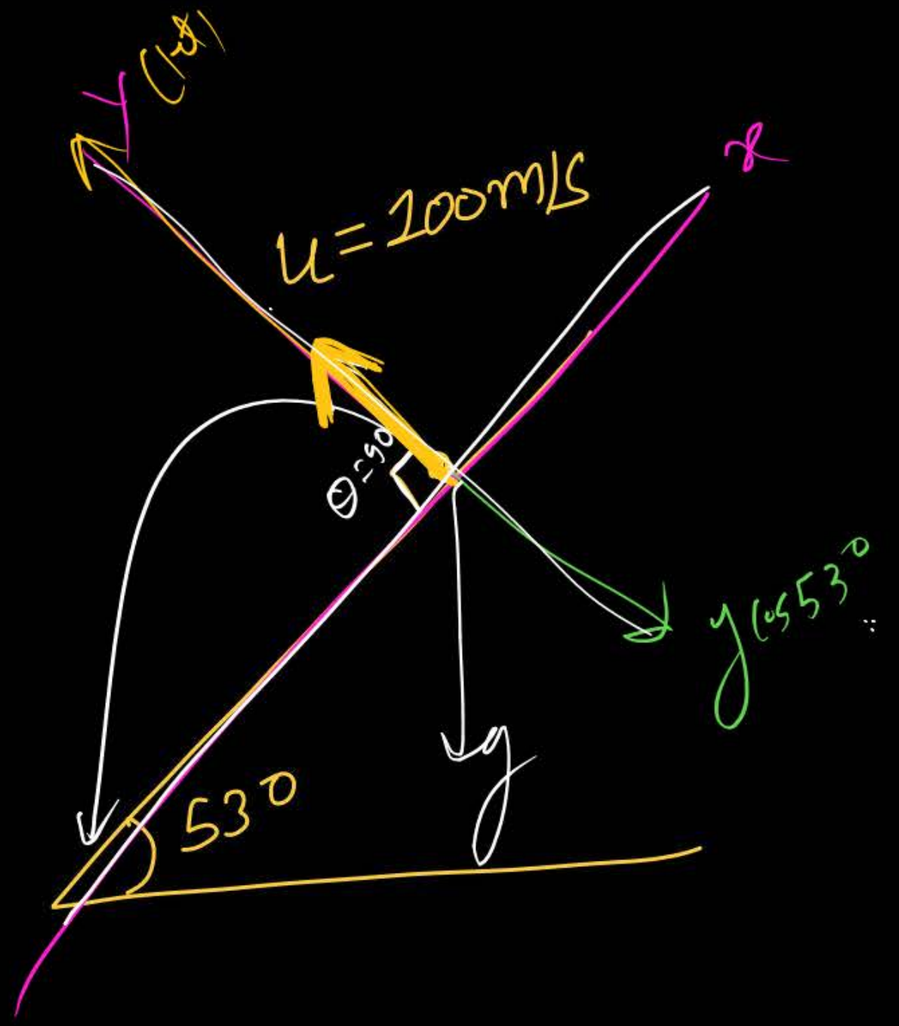
If air friction in x-axis then no effect on y-axis Hence H_{max} & T_f remain Same



find T_f = ??

$$T_f = \frac{2u\sin\alpha}{g\cos\theta}$$

Ball is projected ⊥r to Inclined plane. then find T_f and Range.

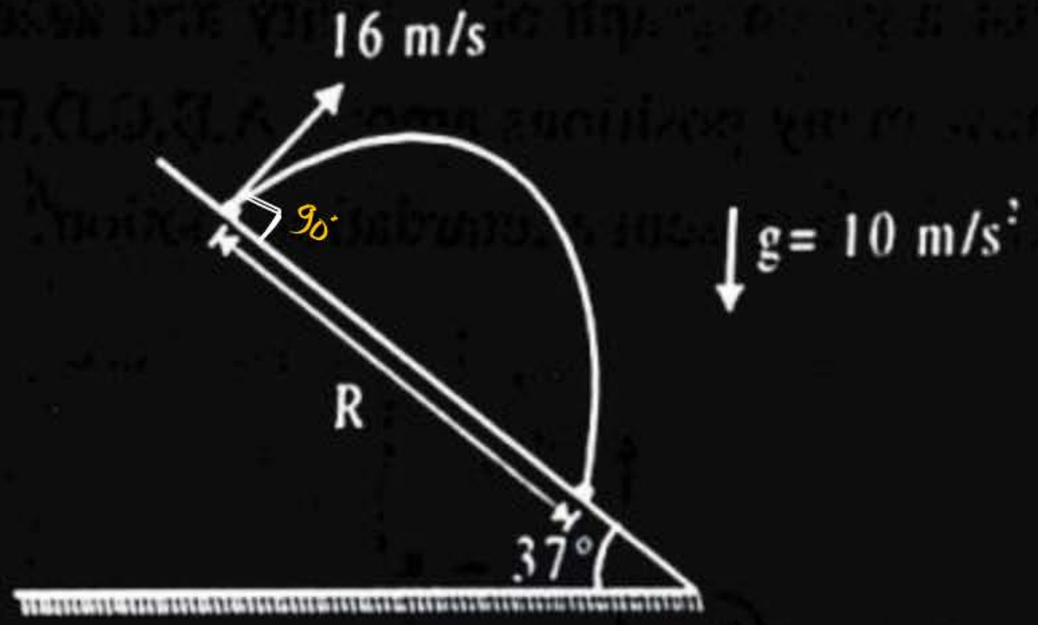


$$T_f = \frac{2u}{g\cos\theta}$$

$$= \frac{2\times 100}{10\times\frac{3}{5}} = \frac{100}{3}$$ ✓

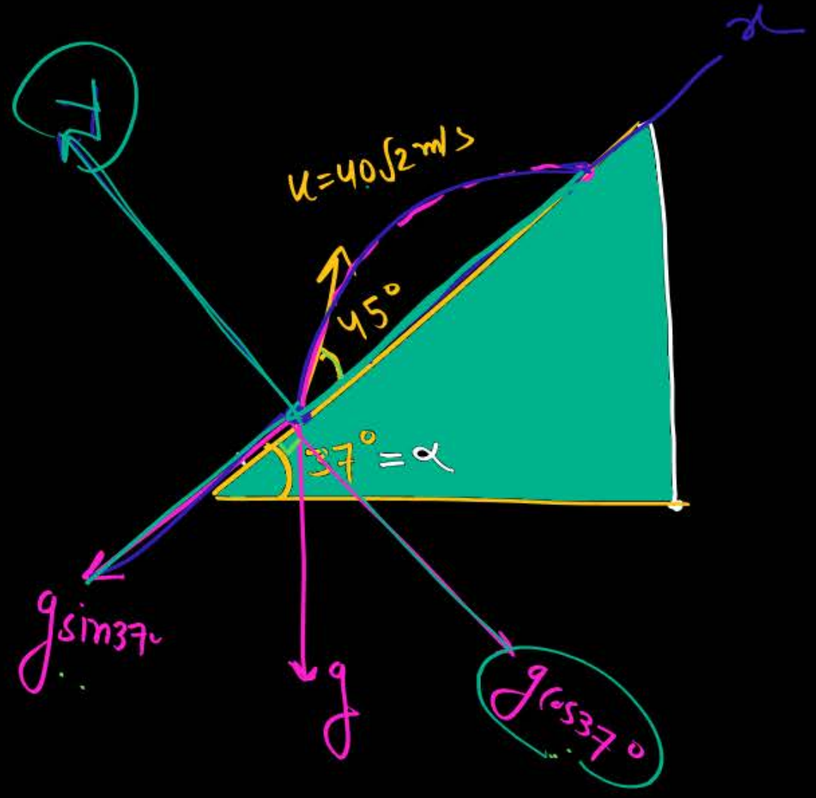
Question

A projectile is launched with a velocity of 16 m/s at right angles to the slope which is inclined at 37° with the horizontal. The value of R is:



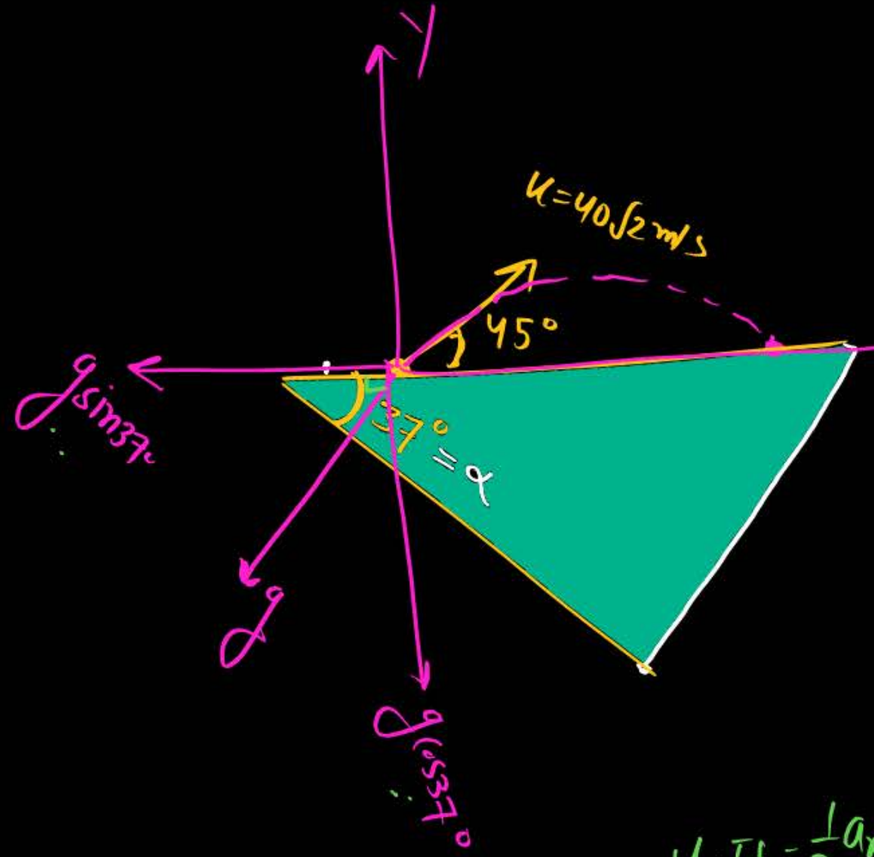
1. 96 m
2. 48 m
3. 72 m
4. None of these

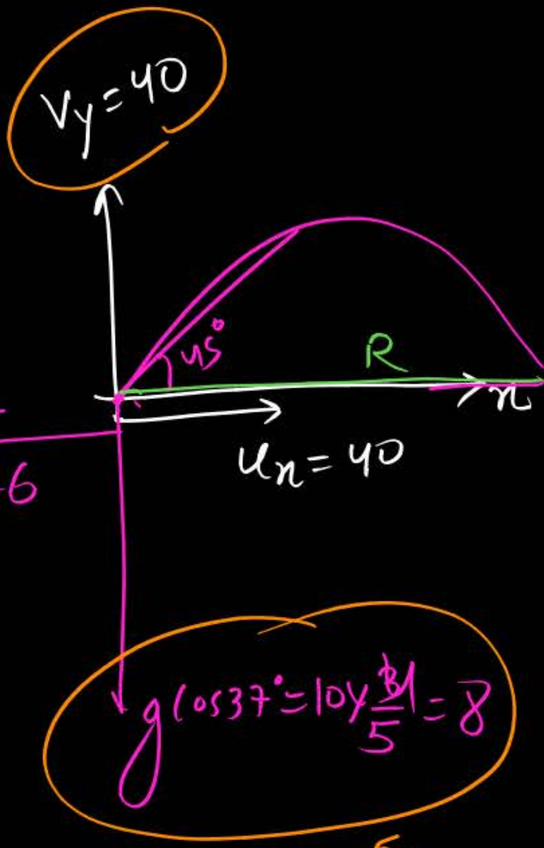
Projectile on Inclined Plane



Same as NLM

find Time of flight:-

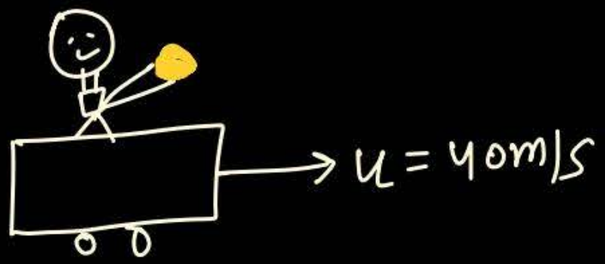




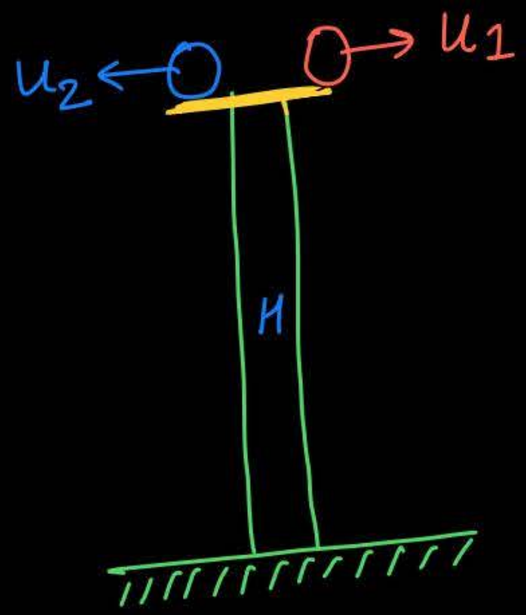
$R_{ag} = u_x T_f - \frac{1}{2} a_x T_f^2$

$T_f = \frac{2u_y}{g_y} = \frac{2 \times 40}{8} = 10\text{sec}$

9f Ramlal Project Ball vertically up with velocity 30m/s then find H_{max} & Range of Ball



Two Ball Projected Horizontaly from Height H. in opposite direction with speed u_1 and u_2 then find time when they moving perpendicular to each other and also find Horizontal distance between them when they are moving perpendicul



THANK YOU