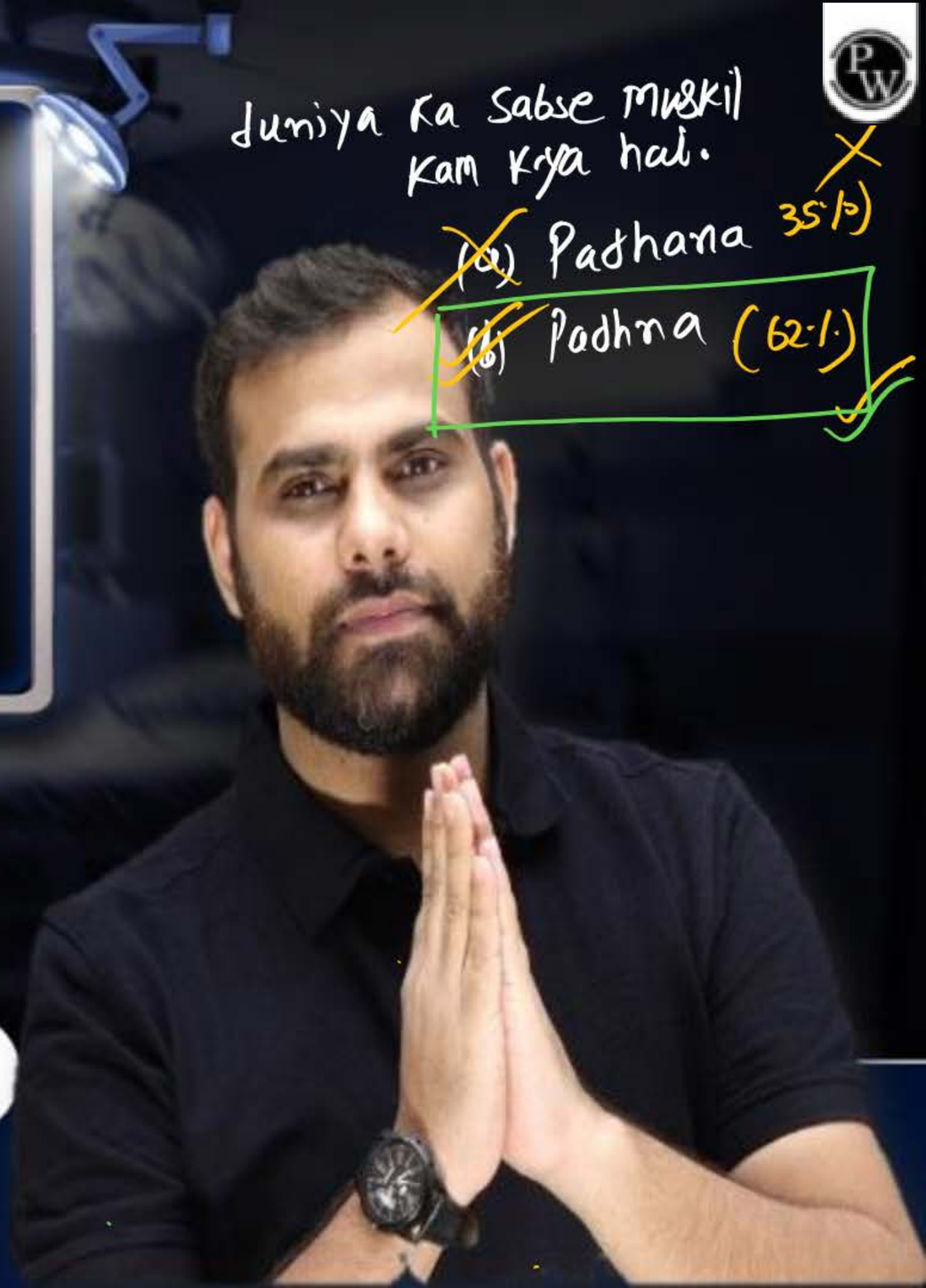
YAKEEN NEET 2.0

2026

Motion in a Plane

Physics | **Lecture - 03**

By- Manish Raj (MR Sir)



Todays Goal

- ✓✓ Horizontal Projectile Motion ✓
- ✓✓ General 2-D motion.

Mahamanthan →

Sangharsh assignment

1. Path length is a scalar quantity, it has magnitude only and no direction. A scalar quantity can be negative also. **True/False**

Distance

Work
Temperature
energy
→ Can be -ve
→ Scalar

(a) True (40%)

(b) false (60%)

MR Scam

@MRPHYSICSS

upload

air friction

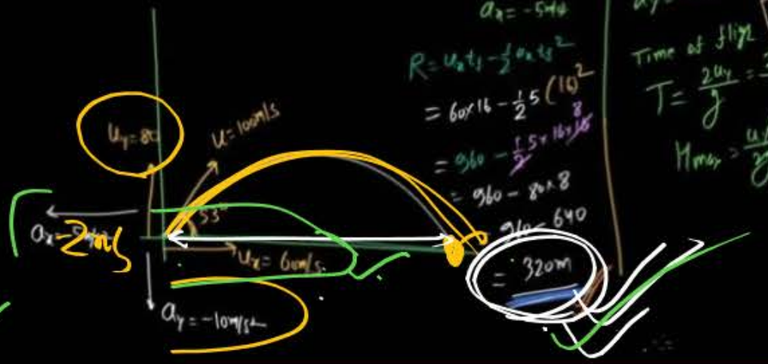
Ball is projected with speed 100m/s at angle 53° and coeff air friction produce retardation $-5m/s^2$ in x-axis only then find H, T, R.

$u_x = 60$ m/s
$a_x = -5$ m/s²
$R = u_x t - \frac{1}{2} a_x t^2$
$= 60 \times 16 - \frac{1}{2} 5 (16)^2$
$= 960 - \frac{1}{2} \times 5 \times 16 \times 16$
$= 960 - 80 \times 8$
$= 960 - 640$
$= 320m$

$u_y = 80$ m/s
$u_y = -10$ m/s²

Consider motion in y

Time of flight
$T = \frac{2u_y}{g} = \frac{2 \times 80}{10} = 16$ sec
$H_{max} = \frac{u_y^2}{2g} = \frac{80 \times 80}{2 \times 10} = 320m$



$V_x = u_x + a_x t$

$0 = 60 - 5t$

$5t = 60$

$t = 12$ sec

Stopping distance $= \frac{(u)^2}{2a}$

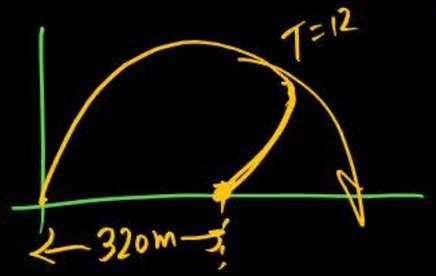
$= \frac{60 \times 60}{10} = 360$

Sir x-axis me constant acceleration or velocity variable hain to ismein x-axis me ham Total Time of Flight nikal sakte hai jo 24 sec aayega to is Time of Flight ka use ham Range ke formule me use karke Range nikal sakte hai lekin sir aapne y-axis main jo Time of Flight hai uska hi use kiya hai to kya ham ye kar sakte jo x-axis me Time of Flight hai uska use karke Range nikale @mrsir_mrstar

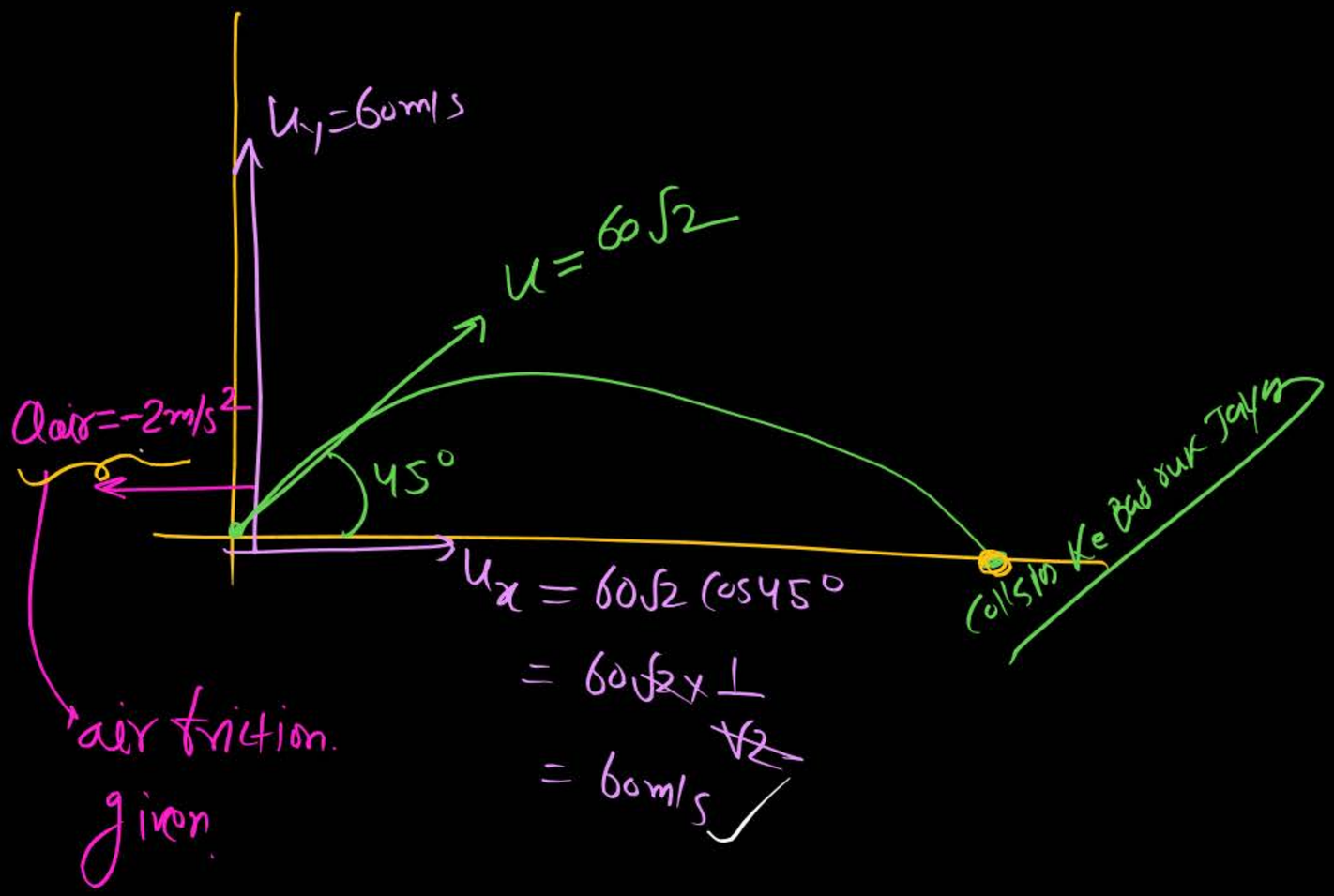
$T = \frac{2u_y}{g} = \frac{2 \times 80}{10}$

$= 16$ sec

T find



(2). हल पर है



$T_f = ??$

$T_f = \frac{2u_y}{g} = \frac{2 \times 60}{10} = 12 sec$ //

motion in x-axis

$V_x = u_x + a_x t$

$0 = 60 - 2t$

rest

$t = 30 sec$

Object 12 sec Ke Baad Collsion Kar Ke ruk Jayga.

Kal Ka HOME work

find Relⁿ B/w α, θ & β

Soln

eqn of Trajectory

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

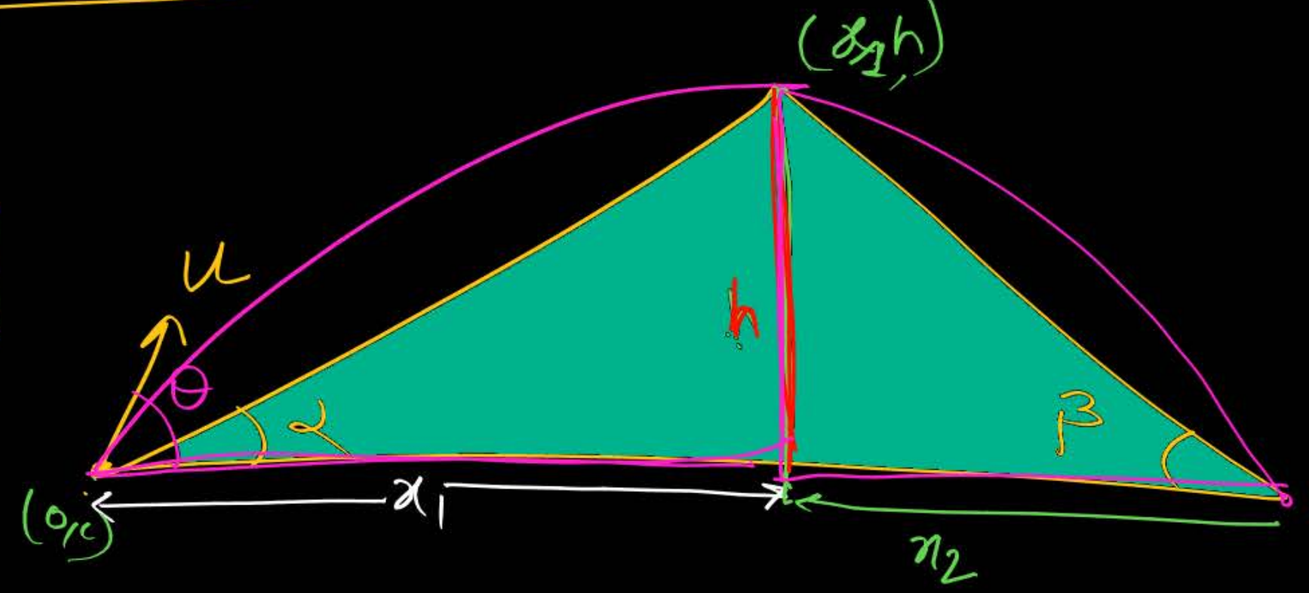
Range

$$h = x_1 \tan\theta \left[\frac{x_1+x_2-x_1}{x_1+x_2}\right]$$

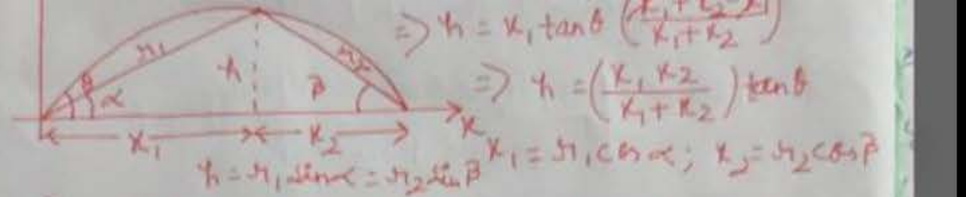
$$h = \frac{x_1 x_2}{x_1+x_2} \tan\theta$$

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

$$\tan\theta = \frac{h}{x_2} + \frac{h}{x_1} = \tan\alpha + \tan\beta$$



$$\tan\theta = \tan\alpha + \tan\beta$$



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

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

$h = r_1 \sin\alpha = r_2 \sin\beta$ $\quad x_1 = r_1 \cos\alpha$; $x_2 = r_2 \cos\beta$

$\Rightarrow r_1 \sin\alpha = \frac{r_1 \cos\alpha \cdot r_2 \cos\beta}{r_1 \cos\alpha + r_2 \cos\beta} (\tan\theta)$

$\Rightarrow r_2 = \frac{r_1 \sin\alpha}{\sin\beta} \Rightarrow r_1 \sin\alpha = \frac{r_1 \cos\alpha \times \frac{r_1 \sin\alpha \cos\beta}{\sin\beta}}{r_1 \cos\alpha + \frac{r_1 \sin\alpha \cos\beta}{\sin\beta}}$

$\Rightarrow \sin\alpha = \frac{\frac{\sin\alpha \cos\alpha}{\tan\beta}}{\cos\alpha + \frac{\sin\alpha}{\tan\beta}} \tan\theta \quad (\tan\theta)$

$\Rightarrow \sin\alpha = \frac{\frac{\sin\alpha \cos\alpha}{\tan\beta}}{\cos\alpha + \frac{\sin\alpha}{\tan\beta}} (\tan\theta)$

$\Rightarrow 1 = \frac{\frac{\sin\alpha \cos\alpha}{\tan\beta}}{\sin\alpha \cdot \cos\alpha + \frac{\sin^2\alpha}{\tan\beta}} (\tan\theta) \quad \rightarrow \frac{\sin\alpha \cos\alpha \tan\beta + \sin^2\alpha}{\tan\beta}$

$\Rightarrow 1 = \frac{\sin\alpha \cos\alpha \tan\beta}{\tan\beta(\sin^2\alpha + \sin\alpha \cos\alpha \tan\beta)} (\tan\theta)$

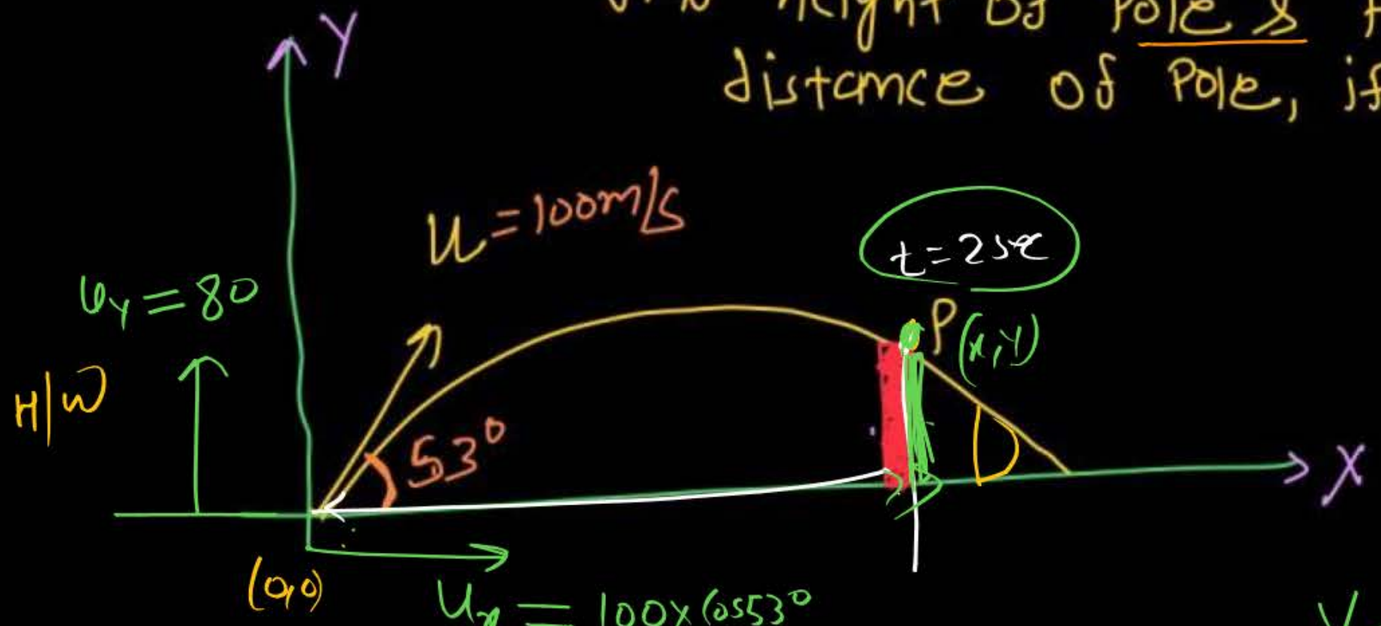
$\Rightarrow \frac{1}{\tan\theta} = \frac{\sin\alpha \cos\alpha}{\sin^2\alpha + \sin\alpha \cos\alpha \tan\beta}$

$\Rightarrow \tan\theta = \frac{\sin^2\alpha}{\sin\alpha \cos\alpha} + \frac{\sin\alpha \cos\alpha \tan\beta}{\sin\alpha \cos\alpha}$

$\Rightarrow \tan\theta = \frac{\sin\alpha}{\cos\alpha} + \tan\beta \quad \therefore \boxed{\tan\theta = \tan\alpha + \tan\beta}$

Ramlal Tintu

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



$u_x = 100 \times \cos 53°$

$= 100 \times \frac{3}{5}$

$= 60$ m/s

$a_x = 0$ ✓

$x = u_x t$ (1)

$= 60 \times 2 = 120$ m ✓

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

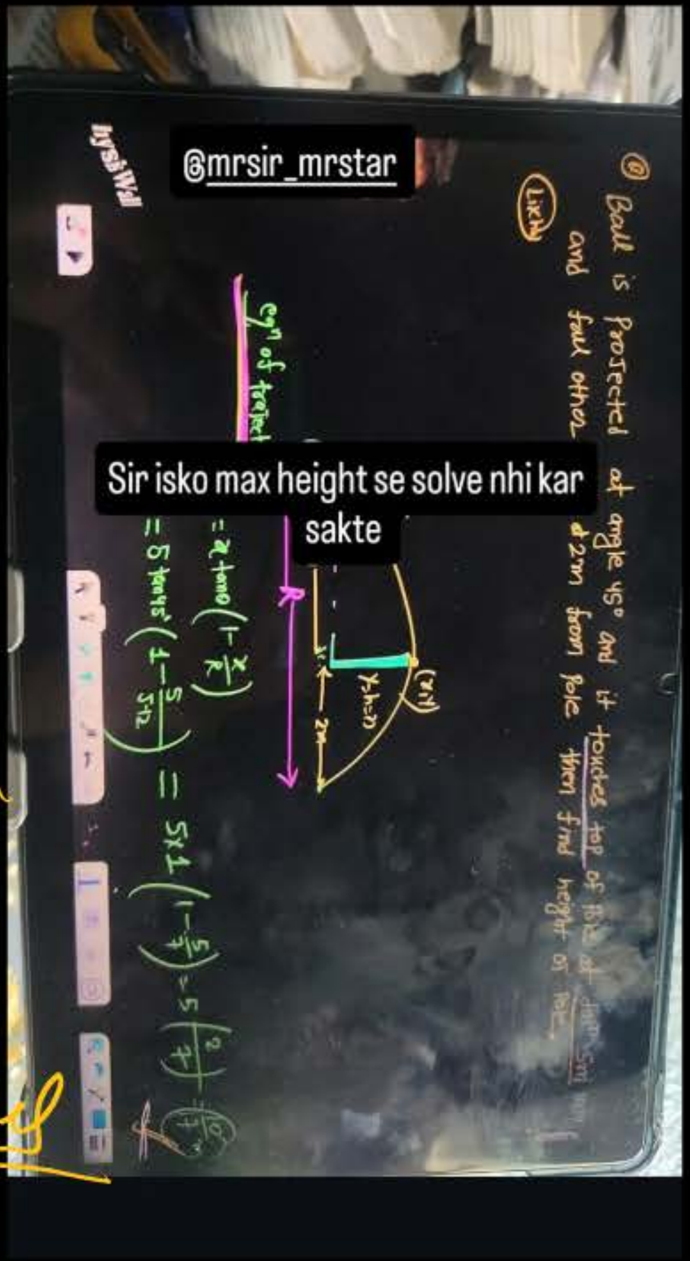
$h = 80 \times 2 - \frac{1}{2} \times 10 \times (2)^2$

$= 160 - 5 \times 4$

$= 160 - 20$

$h = 140$ m height ✓

H/W



Ramlu

115. A particle is projected with a velocity u making an angle θ with the horizontal. At any instant, its velocity v is at right angle to its initial velocity u; then v is:

(1) u cos θ (2) u tan θ (3) u cot θ (4) u sec θ

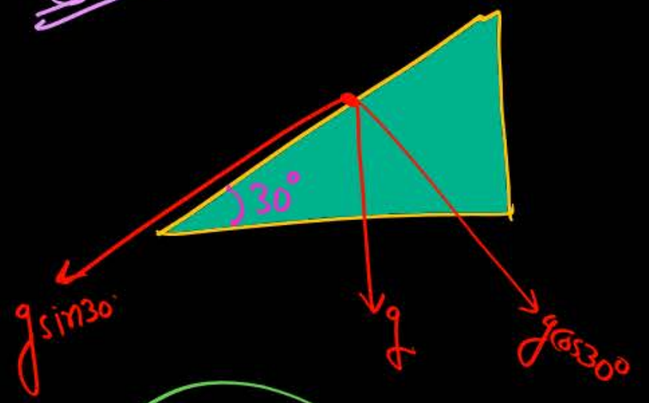
KN0116

H/W Kal.

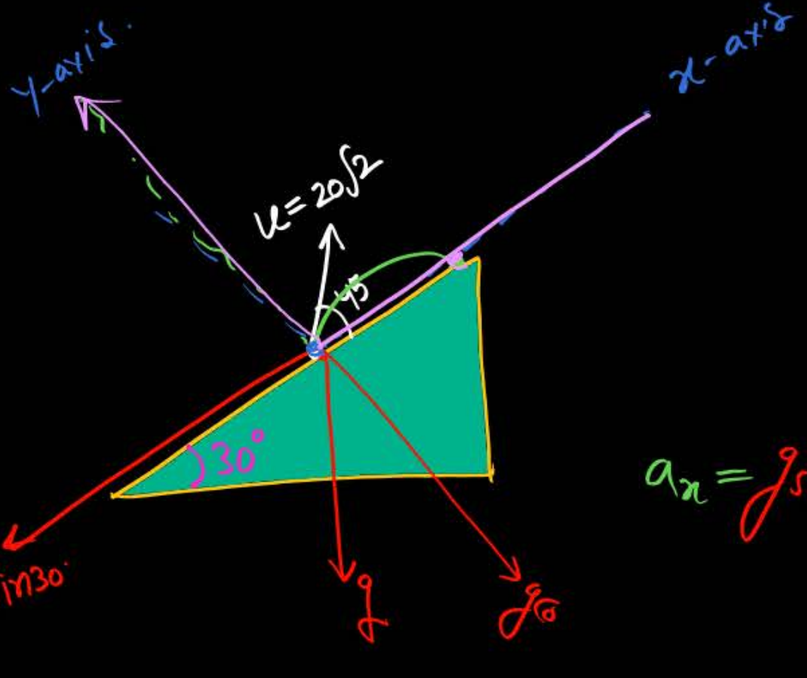
2-line में solve

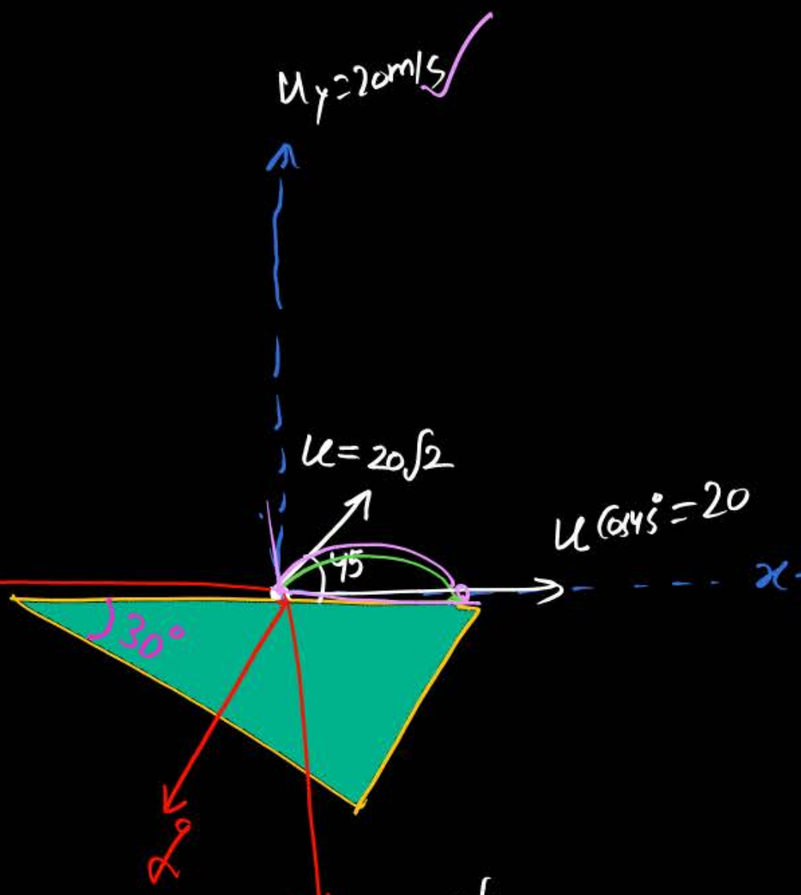
Projectile on Inclined Plane

(a)



Basic Math





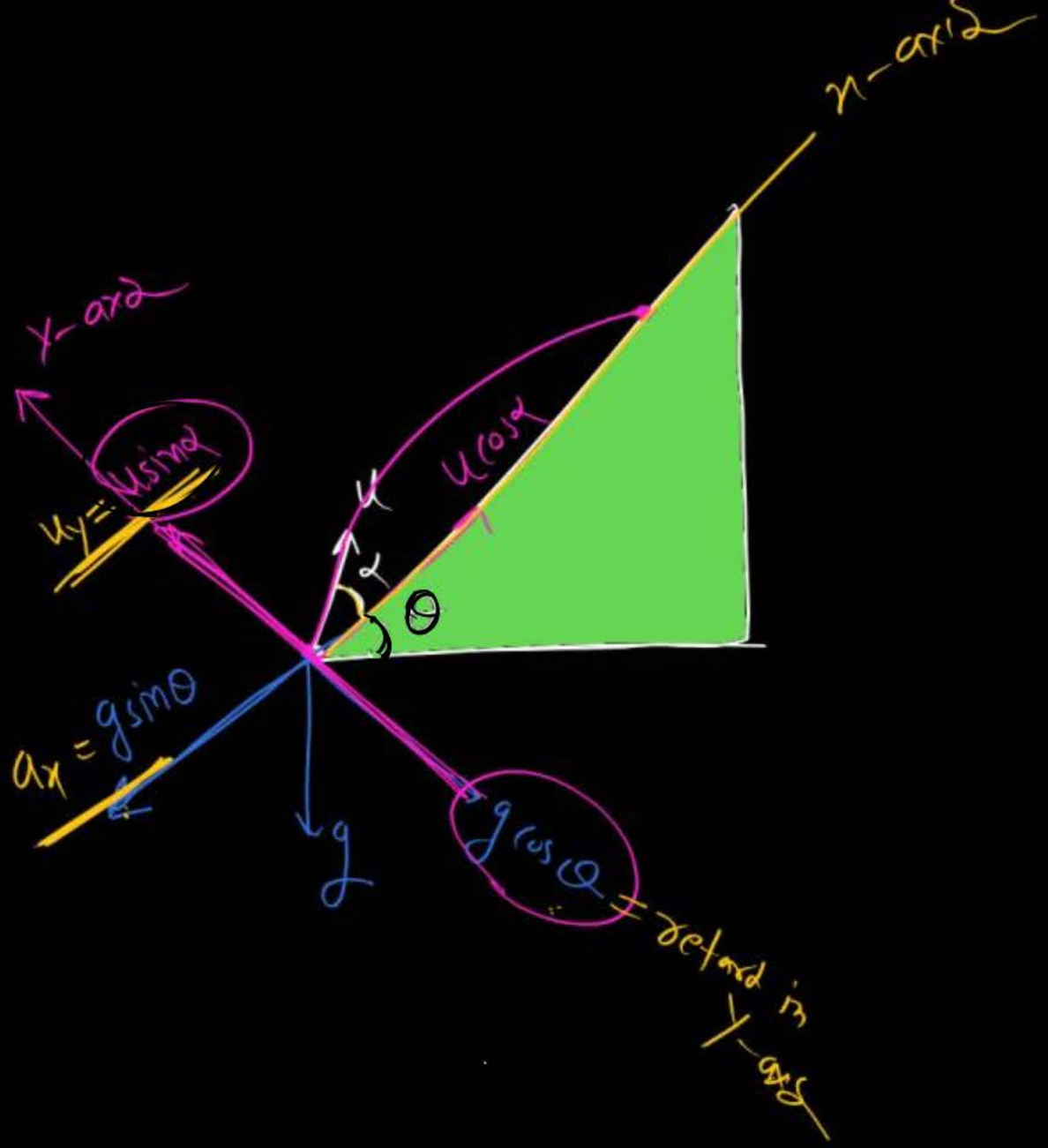
$a_x = g\sin 30° = g/2$

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

$$= 20 \times \frac{8}{\sqrt{3}} - \frac{1}{2} \frac{g}{2} \left(\frac{8}{\sqrt{3}}\right)^2$$

$$T = \frac{2 \times u_y}{g} = \frac{2 \times 20}{10\sqrt{3}/2}$$

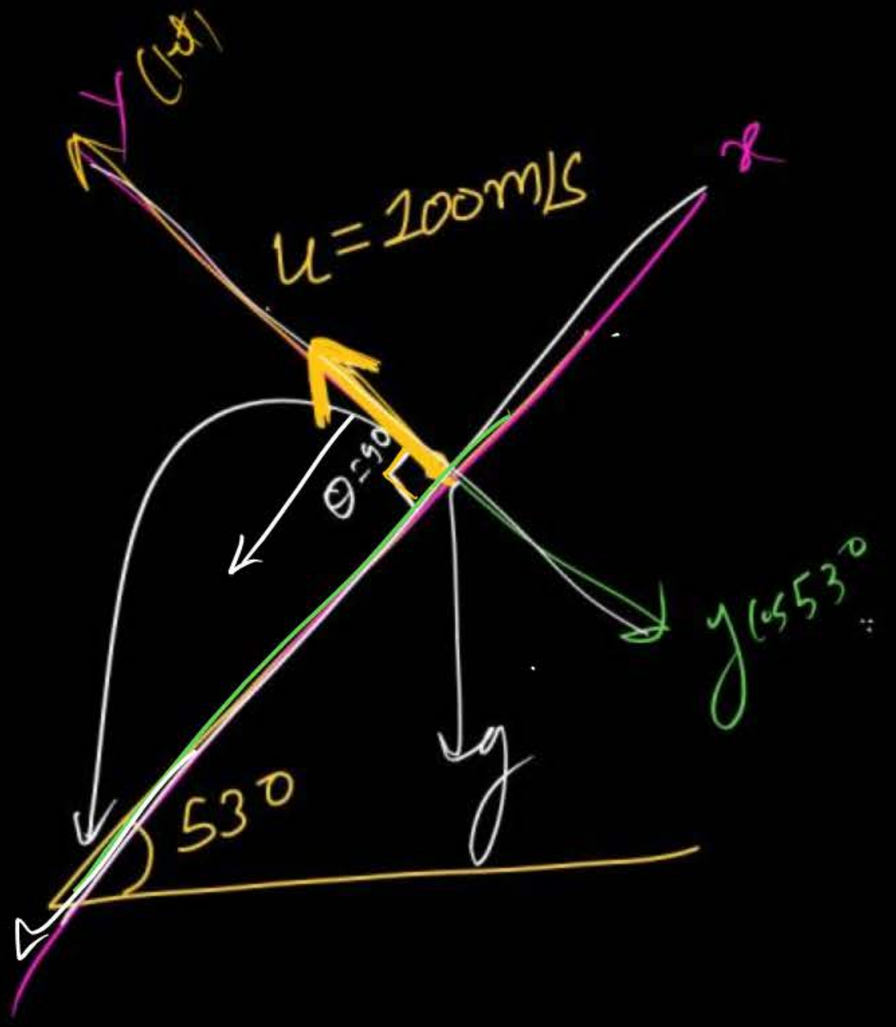
$$= \frac{8}{\sqrt{3}} \text{ sec}$$



find T_f = ??

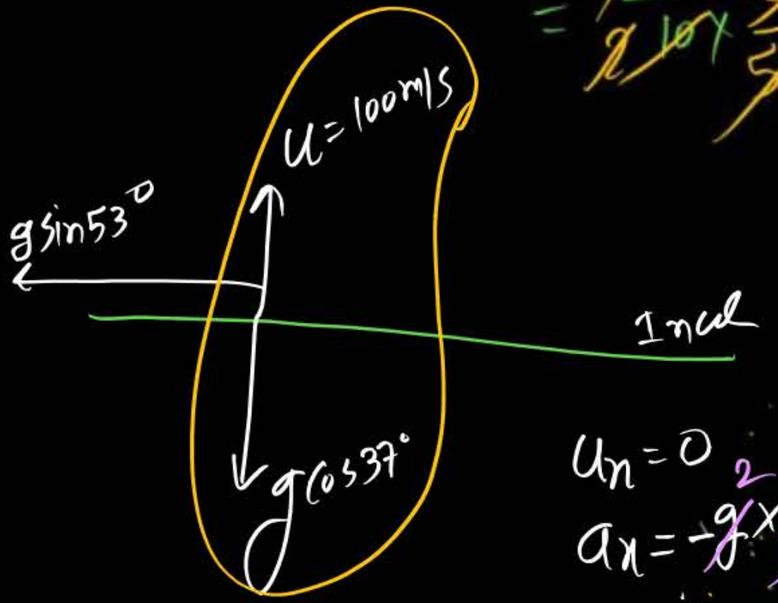
$$T_f = \frac{2u\sin\alpha}{g\cos\theta}$$

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



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

$$= \frac{2\times 100}{g\times\frac{3}{5}} = \frac{100}{3}$$



$u_x = 0$

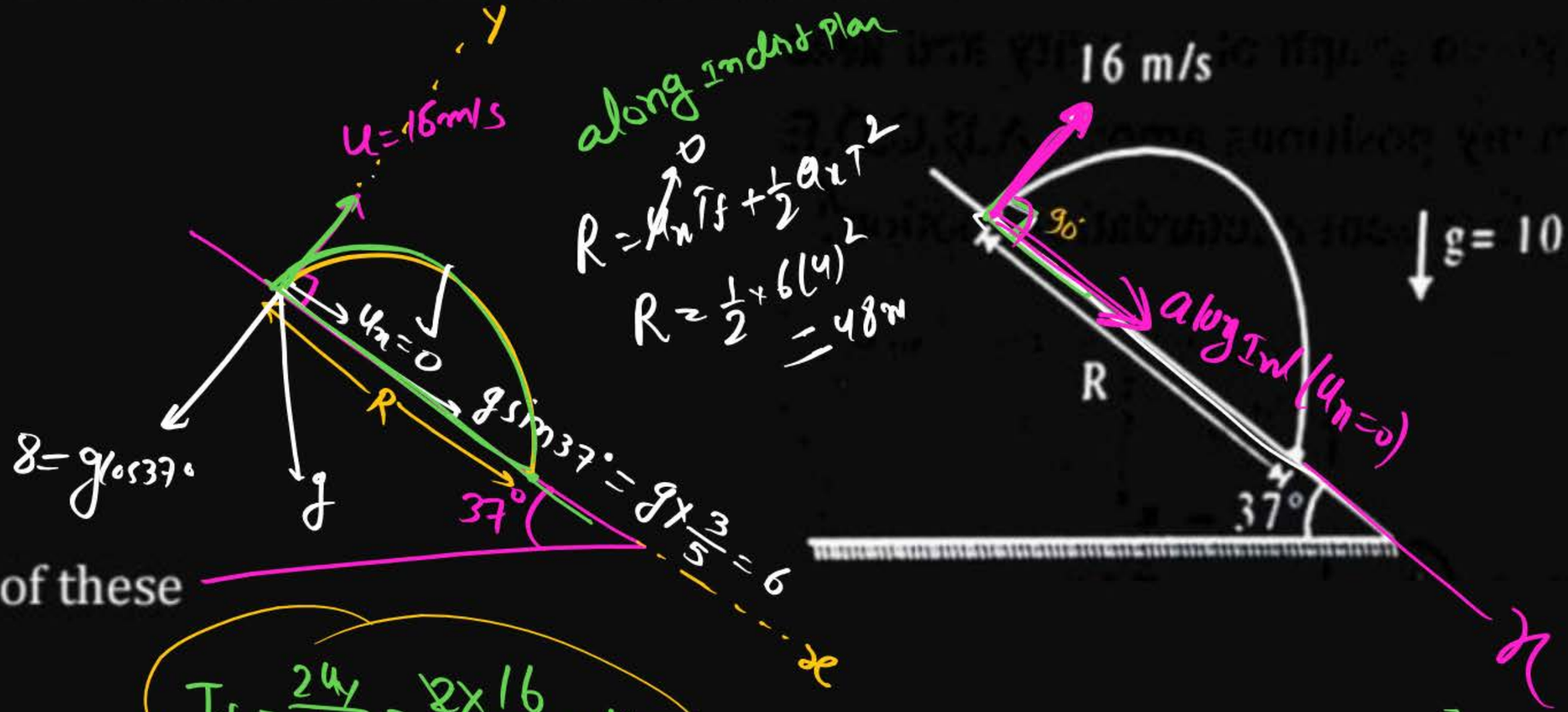
$a_x = -g\times\frac{4}{5} = -8\ m/s^2$

$s = \frac{1}{2}(8)\left(\frac{100}{3}\right)^2$ m.

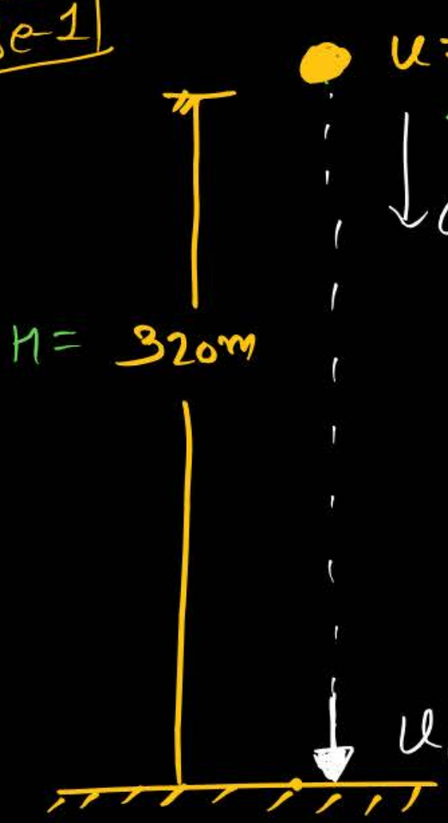
Question

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



Case-1



$u_{collision} = \sqrt{2gH} = \sqrt{2 \times 10 \times 320}$

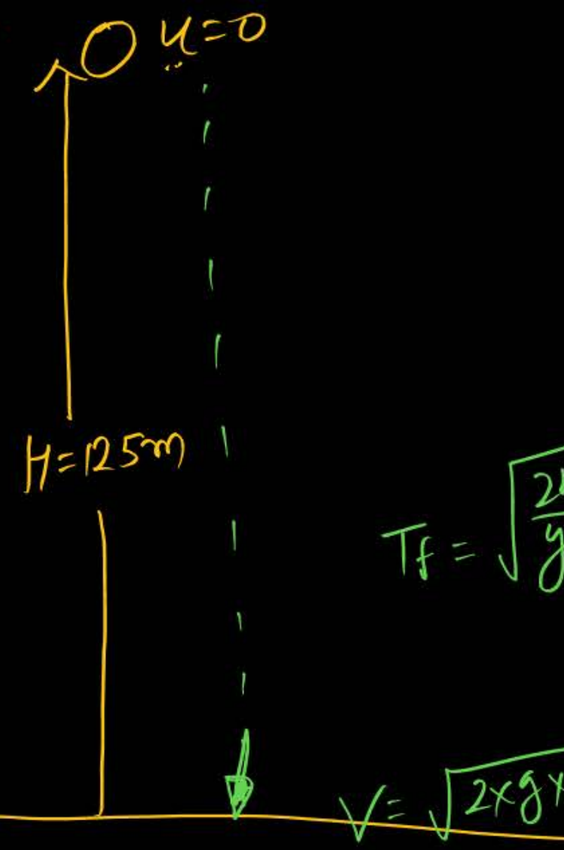
$= 80 m/s$

$\left[S = ut + \frac{1}{2} a t^2 \right]$ y-axis

$H = \frac{1}{2} g T^2$

$T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 320}{10}} = \sqrt{64} = 8 sec.$

Drop



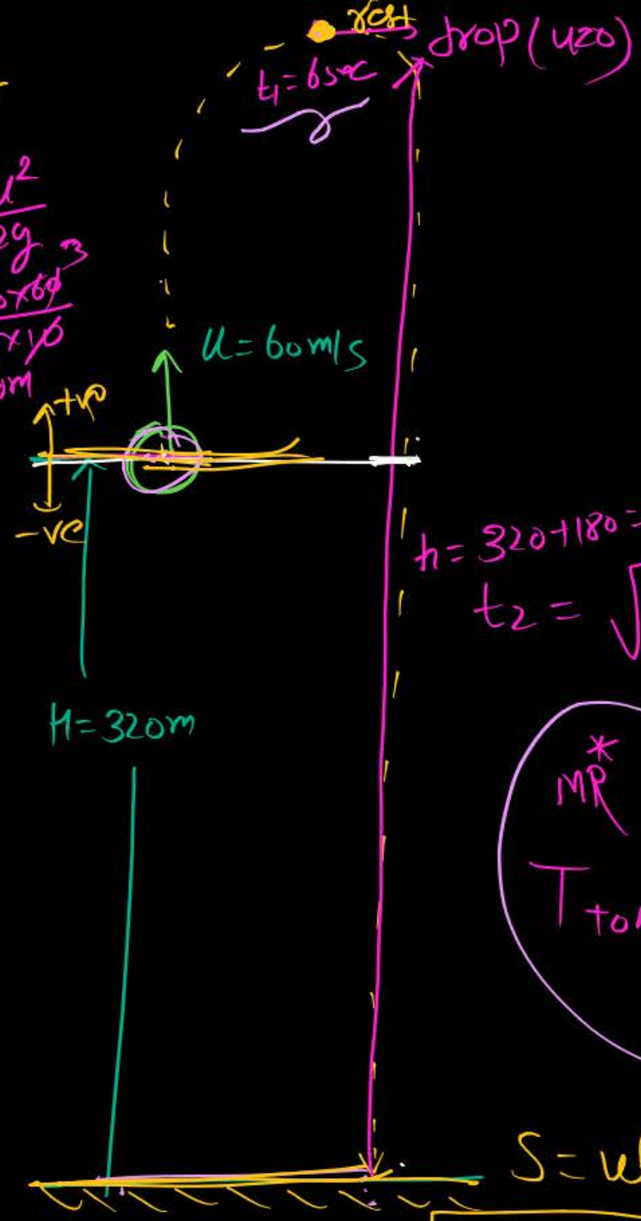
$T_f = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 125}{10}}$

$= 5 sec$

$V = \sqrt{2 \times g \times H} =$

$= 50 m/s.$

Case-2



$h = 320 + 180 = 500$m

$t_2 = \sqrt{\frac{2\times500}{10}} = \sqrt{100} = 10$sec.

MP*

$T_{tot} = 6 + 10$

$= 16$ sec.

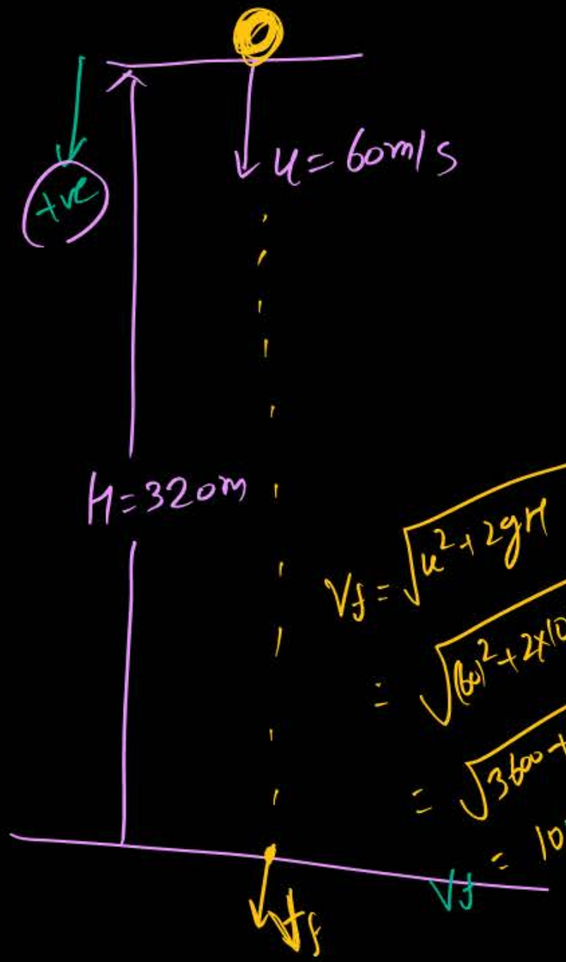
$S = ut + \frac{1}{2}at^2$

$-320 = 60t - \frac{1}{2}10t^2$

$t_1 = 16$sec

$t_2 = -4$sec (X)

Case-3



$v_f = \sqrt{u^2 + 2gH}$

$= \sqrt{(60)^2 + 2\times10\times320}$

$= \sqrt{3600 + 6400}$

$= 100$m/s

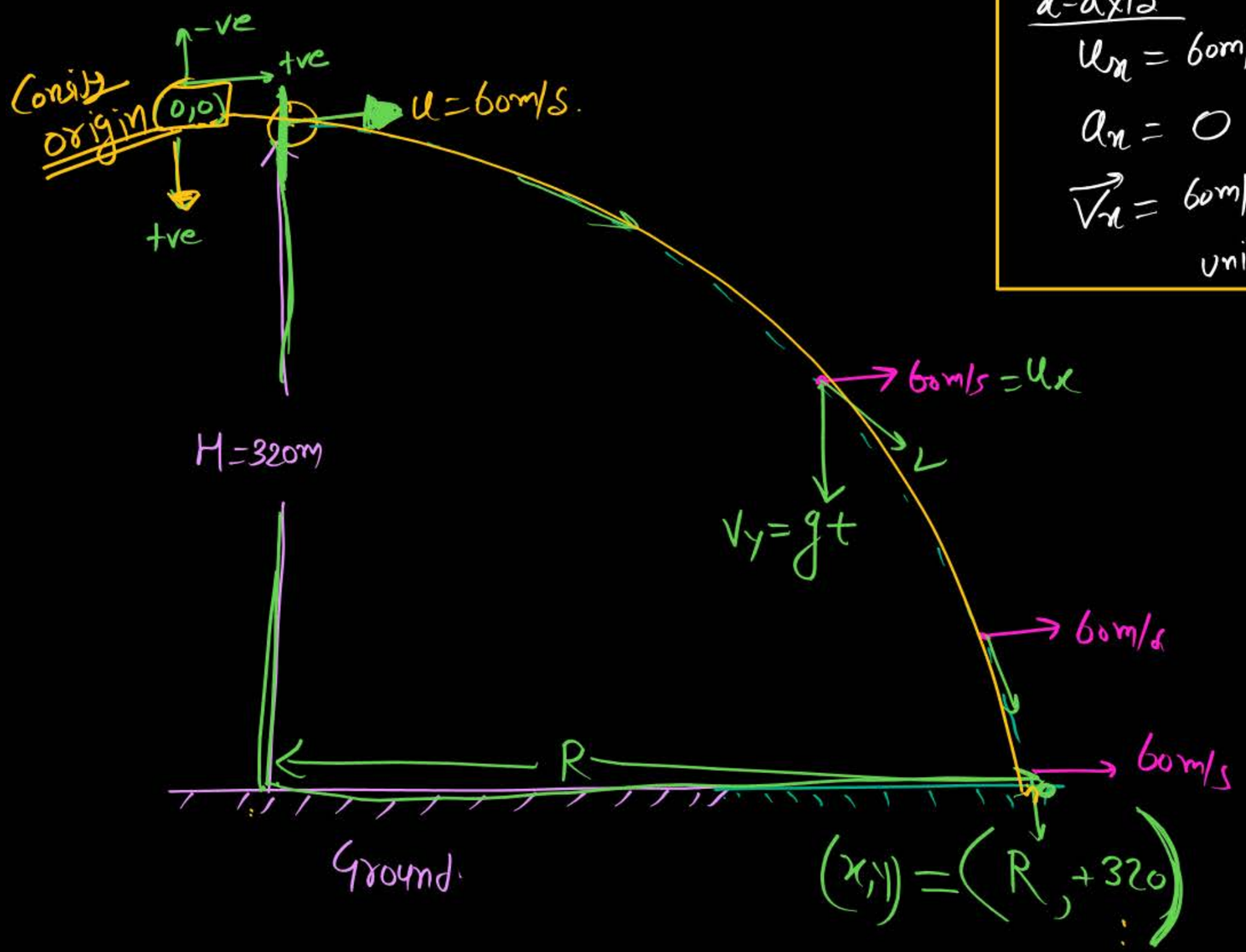
$v_f = u + at$

$100 = 60 + 10t$

$40 = 10t$

$t = 4$sec

Case-4 → Horizontal Projectile



x-axis

- $u_x = 60 m/s$
- $a_x = 0$
- $\vec{v}_x = 60 m/s$ (const^n)
  uniform Mot^n in x-axis

y-axis

- $u_y = 0$
- $a_y = g$ (downward)
- $v_y = u_y + a_y t$
  $v_y = 10t$ = Varible.

Consider mot^n in y-axis

$$S_y = u_y^{0} t + \frac{1}{2} a_y t^2$$

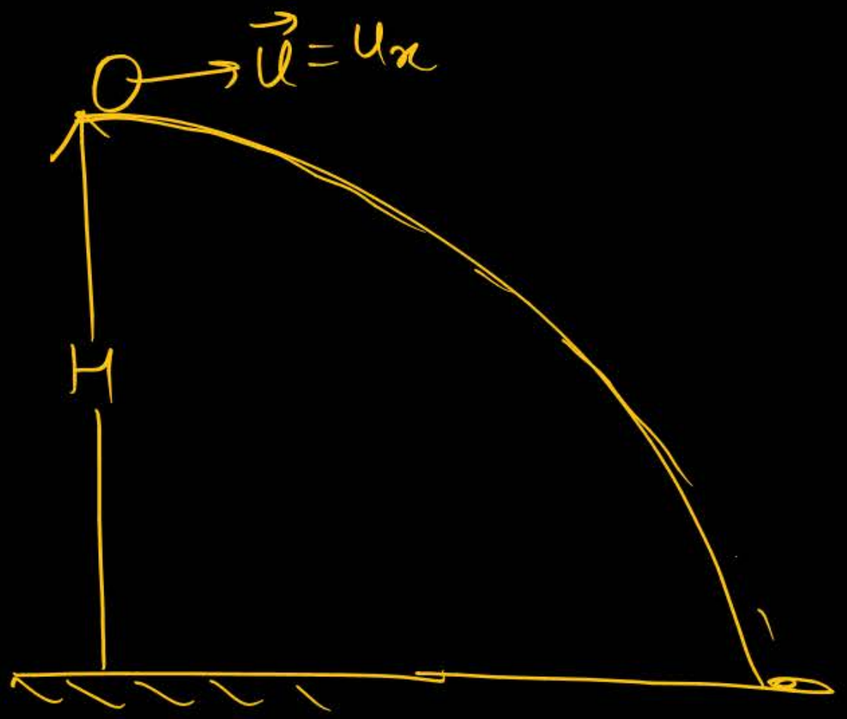
$$H = \frac{1}{2} g t^2$$

Case as case-1

$$\# \quad T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 320}{10}} = \sqrt{64} = 8 \text{ sec}$$

For Range (x-axis)

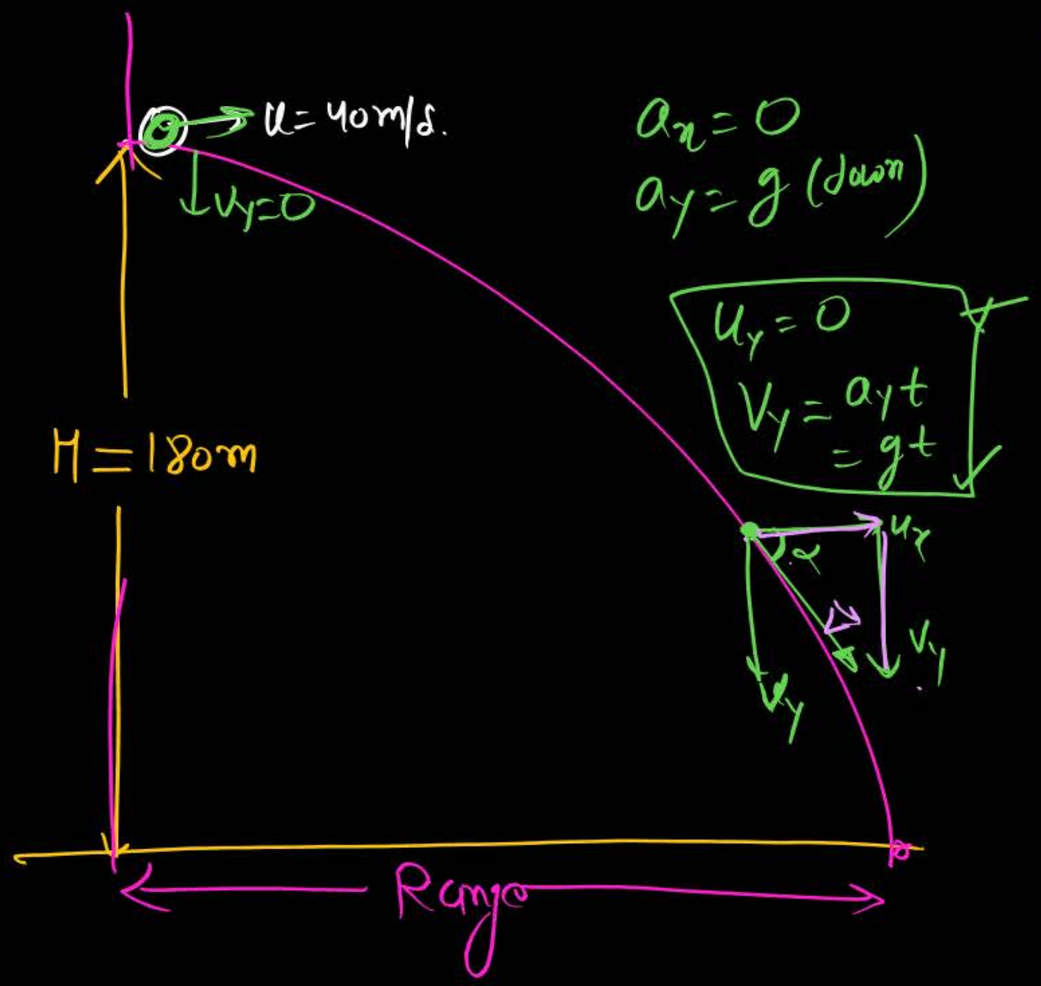
$$\# \quad \underline{R = u_x T_f} = 60 \times 8 = 480 m.$$



$u_y = 0$

$T_f = \sqrt{\frac{2H}{g}}$ $\quad R_{ay} = u_x T_f$

Q.



① Time of flight :—

$$T_f = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2\times 180}{10}} = \sqrt{36} = 6\text{sec}.$$

② Range :—

$$R = u_x T_f = 40 \times 6 = 240\text{m}.$$

③ velocity of object after 2-sec ✓

$$\vec{v} = u_x \hat{i} + v_y \hat{j} = 40\hat{i} + 10\times 2\,\hat{j}.$$

$$\vec{v} = 40\hat{i} + 20\hat{j}$$

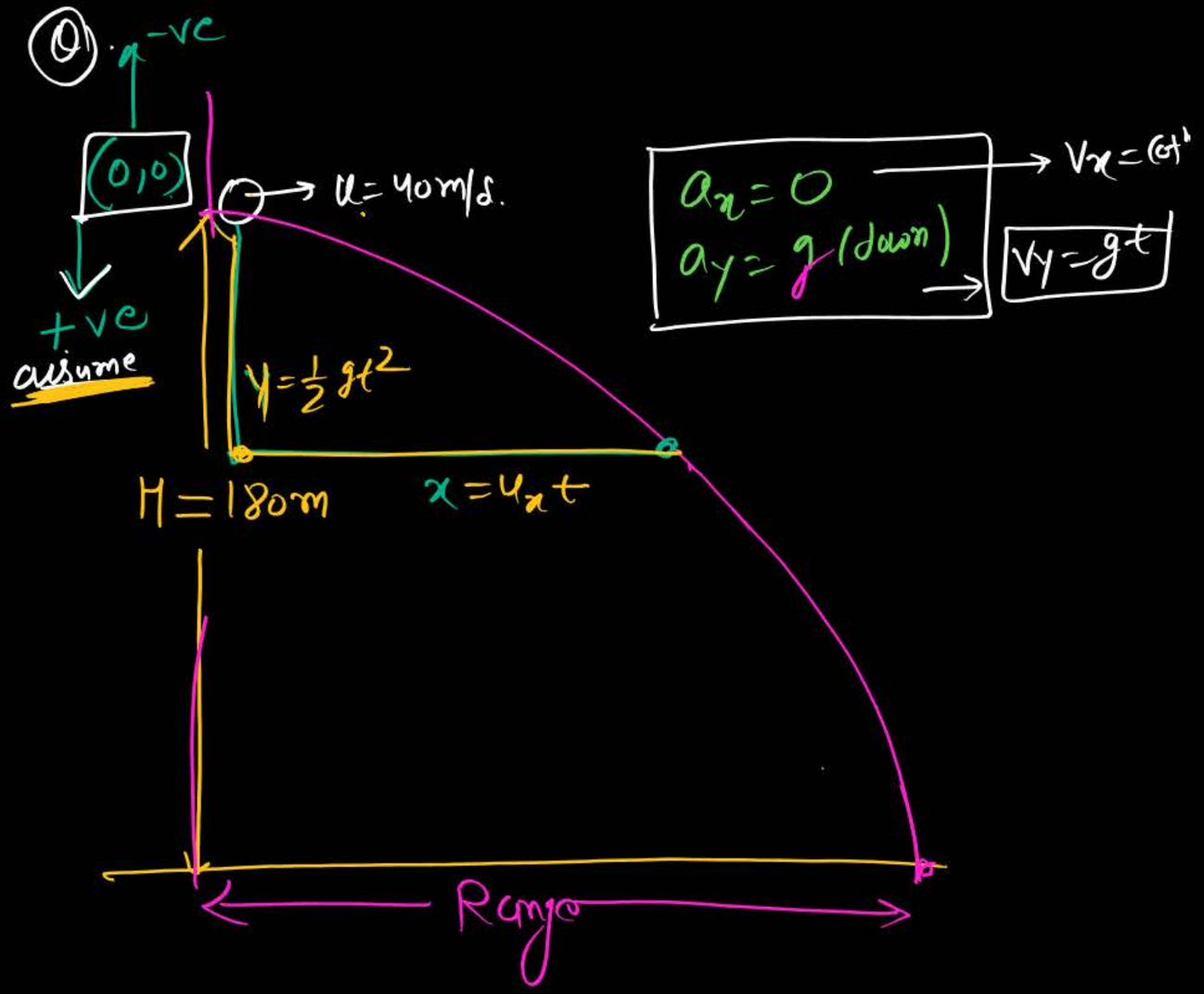
④ Velocity at t = 4sec

$$\vec{v} = 40\hat{i} + 40\hat{j}$$

⑤ dirⁿ of motion (Velocity) at t = 4sec from Horizontal

$$\tan\alpha = \frac{v_y}{v_x} = \frac{40}{40} = 1$$

$$\alpha = 45^\circ \quad ✓$$



$a_x = 0 \rightarrow V_x = u_x$

$a_y = g$ (down) $\rightarrow V_y = gt$

MR* Box
Jaha se object Project kiya wahi origin hua

⑥ Position of object at $t = 3$ sec

$\vec{r} = x\hat{i} + y\hat{j}$

$\Rightarrow x = u_x t = 40 \times 3 = 120\,\hat{i}$

$\Rightarrow y = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times (3)^2 = 45\,\hat{j}$

$\vec{r} = 120\hat{i} + 45\hat{j}$

⑦ Position vector at t

$x = u_x t$ — ①

$t = \frac{x}{u_x}$

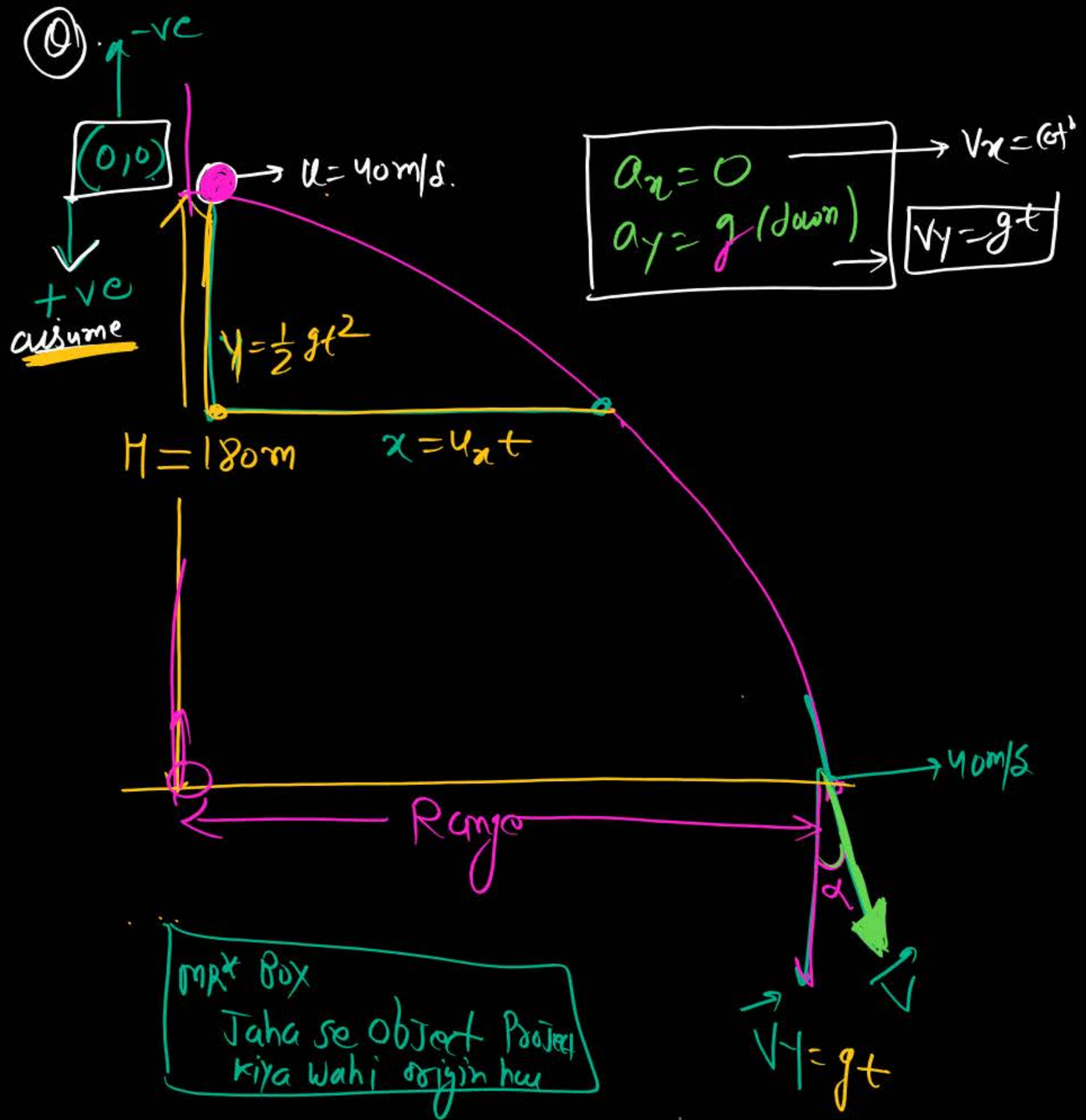
$y = u_y t + \frac{1}{2}gt^2$

$y = \frac{1}{2}gt^2$ — ⑪

⑧ Equation of Trajectory: Rel^n b/w x & y

$$y = \frac{1}{2}g\left(\frac{x}{u_x}\right)^2 = \frac{1}{2}g\frac{x^2}{u_x^2}$$

Parabola



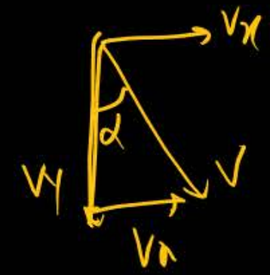
MR* Box
Jaha se object Project kiya wahi orijin hua

(9) Velocity at ground :—

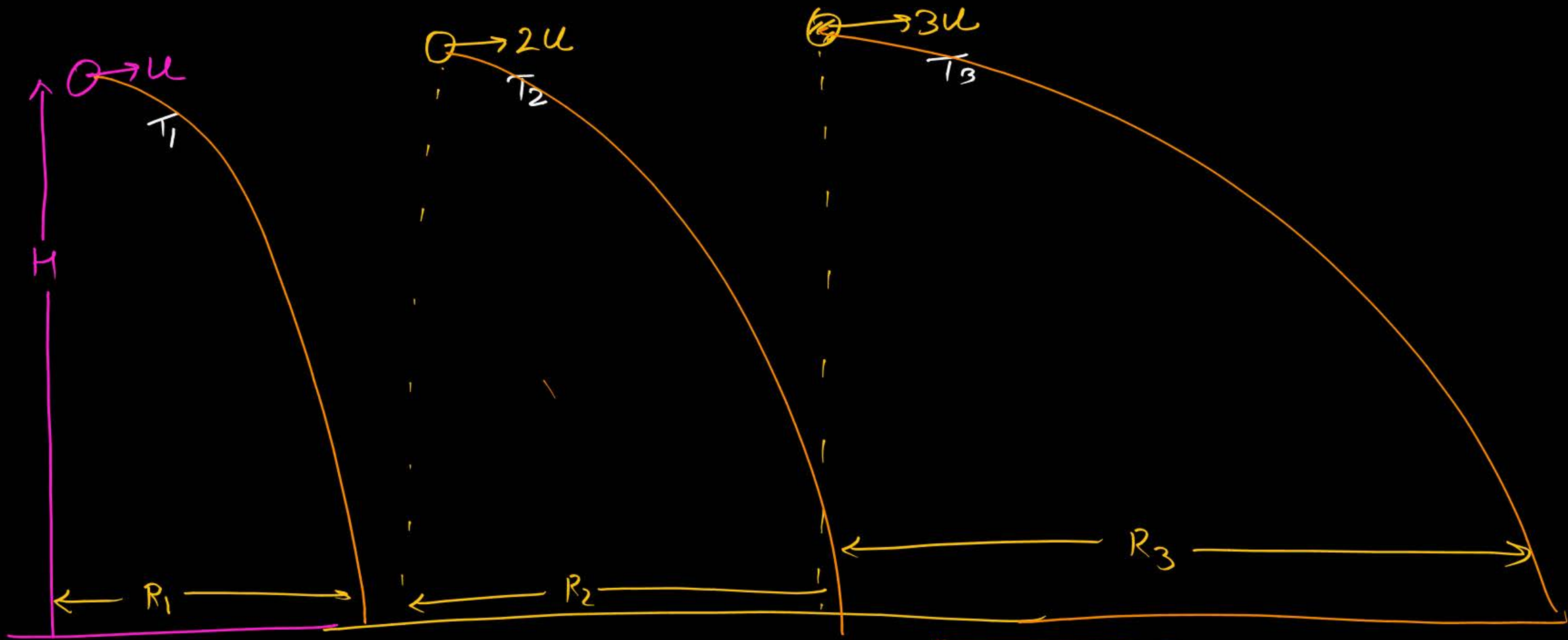
$$\vec{V} = v_x \hat{i} + v_y \hat{j}$$
$$= 40\hat{i} + \sqrt{2gH}\,\hat{j}$$
$$= 40\hat{i} + \sqrt{2\times10\times180}\,\hat{j}$$
$$\vec{V} = 40\hat{i} + 60\hat{j}$$

2nd method: $\vec{V} = u_x \hat{i} + gt\,\hat{j}$
$= 40\hat{i} + 60\hat{j}$

(10) Angle of Collision from vertical at ground :—



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



$T_1 = T_2 = T_3$

$R_1 < R_2 < R_3$

Question Your choise

A projectile is thrown from a point O on the ground at an angle 45° from the vertical and with a speed $5\sqrt{2}$ m/s. The projectile at the highest point of its trajectory splits into two equal parts. One part falls vertically down to the ground 0.5 s after the splitting. The other part, t seconds after the splitting, falls to the ground at a distance x meters from the point O. The acceleration due to gravity $g = 10$ m/s^2.

[JEE Adv. 2021]

The Value of t is _____.

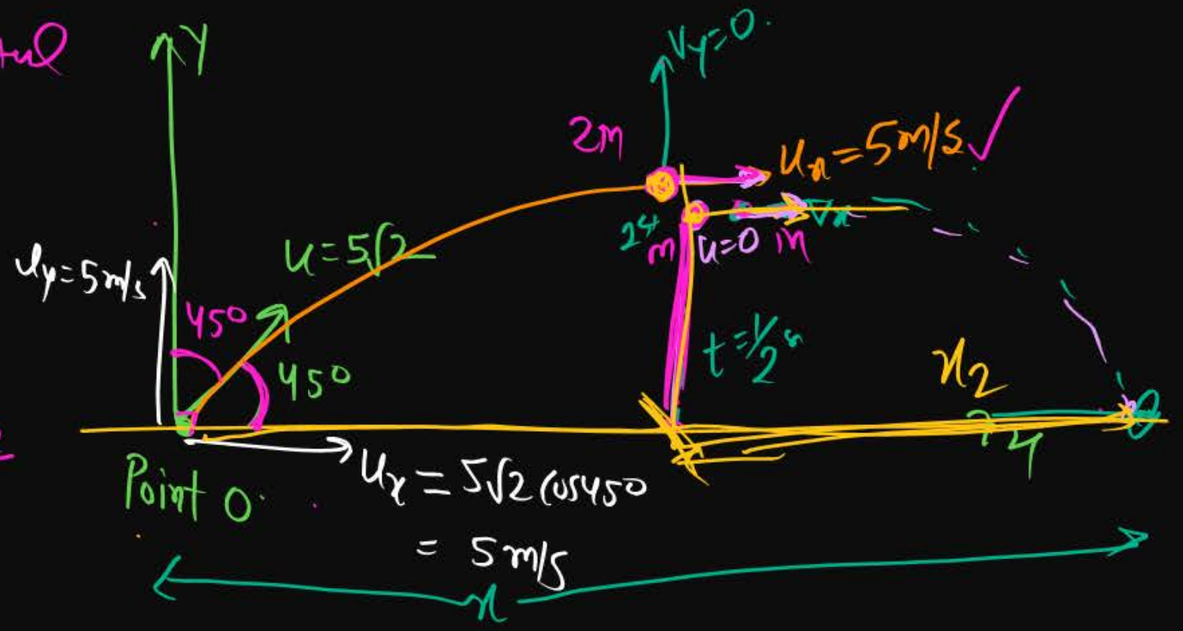
The value of x is _____.

$R = u_x(T_f)_{total}$

$= 5 \times 1$

$= 5m$

$\left(T_f\right)_{for\ g} = \frac{2u_y}{g} = \frac{1sec}{}$



64-1. correct

total dist from O

$x = x_1 + x_2$

$= \frac{R}{2} + x_2 = \frac{5}{2} + 5 = 7.5m$

conservation of momentum

$P_i = P_f$

$2m \times 5 = m \times V_x$

$V_x = 10 m/s$

$x_2 = u_x t_f = 10 \times \frac{1}{2}$

$= 5m$

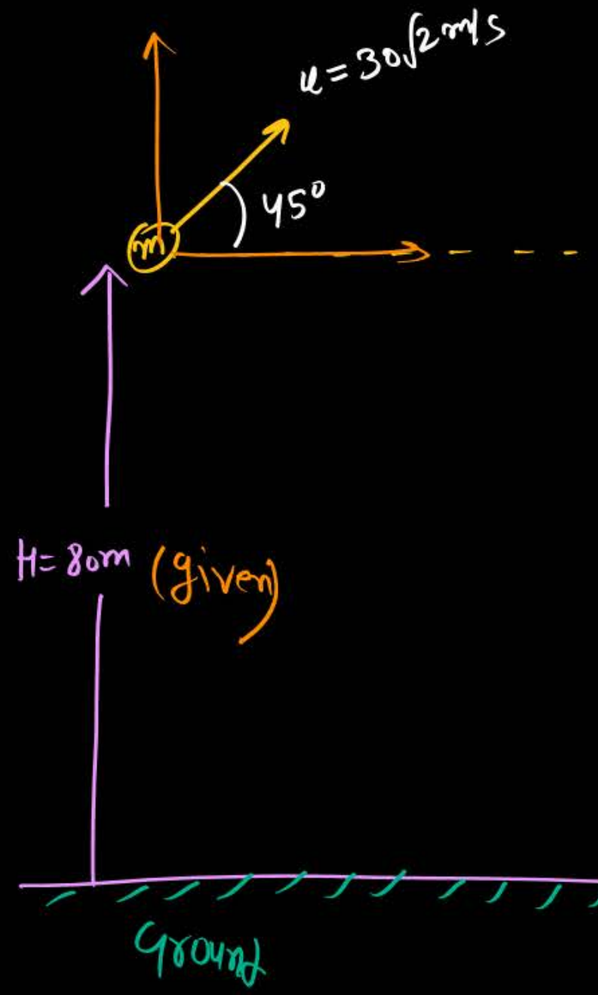
Question

A projectile is fired from horizontal ground with speed v and projection angle θ. When the acceleration due to gravity is g, the range of the projectile is d. If at the highest point in its trajectory, the projectile enters a different region where the effective acceleration due to gravity is $g' = \frac{g}{0.81}$ then the new range is $d' = nd$. The value of n is _____.

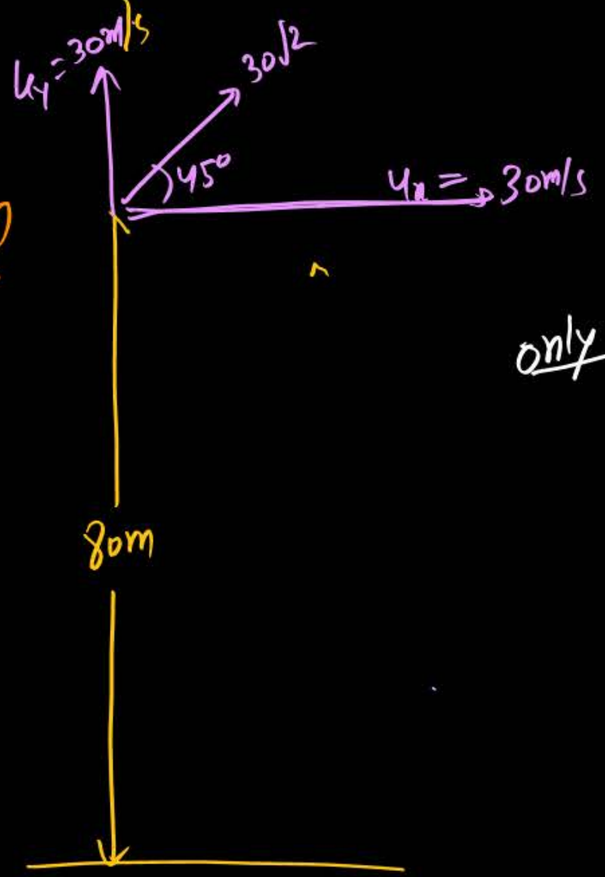
[JEE Adv. 2022]

Prosicht

This is question

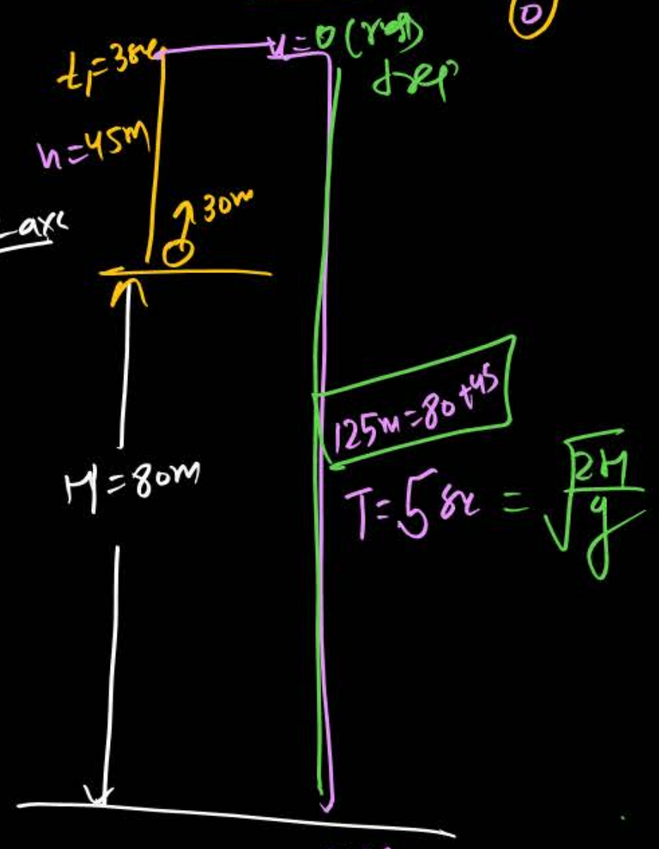


Sol^n



Find Time of flight & Horizontal Range:-

only in y-axis



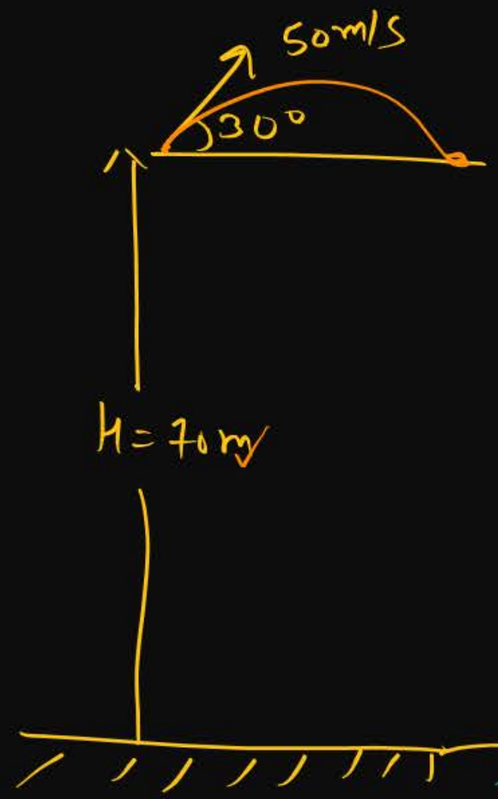
$T_f = 3+5 = 8$sec

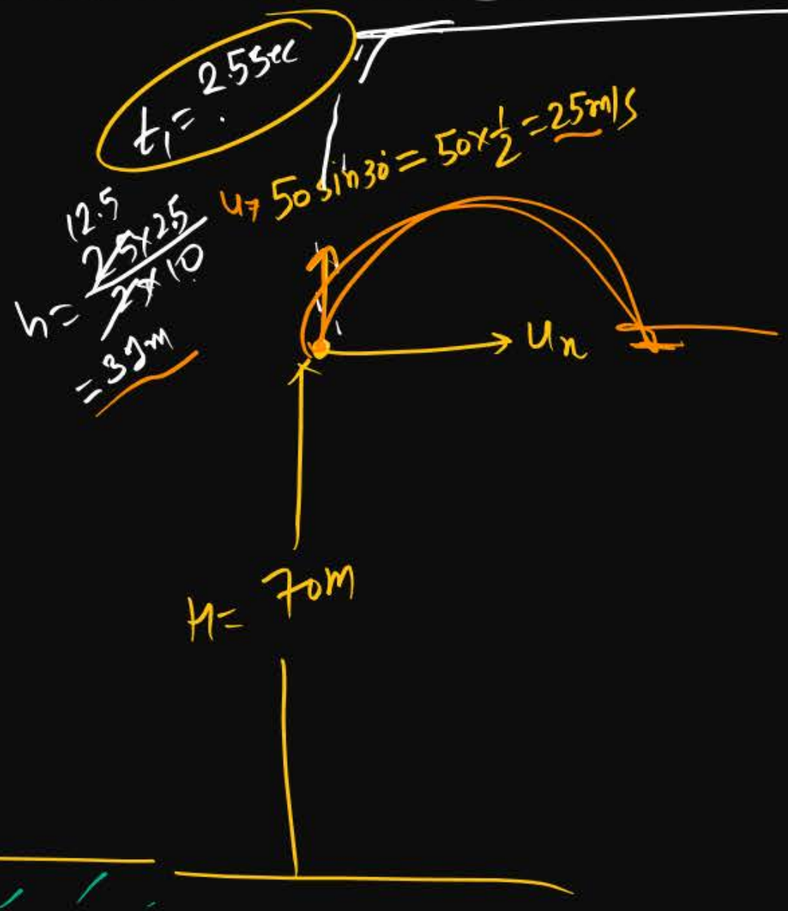
$R = u_x T_f$
$= 30 \times 8$
$= 240$m

Question (JEE main)

A ball is projected upwards from the top of a tower with a velocity of 50 m/s making an angle of 30° with the horizontal. The height of the tower is 70 m. After how much time from the instant of throwing, will the ball reach the ground?

1. ~~2 s~~
2. ~~5 s~~
3. 7 s
4. ~~9 s~~





$t = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 140}{10}}$

$= \sqrt{20} = 4.5$

Question

When a particle is thrown horizontally, with initial velocity 'u' the resultant velocity of the projectile at any time t is given by:

(1) NEET PYQ easy

1. gt
2. $\frac{1}{2}gt^2$
3. $\sqrt{u^2 + g^2t^2}$
4. $\sqrt{u^2 - g^2t^2}$

Question

Ball is projected with 30 m/s in horizontal direction from some height. Find time when it is 45° from horizontal.

H/W
(2) easy

Question

A body is thrown horizontally from the top of a tower of height 5 m. It touches the ground at a distance of 10 m from the foot of the tower. The initial velocity of the body is (g = 10 ms)

1. 2.5 ms
2. 5 ms
3. 10 ms
4. 20 ms

③ H/W
easy

Question

A body is thrown horizontally with a velocity $\sqrt{2gh}$ from the top of a tower of height h. It strikes the level ground through the foot of the tower at a distance x from the tower. The value of x is:

1. h
2. $h/2$
3. $2h$
4. $2h/3$

H/W

4

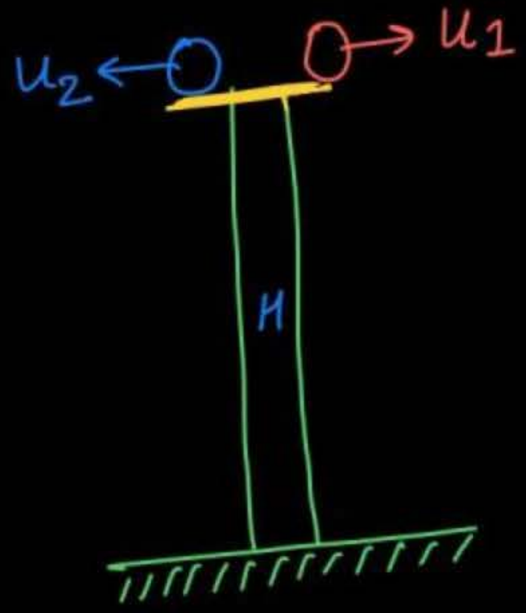
Question

A bomber is flying horizontally with a constant speed of 150 m/s at a height of 78.4 m. The pilot has to drop a bomb at the enemy target. At what horizontal distance from the target should he release the bomb:

1. Zero
2. 300 m
3. 600 m
4. 750 m

5

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 perpendicular



(6)

H/W

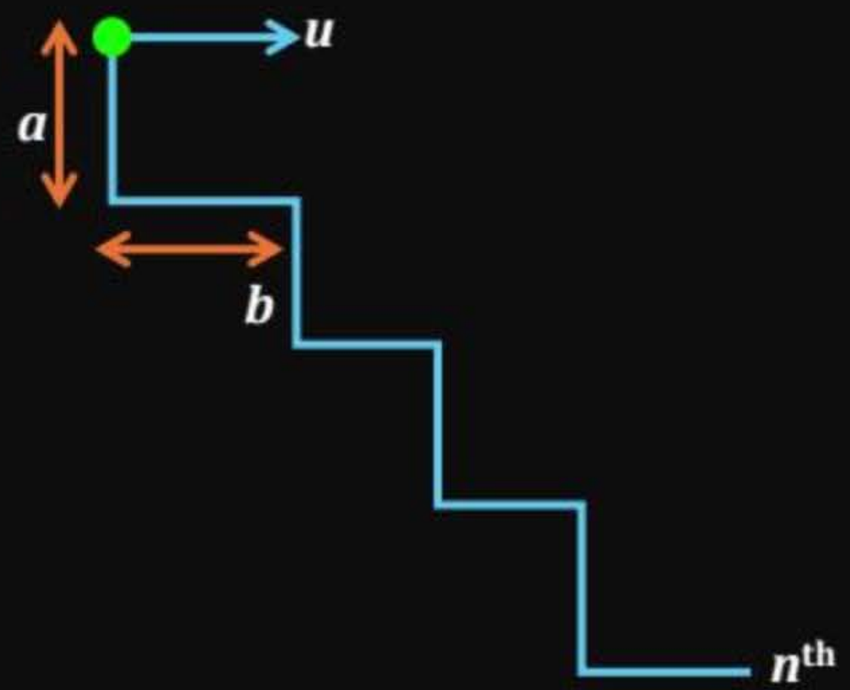
hint:-

Dono ka final velocity 't' time par likho and $\vec{V_1} \cdot \vec{V_2} = 0$

Dono ke final velocity ka product zero.

Question

Find velocity so that ball will fall on n^{th} step.

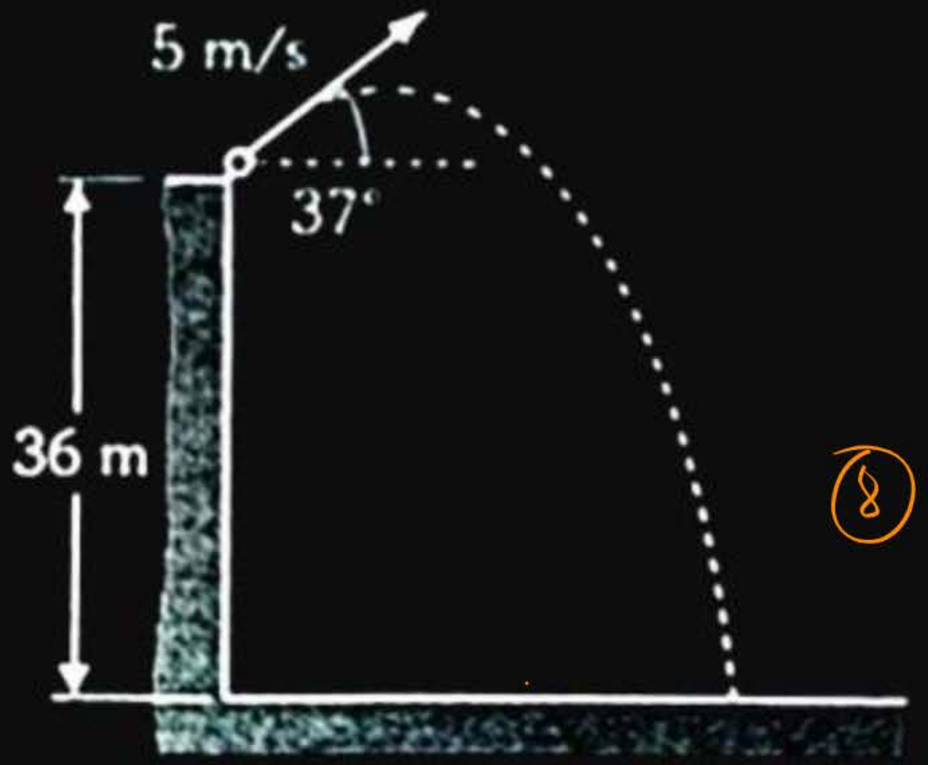


7

Question

A ball is thrown from the top of 36 m high tower with velocity 5 m/s at an angle 37° above the horizontal as shown. Its horizontal distance on the ground is closest to

[$g = 10\ m/s^2$]



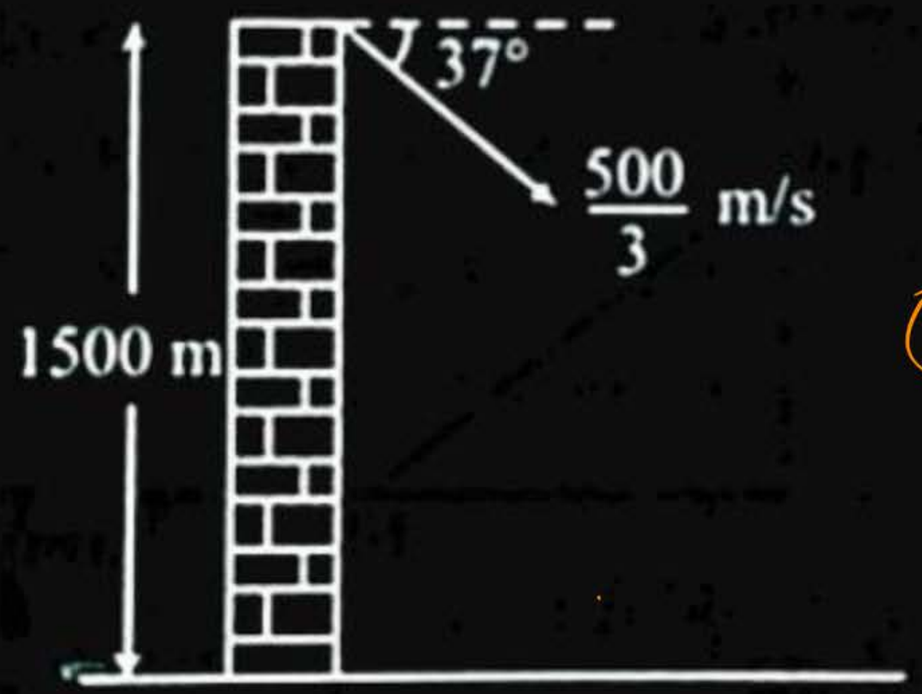
1. 12 m
2. 18 m
3. 24 m
4. 30 m

Question

A particle is projected from a tower as shown in figure, then the distance from the foot of the tower where it will strike the ground will be:

(take $g = 10\ m/s^2$)

1. 4000/3 m
2. 5000/3 m
3. 2000 m
4. 3000 m



General 2-D motion

↙

x and y ko alag-alag solve karo & vector ke help se final Answer

Question

x and y-coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$, where x and y. Acceleration of the particle at $t = 2s$. **[NEET-2017]**

10

Question

A particle has initial velocity $2\hat{\imath} + 3\hat{\jmath}$ and acceleration $(0.3\hat{\imath} + 0.2\hat{\jmath})$. Magnitude of velocity after 10 sec. **[NEET-2012]**

11

H/W

Question

A position vector of a particle $r = 15t^2\,\hat{i} + (4 - 20t^2\,\hat{j})$. Find acceleration at $t = 1$ sec

[JEE Main 2019]

1. 25
2. 40
3. 100
4. 50

12
H/W

Question

Object starts from the point $(2\hat{\imath}, 4\hat{\jmath})$ m at $t = 0$ with velocity $(5\hat{\imath} + 4\hat{\jmath})$ with constant acceleration $(4\hat{\imath} + 4\hat{\jmath})$ m/s^2. What is distance from particle from origin at t = 2 sec.

[JEE Main-2019]

13

H/W

Question

Potion of object $\vec{r} = (t^2 - 38t)\,\hat{\imath} + 2t^3\,\hat{\jmath}$ find instant when velocity and acceleration are perpendicular. **[JEE-2022]**

(19 H/W

Question

A particle starts from origin with velocity $3\hat{j}$ m/s and acceleration $(6\hat{i} + 4\hat{j})$. Then find x-coordinates of particle when y-coordinates is 32. **[IIT-2021]**

H/W

15

Question

Object is moving with velocity $V = 3 \sin(\omega t)\,\hat{i} + 3 \cos(\omega t)\,\hat{j}$ then find distance moved by object in 2 sec.

(16) H/W

Question

Object is moving in west with 5 m/s after 2 sec its velocity is 5 m/s in north then find acceleration.

HOME-work (17) H/W

Sare karne hai

PHYSICS WALLAH

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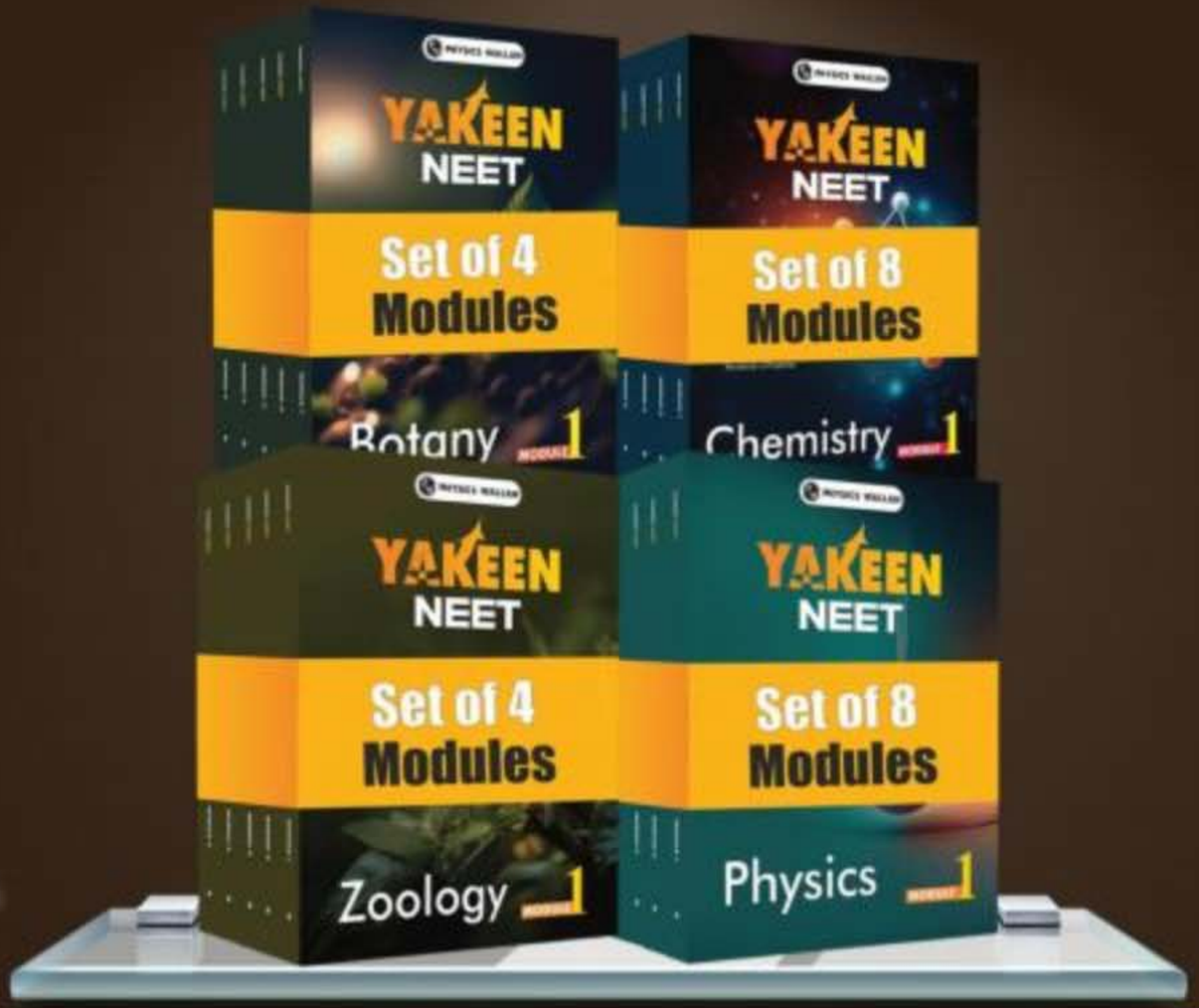

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