



# YAKEEN NEET 2.0

**2026**

**Motion in a Plane**

**Physics**

**Lecture - 5**

**By- Manish Raj (MR Sir)**



## Today's Goal

⇒ H/w discussion.

⇒ General (2-D) motion

⇒ Relative motion

most important for NEET.

Question sare dekh  
liye hai?

(a) Yes,

(b) No,

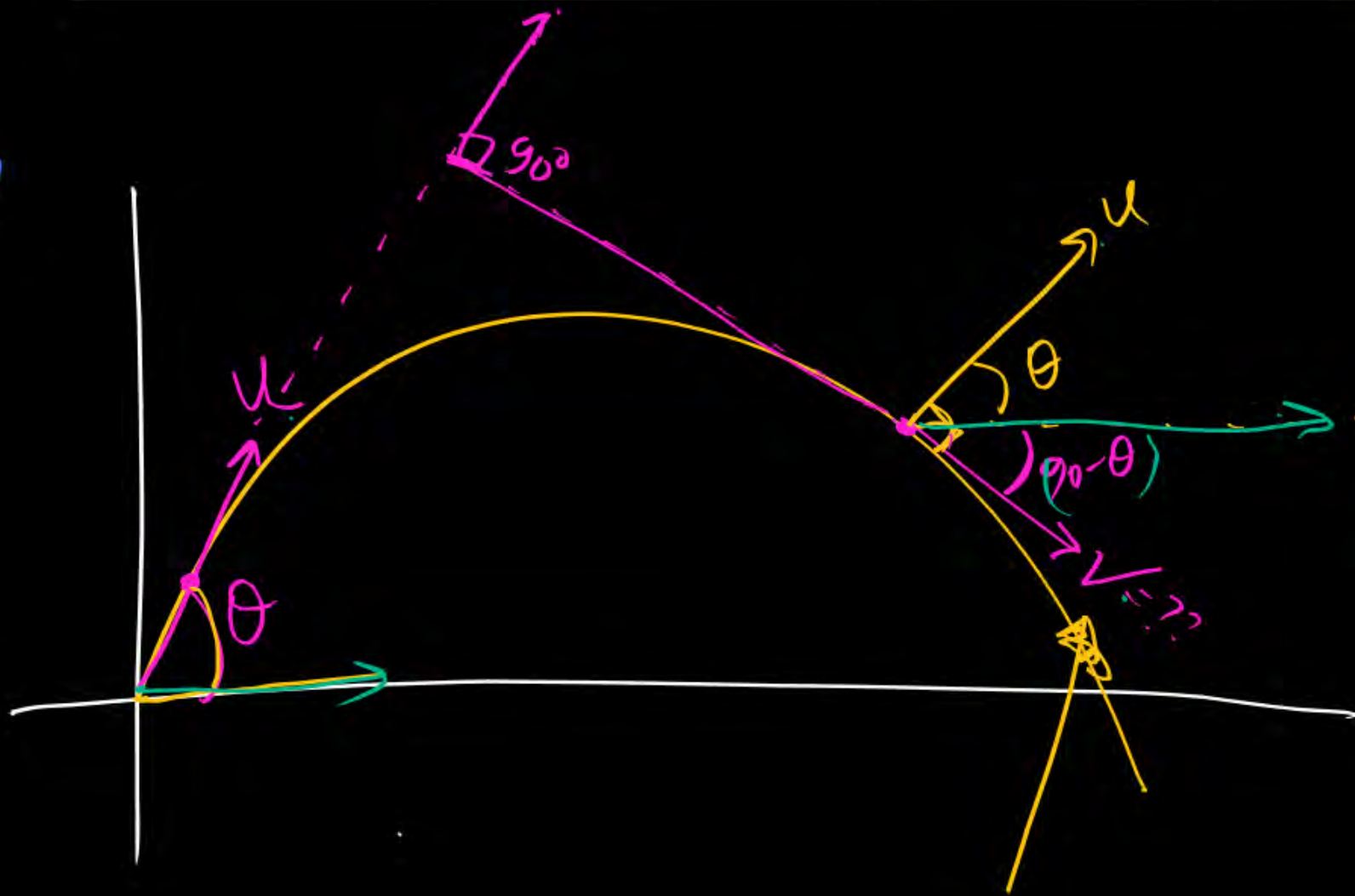


15. A particle is projected with a velocity  $u$  making an angle  $\theta$  with the horizontal. At any instant, its velocity  $v$  is at right angle to its initial velocity  $u$ ; then  $v$  is:

- (1)  $u \cos \theta$  (2)  $u \tan \theta$  (3)  $u \cot \theta$  (4)  $u \sec \theta$

KN0116

Sol<sup>n</sup>



parallel  
x-axis

$$u \cos \theta = v \cos(90^\circ - \theta)$$

$$u \cos \theta = v \sin \theta$$

$$\underline{u \cot \theta} = v$$

1/10 Karl  
2-line  $\frac{g}{u}$  solve  
 $t = \frac{u}{g \sin \theta}$   $\theta \geq 45^\circ$

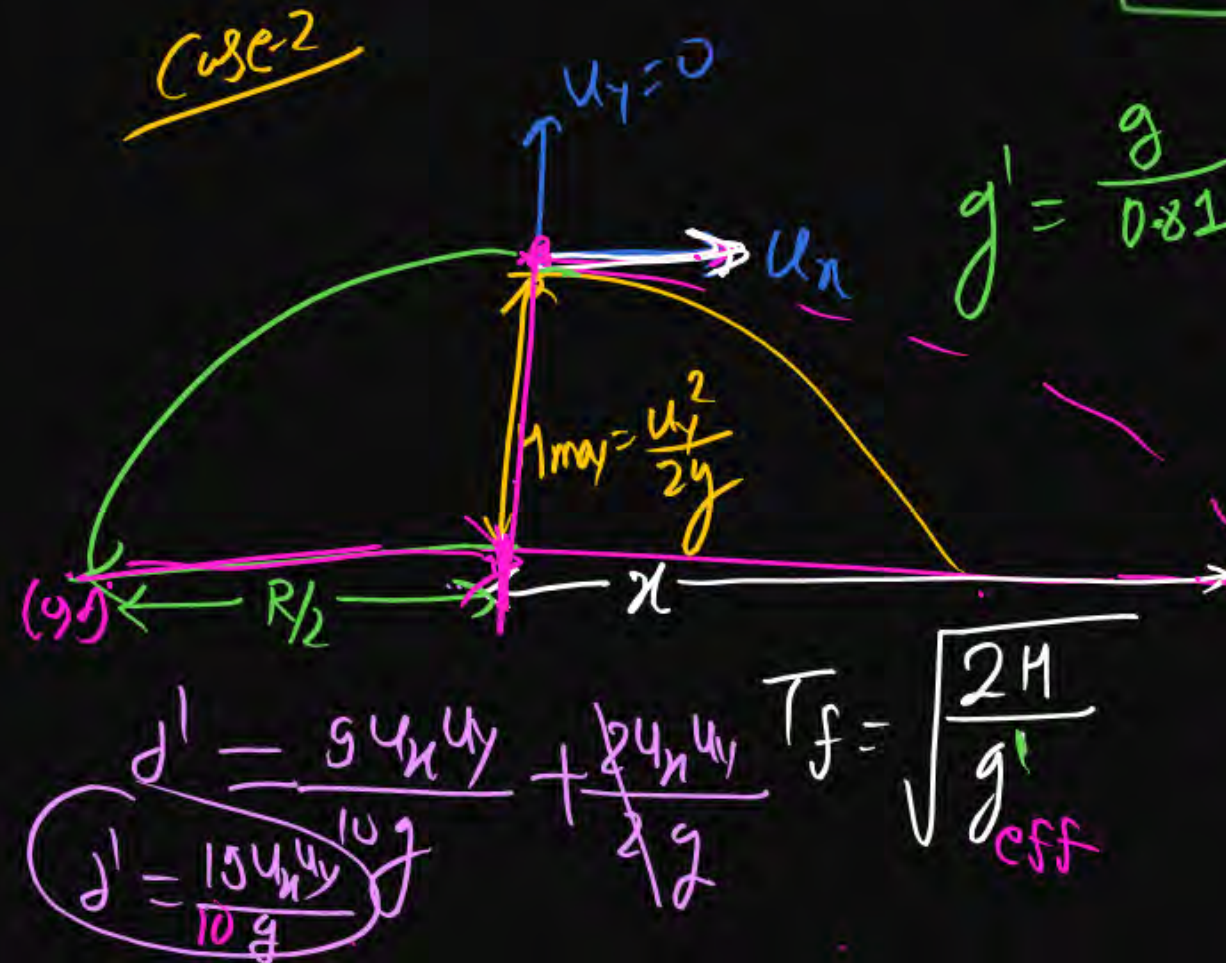
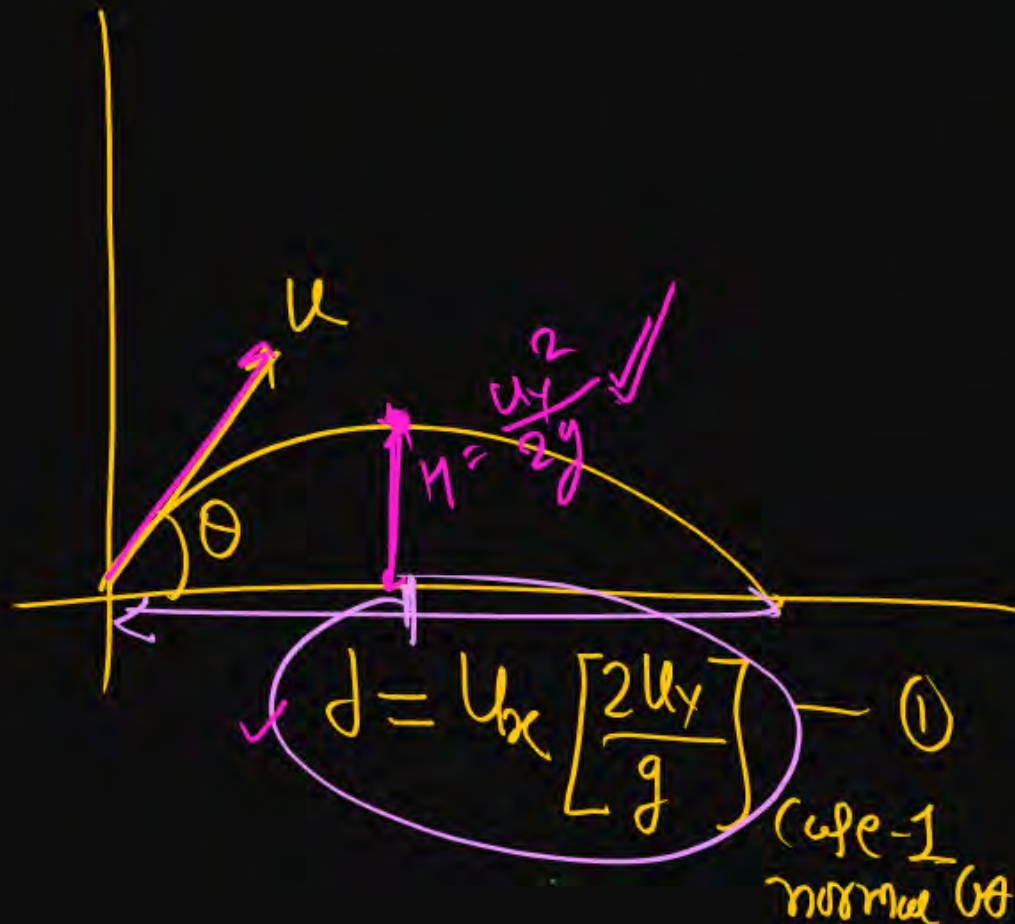


## Question



A projectile is fired from horizontal ground with speed  $v$  and projection angle  $\theta$ . 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]



$$\begin{aligned} x &= u_x \times T_f \\ x &= u_x \sqrt{\frac{2u_y^2}{2g \times \frac{g}{0.81}}} \\ x &= \frac{u_x u_y}{g} \sqrt{0.81} = \frac{g u_x u_y}{10g} \end{aligned}$$

$$\frac{d_1}{d} = \frac{19 \cancel{\mu\mu\mu}}{10 \cancel{g} \times 2 \cancel{\mu\mu\mu}} \quad \frac{g}{g}$$

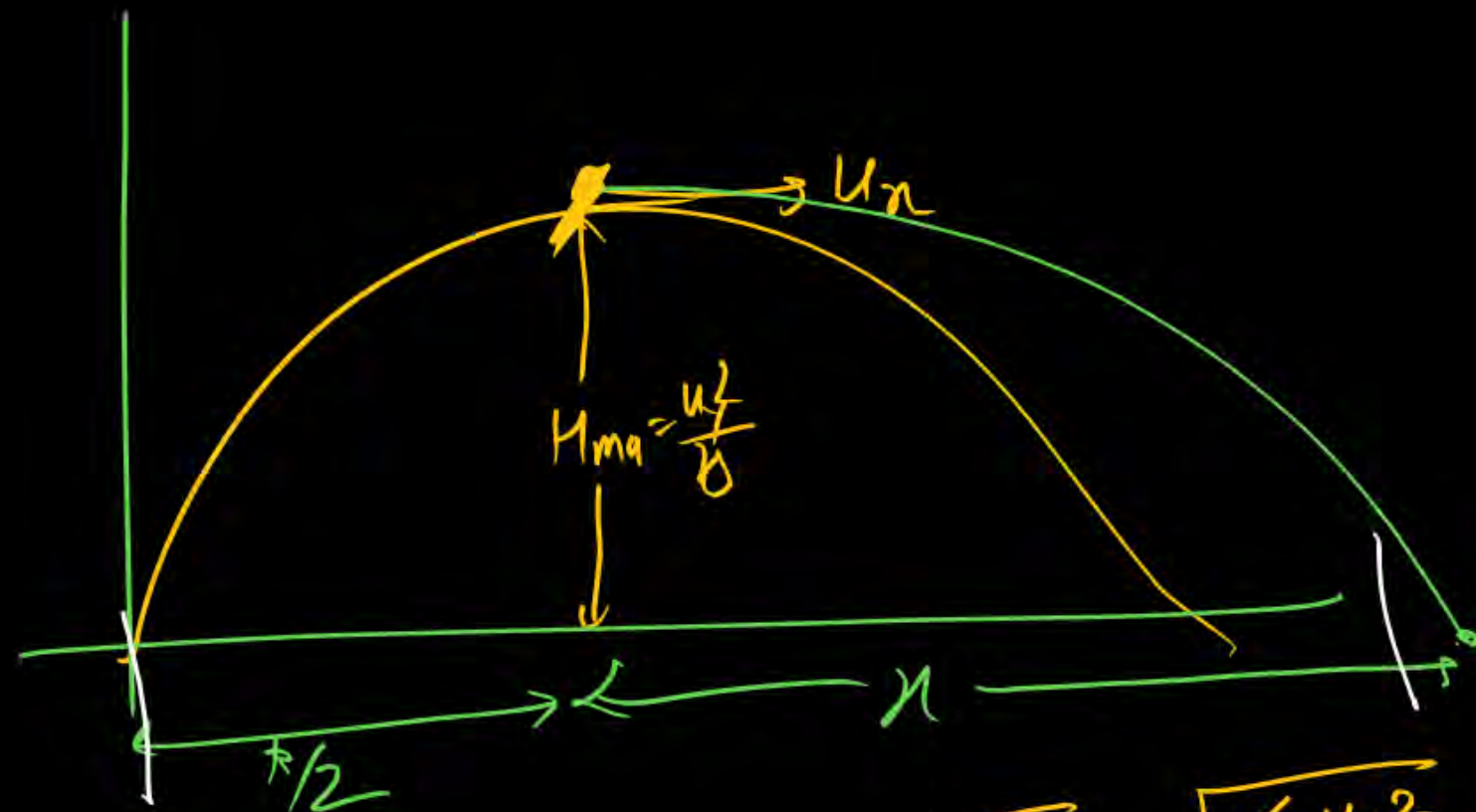
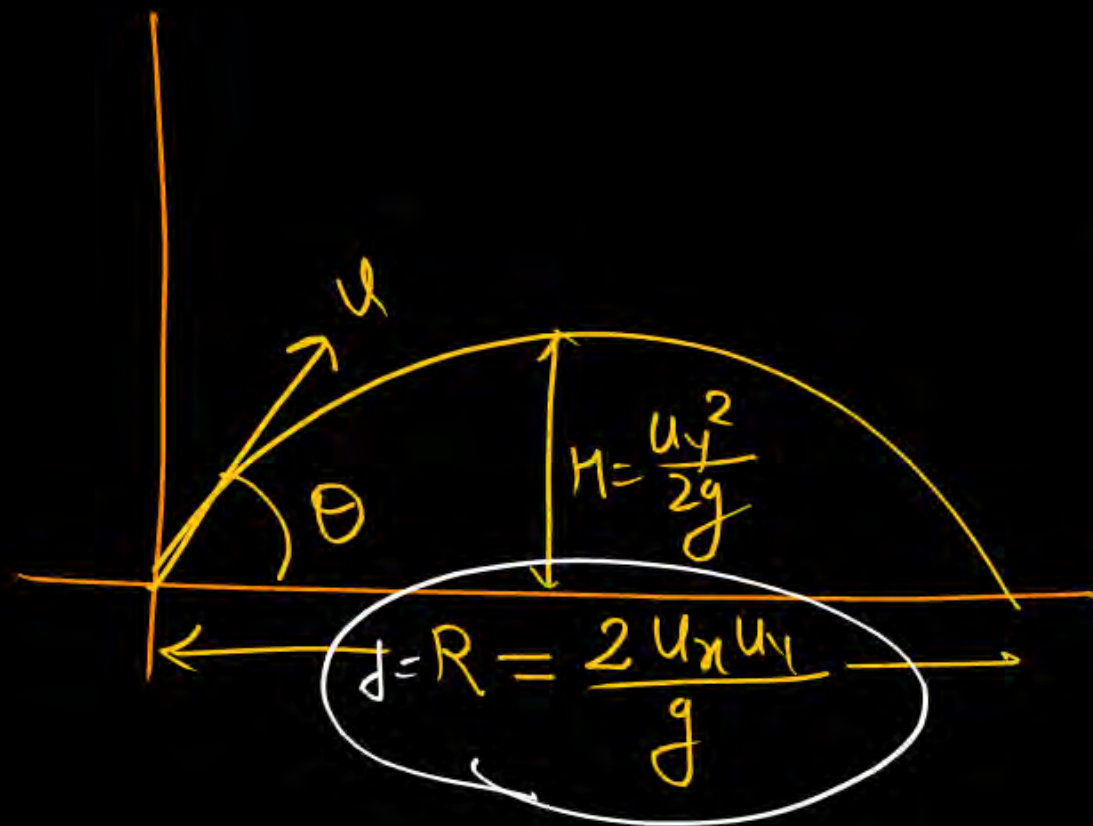
$$\frac{d_1}{d} = \frac{19}{20}$$

$$d_1 = d(0.95)$$

As



Sol<sup>n</sup>



$$d' = \frac{R}{2} + x$$

$$= \frac{u_x u_y}{g} + \frac{u_x u_y g}{10g}$$

$$d' = \frac{19 u_x u_y}{10g}$$

$$T_f = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times u_y^2}{2g \times \frac{g}{0.81}}}$$

$$\Rightarrow x = u_x \sqrt{\frac{u_y^2 \cdot 81}{g^2 \cdot 100}} = \frac{u_x u_y g}{10}$$

## Question

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

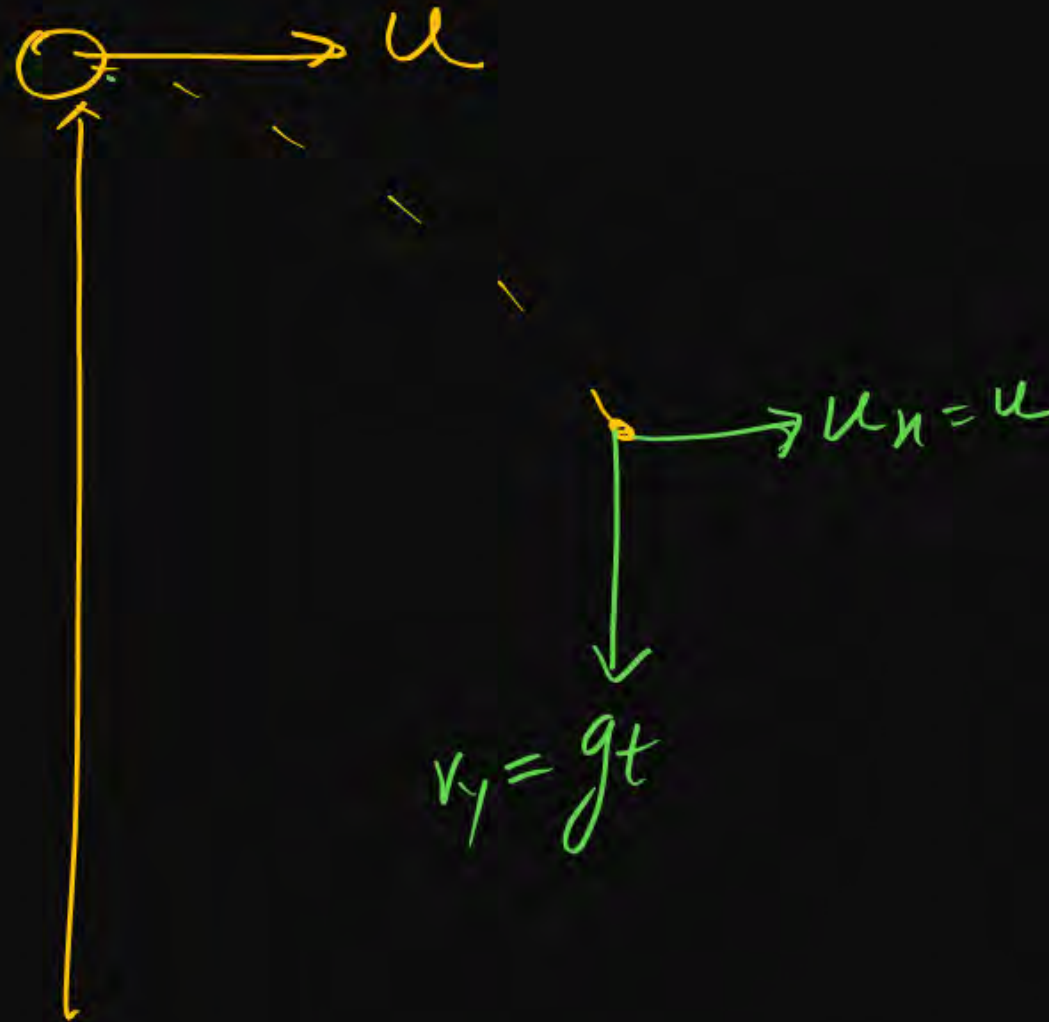
① NEET PYQ  
easy  
ghor PYQ

1  $gt$

2  $\frac{1}{2}gt^2$  ~~dispm.~~

3  $\sqrt{u^2 + g^2t^2}$  ✓

4  $\sqrt{u^2 - g^2t^2}$



$$\vec{v} = u\hat{i} + gt\hat{j}$$

$$|\vec{v}| = \sqrt{u^2 + g^2t^2} \quad \checkmark$$



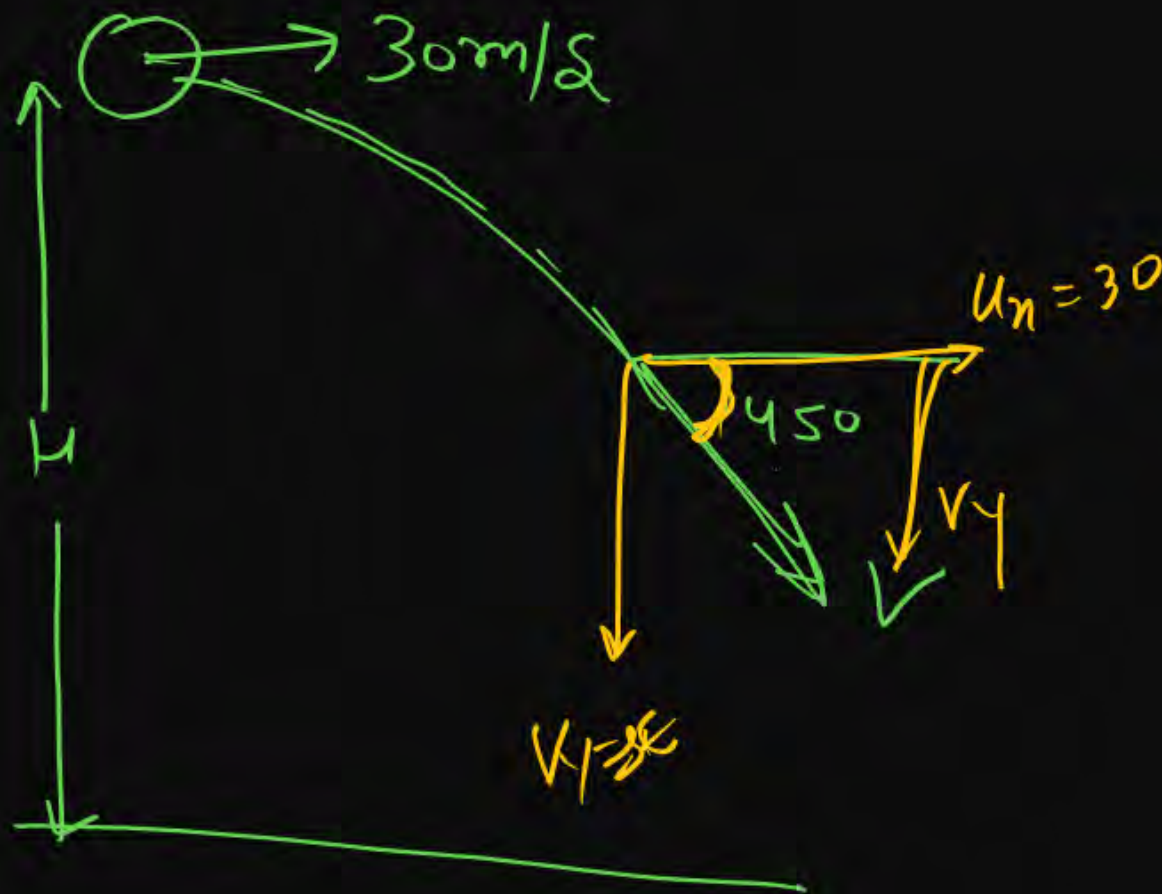
## Question



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

moving at

② H/W easy



$$\tan 45^\circ = \frac{v_y}{u_x}$$

$$1 = \frac{gt}{30}$$

$$30 = gt$$

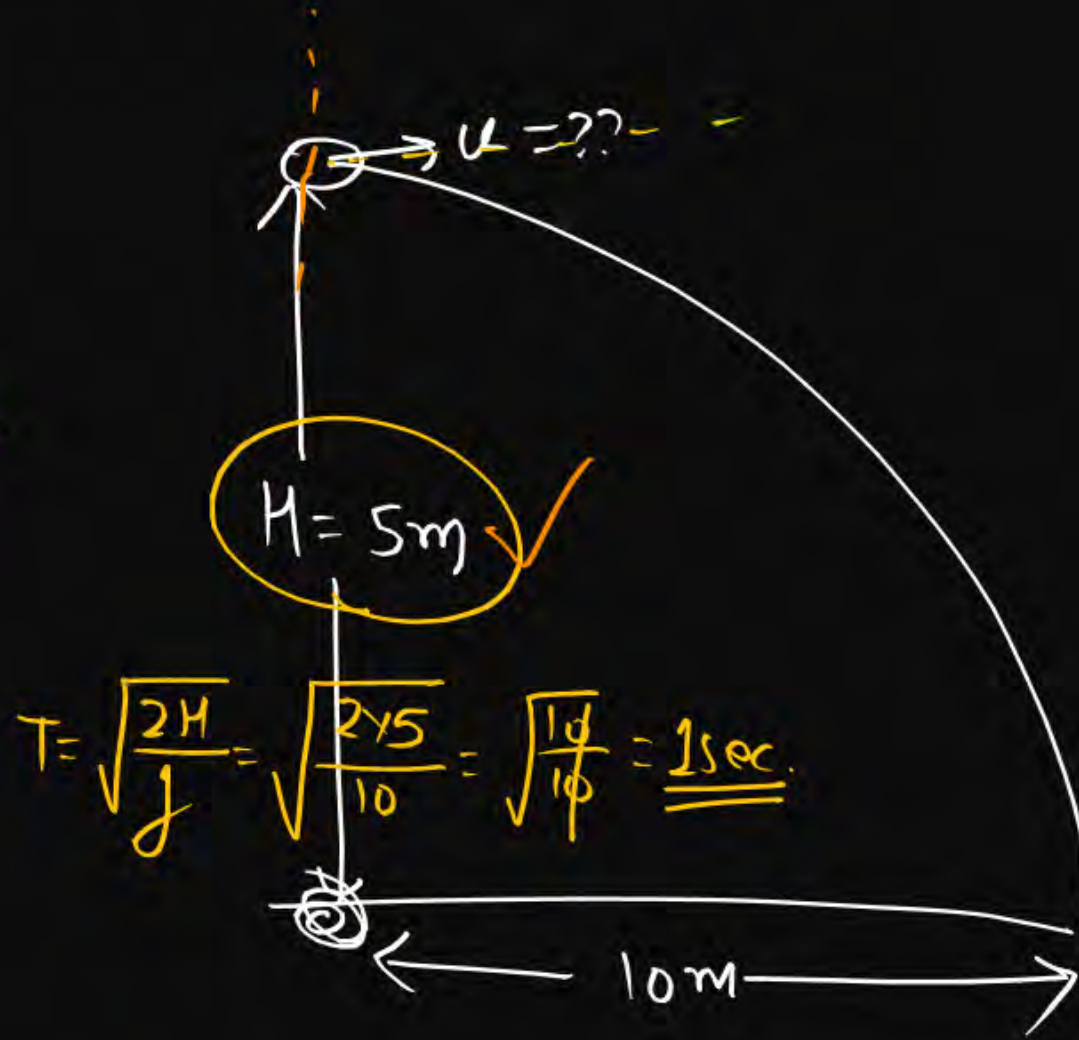
$$t = 3 \text{ sec} \checkmark$$



## 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 ( $g = 10 \text{ ms}^{-2}$ )

- 1 2.5 ms
- 2 5 ms
- 3 10 ms ✓✓
- 4 20 ms



$$T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 5}{10}} = \sqrt{\frac{10}{10}} = \underline{\underline{1 \text{ sec.}}}$$

$$R = u_x T_f$$

$$10 = u_x \times 1$$

$$\boxed{u_x = 10 \text{ m/s}}$$

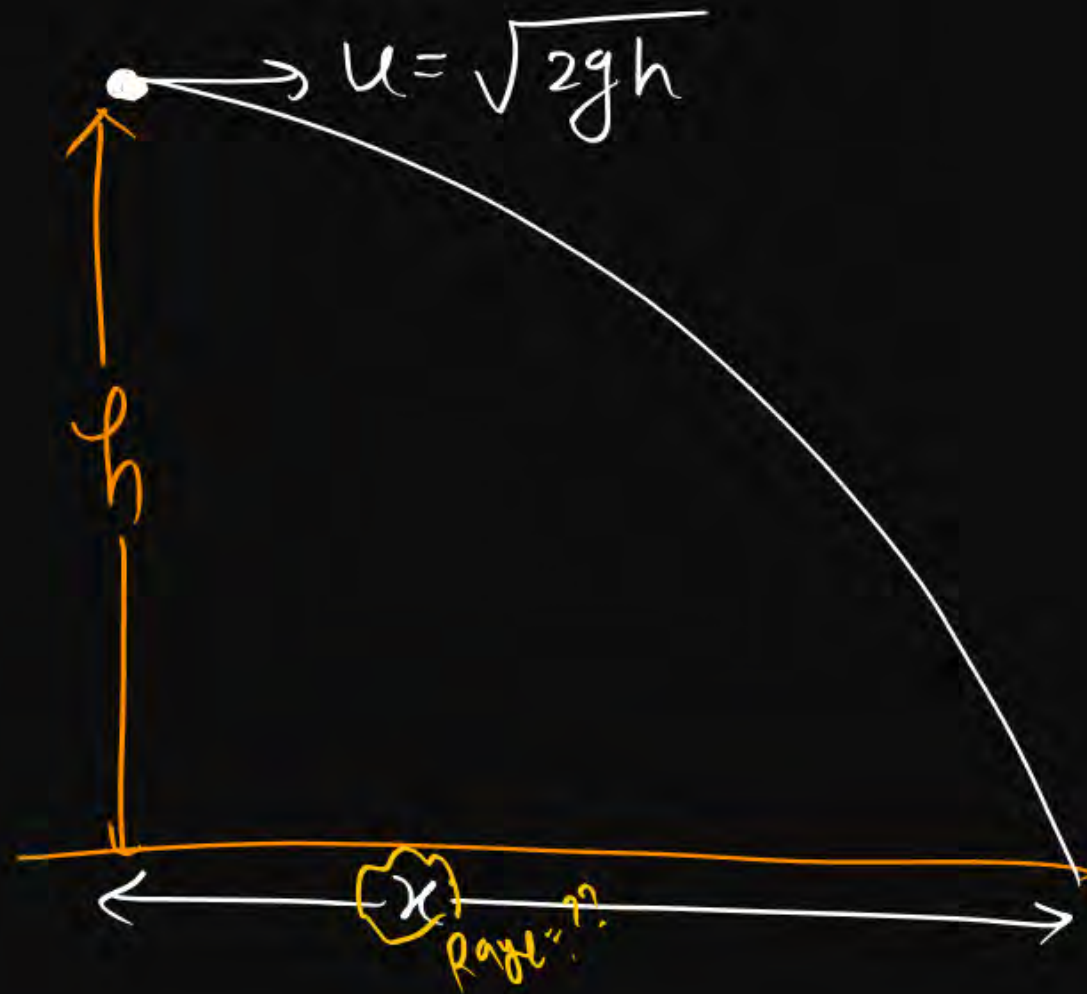
③ H/w  
easy

## 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  $2h/3$

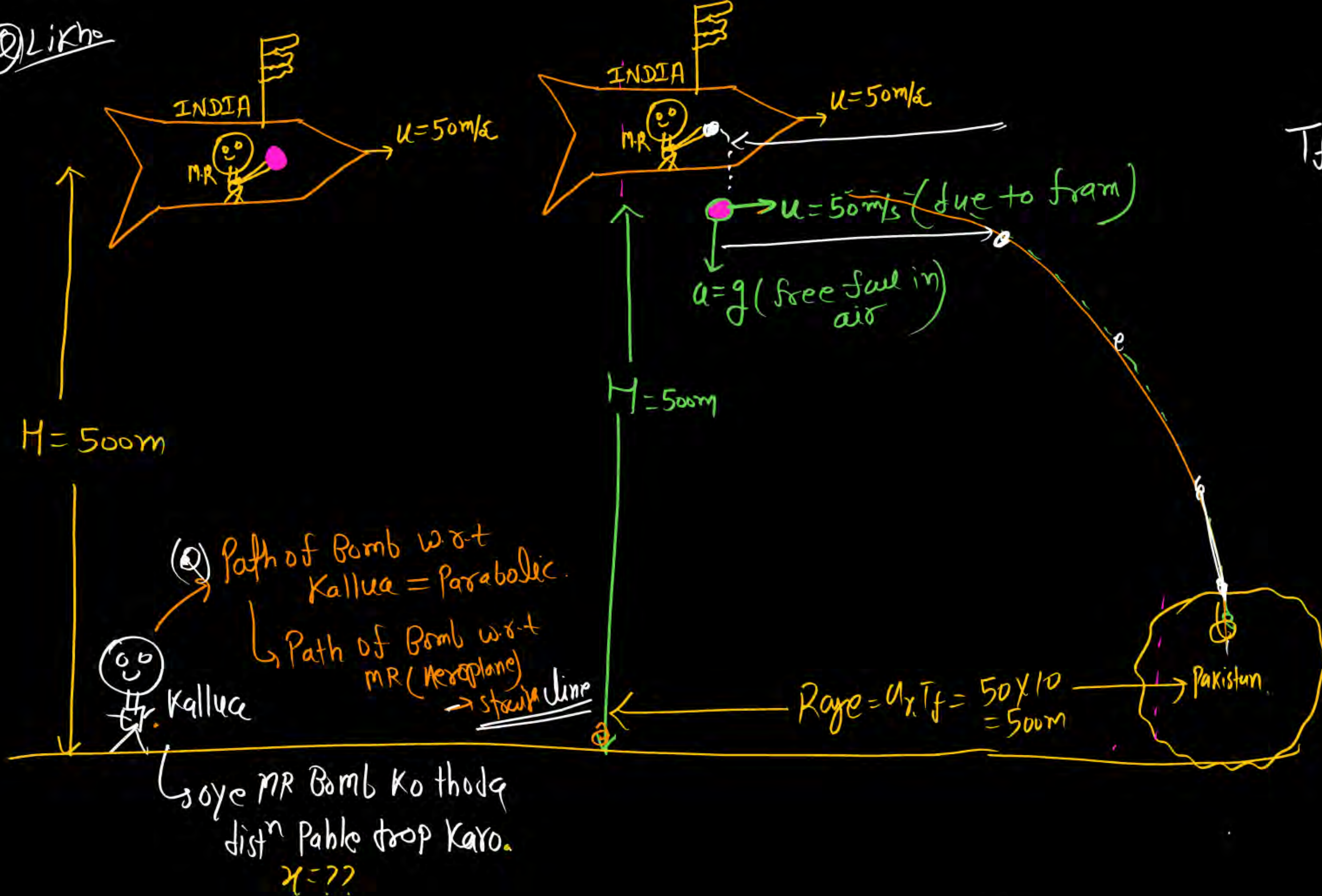


$$\begin{aligned} T_f &= \sqrt{\frac{2h}{g}} \quad \checkmark \\ x &= u \cdot T_f \\ &= \sqrt{2gh} \cdot \sqrt{\frac{2h}{g}} \\ &= \sqrt{\frac{2gh \times 2h}{g}} \\ &= \sqrt{4h^2} = 2h \quad \# \end{aligned}$$

(H/w) (4)



Q) Likh



$$T_f = \sqrt{\frac{2H}{g}}$$

$$= \sqrt{\frac{2 \times 500}{10}}$$

$$= \sqrt{100} = 10 \text{ sec}$$

MR \* BOX  
Jabtak Kuchh  
Na bole air  
resistance ko  
gignore karna  
hai.

## Question

सद मिहरी



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

$$u \rightarrow 150 \text{ m/s}$$

$$H = \frac{78.4 \text{ m}}{X} \approx 80 \text{ m}$$

$$T = \sqrt{\frac{2H}{g}} = 4 \text{ sec}$$

$$\begin{aligned} x &= u_x \times T_f \\ &= 150 \times 4 \\ &= 600 \text{ m} \end{aligned}$$

5



Two Ball Projected Horizontally 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

Sol<sup>n</sup>

$$\vec{v}_1 = u_1 \hat{i} + gt \hat{j}$$

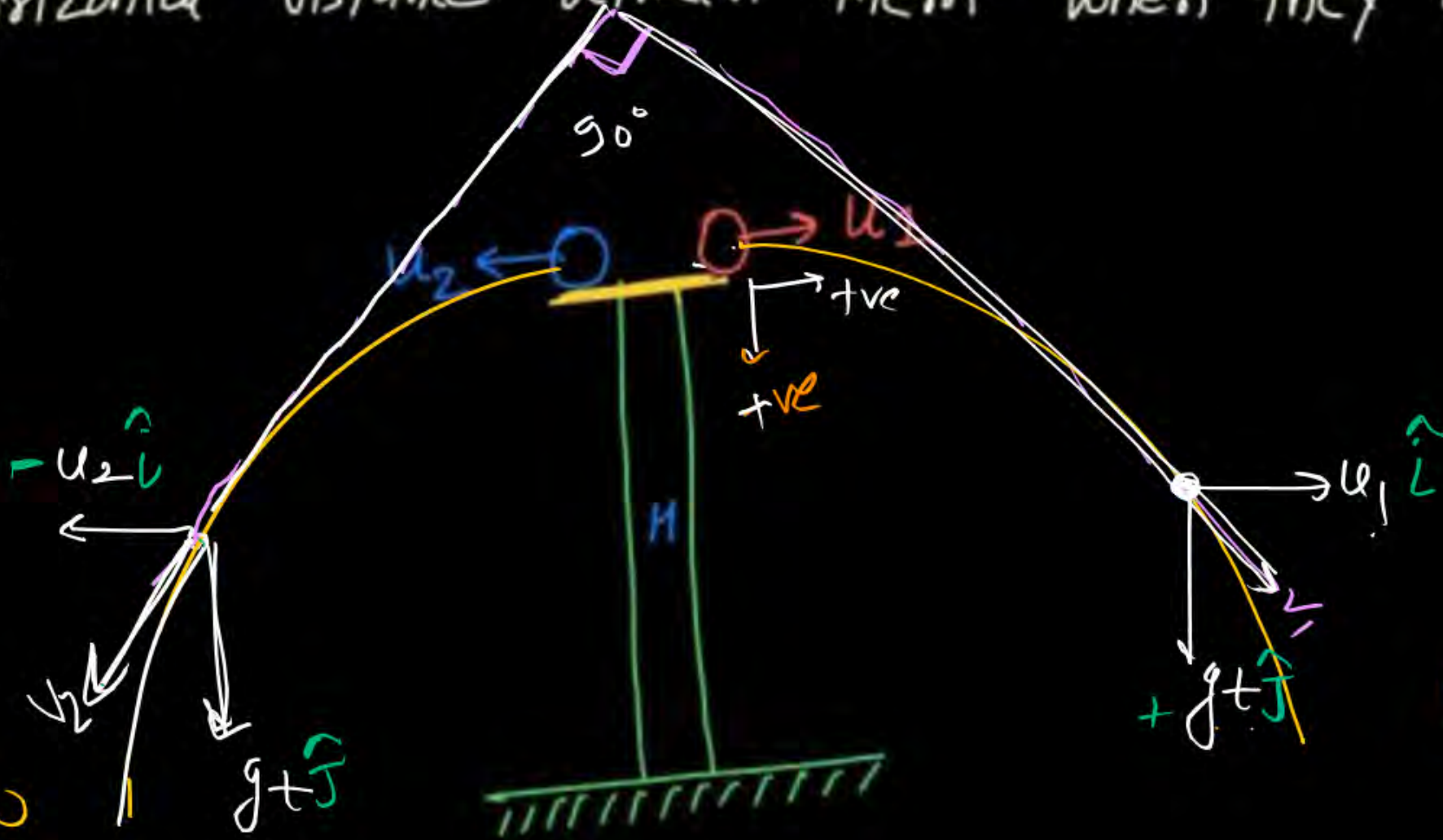
$$\vec{v}_2 = -u_2 \hat{i} + gt \hat{j}$$

#  $\vec{v}_1 \cdot \vec{v}_2 = 0$

$$-u_1 u_2 + g^2 t^2 = 0$$

$$u_1 u_2 = g^2 t^2$$

$$t^2 = \frac{u_1 u_2}{g^2} \quad t = \frac{\sqrt{u_1 u_2}}{g}$$



dist<sup>n</sup> b/w them  
relat<sup>n</sup> may  
H<sup>l</sup> calcul<sup>n</sup>  
pr

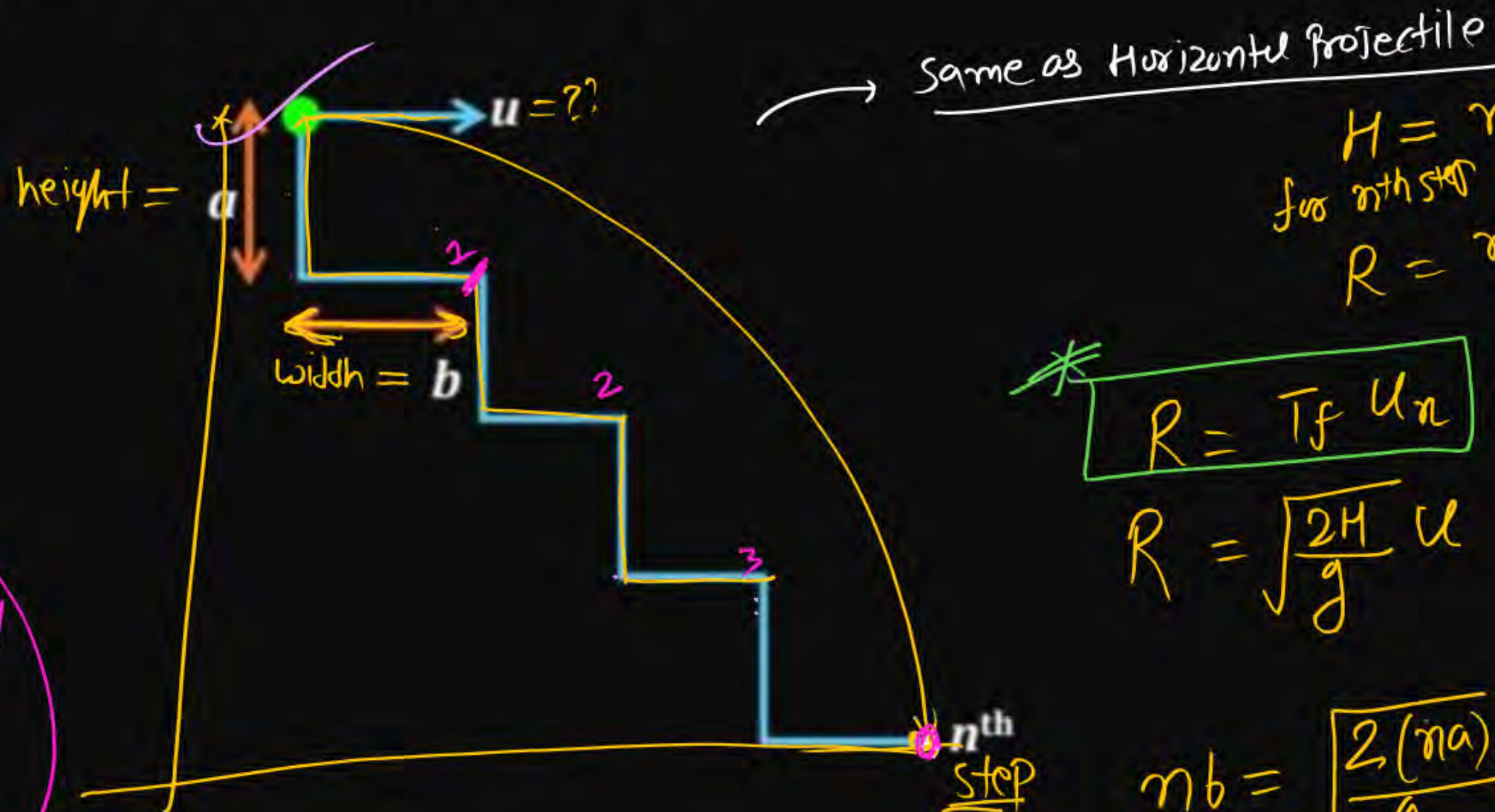
⑥

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 dot  
product zero. ✓



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



Same as Horizontal Projectile

$$H = na \quad \text{--- (i)}$$

$$R = nb \quad \text{--- (ii)}$$

$$R = T_f u_n$$

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

(7)

$$nb = \sqrt{\frac{2(na)}{g}} u$$

$$u = nb \sqrt{\frac{g}{2na}} = \sqrt{\frac{n^2 b^2 g}{2na}}$$

$$u = \sqrt{\frac{nb^2 g}{2a}} \quad R$$

MR\* Scam

find minimum velocity  
So that ball fall  
on  $n^{\text{th}}$  step.

$$u_{\min} = \sqrt{\frac{(n-1)b^2 g}{2a}}$$

Ans





# Question

JEEMains

$$(t_1)_{up} = \frac{u}{g} = \frac{3}{10} = 0.3$$

$$H = \frac{u^2 \sin^2 \theta}{2g} = \frac{9}{20} = 0.45$$



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

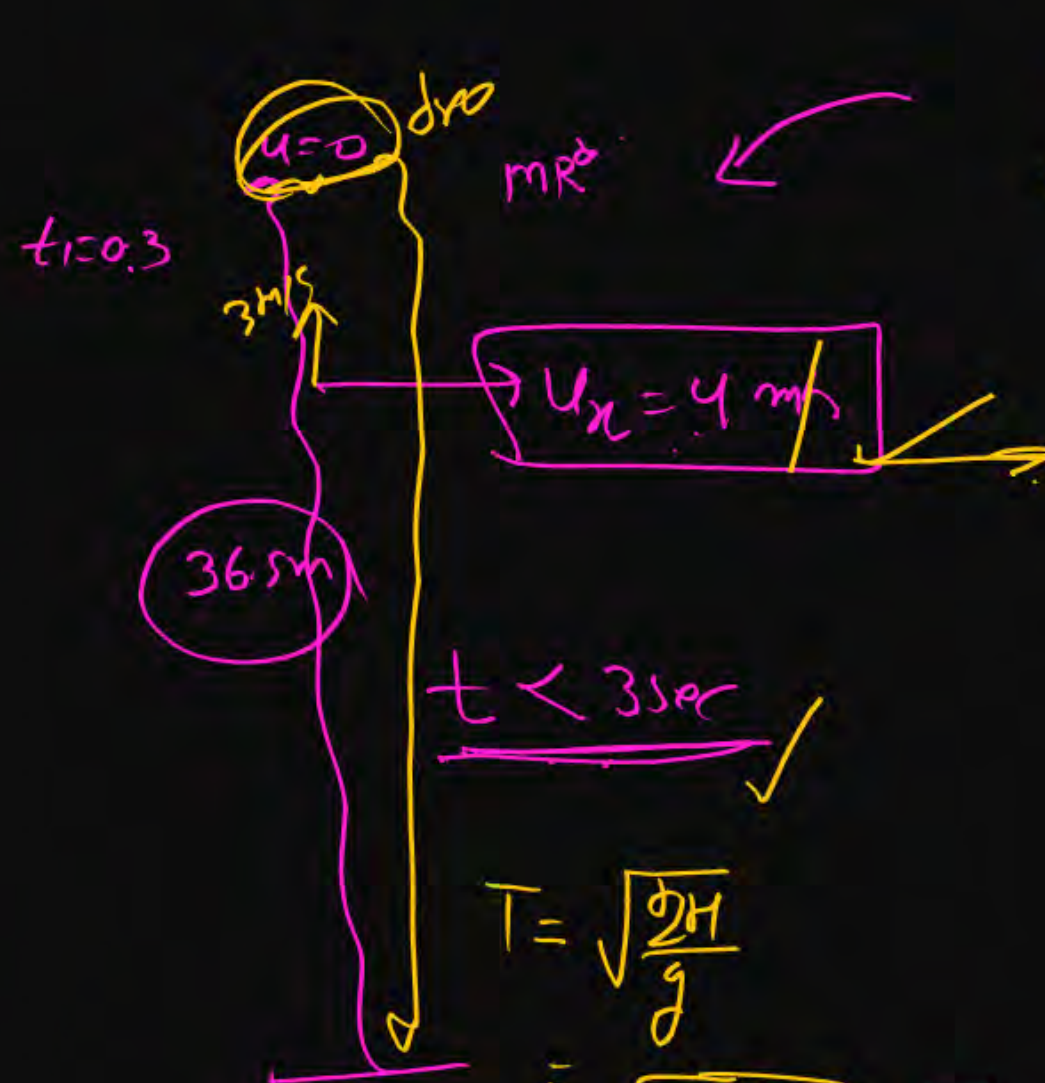
$[g = 10 \text{ m/s}^2]$

1 12 m

2 18 m

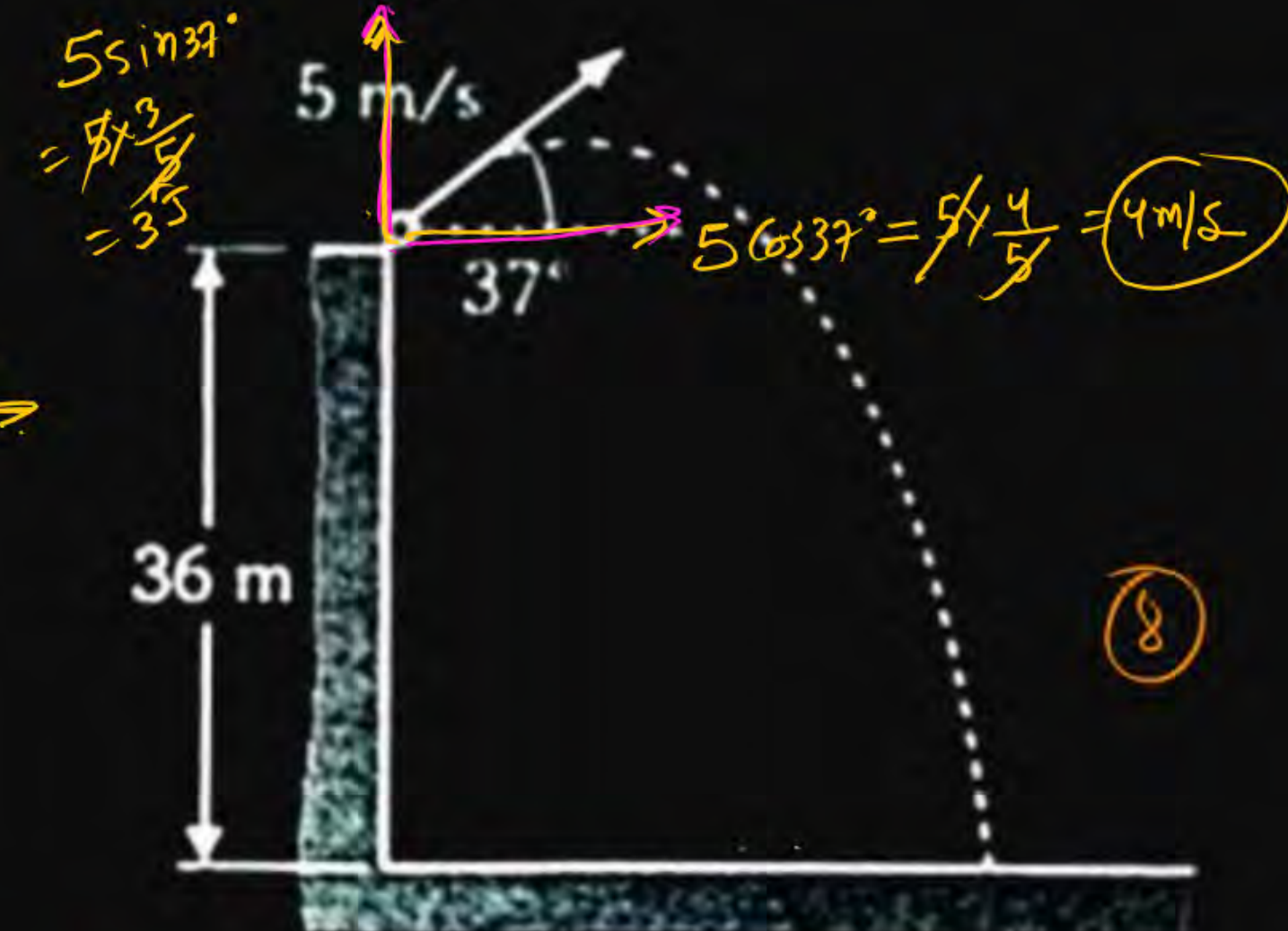
3 24 m

4 30 m



$$T = \sqrt{\frac{2H}{g}}$$

$$= \sqrt{\frac{2 \times 36.5}{10}} = \sqrt{\frac{72}{10}} = \sqrt{7.2}$$



8



# Question

JEE Main

$$(t_1)_{up} = \frac{4}{g} = \frac{4}{10} = 0.4$$

$$t_1 = \frac{312}{28} = \frac{9}{20} = 0.45$$



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

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

1 ✓ 12 m

2 ✗ 18 m

3 ✗ 24 m

4 ✗ 30 m

Motion in y-axis

$$S_y = 36 \text{ m}$$

$$a = g = 10$$

$$u_y = -3$$

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

$$36 = -3t + \frac{1}{2} \times 10 \times t^2$$

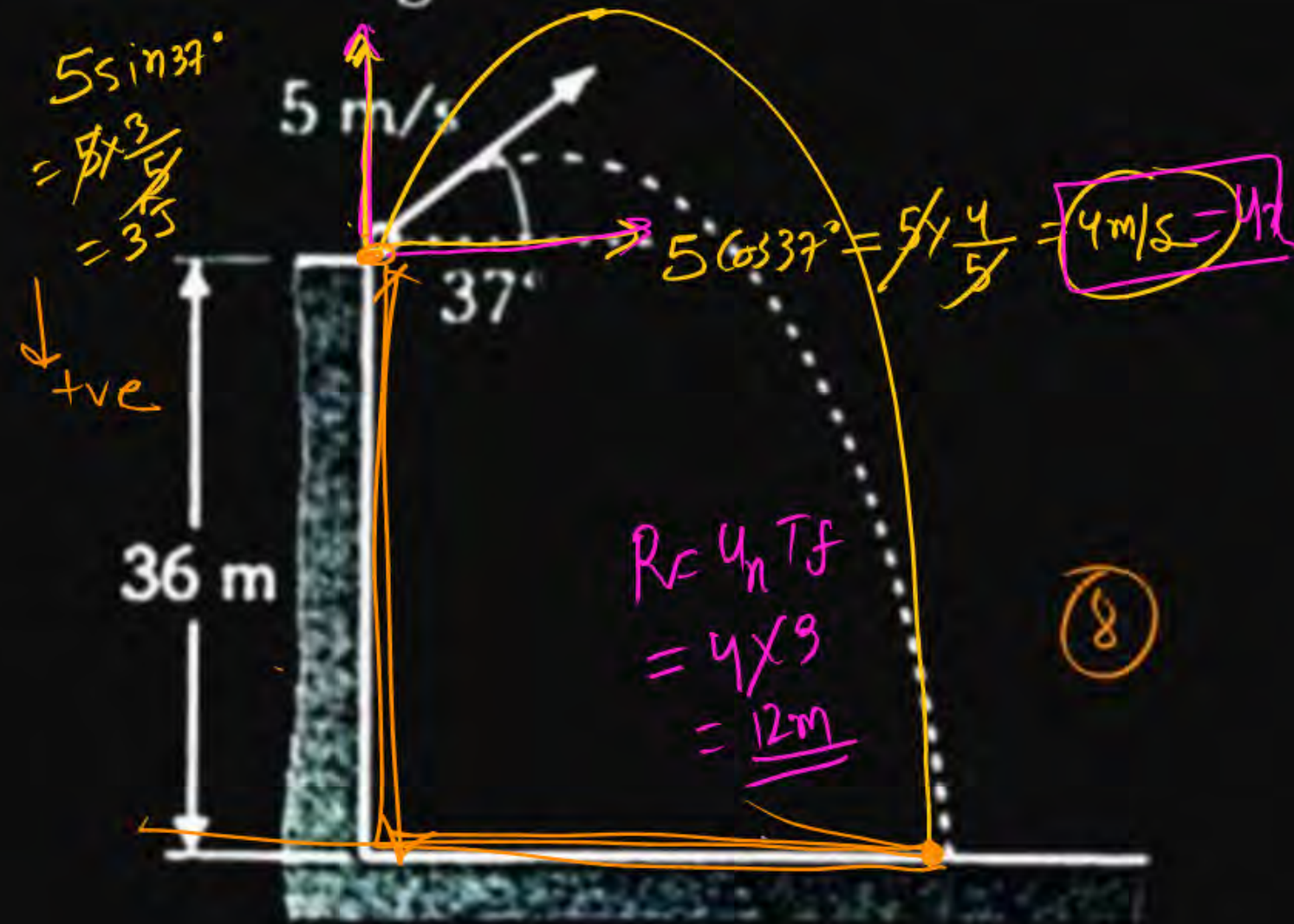
$$5t^2 - 3t - 36 = 0$$

$$5t^2 - 15t + 12t - 36 = 0$$

$$5t(t-3) + 12(t-3) = 0$$

$$(t-3)(5t+12) = 0$$

$t = 3 \text{ s}$



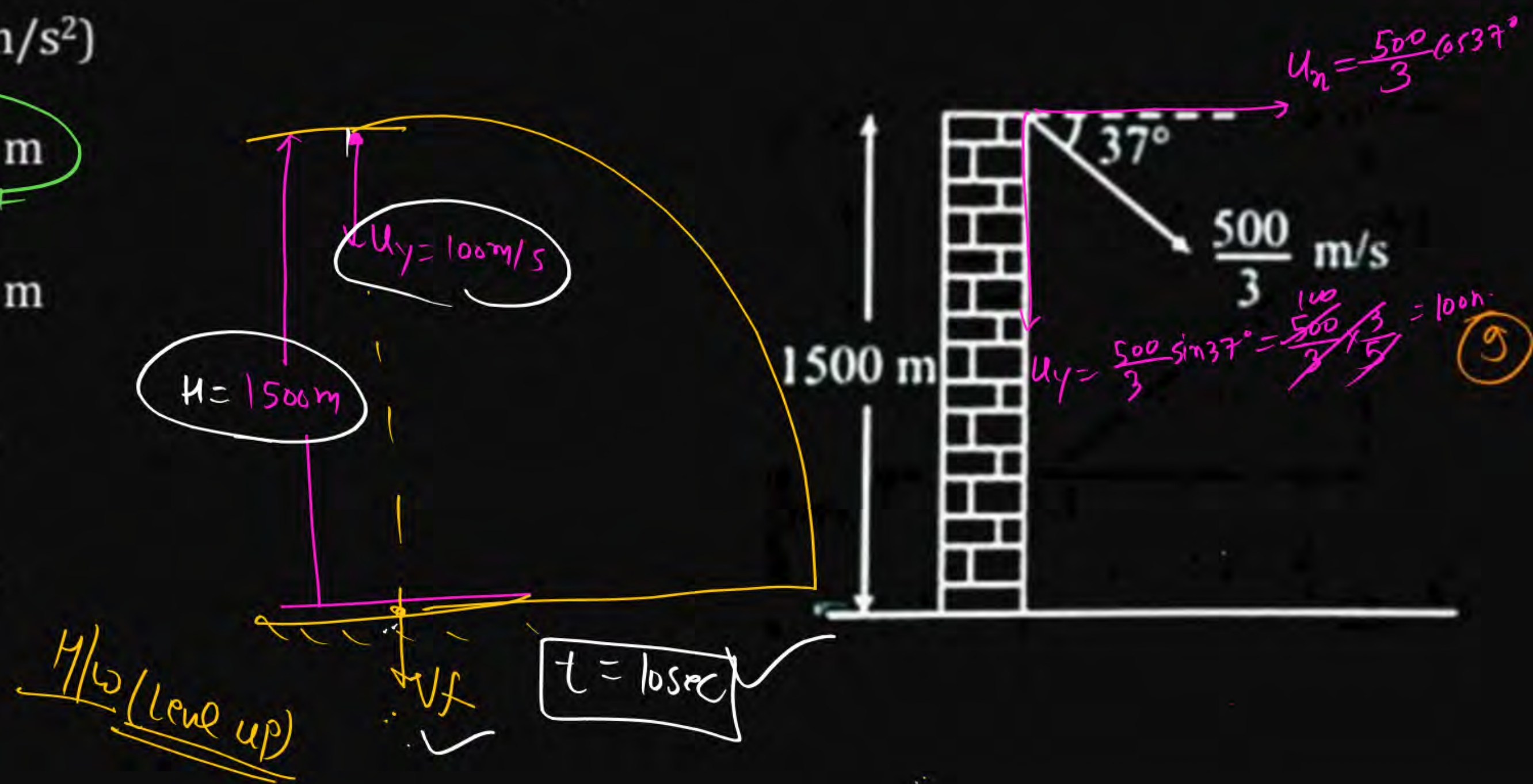


## Question

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  $g = 10 \text{ m/s}^2$ )

- 1  $4000/3 \text{ m}$
- 2  $5000/3 \text{ m}$
- 3  $2000 \text{ m}$
- 4  $3000 \text{ m}$



## General 2-D motion

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

Highly important  
Question ✓

Write in Notes



## Question

Note 2/10/17



$x$  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]**

$$x = 5t - 2t^2$$

$$y = 10t$$

$$V_x = 5 - 2(2t)$$

$$V_y = \frac{dy}{dt} = \frac{d(10t)}{dt} = 10 \times 1 = 10 \text{ m/s}$$

$$a_x = \frac{dV_x}{dt} = 0 - 4(1)$$

$$\frac{dV_y}{dt} = 0 = a_y$$

$$a_x = -4$$

10

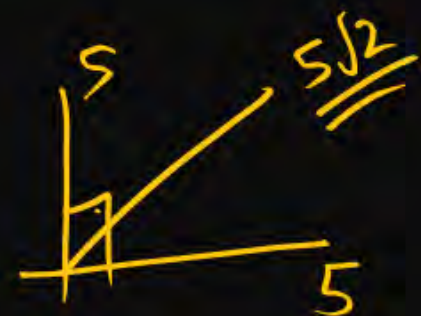
## Question



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

Sol<sup>n</sup>

$$\vec{u} = 2\hat{i} + 3\hat{j}$$
$$\vec{a} = 0.3\hat{i} + 0.2\hat{j}$$



$$V_x = u_x + a_x t$$
$$= 2 + 0.3 \times 10$$
$$= 2 + 3$$

$$V_x = 5\hat{i}$$

$$V_y = u_y + a_y t$$

$$V_y = 3 + 0.2 \times 10$$
$$= 3 + 2 = 5\hat{j}$$

$$\vec{V} = 5\hat{i} + 5\hat{j}$$

$$|\vec{V}| = \sqrt{5^2 + 5^2} = \sqrt{50} = 5\sqrt{2}$$

(11)

W/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

Ans

$$\vec{r} = 15t^2 \hat{i} + (4 - 20t^2) \hat{j}$$

Soln

$$x = 15t^2$$

$$y = 4 - 20t^2$$

$$V_x = \frac{dx}{dt} = 15 \frac{dt^2}{dt}$$

$$V_x = 15(2t)$$

$$\vec{a} = 30\hat{i} - 40\hat{j}$$

$$a_x = 30 \frac{dt}{dt} = 30$$

$$|a| = \sqrt{(30)^2 + (40)^2} = 50 \text{ m/s}^2$$

$$\frac{dy}{dt} = V_y = 0 - 20(2t)$$

$$V_y = -40t$$

$$a_y = -40 \times 1 \quad a_y = -40\hat{j}$$

12 H/W



## Question



Object starts from the point  $(2\hat{i}, 4\hat{j})$  m at  $t = 0$  with velocity  $(5\hat{i} + 4\hat{j})$  with constant acceleration  $(4\hat{i} + 4\hat{j})$  m/s<sup>2</sup>. What is dis<sup>m</sup> from particle from origin at  $t = 2$  sec. ✓

[JEE Main-2019]

↓  
 $(x_f, y_f)_{\text{from orig}} = (20\hat{i} + 20\hat{j})$

$|\text{dis}^m| = \underline{\underline{20\sqrt{2}}} = \underline{\underline{\text{dis}^m}}$

sol<sup>n</sup>

$(x_i, y_i) = (2\hat{i} + 4\hat{j})$

at  $t = 0$

$u = 5\hat{i} + 4\hat{j}$

$a = 4\hat{i} + 4\hat{j}$

x-only

②  $s = x_f - x_i = 5 \times 2 + \frac{1}{2} \times 4 \times (2)^2$

$x_f - x_i = 10 + 8 = 18$

$x_f = 18 + x_i = 18 + 2 = \underline{\underline{20m}}$

t = 2 sec

y-only  
 $s = y_f - y_i = u_y t + \frac{1}{2} a_y t^2$

$y_f - 4 = 4 \times 2 + \frac{1}{2} \times 4 \times (2)^2$

$y_f = 16 + 4 = 20$

13

H/W



## Question



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

$$\vec{r} = (t^2 - 38t) \hat{i} + 2t^3 \hat{j}$$

$$\vec{v} = (2t - 38) \hat{i} + 2(3t^2) \hat{j}$$

$$\vec{a} = 2 \hat{i} + 6(2t) \hat{j}$$

$$\vec{a} = 2\hat{i} + 12t\hat{j}$$

$$\vec{v} \cdot \vec{a} = 0$$

$$2(2t - 38) + 12t(6t^2) = 0$$

$$4t - 76 + 72t^3 = 0$$

$$72t^3 + 4t = 76$$

(19) H/W

$t = 1$  Put  $t = 1$  & verify the eq<sup>n</sup>



## Question



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

Sol<sup>n</sup>

$$\vec{u}_i = 3\hat{i} + 0\hat{j}$$

$$\# \vec{a} = 6\hat{i} + 4\hat{j} \checkmark$$

$$\# \vec{r} = x\hat{i} + 32\hat{j} \checkmark$$

\* motion in y-axis

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

$$32 = 0 + \frac{1}{2} \cdot 4 t^2$$

$$32 = 2t^2$$

$$t = \sqrt{16} = 4 \text{ sec}$$

H/W  
(15)

$$\begin{aligned} \Rightarrow \underline{s_x} &= u_x t + \frac{1}{2} a_x t^2 = 3 \times 4 + \frac{1}{2} \cdot 6 (4)^2 \\ &= 12 + 48 \\ &= 60 \text{ m} \end{aligned}$$



## 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.

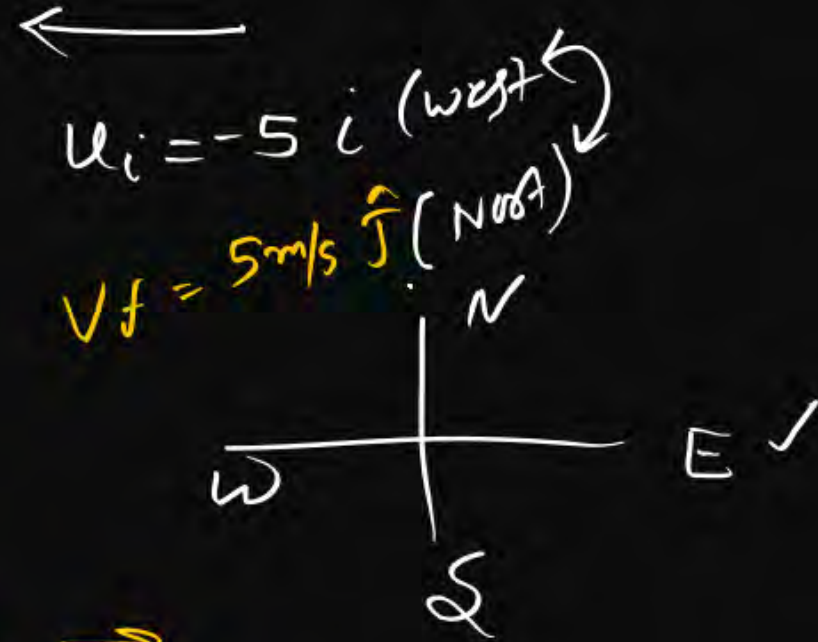
abhy  
done

(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.



$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

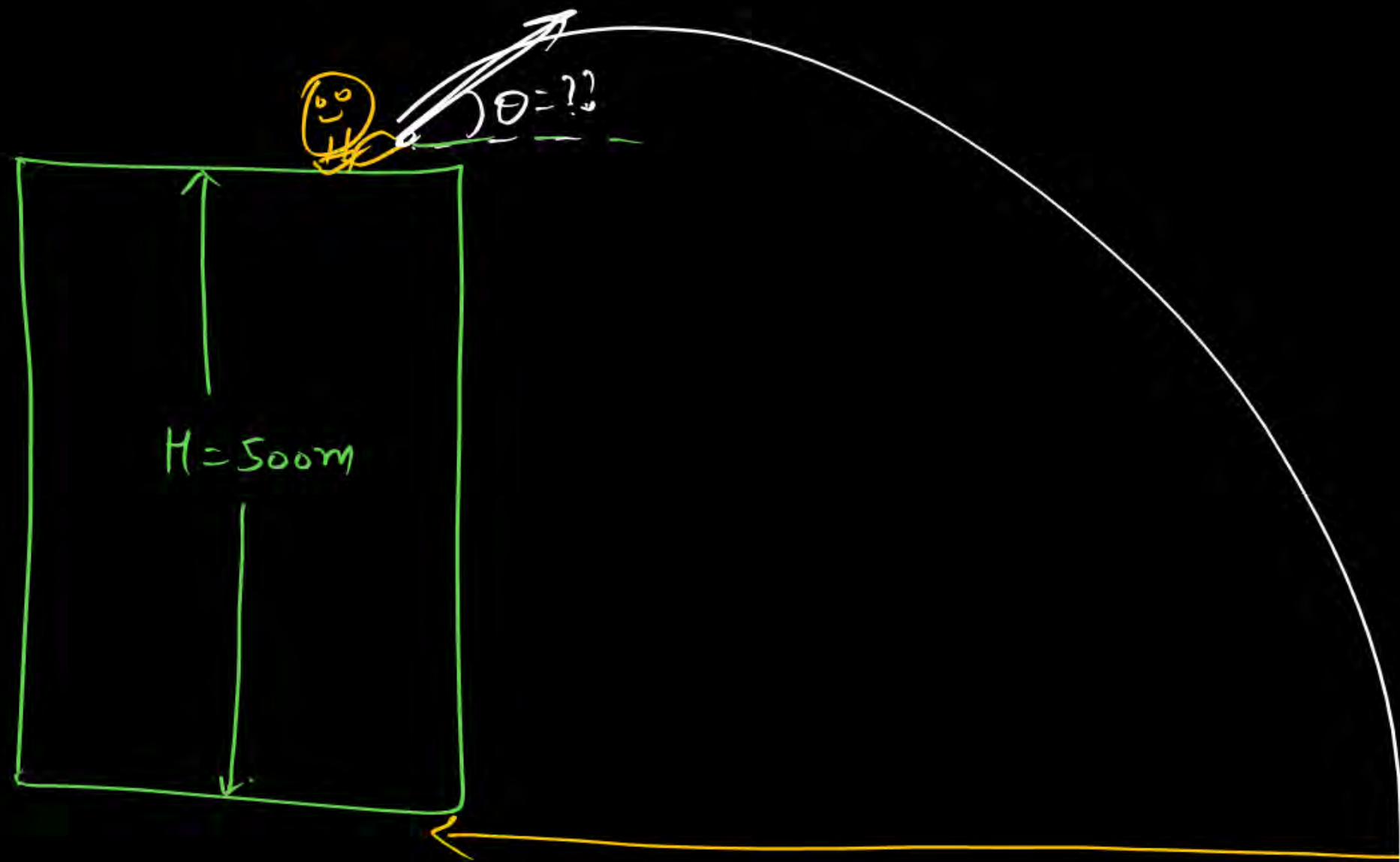
$$\vec{a} = \frac{5\hat{j} - (-5\hat{i})}{2} = \frac{5\hat{j} + 5\hat{i}}{2} \quad (\text{North-east})$$

HOME-work

(17) H/W

Same karne hai





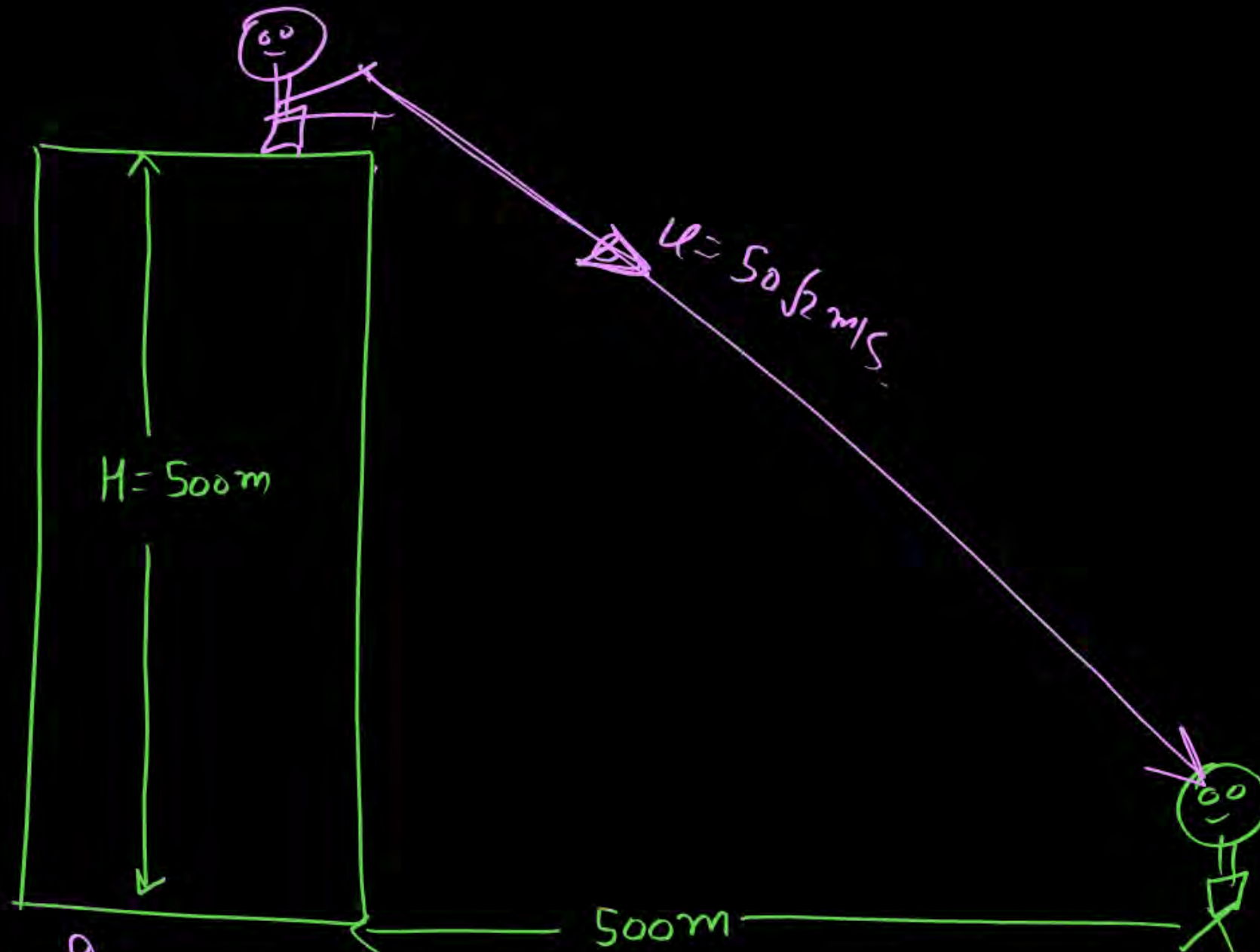
find  $\theta$  so that  
Range will be  
maximum.

~~(a)  $45^\circ$~~  MR SCAM

(b) Not  $45^\circ$

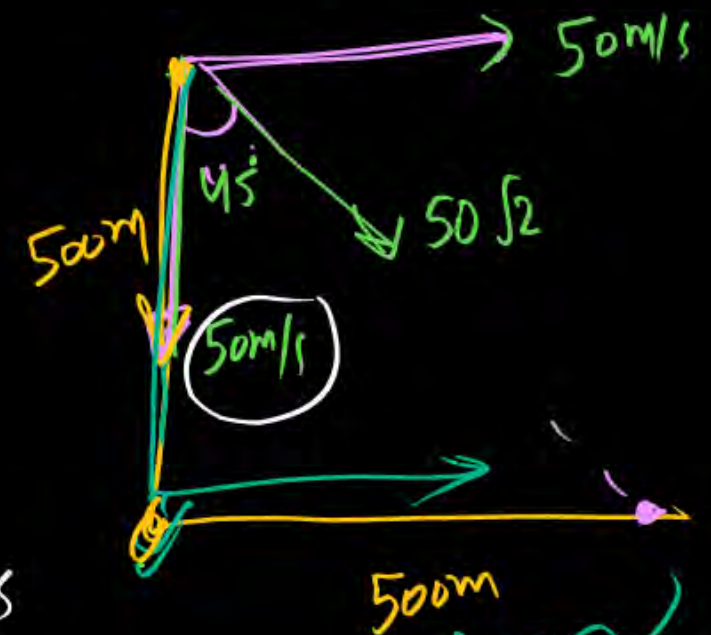
10 min  
think

~~at  $\theta = 45^\circ$  Range will  
be max for  
ground to ground  
projectile motion~~



Ball will hit Kallu or Pinky or none of them.

then find how must dist Ball will fall before Kallu.



कितना पड़ेगा

$$\text{Dist} = 500 - 310 = \underline{\underline{190\text{m}}}$$

$$t = \frac{V_f - u_i}{g} = \frac{112 - 50}{10} = \frac{62}{10} = 6.2\text{se}$$

$$R_y = 50 \times 6.2 = \underline{\underline{310\text{m}}} \text{ (approx)}$$

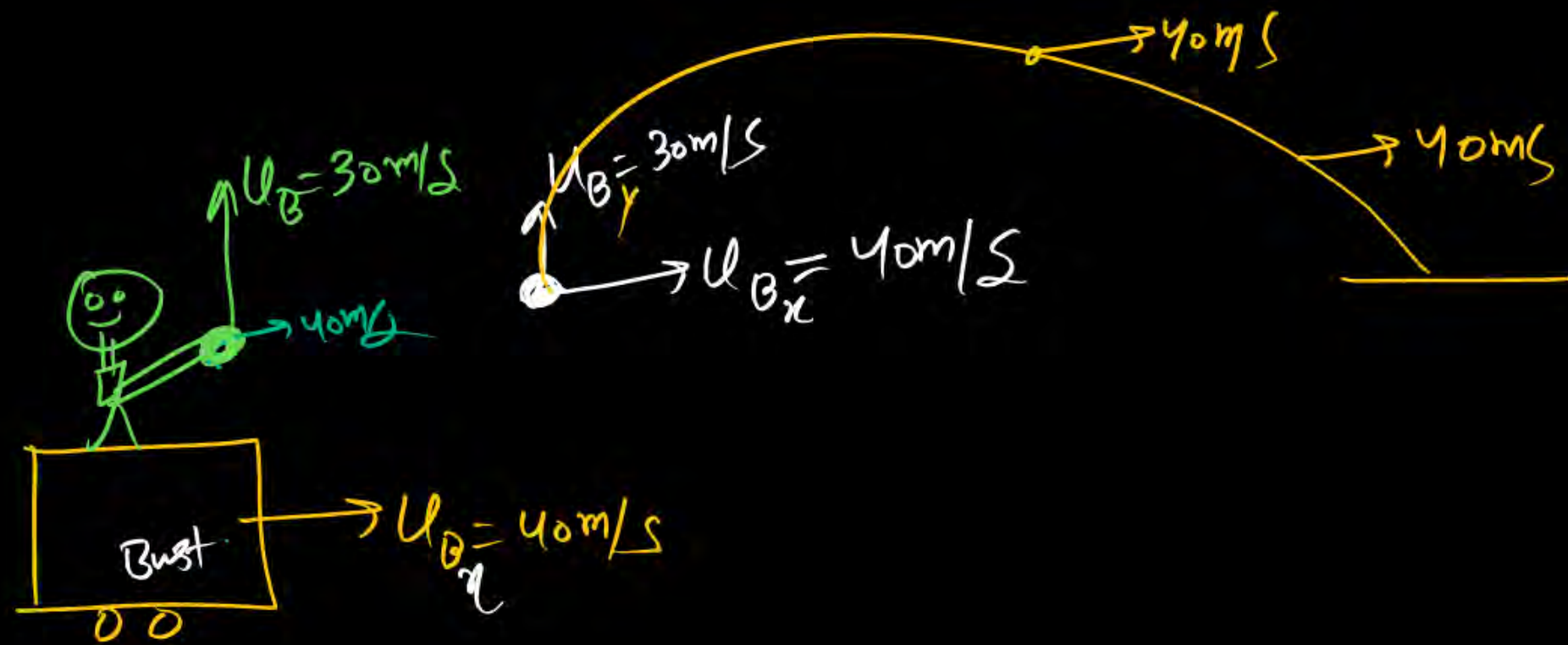
$$V^2 - u^2 = 2as$$

$$V^2 = u^2 + 2as$$

$$V = (50)^2 + 2 \times 10 \times 500 = 2500 + 10000 = 12500$$

$$V = \sqrt{12500} = 111.80\text{m/s} \approx 112\text{m/s}$$





$$T = \frac{2u_y}{g} = \frac{2 \times 30}{10} = 6 \text{ m}$$

$$R = \frac{2u_x u_y}{g} = \frac{2 \times 40 \times 30}{10}$$

Ball is projected by Ramlal with velocity  $= 30 \text{ m/s}$  then find Range  $H_m = \frac{u_y^2}{2g}$



Path of Ball w.r.t Ramlal = Straight line  
 Path of Ball w.r.t Kallu = Parabolic  
 Will Ramlal able to catch Ball again  $\rightarrow$  Yes.

Revision Karo aat

Pura Protective

Lec-1 to Lec-5

---

Theory. लिख  
लिख के





bbbb

**THANK**  
**YOU**

