YAKEEN NEET 2.0

2026

Motion in a Plane

PHYSICS | Lecture - 07

By - Saleem Ahmed Sir

Todays Goal

- motion on inclined plane
- Eqn of trajectory
- ques practice 2D motion

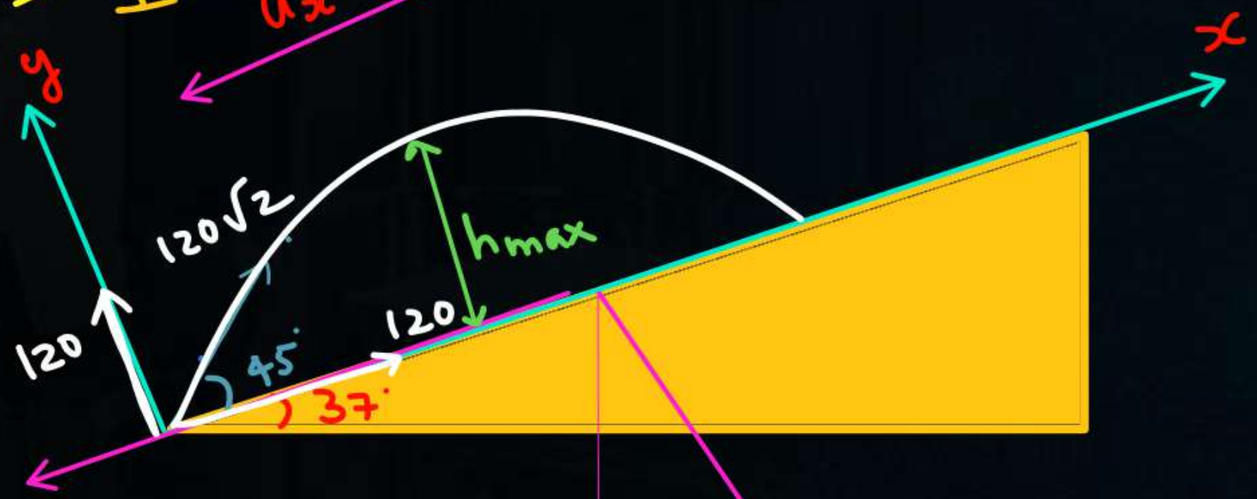
$$\frac{H_{max}}{R} = \frac{u^2 \sin^2\theta}{2g \cdot \frac{u^2 \sin 2\theta}{g}}$$

$$= \frac{\sin^2\theta}{2 \times 2\sin\theta\cos\theta} = \frac{\tan\theta}{4}$$

$$\boxed{\frac{H_{max}}{R} = \frac{\tan\theta}{4}}$$

Q

$a_x = g\sin 37^\circ = 6$



$T = 15 + 15 = 30$

$R_x = 120 \times 30 - \frac{1}{2} \times 6 \times (30)^2$

$h_{max} = \frac{(120)^2}{2 \times 8} = \checkmark$

$g\cos 37 = 8$

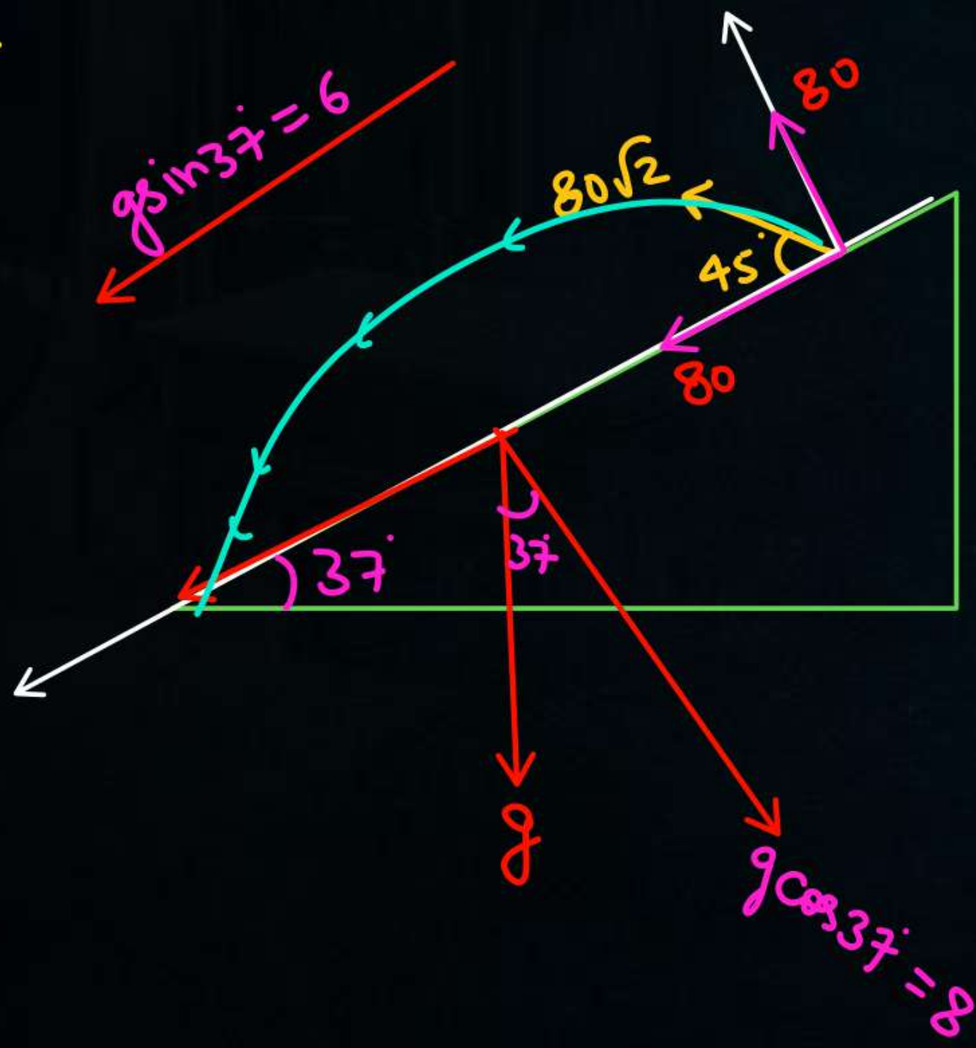
$T = \frac{2u_y}{a_y} = \frac{2 \times 120}{8}$

$= 30$

$H_{max} = \frac{u_y^2}{2a_y} = \frac{(120)^2}{2 \times 10} = \checkmark$

$R = \frac{2u_x u_y}{a_y} = \frac{2 \times 120 \times 120}{g}$

Q



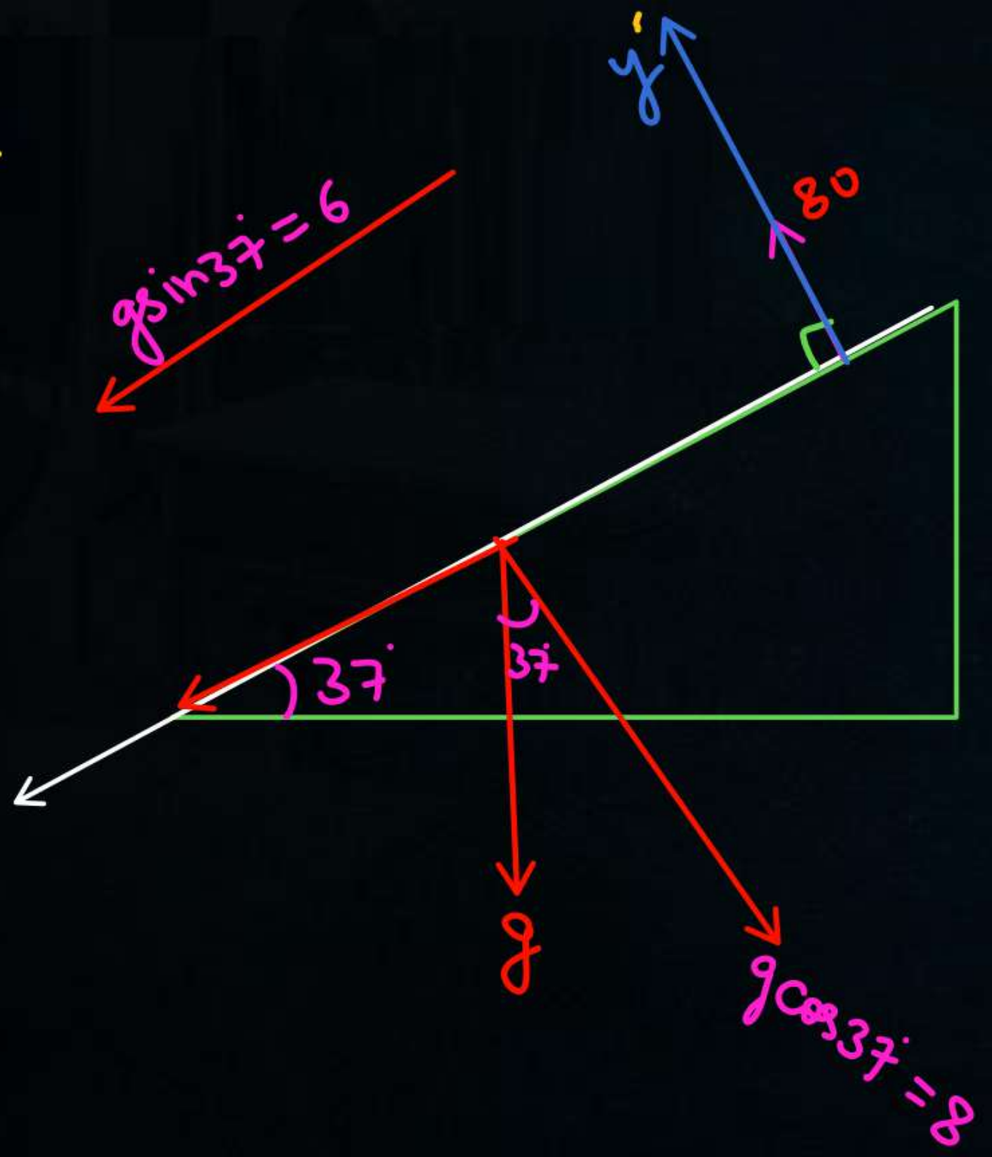
$$T = 20$$

$$T = \frac{2u_y}{a_y} = \frac{2\times80}{8} = 20$$

$$R = 80\times20 + \frac{1}{2}\times6\times(20)^2$$

$$h_{max} = \frac{80^2}{2\times8}$$

Q

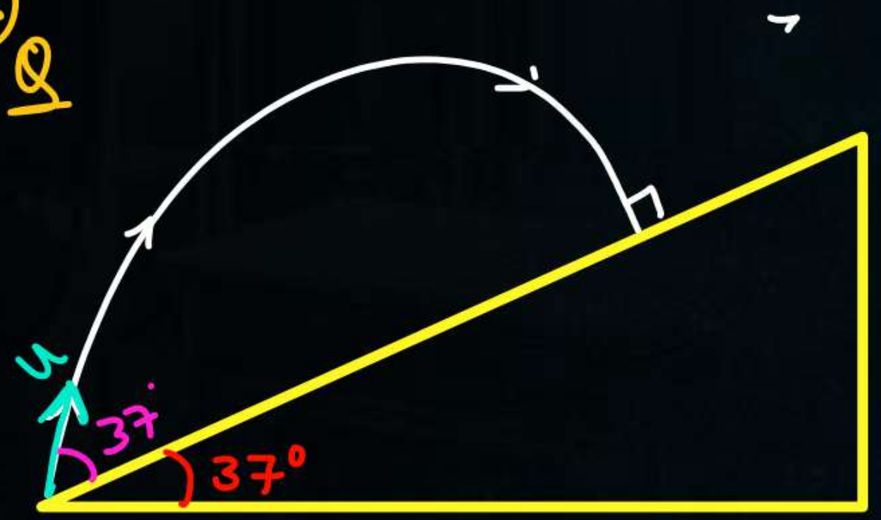


$$T = \frac{2u_y}{a_y} = \frac{2 \times 80}{8} = 20$$

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

$$R = 0 + \frac{1}{2} \times 6 \times (20)^2 = \underline{1200}$$

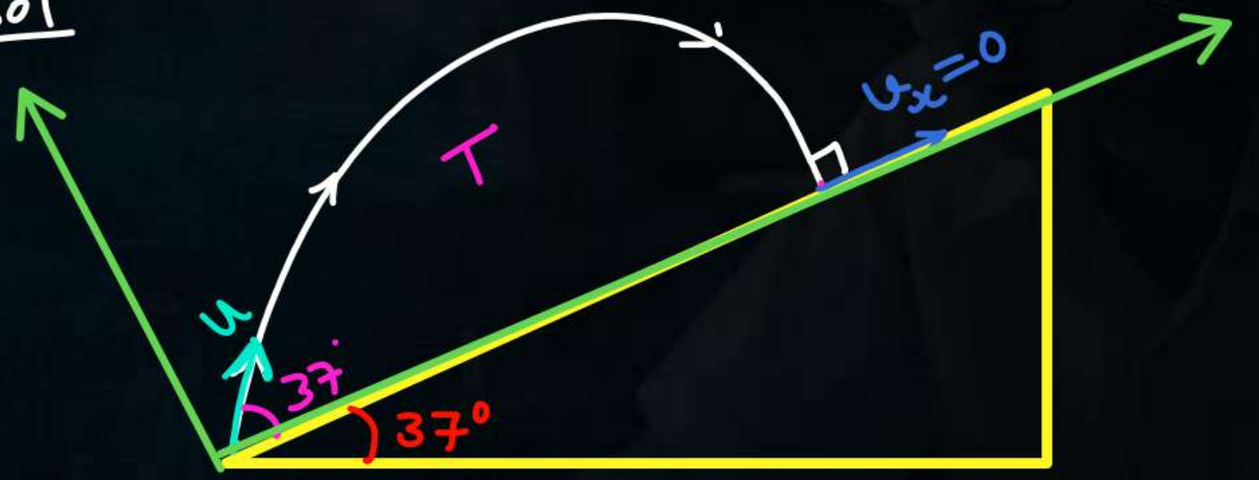
Q



particle strike inclined plane ⊥ly.

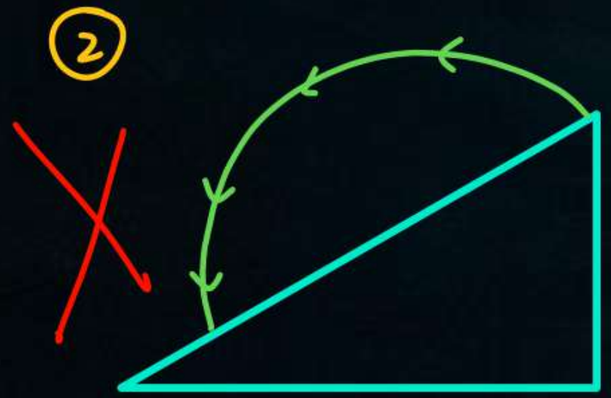
H.W

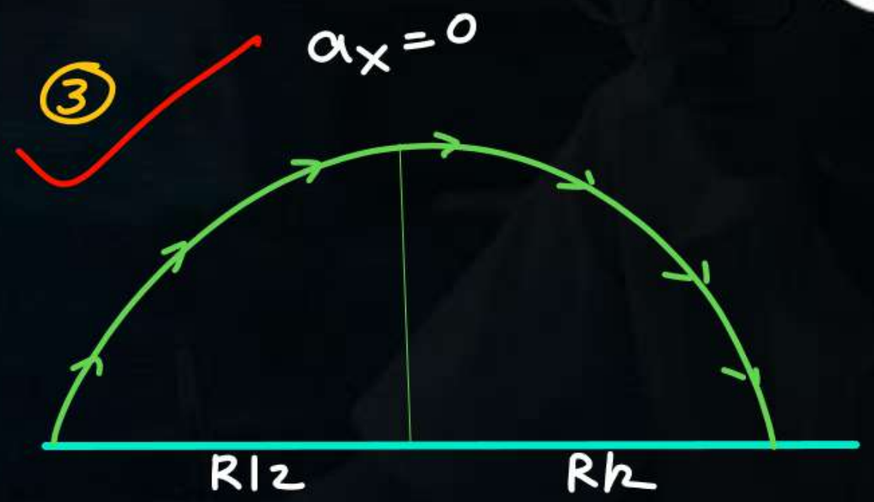
Sol^n



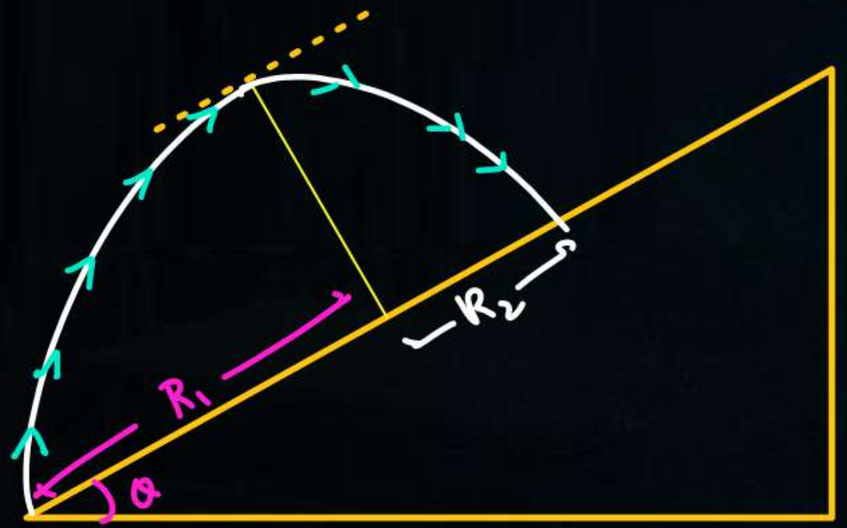
Q which of the optim is correct

① 

② 

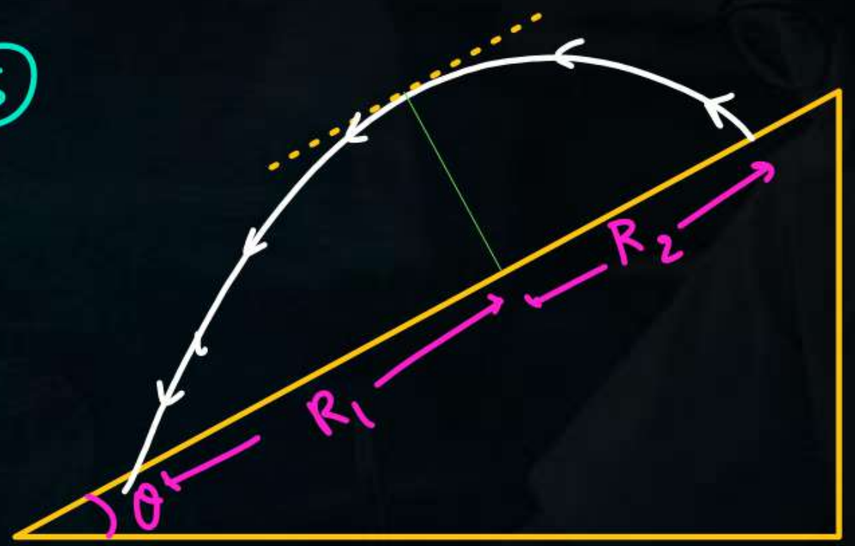
③ 

(4)



$R_1 > R_2$

(5)



$R_1 > R_2$

Equation of trajectory

$x = u\cos\theta . t \qquad t = \frac{x}{u\cos\theta}$

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

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

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

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

$R \rightarrow$ Range

If

Q Eqⁿ of trajectory is

$$y = x - \frac{x^2}{80}$$

Find

① θ angle of projection.

② u

③ Range

④ h_{max}

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

$$y = x - \frac{x^2}{80}$$

Compare, $\tan\theta = 1$

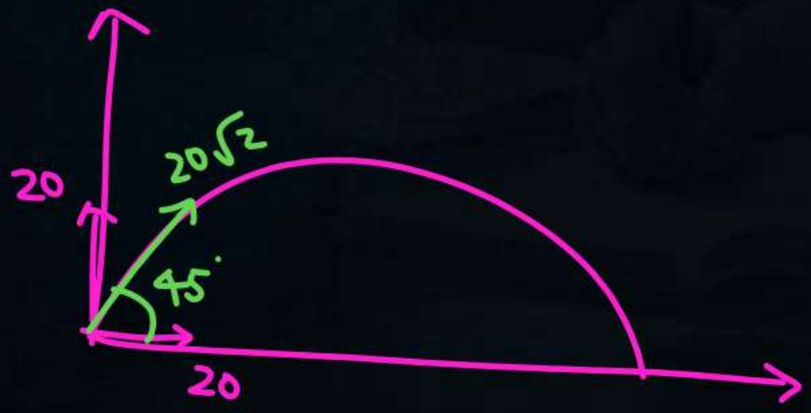
$\theta = 45^\circ$

$\frac{g}{2u^2\cos^2\theta} = \frac{1}{80}$

$\frac{10}{2u^2\cos^2 45} = \frac{1}{80}$

$u^2 = 800$

$u = 20\sqrt{2}$



$T = 4$, $R = 80$, $h_{max} = \frac{(20)^2}{2\times 10} = 20$

$$y = x - \frac{x^2}{80}$$

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

① $\theta = 45^\circ$

② Range $\quad y = x\left(1 - \frac{x}{80}\right)$

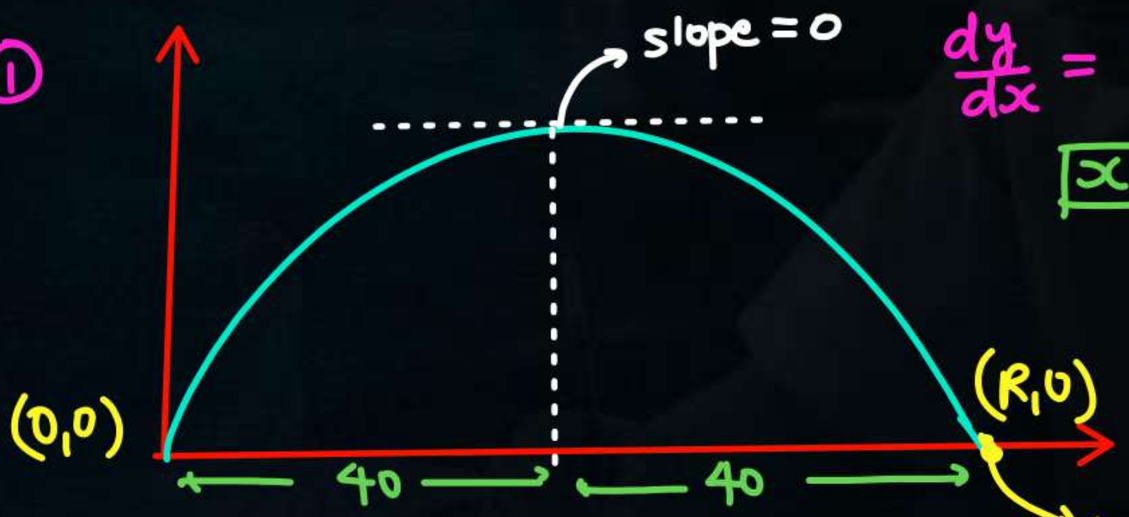
$$y = x\tan\theta\left(1 - \frac{x}{R}\right)$$

$\boxed{R = 80}$

magic of maths in Saleem Bhaia style

$$y = x - \frac{x^2}{80}$$

①



$$\frac{dy}{dx} = 1 - \frac{2x}{80} = 0$$

$\boxed{x = 40}$

$h_{max} = ?$ $\quad \frac{dy}{dx} = 0$, $\boxed{x = 40}$

$$h_{max} = y_{max} = 40 - \frac{(40)^2}{80} = 20$$

Range ⇒ put $y = 0$ & get $x = R$

$$0 = x - \frac{x^2}{80} \quad \boxed{x = 80}$$

$\therefore$

SKC Box.

① x का coff. $\tan\theta$ है देखकर ही θ बता दो

② h_{max} के लिए y_{max} karna hai... put $\frac{dy}{dx}=0$, & get x & put in eqⁿ

③ Range के लिए put $y=0$ & get $x=R$

*④ खुद का style baji करे

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

SKC Box.

① x ka coff. $\tan\theta$ se dekh kar hi θ Bata do

② h_{max} ke liye y_{max} karna hai... put $\frac{dy}{dx}=0$, & get x & put in eq^n

③ Range ke liye put $y=0$ & get $x=R$

*④ For any style baji

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

Q $y = x\sqrt{3} - \frac{x^2}{20\sqrt{3}}$

① $\theta = 60$

② Range. $y=0$, $x = R = 60$

③ y_{max}

④ $u = ?$ $\quad \frac{1}{2}\frac{g}{u^2\cos^2\theta} = \frac{1}{20\sqrt{3}}$

$u =$ ✓

③ $y_{max} \Rightarrow \quad \frac{dy}{dx} = 0$

$0 = \sqrt{3} - \frac{2x}{20\sqrt{3}} \Rightarrow x = 30$

$y_{max} = 30\sqrt{3} - \frac{900}{20\sqrt{3}}$

$y_{max} = 30\sqrt{3} - \frac{900\sqrt{3}}{20\times 3}$

$= 15\sqrt{3}$

Q $y = ax - bx^2$

$\tan\theta = a$

Range $\Rightarrow$ (put $y=0$) $\Rightarrow$ $x = \frac{a}{b} = R$

$y_{max} = h_{max} \Rightarrow \frac{dy}{dx} = a - 2bx = 0$

$x = \frac{a}{2b}$

$y_{max} = a \cdot \frac{a}{2b} - b\left(\frac{a}{2b}\right)^2$

Q A particle is moving on x-y plane s.t.

$x = 2t$

$y = 4t$

① 1D

② ~~2D~~

Soln Find eq^n of trajectory

$t = \frac{x}{2}$

$y = 4t = 4 \times \frac{x}{2}$

$\boxed{y = 2x} \equiv$ St. line $\equiv$ 1D

or

$\frac{x}{y} = \frac{2t}{4t} = \frac{1}{2}$

$y = 2x$

Eq^n

Straight line ⟶ 1D

parabola
Ellipse
Circle ⟶ 2D

Skc * eq^n of traject ke liye 't' ko eliminate karo

t ki value ek eq^n se dusre me patak do

which of the motion is 1D or 2D.

① $\vec{r} = 2t\hat{i} + 4t\hat{j}$

1D.

② $x = 2t$

$y = 4t^2$

$\vec{r} = 2t\hat{i} + 4t^2\hat{j}$

sol^n $t = \frac{x}{2}$

$y = 4t^2 = 4\left(\frac{x}{2}\right)^2$

$y = x^2$

2D

Q $\vec{r} = 2t^2\hat{i} + t^3\hat{j} - 4t\hat{k}$

① Find Posihm vector at $t = 1 \Rightarrow \vec{r} = 2\hat{i} + \hat{j} - 4\hat{k}$

② find $\vec{v} = \frac{d\vec{r}}{dt} = 4t\hat{i} + 3t^2\hat{j} - 4\hat{k}$

③ find $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2x}{dt^2} = 4\hat{i} + 6t\hat{j}$

$x = 2t^2$

$v_x = 4t$

$a_x = 4$

$y = t^3$

$v_y = 3t^2$

$a_y = 6t$

$z = -4t$

$v_z = -4$

$a_z = 0$

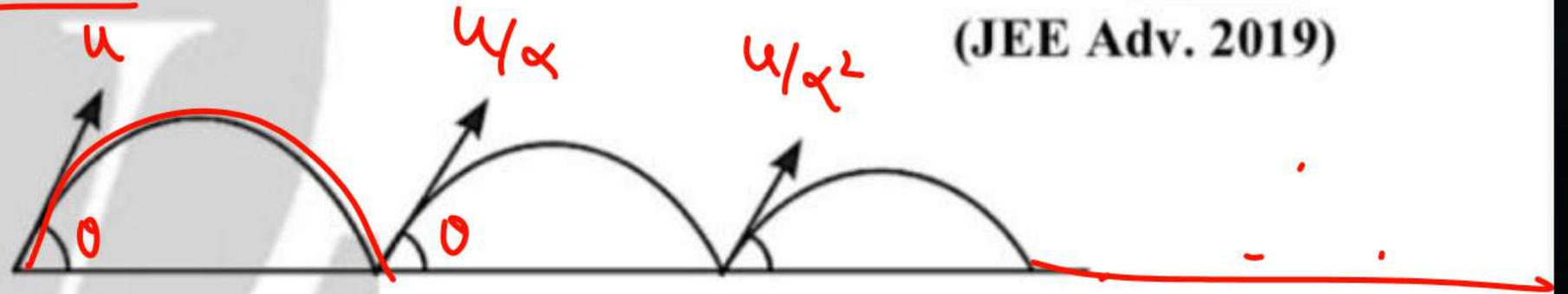
46. The equation of projectile is $y = 16x - \frac{5x^2}{4}$. The horizontal range is:

(*a*) 16 m (*b*) 8 m (*c*) 3.2 m (*d*) 12.8 m

4. A ball is thrown from ground at an angle θ with horizontal and with an initial speed u_0. For the resulting projectile motion, the magnitude of average velocity of the ball up to the point when it hits the ground for the first time is V_1

After hitting the ground, ball rebounds at the same angle θ but with a reduced speed of u_0/α. Its motion continues for a long time as shown in figure. If the magnitude of average velocity of the ball for entire duration of motion is $0.8\ V_1$, the value of α is _____

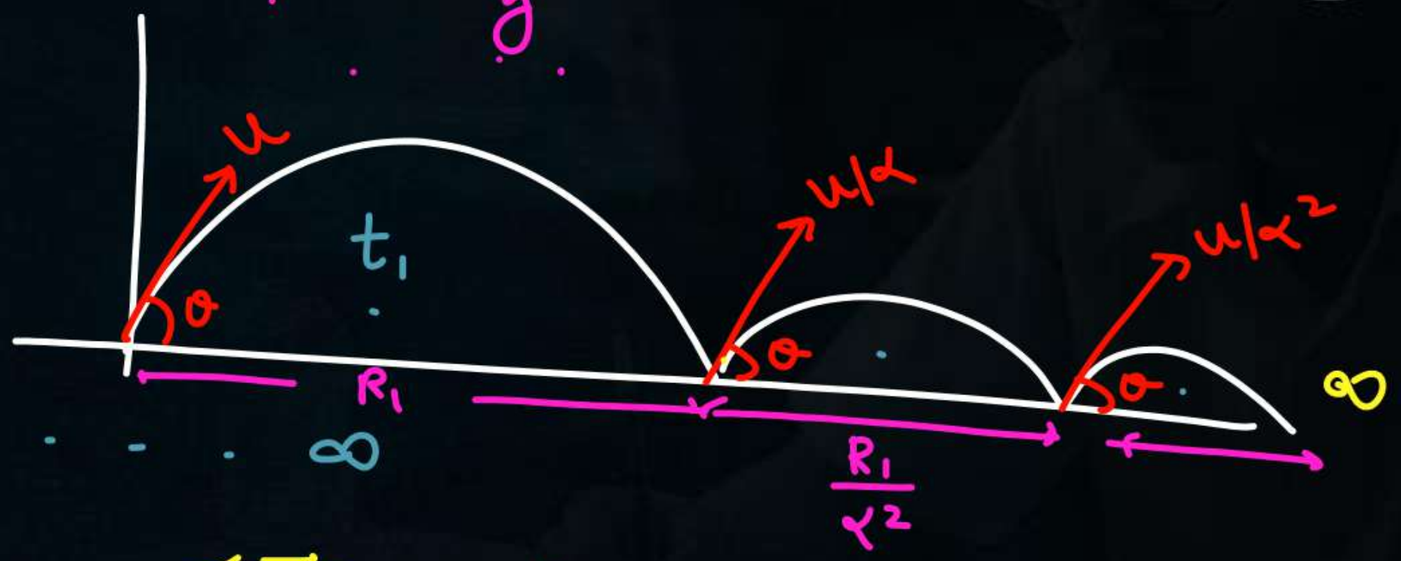
(JEE Adv. 2019)



Ans. (4.00)

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

$$\text{Avg velocity} = \frac{R_{net}}{T_{net}}$$



$$T_{net} = t_1 + \frac{t_1}{\alpha} + \frac{t_1}{\alpha^2} + \frac{t_1}{\alpha^3} + \cdots \infty$$

$$= \frac{t_1}{1 - \frac{1}{\alpha}} = \frac{\alpha t_1}{\alpha - 1}$$

$$R_{net} = R_1 + \frac{R_1}{\alpha^2} + \frac{R_1}{\alpha^4} + \cdots$$

$$= \frac{R_1}{1 - \frac{1}{\alpha^2}} = \frac{R_1 \alpha^2}{\alpha^2 - 1}$$

$$\langle \vec{v} \rangle = \frac{R_1 \alpha^2}{\alpha^2 - 1} \cdot \frac{\alpha - 1}{\alpha t_1}$$

$$\cdot 8 v_1 = \frac{R_1}{t_1} \frac{\alpha}{(\alpha + 1)}$$

$$\frac{8}{10} = \frac{\alpha}{\alpha + 1}$$

$$8\alpha + 8 = 10\alpha$$

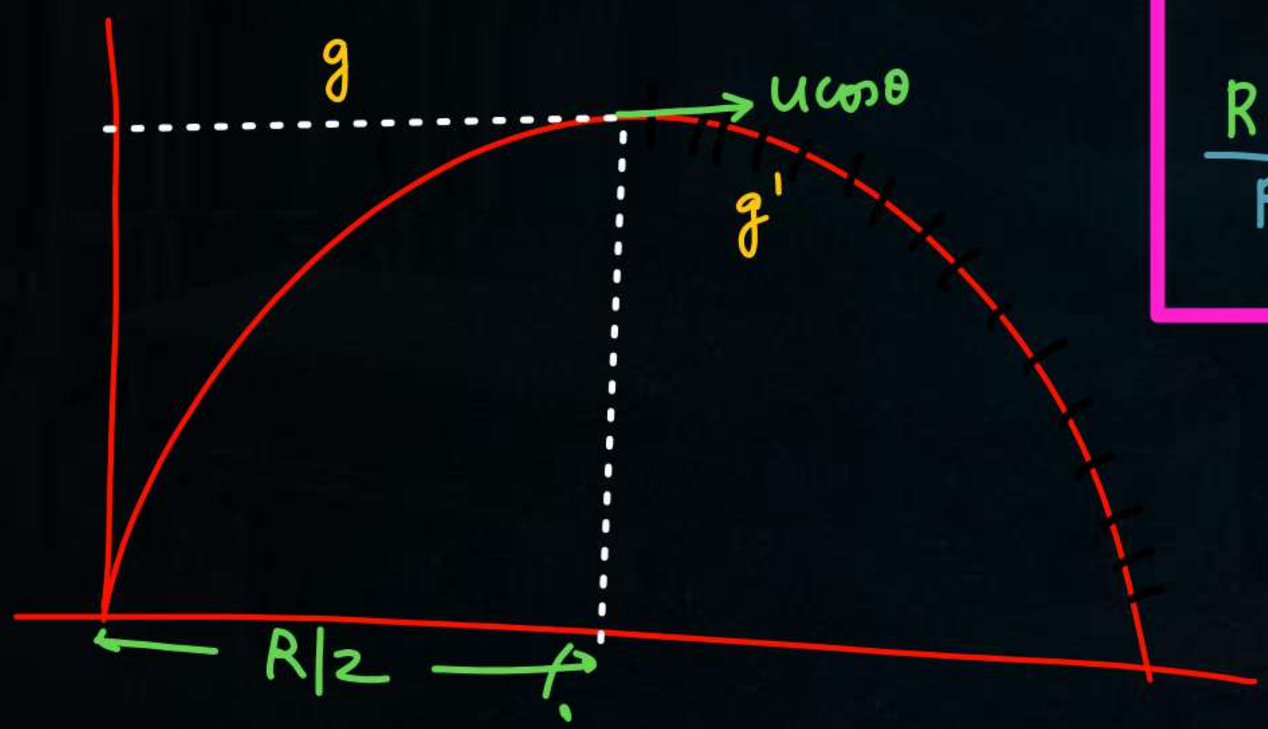
$$\alpha = 4$$

3. 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 _____.

$\frac{R_{new}}{R_{old}} = n = ?$

(JEE Adv. 2022)

Ans. (0.95)



$$\frac{R_{new}}{R} = \frac{\frac{R}{2}}{R} + \frac{(u\cos\theta)\sqrt{\frac{2h}{g'}}}{R}$$

$$= \frac{1}{2} + \frac{u\cos\theta}{R}\sqrt{\frac{2u^2\sin^2\theta}{2g\cdot\frac{g}{.81}}}$$

$$= \frac{1}{2} + \frac{u\cos\theta}{R} \times .9\,\frac{u\sin\theta}{g} \times \frac{2}{2}$$

$$= \frac{1}{2} + \frac{u^2\sin 2\theta}{g} \cdot \frac{R}{R} \times .9 \times .9$$

$$= \frac{1}{2} + \frac{.9}{2} = 1.9 \times .5 = .95$$

20. The equation of the path of the projectile is $y = 0.5x - 0.04x^2$. The initial speed of the projectile is

HW

(*a*) 10 m/s

(*b*) 15 m/s

(*c*) 12.5 m/s

(*d*) None of these

14. A Bomber flying upward at an angle of 53° with the vertical releases a bomb at an altitude of 800 m. The bomb strikes the ground 20 s after its release. Find: [Given $\sin 53° = 0.8$; $g = 10\ m/s^2$]

H/W

(i) The velocity of the bomber at the time of release of the bomb .

(ii) The maximum height attained by the bomb .

(iii) The horizontal distance travelled by the bomb before it strikes the ground

(iv) The velocity (magnitude & direction) of the bomb just when it strikes the ground .

एक बमवर्षक वायुयान ऊपर की ओर उर्ध्वाधर से 53° कोण पर उड़ रहा है। यह 800 m की ऊंचाई पर से एक बम छोड़ता है। बम को छोड़ने के 20 s बाद यह जमीन से टकराता है। ज्ञात कीजिये:- [दिया है $\sin 53° = 0.8$; $g = 10\ m/s^2$]

(i) बम को छोड़ते समय बमवर्षक वायुयान का वेग।

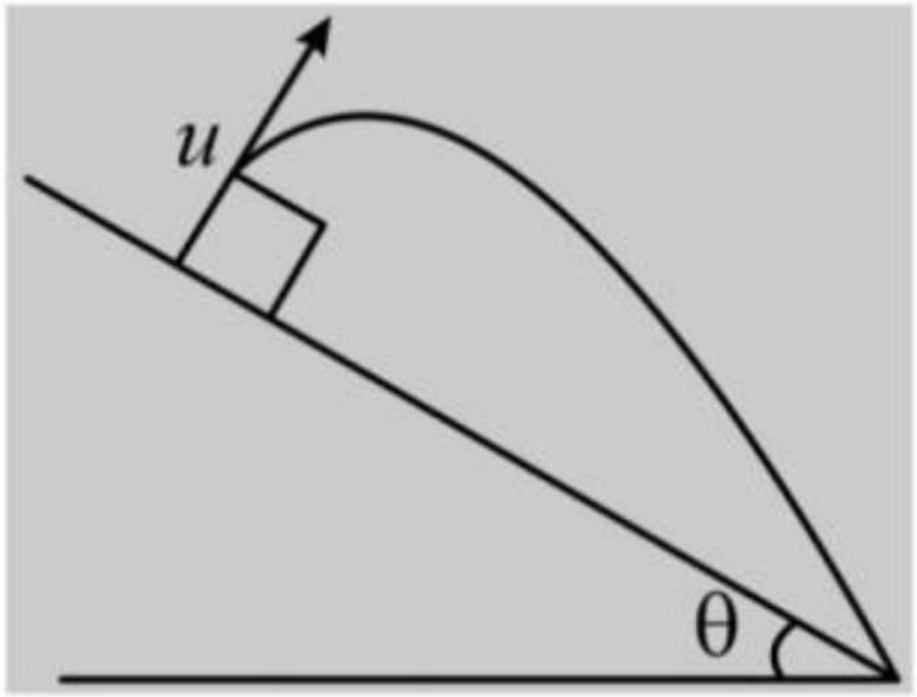
(ii) बम द्वारा प्राप्त की गई अधिकतम ऊंचाई।

(iii) जमीन पर टकराने से पहले बम द्वारा तय की गई क्षैतिज दूरी

(iv) बम का वेग(परिमाण तथा दिशा) जब यह जमीन से टकराता है।

Ans. (i) 100 m/s (ii) 980 m (iii) 1600 m (iv) $\left(80\hat{i} - 140\hat{j}\right)$

33. A particle is projected perpendicularly to an inclined plane as shown in the figure. If the initial velocity of the particle is u, calculate how far from the point of projection does it hit the plane again if the distance is measured along the plane?



(a) $\frac{2u^2}{g}$

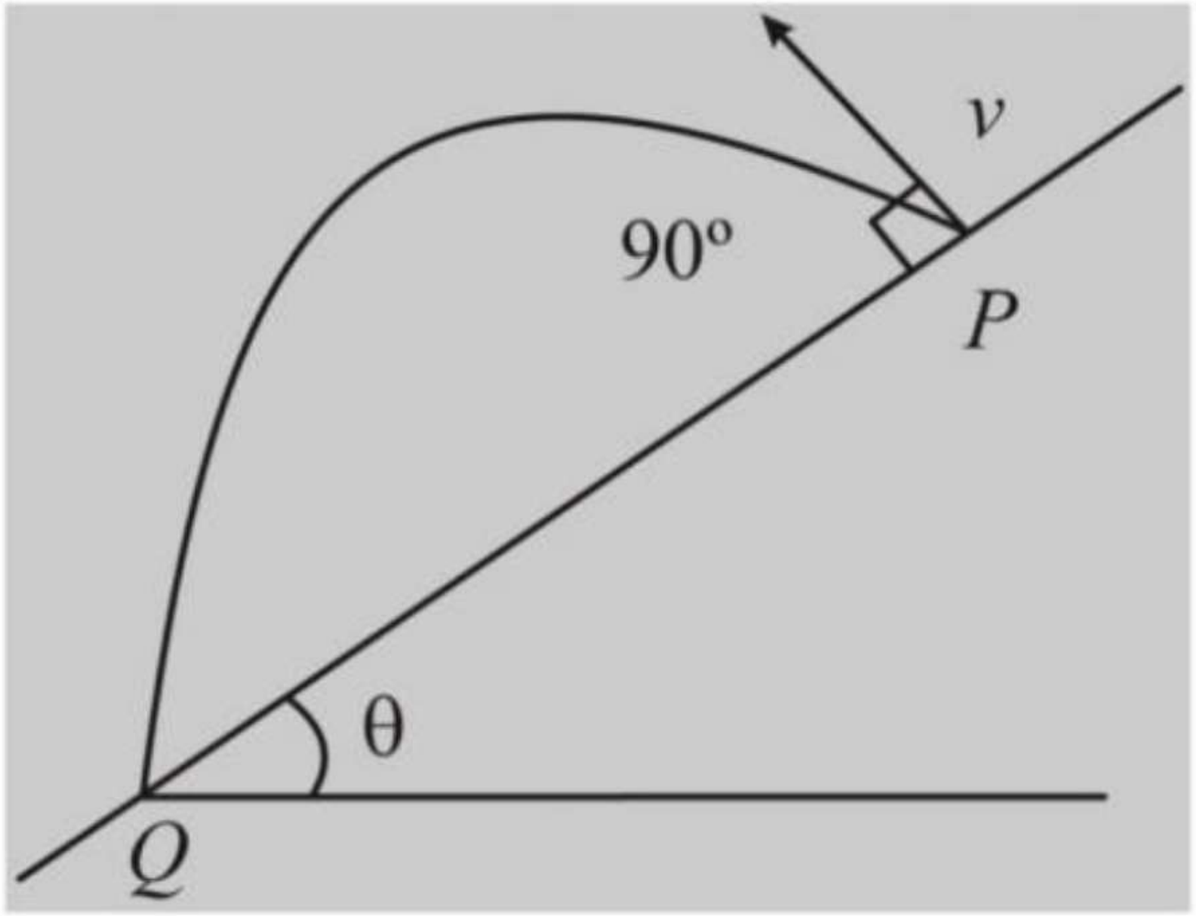
(b) zero

(c) $\frac{2u^2}{g}\sin\theta$

(d) $\frac{2u^2}{g}\tan\theta\sec\theta$

62. If time taken by the projectile to reach Q is T, then $PQ =$

H/W



(a) $Tv \sin \theta$

(b) $Tv \cos \theta$

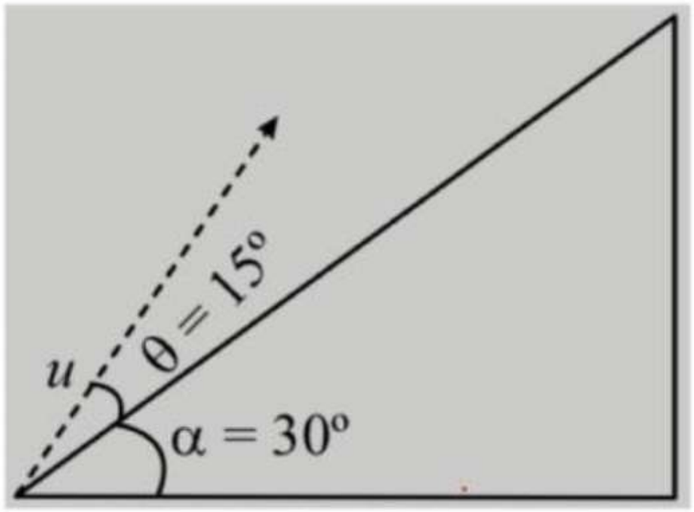
(c) $Tv \sec \theta$

(d) $Tv \tan \theta$

15. A plane is inclined at an angle $\alpha = 30°$ with a respect to the horizontal. A particle is projected with a speed $u = 2\ ms^{-1}$ from the base of the plane, making an angle $\theta = 15°$ with respect to the plane as shown in the figure.

The distance from the base, at which the particle hits the plane is close to: **[10 April, 2019 (Shift-II)]**

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



(a) 14 cm

(b) 20 cm

(c) 18 cm

(d) 26 cm

30. Trajectory of particle in a projectile motion is given as $y = x - x^2/80$. Here, x and y are in metres and considered along horizontal and vertical direction respectively ($g = 10\ \text{m/s}^2$). For this projectile motion.

H/W

(a) angle of projection is 45°

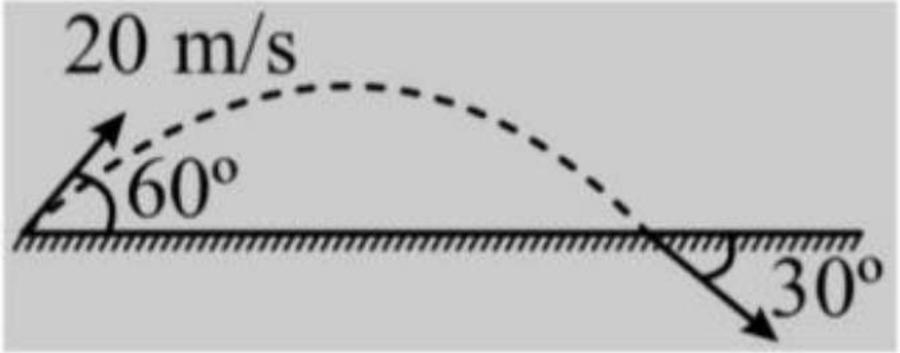
(b) angle of velocity with horizontal after 4s is $\tan^{-1}(1/2)$

(c) maximum height is 80 m

(d) horizontal range is 20 m

32. A particle is projected from a horizontal surface with a velocity of 20 m/s at an angle of 60° with the horizontal. When it hits the horizontal surface, its velocity makes an angle of 30° with the horizontal. Apart from gravity, a horizontal force acts on the particle during the motion. The speed of the particle when it hits the ground is

HW



(a) 20 m/s

(b) $20\sqrt{3}$ m/s

(c) 10 m/s

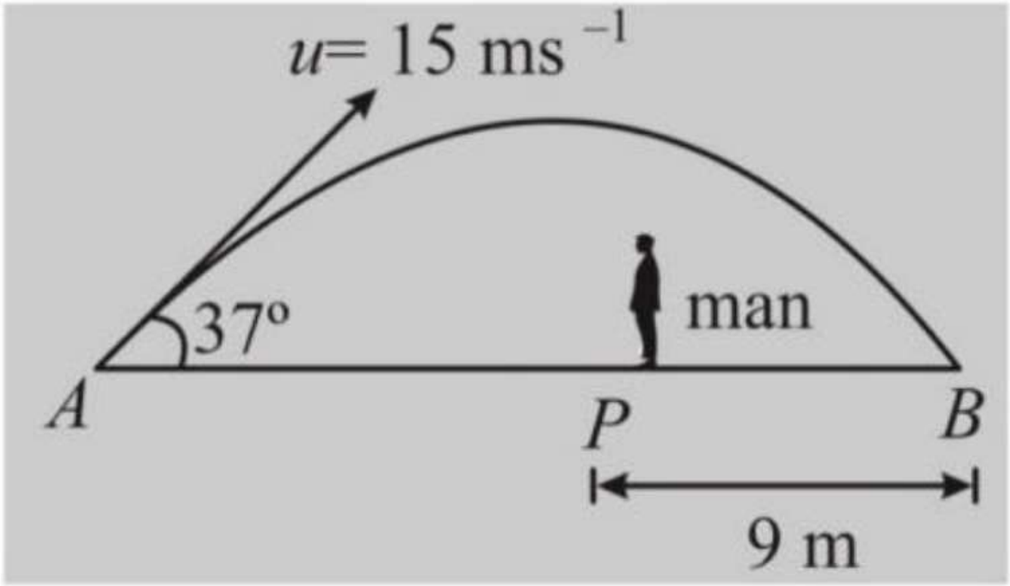
(d) $10\sqrt{3}$ m/s

46. The equation of projectile is $y = 16x - \frac{5x^2}{4}$. The horizontal range is:

#(3

(*a*) 16 m (*b*) 8 m (*c*) 3.2 m (*d*) 12.8 m

48. A ball is hit by a batsman at an angle of 37° as shown in figure. The man standing at P should run at what minimum velocity so that he catches the ball before it strikes the ground? Assume that height of man is negligible in comparison to maximum height of projectile.



(a) 3 ms^{-1}

(b) 5 ms^{-1}

(c) 9 ms^{-1}

(d) 12 ms^{-1}

10. If the initial velocity in horizontal direction of a projectile is unit vector $\hat{i}$ and the equation of trajectory is $y = 5x\,(1 - x)$. The y component vector of the initial velocity is _____ $\hat{j}$

(Take $g = 10\ m/s^2$) **2022]**

Home Work

- Solve all ques attached. in this ppt
- Solve KPP 17 if you havenot.
- KPP-18 (if i uploaded then solve)

THANK YOU