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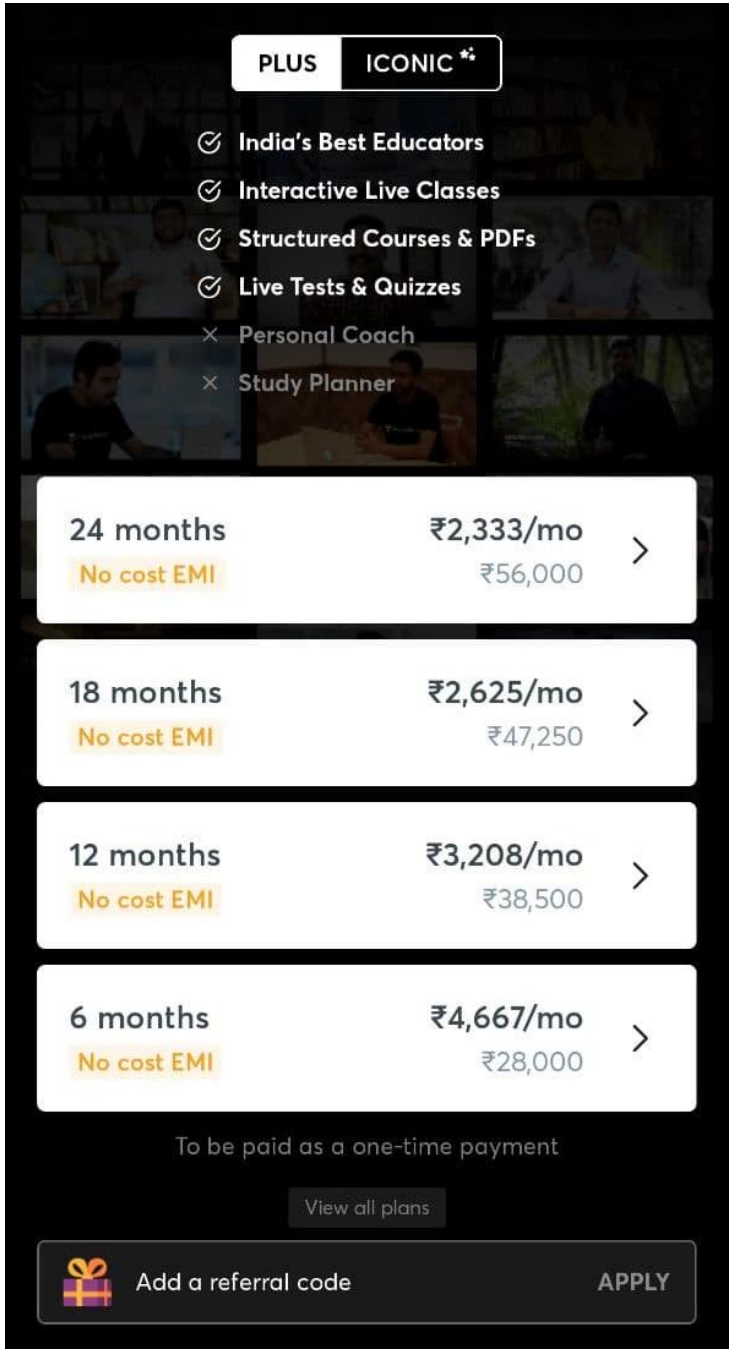

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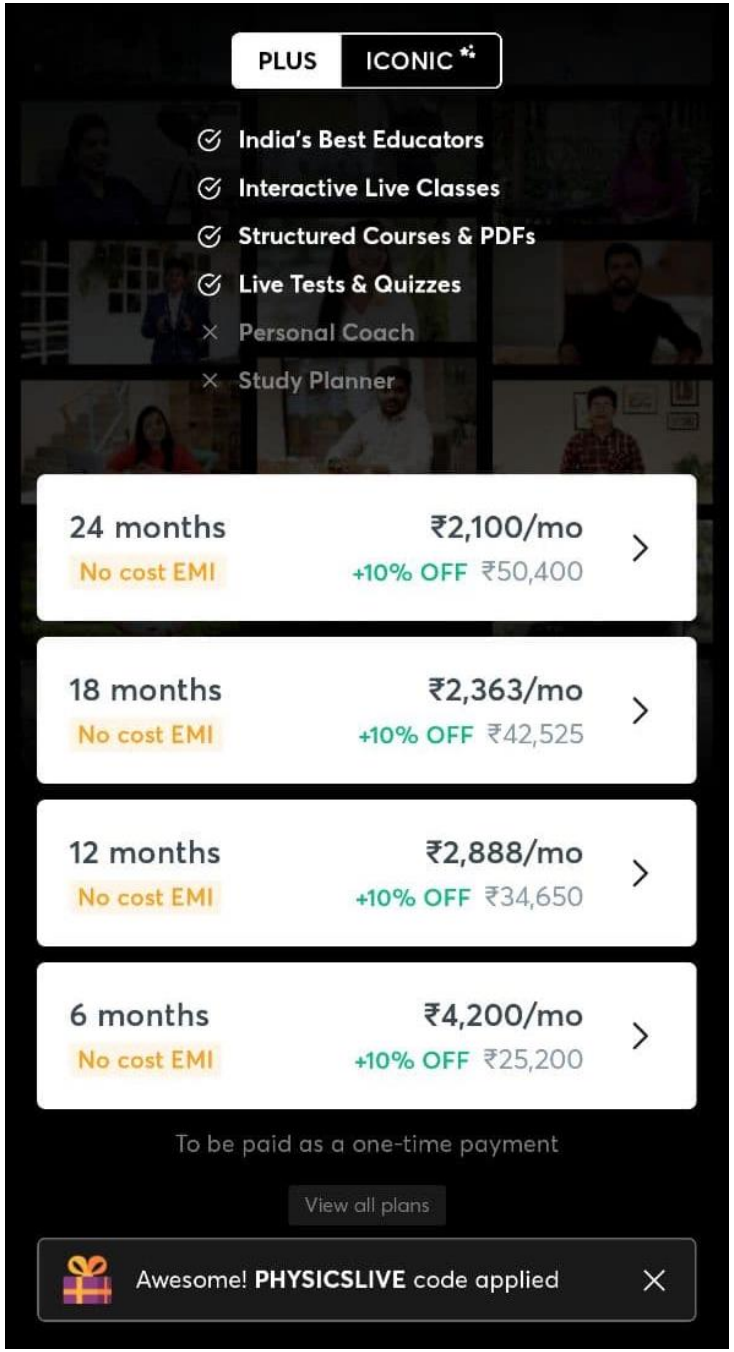

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Physics DPP

DPP-6 Projectile Motion on inclined plane

By Physicsaholics Team

Q) A projectile is projected upward with speed 2 m/s on an incline plane of inclination 30^0 at an angle of 15^0 from the plane. Then the distance along the plane where projectile will fall is:

(a) $\frac{4}{15}$

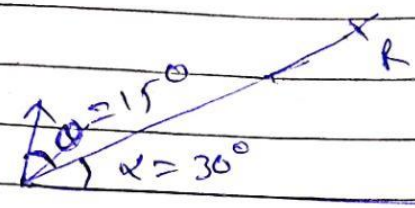
(b) $\frac{4}{5}\left(\frac{1}{\sqrt{3}}+\frac{1}{3}\right)$

(c) $\frac{4}{5}\left(\frac{1}{\sqrt{3}}-\frac{1}{3}\right)$

(d) $\frac{4}{\sqrt{3}}\left(\frac{1}{\sqrt{3}}-\frac{1}{3}\right)$

Ans. c

$$R = \frac{2u^2 \sin\theta \cos(\theta+\alpha)}{g\cos^2\alpha}$$



$$R = \frac{2(2)^2 \sin(15^\circ)\cos(15+30^\circ)}{g\cos^2(30^\circ)}$$

$$R = \frac{8}{g} \times \frac{\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right) \times \frac{1}{\sqrt{2}}}{3/4}$$

$$R = \frac{32}{3g} \times \frac{\sqrt{3}-1}{4}$$

$$= \frac{8}{3g}(\sqrt{3}-1) = \frac{8}{3\times 10}(\sqrt{3}-1)$$

$$= \frac{4}{15}(\sqrt{3}-1)$$

$$\boxed{R = \frac{4}{5}\left(\frac{1}{\sqrt{3}} - \frac{1}{3}\right)\ m}$$

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Q) A projectile is projected with speed u at an angle of 60^0 with horizontal from the foot of an inclined plane. If the projectile hits the inclined plane horizontally, the range on inclined plane will be:

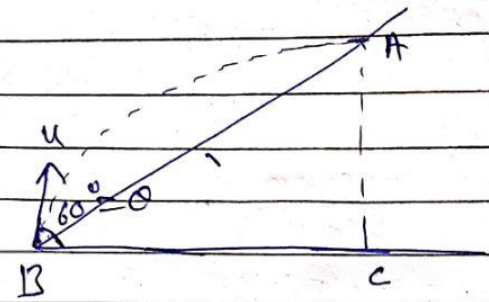
(a) $\frac{u^2(\sqrt{21})}{2g}$

(b) $\frac{3u^2}{4g}$

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

(d) $\frac{u^2(\sqrt{21})}{8g}$

Ans. d



$$AC = \frac{u^2 \sin 2\theta}{2g} = \frac{u^2 \sin^2(60°)}{2g}$$

$$AC = \frac{3u^2}{8g}$$

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

$$BC = \frac{u^2 \sin(2\times 60)}{2g} = \frac{\sqrt{3}u^2}{4g}$$

$$BC = \frac{\sqrt{3}u^2}{4g} \text{ or } \frac{2\sqrt{3}u^2}{8g}$$

Range on incline plane is: AB

$$AB = \sqrt{AC^2 + BC^2}$$

$$= \sqrt{9\left(\frac{u^2}{8g}\right)^2 + 12\left(\frac{u^2}{8g}\right)^2}$$

$$\boxed{AB = \frac{u^2\sqrt{21}}{8g}}$$

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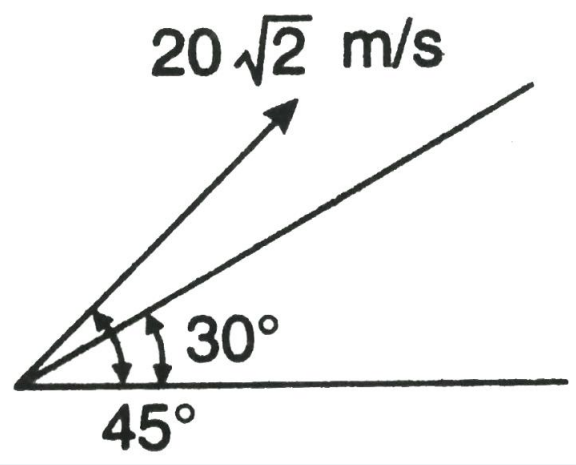
Q) Find time of flight of the projectile along the inclined plane as shown in figure: $(g = 10\ m/s^2)$



(a) 2 *sec*

(b) 1.69 *sec*

(c) 2.69 *sec*

(d) 1 *sec*

Ans. b

$\theta = 15^\circ$

$\alpha = 30^\circ$

$$T = \frac{2u \sin\theta}{g \cos\alpha} - \frac{2u \sin 15^\circ}{g \cos 30^\circ}$$

$$T = \frac{2(20\sqrt{2}) \times \left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)}{10 \times \left(\frac{\sqrt{3}}{2}\right)}$$

$$= \frac{4\sqrt{2}}{\sqrt{6}} (\sqrt{3}-1)$$

$$= \frac{4}{\sqrt{3}} (\sqrt{3}-1)$$

$$\boxed{T = 1.69 \text{ sec}}$$

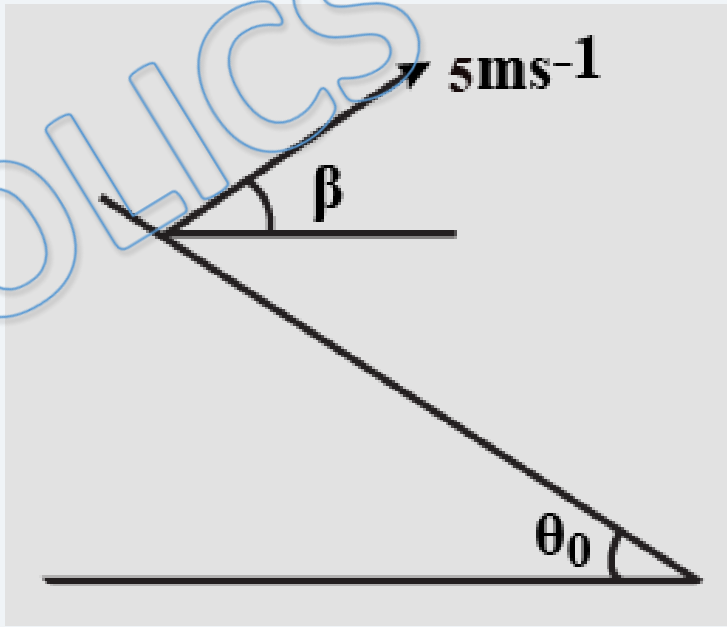
Q) An inclined plane makes an angle $\theta_o = 30^0$ with the horizontal. A particle is projected from this plane with a speed of 5 m/s at an angle of elevation $\beta = 30^0$ with the horizontal as shown in Fig. Find the range of the particle on the plane when it strikes the plane: $(g = 10\ m/s^2)$

(a) $5\ m$

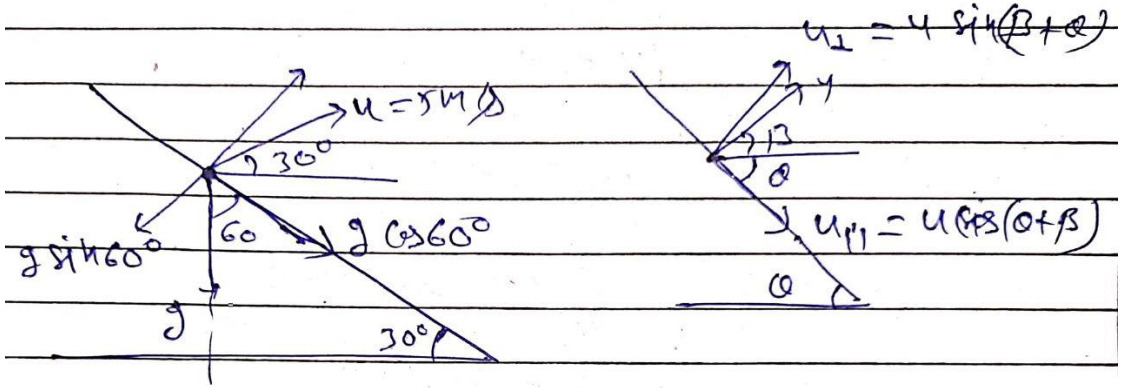
(b) $\frac{5}{3}\ m$

(c) $\frac{5}{2}\ m$

(d) $\frac{2}{5}\ m$



Ans. a



$u_1 = u \sin(\beta + \theta)$

$u_{11} = u \cos(\theta + \beta)$

$u_1 = 5 \sin(30+30)$

$= \frac{5\sqrt{3}}{2}$ m/s

$u_{11} = 5 \cos(30+30)$

$= \frac{5}{2}$ m/s

$T = \frac{2u_1}{g \sin 60^\circ} = \frac{2\left(\frac{5\sqrt{3}}{2}\right)}{\left(\frac{\sqrt{3}}{2}\right) \times 10}$

$T = 1$ sec

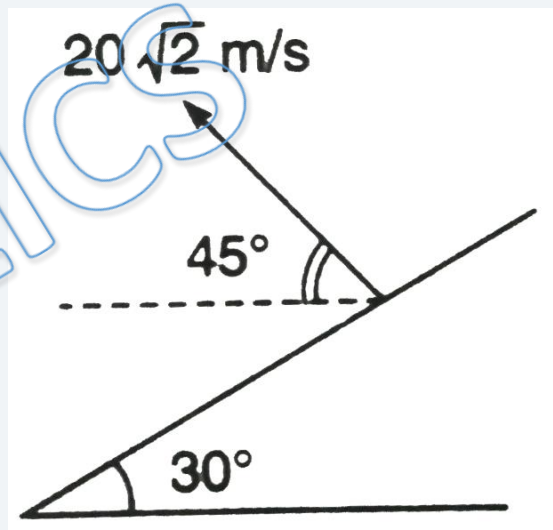
$R = u_{11} T + \frac{1}{2}(g \cos 60^\circ) \cdot T^2$

$= \frac{5}{2}(1)^2 + \frac{1}{2} \times 10 \times \frac{1}{2} \times (1)^2$

$= \frac{5}{2} + \frac{5}{2}$

$R = 5$ m

Q) Find time of flight of the projectile along the inclined plane as shown in figure: $(g = 10\ m/s^2)$



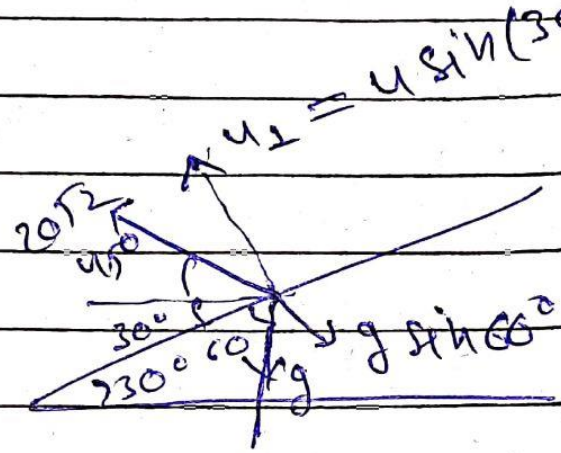
(a) 5 *sec*

(b) 6.31 *sec*

(c) 3.31 *sec*

(d) 2.21 *sec*

Ans. b



$$T = \frac{2u_1}{g\sin 60^\circ}$$

$$= \frac{2 \times 20\sqrt{2} \times \sin 75^\circ}{10 \times \left(\frac{\sqrt{3}}{2}\right)}$$

$$= \frac{8\sqrt{2}}{\sqrt{3}} \times \left(\frac{\sqrt{3}+1}{\sqrt{2}}\right) = \frac{4(\sqrt{3}+1)}{\sqrt{3}}$$

$$= 4\left(1 + \frac{1}{\sqrt{3}}\right)$$

$$\boxed{T = 6.31 \text{ sec}}$$

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Q) A particle is projected with a velocity of 30 m/s at an angle 60° above the horizontal on a slope of inclination 30°. Find its range and time of flight: ($g = 10\ m/s^2$)

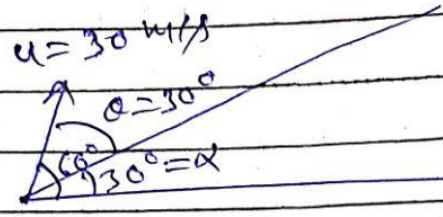
(a) $30\ m, \sqrt{3}\ s$

(b) $30\ m, 2\sqrt{3}\ s$

(c) $60\ m, 2\sqrt{3}\ s$

(d) $60\sqrt{3}\ m, 2\ s$

Ans. c



$\alpha = 30^\circ$

$\theta = 30^\circ$

$$T = \frac{2u\sin\theta}{g\cos\alpha} = \frac{2\times 30 \sin 30^\circ}{10 \times \cos 30^\circ}$$

$$= 6 \times \frac{1}{\sqrt{3}} = 2\sqrt{3}$$

$$\boxed{T = 2\sqrt{3} \text{ sec}}$$

$$R = \frac{2u^2 \sin\theta \cos(\alpha+\theta)}{g\cos^2\alpha}$$

$$= \frac{2 \times (30)^2 \times \sin 30^\circ \cos 60^\circ}{10 \times (\cos 30^\circ)^2}$$

$$= \frac{180 \times \frac{1}{2} \times \frac{1}{2}}{\frac{3}{4}}$$

$$\boxed{R = 60 \text{ m}}$$

Q) A particle is projected with a velocity of 30 m/s at an angle 60° above the horizontal on a slope of inclination 30°. Find its angle of hit: $(g = 10\ m/s^2)$

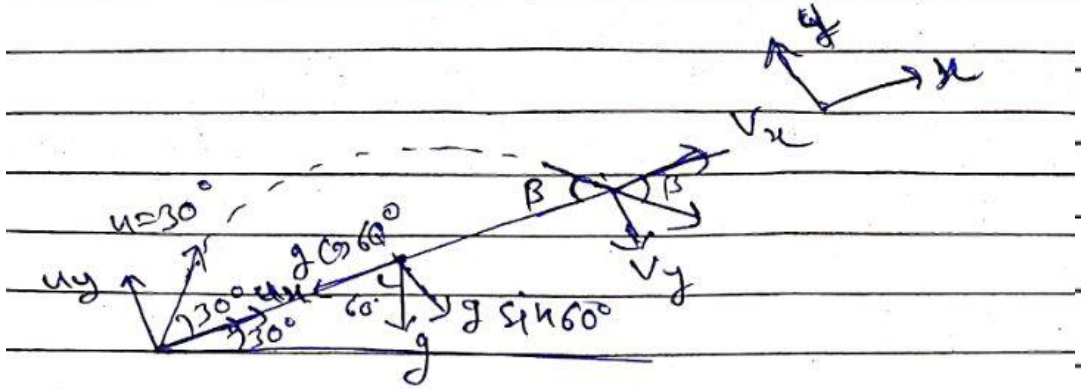
(a) 30^0

(b) 60^0

(c) 90^0

(d) 45^0

Ans. b



$u_y = u\sin 30^\circ$; $u_x = u\cos 30^\circ$

$T = 2\sqrt{3}$ sec

$V_y = u_y - g\sin 60\, T$

$V_y = \left(30\times\frac{1}{2}\right) - 10\times\frac{\sqrt{3}}{2}(2\sqrt{3})$

$V_y = 15 - 30$

$\boxed{V_y = -15\ m/s}$

$V_x = u_x \cos - \frac{g}{2}\cos 60\, T$

$= \left(30\times\frac{\sqrt{3}}{2}\right) - 10\times\frac{1}{2}\times(2\sqrt{3})$

$V_x = 15\sqrt{3} - 10\sqrt{3}$

$\boxed{V_x = 5\sqrt{3}\ m/s}$

$\tan\beta = \frac{V_y}{V_x} = \frac{15}{5\sqrt{3}} = \sqrt{3}$

$\boxed{\beta = 60^\circ}$

Q) A projectile is fired horizontally from an inclined plane (of inclination 45^0 with horizontal) with speed = 50 m/s. if $g = 10\ m/s^2$, the range measured along the incline is:

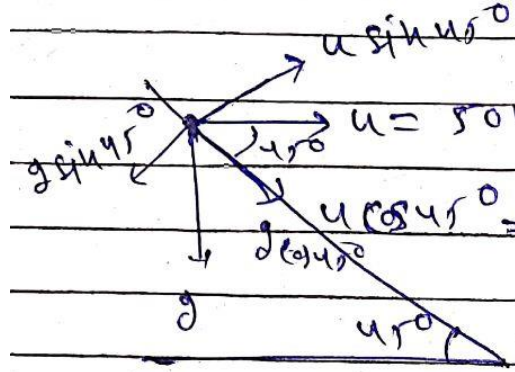
(a) $500\ m$

(b) $500\sqrt{2}\ m$

(c) $200\sqrt{2}\ m$

(d) none of these

Ans. b



$$R = u_{\parallel} T + \frac{1}{2} g \cos 45^\circ T^2$$

$$T = \frac{2u_{\perp}}{g \sin 45^\circ} = \frac{2 \times 50 \times \sin 45^\circ}{10 \times \sin 45^\circ}$$

$$\boxed{T = 10 \text{ sec}}$$

$$R = \left(50 \times \frac{1}{\sqrt{2}}\right) \times 10 + \frac{1}{2}\left(10 \times \frac{1}{\sqrt{2}}\right) \times (10)^2$$

$$= \frac{500}{\sqrt{2}} + \frac{500}{\sqrt{2}}$$

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

$$\boxed{R = 500\sqrt{2} \text{ m}}$$

Q) An inclined plane is making an angle β with horizontal. A projectile is projected from the bottom of the plane with a speed u at an angle α with horizontal then its maximum range R_{max} is:

(a) $R_{max} = \frac{u^2}{g(1-\sin\beta)}$

(b) $R_{max} = \frac{u^2}{g(1+\sin\beta)}$

(c) $R_{max} = \frac{u}{g(1-\sin\beta)}$

(d) $R_{max} = \frac{u}{g(1+\sin\beta)}$

Ans. b

$$R_{max} = \frac{u^2}{g(1+\sin\alpha)}$$

here; $\alpha = \beta$

$$\therefore \boxed{R_{max} = \frac{u^2}{g(1+\sin\beta)}}$$

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Q) A particle is projected from the bottom of an inclined plane of inclination 30^0. At what angle α (from the horizontal) should the particle be projected to get the maximum range on the inclined plane.

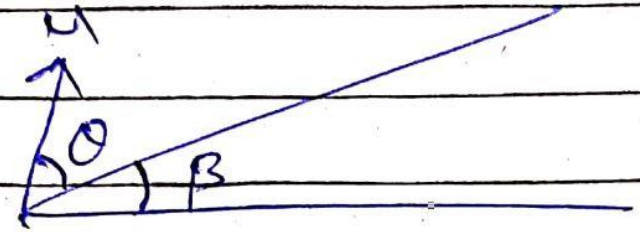
(a) 15^0

(b) 30^0

(c) 45^0

(d) 60^0

Ans. d



for maximum Range

$$\theta = \frac{\pi}{4} - \frac{\beta}{2}$$

$$\beta = 30^\circ$$

$$\theta = \frac{\pi}{4} - \frac{30^\circ}{2} = 45^\circ - 15^\circ$$

$$\theta = 30^\circ$$

Hence $\alpha = \theta + \beta$

$$\alpha = 30 + 30$$

$$\boxed{\alpha = 60^\circ}$$

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