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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° at an angle of 15° from the plane. Then the distance along the plane where projectile will fall is:

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

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

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

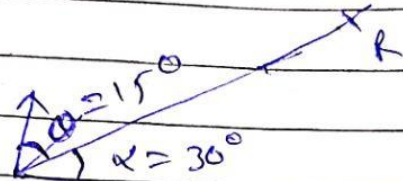
(d) $\frac{4}{\sqrt{3}} \left(\frac{1}{\sqrt{3}} - \frac{1}{3} \right)$

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Ans. c

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



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

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

$\frac{3}{4}$

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

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

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

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

Q) A projectile is projected with speed u at an angle of 60° 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) $\frac{3u^2}{4g}$

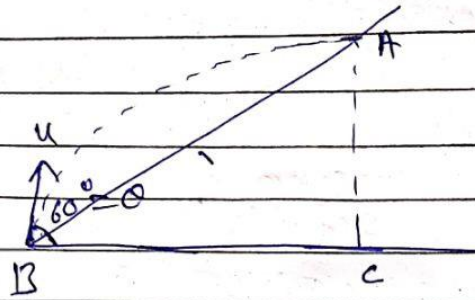
(c) $\frac{u^2}{2g}$

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

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Ans. d



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

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

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

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

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

Range on inclined plane is: AB

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

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

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

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

(a) 2 sec

(c) 2.69 sec

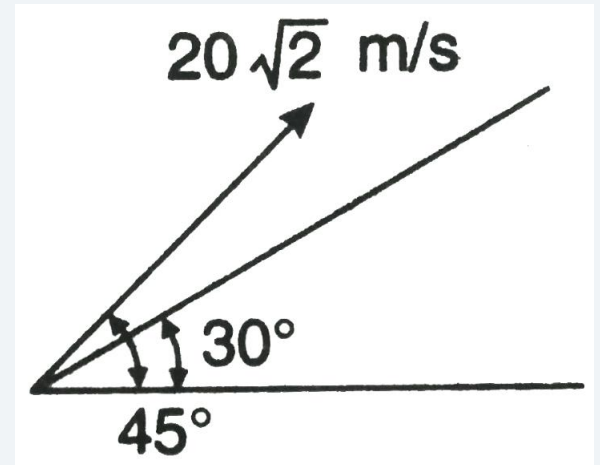
(a) 2 sec
(c) 2.69 sec

(b) 1.69 sec

(d) 1 sec

(d) 1 sec

(b) 1.69 sec



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Ans. b

$$\theta = 15^\circ$$

$$\alpha = 30^\circ$$

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

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

$$10 \times \left(\frac{\sqrt{3}}{2}\right)$$

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

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

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

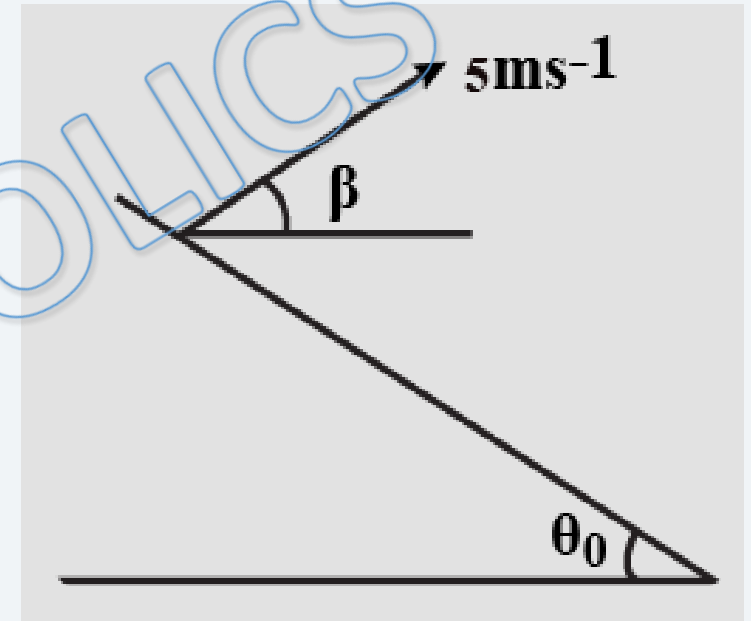
Q) An inclined plane makes an angle $\theta_0 = 30^\circ$ with the horizontal. A particle is projected from this plane with a speed of 5 m/s at an angle of elevation $\beta = 30^\circ$ with the horizontal as shown in Fig. Find the range of the particle on the plane when it strikes the plane: ($g = 10 \text{ m/s}^2$)

(a) 5 m

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

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

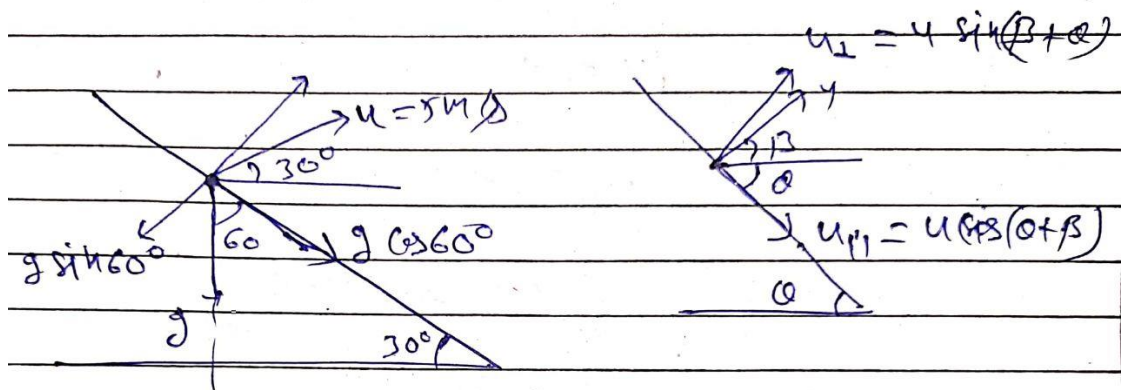
(d) $\frac{2}{5} \text{ m}$



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Ans. a



$$u_{\perp} = 5 \sin(30 + 30)$$

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

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

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

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

$$\boxed{T = 1 \text{ sec}}$$

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

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

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

$$\boxed{R = 5 \text{ m}}$$

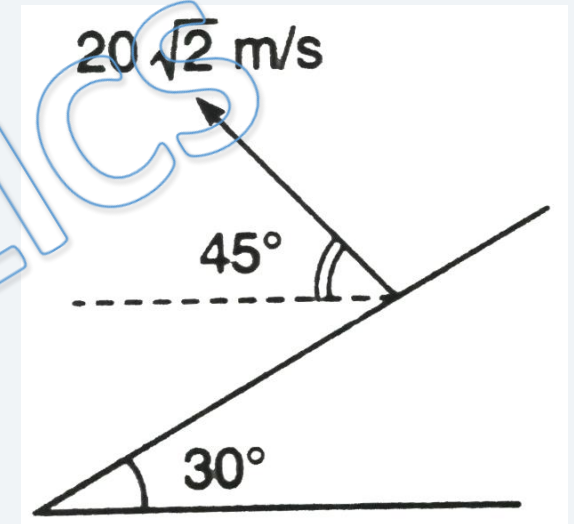
Q) Find time of flight of the projectile along the inclined plane as shown in figure:
($g = 10 \text{ m/s}^2$)

(a) 5 sec

(b) 6.31 sec

(c) 3.31 sec

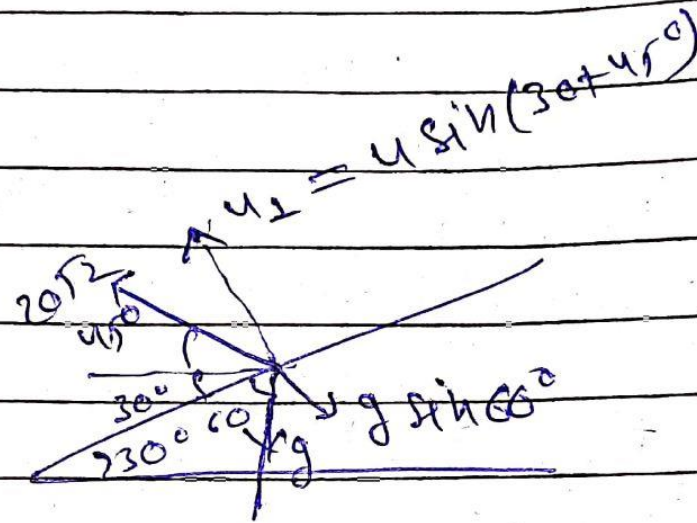
(d) 2.21 sec



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Ans. b



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

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

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

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

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

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

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

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

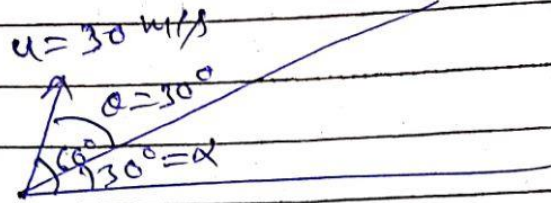
(c) $60 \text{ m}, 2\sqrt{3} \text{ s}$

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

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Ans. c



$$\alpha = 30^\circ$$

$$\theta = 30^\circ$$

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

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

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

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

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

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

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

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

(a) 30°

(b) 60°

(c) 90°

(d) 45°

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Ans. b

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

(a) 500 m

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

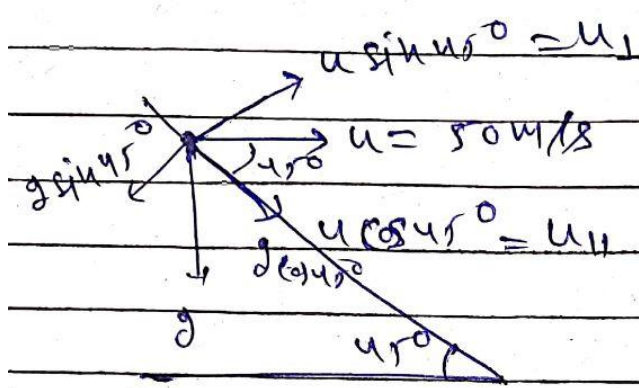
(c) $200\sqrt{2} \text{ m}$

(d) none of these

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Ans. b



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

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

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

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

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

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

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

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:

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

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

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

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

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Ans. b

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

here; $\alpha = \beta$

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

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

(a) 15°

(b) 30°

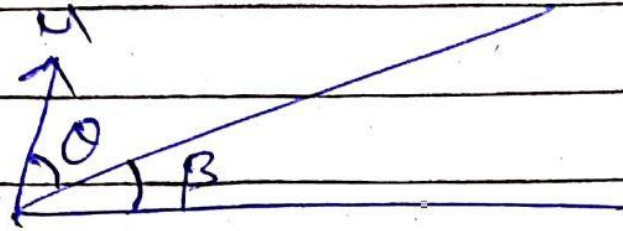
(c) 45°

(d) 60°

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Ans. d



for maximum Range

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

$$\beta = 30^\circ$$

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

$$\theta = 30^\circ$$

hence $\alpha = \theta + \beta$

$$\alpha = 30 + 30$$

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

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