Oblique Projection

1. **A body is projected from a point with different angles of projections 20^0, 35^0, 45^0, 60^0 with the horizontal but with same initial speed. Their respective horizontal ranges are R_1, R_2, R_3 and R_4. Identify the correct order in which the horizontal ranges are arranged in increasing order**

   1) R_1, R_4, R_2, R_3 2) R_2, R_1, R_4, R_3 3) R_1, R_2, R_4, R_3 4) R_4, R_1, R_2, R_3

2. **Two particles are projected from the same point with the same speed at different angles θ_1 and θ_2 to the horizontal. If their respective times of flights are T_1 and T_2 and horizontal ranges are same then**

   a) $\theta_1 + \theta_2 = 90^0$ **b) $T_1 = T_2 \tan \theta_1$**

   c) $T_1 = T_2 \tan \theta_2$ **d) $T_1 \sin = \theta_2 T_2 \sin \theta_1$**

   1) a, b, d are correct 2) a, c, d are correct

   3) b, c, d are correct 4) a, b, c are correct

3. **Two bodies are projected at angles 30^0 and 60^0 to the horizontal from the ground such that the maximum heights reached by them are equal. Then**

   a) Their times of flight are equal

   b) Their horizontal ranges are equal

   c) The ratio of their initial speeds of projection is $\sqrt{3}:1$

   d) Both take same time to reach the maximum height.

Mark the answer as

1) If a, b, c and d are correct
2) If only a, b and c are correct
3) If only a and c are correct
4) If a, c and d are correct

4. **A): A metal ball and a wooden ball of same radius are dropped from the same height in vacuum reach the ground same time.**

   R): In vacuum all the bodies dropped from same height take same time to reach the ground.

   1) Both (A) and (R) are true and (R) is the correct explanation of (A).

   2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

   3) (A) is true but (R) is false.

   4) (A) is false but (R) is true.

5. **A): The path followed by one projectile as observed by another projectile is a straight line in uniform gravitation field.**

   R): The relative velocity between two projectiles at a given place does not change with time, because their relative acceleration is zero.

   1) Both (A) and (R) are true and (R) is the correct explanation of (A).

   2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

   3) (A) is true but (R) is false.

   4) (A) is false but (R) is true.

6. **A): If a body is projected obliquely at angle above horizontal with initial speed u then its speed at the instant when its velocity makes an angle above the horizontal is**

R): Horizontal component of velocity of projectile remains constant.

1) Both (A) and (R) are true and (R) is the correct explanation of (A).

2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

3) (A) is true but (R) is false.

4) (A) is false but (R) is true.

7. **(A): In case of projectile the angle between velocity and acceleration changes from point to point.**

(R): Because it's horizontal component of velocity remains constant while vertical component of velocity changes from point to point due to acceleration due to gravity.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

8. **Angle between velocity and acceleration vectors in the following cases.**

List - I	List - II
a) Vertically projected body	**e) 90^0**
b) For freely falling body	**h) 180^0**
c) For projectile	**f) Changes from point to point**
d) In uniform circular motion	**g) Zero**

1) a – h ; b – g ; c – f ; d – e 2) a – f ; b – g ; c – h ; d – e

3) a – e ; b – f ; c – h ; d – g 4) a – g ; b – h ; c – e ; d – f

9. **A body of mass m is projected with velocity u at an angle of 45^o with the horizontal. Match the expressions for its kinetic energy, potential energy, linear momentum and angular momentum at the top of trajectory.**

Quantities	Expressions
(a) Total energy	**(e)** $\frac{mU^2}{4\sqrt{2g}}$
(b) Potential energy	**(f) mu/** $\sqrt{2}$
(c) Linear momentum	**(g)** $mu^2/2$
(d) Angular momentum	**(h)** $\frac{mu^2}{4}$

(1) a-h, b-g, c-e, d-f (2) a-h, b-g, c-f, d-e

(3) a-g, b-h, c-e, d-f (4) a-g, b-h, c-f, d-e

10. **A body is projected at an angle of 45^o with the horizontal on a flat ground, the angle is the made by the velocity vector and the acceleration due to gravity at any instant match the values of for various situations.**

Angle	Situation
(a) 45^o	**(e) At the time of launching**
(b) 90^o	**(f) At the same time of striking the ground**
(c) 135^o	**(g) Vertical projection at the time of launching**
(d) 180^o	**(h) At the top of the trajectory**

(1) a-f, b-h, c-e, d-g (2) a-f, b-g, c-e, d-h

(3) a-e, b-g, c-f, d-h (4) a-e, b-h, c-f, d-g

11. **Two objects are projected with the same velocity u at complimentary angle (θ, 90 - θ) of projection.**

List -I	List - II
(a) The ratio of their ranges	(e) $\tan^2\theta:1$
(b) The product of their times of flight	(f) $\frac{u^2}{2g}$
(c) The ratio of their maximum heights	(g) 1:1
(d) Sum of their maximum heights	(h) $\frac{2R}{g}$

(1) a-e, b-f, c-g, d-h (2) a-g, b-e, c-g, d-f

(3) a-g, b-h, c-e, d-f (4) a-e, b-f, c-g, d-h

12. **In the presence of heavy atmospheric resistance, the parameters pertaining to projectile's motion is affected as follows.**

(a) Its maximum height is increased.

(b) Its range is reduced

(c) Its total time of flight is increased

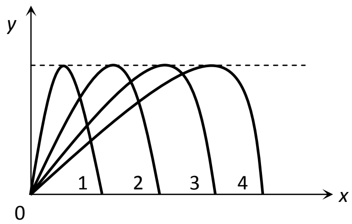
(d) Its striking angle is decreased

(1) b, c (2) a, d (3) a, c (4) b, d

13. **A projectile of mass m is fired with velocity v at an angle θ to the horizontal from a point P. Neglecting air resistance, the magnitude of change of momentum between the leaving point P and the arriving point Q at the same level is**

(1) mv/ $\sqrt{2}$ (2) $2mv\cos\theta$ (3) $2mv\sin\theta$ (4) $\sqrt{mv}\tan\theta$

14. **Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to initial horizontal velocity component, highest first**



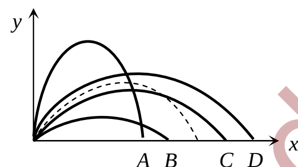
(1) 1, 2, 3, 4

(2) 2, 3, 4, 1

(3) 3, 4, 1, 2

(4) 4, 3, 2, 1

15. **The path of a projectile in the absence of air drag is shown in the figure by dotted line. If the air resistance is not ignored then which one of the path shown in the figure is appropriate for the projectile?**



(1) B

(2) A

(3) D

(4) C

16. A body is projected with a velocity 60 ms^{-1} at 30^0 to horizontal. Its initial velocity vector is

1) $10\hat{i} + 10\sqrt{3}\hat{j}$ 2) $30\hat{i} + 30\sqrt{3}\hat{j}$ 3) $30\sqrt{3}\hat{i} + 30\hat{j}$ 4) $30\sqrt{3}\hat{i}$

17. A body is projected with velocity u such that its horizontal range and maximum vertical heights are same. The maximum heights is

1) $\frac{u^2}{2g}$ 2) $\frac{3u^2}{4g}$ 3) $\frac{16u^2}{17g}$ 4) $\frac{8u^2}{17g}$

18. A body is projected at an angle 30° to the horizontal with a speed of 30 ms^{-1}. The angle made by the velocity vector with the horizontal after 1.5 s is (g=10 ms^{-2})

1) Zero 2) 60^0 3) 45^0 4) 90^0

19. Two bodies are thrown from the same point with the same velocity of 50ms^{-1}. If their angles of projection are complimentary angles and the difference of maximum heights is 30m, their maximum heights (g=10ms^{-2})

1) 50m and 80m 2) 47.5m and 77.5m 3) 30m and 60m 4) 25m and 55m

20. A particle is thrown with a velocity u at an angle θ from the horizontal. Another particle is thrown with the same velocity at an angle a from the vertical. The ratio of times of flight of the two particles will be

1) Tan 2 θ : 1 2) Cot 2 θ: 1 3) Tan θ : 1 4) Cot θ : 1

21. The horizontal and vertical displacement of a projectile are given by x = 12t and

y = 16t - 5t^2, all the quantities being measured in S.I. system. The maximum height of the projectile is (g=10ms^{-2})

1) 25.6 m 2) 12.8 m 3) 64 m 4) 6.4 m

22. The equation of trajectory of a projectile is y = 10x–$\left(\frac{5}{9}\right)x^2$. If we assume g = 10$ms^{-2}$ the range of projectile (in meters) is [05 E]

1) 36 2) 24 3) 18 4) 9

23. The speed of a projectile at its maximum height is $\frac{\sqrt{3}}{2}$ times its initial speed. If the range of the projectile is p times the maximum height attained by it, then p=

1) 4/3 2) 2 3) 4 4) 3/4

24. Two bodies are thrown with the same initial velocity at angles α and (90- α) to the horizon. What is the ratio of the maximum heights reached by the bodies?

1) $\cot^2\alpha$ 2) $\tan^2\alpha$ 3) $\sec^2\alpha$ 4) $\cos^2\alpha$

25. A projectile is thrown at an angle of 30° with a velocity of 10m/s. the change in velocity during the time interval in which it reaches the highest point is

1) 10 m/s 2) 5 m/s 3) 5 m/s 4) 10m/s

26. A player kicks a foot ball obliquely at a speed of 20ms^{-1} so that its range is maximum. Another player at a distance of 24m away in the direction of kick starts running at that instant to catch the ball. Before the ball hits the ground to catch it, the speed with which the second player has to run is (g = 10ms^{-2})

1) 4 ms^{-1} 2) $4\sqrt{2}$ ms^{-1} 3) $8\sqrt{2}$ ms^{-1} 4) 8 ms^{-1}

27. A ball A is projected from the ground such that its horizontal range is maximum. Another ball B is dropped from a height equal to the maximum range of A. The ratio of the time of flight of A to the time of fall of B is

1) $\sqrt{2}:1$ 2) 1: 2 3) 1: 1 4) 1: $\sqrt{2}$

28. A particle is projected with velocity $2\sqrt{gh}$ and at an angle 60° to the horizontal so that it just clears two walls of equal height h which are a distance 2 h from each other. The time interval for which the particle travels between these two walls is

1) $2\sqrt{\frac{h}{g}}$ 2) $\sqrt{\frac{h}{g}}$ 3) $\sqrt{\frac{2h}{g}}$ 4) $\sqrt{\frac{h}{2g}}$

29. A particle is aimed at a mark which is in the same horizontal plane as that of point of projection. If falls 10 m short of the target when it is projected of an angle of 75° and falls 10m ahead of the target when it is projected with an elevation of 45°. The angle of projection for which the particle exactly hits this target is ($g=10ms^{-1}$)

1) $\frac{1}{2}Sin^{-1}\left(\frac{3}{4}\right)$ 2) $\frac{1}{2}Sin^{-1}\left(\frac{4}{5}\right)$ 3) $\frac{1}{2}\tan^{-1}\left(\frac{1}{2}\right)$ 4) $\tan^{-1}(2)$

30. When a body is projected from a level ground the ratio of its speed in the vertical and horizontal direction is 4: 3. If the velocity of projection is u, the time after which, the ratio of the velocities in the vertical and horizontal directions are reversed is

1) $\frac{7u}{20g}$ 2) $\frac{35u}{10g}$ 3) $\frac{9u}{g}$ 4) $\frac{10u}{g}$

31. A body of mass 2kg is projected from the ground with a velocity $20ms^{-1}$ at an angle 30° with the vertical. If t_1 is the time in seconds at which the body is projected and t_2 is the time in seconds at which it reaches the ground, the change in momentum in $kgms^{-1}$ during the time $(t_2 - t_1)$ is

1) 40 2) $40\sqrt{3}$ 3) $50\sqrt{3}$ 4) 60

32. A projectile has initially the same horizontal velocity as it would acquire if it had moved from rest with uniform acceleration of $3ms^{-2}$ for 0.5 minutes. If the maximum height reached by it is 80m then the angle of projection is [g = 10ms^{-2}]

1) $\tan^{-1}(3)$ 2) $\tan^{-1}\left(\frac{3}{2}\right)$ 3) $\tan^{-1}\left(\frac{4}{9}\right)$ 4) $\sin^{-1}\left(\frac{4}{9}\right)$

33. A body of mass m_1 projected vertically upwards with an initial velocity 'u' reaches a maximum height 'h'. Another body of mass m_2 is projected along an inclined plane making an angle 30^0 with the horizontal and with speed 'u'. The maximum distance travelled along the incline is

1) 2h 2) h 3) $\frac{h}{2}$ 4) $\frac{h}{4}$

34. The height y and the distance x along the horizontal plane of a projectile on a certain planet (with no surrounding atmosphere) are given by $y=(8t-5t^2)$ *meter* and $x=6t$ *meter*, where t is in second. The velocity with which the projectile is projected is

(a) 8 *m/sec*

(b) 6 *m/sec*

(c) 10 *m/sec*

(d) Not obtainable from the data

35. **A body of mass *m* is thrown upwards at an angle θ with the horizontal with velocity *v*. While rising up the velocity of the mass after *t seconds* will be**

(a) $\sqrt{(v\cos\theta)^2+(v\sin\theta)^2}$

(b) $\sqrt{(v\cos\theta-v\sin\theta)^2-gt}$

(c) $\sqrt{v^2+g^2t^2-(2v\sin\theta)gt}$

(d) $\sqrt{v^2+g^2t^2-(2v\cos\theta)gt}$

36. **Neglecting the air resistance, the time of flight of a projectile is determined by**

(a) $U_{vertical}$

(b) $U_{horizontal}$

(c) $U=U^2{}_{vertical}+U^2{}_{horizontal}$

(d) $U=U(U^2{}_{vertical}+U^2{}_{horizontal})^{1/2}$

37. **A ball is thrown from a point with a speed v_o at an angle of projection θ. From the same point and at the same instant a person starts running with a constant speed $v_o/2$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection?**

(a) Yes, 60^o (b) Yes, 30^o

(c) No (d) Yes, 45^o

Key

1) 1	2) 1	3) 4	4) 1	5) 1	6) 1	7) 1	8) 1
9) 4	10) 1	11) 3	12) 1	13) 3	14)4	15)1	16) 3
17) 4	18) 1	19) 2	20) 3	21) 2	22) 3	23) 3	24)2
25) 2	26) 2	27) 3	28) 1	29) 1	30) 1	31) 2	32)3
33) 1	34)3	35)3	36)1	37)1			

Hints

16. $u_x = u\cos\theta \qquad u_y = u\sin\theta$

$$u_X = 60\times\frac{\sqrt{3}}{2} \qquad u_y = 60\times\left(\frac{1}{2}\right)$$

$$\bar{u} = 30\sqrt{3}\ \vec{i} + 30\ \vec{j}$$

17. $R = H$

$\tan\theta = 4$

$$\sin\theta = \frac{4}{\sqrt{17}}$$

$$H = \frac{u^2\sin^2\theta}{2g} = \frac{u^2\frac{16}{17}}{2g}$$

$$H = \frac{8u^2}{17g}$$

18. $\tan\alpha = \dfrac{30\times\frac{1}{2} - 15}{30.\frac{\sqrt{3}}{2}} \Rightarrow \alpha = 0$

19. $H_1 + H_2 = \dfrac{50\times 50}{2\times 10} = 125$

$H_1 - H_2 = 30 \qquad H_1 = 77.5$

$2H_1 = 155 \qquad H_2 = 47.5$

20. $\frac{t_1}{t_2} = \frac{\frac{2u\sin a}{g}}{\frac{2u\cos a}{g}} = \frac{\tan a}{1}$

21. $H = \frac{u^2 \sin^2\theta}{2g} = \frac{(u\sin\theta)^2}{2g} = \frac{16^2}{2\times 10} = 12.8m$

22. $R = \frac{A}{B} = \frac{10}{5/9} = 18m\,\text{s}$

23. $\text{u}\frac{\sqrt{3}}{2} = \text{u}\cos\theta$

$\theta = 30^0$

$\frac{\text{R}\tan\theta = 4\text{H}}{\text{R} = \text{PH}}$

$\frac{1}{\sqrt{3}} = \frac{4}{\text{P}}$

$\text{P} = 4\sqrt{3}$

25. $\Delta V_x = 0$

$\Delta V_y = u\sin\theta$

$\Delta V_y = 10\times\frac{1}{2} = 5ms^{-1}$

26. For $\theta = 45^0$

$R_{\max} = \frac{u^2}{g} = \frac{20^2}{10} = 40m$

$T = \frac{2u\sin\theta}{g} = \frac{2\times 20}{10}\times\frac{1}{\sqrt{2}}$

$T = 2\sqrt{2}S$

27. $H = \frac{gt^2}{8}$

28. $\Delta x = u\cos\theta \times \Delta t$

$2h = u \times \frac{1}{2} \times \Delta t$

$2h = 2\sqrt{gh} \times \frac{1}{2} \times \Delta t$

$\Delta t = \frac{2h}{\sqrt{gh}}$ $\quad\quad$ $\Delta t = 2\sqrt{\frac{h}{g}}$

29. $\frac{R-10}{R+10} = \frac{\sin(2\times 75)}{\sin(2\times 45)}$

$\frac{R-10}{R+10} = \frac{1}{2} \Rightarrow R = 30$

But $\theta = 45^0$ $R = \frac{u^2}{g} = 40$

$30 = \frac{u^2}{g}\sin(2\theta)$

$30 = 40\sin(2\theta)$

$2\theta = \sin^{-1}(3/4)$ $\theta = \frac{1}{2}.\sin^{-1}(3/4)$

30. $\frac{u_y}{u_x} = \frac{4}{3}$ $\frac{V_y}{V_x} = \frac{u_y - gt}{u_x} = \frac{3}{4}$

$4u_y - 4gt = 3\,U_x$

$$4.\left(\frac{4}{3}u_x\right)-4gt=3u_x$$

$$\frac{16}{3}u_x-3u_x=4gt$$

$$t=\frac{7u_x}{12g}\quad \frac{u_y}{u_x}=\frac{4}{3}\rightarrow\frac{u_y^2}{u_x^2}+1=\frac{16}{9}+1$$

$$\frac{u_y^2+u_x^2}{u_x^2}=\frac{25}{9}\qquad \frac{u^2}{u_x^2}=\frac{25}{9}$$

$$u_x=\frac{3u}{5}\quad \therefore t=\frac{7}{12g}\times\frac{3u}{5}$$

$$t=\frac{7u}{20g}$$

31. $\Delta p=mg\times T$

$$\Delta p=(2\times10)\left(\frac{2\times20\times\sqrt{3}}{10\times2}\right)$$

$$=2\times10\times2\sqrt{3}$$

$$\Delta p=40\sqrt{3}$$

32. V = at = 30 x 0.5 x 60

V = 90 ms^{-1}

But u $\cos\theta=90$

$$H=\frac{u^2\sin^2\theta}{2g}=80$$

$$u^2\sin^2\theta=1600$$

$u \sin\theta = 40$

$u \cos\theta = 90$

$Tan\theta = \frac{4}{9}$

$\theta = Tan^{-1}(4/9)$

33. $h = \frac{u^2}{2g}$

$mgh^1 = \frac{1}{2}mu^2$

$\sin\theta = \frac{h}{l}$

$l = 2h$

34. $v_y = \frac{dy}{dt} = 8 - 10t$, $v_x = \frac{dx}{dt} = 6$

At the time of projection *i.e.* $v_y = \frac{dy}{dt} = 8$ and $v_x = 6$

$\therefore v = \sqrt{v_x^2 + v_y^2} = \sqrt{6^2 + 8^2} = 10\ m/s$

35. Instantaneous velocity of rising mass after *t* sec will be $v_t = \sqrt{v_x^2 + v_y^2}$

Where $v_x = v\cos\theta =$ Horizontal component of velocity

$v_y = v\sin\theta - gt =$ Vertical component of velocity

$v_t = \sqrt{(v\cos\theta)^2 + (v\sin\theta - gt)^2}$

$v_t = \sqrt{v^2 + g^2t^2 - 2v\sin\theta\, gt}$

36. Time of flight = $\frac{2u\sin\theta}{g} = \frac{2u_y}{g} = \frac{2 \times u_{\text{vertical}}}{g}$

37. Person will catch the ball if its velocity will be equal to horizontal component of velocity of the ball. $\frac{v_0}{2} = v_0\cos\theta \Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = 60°$