EXERCISE-1

OBJECTIVE PROBLEMS

1. Two stones are projected from the same point with same speed making angles $45^\circ + \theta$ and $45^\circ - \theta$ with the horizontal respectively. If $\theta < 45^\circ$, then the horizontal ranges of the two stones are in the ratio of
(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 4

2. A hunter takes an aim at a monkey sitting an a tree and fires a bullet. Just when the bullet leaves barrel of the gun, it so happens that the monkey begins to fall freely. The bullet will
(A) go above the monkey (B) go below the monkey
(C) hit the monkey
(D) may or may not hit the monkey. It will depend upon the velocity of the bullet.

3. It was calculated that a shell when fired form a gun with a certain velocity and at an angle of elevation $\frac{5\pi}{36}$ rad should strike a given target. In actual practice, it was found that a hill just prevented the trajectory. At what angle of elevation should the gun be fired to hit the target.
(A) $\frac{5\pi}{36}$ rad (B) $\frac{11\pi}{36}$ rad (C) $\frac{7\pi}{36}$ rad (D) $\frac{13\pi}{36}$ rad.

4. A projectile is thrown with a speed v at an angle θ with the vertical. Its average velocity between the instants it crosses half the maximum height is
(A) v sin θ, horizontal and in the plane of projection
(B) v cos θ, horizontal and in the plane of projection
(C) 2v sin θ, horizontal and perpendicular to the plane of projection
(D) 2v cos θ, vertical and in the plane of projection.

5. Two bullets are fired horizontally, simultaneously and with different velocities from the same place. Which bullet will hit the ground earlier?
(A) It would depend upon the weights of the bullets (B) The slower one.
(C) The faster one (D) Both will reach simultaneously.

6. A stone is thrown upwards. It returns to ground describing a parabolic path. Which of the following remains constant?
(A) speed of the ball (B) kinetic energy of the ball
(C) vertical component of velocity (D) horizontal component of velocity.

7. 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
(A) h (B) $\frac{h}{2}$ (C) 2h (D) $\frac{2h}{3}$

8. A particle, with an initial velocity v_0 in a plane, is subjected to a constant acceleration in the same plane. Then, in general, the path of the particle could be
(A) a circle (B) a straight line (C) a parabola (D) a hyperbola.

9. A ball is projected from a certain point on the surface of a planet at a certain angle with the horizontal surface. The horizontal and vertical displacement x and y vary with time t in second as:

$$x = 10\sqrt{3t} \text{ and } y = 10t - t^2$$

The maximum height attained by the ball is
(A) 100 m (B) 75 m (C) 50 m (D) 25 m.

10. A bag is dropped from an aeroplane flying horizontally at a constant speed. If air resistance is ignored, where will the aeroplane be when the bag hits the ground?
(A) ahead of the bag (B) directly above the bag
(C) far behind the bag (D) data is not sufficient.

11. The path of one projectile in motion as seen from another moving projectile is
(A) a straight line (B) a circle (C) an ellipse (D) a parabola.

12. A plane surface is inclined making an angle θ with the horizontal. From the bottom of this inclined plane, a bullet is fired with velocity v. The maximum possible range of the bullet on the inclined plane is

(A) $\frac{v^2}{g}$ (B) $\frac{v^2}{g(1+\sin\theta)}$ (C) $\frac{v^2}{g(1-\sin\theta)}$ (D) $\frac{v^2}{g(1+\cos\theta)}$

13. A ball is projected horizontal with a speed v from the top of a plane inclined at an angle 45º with the horizontal. How far from the point of projection with the ball strike the plane?

(A) $\frac{v^2}{g}$ (B) $\sqrt{2}\,\frac{v^2}{g}$ (C) $\frac{2v^2}{g}$ (D) $\sqrt{2}\left[\frac{2v^2}{g}\right]$

14. The time of flight of a projectile on an upward inclined plane depends upon
(A) angle of inclination of the plane (B) angle of projection
(C) the value of acceleration due to gravity (D) all of these.

15. A ball rolls of the top of a stairway horizontally with a velocity of 4.5 m s^{-1}. Each step is 0.2 m high and 0.3 m wide. If g is 10 ms^{-1}, then the ball will strike the nth step where n is equal to
(A) 9 (B) 10 (C) 11 (D) 12

16. The velocity of projection of a projectile is $(6\hat{i} + 8\hat{j})$ ms^{-1}. The horizontal range of the projectile is
(A) 4.9 m (B) 9.6 m (C) 19.6 m (D) 14 m.

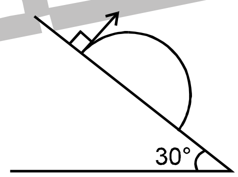
17. If R and h represent the horizontal range and maximum height respectively of an obliquie projectile, then $\frac{R^2}{8h} + 2h$ represents
(A) maximum horizontal range (B) maximum vertical range
(C) time of flight (D) velocity of projectile at highest point

18. A particle move along the parabolic path $x = y^2 + 2y + 2$ in such a way that the y-component of velocity vector remain 5m/s during the motion. The magnitude of the accleration of the particle is :
(A) 50 m/s^2 (B) 100 m/s^2 (C) $10\sqrt{2}$ m/s^2 (D) 0.1 m/s^2

19. A ball is projected from point A with a velocity 10 m/s perpendicular to the inclined plane as shown in figure. Range of the ball on the inclined plane is :

(A) $\frac{40}{3}$ m (B) $\frac{20}{13}$ m

(C) $\frac{13}{20}$ m (D) $\frac{13}{40}$ m



SUBJECTIVE PROBLEMS

20. In order to project a body for maximum range, what is the condition ?

21. What is the angle between the directions of velocity & acceleraiton at the highest point of a projectile path ?

22. At what point of the projectile path the speed is minimum ?

23. Two bodies are projected at angles θ and $(90 - \theta)$ to the horizontal with the same speed. Find the ratio of their times of flight?

24. In above question find the ratio of the maximum vertical heights ?

25. What should be the angles of projection to obtain maximum height and maximum time of flight ?

26. A bob of mass 0.1 kg hung from the ceiling of a room by a string 2 m long is set into oscillation. The speed of the bob at its mean position is 1 ms^{-1}. What is the trajectory of the bob ; if the string is cut

(a) when the bob is at one of its extreme position
(b) at its mean position

27. A projectile can have the same range R for two angles of projections. If t_1 & t_2 be the times of flight in two cases, then find out relation between t_1t_2 and R ?

28. The height y and the distance x along the horizontal plane of a projectile on a certain planet (without no surrounding atmosphere) are given by $y = (8t - 5t^2)$ metere & $x = 6t$ m. Then what will be the velocity of projection ?

29. A glass marble projected horizontal from the top of a table falls at a distance x from the edge of the table. If h is the height of the table, find the velocity of projection ?

30. A projectile is fired horizontally with a velocity of 98 m/s from the top of a hill 490 m high. Find :
(i) the time taken to reach the ground
(ii) the distance of the target from the hill
(iii) the velocity with which the particle hits the ground

31. The equation of a projectile is $y = \sqrt{3}\,x - \frac{gx^2}{2}$, find the angle of projection ?

32. Consider a boy on a trolley who throws a ball with speed 20 m/s at an angle 37^0 w.r.t. trolley which moves horizontally with speed 10 m/s.

(a) Find horizontal and vertical components of initial velocity of ball when ball is projected in direction of motion of trolley.

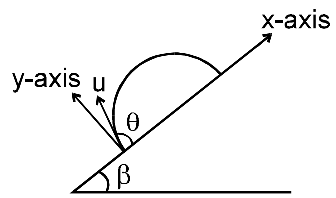
(b) Find horizontal and vertical components of initial velocity of ball when ball is projected opposite to direction of motion of trolley

33. Consider a boy on a platform who throws a ball with speed 20 m/s at an angle 37^0 w.r.t. platform which moves upwards with speed 10 m/s. (a) Find the horizontal and vertical component of balls velocity.

(b) Find horizontal and vertical components of balls velocity when ball is projected downwards from the platform.

34. A bomb is dropped from an aeroplane moving horizontally at a certain height from the ground. Does the time taken by the bomb to reach the ground depend on the velocity of the aeroplane ?

35. A particle is projected at an angle θ with an inclined plane making an angle β with the horizontal as shown in figure, speed of the particle is u, after time t find :
(a) x component of acceleration ?
(b) y component of acceleration ?
(c) x component of velocity ?
(d) y component of velocity ?
(e) x component of displacement ?
(f) y component of displacement ?
(g) y component of velocity when particle is at maximum distance from the incline plane ?



36. On an inclined plane of inclination 30º, a ball is thrown at an angle of 60º with the horizontal from the foot of the incline with a velocity of $10\sqrt{3}$ ms^{-1}. If $g = 10\ ms^{-2}$, then find the time in which ball will hit the inclined plane?

37. The direction of motion of a projectile at a certain instant is inclined at an angle α to the horizon. After t seconds it is inclined an angle β . Find the horizontal component of velocity of projection in terms of g, t , α and β.

38. A radius vector of a point A relative to the origin varies with time t as $\vec{r} = at\,\hat{i} - bt^2\,\hat{j}$, where a and b are positive constants and $\hat{i}$ and $\hat{j}$ are the unit vectors of the x and y axes. Find:

Teko Classes, Maths : Suhag R. Kariya (S. R. K. Sir), Bhopal Phone : 0 903 903 7779, 0 98930 58881.

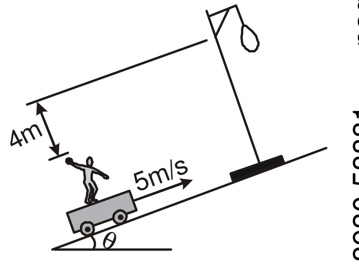
(i) the equation of the point's trajectory y (x) ; plot this function

(ii) the time dependence of the velocity **v** and acceleration **a** vectors as well as of the moduli of these quantities .

39. Two particles are projected simultaneously with the same speed V in the same vertical plane with angles of elevation θ and 2θ, where $\theta < 45^\circ$. At what time will their velocities be parallel.

40. If 4 seconds be the time in which a projectile reaches a point P of its path and 5 seconds the time from P till it reaches the horizontal plane through the point of projection . Find the height of P above the horizontal plane. [g = 9.8 m/sec^2]

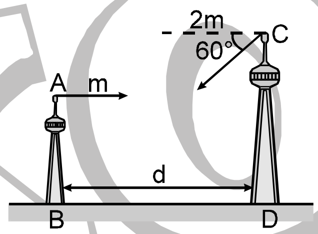
41. A man is travelling on a flat car which is moving up a plane inclined at $\cos\theta = 4/5$ to the horizontal with a speed 5 m/s. He throws a ball towards a stationary hoop located perpendicular to the incline in such a way that the ball moves parallel to the slope of the incline while going through the centre of the hoop. The centre of the hoop is 4 m high from the man's hand calculate the time taken by the ball to reach the hoop.



EXERCISE-2

1. A ship is approaching a cliff of height 105 m above sea level. A gun fitted on the ship can fire shots with a speed of 110 ms^{-1}. Find the maximum distance from the foot of the cliff from where the gun can hit an object on the top of the cliff. [g = 10 m/s^2] **[REE '94, 6]**

2. Two towers AB and CD are situated a distance ' d ' apart as shown in the fig. AB is 20 m high and CD is 30 m high from the ground. An object of mass ' m ' is thrown from the top of AB horizontally with a velocity of 10 m/s towards CD. Simultaneously another object of mass 2 m is thrown from the top of CD at an angle of 60º to the horizontal towards AB with the same magnitude of initial velocity as that of the first object. The two objects move in the same vertical plane, collide in mid air and stick to each other.



(i) calculate the distance ' d ' between the towers.

(ii) find the position where the objects hit the ground. **[JEE ' 94, 6]**

3. A building 4.8 m high 2b meters wide has a flat roof. A ball is projected from a point on the horizontal ground 14.4 m away from the building along its width. If projected with velocity 16 m/s at an angle of 45º with the ground, the ball hits the roof in the middle, find the width 2b. Also find the angle of projection so that the ball just crosses the roof if projected with velocity $10\sqrt{3}$ m/s. **[REE '95, 6]**

4. Two guns situated on the top of a hill of height 10 m, each fired shots with the same speed $5\sqrt{3}$ m/s at some interval of time. One gun fires horizontally and other fires upwards at an angle of 60º with the horizontal. The shot collide in air at a point P. Find: **[JEE '96, 5]**

(i) the time interval between the firings and

(ii) the coordinates of the point P.

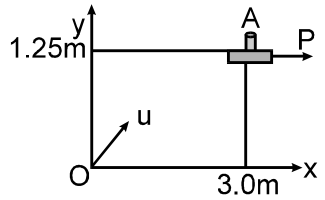
Take origin of the coordinate system at the foot of the hill right below the muzzle and trajectories in x-y plane.

5. A vertical pole has a red mark at some height. A stone is projected from a fixed point on the ground. When projected at an angle of 45º it hits the pole orthogonally 1 m above the mark. When projected with a different velocity at an angle of $\tan^{-1}(3/4)$, it hits the pole orthogonally 1.5 m below the mark. Find the velocity and angle of projection so that it hits the mark orthogonally to the pole. [g = 10 m/sec^2] **[REE '96, 6]**

6. The trajectory of a projectile in a vertical plane is $y = ax - bx^2$, where a, b are constants and x and y are respectively the horizontal and vertical distances of the projectile from the point of projection. The maximum height attained is _______ and the angle of projection from the horizontal is _______. **[JEE '97, 2]**

7. The coordinates of a particle moving in a plane are given by $x(t) = a\cos(pt)$ and $y(t) = b\sin(pt)$, where a, b (< a) and p are positive constants of appropriate dimensions.
(A) the path of the particle is an ellipse
(B) the velocity and acceleration of the particle are normal to each other at $t = \pi/2p$
(C) the acceleration of the particle is always directed towards a focus
(D) the distance travelled by the particle in time interval t = 0 to $= \pi/2p$ is a. **[JEE '99, 2]**

8. An object A is kept fixed at the point x = 3 m and y = 1.25 m on a plank P raised above the ground. At time t = 0 the plank starts moving along the + x direction with an acceleration 1.5 m/s². At the same instant a stone is projected from the origin with a velocity u as shown. A stationary person on the ground observes the stone hitting the object during its downward motion at an angle of 45º to the horizontal. All the motions are in x-y plane. Find 'u' and the time after which the stone hits the object. [Take g = 10 m/s²] **[JEE 2000, 5]**



9. Shots fired simultaneously from the top and foot of a vertical cliff at elevations of 30^0 and 60^0 respectively, strike an object simultaneously which is at a height of 100 meters from the ground and at a horizontal distance of $200\sqrt{3}$ meters from the cliff. Find the height of the cliff, the velocities of projection of the shots and the time taken by the shots to hit the object. **[REE '2000, 5]**

ANSWER

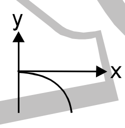
EXERCISE # 1

OBJECTIVE PROBLEMS

1. A	**2.** C	**3.** D	**4.** A
5. D	**6.** D	**7.** C	**8.** B,C
9. D	**10.** B	**11.** A	**12.** B
13. D	**14.** D	**15.** A	**16.** B
17. A	**18.** A	**19.** A	

SUBJECTIVE PROBLEMS

20. Angle of projection = 45^0. **21.** 90^0.
22. At the highest point. **23.** $\sin\theta : \cos\theta$
24. $\sin^2\theta : \cos^2\theta$
25. (a) $\theta = 90^0$, (b) $\theta = 90^0$.
26. (a) vertically downwards (b) parabolic path
27. $t_1t_2 = 2R/g$ **28.** 10 m/s **29.** $x\sqrt{\dfrac{g}{2h}}$
30. (i) 10 sec. (ii) 980 m (iii) 138.59 m/s
31. $\tan\theta = \sqrt{3}$ **32.** (a) 26, 12 (b) –6, 12
33. (a) 16, 22 (b) 16, 2 **34.** No
35. (a) $-g\sin\beta$, (b) $-g\cos\beta$, (c) $u\cos\theta - g\sin\beta \times t$, (d) $u\sin\theta - g\cos\beta \times t$, (e) $u\cos\theta \times t - \frac{1}{2}g\sin\beta \times t^2$, (f) $u\sin\theta \times t - \frac{1}{2}g\cos\beta \times t^2$, (g) zero.
36. 2 s **37.** $\dfrac{gt}{\tan\alpha - \tan\beta}$
38. (i) $y = -\dfrac{bx^2}{a^2}$



(ii) $\vec{v} = a\hat{i} - 2bt\hat{j}$, $\vec{\omega} = -2b\hat{j}$,

$|\vec{v}| = \sqrt{a^2 + 4b^2t^2}$, $|\vec{\omega}| = 2b$

39. $\dfrac{v}{g}\cos\left(\dfrac{\theta}{2}\right)\operatorname{cosec}\left(\dfrac{3\theta}{2}\right)$ **40.** 98 meters **41.** 1 s

EXERCISE # 2

1. 1100 m
2. (i) 17.32 m
(ii) combined mass strikes at 11.55 m from B and 5.77 m from D
3. width of the roof is 9.6 m; $\theta = \tan^{-1}\left(\dfrac{3}{2}\right)$
4. (i) 1 s (ii) $(5\sqrt{3}, 5)$
5. $\dfrac{\sqrt{3620}}{3}$ m/s , $\tan^{-1}\left(\dfrac{9}{10}\right)$ **6.** $\dfrac{a^2}{4b}$, $\tan^{-1} a$
7. A, B **8.** u = 7.29 m/s, t = 1 s.
9. 400 m, $V_T = 40\sqrt{3}$ m/s, $V_F = 40$ m/s, T = 10 s.