

I PUC – CHAPTER 04
MOTION IN A PLANE

1. A bird is flying towards north with a velocity 40 km h^{-1} and a train is moving with velocity 40 km h^{-1} towards east. What is the velocity of the bird noted by a man in the train?
(a) $40\sqrt{2}\text{ km h}^{-1}$ N-E (b) $40\sqrt{2}\text{ km h}^{-1}$ S-E (c) $40\sqrt{2}\text{ km h}^{-1}$ N-W (d) $40\sqrt{2}\text{ km h}^{-1}$ S-W

2. A swimmer wishes to cross a 500 m river flowing at 5 km h^{-1} . His speed with respect to water is 3 km h^{-1} . The shortest possible time to cross the river is
(a) 10 min (b) 20 min (c) 6 min (d) 7.5 min

3. Rain, driven by the wind, falls on a railway compartment with a velocity of 20 ms^{-1} , at an angle of 30° to the vertical. The train moves, along the direction of wind flow, at a speed of 108 km h^{-1} . Determine the apparent velocity of rain for a person sitting in the train.
(a) $20\sqrt{7}\text{ ms}^{-1}$ (b) $10\sqrt{7}\text{ ms}^{-1}$ (c) $15\sqrt{7}\text{ ms}^{-1}$ (d) $10\sqrt{7}\text{ km h}^{-1}$

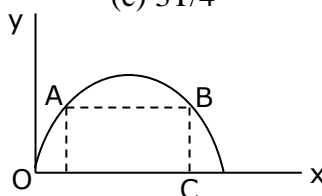
4. A particle is moving in a circle of radius ' r ' centred at O with constant speed v . What is the change in velocity in moving from A to B ($\angle AOB = 40^\circ$)?
(a) $2v\sin 20^\circ$ (b) $4v\sin 40^\circ$ (c) $2v\sin 40^\circ$ (d) $v\sin 20^\circ$

5. A particle is projected with a velocity v so that its range on a horizontal plane is twice the greatest height attained. If g is acceleration due to gravity, then its range is
(a) $\frac{4v^2}{5g}$ (b) $\frac{4g}{5v^2}$ (c) $\frac{4v^3}{5g^2}$ (d) $\frac{4v}{5g^2}$

6. A shot is fired from a point at a distance of 200 m from the foot of a tower 100 m high so that it just passes over it horizontally. The direction of shot with horizontal is
(a) 30° (b) 45° (c) 60° (d) 70°

7. A ball is thrown from a point with a speed v_0 at an angle of projection θ . From the same point and at the same instant, a person starts running with a constant speed $v_0/2$ 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° (b) Yes, 30° (c) No (d) Yes, 45°

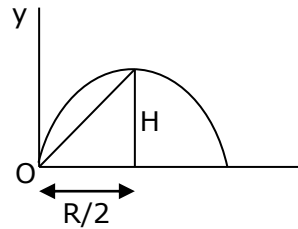
8. A body has an initial velocity of 3ms^{-1} and has an acceleration of 1ms^{-2} normal to the direction of the initial velocity. Then its velocity 4s after the start is
- 7ms^{-1} along the direction of initial velocity
 - 7ms^{-1} along the normal to the direction of initial velocity.
 - 7ms^{-1} midway between the two directions.
 - 5ms^{-1} at an angle $\tan^{-1}(4/3)$ with the direction of initial velocity.
9. The equation of motion of a projectile is $y = 12x - \frac{3}{4}x^2$. The horizontal component of velocity is 3ms^{-1} . What is the range of the projectile?
- 18m
 - 16m
 - 12m
 - 21.6m
10. A ball is thrown upwards at an angle of 60° to the horizontal. It falls on the ground at a distance of 90 m. If the ball is thrown with the same initial velocity at an angle of 30° , it will fall on the ground at a distance of
- 120 m
 - 90 m
 - 60 m
 - 30 m
11. A projectile is thrown in the upward direction making an angle of 60° with the horizontal direction with a velocity of 150ms^{-1} . Then the time after which its inclination with the horizontal is 45° is ($g = 10\text{ms}^{-2}$)
- $15(\sqrt{3} - 1)\text{s}$
 - $15(\sqrt{3} + 1)\text{s}$
 - $7.5(\sqrt{3} - 1)\text{s}$
 - $7.5(\sqrt{3} + 1)\text{s}$
12. A cannon on a level ground is aimed at an angle α above the horizontal and a shell is fired with a muzzle velocity v_0 towards a vertical cliff at distance R away. Then the height from the bottom at which the shell strikes the side walls of the cliff is
- $R \sin \alpha - \frac{1}{2} \frac{gR^2}{v_0^2 \sin^2 \alpha}$
 - $R \cos \alpha - \frac{1}{2} \frac{gR^2}{v_0^2 \cos^2 \alpha}$
 - $R \tan \alpha - \frac{1}{2} \frac{gR^2}{v_0^2 \cos^2 \alpha}$
 - $R \tan \alpha - \frac{1}{2} \frac{gR^2}{v_0^2 \sin^2 \alpha}$
13. There are two values of time for which a projectile is at the same height. The sum of these two times is equal to ($T =$ Time of flight of the projectile)
- $3T/2$
 - $4T/3$
 - $3T/4$
 - T



14. The trajectory of a projectile in a vertical plane is $y = ax - bx^2$, where 'a' and 'b' are constants and 'x' and 'y' are respectively, horizontal and vertical distances of the projectile from the point of projection. The maximum height attained by the particle and the angle of projection from the horizontal are
- (a) $\frac{b^2}{2a}, \tan^{-1}(b)$ (b) $\frac{a^2}{b}, \tan^{-1}(2b)$ (c) $\frac{a^2}{4b}, \tan^{-1}(a)$ (d) $\frac{2a^2}{b}, \tan^{-1}(a)$

15. A particle is projected from the ground with an initial speed of 'v' at an angle θ with horizontal. The average velocity of the particle between its point of projection and highest point of trajectory is

- (a) $\frac{v}{2}\sqrt{1+2\cos^2\theta}$ (b) $\frac{v}{2}\sqrt{1+\cos^2\theta}$ (c) $\frac{v}{2}\sqrt{1+3\cos^2\theta}$ (d) $v\cos\theta$



16. A body of mass m is projected horizontally with a velocity 'v' from the top of a tower of height 'h' and it reaches the ground at a distance 'x' from the foot of the tower. If a second body of mass $2m$ is projected horizontally from the top of a tower of height $2h$, it reaches the ground at a distance '2x' from the foot of the tower. The horizontal velocity of the second body is

- (a) v (b) $2v$ (c) $\sqrt{2}v$ (d) $v/2$

17. The horizontal range and maximum height attained by a projectile are R and H respectively. If a constant horizontal acceleration $a = g/4$ is imparted to the projectile due to wind, then its horizontal range and maximum height will be

- (a) $(R+H), \frac{H}{2}$ (b) $\left(R + \frac{H}{2}\right), 2H$ (c) $(R+2H), H$ (d) $(R+H), H$

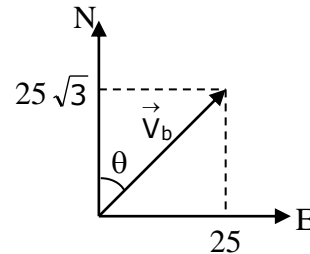
18. A body is moving in a circle with a speed of 1ms^{-1} . This speed increases at a constant rate of 2ms^{-1} every second. Assume that the radius of the circle described is 25 m. The total acceleration of the body after 2s is

- (a) 2ms^{-2} (b) 25ms^{-2} (c) $\sqrt{5}\text{ms}^{-2}$ (d) $\sqrt{7}\text{ms}^{-2}$

19. A boat is moving with a velocity $3\hat{i} + 4\hat{j}$ with respect to ground. The water in the river is moving with a velocity $-3\hat{i} - 4\hat{j}$ with respect to ground. The relative velocity of the boat with respect to water is

- (a) $8\hat{j}$ (b) $-6\hat{i} - 8\hat{j}$ (c) $6\hat{i} + 8\hat{j}$ (d) $5\sqrt{2}$.

20. A car is moving towards east with a speed of 25 km h^{-1} . To the driver of the car, a bus appears to move towards north with a speed $25\sqrt{3} \text{ km h}^{-1}$. What is the actual velocity of the bus?
- (a) 50 km h^{-1} , 30° E of N (b) 50 km h^{-1} , 30° N of E
(c) 25 km h^{-1} , 30° E of N (d) 25 km h^{-1} , 30° N of E



21. During a projectile motion, if the maximum height equals the horizontal range, then the angle of projection with the horizontal is
- (a) $\tan^{-1}(1)$ (b) $\tan^{-1}(2)$ (c) $\tan^{-1}(3)$ (d) $\tan^{-1}(4)$
22. A projectile has a time of flight T and range R . If the time of flight is doubled, keeping the angle of projection same, what happens to the range?
- (a) $R/4$ (b) $R/2$ (c) $2R$ (d) $4R$
23. At a height 0.4m from the ground, the velocity of a projectile in vector form is $\vec{v} = (6\hat{i} + 2\hat{j})\text{ms}^{-1}$. The angle of projection is ($g = 10 \text{ m/s}^2$)
- (a) 45° (b) 60° (c) 30° (d) $\tan^{-1}\left(\frac{3}{4}\right)$
24. A hose lying on the ground shoots a stream of water upward at an angle of 60° to the horizontal with the velocity of 16ms^{-1} . The height at which the water strikes the wall 8m away is ($g = 10 \text{ m/s}^2$)
- (a) 8.9 m (b) 10.9 m (c) 12.9 m (d) 6.9 m
25. Two paper screens A and B are separated by 150 m . A bullet pierces A and B. The hole in B is 15 cm below the hole in A. If the bullet is travelling horizontally at the time of hitting A, then the velocity of the bullet at A is ($g = 10\text{ms}^{-2}$)
- (a) $100\sqrt{3} \text{ ms}^{-1}$ (b) $200\sqrt{3} \text{ ms}^{-1}$ (c) $300\sqrt{3} \text{ ms}^{-1}$ (d) $500\sqrt{3} \text{ ms}^{-1}$

26. A ball is thrown at different angles with the same speed u from the same point and it has the same range in both the cases. If y_1 and y_2 are the heights attained in the cases, then $y_1 + y_2$ is equal to

- (a) $\frac{u^2}{g}$ (b) $\frac{2u^2}{g}$ (c) $\frac{u^2}{2g}$ (d) $\frac{u^2}{4g}$

27. A vector A is along the positive z-axis and its vector product with another vector B is zero, then vector B could be

- (a) $\hat{i} + \hat{j}$ (b) $4\hat{i}$ (c) $\hat{j} + \hat{k}$ (d) $-7\hat{k}$

28. A golfer standing on level ground hits a ball with a velocity of $u = 52 \text{ ms}^{-1}$ at an angle α above the horizontal. If $\tan \alpha = 5/12$, then time for which the ball is at least 15m above the ground will be (take $g = 10 \text{ ms}^{-2}$)

- (a) 1 s (b) 2 s (c) 3 s (d) 4 s

29. The speed of a projectile at its maximum height is $\sqrt{3}/2$ times its initial speed. If the range of the projectile is P times the maximum height attained by it, P is equal to

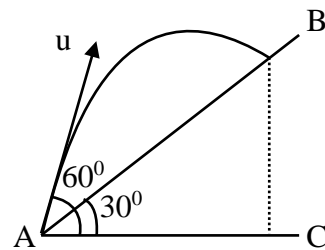
- (a) $4/3$ (b) $2\sqrt{3}$ (c) $4\sqrt{3}$ (d) $3/4$

30. A projectile is given an initial velocity of $\hat{i} + 2\hat{j}$. The Cartesian equation of its path is ($g = 10 \text{ ms}^{-2}$).

- (a) $y = 2x - 5x^2$ (b) $y = x - 5x^2$ (c) $4y = 2x - 5x^2$ (d) $y = 2x - 25x^2$.

31. In figure, the time taken by the projectile to reach from A to B is t . Then the distance AB is equal to

- (a) $\frac{ut}{\sqrt{3}}$ (b) $\frac{\sqrt{3}ut}{2}$
 (c) $\sqrt{3}ut$ (d) $2ut$



32. The angular velocity of a particle moving in a circle of radius 50 cm is increased in 5 min from 100 revolutions per minute to 400 revolutions per minute. Find the tangential acceleration of the particle.

- (a) 60 ms^{-2} (b) $\frac{\pi}{30} \text{ ms}^{-2}$ (c) $\frac{\pi}{15} \text{ ms}^{-2}$ (d) $\frac{\pi}{60} \text{ ms}^{-2}$

33. A is a vector which when added to the resultant of vectors $(2\hat{i} - 3\hat{j} + 4\hat{k})$ and $(\hat{i} + 5\hat{j} + 2\hat{k})$ yields a unit vector along the y-axis. Then vector A is

- (a) $-3\hat{i} - \hat{j} - 6\hat{k}$ (b) $3\hat{i} + \hat{j} - 6\hat{k}$ (c) $3\hat{i} - \hat{j} + 6\hat{k}$ (d) $3\hat{i} + \hat{j} + 6\hat{k}$

34. The point from where a ball is projected is taken as the origin of the coordinate axes. The x and y components of its displacement are given by $x = 6t$ and $y = 8t - 5t^2$. What is the velocity of projection?
 (a) 6 ms^{-1} (b) 8 ms^{-1} (c) 10 ms^{-1} (d) 14 ms^{-1}

35. The angle between two vectors A and B is θ . Vector R is the resultant of the two vectors. If R makes an angle $\frac{\theta}{2}$ with A, then
 (a) $A = 2B$ (b) $A = \frac{B}{2}$ (c) $A = B$ (d) $AB = 1$

36. A body of mass 2 kg has an initial velocity of 3 m/s along x-axis and it is subjected to a force of 4N in y-direction. The distance of the body from origin after 4 s will be: (the body was subjected to force at the origin at $t = 0$)
 (a) 12 m (b) 28 m (c) 20 m (d) 48 m

37. The initial velocity of a particle is $u = (4\hat{i} + 3\hat{j}) \text{ m/s}$. It is moving with uniform acceleration $a = (0.4\hat{i} + 0.3\hat{j}) \text{ m/s}^2$. The magnitude of its velocity after 10s is
 (a) 3 m/s (b) 3 m/s (c) 5 m/s (d) 10 m/s

38. If a_r and a_t represent radial and tangential accelerations, the motion of a particle will be uniformly circular if
 (a) $a_r = 0$ and $a_t = 0$ (b) $a_r = 0$ but $a_t \neq 0$ (c) $a_r \neq 0$ but $a_t = 0$ (d) $a_r \neq 0$ and $a_t \neq 0$

39. From the top of a tower 19.6 m high, a ball is thrown horizontally. If the line joining the point of projection to the point where it hits the ground makes an angle of 45° with the horizontal, then the initial velocity of the ball is ($g = 9.8 \text{ m/s}^2$)
 (a) 9.8 ms^{-1} (b) 4.9 ms^{-1} (c) 14.7 ms^{-1} (d) 2.8 ms^{-1}

40. Two tall buildings are 30 m apart. The speed with which a ball must be thrown horizontally from a window 150 m above the ground from one building so that it enters a window 27.5 m from the ground in the other building is ($g = 9.8 \text{ m/s}^2$)

(a) 2 ms^{-1}

(b) 6 ms^{-1}

(c) 4 ms^{-1}

(d) 8 ms^{-1}

41. Given: $\vec{A} = 2\hat{i} - \hat{j} + 2\hat{k}$ and $\vec{B} = -\hat{i} - \hat{j} + \hat{k}$. The unit vector of $\vec{A} - \vec{B}$ is

(a) $\frac{3\hat{i} + \hat{k}}{\sqrt{10}}$

(b) $\frac{3\hat{i}}{\sqrt{10}}$

(c) $\frac{\hat{k}}{\sqrt{10}}$

(d) $\frac{-3\hat{i} - \hat{k}}{\sqrt{10}}$

42. A body is projected up a smooth inclined plane with velocity V from the point A as shown in the figure. The angle of inclination is 45° and the top is connected to a well of diameter 40m. If the body just manages to cross the well, what is the value of V ?

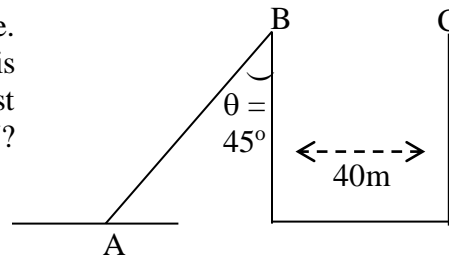
Length of inclined plane is $20\sqrt{2}$ m.

(a) 40 ms^{-1}

(b) $40\sqrt{2} \text{ ms}^{-1}$

(c) 20 ms^{-1}

(d) $20\sqrt{2} \text{ ms}^{-1}$



43. The friction of the air causes a vertical retardation equal to 10% of the acceleration due to gravity (Take $g = 10 \text{ ms}^{-2}$). The maximum height will be decreased by

(a) 8%

(b) 9%

(c) 10%

(d) 11%

44. A projectile has a maximum range of 16 km. At the highest point of its motion, it explodes into two equal masses. One mass drops vertically downwards. The horizontal distance covered by the other mass from the time of explosion is

(a) 8 km

(b) 16 km

(c) 24 km

(d) 32 km

45. A stuntman plans to run across a roof top and then horizontally off it to land on the roof of next building. The roof of the next building is 4.9 m below the first one and 6.2 m away from it. What should be his minimum roof top speed in m/s, so that he can successfully make the jump? ($g = 9.8 \text{ m/s}^2$)

(a) 3.1

(b) 4.0

(c) 4.9

(d) 6.2

46. Two equal forces act at a point. The square of their resultant is three times their product. The angle between them is

(a) 0°

(b) 30°

(c) 60°

(d) 90°

47. A man walks 4m towards East and the 3m towards North and there he fixes a pole 12m high. The distance between the starting point and tip of the pole in space is

(a) 7m

(b) 11 m

(c) 13m

(d) 19 m

48. Vector C is the sum of two vectors A and B vector D is the cross product of vectors A and B. What is the angle between vectors C and D?

(a) zero

(b) 60°

(c) 90°

(d) 180°

49. A body is projected at time $t = 0$ from a certain point on a planet's surface with a certain velocity at a certain angle w.r.to surface (assumed horizontal). The horizontal and vertical displacements x and y (in m) respectively vary with time t (in second) as $x = 10\sqrt{3}t$ and $y = 10t - t^2$

What is the magnitude and direction of the velocity with which the body is projected?

(a) 20 m/s at an angle of 30° with the horizontal

(b) 20 m/s at an angle of 60° with the horizontal

(c) 10 m/s at an angle of 30° with the horizontal

(d) 10 m/s at an angle of 60° with the horizontal

50. From the top of a tower of height 40 m, a ball is projected upwards with a speed of 20 m/s at an angle of elevation of 30° . The ratio of the total time taken by the ball to hit the ground to its time of flight (time taken to come back to the same elevation) is (Take $g = 10 \text{ m/s}^2$)

(a) 2 : 1

(b) 3 : 1

(c) 3 : 2

(d) 1.5 : 1