Chapter- 4

MOTION IN A PLANE

1 Mark Questions:

1. State for each of the following physical quantities if it is a scalar or a vector: volume, mass, work, velocity, acceleration, force, speed.

2. Read each statement below carefully and state with reasons, if it is true or false:

(a) The magnitude of a vector is always a scalar. (b) each component of a vector is always a scalar. (c) the total path length is always equal to the magnitude of the displacement vector of a particle. (d) the average speed of a particle (defined as total path length divided by the time taken to cover the path) is either greater or equal to the magnitude of the average velocity of the particle over the same interval of time. (e) Three vectors not lying in a plane can never add up to give a null vector.

3. On open ground, a motorist follows a track that turns to his left by an angle of after every 500m. Starting from a given turn, specify the displacement of the motorist at the third, sixth, and eight turns. Compare the magnitude of the displacement with the total path length covered by the motorist in each case.

4. Are the magnitude and direction of $\vec{A}+\vec{B}$ the same as that of $\vec{A}-\vec{B}$.

5. Can two vectors of different magnitudes be combined to give zero resultant?

6. Can $\vec{A}+\vec{B}=\vec{A}-\vec{B}$? If yes under what condition?

7. Under what condition the sum of three vectors is zero?

8. What is the maximum and minimum value of $|\vec{a}-\vec{b}|$?

9. Can the magnitude of the rectangular component of a vector be greater than the magnitude of that vector?

10. If $\vec{a} = 2\left(\hat{i} + \sqrt{3}\hat{j}\right)$, what is the angle made by $\vec{a}$ with $x-axis$?

11. What is the magnitude and direction of the vectors $\hat{i} + \hat{j}$ & $\hat{i} - \hat{j}$

12. If $\vec{A} = \frac{1}{4}\hat{i} - \frac{1}{3}\hat{j} + c\hat{k}$ is a unit vector, what is the value of c?

13. A particle starts from the origin at $t = 0\,s$ with a velocity of $10.0\hat{j}\,m/s$ and moves in the x-y plane with a constant acceleration of $\left(8.0\hat{i} + 2.0\hat{j}\right)m.s^{-2}$. (a) At what time is the x-coordinate of the particle16 m? What is the y-coordinate of the particle at that time? (b) What is the speed of the particle at the time?

14. If the magnitudes of two vectors are 3N, 8N, and their dot product is 12N, find the angle between the two vectors.

15. What are the components of a vector $A = 2\hat{i} + 3\hat{j}$ along with the directions of $\hat{i} + \hat{j}$ and $\hat{i} - \hat{j}$?

16. Find the angle between the force $\vec{F} = \left(3\hat{i} + 4\hat{j} - 5\hat{k}\right)$ unit and the displacement $\vec{d} = \left(5\hat{i} + 4\hat{j} + 3\hat{k}\right)$ unit. Also, find the projection of $\vec{F}$ on $\vec{d}$.

17. For what value of x, the vector $\vec{A} = x\hat{i} + 2\hat{j} - \hat{k}$ is perpendicular to $\vec{B} = 3\hat{i} - \hat{j} + 4\hat{k}$?

18. If $\left|\vec{A}\right| = 2, \left|\vec{B}\right| = 5,$ and the angle between $\vec{A}, \vec{B}$, 30^0 find the value of $\left|\vec{A} \times \vec{B}\right|$.

19. If $\left|\vec{A} \times \vec{B}\right| = \vec{A}.\vec{B}$, what is the angle between $\vec{A}$ and $\vec{B}$?

20. What is the angle between $\left(\vec{A} + \vec{B}\right)$ and $\left(\vec{A} \times \vec{B}\right)$?

21. If $\left|\vec{A}\right|=2,\left|\vec{B}\right|=5,\left|\vec{A}\times\vec{B}\right|=8$, find the value of $\left|\vec{A}.\vec{B}\right|$.

22. Find the value of $\hat{i}.\hat{j}\ \&\ \hat{i}\times\hat{i}$

23. If $|\vec{A}\times\vec{B}|=\vec{A}\cdot\vec{B}$, find $|\vec{A}+\vec{B}|$.

24. Why does a projectile fired along the horizontal not follow a straight line path?

25. A body is thrown with a velocity of 9.8 m/s making an angle of 30^0 with the horizontal. After what time will it hit the ground?

26. What will be the effect on the horizontal range of a projectile when its initial velocity is doubled, keeping the angle of projection the same?

27. A hunter aims his gun on a monkey hanging from a branch of a tree. The instant the hunter fires, the monkey leaves the branch. Will the bullet hit the monkey?

28. Shells of different masses are fired from a cannon at the same angle with the same speed. Will their range and time of flight differ?

(a) w.r.t train (b) w.r.t ground

29. A ball is dropped from the window of a train moving along horizontal rails. Along what path the ball travels to reach the ground as viewed by a person standing on the ground ?

30. A projectile is fired with kinetic energy K. If the range is maximum, what is its KE at the highest point?

31. What is the angle between velocity and acceleration vector in uniform circular motion?

32. How an acceleration must act on a body to make it move with a constant speed along a circular path?

2 Marks Questions:

33. A man can swim with a speed of 4.0 km/h in still water. How long does he take to cross a river 1.0 km wide if the river flows steadily at 3.0 km/h and he makes his strokes normal to the river current? How far down the river does he go when he reaches the other bank?

34. Find the angle made by the vector $2\hat{i}+3\hat{j}$ with X-axis.

35. Prove that vectors $\vec{A}=\hat{i}+2\hat{j}+3\hat{k}$ and $2\hat{i}-\hat{j}$ are perpendicular to each other.

36. If two vectors $18\hat{i}+4\hat{j}+5\hat{k}$ and $9\hat{i}+2\hat{j}+c\hat{k}$ are parallel, find the value of c.

37. If the maximum range of a gun along the horizontal is 16 km, then find the muzzle velocity of the shell.

38. A particle is projected with a velocity 'u' so that its horizontal range is thrice the greatest height attained. What is its horizontal range?

39. Which is greater: the angular velocity of the hour hand of a watch or angular velocity of the earth around its own axis? Calculate.

3 Marks Questions:

40. Rain is falling vertically with a speed of 35 ms^{-1}. Winds start blowing after some time with a speed of 12 ms^{-1} in the east to west direction. In which direction should a boy waiting at a bus stop hold his umbrella?

41. The position vector of a particle at the time t is given by $\vec{r}=3t\hat{i}+2t^2\hat{j}+5\hat{k}$ where t is seconds and r is in a meter. Find the magnitude and direction of velocity and acceleration at the time t = 1s.

42. The ceiling of a long hall is 25m high. What is the maximum horizontal distance that a ball thrown with a speed of 40 ms^{-1} can go without hitting the ceiling of the hall?

5 marks questions:

43. State parallelogram law of vector additions. Derive the expression of the magnitude and direction of the resultant vector. A man is going due east with a velocity of 3 km/h. Rain falls vertically downwards of a speed of 10 km/h. Calculate the relative velocity of rain with respect to man, and the angle at which he should hold his umbrella to save himself from rain.