3

MOTION IN A PLANE

MCQs with One Correct Answer

1. If $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 7\hat{i} + 24\hat{j}$, the vector having the same magnitude as B and parallel to A is

(a) $5\hat{i} + 20\hat{j}$ (b) $15\hat{i} + 10\hat{j}$

(c) $20\hat{i} + 15\hat{j}$ (d) $15\hat{i} + 20\hat{j}$

2. Two balls are projected at an angle θ and $(90^\circ - \theta)$ to the horizontal with the same speed. The ratio of their maximum vertical heights is

(a) 1 : 1 (b) $\tan\theta$: 1

(c) 1 : $\tan\theta$ (d) $\tan^2\theta$: 1

3. A stone projected with a velocity u at an angle θ with the horizontal reaches maximum height H_1. When it is projected with velocity u at an angle $\left(\frac{\pi}{2} - \theta\right)$ with the horizontal, it reaches maximum height H_2. The relation between the horizontal range R of the projectile, heights H_1 and H_2 is

(a) $R = 4\sqrt{H_1 H_2}$ (b) $R = 4(H_1 - H_2)$

(c) $R = 4(H_1 + H_2)$ (d) $R = \frac{H_1^2}{H_2^2}$

4. The equation of a projectile is $y = \sqrt{3}x - \frac{gx^2}{2}$

The angle of projection is given by

(a) $\tan\theta = \frac{1}{\sqrt{3}}$ (b) $\tan\theta = \sqrt{3}$

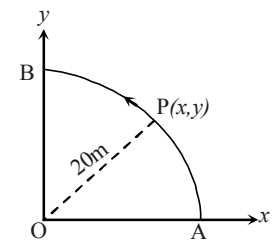
(c) $\frac{\pi}{2}$ (d) zero.

5. A particle moves along a circle of radius $\left(\frac{20}{\pi}\right)$m with constant tangential acceleration. It the velocity of particle is 80 m/sec at end of second revolution after motion has begun, the tangential acceleration is

(a) 40π m/sec^2 (b) 40 m/sec^2

(c) 640π m/sec^2 (d) 160π m/sec^2

6. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius



of the path is 20 m. The acceleration of 'P' when $t = 2$ s is nearly.

(a) 13m/s^2 (b) 12 m/s^2

(c) 7.2 ms^2 (d) 14m/s^2

7. The vectors $\vec{A}$ and $\vec{B}$ are such that

$|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$

The angle between the two vectors is

(a) 60° (b) 75°

(c) 45° (d) 90°

8. Two balls are projected simultaneously in the same vertical plane from the same point with velocities v_1 and v_2 with angle θ_1 and θ_2 respectively with the horizontal. If $v_1 \cos\theta_1 = v_2 \cos\theta_2$, the path of one ball as seen from the position of other ball is :

(a) parabola
(b) horizontal straight line
(c) vertical straight line
(d) straight line making 45° with the vertical

9. A projectile with same projection velocity can have the same range 'R' for two angles of projection. If 'T_1' and 'T_2' be time of flights in the two cases, then the product of the two time of flights is directly proportional to

(a) R (b) $\frac{1}{R}$

(c) $\frac{1}{R^2}$ (d) R^2

10. A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the ground in 10 sec. Angle with the ground at which it strikes the ground will be ($g = 10\ m/s^2$)

(a) $\tan^{-1}\left(\frac{1}{5}\right)$ (b) $\tan\left(\frac{1}{5}\right)$

(c) $\tan^{-1}(1)$ (d) $\tan^{-1}(5)$

11. Starting from the origin at time $t = 0$, with initial velocity $5\hat{j}$ ms^{-1}, a particle moves in the x–y plane with a constant acceleration of $(10\hat{i} + 4\hat{j})$ ms^{-2}. At time t, its coordiantes are (20 m, y_0 m). The values of t and y_0 are, respectively :

(a) 2 s and 18 m (b) 4 s and 52 m
(c) 2 s and 24 m (d) 5 s and 25 m

12. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15\,t^2\,\hat{i} + (4 - 20\,t^2)\hat{j}$. What is the magnitude of the acceleration at $t = 1$?

(a) 40 (b) 25
(c) 100 (d) 50

13. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $\left(\vec{A} + \vec{B}\right)$ is 'n' times the magnitude of $\left(\vec{A} - \vec{B}\right)$. The angle between $\vec{A}$ and $\vec{B}$ is:

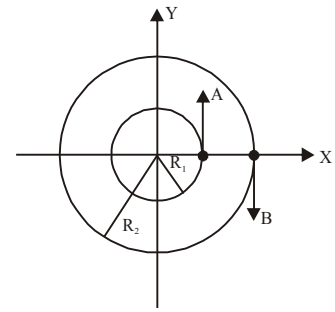
(a) $\cos^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ (b) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$

(c) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ (d) $\sin^{-1}\left[\frac{n-1}{n+1}\right]$

14. Ship A is sailing towards north-east with velocity km/hr where points east and , north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in:

(a) 4.2 hrs. (b) 2.6 hrs.
(c) 3.2 hrs. (d) 2.2 hrs.

15. Two particles A, B are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At t = 0, their positions and direction of motion are shown in the figure :



The relative velocity $v_A - v_B$ and $t = \frac{\pi}{2\omega}$ is given by:

(a) $\omega(R_1 + R_2)\,\hat{i}$ (b) $-\omega(R_1 + R_2)\,\hat{i}$

(c) $\omega(R_2 - R_1)\,\hat{i}$ (d) $\omega(R_1 - R_2)\,\hat{i}$

16. A particle is moving with velocity $\vec{v} = k(y\hat{i} + x\hat{j})$, where k is a constant. The general equation for its path is

(a) $y = x^2$ + constant
(b) $y^2 = x$ + constant
(c) xy = constant
(d) $y^2 = x^2$ + constant

17. A particle moves such that its position vector $\vec{r}\ (t) = \cos \omega t\, \hat{i} + \sin \omega t\, \hat{j}$ where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}\ (t)$ and acceleration $\vec{a}\ (t)$ of the particle:

(a) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin

(b) $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$

(c) $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$

(d) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

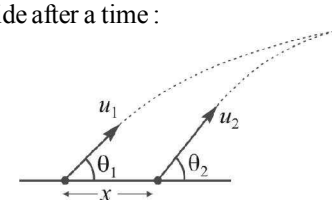
18. The position of a projectile launched from the origin at $t = 0$ is given by $\vec{r} = \left(40\hat{i} + 50\hat{j}\right)$ m at t = 2s. If the projectile was launched at an angle θ from the horizontal, then θ is

(take g = 10 ms^{-2})

(a) $\tan^{-1}\frac{2}{3}$ (b) $\tan^{-1}\frac{3}{2}$

(c) $\tan^{-1}\frac{7}{4}$ (d) $\tan^{-1}\frac{4}{5}$

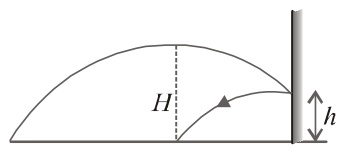
19. Two particles are projected simultaneously from the level ground as shown in figure. They may collide after a time :



(a) $\frac{x\sin\theta_2}{u_1}$ (b) $\frac{x\cos\theta_2}{u_2}$

(c) $\frac{x\sin\theta_2}{u_1\sin(\theta_2-\theta_1)}$ (d) $\frac{2x\sin\theta_1}{u_2\sin(\theta_2-\theta_1)}$

20. A stone is projected from a horizontal plane. It attains maximum height H and strikes a stationary smooth wall and falls on the ground vertically below the maximum height. Assuming the collision to be elastic, the height of the point on the wall where ball will strike is:



(a) $\frac{H}{4}$ (b) $\frac{H}{2}$

(c) $\frac{3H}{4}$ (d) $\frac{7H}{8}$

Numeric Value Answer

21. The resultant of two vectors $\vec{A}$ and $\vec{B}$ is perpendicular to the vector $\vec{A}$ and its magnitude is equal to half the magnitude of vector $\vec{B}$. The angle (in degree) between $\vec{A}$ and $\vec{B}$ is

22. A body is thrown horizontally from the top of a tower of height 5 m. It touches the ground at a distance of 10 m from the foot of the tower. The initial velocity (in ms^{-1}) of the body is (g = 10 ms^{-2})

23. A particle describes uniform circular motion in a circle of radius 2 m, with the angular speed of 2 rad s^{-1}. The magnitude of the change in its velocity in $\frac{\pi}{2}$ s is _____ms^{-1}.

24. A particle has an initial velocity of $3\hat{i} + 4\hat{j}$ and an acceleration of $0.4\hat{i} + 0.3\hat{j}$. Its speed after 10 s is :

25. If a vector $2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $4\hat{j} - 4\hat{i} + \alpha\hat{k}$, then the value of α is

26. A particle moves from the point $\left(2.0\hat{i} + 4.0\hat{j}\right)$ m, at t = 0, with an initial velocity $\left(5.0\hat{i} + 4.0\hat{j}\right)$ ms^{-1}. It is acted upon by a constant force which produces a constant acceleration $\left(4.0\hat{i} + 4.0\hat{j}\right)$ ms^{-2}. What is the distance (in m) of the particle from the origin at time 2s?

27. A particle starts from the origin at $t = 0$ with an initial velocity of $3.0\hat{i}$ m/s and moves in the x-y plane with a constant acceleration $(6.0\hat{i} + 4.0\hat{j})$ m/s^2. The x-coordinate of the particle at the instant when its y-coordinate is 32 m is D meters. The value of D is:

28. A particle is moving along the *x*-axis with its coordinate with time '*t*' given by $x(t) = 10 + 8t - 3t^2$. Another particle is moving along the *y*-axis with its coordinate as a function of time given by $y(t) = 5 - 8t^3$. At $t = 1$ s, the speed of the second particle as measured in the frame of the first particle is given as $\sqrt{v}$. Then *v* (in m/s) is____

29. A force $\vec{F} = (\hat{i} + 2\hat{j} + 3\hat{k})$ N acts at a point $(4\hat{i} + 3\hat{j} - \hat{k})$ m. Then the magnitude of torque about the point $(\hat{i} + 2\hat{j} + \hat{k})$ m will be $\sqrt{x}$ N-m. The value of *x* is _____.

30. The sum of two forces $\vec{P}$ and $\vec{Q}$ is $\vec{R}$ such that $|\vec{R}| = |\vec{P}|$. The angle θ (in degrees) that the resultant of 2 $\vec{P}$ and $\vec{Q}$ will make with $\vec{Q}$ is _____.

ANSWER KEY																			
1	(d)	**4**	(b)	**7**	(d)	**10**	(a)	**13**	(a)	**16**	(d)	**19**	(c)	**22**	(10)	**25**	(–0.5)	**28**	(580)
2	(d)	**5**	(b)	**8**	(c)	**11**	(a)	**14**	(b)	**17**	(d)	**20**	(c)	**23**	(8)	**26**	($20\sqrt{2}$)	**29**	(195)
3	(a)	**6**	(d)	**9**	(a)	**12**	(d)	**15**	(c)	**18**	(c)	**21**	(150)	**24**	($7\sqrt{2}$)	**27**	(60)	**30**	(90)