



Chapter 3 : Motion in a Plane (50 Important MCQs)

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Notes

50 important MCQs from GSEB, CBSE, NEET and JEE exams · Answer key at the end

Section A — Multiple Choice Questions

Each question carries 4 marks. Choose the correct option.

Q.1 A particle starts from the origin with velocity $2\hat{i} \text{ m s}^{-1}$ and moves in the x-y plane with uniform acceleration $(\hat{i} + 3\hat{j}) \text{ m s}^{-2}$. The speed of the particle at 4 s is m/s.

- (A) 10.65 (B) 12.65 (C) 18.65 (D) 13.41

Q.2 An object is thrown vertically upward with velocity 20 m s^{-1} . The maximum height attained by the object is ($g = 10 \text{ m/s}^2$)

- (A) 10 m (B) 20 m (C) 15 m (D) 40 m

Q.3 The x-component of the position vector $\vec{r}$ of a particle is 4 m in the positive x-direction, and its y-component is 3 m in the negative y-direction. The direction of the position vector with respect to the positive x-direction is

- (A) $\tan^{-1} \left(\frac{4}{3} \right)$ (B) $\tan^{-1} \left(\frac{3}{4} \right)$ (C) $\tan^{-1} \left(\frac{-3}{4} \right)$ (D) none of these

Q.4 In a projectile motion, if the maximum height of the projectile is three times its range, then the angle of projection with the horizontal is

- (A) $\tan^{-1} (12)$ (B) $\tan^{-1} (3)$
(C) $\tan^{-1} (2)$ (D) none of these

Q.5 If two forces of equal magnitude F act on a particle at an angle of 60° , their resultant force is

- (A) $\sqrt{3} F$ (B) $3F$ (C) $2F$ (D) none

Q.6 The component of vector $\hat{i} + \hat{j}$ in the direction of $2\hat{i} + 3\hat{j}$ is

- (A) $\frac{5}{\sqrt{13}}$ (B) $\frac{5}{\sqrt{26}}$ (C) $\frac{5}{\sqrt{2}}$ (D) $\frac{5}{2}$

Q.7 The equation of trajectory of a projectile is $y = \sqrt{3} x - 0.8x^2$ (x, y in metres, $g = 10 \text{ m/s}^2$). Match the following:

- Initial velocity (m/s): (a) 25 (b) 10 (c) 5 (d) $5/2$
- Range (m): (a) $15/4$ (b) $5\sqrt{3}/4$ (c) $15/\sqrt{3}$ (d) $5\sqrt{3}$
- Time of flight (s): (a) $\sqrt{3}$ (b) $\sqrt{3}/2$ (c) $2\sqrt{3}/5$ (d) $\sqrt{6}$
- Maximum height (m): (a) $15/12$ (b) $15/16$ (c) $15/4$ (d) $15/8$

(A) 1-(a), 2-(b), 3-(b), 4-(d)

(B) 1-(c), 2-(b), 3-(b), 4-(b)

(C) 1-(d), 2-(d), 3-(b), 4-(c)

(D) 1-(a), 2-(b), 3-(c), 4-(b)

Q.8 A ball thrown vertically upward attains a maximum height of 36 m. At what height would its velocity be half of its initial velocity?

(A) 24 m

(B) 27 m

(C) 36 m

(D) 12 m

Q.9 An object is thrown vertically up with initial velocity 10 m/s. Calculate (a) the time taken to reach maximum height, (b) the maximum height. [Take $g = 10 \text{ m/s}^2$]

(A) 2 s, 5 m

(B) 1 s, 10 m

(C) 1 s, 5 m

(D) 2 s, 10 m

Q.10 A particle describes uniform circular motion on a circle of radius 5 cm with a speed of 10 cm/s. Its centripetal acceleration will be

(A) 50 cm s^{-2} (B) 2 cm s^{-2} (C) 2.5 cm s^{-2} (D) 20 cm s^{-2}

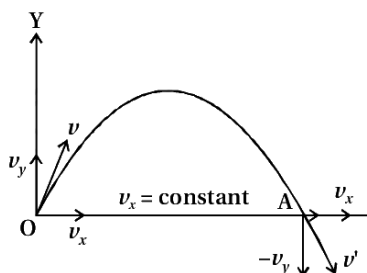
Q.11 The equation of motion of an object moving in a straight line is $x = 8 + 12t - t^3$, where x is in metres and t in seconds. What is the magnitude of its acceleration when its velocity is zero?

(A) 24 m s^{-2}

(B) zero

(C) 6 m s^{-2} (D) 12 m s^{-2}

Q.12 The velocity of a projectile at the initial point O is $(2\hat{i} + 3\hat{j}) \text{ m/s}$. Its velocity (in m/s) at point A, where it returns to the same horizontal level, is

(A) $2\hat{i} + 3\hat{j}$ (B) $-2\hat{i} - 3\hat{j}$ (C) $-2\hat{i} + 3\hat{j}$ (D) $2\hat{i} - 3\hat{j}$

Q.13 A stone falls freely under gravity. It covers distances h_1 , h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1 , h_2 and h_3 is

(A) $h_1 = h_2 = h_3$ (B) $h_1 = 2h_2 = 3h_3$ (C) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (D) $h_2 = 3h_1$ and $h_3 = 3h_2$

Q.14 A projectile is fired from the surface of the earth with a velocity of 5 m s^{-1} at angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 m s^{-1} at the same angle follows a trajectory identical with that of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (given $g = 9.8 \text{ m s}^{-2}$)

(A) 3.5 m/s^2 (B) 5.9 m/s^2 (C) 16.3 m/s^2 (D) 110.8 m/s^2

Q.15 A particle moves such that its position coordinates (x, y) are (2 m, 3 m) at $t = 0$, (6 m, 7 m) at $t = 2 \text{ s}$ and (13 m, 14 m) at $t = 5 \text{ s}$. The average velocity vector from $t = 0$ to $t = 5 \text{ s}$ is

(A) $\frac{1}{5} (13\hat{i} + 14\hat{j})$ (B) $\frac{7}{3} (\hat{i} + \hat{j})$ (C) $2 (\hat{i} + \hat{j})$ (D) $\frac{11}{5} (\hat{i} + \hat{j})$

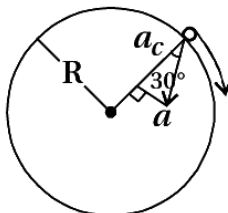
Q.16 If vectors $\vec{A} = \cos \omega t \hat{i} + \sin \omega t \hat{j}$ and $\vec{B} = \cos \frac{\omega t}{2} \hat{i} + \sin \frac{\omega t}{2} \hat{j}$ are functions of time, then the value of t at which they are orthogonal to each other is

(A) $t = 0$ (B) $t = \frac{\pi}{4\omega}$ (C) $t = \frac{\pi}{2\omega}$ (D) $t = \frac{\pi}{\omega}$

Q.17 The position vector of a particle as a function of time is $\vec{R} = 4 \sin (2\pi t) \hat{i} + 4 \cos (2\pi t) \hat{j}$, where R is in metres and t in seconds. Which one of the following statements is **wrong** for the motion of the particle?

- (A) The path of the particle is a circle of radius 4 m.
 (B) The acceleration vector is along $-\vec{R}$.
 (C) The magnitude of the acceleration vector is $\frac{v^2}{R}$, where v is the velocity of the particle.
 (D) The magnitude of the velocity of the particle is 8 m/s.

Q.18 A particle is moving on a circular path of radius $R = 2.5$ m. At a given instant its total acceleration is $a = 15$ m/s², making an angle of 30° with the radius (as shown). What is the speed of the particle at that time?



- (A) 5.7 m/s (B) 6.2 m/s (C) 4.5 m/s (D) 5.0 m/s

Q.19 A stone is dropped from the top of a tower. If its velocity at the midpoint of the height of the tower is 10 m s⁻¹, then the height of the tower is ($g = 10$ m s⁻²)

- (A) 8 m (B) 20 m (C) 10 m (D) 16 m

Q.20 A particle P moves clockwise in a circle of radius 3 m with time period $T = 4$ s. At $t = 0$, P is at the top of the circle, on the positive y-axis. The y-projection of its radius vector is

- (A) $y(t) = 3 \cos \left(\frac{\pi t}{2} \right)$ m (B) $y(t) = -3 \cos 2\pi t$ m
 (C) $y(t) = 4 \sin \left(\frac{\pi t}{2} \right)$ m (D) $y(t) = 3 \cos \left(\frac{3\pi t}{2} \right)$ m

Q.21 The speed of a swimmer in still water is 20 m/s. The speed of river water is 10 m/s, flowing due east. If he stands on the south bank and wishes to cross the river along the shortest path, the angle at which he should make his strokes w.r.t. north is

- (A) 45° west (B) 30° west (C) 0° (D) 60° west

Q.22 When an object is shot from the bottom of a long smooth inclined plane kept at 60° with the horizontal, it travels a distance x_1 along the plane. When the inclination is decreased to 30° and the same object is shot with the same velocity, it travels x_2 . Then $x_1 : x_2$ is

- (A) 1 : $2\sqrt{3}$ (B) 1 : $\sqrt{2}$ (C) $\sqrt{2} : 1$ (D) 1 : $\sqrt{3}$

Q.23 A small block slides down a smooth inclined plane, starting from rest at $t = 0$. Let S_n be the distance travelled by the block in the interval $t = n - 1$ to $t = n$. Then the ratio $\frac{S_n}{S_{n+1}}$ is

- (A) $\frac{2n}{2n-1}$ (B) $\frac{2n-1}{2n}$ (C) $\frac{2n-1}{2n+1}$ (D) $\frac{2n+1}{2n-1}$

Q.24 A car starts from rest and accelerates at 5 m/s². At $t = 4$ s, a ball is dropped out of a window by a person sitting in the car. What are the velocity and acceleration of the ball at $t = 6$ s? (Take $g = 10$ m/s²)

- (A) $20\sqrt{2}$ m/s, 10 m/s² (B) 20 m/s, 5 m/s²
 (C) 20 m/s, 0 (D) $20\sqrt{2}$ m/s, 0

Q.25 A particle moving in a circle of radius R with a uniform speed takes a time T to complete one revolution. If this particle were projected with the same speed at an angle θ to the horizontal, the maximum height attained by it equals $4R$. The angle of projection θ is given by

- (A) $\theta = \sin^{-1} \left(\frac{2gT^2}{\pi^2 R} \right)^{1/2}$ (B) $\theta = \cos^{-1} \left(\frac{gT^2}{\pi^2 R} \right)^{1/2}$
 (C) $\theta = \cos^{-1} \left(\frac{\pi^2 R}{gT^2} \right)^{1/2}$ (D) $\theta = \sin^{-1} \left(\frac{\pi^2 R}{gT^2} \right)^{1/2}$

Q.26 The displacement–time graphs of two moving particles make angles of 30° and 45° with the time axis. The ratio of their respective velocities is

- (A) 1 : 2 (B) $1 : \sqrt{3}$ (C) $\sqrt{3} : 1$ (D) 1 : 1

Q.27 A bullet is fired from a gun at a speed of 280 m s^{-1} in a direction 30° above the horizontal. The maximum height attained by the bullet is ($g = 9.8 \text{ m s}^{-2}$, $\sin 30^\circ = 0.5$)

- (A) 3000 m (B) 2800 m (C) 2000 m (D) 1000 m

Q.28 A student standing on a bridge throws a small ball vertically upwards with a velocity of 4 m s^{-1} . The ball strikes the water surface after 4 s. The height of the bridge above the water surface is ($g = 10 \text{ m s}^{-2}$)

- (A) 68 m (B) 56 m (C) 60 m (D) 64 m

Q.29 A ball is projected at an angle θ with the horizontal with a velocity v_0 . At the same time, a man runs horizontally to catch the ball with uniform velocity $\frac{v_0}{2}$. If the man can catch the ball, θ is

- (A) 60° (B) 30° (C) 45° (D) none of these

Q.30 From a tower of height H , a particle is thrown vertically upwards with a speed u . The time taken by the particle to hit the ground is n times the time taken by it to reach the highest point of its path. The relation between H , u and n is

- (A) $2gH = nu^2 (n - 2)$ (B) $gH = (n - 2) u^2$
 (C) $2gH = n^2 u^2$ (D) $gH = (n - 2)^2 u^2$

Q.31 Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $(\vec{A} + \vec{B})$ is n times the magnitude of $(\vec{A} - \vec{B})$. 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) $\sin^{-1} \left(\frac{n - 1}{n + 1} \right)$ (D) $\sin^{-1} \left(\frac{n^2 - 1}{n^2 + 1} \right)$

Q.32 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 $\vec{Q}$ makes with $\vec{Q}$ is

- (A) 45° (B) 60° (C) 75° (D) 90°

Q.33 Starting from the origin at $t = 0$ with initial velocity $5\hat{j} \text{ m s}^{-1}$, a particle moves in the x - y plane with a constant acceleration of $(10\hat{i} + 4\hat{j}) \text{ m s}^{-2}$. At time t its coordinates are $(20 \text{ m}, y_0 \text{ m})$. The values of t and y_0 are respectively

- (A) 4 s and 52 m (B) 2 s and 24 m (C) 2 s and 18 m (D) 5 s and 25 m

Q.34 A ball is projected from the ground with a speed of 15 m s^{-1} at an angle θ with the horizontal so that its range and maximum height are equal. Then $\tan \theta$ will be equal to

- (A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) 2 (D) 4

Q.35 The position of an ant (S in metres) moving in the Y-Z plane is given by $\vec{S} = 2t^2\hat{j} + 5t\hat{k}$ (t in seconds). The magnitude and direction of the velocity of the ant at $t = 1 \text{ s}$ will be

- (A) 16 m/s in y-direction (B) 4 m/s in x-direction
(C) 9 m/s in z-direction (D) 4 m/s in y-direction

Q.36 For a one-dimensional motion, the relation between position x and time t is $t = \alpha x^2 + \beta x$. Find the relation between velocity v and acceleration a.

- (A) $a = \alpha v$ (B) $a = -2\alpha v$ (C) $a = -2\alpha v^3$ (D) $a = 2\alpha v^2$

Q.37 Two projectiles are fired with the same initial speed from the same point on the ground at angles of $(45^\circ - \alpha)$ and $(45^\circ + \alpha)$ respectively with the horizontal. The ratio of their maximum heights is

- (A) $\frac{1 + \sin 2\alpha}{1 - \sin 2\alpha}$ (B) $\frac{1 + \sin \alpha}{1 - \sin \alpha}$ (C) $\frac{1 + \tan \alpha}{1 - \tan \alpha}$ (D) $\frac{1 - \sin 2\alpha}{1 + \sin 2\alpha}$

Q.38 The magnitudes of two vectors are $2A$ and $\sqrt{2}A$, and the magnitude of their resultant is $\sqrt{10}A$. The angle between the two vectors is

- (A) 30° (B) 45° (C) 60° (D) 90°

Q.39 If $0.5\hat{i} + 0.8\hat{j} + c\hat{k}$ is a unit vector, then c is

- (A) $\sqrt{0.11}$ (B) $\sqrt{0.22}$ (C) $\sqrt{0.33}$ (D) $\sqrt{0.89}$

Q.40 Two stones are projected at different angles but with the same velocity. Their ranges are equal. The angle of projection of the first stone is 30° and its maximum height is H_1 . The maximum height attained by the second stone will be

- (A) $\frac{H_1}{2}$ (B) H_1 (C) $2H_1$ (D) $3H_1$

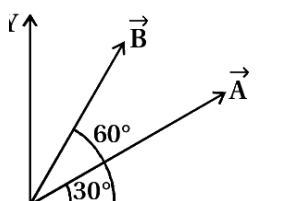
Q.41 Two objects are projected such that their ranges are equal. The maximum heights attained by them are H_1 and H_2 ($H_1 > H_2$). The difference in their maximum heights is equal to the average of their maximum heights. The angle of projection of the second object will be

- (A) 45° (B) 60° (C) 30° (D) $\tan^{-1}\left(\frac{3}{4}\right)$

Q.42 A particle attains a maximum height h_1 when projected at an angle θ with the horizontal. If the same particle is projected with the same speed at an angle $\left(\frac{\pi}{2} - \theta\right)$, it attains a maximum height h_2 . The relation between the range R, h_1 and h_2 is

- (A) $R = \sqrt{h_1 h_2}$ (B) $R = \sqrt{2h_1 h_2}$ (C) $R = 2\sqrt{h_1 h_2}$ (D) $R = 4\sqrt{h_1 h_2}$

Q.43 Vector $\vec{A}$ makes an angle of 30° with the X-axis and vector $\vec{B}$ makes an angle of 60° with the X-axis (as shown). What is the component of $\vec{A} + \vec{B}$ along the X-axis?



ector for the distance be:

(A) $A \cos 30^\circ + B \cos 60^\circ$

(B) $A \cos 30^\circ + B \sin 60^\circ$

(C) $A \sin 30^\circ + B \cos 60^\circ$

(D) $A \sin 30^\circ + B \sin 60^\circ$

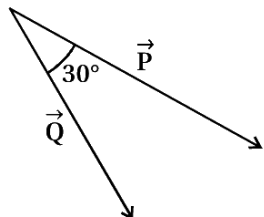
Q.44 Which of the following is perpendicular to $\cos \theta \hat{i} + \sin \theta \hat{j}$?

(A) $\cos \theta \hat{i} + \sin \theta \hat{j}$

(B) $-\cos \theta \hat{i} + \sin \theta \hat{j}$

(C) $-\cos \theta \hat{i} - \sin \theta \hat{j}$

(D) $-(\sin \theta \hat{i} - \cos \theta \hat{j})$

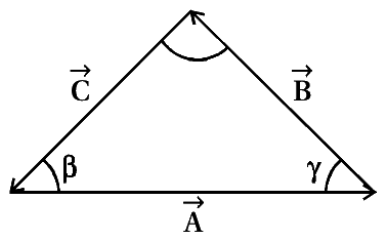
Q.45 Find $|\vec{P} - \vec{Q}|$ from the diagram shown, where $|\vec{P}| = 3$, $|\vec{Q}| = 2$ and the angle between them is 30° .

(A) $(13 + 6\sqrt{3})^{1/2}$

(B) $(13 - 6\sqrt{3})^{1/2}$

(C) $(13 - 2\sqrt{3})^{1/2}$

(D) $(12 - 6\sqrt{3})^{1/2}$

Q.46 Three vectors form a plane triangle (as shown). If $|\vec{A}| = 2$, the angle α opposite to $\vec{A}$ is 30° , and $|\vec{B}| = 2\sqrt{3}$, find the angle β opposite to $\vec{B}$.

(A) 60°

(B) 30°

(C) 45°

(D) 90°

Q.47 The resultant of two forces $(A + B)$ and $(A - B)$ is $\sqrt{3A^2 + B^2}$. Then the angle between the two forces is

(A) $\frac{\pi}{4}$

(B) $\frac{\pi}{3}$

(C) $\frac{\pi}{2}$

(D) π

Q.48 Vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A}| = |\vec{B}|$ and the angle between them is 60° . The angle made by the resultant of $\vec{A}$ and $\vec{B}$ with $\vec{A}$ will be

(A) 30°

(B) 45°

(C) 60°

(D) 120°

Q.49 The position of a particle changes from $\vec{r}_1 = 2\hat{i} - 2\hat{j} + 3\hat{k}$ to $\vec{r}_2 = 3\hat{i} + 2\hat{j} - \hat{k}$ in 5 s. Its average velocity will be

(A) $0.5\hat{i} + 0.4\hat{k}$

(B) $0.1\hat{i} + 0.4\hat{j} - 0.4\hat{k}$

(C) $\hat{i} + 0.8\hat{j} + 0.5\hat{k}$

(D) $0.2\hat{i} + 0.8\hat{j} - 0.8\hat{k}$

Q.50 The coordinates of an object are $x = 3t^3$, $y = 2t^2 + 8t$ and $z = 6t - 5$. The initial speed of the particle is

(A) 20

(B) 13

(C) 10

(D) 5

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	11	D	21	B	31	A	41	C
2	B	12	D	22	D	32	D	42	D
3	C	13	C	23	C	33	C	43	A
4	A	14	A	24	A	34	D	44	D
5	A	15	D	25	A	35	D	45	B
6	A	16	D	26	B	36	C	46	A
7	B	17	D	27	D	37	D	47	B
8	B	18	A	28	D	38	B	48	A
9	C	19	C	29	A	39	A	49	D
10	D	20	A	30	A	40	D	50	C

