Exercise-1

Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

Section (A) : Definition, Projectile on a horizontal plane

A-1. A ball is thrown upwards. It returns to ground describing a parabolic path. Which of the following remains constant?
(1) ? speed of the ball
(2) kinetic energy of the ball
(3) vertical component of velocity
(4) horizontal component of velocity.

A-2. A bullet is fired horizontally from a rifle at a distant target. Ignoring the effect of air resistance, which of the following is correct?

	Horizontal Acceleration	Vertical Acceleration
(1)	10 ms^{-2}	10 ms^{-2}
(2)	10 ms^{-2}	0 ms^{-2}
(3)	0 ms^{-2}	10 ms^{-2}
(4)	0 ms^{-2}	0 ms^{-2}.

A-3. 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
(1) v sin θ, horizontal and in the plane of projection
(2) v cos θ, horizontal and in the plane of projection
(3) 2v sin θ, horizontal and perpendicular to the plane of projection
(4) 2v cos θ, vertical and in the plane of projection.

A-4. During projectile motion acceleration of a particle at the highest point of its trajectory is
(1) g
(2) zero
(3) less than g
(4) dependent upon projection velocity

A-5. Two bodies are projected with the same velocity if one is projected at an angle of 30º and the other at an angle of 60º to the horizontal, the ratio of the maximum heights reached is-
(1) 3 : 1 (2) 1 : 3 (3) 1 : 2 (4) 2 : 1

A-6. A bomb is fired from a cannon with a velocity of 1000 m/s making an angle of 30º with the horizontal. What is the time taken by the bomb to reach the highest point-
(1) 11 sec (2) 23 sec (3) 38 sec (4) 50 sec

A-7. For a projectile the ratio of maximum height reached to the square of flight time is- (g = 10 ms^{-2})
(1) 5 : 4 (2) 5 : 2 (3) 5 : 1 (4) 10 : 1

A-8. If a projectile is thrown such that range [R] is four times than the height [h] attained then angle of projection is-
(1) 30° (2) 45° (3) 60° (4) 90°

A-9. The range of projectile is 50 m when θ is inclined with horizontal at 15°. What is the range when θ becomes 45°
(1) 400 m (2) 300 m (3) 200 m (4) 100 m

A-10. It was calculated that a shell when fired from a gun with a certain velocity and at an angle of elevation $\frac{5\pi}{36}$ rad should strike a given target in the same horizontal plane. 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.

(1) $\frac{5\pi}{36}$ rad (2) $\frac{11\pi}{36}$ rad (3) $\frac{7\pi}{36}$ rad (4) $\frac{13\pi}{36}$ rad.

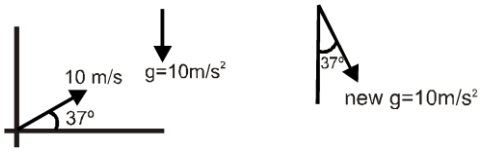
A-11. The velocity of projection of a projectile is (6 + 8) ms^{-1}. The horizontal range of the projectile is ($g = 10m/s^2$)

(1) 4.9 m (2) 9.6 m (3) 19.6 m (4) 14 m

A-12. The time of flight of a projectile is 10s and range is 500m. Maximum height attained by it is-[$g = 10\ m/s^2$]

(1) 25 m (2) 50 m (3) 82 m (4) 125 m

A-13. A particle is projected with a velocity 10 m/s at an angle 37^0 with the horizontal.It reaches to a point P in 1 sec. Now the direction of gravity is changed by 37^0 with the vertical as shown.



The new projection velocity so that the particle reaches the same point P in 1 sec, is:

(1) $\sqrt{10}$ m/s (2) 20 m/s (3) $5\sqrt{2}$ m/s (4) $10\sqrt{3}$ m/s

Section (B) : Projectile from A tower

B-1. A body is projected horizontally from the top of a tower with initial velocity 18 ms^{-1}. It hits the ground at angle 45º. What is the vertical component of velocity when it strikes the ground?

(1) $18\sqrt{2}$ ms^{-1} (2) 18 ms^{-1} (3) $9\sqrt{2}$ ms^{-1} (4) 9 ms^{-1}

B-2. One stone is projected horizontally from a 20 m high cliff with an initial speed of 10 ms^{-1}. A second stone is simultaneously dropped from that cliff. Which of the following is true?

(1) Both strike the ground with the same speed.
(2) The ball with initial speed 10 ms^{-1} reaches the ground first.
(3) Both the balls hit the ground at the same time.
(4) None of these

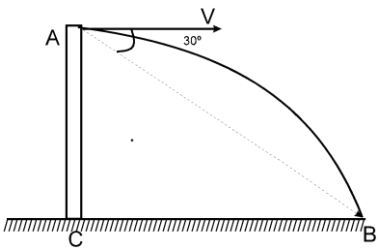
B-3. An aeroplane flying horizontally 490 m above the ground level at 100 m/s, releases a block. How far on the ground will it strike-

(1) 0.1 km (2) 1 km (3) 2 km (4) None of the above

B-4. A sphere thrown from a flying aeroplane (not vertically) shows ..... path

(1) Parabolic (2) Circular (3) Straight line (4) Spiral

B-5. An object is thrown horizontally from a point 'A' from a tower and hits the ground 3s later at B. The line from 'A' to 'B' makes an angle of 30º with the horizontal. The initial velocity of the object is (take $g = 10\ m/s^2$)



(1) $15\sqrt{3}$ m/s (2) 15 m/s

(3) $10\sqrt{3}$ m/s (4) $25/\sqrt{3}$ m/s

B-6. A particle of mass 0.01 kg is projected with velocity v = 2 i m/s from point (x = 0, y = 20). After 2 second, its position coordinates are-
(1) (4, 0) (2) 20, 4 (3) 0, 4 (4) 4, 20

Section (C) : Equation of Trajectory

C-1. 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 :
$x = 10\sqrt{3}\,t$ and $y = 10t - t^2$
The maximum height attained by the ball is
(1) 100 m (2) 75 m (3) 50 m (4) 25 m.

C-2. Equation of motion of a projetile is-
(1) $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$ (2) $y = x\tan\theta + \frac{gx^2}{2u^2\cos^2 q}$
(3) $y = x\sin\theta - \frac{gx^2}{2u^2\cos^2\theta}$ (4) $y = x\sin\theta + \frac{gx^2}{2u^2\cos^2\theta}$

C-3. The trajectory of a projectile fired horizontally with velocity is parabola given by (Take vertical downward direction as positve)
(1) $y = \frac{9}{2u^2}x^2$ (2) $y = -\frac{g}{2u^2}x^2$ (3) $x = \frac{g}{2u^2}y^2$ (4) $x = -\frac{g}{2u^2}y^2$

C-4. The horizontal and verticle distances travelled by a particle in time t are given by x = 6t and $y = 8t - 5t^2$. If g = 10 m/sec^2, then the initial velocity of the particle is-
(1) 8 m/sec (2) 10 m/sec (3) 5 m/sec (4) Zero

C-5. The equation of motion of a projectile are given by x = 36 t metre and $2y = 96\,t - 9.8\,t^2$ metre. The angle of projection is-
(1) $\sin^{-1}\left(\frac{4}{5}\right)$ (2) $\sin^{-1}\left(\frac{3}{5}\right)$ (3) $\sin^{-1}\left(\frac{4}{3}\right)$ (4) $\sin^{-1}\left(\frac{3}{4}\right)$

Section (D) : Projectile on an inclined plane

D-1. A particle is projected at angle 37° with the incline plane in upward direction with speed 10 m/s. The angle of incline plane is given 53°. Then the maximum height above the incline plane attained by the particle will be -
(1) 3m (2) 4 m (3) 5 m (4) zero

D-2. 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 the time in which ball will hit the inclined plane is -
(1) 1 sec. (2) 6 sec. (3) 2 sec. (4) 4 sec.

D-3. A shell is fired from a gun from the bottom of a hill along its slope. The slope of the hill is α = 30°, and the angle of this barrel to the horizontal is β = 60º. The Initial velocity v of the shell is 21 m/sec. Then distance of point from the gun at which shell will fall-
(1) 10 m (2) 20 m (3) 30 m (4) 40 m

D-4. A ball is horizontally projected 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?
(1) $\frac{v^2}{g}$ (2) $\frac{\sqrt{2}\,v^2}{g}$ (3) $\frac{2v^2}{g}$ (4) $\left[\frac{2\sqrt{2}\,v^2}{g}\right]$

Exercise-2

Marked Questions can be used as Revision Questions.

PART - I : OBJECTIVE QUESTIONS

1. An arrow is shot in air, its time of flight is 5 sec and horizontal range is 200m. The inclination of the arrow with the horizontal is-

(1) $\tan^{-1}\frac{5}{8}$ (2) $\tan^{-1}\frac{8}{5}$ (3) $\tan^{-1}\frac{1}{8}$ (4) 45°

2. A ball is thrown at an angle of 30° to the horizontal. It falls on the ground at a distance of 90m. If the ball is thrown with the same initial speed at an angle 30° to the vertical, it will fall on the ground at a distance of-

(1) 120 m (2) 27 m (3) 90 m (4) 30 m

3. A particle moves in the xy plane with only an x-component of acceleration of 2 m s^{-2}. The particle starts from the origin at t = 0 with an initial velocity having an x-component of 8 m s^{-1} and y-component of –15 ms^{-1}. Velocity of particle after time t is :

(1) $[(8 + 2t)\,\hat{i} - 15]\,\hat{j}$ m s^{-1} (2) zero

(3) $2t\hat{i} + 15\hat{j}$ (4) directed along z-axis.

4. A plane flying horizontally at a height of 1500 m with a velocity of 200 ms^{-1} passes directly overhead an antiaircraft gun. Then the angle with the horizontal at which the gun should be fired for the shell with a muzzle velocity of 400 m s^{-1} to hit the plane, is -

(1) 90º (2) 60º (3) 30º (4) 45º

5. A projectile is thrown with velocity v making an angle θ with the horizontal. It just crosses the top of two poles, each of height h, after 1 second and 3 second respectively. The time of flight of the projectile is

(1) 1 s (2) 3 s (3) 4 s (4) 7.8 s.

6. A body has an initial velocity of 3 ms^{-1} and has an acceleration of 1 ms^{-2} normal to the direction of the initial velocity. Then its velocity, 4 second after the start is

(1) 7 ms^{-1} along the direction of initial velocity

(2) 7 ms^{-1} along the normal to the direction of the initial velocity

(3) 7 ms^{-1} mid-way between the two directions

(4) 5 ms^{-1} at an angle of $\tan^{-1}\frac{4}{3}$ with the direction of the initial velocity

7. 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 . The height of P above the horizontal plane will be - [g = 9.8 m/sec^2]

(1) 98 meters (2) 49 meters (3) 196 meters (4) 147 meters

8. At what angle should a body be projected with a velocity 24 ms^{-1} just to pass over the obstacle 14 m high at a distance of 24 m. [Take g = 10 ms^{-2}]

(1) $\tan\theta = 19/5$ (2) $\tan\theta = 4$ (3) $\tan\theta = 3$ (4) $\tan\theta = 2$

9. A projectile is projected at an angle α (> 45°) with an initial velocity u. The time t at which its horizontal component will equal the vertical component in magnitude:

(1) $t = \frac{u}{g}(\cos\alpha - \sin\alpha)$ (2) $t = \frac{u}{g}(\cos\alpha + \sin\alpha)$

(3) $t = \frac{2u}{g}(\sin\alpha - \cos\alpha)$ (4) $t = \frac{u}{g}(\sin^2\alpha - \cos^2\alpha)$

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion / Reasoning

A-1. **STATEMENT-1 :** In a projectile motion, the velocity at its highest point is zero.
STATEMENT-2 : In a projectile motion from ground to ground projection, the acceleration is g downwards due to which speed of the projectile first decreases then increases to the same value.
(1) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is correct explanation for STATEMENT-1
(2) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is not correct explanation for STATEMENT-1
(3) STATEMENT-1 is true, STATEMENT-2 is false
(4) STATEMENT-1 is false, STATEMENT-2 is true

A-2. **STATEMENT-1 :** Two stones are simultaneously projected from level ground from same point with same speeds but different angles with horizontal. Both stones move in same vertical plane. Then the two stones may collide in mid air.
STATEMENT-2 : For two stones projected simultaneously from same point with same speed at different angles with horizontal, their trajectories may intersect at some point.
(1) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is correct explanation for STATEMENT-1
(2) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is not correct explanation for STATEMENT-1
(3) STATEMENT-1 is true, STATEMENT-2 is false
(4) STATEMENT-1 is false, STATEMENT-2 is true

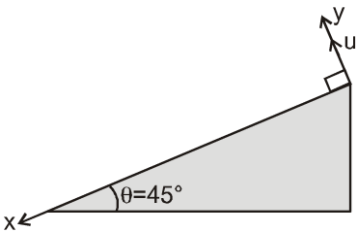
A-3. **STATEMENT-1 :** Horizontal component of velocity is constant in a projectile motion under gravity.
STATEMENT-2 : Acceleration is along the vertical direction in projectile motion under gravity.
(1) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is correct explanation for STATEMENT-1
(2) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is not correct explanation for STATEMENT-1
(3) STATEMENT-1 is true, STATEMENT-2 is false
(4) STATEMENT-1 is false, STATEMENT-2 is true

A-4. **STATEMENT-1 :** A stone is projected (not vertically upwards) from level ground . The average velocity of this stone is in horizontal direction in between the two instants of time when velocity of stone makes same angle(in magnitude) with horizontal . (Neglect air friction)
STATEMENT-2 : The average velocity of a projectile (not projected vertically upwards) in between any two instants of time is always in horizontal direction.
(1) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is correct explanation for STATEMENT-1
(2) STATEMENT-1 is true, STATEMENT-2 is true and STATEMENT-2 is not correct explanation for STATEMENT-1
(3) STATEMENT-1 is true, STATEMENT-2 is false
(4) STATEMENT-1 is false, STATEMENT-2 is true

Section (B) : Match the column

B-1. Match the following :

An inclined plane makes an angle $\theta = 45°$ with horizontal. A stone is projected normally from the inclined plane, with speed u m/s at t = 0 sec. x and y axis are drawn from point of projection along and normal to inclined plane as shown. The length of incline is sufficient for stone to land on it and neglect air friction. Match the statements given in column I with the results in column II.

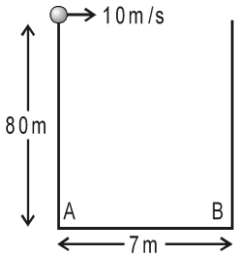


Column I	Column II
(1) The instant of time at which velocity of stone is parallel to x-axis	(p) $\frac{2\sqrt{2}u}{g}$
(2) The instant of time at which velocity of stone makes an angle $\theta = 45°$ with positive x-axis.	(q) $\frac{2u}{g}$
(3) The instant of time till which (starting from t = 0) component of displacement along x-axis is half the range on inclined plane is	(r) $\frac{\sqrt{2}u}{g}$
(4) Time of flight on inclined plane is	(s) $\frac{u}{\sqrt{2}g}$

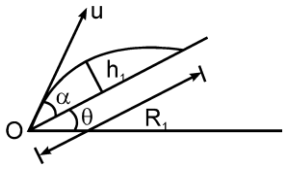
Section (C) : One or More Than One Options Correct

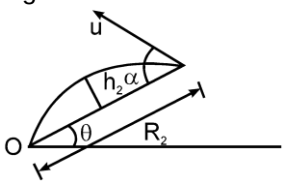
C-1. A ball is projected horizontally from top of a 80 m deep well with velocity 10 m/s. Then particle will fall on the bottom at a distance of (all the collisions with the wall are elastic) :

(1) 5 m from A
(2) 5 m from B
(3) 2 m from A
(4) 2 m from B



C-2. Two balls are thrown from an inclined plane at angle of projection α with the plane one up the incline plane and other down the incline as shown in the figure. If R_1 & R_2 be their respective ranges, then:





(1) $h_1 = h_2$ (2) $R_2 - R_1 = T_1^2$

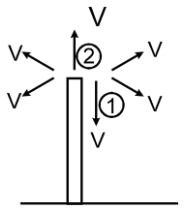
(3) $R_2 - R_1 = g \sin\theta\, T_2^2$ (4) $R_2 - R_1 = g \sin\theta\, T_1^2$

[here T_1 & T_2 are times of flight in the two cases respectively]

C-3. At what angle should a body be projected with a velocity 24 ms^{-1} just to pass over the obstacle 14 m high at a distance of 24 m. [Take g = 10 ms^{-2}]

(1) $\tan\theta = 19/5$ (2) $\tan\theta = 1$ (3) $\tan\theta = 3$ (4) $\tan\theta = 2$

C-4. Particles are projected from the top of a tower with same speed at different angles as shown. Which of the following are True ?



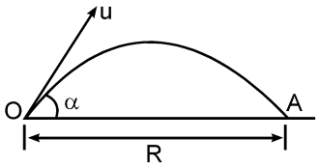
(1) All the particles would strike the ground with (same) speed.
(2)All the particles would strike the ground with (same) speed simultaneously.
(3) Particle 1 will be the first to strike the ground.
(4) Particle 1 strikes the ground with maximum speed.

C-5. A projectile is projected at an angle α (> 45°) with an initial velocity u. The time t at which its horizontal component will equal the vertical component in magnitude:

(1) $t = \frac{u}{g}(\cos\alpha - \sin\alpha)$ (2) $t = \frac{u}{g}(\cos\alpha + \sin\alpha)$

(3) $t = \frac{u}{g}(\sin\alpha - \cos\alpha)$ (4) $t = \frac{u}{g}(\sin^2\alpha - \cos^2\alpha)$

C-6. A particle projected from O and moving freely under gravity strikes the horizontal plane passing through O at a distance R from starting point O as shown in the figure. Then :



(1) There will be two angles of projection if $Rg < u^2$
(2) The two possible angles of projection are complementary
(3) The product of the possible times of flight from O to A is 2R/g
(4) There will be more than two angles of projection if $Rg = u^2$

Exercise-3

Marked Questions can be used as Revision Questions.

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. A ball whose kinetic energy is E, is projected at an angle of 45° to the horizontal.The kinetic energy of the ball at the highest point of its flight will be : **[AIEEE-2002, 4/300]**

(1) E (2) $E/\sqrt{2}$ (3) E/2 (4) zero

2. A boy playing on the roof of a 10 m high building throws a ball with a speed of 10 m/s at an angle of 30º with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground? **[AIEEE-2002, 4/300]**

[$g = 10\ m/s^2$, $\sin 30^\circ = 1/2$, $\cos 30^\circ = \frac{\sqrt{3}}{2}$]

(1) 5.20 m (2) 4.33 m (3) 2.60 m (4) 8.66 m

3. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two times of flights is directly proportional to **[AIEEE-2004, 4/300]**

(1) $1/R^2$ (2) 1/R (3) R (4) R^2

4. A ball is thrown from a point with a speed v_0 at 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? If yes, what should be the angle of projection? **[AIEEE-2004, 4/300]**

(1) Yes, 60º (2) Yes, 30º (3) No (4) Yes, 45º

5. A particle is projected at 60º to the horizontal with a kinetic energy K. The kinetic energy at the highest point is **[AIEEE-2007, 3/120]**

(1) K (2) Zero (3) K/4 (4) K/2

6. 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 : **[AIEEE-2009, 4/144]**

(1) $7\sqrt{2}$ units (2) 7 units (3) 8.5 units (4) 10 units

7. 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: **[AIEEE 2010, 4/144]**

(1) $y = x^2 + \text{constant}$ (2) $y^2 = x + \text{constant}$ (3) $xy = \text{constant}$ (4) $y^2 = x^2 + \text{constant}$

8. A water fountain on the ground sprinkles water all around it. If the speed of water coming out of the fountain is v, the total area around the fountain that gets wet is : **[AIEEE - 2011, 4/120, –1]**

(1) $\pi\frac{v^2}{g}$ (2) $\pi\frac{v^4}{g^2}$ (3) $\frac{\pi}{2}\frac{v^4}{g^2}$ (4) $\pi\frac{v^2}{g^2}$

9. A boy can throw a stone up to a maximum height of 10m. The maximum horizontal distance that the boy can throw the same stone up to will be : **[AIEEE 2012 ; 4/120, –1]**

(1) $20\sqrt{2}$ m (2) 10 m (3) $10\sqrt{2}$ m (4) 20m

10. A projectile is given an initial velocity of $\left(\hat{i}+2\hat{j}\right)$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10 m/s^2, the equation of its trajectory is : **[JEE(Main)-2013, 4/120, –1]**

(1) $y = x - 5x^2$ (2) $y = 2x - 5x^2$ (3) $4y = 2x - 5x^2$ (4) $4y = 2x - 25x^2$

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1.* The coordinates of a particle moving in a plane are given by x (t) = a cos (p t) and y (t) = b sin (pt), where a, b (< a) and p are positive constants of appropriate dimensions then **[JEE 1999, 3/200]**

(A) The path of the particle is an ellipse

(B) The velocity and acceleration of the particle are normal to each other at t = π/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 = π/2p is a.

Answers

EXERCISE-1

Section : A

A-1.	(4)	**A-2.**	(3)	**A-3.**	(1)
A-4.	(1)	**A-5.**	(2)	**A-6.**	(4)
A-7.	(1)	**A-8.**	(2)	**A-9.**	(4)
A-10.	(4)	**A-11.**	(2)	**A-12.**	(4)
A-13.	(3)				

Section : B

B-1.	(2)	**B-2.**	(3)	**B-3.**	(2)
B-4.	(1)	**B-5.**	(1)	**B-6.**	(1)

Section : C

C-1.	(4)	**C-2.**	(1)	**C-3.**	(1)
C-4.	(2)	**C-5.**	(1)		

Section : D

D-1.	(1)	**D-2.**	(3)	**D-3.**	(3)
D-4.	(4)				

EXERCISE-2

PART- I

1.	(1)	**2.**	(3)	**3.**	(1)
4.	(2)	**5.**	(3)	**6.**	(4)
7.	(1)	**8.**	(1)	**9.**	(2)

PART- II

Section : A

A-1.	(4)	**A-2.**	(4)	**A-3.**	(1)
A-4.	(3)				

Section : B

B-1. (1 → r), (2 → s), (3 → q), (4 → p)

Section : C

C-1.	(2,3)	**C-2.**	(1,3,4)	**C-3.**	(1,2)
C-4.	(1,3)	**C-5.**	(2,3)	**C-6.**	(1,2,3)

EXERCISE-3

PART- I

1.	(3)	**2.**	(4)	**3.**	(3)
4.	(1)	**5.**	(3)	**6.**	(1)
7.	(4)	**8.**	(2)	**9.**	(4)
10.	(2)				

PART- II

1. (A,B)