10. Assignment (Subjective Problems)

LEVEL – I

1. A cricketer hits a ball from the ground level with a velocity $\vec{v}_0 = (20\hat{i} + 10\hat{j})$ m/sec. Find the velocity of the ball at t = 1 sec, from the instant of projection ($g = 10$ m/sec^2).

2. A body is projected vertically up with a speed V_0. Find the magnitude of time average velocity of the body during its ascent.

3. A bomb is released from an aeroplane flying with a horizontal velocity of magnitude 100 m/sec at an altitude of 1 km. What is the displacement during the time of its flight?

4. A football player kicks the football so that it will have a "hang time" (time of flight) of 5s and lands 50 m away. If the ball leaves the player's foot 1.5m above the ground, what is its initial velocity (magnitude and direction)? ($g = 10$ m/sec^2)

5. A rocket is fired vertically up from the ground with a resultant vertical acceleration of 10 m/s^2. The fuel is finished in 1 minute and it continues to move up
   (a) what is the maximum height reached ?
   (b) After how much time from then will the maximum height be reached?
   (Take $g = 10$ m/s^2)

6. A ball is falling from the top of a cliff of height h with an initial speed V. Another ball is simultaneously projected vertically up with the same speed. When do they meet ?

7. If an object travels one-half its total path in the last second of its fall from rest, find (a) the time and (b) the height of its fall. Explain the physically unacceptable solution of the quadratic time equation.

8. A particle starts moving due east with a velocity $v_1 = 5$ m/sec. for 10 sec. and turns to north with a velocity $v_2 = 10$ m/sec. for 5 sec. Find the average velocity of the particle during 15 sec. from starting.

9. A particle is moving with a speed v_0 in a circular path of radius R. Find the ratio of average velocity to its instantaneous velocity when the particle describes an angle θ ($< \pi/2$).

10. To a man moving due east with a speed v in a rain, the rain appears to fall vertically. If he changes his speed by a factor n, the rain appears to fall at an angle θ to vertical. Find the speed of the rain.

LEVEL – II

1. Two particles are projected horizontally in opposite directions with v_1 & v_2 from the top of a pole. If the particles move perpendicular to each other just before striking the ground, find the height of the pole.
2. A cannon fires successively two shells with velocity v_o = 250 m/s; the first at the angle α_1 = 60° and the second at the angle α_2 = 45° to the horizontal, the azimuth being the same. Neglecting the air drag, find the time interval between firings leading to the collision of the shells.
3. An aeroplane flies in still air at a speed of 400 km/hr. Air is blowing from the south at a speed of 50 km/hr. The pilot wants to travel from point A to point B north-east of A and then to return. Calculate the direction he must steer (a) on his onward journey (b) on his return journey. If the distance AB is 1000 km then calculate the time taken in two journeys.
4. Two particles move in a uniform gravitational field with an acceleration g. At the initial moment the particles were located at one point in space and moved with velocities v_1 = 3.0 m/s and v_2 = 4.0 m/s horizontally in opposite directions. Find the distance between the particles at the moment when their velocity vectors become mutually perpendicular.
5. A point moves rectilinearly with deceleration whose modulus depends on the velocity v of the particle as $w = a\sqrt{v}$, where 'a' is a positive constant. At the initial moment the velocity of the point is equal to v_o. What distance will it traverse before it stops? What time will it take to cover that distance?

6. Find the ratio between the normal and tangential acceleration of a point on the rim of a rotating wheel when at the moment when the vector of the total acceleration of this point forms an angle of 30° with the vector of the linear velocity.
7. A fan rotates with a velocity corresponding to a frequency of 900 rev/min. When its motor is switched off, the fan uniformly slows down and performs 75 revolutions before it comes to a stop. How much time elapsed from the moment the fan was switched off to the moment it stopped?
8. A motor cyclist, going due east with a velocity of 10 m/s, finds that the wind is blowing directly from the north. When he doubles his speed, he finds that the wind is blowing from north east. In what direction and with what velocity is the wind blowin?.
9. The acceleration vector of a particle having initial speed V_0 changes with distance as $a = \sqrt{x}$. Find the distance covered by the particle when its speed becomes twice the initial speed.
10. An observer in a train moving with a uniform velocity finds that a car moving parallel to the train has a speed of 10 km/h in the direction of motion of the train. An object falls from the car and the observer in the train notices that the car has moved on for one minute, turned back, and moved with a speed of 10 km/h and picked up the object two minutes after turning. Find
    (a) the velocity of the train relative to the ground and
    (b) the velocity of the car during its forward and reverse journeys.
    Assume that the object comes to rest immediately on fall from the point of view of the observer on the ground.

11. Assignment (Objective Problems)

LEVEL- I

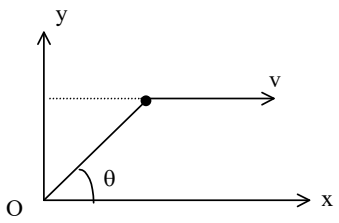
1. A stone is released from an elevator going up with acceleration 5 m/s^2. The acceleration of the stone after the release is:
(A) 5 ms^{-2} (B) 4.8 ms^{-2} upward
(C) 4.8 down ward (D) 9.8 ms^{-2} down ward

2. The locus of a projectile relative to another projectile is a
(A) straight line (B) circle
(C) ellipse (D) parabola

3. A car accelerates from rest at constant rate of 2 m/s^2 for some time. Then its retards at a constant rate of 4 m/s^2 and comes to rest. What is the maximum speed attained by the car if it remains in motion for 3 seconds
(A) 2 m/s (B) 3 m/s
(C) 4 m/s (D) 6 m/s

4. The co-ordinates of a moving particle at any time t are given by x = ct^2 and y = bt^2. The speed of the particle is given by:
(A) 2t (c + b) (B) 2t $\sqrt{(c^2 - b^2)}$
(C) t$\sqrt{(c^2 + b^2)}$ (D) 2t$\sqrt{(c^2 + b^2)}$

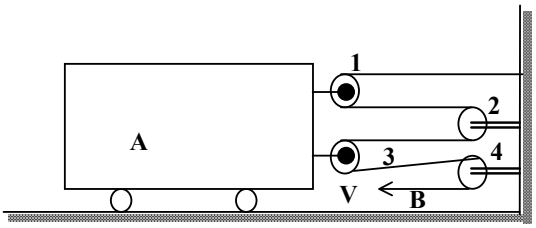
5. A particle parallel to x-axis as shown in the figure such that at all instant the y axis component of its position vector is constant and is equal to 'b'. The angular velocity of the particle about the origin is



(A) $\frac{v}{b}$ (B) $\frac{v}{b}\sin\theta$
(C) $\frac{v}{b}\sin^2\theta$ (D) vb

6. A particle is projected vertically upwards and it attains maximum height H. If the ratio of times to attain height h(h < H) is 1/3, then h equals
(A) 2/3. H (B) 3/ 4. H
(C) 4/3 . H (D) 3/2. H

7. A boy B drags a wedge A by an in extensible string passing over the pulleys 1,2,3 & 4 as shown in the figure If all the pulleys are smooth and the boy walks with constant velocity of magnitude v, the magnitude of relative velocity between the boy and the wedge is equal to



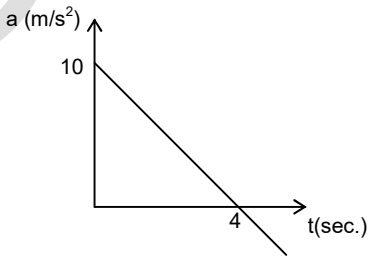
(A) v (B) 2v
(C) 1.5v (D) 1.25v

8. A swimmer wishes to reach directly opposite bank of a river, flowing with velocity 8 m/s. The swimmer can swim 10 m/s in still water. The width of the river is 480 m. Time taken by him to do so:
(A) 60 sec (B) 48 sec
(C) 80 sec (D) None of these

9. A man can swim at a speed of 5 km/h w.r.t. water. He wants to cross a 1.5 km wide river flowing at 3 km/h. He keeps himself always at an angle of 60° with the flow direction while swimming. The time taken by him to cross the river will be
(A) 0.25 hr. (B) 0.35 hr.
(C) 0.45 hr. (D) 0.55 hr.

10. A disc of radius R is rotating inside a room A boy standing near the rim of the disc, finds the water droplets falling from the ceiling is always hitting on his head. As one drop hits his head the next one starts from the ceiling. If height of the roof above his head is H. Angular velocity of disc is:
(A) $\pi\sqrt{\frac{2gR}{H^2}}$ (B) $\pi\sqrt{\frac{2gH}{R^2}}$
(C) $\pi\sqrt{\frac{2g}{H}}$ (D) $2\pi\sqrt{\frac{2g}{H}}$

11. The acceleration-time graph of a particle moving along a straight line is as shown in figure. At what time the particle acquires its initial velocity?
(A) 12 sec.
(B) 5 sec.
(C) 8 sec.
(D) 16 sec.



12. What are the speeds of two objects if they move uniformly towards each other, they get 4m closer in each second and if they move uniformly in the same direction with the original speeds they get 4m closer in each 10 sec ?
(A) 2.8 m/s and 1.2 m/s (B) 5.2 m/s and 4.6 m/s
(C) 3.2 m/s and 2.1 m/s (D) 2.2 m/s and 1.8 m/s

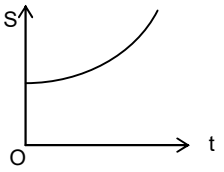
13. From the top of a tower, a stone is thrown up. It reaches the ground in 5 sec. A second stone is thrown down with the same speed and reaches the ground in 1sec. A third stone is released from rest and reaches the ground in
(A) 3 sec. (B) 2 sec.
(C) $\sqrt{5}$ sec. (D) 2.5 sec.

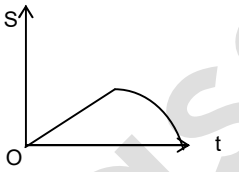
14. A particle has an initial velocity of $(3\hat{i}+4j)$m/s and a constant acceleration of $(4\hat{i}-3\hat{j})$ m/s^2. Its speed after one second will be equal to
(A) 0 (B) 10 m/sec
(C) $5\sqrt{2}$ m/sec (D) 25 m/sec

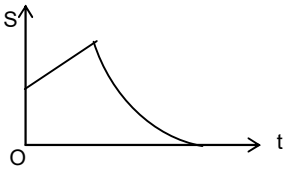
15. A balloon starts rising from the ground with an acceleration of 1.25 m/s^2. After 8 seconds, a stone is released from the balloon. After releasing, the stone will

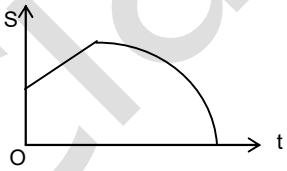
A) cover a distance of 40 m till it strikes the ground.
(B) have a displacement of 50 m till it reaches the ground
(C) reach the ground in 4 seconds.
(D) begin to move down instantaneously

16. Two balls are dropped from the top of a high tower with a time interval of t_0 second, where t_0 is smaller than the time taken by the first ball to reach the floor which is perfectly inelastic. The distance S between the two balls, plotted against the time lapse 't' from the instant of dropping the second ball is best represented by

(A)


(B)


(C)


(D)


17. The K.E. (K) of a particle moving along a circle of radius R depends on the distance covered s as $K = as^2$. The force acting on particle is

(A) $\frac{2as^2}{R}$ (B) $\frac{2as}{\left(1+\frac{s^2}{R}\right)^{1/2}}$

(C) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$ (D) none of these.

18. Two particles P and Q start from rest and move for equal time on a straight line. Particle P has an acceleration of X m/s^2 for the first half of the total time and 2x m/s^2 for the second half. Particle Q has an acceleration of 2X m/s^2 for the first half of the total time and X m/s^2 for the second half. Which particle has covered larger distance?
(A) Both have covered the same distance
(B) P has covered the larger distance
(C) Q has covered the larger distance
(D) data insufficient

19. A particle is moving in a circle of radius R in such a way that at any instant the normal and tangential components of its acceleration are equal. If its speed at t = 0 is v_0 the time taken to complete the first revolution is
(A) R/v_0 (B) v_0/R
(C) $R/v_0\,(1 - e^{-2\pi})$ (D) $R/v_0\,(e^{-2\pi})$

20. A motor boat of mass m moves along a lake with velocity v_0. At t = 0, the engine of the boat is shut down. Resistance offered to the boat is equal to σv. What is the total distance covered till it stops completely?

(A) $\frac{mv_0}{\sigma}$ (B) $\frac{3mv_0}{2\sigma}$

(C) $\frac{mv_0}{2\sigma}$ (D) $\frac{2mv_0}{\sigma}$

LEVEL- II

1. A particle moves along positive branch of the curve $y = \frac{x}{2}$ where $x = \frac{t^3}{3}$, x and y are measured in metres and t in seconds, then

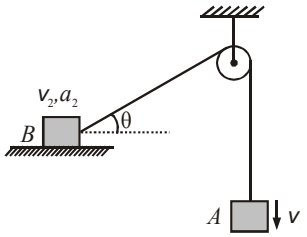
(A) the velocity of particle at t = 1 s is $\hat{i} + \frac{1}{2}\hat{j}$

(B) the velocity of particle at t = 1 s is $\frac{1}{2}\hat{i} + \hat{j}$

(C) the acceleration of particle at t = 2 s is $2\hat{i} + \hat{j}$

(D) the acceleration of particle at t = 2 s is $\hat{i} + 2\hat{j}$

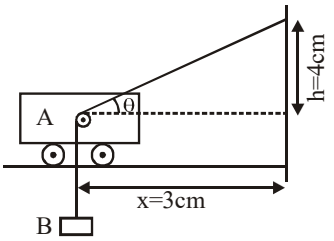
2. Figure shows two blocks, each of mass m. The system is released from rest at the position, shown in fig. If initial acceleration of blocks A and B are a_1 and a_2 respectively and during the motion velocities of A and B are v_1 and v_2 respectively, then :



(A) $a_1 = a_2 \cos\theta$ (B) $a_2 = a_1 \cos\theta$

(C) $v_1 = v_2 \cos\theta$ (D) $v_2 = v_1 \cos\theta$

3. The string shown in the figure is passing over small smooth pulley rigidly attached to trolley *A*. If speed of trolley is constant and equal to V_A. Speed and magnitude of acceleration of block B at the instant shown in figure is



(A) $v_B = v_A$, $a_B = 0$ (B) $a_B = 0$

(C) $v_B = \frac{3}{5}v_A$ (D) $a_B = \frac{16v_A}{125}$

4. A particle is projected from the ground in earth's gravitational field at an angle θ with the horizontal then

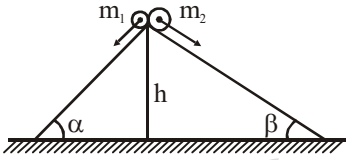
(A) center of curvature of projectile's trajectory at the highest point is below the ground level if $\theta < \tan^{-1}\sqrt{2}$

(B) centre of curvature of projectile's trajectory at the highest point is above the ground level if $\theta > \tan^{-1}\sqrt{2}$

(C) center of curvature of projectile's trajectory at the highest point is above ground level if $\theta < \tan^{-1} 2$

(D) center of curvature of projectile's trajectory at the highest point is below the ground level is $\theta > \tan^{-1} 2$

5. Two different balls of masses m_1 and m_2 are allowed to slide down from rest and from same height h along two smooth inclined planes having different angles of inclination α and β. Then



(A) the final speed velocity acquired by them will be the same
(B) the final speed acquired by them will be different
(C) the times taken by them to reach the bottom will be the same
(D) the times taken by them to reach the bottom will be in the ratio ($\sin\beta/\sin\alpha$)

6. A particle is moving along a curve. Then
(A) if its speed is constant it has no acceleration
(B) if its speed is increasing the acceleration of the particle is along its direction of motion
(C) if its speed is constant the magnitude of its acceleration is proportional to its curvature.
(D) the direction of its acceleration cannot be along the tangent.

7. A particle of mass m moves along x-axis as follows : it starts from rest at t = 0 from the point x = 0, and comes to rest at t = 1 sec at the point x = 1. No other information is available about its motion at intermediate times (0 < t < 1). If α denotes the acceleration of the particle then,
(A) α cannot remain positive for all t in the interval $0 \le t \le 1$.
(B) $|\alpha|$ can not exceed 2at any point in its path.
(C) $|\alpha|$ must be ≥ 4 at some point or points in its path.
(D) α must change sign during the motion, but no other assertion can be made with the information given :

8. Mark the correct statements for a particle going on a straight line
(A) if the velocity is zero at any instant, the acceleration should also be zero at that instant
(B) if the velocity is zero for a time interval, the acceleration is zero at any instant within the time interval
(C) if the velocity and acceleration have opposite sign, the object is slowing down
(D) if the position and velocity have opposite sign, the particle is moving towards the origin

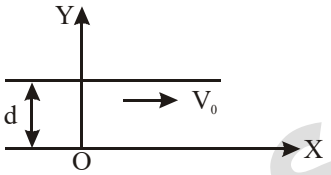
9. A particle initially at rest is subjected to two forces. One is constant, the other is a retarding force proportional to the particle velocity. In the subsequent motion of the particle :
(A) the acceleration will increase from zero to a constant value
(B) the acceleration will decrease from its initial value to zero
(C) the velocity will increase from zero to maximum & then decrease
(D) the velocity will increase from zero to a constant value.

10. Which of the following statements are true for a moving body?
(A) If its speed changes, its velocity must change and it must have some acceleration
(B) If its velocity changes, its speed must change and it must have some acceleration
(C) If its velocity changes, its speed may or may not change, and it must have some acceleration
(D) If its speed changes but direction of motion does not change, its velocity may remain constant

COMPREHENSIONS

Comprehension I:

Using the concept of relative motion, answer the following question. Velocity of the river with respect to ground is given by 'V_0'. Width of the river is 'd'. A swimmer swims (with respect to water) perpendicular to the current with acceleration a = 2t (where t is time) starting from rest form the origin O at t = 0.



1. The time of crossing the river is
   (A) $(D)^{1/3}$ (B) $(2d)^{1/3}$
   (C) $(3d)^{1/3}$ (D) Information is insufficient

2. The drift of the swimmer is
   (A) $V_0(D)^{1/3}$ (B) $V_0(2d)^{1/3}$
   (C) $V_0(3d)^{1/3}$ (D) None of these

3. The equation of trajectory of the path followed by the swimmer
   (A) $y = \frac{x^3}{3V_0^3}$ (B) $y = \frac{x^2}{2V_0^2}$
   (C) $y = \frac{x}{V_0}$ (D) $y = \sqrt{\frac{x}{V_0}}$

Comprehension II :

When a particle is projected at some angle with the horizontal, the path of the particle is parabolic in nature. In the process the horizontal velocity remains constant but the magnitude of vertical velocity changes. At any instant during flight the acceleration of particle remains g in vertically downward direction. During flight at any point the path of particle can be considered as a part of circle and radius of that circle is called the radius of curvature of the path of particle.

Consider that a particle is projected with velocity u = 10 m/s at an angle θ = 60º with the horizontal then :

Answer the following questions

4. The radius of curvature of path of particle at the instant when the velocity vector of the particle becomes perpendicular to initial velocity vector is
   (A) $\frac{20}{3\sqrt{3}}$m (B) $\frac{10}{3\sqrt{3}}$m
   (C) $\frac{40}{3\sqrt{3}}$m (D) $\frac{80}{3\sqrt{3}}$m

5. The magnitude of acceleration of particle at that instant is
   (A) 10 m/s^2 (B) $5\sqrt{3}$ m / s^2
   (C) 5 m/s^2 (D) $10\sqrt{3}$ m / s^2

6. Tangential acceleration of particle at that instant will be

(A) 10 m/s^2 (B) 20 m/s^2

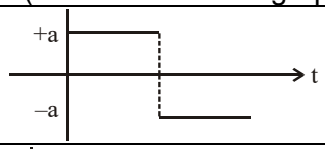
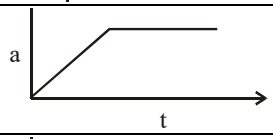
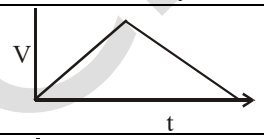
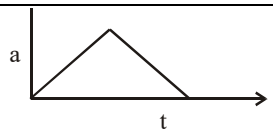
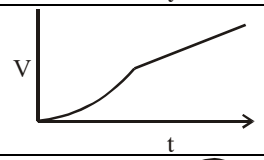
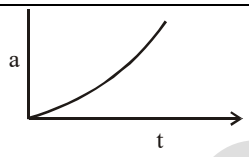
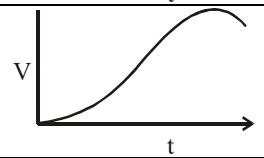
(C) 5 m/s^2 (D) $5\sqrt{3}$ m / s^2

MATCH THE FOLLOWING

1. A body is projected with a velocity of 60 m/s at 30° to horizontal (g = 10 m/s^2) :

Column A		Column B	
(A)	Initial velocity vector	(p)	$60\sqrt{3}\,\hat{i} + 40\,\hat{j}$
(B)	**Velocity just after 3 sec**	(q)	$30\sqrt{3}\,\hat{i} + 10\,\hat{j}$
(C)	Displacement just after 2 sec	(r)	$30\sqrt{3}\,\hat{i} + 30\,\hat{j}$
(D)	Velocity just after 2 sec	(s)	$30\sqrt{3}\,\hat{i}$

2. Match the following :

	Column I (acceleration–time graph)		**Column II** (velocity–time graph)
(A)		(p)	
(B)		(q)	
(C)		(r)	
(D)		(s)	

12. Hints to Subjective Assignments

LEVEL - I

1. Apply $v_y = v_o \sin\theta - gt$; $v_x = v_o\cos\theta$

2. Find the maximum height reached.

3. Vertical displacement of bomb = 1km

Horizontal displacement of bomb = velocity of plane $\times$ time of flight.

4. Vertical displacement of the projectile is -1.5 meter and horizontal displacement is 50 meter.

5. Find velocity of the rocket after 1 minute.

6. They meet when their separation is zero.

7. Use kinematical equations.

8. Use vector method to find out displacement vector.

9. First find out time to move through an angle θ. Then find the displacement during this time and average velocity.

10. Draw the vector diagram clearly.

LEVEL- II

1. Use the concept of dot product.

2. Write equations for their positions at a time t. Solve these equations.

3. Draw the vector diagram clearly in two cases. Note that velocity of plane in still air + velocity of air = velocity of plane in blowing air.

4. Use the concept of dot product.

5. Deceleration equals to $-v\frac{dv}{dx} = a\sqrt{v}$.

6. Normal acceleration is (v^2/R) while tangential acceleration is $R\alpha$.

7. Use simple kinematical equations.

8. Draw the vector diagram clearly.

9. Acceleration; $a = v\frac{dv}{dx} = \sqrt{x}$.

10. Velocity of car as observed from train

= velocity of car relative to ground $-$ velocity of train relative to ground.

13. Answers to Subjective Assignments

LEVEL - I

1. $20\ \vec{i}$
2. $\frac{v_0}{2}$
3. 1732 m, $\tan^{-1}(0.707)$
4. 26.64 m/s, 67.96°
5. (a) 36 km (b) 1 minute
6. $\frac{h}{2v}$
7. (a) 3.4 sec (b) 57m
8. $\frac{5\sqrt{2}}{3}$ due north of east
9. $\frac{2\sin(\theta/2)}{\theta}$
10. $v\sqrt{1+n^2\cot^2\theta}$

LEVEL – II

1. $\frac{v_1 v_2}{2g}$
2. $\Delta t = \frac{2v_0\sin(\theta_1-\theta_2)}{g(\cos\theta_1+\cos\theta_2)}$, 10.7 sec.
3. (a) 39^0 56' north of east, 2.3 hour (b) 39^0 56 ' west of south, 2.75 hour
4. 2.5 m
5. $\left(\frac{2}{3a}\right)v_0^{3/2}$, $\frac{2\sqrt{v_o}}{a}$
6. $\frac{a_r}{a_t} = \frac{1}{\sqrt{3}}$
7. 10 sec
8. $10\sqrt{2}$ m/s, from north west
9. $\left(\frac{3v_0}{2}\right)^{\frac{4}{3}}$
10. (a) 3.33 km/hr (b) 13 km/hr, 6.67 km/hr

14. Answers to Objective Assignments

LEVEL - I

1.	**(D)**	2.	**(A)**
3.	**(C)**	4.	**(D)**
5.	**(C)**	6.	**(C)**
7.	**(D)**	8.	**(C)**
9.	**(B)**	10.	**(C)**
11.	**(C)**	12.	**(D)**
13.	**(C)**	14.	**(C)**
15.	**(C)**	16.	**(D)**
17.	(C)	18.	**(C)**
19.	**(C)**	20.	**(A)**

LEVEL – II

1.	**(B), (C)**	2.	**(A), (C)**
3.	**(C), (D)**	4.	**(A), (B)**
5.	**(A), (D)**	6.	**(C), (D)**
7.	**(A), (C)**	8.	**(B), (C), (D)**
9.	**(B), (D)**	10.	**(A), (C)**

COMPREHENSIONS

1.	**(C)**	2.	**(C)**
3.	**(A)**	4.	**(A)**
5.	**(A)**	6.	**(C)**

MATCH THE FOLLOWING

1. (A) – (r); (B) – (s); (C) – (p); (D) – (a)
2. (A) – (q); (B) – (r); (C) – (s) ; (D) – (p)