MOTION IN A PLANE

1. The co-ordinates of a moving particle are $x = at^2$, $y = bt^2$, where a and b are constants. The velocity and acceleration of the particle at time t are respectively:
   (a) $t\sqrt{a^2+b^2}$, $2\sqrt{a^2+b^2}$ (b) $2\sqrt{a^2+b^2}$, $2t\sqrt{a^2+b^2}$ (c) $2t\sqrt{a+b}$, $2\sqrt{a+b}$ **(d)** $2t\sqrt{a^2+b^2}$, $2\sqrt{a^2+b^2}$
2. A particle is moving eastwards with a velocity of 10 m/s. In 10 s, the velocity changes to 10 m/s southwards. The average acceleration in this time is:
   (a) zero (b) $\sqrt{2}$ m/s^2 towards north-west **(c)** $\sqrt{2}$ m/s^2 towards south-west (d) $\sqrt{2}$ m/s^2 towards north-east
3. A body travels due west for 60 km. It then turns due north and travels 80 km before stopping. The resultant displacement of the car is:
   (a) 100 km, 53° north of west (b) 100 km, 53° east of south (c) 140 km, 37° north of east (d) 100 km, 37° west of south
4. In 1.0 s, a particle goes from point A to point B, moving in a semicircle of radius 1.0 m. The magnitude of the average velocity of the particle is:
   (a) 6.28 m/s (b) 3.14 m/s **(c)** 2.0 m/s (d) zero
5. Three persons K, L and M are initially at the corners of an equilateral triangle of side of length d. If every person starts moving with the same speed v such that K is always headed towards L, L towards M, M is headed directly towards K, then the three persons will meet after:
   (a) 2d/3v (b) (b) 2d/v (c) d/3v (d) d/$\sqrt{2}$ v
6. If the velocity (in m/s) of a particle is given by $3\hat{\imath} + 6t\hat{\jmath}$, then the magnitude of its acceleration (in m/s^2) is:
   (a) 4 (b) 5 **(c)** 6 (d) 9
7. The (x, y, z) co-ordinates of two points A and B are given respectively as (0, 3, 2) and (2, −4, 5). The displacement vector from A to B is given by:
   (a) $-2\hat{\imath} + 7\hat{\jmath} + 3\hat{k}$ **(b)** $2\hat{\imath} - 7\hat{\jmath} + 3\hat{k}$ (c) $2\hat{\imath} - 4\hat{\jmath} + 5\hat{k}$ (d) $2\hat{\imath} + 4\hat{\jmath} - 3\hat{k}$
8. An athlete completes one round of a circular track of radius R in 40 s. What will be his distance and displacement, respectively at the end of 2 min 20 sec?
   (a) 5πR, 2R **(b)** 7πR, 2R (c) 4R, 2R (d) 3R, Zero
9. A particle moves in the x-y plane with velocity $v_x = 8t - 2$ and $v_y = 2$. If it passes through the point x = 14 and y = 4 at t = 2 s, then the equation of the path is:
   (a) $x = y^2 + 2y + 4$ **(b)** $x = y^2 - y + 2$ (c) $x = y^2 - 4y + 3$ (d) $x = y^2 + 2y - 2$
10. A particle moves on a curve is given by x = 2sint, y = 3cost and z = $\sqrt{5}$ sin t. What is the magnitude of velocity of the particle at any time t?
    (a) 5 sin t (b) $3\sqrt{5}$ cost **(c)** 3 (d) $3\sqrt{5}$
11. Two particles X and Y start moving from the origin with same velocity of 50 km/h. Particle X moves towards south and particle Y is moving towards east. What is the relative velocity of Y with respect to X?
    (a) $50\sqrt{2}$ km/h towards south-east (b) $50\sqrt{2}$ km/h towards north-west (c) $50\sqrt{2}$ km/h towards south-west **(d)** $50\sqrt{2}$ km/h towards north-east
12. A man runs at a constant speed on a circular track of radius 10 m, taking 6.28 seconds for every circular lap. The average velocity and average speed for each circular lap respectively is:
    (a) 10 m/s, 10 m/s **(b)** 0, 10 m/s (c) 3.14 m/s, 6.28 m/s (d) 0 m/s, 6.28 m/s

13. A boat is traveling upstream at 14 km/h with respect to a river that is flowing at 6 km/h (with respect to the ground). A man runs directly across the boat, from one side to the other, at 6 km/h (with respect to the boat). The speed of the man with respect to the ground is:
    (a) 10 km/h (b) 14 km/h (c) 18.5 km/h (d) 21 km/h
14. A ship A is moving westwards with a speed of 10 km/h and a ship B 100 km south of A, is moving northwards with a speed of 10 km/h. The time after which the distance between them becomes shortest, is:
    (a) $10\sqrt{2}$ h (b) $5\sqrt{2}$ h (c) 7.5 h **(d)** 5 h
15. A particle has initial velocity $4\hat{\imath} + 3\hat{\jmath}$ and has acceleration$0.3\hat{\imath} + 0.4\hat{\jmath}$. Its speed after 10 s is:
    (a) 5 units (b) 7 units **(c)** $7\sqrt{2}$ units (d) zero
16. A ferry boat is sailing at 12 km/h 30° W of N with respect to a river that is flowing at 6.0 km/h E. As observed from the shore, the ferry boat is sailing:
    (a) 30° E of N **(b)** due N (c) 30° W of N (d) 45° E of N
17. A boat is moving with a velocity $4\hat{\imath} + 3\hat{\jmath}$ with respect to ground. The water in the river is moving with a velocity $-2\hat{\imath} + 7\hat{\jmath}$ with respect to ground. The relative velocity of the boat with respect to water is:
    (a) $6\hat{\imath} - 4\hat{\jmath}$ (b) $2\hat{\imath} + 10\hat{\jmath}$ (c) $7\hat{\imath} + 5\hat{\jmath}$ (d) $-6\hat{\imath} + 4\hat{\jmath}$
18. The position of a particle is given by $2t^2\hat{\imath} + 3t\hat{\jmath} + 3\hat{k}$ where t is in second and the coefficients have proper units for position vector to be in metre. The acceleration of the particle at t =1 s is:
    (a) 4 ms^2 along y-direction **(b)** 4 ms^2 along x-direction (c) 4 ms^2 along z-direction (d) 2 ms^2 along – y-direction
19. A man moves 20 m north, then 10 m east and then $10\sqrt{2}$ m south-west. His displacement is:
    (a) 20 m north **(b)** 10 m north (b) $10\sqrt{2}$ m north-west (d) $10\sqrt{2}$ m south-east
20. A particle is moving such that its position co-ordinates are (2 m, 3 m) at time t = 0, (6 m, 7 m) at time t = 2 s and (13 m, 14 m) at time t = 5 s. Average velocity vector from t = 0 to t = 5 s is:
    (a) $2\hat{\imath} + 10\hat{\jmath}$ **(b)** $\frac{11}{5}(\hat{\imath} + \hat{\jmath})$ (c) $\frac{7}{5}(\hat{\imath} + \hat{\jmath})$ (d) $\frac{11}{3}(\hat{\imath} + \hat{\jmath})$