CBSE

MOTION IN A PLANE WS 11

Class 11 - Physics

Section A

1. For an object moving in a plane, necessary condition/s for kinematical equations for X-component of position and velocity to be identical with kinematical equations for Y-component of position and velocity respectively is/are **[1]**

   a) $v_x = v_y$ and $a_x = a_y$

   b) $u_x = u_y$ and $a_x = a_y$

   c) $u_x = u_y$ and dx = dy

   d) $u_x = u_y$ and dx = dy over same time interval dt

2. An object moves at a constant speed along a circular path in a horizontal XY-plane, with the centre at the origin. When the object is at x = -2 m, its velocity A is -(4 m/s)$\hat{j}$. What is the object's acceleration when it is at y = 2 m? **[1]**

   a) $\frac{-4m}{s^2}\hat{j}$

   b) $\frac{-8m}{s^2}\hat{i}$

   c) $\frac{-8m}{s^2}\hat{j}$

   d) $\frac{4m}{s^2}\hat{i}$

3. A particle has initial velocity $(2\hat{i} + 3\hat{j})$ and acceleration $(0.3\hat{i} + 0.2\hat{j})$. The magnitude of velocity after 10 seconds will be **[1]**

   a) $5\sqrt{2}$ units

   b) $9\sqrt{2}$ units

   c) 9 units

   d) 5 units

4. A particle moves in x-y plane according to rule x = a sin ωt and y = a cos ωt. The particle follows: **[1]**

   a) an elliptical path

   b) a straight line path inclined equally to x- and y-axes

   c) a parabolic path

   d) a circular path

5. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is **[1]**

   a) 1 m/s^2

   b) $\sqrt{7}$ m/s^2

   c) 7 m/s^2

   d) 5 m/s^2

6. At an instant t, the coordinates of a particle are x = at^2, y = bt^2 and z = 0. The magnitude of velocity of particle at an instant t is **[1]**

   a) $\frac{v}{\sqrt{2}}$

   b) $t\sqrt{a^2 + b^2}$

   c) $\frac{v}{\sqrt{3}}$

   d) $2t\sqrt{a^2 + b^2}$

7. An aircraft is flying at a height of 3400 m above the ground. If the angle subtended at a ground observation point by the aircraft positions 10.0 s apart is 30^o, what is the speed of the aircraft? **[1]**

   a) 193 m/s

   b) 172 m/s

c) 182 m/s

d) 192 m/s

8. At a distance L = 400m from the traffic lights, the brakes are applied to a locomotive moving at a velocity v = 54km/hr. Determine the position of locomotive relative to the traffic lights 1 minute after the application of the brakes if its acceleration is -0.3m/s^2? **[1]**

a) 30 m

b) 40 m

c) 15 m

d) 50 m

9. A man is slipping on a frictionless inclined plane and a bag falls down from the same height. Then the velocity of both is related as **[1]**

a) $v_B > v_m$

b) v_B and v_m can't be related

c) $v_B = v_m$

d) $v_B < v_m$

10. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then which of the following are necessarily true: **[1]**

a) The acceleration of the particle is bounded.

b) The acceleration of the particle is necessarily in the plane of motion.

c) The acceleration of the particle is zero.

d) The particle must be undergoing a uniform circular motion

11. The x and y coordinates of the particles at any time are x = 5t - 2t^2 and y =10t respectively, where x and y are in metres and t in seconds. The acceleration of the particle at t = 2 s is **[1]**

a) 5 m/s^2

b) -8 m/s^2

c) 0

d) -4 m/s^2

12. For motion in two or three dimensions, the angle between velocity and acceleration is: **[1]**

a) 180°

b) 0°

c) Any angle between 0° and 180°

d) 90°

13. A car is travelling with a linear velocity v on a circular road of radius r. If it is increasing its speed at the rate of a m/s^2, then the resultant acceleration will be **[1]**

a) $\sqrt{\frac{v^4}{r^2} + a^2}$

b) $\sqrt{\frac{v^2}{r^2} - a^2}$

c) $\sqrt{\frac{v^2}{r^2} + a^2}$

d) $\sqrt{\frac{v^4}{r^2} - a^2}$

14. A ball is dropped from a height. If it takes 0.2 s to cross the last 6.0 m before hitting the ground, find the height from which it was dropped. (Take g = 10m/s^2) **[1]**

a) 57.05 m

b) 30.48 m

c) 32.35 m

d) 48.05 m

15. A body is whirled in a horizontal circle of a radius 20 cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on a circular path? **[1]**

a) 2 m/s

b) 10 m/s

c) $\sqrt{2}$ m/s

d) 20 m/s

16. **Assertion (A):** A body X is thrown vertically upwards with an initial speed 45 m/s. Another body Y is also thrown vertically upwards with an initial speed 27 m/s. During the last $\frac{1}{2}$ sec of motion of each body, speed of each reduces by the same value. **[1]**

Reason (R): Both bodies are moving with same acceleration.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

17. **Assertion (A):** In projectile motion, the angle between the instantaneous velocity and acceleration at the highest point is 180^o. **[1]**

Reason (R): At the highest point, velocity of projectile will be in horizontal direction only.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

18. **Assertion (A):** In projectile motion, the angle between the instantaneous velocity and acceleration at the highest point is 180°. **[1]**

Reason (R): At the highest point, velocity of projectile will be in horizontal direction only.

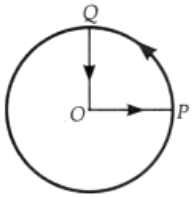
a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

19. A cyclist starts from the centre O of a circular park of radius 1 km, reaches the edge P of the park, then cycles along the circumference and returns to the centre along QO as shown in the figure. If the round trip takes 10 min, the net displacement and average speed of the cyclist (in metre and kilometre per hour) are **[1]**



a) $\frac{\pi+4}{2}, 0$

b) 0, 21.4

c) 214, $\frac{\pi+4}{2}$

d) 0, 1

20. A circular wheel of 0.50 m radius is moving with a speed of 10 ms^{-1}. Find the angular speed. **[1]**

21. Two balls of different masses are thrown vertically upward with same initial velocity. Maximum heights attained by them are h_1 and h_2 respectively. What is $\frac{h_1}{h_2}$? **[1]**

22. A particle moves in a plane with uniform acceleration in a direction different from its initial velocity. What will be the trajectory followed by the particle? **[1]**

Section B

23. A person sitting in a moving train throws a ball vertically upwards. How will the ball appear to move to an observer (i) sitting inside the train (ii) standing outside the train? Give reason. **[2]**

24. The position of a particle is given by $\mathbf{r} = 3.0t\ \hat{i} - 2.0t^2\ \hat{j} + 4.0\ \hat{k}$ m where t is in seconds and the coefficients have the proper units for **r** to be in metres? **[2]**

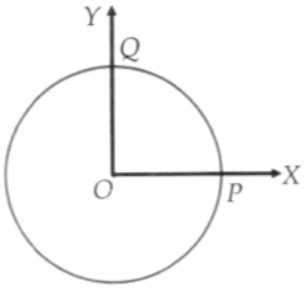
a. Find the **v** and **a** of the particle?

b. What is the magnitude and direction of velocity of the particle at t = 2.0 s?

25. A car travelling at a speed of 20 ms^{-1} due north along the highway makes a right turn on to a side road that heads due east. It takes 50 s for the car to complete the turn. At the end of 50 seconds, the car has a speed of 15 ms^{-1} along the side road. Determine the magnitude of average acceleration over the 50-second interval. **[2]**

26. If the position vector of a particle is given by: **[2]**
$\vec{r} = (4\cos 2t)\hat{i} + (4\sin 2t)\hat{j} + (6t)\hat{k}$ m, calculate its acceleration at t = $\frac{\pi}{4}$

27. A particle moves in a circle of radius 4.0 cm clockwise at a constant speed of 2 cms^{-1}. If $\hat{x}$ and $\hat{y}$ are unit acceleration vectors along X-axis and Y-axis respectively (in cms^{-2}), find the acceleration of the particle at the instant halfway between P and Q. Refer to Fig. (a). **[2]**



(a)

28. A particle starts from origin at t = 0 with a velocity $5\hat{i}$ m/s and moves in xy-plane under action of a force which produces a constant acceleration of $(3\hat{i} + 2\hat{j})$ m/s^2. **[2]**

i. What is the y-coordinate of the particle at the instant its x-coordinate is 84 m?

ii. What is the speed of the particle at this time?

29. Derive the relation between linear displacement and angular displacement. **[2]**

Section C

30. **Fill in the blanks:** **[3]**

(a) _____ is defined as the ratio of change in velocity and the corresponding time interval. **[1]**

(b) A cricket ball hit by a player comes under _____ dimensional motion. **[1]**

(c) The acceleration vector a particle moving with a uniform velocity is a _____ vector. **[1]**

31. An aircraft is flying at a height of 3400 m above the ground. If the angle subtended at a ground observation point by the aircraft positions 10.0 s apart is 30^o, what is the speed of the aircraft? **[3]**

Section D

32. **State True or False:** **[4]**

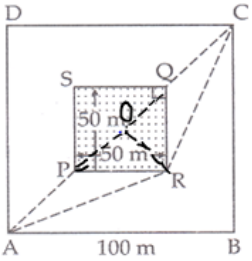
(a) For any arbitrary motion in space, $r(t) = r(0) + v(0)t + \left(\frac{1}{2}\right) a\, t^2$ **[1]**

(b) The velocity vector of a particle at a point is always along the tangent to the path of the particle at that point. **[1]**

(c) For any arbitrary motion in space, $\mathbf{a}_{\text{average}} = \frac{[\mathbf{v}(t_2) - \mathbf{v}(t_1)]}{(t_2 - t_1)}$ **[1]**

(d) The average speed of a particle (defined as total path length divided by the time taken to cover the path) is either greater or equal to the magnitude of average velocity of the particle over the same interval of time. **[1]**

Section E

33. A man wants to reach from A to the opposite corner of the square C (as in figure). The sides of the square are 100 m. A central square of 50m $\times$ 50m is filled with sand. Outside this square, he can walk at a speed 1 m/s^{-1}. In the central square, he can walk only at a speed of vm/s (v<1) What is smallest value of v for which he can **[5]**

reach faster via a straight path through the sand than any path in the square outside the sand?