MOTION IN A PLANE IMP QUESTIONS

Class 11 - Physics

Section A

1. A particle starting from the origin (0, 0) moves in a straight line in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x-axis an angle of **[1]**

   a) 30°
   b) 45°
   c) 60°
   d) 0°

2. 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

3. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 s for every circular lap. The average velocity and average speed for each circular lap respectively are **[1]**

   a) 0, 10 m/s
   b) 10 m/s, 10 m/s
   c) 0, 0
   d) 10 m/s, 0

4. 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) $2t\sqrt{a^2+b^2}$

5. 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

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

   a) Displacements in equal time intervals are equal.
   b) Average acceleration must always vanish.
   c) The average velocity is not zero at any time.
   d) Equal path lengths are traversed in equal intervals.

7. For an object moving in a plane, necessary condition/s for kinematical equations for X-component of position **[1]**

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and velocity to be identical with kinematical equations for Y-component of position and velocity respectively is/are

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

8. 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

9. 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

10. 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

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

12. A particle moves in a plane with a constant acceleration in a direction different from the initial velocity. The path of the particle is a/an: **[1]**

a) ellipse

b) straight line

c) arc of a circle

d) parabola

13. A particle starts from the origin at t = 0 s with a velocity of 10.0 $\hat{j}$ m/s and moves in the x-y plane with a constant acceleration of $(8.0\hat{i} + 2.0\hat{j})$ m s^{-2}. At what time is the x-coordinate of the particle 16 m? What is the y-coordinate of the particle at that time? **[1]**

a) 2 s, 24 m

b) 1.5 s, 20 m

c) 2.2 s, 22 m

d) 1 s, 14 m

14. As a ball rises, the vertical component of its velocity **[1]**

a) Can't be determined

b) Remains constant

c) Increase

d) Decrease

[1]

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15. The ceiling of a hall is 30 m high. A ball is thrown with 60 ms^{-1} at an angle θ, so that maximum horizontal distance may be covered. The angle of projection θ is given by

a) $\sin\theta = \frac{1}{\sqrt{6}}$ b) $\sin\theta = \frac{1}{\sqrt{3}}$

c) $\sin\theta = \frac{1}{\sqrt{4}}$ d) $\sin\theta = \frac{1}{\sqrt{8}}$

16. At the top of the trajectory of a projectile, thrown at an angle of projection $\theta < 90°$, its **[1]**

a) velocity is anti-parallel to the direction of acceleration

b) velocity is perpendicular to the direction of acceleration

c) velocity is parallel to the direction of acceleration

d) velocity is zero

17. A projectile is fired at an angle of 45° with the horizontal. The elevation angle of the projectile at its highest point as seen from the point of projection is **[1]**

a) 60° b) $\tan^{-1}\frac{1}{2}$

c) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ d) 45°

18. The maximum range of a gun of horizontal terrain is 16 km. If g = 10 ms^{-2}, then muzzle velocity of a shell must be **[1]**

a) 160 ms^{-1} b) 800 ms^{-1}

c) 400 ms^{-1} d) $200\sqrt{2}$ ms^{-1}

19. A motorcycle stunt rider rides off the edge of a cliff. Just at the edge, his velocity is horizontal, with a magnitude of 9.0 m/s. Find the magnitude of the motorcycle's velocity vector, 0.50 s after it leaves the edge of the cliff. **[1]**

a) 11.3 m/s b) 8.98 m/s

c) 10.2 m/s d) 9.65 m/s

20. Which of the following is true regarding projectile motion? **[1]**

a) Acceleration is not constant. b) Horizontal velocity of projectile is constant.

c) Momentum is constant. d) Vertical velocity of projectile is constant.

21. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectiles is **[1]**

a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$ b) $\theta = 45^o$

c) $\theta = \tan^{-1}(4)$ d) $\theta = \tan^{-1}(2)$

22. A coastguard ship locates a pirate ship at a distance of 560 m. It fires a cannon ball with an initial speed 82 m/s. At what angle from horizontal the ball must be fired so that it hits the pirate ship? **[1]**

a) 18° b) 125°

c) 54° d) 27°

23. At the height 80 m, an aeroplane is moving with 150 m/s. A bomb is dropped from it so as to hit a target. At what distance from the target should the bomb be dropped? (Given g =10m/s^2) **[1]**

a) 230 m b) 605.3 m

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c) 80 m

d) 600 m

24. A missile is fired for maximum range with an initial velocity of 20 m/s. If g = 10m/s^2, the range of the missile is **[1]**

a) 20 m

b) 50 m

c) 60 m

d) 40 m

25. A particle is projected from the ground with an initial speed of v at angle θ with the horizontal. The average velocity of the particle between its point of projection and highest point of trajectory is **[1]**

a) $\frac{v}{2}\sqrt{1+2\cos^2\theta}$

b) $\frac{v}{2}\sqrt{1+3\cos^2\theta}$

c) v cos θ

d) $\frac{v}{2}\sqrt{1+\cos^2\theta}$

26. An object is being thrown at a speed of 20 m/s in a direction 45° above the horizontal. The time taken by the object to return to the same level is **[1]**

a) $\frac{20\sqrt{2}}{g}$

b) $\frac{20}{g}$

c) $20\sqrt{2}g$

d) 20g

27. At the highest point on the trajectory of a projectile, its: **[1]**

a) acceleration is maximum

b) velocity is maximum

c) acceleration is minimum

d) velocity is minimum

28. A projectile is fired a velocity of 150 meters per second at an angle of 30 degrees with the horizontal. What is the magnitude of the vertical component of the velocity at the time the projectile is fired? **[1]**

a) 225 m/s

b) 75 m/s

c) 150 m/s

d) 130 m/s

29. The horizontal range of a projectile fired at an angle of 15° is 50 m. If it is fired with the same speed at an angle of 45°, its range will be **[1]**

a) 100 m

b) 141 m

c) 71 m

d) 60 m

30. The horizontal range of projectile is $4\sqrt{3}$ times of its maximum height. The angle of projection will be **[1]**

a) 30°

b) 90°

c) 40°

d) 45°

31. When a projectile is fired at an angle θ w.r.t. horizontal with velocity u, then the horizontal component ignoring air resistance: **[1]**

a) goes on increasing with height

b) goes on decreasing with height

c) first increases and then decreases with height

d) remains same

32. A batter hits a baseball so that it leaves the bat at speed v_0 = 37.0 m/s at an angle a = 53.1^o. Find the time when the ball reaches the highest point of its flight, and its height h at this time? **[1]**

a) 3.02 s, 44.7 m

b) 3.32 s, 41.7 m

c) 3.12 s, 43.7 m

d) 3.22 s, 42.7 m

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33. Two bodies are projected with the same velocity. If one is projected at an angle of 30° and the other at 60° to the horizontal, then ratio of maximum heights reached is **[1]**

a) 2:1 b) 3:1

c) 1:3 d) 1:2

34. The speed of a projectile when it is at its greatest height is $\sqrt{\frac{2}{5}}$ times its speed at half the maximum height. What is the angle of projection? **[1]**

a) 60° b) 90°

c) 15° d) 45°

35. The circular motion of a particle with constant speed is **[1]**

a) neither periodic nor simple harmor b) simple harmonic but not periodic

c) periodic but not simple harmonic d) periodic and simple harmonic

36. A body is tied with a string and is given a circular motion with a velocity v in radius r. The magnitude of the acceleration is **[1]**

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

c) $\frac{v^2}{r}$ d) $\frac{v}{r}$

37. A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is **[1]**

a) 36m/s^2 b) 5 m/s^2

c) 25 m/s^2 d) 15 m/s^2

38. A cyclist is riding with a speed of 27 km/h. As he approaches a circular turn on the road of radius 80 m, he applies brakes and reduces his speed at the constant rate of 0.50 m/s every second. What is the magnitude and direction of the net acceleration of the cyclist on the circular turn? **[1]**

a) 0.84 ms^{-2}, 58.5^o with the direction of the velocity

b) 0.82 ms^{-2}, 59.5^o with the direction of the velocity

c) 0.85 ms^{-2}, 56.5^o with the direction of the velocity.

d) 0.86 ms^{-2}, 54.5^o with the direction of the velocity.

39. The angular speed of a flywheel making 120 revolutions/minute is **[1]**

a) $4\pi^2$ rad/s b) 4π rad/s

c) 2π rad/s d) π rad/s

40. The magnitude and direction of the acceleration of a body both are constant. Will the path of the body necessarily be a straight line? **[1]**

41. A stone is thrown vertically upwards and then it returns to the thrower. Is it a projectile? Explain. **[1]**

Section B

42. 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 = $\frac{\pi}{4}$

43. At what range will a radar set show a fighter plane flying at 3 km above its centre and at distance of 4 km from it? **[2]**

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44. 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]**

45. A cyclist moves along a circular path of radius 70 m. If he completes one round in 11 s, calculate **[2]**

i. total length of path,

ii. magnitude of the displacement,

iii. average speed, and

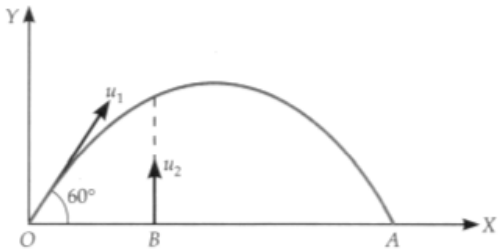
iv. magnitude of average velocity

46. 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]**

47. A body is thrown horizontally with a velocity v from a tower of height H. After how much time and at what distance from the base of the tower will the body strike the ground? **[2]**

48. What is the angle of projection at which horizontal range and maximum height are equal? **[2]**

49. As shown in Figure, a body is projected with velocity u_1 from point A. At the same time **[2]**



another body is projected vertically upwards with the velocity u_2 from point B. What should be the value of $\frac{u_1}{u_2}$ for both the bodies to collide?

50. A ball is thrown horizontally and at the same time another ball is dropped down from the top of a tower **[2]**

i. Will both the balls reach the ground at the same time ?

ii. Will both strike the ground with the same velocity?

51. A bullet fired at an angle of 30° with the horizontal hits the ground 3 km away. By adjusting its angle of projection, can one hope to hit a target 5 km away? Assume the muzzle speed to be fixed, and neglect air resistance. **[2]**

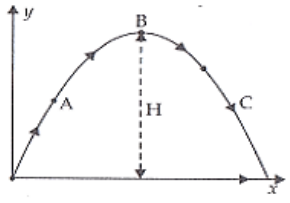
52. A football is kicked into the air vertically upwards. What is its **[2]**

i. acceleration?

ii. velocity at the highest point?

53. A body is thrown horizontally from the top of a tower and strikes the ground after two seconds at an angle of 45° with the horizontal. Find the height of the tower and the speed with which the body was thrown. Take g = 9.8 ms^{-2} **[2]**

54. A particle is projected in the air at some angle to the horizontal, moves along the parabola as shown in the figure, where x and y indicate horizontal and vertical directions respectively. Show in the diagram, direction of velocity and acceleration at points A, B and C. **[2]**



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55. Two tall buildings face each other and are at a distance of 180 m from each other. With what velocity must a ball be thrown horizontally from a window 55 m above the ground in one building, so that it enters a window 10.9 m above the ground in the second building? **[2]**

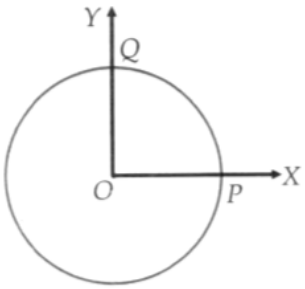
56. A projectile is projected in the upward direction making an angle of 60° with the horizontal direction with a velocity of 147 ms^{-1}. After what time will its inclination with the horizontal be 45°? **[2]**

57. For a uniform circular motion show that: **[2]**
(i) $v = r\omega$ (ii) $a = r\omega^2$

58. What is a uniform circular motion? Explain the terms: time period, frequency and angular velocity. Establish relation between them. **[2]**

59. An aircraft executes a horizontal loop of radius 1 km with a steady speed of 900 kmh^{-1}. Compare its centripetal acceleration with the acceleration due to gravity. **[2]**

60. 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)

61. Which is greater the angular velocity of the hour hand of a watch or angular velocity of earth around its own axis? Give their ratio. **[2]**

62. Establish a relation between linear velocity and angular velocity in a uniform circular motion and explain the direction of linear velocity. **[2]**

63. Justify the statement that a uniform circular motion is an accelerated motion. **[2]**

64. A vector has both magnitude and direction. Does it mean that anything that has magnitude and direction is necessarily a vector? The rotation of a body can be specified by the direction of the axis of rotation, and the angle of rotation about the axis. Does that make any rotation a vector? **[2]**

Section C

65. A passenger arriving in a new town wishes to go from the station to a hotel located 10 km away on a straight road from the station. A dishonest cabman takes him along a circuitous path 23 km long and reaches the hotel in 28 min. What is **[3]**

a. the average speed of the taxi?

b. the magnitude of average velocity? Are the two equal?

66. Is it important in the long jump that how much height you take for jumping? What factors determine the span of a jump? **[3]**

67. A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant the bullet leaves the barrel of the gun, the monkey drops. Will the bullet hit the monkey? Substantiate your answer with proper reasoning. **[3]**

68. A ball is thrown from a rooftop at an angle of 45^o above the horizontal. It hits the ground a few seconds later. At what point during its motion, does the ball have **[3]**

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i. greatest speed

ii. smallest speed

iii. greatest acceleration? Explain.

69. Two projectiles are thrown with different velocities and at different angles so as to cover the same maximum height. Show that the sum of the times taken by each to reach the highest point is equal to the total time taken by either of the projectiles. **[3]**

70. A machine gun is mounted on the top of a tower 100 m high. At what angle should the gun be inclined to cover a maximum range of firing on the ground below? The muzzle speed of the bullet is 150 ms^{-1}, take g = 10 ms^{-2} **[3]**

71. A bullet fired at an angle of 30° with the horizontal hits the ground 3.0 km away. By adjusting its angle of projection, can one hope to hit a target 5.0 km away? Assume the muzzle speed to the fixed, and neglect air resistance. **[3]**

72. How does the knowledge of projectile help, a player in the baseball game? **[3]**

73. A particle is projected horizontally with a speed u from the top of plane inclined at an angle θ with the horizontal. How far from the point of projection will the particle strike the plane? **[3]**

74. Show that there are two angles of projection for a projectile to have the same horizontal range. What will be the maximum heights attained in the two cases? Compare the two heights for θ = 30° and 60° **[3]**

75. A plane is flying horizontally at a height of 1000 m with a velocity of 100 ms^{-1}. when a bomb is released from it. Find **[3]**

i. the time taken by it to reach the ground

ii. the velocity with which the bomb hits the target and

iii. the distance of the target.

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