MOTION IN A PLANE - 1

Q1. A particle starts form origin at t=0with a velocity $5\hat{\imath}$ m/s and moves in XY-plane under the action of a force, which produces a constant acceleration of 3i+2j m/s^2.

(a) what is the y-coordinate of the particle at the instant its x coordinate is 84m?

(b) what is speed of the particle at this time?

Q2. from the top of a tower 156.8m high, a projectile is thrown up with a velocity of 39.2m/s making an angle of 30^0 with the horizontal direction. Find the distance from the foot of the tower. Where it strikes the ground and time taken by it to do so .

Q3. A projectile is thrown horizontally from the top of a tower and strikes the ground after 3s.at an angle of 45^0 with the horizontal. Find the height of the tower and speed with which the body was projected. (g=9.8m/s^2)

Q4. From the top of a building 19.6m high, a ball is projected horizontally. After how long does it strike the ground? If the line joining the point of projection to the point, where it hits the ground makes an angle of 45^0 with the horizontal, what is the initial velocity of the ball?

Q5. i and j are unit vectors along X and Y axes respectively. (i) what are the magnitude and direction of the vectors $\hat{\imath}+\hat{\jmath}$and $\hat{\imath}-\hat{\jmath}$? (ii) what are the components of vector A= $2\hat{\imath}+3\hat{\jmath}$ direction of $\hat{\imath}+\hat{\jmath}$ and $\hat{\imath}-\hat{\jmath}$?

Q6. A fighter plane flying horizontally at an altitude of 1.5km with speed 720km/hr. passes directly overhead an anti- aircraft gun. At what angle from vertical should the gun be fired for the shell with muzzle speed 600m/s to hit the plane?

Q7. Two forces, whose magnitude are at the ratio of 3:5 give a resultant of 35N. if angle of inclination is 60^0. Find magnitude of each force.

Q8. At what angle the two forces A+B and A-B act, so that their resultant is $\sqrt{3A^2+B^2}$.

Q9. The vector some of two vectors P and Q is R. if vector $\vec{Q}$ is reversal, the resultant becomes $\vec{S}$ then prove that

$$R^2+S^2 = 2(P^2+Q^2)$$

Q10. Two forces P and Q acting at a point at an angle Θ have their resultant $2(n+1)\sqrt{P^2+Q^2}$. Show that

tanΘ=(n-1)/(n+1)

Q11. A vector X, when added to two vector A=i+j+k and B= 2i+4j-3k gives a unit vector along Y-axis as their resultant. Find the vector X.

Q12.A baseball is hit at an angle of 45^0 at a height of 0.9m. the ball travels a total distance of 120m. what is the initial velocity of the ball ? what is the height of the ball above 3m fence 100m from where the ball is hit. ?

Q13. A motorcycle stunt rider will jump a 100m wide row of cars. The Launch ramp is 30^0 and is 9m high. The land ramp is also 30^0 high id 6m high. Find the minimum speed for the launch

Q14. the position of a particle is given by

R= $3t\hat{\imath} + 4t^2\hat{\jmath} + 5\hat{k}$,

Where t is in seconds and r is in meters

(a) Find $\vec{V}$ (t) and a (t) of the particle
(b) Find the magnitude an direction of $\vec{V}$ (t) at t = 3 seconds

Q15. Prove that the maximum horizontal range is four times the maximum height attained by the projectile, when fired at an inclination so as to have maximum horizontal range.

Q16. A particle is moving eastward with the velocity 5m/s. In 10 seconds the velocity changes to 5m/s northward. Find the average acceleration of the particle during this time.

Q17. Drops of water fall at regular intervals from the roof of a building at a height 16m, the first drop striking the ground at same moment when the fifth drop detaches itself from the roof. Find the distance between the separate drops in air as the first drop reaches the ground.

Q18. The velocity varies with time as v=4t, find the distance travelled by the body in the time interval of 2 to 4s.

Q19. A projectile is thrown from a point 39.2m away from the foot of a building 19.6m high and just reaches the top horizontally find the velocity of the projection and angle of throw.

Q20. The particles A,B and C are situated at the varies of an equilateral triangle of side 'r' at t=0. The particle A heads towards B, B towards C and C towards A with constant speeds V. Find the time of their meeting.

Q21. If three α, β and γ are made by $\vec{A}$ with X, Y and Z axes of a rectangular coordinate system respectively, show that

$\cos^2\alpha + \cos^2\beta + \cos^2 r = 1$

Q22. Calculate the area of a parallelogram when adjacent sides are given by vectors $\vec{A} = \hat{\imath} + 2\hat{\jmath} + 3\hat{k}$, $\vec{B} = 2\hat{\imath} - 3\hat{\jmath} + \hat{k}$

Q23. The angles between $\vec{A}$ and $\vec{B}$ is Θ. Find the value of $\vec{A}$ ($\vec{B}$ x $\vec{A}$).

Q24. if the sum of two unit vectors is a unit vector, then find the magnitude of their difference.

Q25. A bullet with muzzle speed 100m/s is to be shot at a target 30m away in the same horizontal line. How high above the target must the rifle be aimed so that the bullet will hit the target?

Q26. Two billboard balls are rolling on a flat table. One has the velocity components V_x =1m/s and V_y= √3 and the other has components V^1_x =2m/s and V^1_y=2m/s. If both the balls starts moving from the same point, what is the angle between their paths ?

Q27. A ball rolls off the top of a stairway with horizontal velocity of 1.8m/s. The steps are 0.24m high and 0.2 m wide. Which step will the ball hit first ?

Q28. If the horizontal range of a projectile is R and the maximum height attained by it is H, then prove that the velocity of projection is 4 $[2g(H+\frac{R2}{16H})]^{1/2}$.

Q29. the acceleration associated with a mass m moving in a circular path is to be found. It is given that the velocity at any instant is v=Krt, where K is a constant, classify the motion and find acceleration

Q30. The position of particle is given by r= $(3.0t\hat{\imath} - 2.0t\hat{\jmath} + 4.0\hat{k})$m where t is in seconds and the coefficient have the proper units for r to be in meters.

(a) find v and a of the particle.

(b) what is the magnitude and direction of velocity of the particle at t=2s?

Q31. A particles starts from the origin at t=0s with a velocity of 10.0jm/s and moves in the x-y plane with a constant acceleration of $(8.0\hat{\imath} + 2.0\hat{\jmath})$m/s

(a)at what time is the x-coordinate of the particle be 16m ? what is the y- coordinate of the particle at that time?

(b) what is the speed of the particle at that time?

Q32. A river one km wide is flowing at 3km/h. A swimmer, whose velocity is still water is 4km/h, can swim only for 15 minutes. In what direction should he strikes out so as to reach the opposite bank in 15 minutes? What total distance will he swim ?

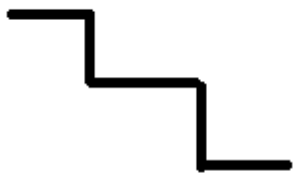
Q33. A man is going due east with a velocity of 3km/h. Rain falls vertically downward with a speed of 10km/h. calculate the angle at which he should hold the umbrella to save himself?

Q34. if a shower of rain appears to be falling vertically downwards with a speed of 12km/h to a person walking due east with a speed of 5kmph, what is the actual direction of the rain ?

Q35. An Aeroplane has to go from a point A to another point B. 500 km away due 30' east of north . A wind is blowing due north at a speed of 20m/s. The air speed of the plane is 105m/s (i) find the direction in which the pilot should head the plane to reach the point B (ii) find the time taken by plane to go from point A to point B.

Q36. six particle situated at the cornors of a regular hexagon of side 'a' move at a constant speed v. Each particle maintains a direction towards the particle at the next corner. Calculate the time the particles will take to meet each other.

Q37. A staircase contains 3 steps each 3cm high and 20 cm wide. What should be the minimum horizontal velocity of a ball rolling off uppermost plane so as to hit the lowest plane directly?



Q38. A boy standing on a long railroad car, throws a ball straight upward. The car is moving on the horizontal road with an acceleration $1m/s^2$ and the projection velocity in the vertical direction is9.8m/s. how far behind the boy ball will fall on car?

Q39. A man running on a horizontal road at 8kmph finds the rain falling vertically. He increases his speed to 12kmph and finds that the drops makes 30^0 with the vertical. Find the speed and direction of the rain with respect to the road.

Q40. A man can swim at a speed of 3kmph in still water. He wants to cross a 500m wide river flowing at 2kmph. He keeps himself always at an angle of 120^0 with the river while swimming .

(i) find the time he takes to cross the river.

(ii) at what point on the opposite bank will he arrive?

Q41. Prove that the vectors $\vec{A}$= $3\hat{\imath}+\hat{\jmath}-2\hat{k}$, $\vec{B}$= $-\hat{\imath} + 3\hat{\jmath}+4\hat{k}$ and $\vec{C}$= $4\hat{\imath}- 2\hat{\jmath}-6\hat{k}$ can form a triangle.

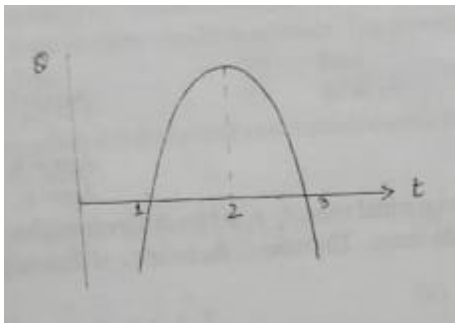
MOTION IN A PLANE -2

Q1. A shell is fired from a canon with a velocity V at an angle Θ with the horizontal. At the highest point in its path, it explodes into two pieces of equal mass. One of the pieces retraces its path to canon. Find the speed of the other piece immediately after explosion.

Q2. the maximum range of projectile is 2/√3 times its equal range. Find the angle of projection for actual range.

Q. Instantaneous velocity of a particle moving in a circular path is (2i-2j)m/s. Through which quadrant is the particle moving when it is travelling (i) clockwise (ii)anti clockwise

Q3. Study the following graph and give the sign of angular velocity at t= 1,2 and 3s.



Q4. Linear velocity of a particle moving on the circumference of a circle is equal to the velocity acquired by a freely falling body at distance equal to one fourth the diameter of a circle. What is the centripetal acceleration of the particle moving along the circle.

Q5. A projectile of mass m is fired with velocity v at an angle Θwith the horizontal what is the change in momentum as it rises to the highest point of the trajectory?

Q6. Show diagrammatically that vector substraction is not commutative.

Q7. Can three vectors not lying in a plane give zero resultant?

Q8. given $\vec{c}=\vec{a}+\vec{b}$ and $|\vec{c}|=|\vec{a}|$. If c is perpendicular to a find the angle between $\vec{a}$ and $\vec{b}$

Q9. identify the plane in which a particle would move under the effect of following four forces.

$\overrightarrow{f1} = 3\hat{\imath}-\hat{\jmath}+9\hat{k}$ N, $\overrightarrow{f2}=2\hat{\imath}- 2\hat{\jmath}+16\hat{k}$ N

$\overrightarrow{f3}= 9\hat{\imath}-\hat{\jmath}+18\hat{k}$ N, $\overrightarrow{f4}=\hat{\imath}+2\hat{\jmath}-18\hat{k}$ N

Q10. resultant of two vector $\vec{P}$ and $\vec{Q}$ is perpendicular to $\vec{P}$ and its magnitude is half of $\vec{Q}$. find the angle between $\vec{p}$ and $\vec{Q}$.

Q11. A stone dropped from the window of a stationary bus takes 4s to reach the ground. How much time will it take if the bus is moving with a

(a)constant velocity of 90kmph.

(b) constant acceleration of $2km/h^2$

Q12. find the value of 'g' from the following data of an oblique projectile

$Y= 8t-5t^2$

Q13. Two particles located at a point begin to move with velocity 4m/s and 1m/s horizontally in opposite direction. Find the time when velocity vector becomes perpendicular. Assume the value of g remain constant.

MCQ

Q1. A particle is kept fixed on a turntable, rotating uniformly. As seen by the observer on ground the particle moves on a circular path with a speed of 20cm/s and its acceleration is 20cm/s^2. The particle is now shifted to a position to make the radius half of the original value. The new values of the speed and acceleration are:

(a)10cm/s, 10cm/s^2 (b) 10cm/s, 80 en

(c) 40cm/s, 10cm/s^2 (d) 40cm/s, 40 en

Q2. The x and y coordinates of a particle at any time t are given by x=2t+ $4t^2$ and y=5t, where x and y are in meters and t in seconds. The acceleration of particle at t=5 s is

(a)zero (b)8ms^{-2}

(c)20ms^{-2} (d)40ms^{-2}

Q3. For motion in a plane with constant acceleration A, initial velocity u_0 and final velocity v (after time t), we have

(a)$\vec{v}.(\vec{v}-\vec{a}t)=\vec{v}.(\overrightarrow{v0}+\vec{a}t)$ (b) $\vec{v}.\overrightarrow{v0}=at^2$

(c) $\overrightarrow{v0}.\overrightarrow{v0}=\vec{a}.\overrightarrow{v0}\,t$ (d) $\vec{v}.\overrightarrow{v0}=\vec{a}.\overrightarrow{v0}\,t$

Q4. The equation of a projectile is

$Y=\sqrt{3x}-\frac{x2g}{2}$

The angle of projection is

(a)π/2 (b) π/3

(c) π (d)Zero

Q5. In the above question the initial velocity is

(a)4m/s (b) 2m/s

(c) 1m/s (d) 5m/s

Q6. two particles are projected upward with the same initial velocity v_0 at two different angle of projection such that their horizontal range are the same. The ratio of the heights of their highest point will be

(a)$\tan^2\Theta$ (b) v sinΘ

(c)Vg/cosΘ (d)$v_0^2\sin^2\Theta$

Where Θ is the angle of projection of the first particle

Q7. the velocity at the maximum height of a projectile is half of its initial velocity u. its range on the horizontal plane is :

(a)$2u^2/3g$ (b)$3u^2/g$

(c)$\sqrt{3}u^2/2g$ (d)$u^2/3g$

Q8. the horizontal distance x and the height covered by a particle at any instant are given follows:

$Y= bt^2$ and $x= ct^2$. What is the speed of the particle one second after the firing?

(a)(b+c) (b) 2(b-c)

(c)$2(b^2+c^2)^{1/2}$ (d) $2(b^2-c^2)^{1/2}$

Q9. At what angle an object must be projected so that the horizontal range is equal to the maximum height:

(a)$\tan^{-1}$ (b) $\tan^{-2}$

(c)$\tan^{-3}$ (d)$\tan^{-4}$

Q10. At any instant a projectile is moving with velocity u in a direction making an angle Θ with horizontal. After what time the direction of motion turns through an angle α?

(a)ucosΘ / gsin(Θ-α) (b)usinα /gcos((Θ-α)

(c)u/ gsin(Θ-α) (d)u/ gcos(Θ-α)

Q11. A bullet is fired with a speed of 1000 m/s in order to hit a target 100m away. If $g= 10m/s^2$, the gun should be aimed

(a)directly towards the target

(b)5cm above the target

(c) 10cm above the target

(d) 15cm above the target