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QUESTION BANK

Title of the Paper

DYNAMICS

COURSE – III B.Sc., Maths

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CORE COURSE - XIV

DYNAMICS

UNIT I

Introduction- kinematics: velocity – Relative velocity – Angular velocity acceleration – Relative acceleration – Motion in a straight line under uniform acceleration.

UNIT II

Projectile: Projectile – Path of a projectile – Characteristic – Horizontal projection – projectile up/ down an inclined plane – Enveloping parabola.

UNIT III

Collision of elastic bodies: Introduction – Definitions – Fundamental laws of impact – Impact of a smooth sphere on a fixed smooth plane – Direct impact of two smooth spheres – Oblique impact of two smooth spheres – Dissipation of energy due to impact – Compression and restitution – Impact of a particle on an rough plane.

UNIT IV

Simple harmonic motion: Introduction SHM in straight line – Composition of simple harmonic motion of a same period.

UNIT V

Motion under the action of central forces: Velocity & acceleration in polar co-ordinates – Equiangular spherical – Definitial equation of central orbits – Pedal equation of the central orbit – Two field problems.

UNIT- I

CHOOSE THE CORRECT ANSWER:

1. If two velocities are equal in magnitude, then magnitude of resultant velocity is

a) $2v\cos\frac{\alpha}{2}$

b) $2v\cos\alpha$

c) $2v^2\cos\frac{\alpha}{2}$

d) $v\cos\frac{\alpha}{2}$

2. When the changes of velocity of a point in any equal interval of time, however small these be, are equal in magnitude and the same in direction, its acceleration is said to be

a) Equal

b) Uniform

c) Variable

d) None of these

3. The velocity component in the tangential direction is

a) $\dot{s}$

b) r

c) $a\dot{\theta}$

d) $r\dot{\theta}$

4. Units of velocity in M.K.S is

a) 1m/sec

b) 1cm/sec

c) $1m/sec^2$

d) $1cm/sec^2$

5. If the velocities $\overline{v_1}$ and $\overline{v_2}$ are perpendicular then the value of $|\overline{v_1}+\overline{v_2}|$ is

a) $\sqrt{v_1^2 + v_2^2 + 2v_1v_2}$

b) $\sqrt{v_1^2 + v_2^2}$

c) $\sqrt{v_1^2 + v_2^2 - 2v_1v_2}$

d) $\sqrt{v_1^2 - v_2^2}$

6. The radial acceleration is

a) $\ddot{r}$

b) $\ddot{r} - r\dot{\theta}^2$

c) $\ddot{r} + r\dot{\theta}^2$

d) $r + \dot{\theta}^2$

7. If a particle equation of motion is

a) $m\vec{v} = \vec{F}$

b) $m\vec{F} = \vec{a}$

c) $m\vec{a} = \vec{F}$

d) $m\vec{F} = \vec{v}$

8.Unit of angular velocity is

a) 1 radian/ sec

b) 2 radian/ sec

c) 1 radian/ min

d) 2 radian/ min

9. When a particle starts from rest and moves with constant acceleration f, then

a) $v = 2fs$

b) $v^2 = fs$

c) $v^2 = 2fs$

d) $s = 2fv$

10. Unit of acceleration in C.G.S is

a) $1m/ sec^2$

b) 1m/ sec

c) 1cm/ sec

d) $1cm/ sec^2$

ANSWERS :

1) a 2) b 3) d 4) a 5) b 6) b 7) c 8) a 9) c 10) d

TWO MARK QUESTIONS

11. Define Dynamics.

12. Define velocity.

13. Define vector function.

14. Define Relative velocity.

15. Define Rectilinear motion.

16. Write the Newton's second law of motion.

17. Define Acceleration.

18. Define Relative angular velocity.

19. Define Angular velocity.

20. Define Displacement

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FIVE MARK QUESTIONS

21. To find the magnitude and direction of the resultant of the velocity $\overline{v_1}$ and $\overline{v_2}$.

22. To resolve a velocity $\bar{v}$ into components in two given directions.

23. A particle has two velocity $\overline{v_1}$ and $\overline{v_2}$ its resultant velocity is equal to $\overline{v_1}$ in magnitude. Show that when the velocity $\overline{v_1}$ is doubled the new resultant is perpendicular $\overline{v_2}$.

24. Derive the equation of a motion if a particle.

25. A body has an initial velocity u and a constant acceleration α. Show that the distance it travelled in the t^th^ second is $u + \frac{1}{2}\alpha(2t - 1)$.

26. If a, b, c are the distances described in the p^th^, q^th^, r^th^ seconds. Show that $a\,(q - r) + \;b\,(r - p) + c\,(p - q) = 0$.

27. The two ends of a train moving with constant acceleration pass a certain point with velocities u and v. show that the velocity with which the middle point of the train passes the same point is $\sqrt{\frac{u^2+v^2}{2}}$.

28. If a point moves in a straight line with uniform acceleration and successive equal distances in times t_1, t_2, t_3 then show that $\frac{1}{t_1} - \frac{1}{t_2} + \frac{1}{t_3} = \frac{3}{t_1+t_2+t_3}$.

29. A train moves in a straight line with a uniform acceleration and describes equal distance s in two successive intervals of durations t_1, and t_2. Show that its acceleration is $\frac{2s(t_1-t_2)}{t_1t_2(t_1+t_2)}$.

30. A is a point (o, a) and the point p (a $\cos\mu t$, a $\sin\mu t$) where a and μ are constant AP meets X axis at Q if the speed of Q is v. show that its acceleration is of magnitude $\frac{v^2\cos\mu t}{a}$.

TEN MARK QUESTIONS

31. A particle moves along a straight line under the constant accelerations 'f' if 'u' is the initial velocity and 'v' is the final velocity 's' is the displacement. Then prove that

i) $v = u + ft$

ii) $s = ut + \frac{1}{2}ft^2$

iii) $v^2 = u^2 + 2fs$.

32. Find the components of velocity and acceleration of a particle in the radial and transverse directions.

33. Find the components of velocity and acceleration of a particle in the tangent and normal directions.

34. A particle moves with uniform acceleration and v_1, v_2, v_3 denoted by average velocities in the three successive intervals of time t_1, t_2, t_3. Prove that $v_1 - v_2 : v_2 - v_3 = t_1 + t_2 : t_2 + t_3$ (or) $\frac{v_1-v_2}{v_2-v_3} = \frac{t_1+t_2}{t_2+t_3}$.

35. A train moves in a straight line with uniform acceleration and describes distances 'a' and 'b' in successive intervals of durations t_1 and t_2. Show that its acceleration is $\frac{2(bt_1-at_2)}{t_1t_2(t_1+t_2)}$.

36. The speed of a train increases at a constant rate α from o to v and then remains constant for an interval and finally discreases at o at a constant rate β. If s is the total distance described prove that $T = \frac{S}{V} + \frac{V}{2}(\frac{1}{\alpha} + \frac{1}{\beta})$.

37. A body travelles a distance s in t seconds. Its starts from rest and ends at rest. In the first part of the journey it moves with a constant acceleration 'a' and in the second part of the journey it moves with a constant retardation a'. Show that $aa't^2$ = 2s $(a + a')$

38. Two particles described concentric circles of radii a_1 and a_2 with constant speed v_1 and v_2. Show that the angular velocity of one with respect to the other vanishes. Prove that the angle θ between the radii through then is $\cos^{-1}\left(\frac{a_1v_1+a_2v_2}{a_2v_1+a_1v_2}\right)$.

39. The two planets describes nearly circles of radii a_1 and a_2 round the sum as center with speed varying inversely as the square root of the radii. Show that their relative angular velocity vanishes when the angle between the radii to these planets is $\cos^{-1}\left[\frac{\sqrt{a_1a_2}}{a_1-\sqrt{a_1a_2}+a_2}\right]$.

40. A lift ascends with a constant acceleration 'a' then with a constant velocity and finally stops with a constant retardation 'a'. If the total distance travelled is 's' and the total time occupied is T, show that the time for which the lift was ascending with constant velocity is $\sqrt{T^2 - {4s}/{a}}$

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UNIT-II

CHOOSE THE CORRECT ANSWER:

1. Time taken by the projectile to reach the greatest height is

a) $\frac{u\ sin\alpha}{g}$

b) $\frac{u^2 sin\alpha}{g}$

c) $\frac{u\ sin2\alpha}{g}$

d) $\frac{u\ sin\alpha}{g^2}$

2. The time of flight of a projectile is

a) $\frac{u\ sin2\alpha}{g}$

b) $\frac{u^2\ sin^2\alpha}{g}$

c) $\frac{2u\ sin\alpha}{g}$

d) $\frac{u^2\ sin^2\alpha}{2g}$

3. A particle is projected with a velocity of 24m/sec at an elevation of 30^0. Then the time of flight is

a) $\frac{12}{g}$

b) $\frac{36}{g}$

c) $\frac{24^2}{g}$

d) $\frac{24}{g}$

4. For a given speed u the maximum range up the inclined plane is

a) $\frac{u^2}{g(1-sin\beta)}$

b) $\frac{u^2}{g(1+sin\beta)}$

c) $\frac{u^2}{g(1-cos\beta)}$

d) $\frac{u^2}{g(1+cos\beta)}$

5. The horizontal range R of a projectile is

a) $\frac{u^2 sin\alpha}{g}$

b) $\frac{u^2}{g}$

c) $\frac{u^2 sin2\alpha}{g}$

d) None of these

6. The greatest height of a projectile is

a) $\frac{u^2 sin\alpha}{2g}$

b) $\frac{u^2 sin^2\alpha}{2g}$

c) $\frac{usin^2\alpha}{g}$

d) $\frac{u^2 sin2\alpha}{g}$

7. The range on the inclined plane of the projectile is

a) $\frac{u^2 \sin(\alpha-\beta)}{g\ cos\beta}$

b) $\frac{usin^2(\alpha-\beta)}{g\ cos^2\beta}$

c) $\frac{2u^2 \sin(\alpha-\beta)cos\alpha}{g\ cos^2\beta}$

d) $\frac{u^2 sin^2(\alpha-\beta)}{g\ cos\beta}$

8. The horizontal range of a projectile is maximum when angle of projection is

a) 90^0

b) 60^0

c) 45^0

d) 30^0

9. The maximum range of a projectile is

a) $\frac{2u^2}{g}$

b) $\frac{u^2}{g}$

c) $\frac{2u^2}{g^2}$

d) $\frac{u^2}{g^2}$

10. For a given speed u, the maximum range down the inclined plane is

a) $\frac{u^2}{g\ (1+sin\beta\ )}$

b) $\frac{u^2}{g\ (1-cos\beta\ )}$

c) $\frac{u^2}{g\ (1-sin\beta\ )}$

d) $\frac{u^2}{g\ (1+cos\beta\ )}$

ANSWERS:

1) a 2) c 3) d 4) b 5) c 6) b 7) c 8) c 9) b 10) c

TWO MARK QUESTIONS

11. Define Projectile.

12. Define Trajectory.

13. Define Horizontal range.

14. Define Range on an inclined plane.

15. Define Maximum height.

16. Prove that the relation $gT^2 = 2R\ tan\alpha$, where T is the time of flight, R is the horizontal range and α is the projection of a particle projected from the ground.

17. If the greatest height attained by a projectile is one- quarter of its range on the horizontal plane, show that the angle of projection is 45^0.

18. Write the formula for range on the inclined plane.

19. Define Angle of projection.

20. Define Velocity of projection.

FIVE MARK QUESTIONS

21. Displacement as a combination of vertical and horizontal displacement.

22. A particle projected from the top O of a wall AO, 50m height at an angle of 30^0 above the horizon strikes the level ground through A at B at an angle of 45^0. Show that the angle of depression of B from O is $\tan^{-1}\frac{\sqrt{3}-1}{2\sqrt{3}}$.

23. A particle is projected over a triangle from one end of a horizontal base (plane) to graze the vertex fall at the other end of the base. If B and C are the base angles and α the angle of projection. Show that $\tan\alpha = \ tan\, B \ + tan\, C$.

24. Two particles are projected from the same point 'O' with the same velocity u at an angle α and β and aimed at a target on the horizontal plane through 'O' one falls 'a' meter too short and the other 'b' meter too far from the target. If θ be the correct angle of projection so as to hit the target. Show that $(a+b)\ sin\ 2\theta \ = \ a\ sin\ 2\beta \ + \ b\ sin\ 2\alpha$.

25. If h and h' be the greatest height in the two paths of projective with a given velocity for a given range R. prove that $R \ = \ 4\sqrt{hh'}$.

26. Describe motion of a projectile on an inclined plane.

27. Find the range on an inclined plane through the point of projection.

28. Find the time of flight on an inclined plane.

29. Find the maximum range on an inclined plane.

30. A gun is situated on an inclined plane and the maximum ranges up and down the plane are L_1 and L_2. If L is the maximum range in a direction perpendicular to the line of greatest slope. Show that $\frac{1}{L_1} + \frac{1}{L_2} = \frac{2}{L}$.

TEN MARK QUESTIONS

31. Show that the path of a projectile is a parabola.

32. A particle is projected from a point O an the ground with a velocity u inclined to the horizontal at an angle α it hits the ground at A. Find

(i) Maximum height H attained by the particle.

(ii) Time taken to attained the maximum height.

(iii) Time of flight.

(iv) Horizontal range R.

(v) Velocity at time t.

33. A ball is projected so as to just clear two parallel walls the first of height ‘a’ at a distance ‘b’ from the point of projection and the second of height ‘b’ at a distance ‘a’ from the point of projection. Supposing the path of the ball to lie in a plane perpendicular to the walls find the range on the horizontal plane and show that the angle of projection exceeds $\tan^{-1} 3$.

34. A particle projected from a given point on the ground just cross the wall of height ‘h’ at a distance ‘a’ from the point of a projection. If the particle moves in a vertical plane perpendicular to the wall and R is in the horizontal range. Show that

(i) Elevation of projection is given by $tan\ \alpha = \frac{Rh}{a(R-a)}$

(ii) Velocity of projection is given by $= \frac{g}{2}\left[\frac{R^2h^2+a^2(R-a)^2}{ha(R-a)}\right]$.

35. A particle is projected with a velocity u at an elevation α to the horizontal. Show that the deviation D in the direction of motion of the particle at time t is given by

$tan\ D\ = \frac{gt\ cos\alpha}{u-gt\ sin\alpha}$. Deduce that the particle will moving at right angles to the initial direction after a time $\frac{u\ cosec\alpha}{g}$.

36. A particle is projected from a point P so as to passes through the another point Q. Show that the produce of two kinds of flight from P to Q with the given velocity of projection is $\frac{2PQ}{g}$.

37. Show that the least velocity require to projected a particle from a height 'h' to fall on the ground at horizontal distance 'a' from the point of projection is given by u^2 = g$\left[\sqrt{a^2+h^2}-h\right]$.

38. Show that the greatest height which a particle with initial velocity 'v' can be reach on α vertical wall at a distance 'a' from the point of projection is $\frac{v^2}{2g}-\frac{ga^2}{2v^2}$. Prove also that the greatest height above the point of projection attained by the particle in its flight is $\frac{v^6}{2g(v^4+g^2\alpha^2)}$.

39. A particle is projected with a speed u strikes at right angles a plane through the point of projection, inclined at an angle β to the horizon. If α, T and R are the angle of projection, the time of flight and the range on the inclined plane, show that

(i) $cot\,\beta\ =\ 2\,tan\,(\alpha-\beta)$

(ii) $cot\,\beta\ =\ tan\,\alpha\ -\ 2\,tan\,\beta$

(iii) $T\ =\frac{2u}{g\sqrt{1+3\,sin^2\beta}}$

(iv) $R\ =\frac{2u^2\,sin\beta}{g(1+3\,sin^2\beta)}$.

40. A particle is projected with a velocity $\sqrt{2ag}$ from a point at a height above the level plane. Show that the maximum range on the plane and the corresponding angle of projection are $x\ =2\sqrt{a(a+h)}$ and α = $\tan^{-1}\left(\frac{\sqrt{a}}{\sqrt{a+h}}\right)$.

UNIT –III

CHOOSE THE CORRECT ANSWER:

1. The formula of impulse is

a) $\int_a^b Fdt$

b) $\int_0^a Fdv$

c) $\int_0^\tau Fdt$

d) $\int_0^a Fdt$

2. For a direct impact when e = 1, the loss of kinetic energy is

a) 0

b) 1

c) 2

d) None of these

3. When the plane is perfectly elastic

a) 0

b) 2

c) 1

d) 3

4. A large force which, acting on a body for an infinitesimally small period, produces a finite change of momentum in that interval, is called an ____?.

a) impulse

b) acceleration

c) impulsive action

d) impulsive force.

5. The formula of kinetic energy

a) $\frac{1}{2}mv^2$

b) $\frac{1}{2}m^2v^2$

c) $\frac{1}{2}mr^2$

d) $\frac{1}{2}m^2r^2$.

6. The principle of conservation of momentum for a particle that, if the applied force on a particle is ____?

a) 0

b) 1

c) 2

d) None of these.

7. Impact of spheres can be classified into two groups namely_____.

a) Indirect and oblique

b) Direct and oblique

c) Direct and un oblique

d) Indirect and un oblique.

8. Two smooth sphere of masses m_1 and m_2 moving with velocities u_1 and u_2 impact directly find the impulse of the sphere is

a) $\frac{(u_1-u_2)(1+e)(m_1 m_2)}{m_1+m_2}$

b) $\frac{(u_1+u_2)(1+e)(m_1 m_2)}{m_1+m_2}$

c) $\frac{(u_1-u_2)(1-e)(m_1 m_2)}{m_1-m_2}$

d) $\frac{(u_1+u_2)(1+e)(m_1 m_2)}{m_1-m_2}$

9. For a oblique impact when e = 1, the loss of kinetic energy is

a) 1

b) 2

c) 0

d) 3

10. If two sphere are smooth and perfectly elastic an equal masses and if the first sphere impinge and obliquely on the second sphere at rest. What is the angle after impact will move?

a) 45^0

b) 90^0

c) 180^0

d) 30^0

ANSWERS:

1) c 2) a 3) c 4) d 5) a 6) a 7) b 8) a 9) c 10) b

TWO MARK QUESTIONS

11. Define Impulsive force.

12. Define Impulse.

13. Define Direct impact.

14. Define Oblique impact.

15. Define Conservation of linear momentum.

16. Write the formula for Newton's experimental law.

17. State the principle of conversation of momentum for a particle.

18. Define Kinetic energy generated.

19. Define Direct impact of two smooth spheres.

20. Define Oblique impact of two smooth spheres.

FIVE MARK QUESTIONS

21. Explain laws of impact.

22. Two smooth sphere's of masses m_1 and m_2 moving with velocities u_1 and u_2 impact directly find their velocities after impact.

23. If two sphere are smooth and perfectly elastic and if the first sphere impinges obliquely second sphere at rest and move at right angle after impact. Show that two sphere are of same masses.

24. A smooth sphere impinges directly on a fixed plane with a velocity u. Find it's velocity of rebound and the loss in K.E due to impact.

25. Two equal balls of mass m are in contact on a table. A third equal ball strikes both symmetrically and remains at rest after impact. Show that $e = 2/3$.

26. A ball of mass 8 gram moving with a velocity of 10cm/ s impinge directly on another of mass 24 gram moving at 2cm/ s in the same direction. If $e = ½$ find the velocities after impact also calculate the loss in K.E.

27. If two sphere are smooth and perfectly elastic an equal masses and if the first sphere impinge obliquely on the second sphere at rest. Show that the will move at right angle after its Impact.

28. A small ball A impinges directly upon an equal ball B. Then B strikes a cushion which is at right angles to the direction of motion of B and, after rebounding, meets A at a point exactly halfway between the cushion and its own initial position. If the coefficient of restitution between the balls is e and that between the ball and the cushion is e', then show that $e' = \frac{1-e}{3e-1}$.

29. A smooth circular table is surrounded by a smooth rim whose interior surface is vertical. Show that a ball projected along the table from a point A on the rim in a direction making an angle α with the radius through A will return to the point of projection after two impacts if tan $\alpha = \frac{e^{3/2}}{\sqrt{1+e+e^2}}$.

30. A sphere of mass m_1 moving with velocity u_1 impinge obliquely on a sphere of mass m_2 at rest. If makes an angle α to the common normal. Show that the second after impact.

TEN MARK QUESTIONS

31. A gun is rigidly mounted on a carriage on a smooth horizontal plane. The total mass of the carriage and the gun is M. If the gun is elevated at an angle α to the horizon, show that, when a shot of mass m is fired, it leaves the gun in a direction at an angle θ to the horizontal given by $tan\ \theta = \frac{M+m}{M}\ tan\ \alpha$.

32. A shell of mass 'm' is moving with a velocity v an interval explosion generates an energy E and breaks the shell into two portions whose masses are in the ratio a : b they continue to move in the original line of motion. Show that their velocities after explosion are $v + \sqrt{\frac{2bE}{am}}$, $v - \sqrt{\frac{2aE}{bm}}$.

33. Two smooth sphere of masses m_1 and m_2 moving with velocities u_1 and u_2 impact directly find

(i) Their velocities after impact

ii) The impulse of the sphere

(iii) The loss of kinetic energy due to impact.

34. The masses of 3 sphere A, B and C are 7m, 7m, m their coefficient of restitution is unity. Their centers are in a straight line and C lies between A and B initially A and B are at rest and C is given a velocity in the line of center in the direction of A. Show that it's strikes A twice and B once and that the final velocity of A, B, C are 21: 12: 1.

35. A ball dropped from a height h on a horizontal plane bounces up and down. If the coefficient of restitution is e, prove that

(i) The whole distance H covered before it comes to rest is $h\frac{1+e^2}{1-e^2}$.

(ii) The total time T taken is $\frac{1+e}{1-e}\sqrt{\frac{2h}{g}}$.

36. A ball of mass m impinges on another of mass 2m which is moving in the same direction as the first but with one-seventh of its velocity. If e = ¾, show that the first ball is reduced to rest after impact.

37. A ball A impinges directly on an exactly equal and similar ball B lying on a horizontal plane. If the coefficient of restitution is e. Prove that after impact, the velocity of B will be to that of A is as $1 + e : 1 - e$.

38. Two perfectly elastic smooth sphere of masses m and 3m are moving with equal momentum in the same straight line and in the same direction. Show that the smaller sphere reduced to rest after it strikes the other.

39. A smooth sphere impinges directly on a fixed plane with a velocity u. To find its velocity of rebound and the loss in its kinetic energy due to impact and the impulse imparted to the sphere.

40. A sphere projected from a given point O with given velocity u at an inclination α to the horizontal, after hitting a smooth vertical wall at a distance d from O, returns to O. If e is the coefficient of restitution, show that $d = \frac{u^2 \sin 2\alpha}{g} . \frac{e}{1+e}$ and also if the line joining the point of projection and the point of impact makes an angle θ with the horizontal, show that $(1 + e)\, tan\, \theta = tan\, \alpha$.

UNIT – IV

CHOOSE THE CORRECT ANSWER:

1. The period of simple harmonic motion is independent of the ____?

a) Frequency

b) Amplitude

c) Displacement

d) None of these.

2. The frequency is the reciprocal of

a) Amplitude

b) Displacement

c) Period

d) None of these

3. The period of simple harmonic motion is

a) $\frac{2\pi}{\sqrt{\mu}}$

b) $\frac{\sqrt{\mu}}{2\pi}$

c) $\frac{\pi}{2\sqrt{\mu}}$

d) $\frac{2\sqrt{\mu}}{\pi}$

4. In a simple harmonic motion, the phase at time t is,

a) $t + \frac{\epsilon}{\sqrt{\mu}}$

b) $t + \frac{1}{\sqrt{\mu}}$

c) $t - \frac{\epsilon}{\sqrt{\mu}}$

d) $t + \frac{1}{2\epsilon}$

5. In the simple harmonic motion whose equation of motion of the particle is

a) $\dot{x} = n^2x$

b) $\dot{x} = -n^2x^2$

c) $\ddot{x} = -n^2x$

d) $\ddot{x} \ = n^2x^2$

6. The motion of the particle from one extremity to the other extremity of its path, is called a ____?

a) Oscillation

b) Vibration

c) Amplitude

d) None of these

7. The time taken by the particle to make ___ oscillation is called the period of the motion.

a) 1

b) 2

c) 3

d) 4

8. In the simple harmonic motion two vibration = _____?

a) Two oscillation

b) Three oscillation

c) One oscillation

d) None of these

9. In the simple harmonic motion time for one oscillation = ____?

a)1/ 126 min

b) 1/ 128 sec

c) 1/ 126 sec

d) 1/ 128 min

10. The phase and epoch general form of the displacement x of the particle is

a) $x = a\, sin(nt + \in)$

b) $x = a\, sec(nt - \in)$

c) $x = a\, cos(nt + \in)$

d) $x = a\, tan\,(nt - \in)$

ANSWERS:

1) b 2) c 3) a 4) a 5) c 6) b 7) a 8) c 9) b 10) c

TWO MARK QUESTIONS

11. Define Simple harmonic motion.

12. Define Oscillation.

13. Define Vibration.

14. Define Amplitude.

15. Define Period.

16. Define Frequency.

17. Define Phase and epoch.

18. A body moving with a SHM as amplitude 'a' and period 'T' show that the velocity 'v' at a distance 'x' from the mean position is given by $v^2T^2 = 4\pi^2(a^2 - x^2)$.

19. Define Simple pendulum.

20. Define Seconds pendulum.

FIVE MARK QUESTIONS

21. Show that the equation of motion of the particle in SHM?

22. Show that in a simple harmonic motion the sum of kinetic energy and potential energy is constant.

23. A particle moves along a circle with a uniform speed. To show that the motion of its projection on a fixed diameter is simple harmonic.

24. Show that the resultant motion of two simple harmonic motion of same period along two perpendicular line is along an ellipse.

25. A particle is executing a SHM with O as the mean position and a as the amplitude when it is at a distance a/ 2 from O, its velocity is quadrupled by a blow. Show that its new amplitude is $7a/\,2$.

26. A particle moves in a straight line if v is its velocity when at a distance x from a fixed point in the line and if $v^2 = \alpha - \beta x^2$. Where α and β are the constant. Show that the motion is SHM and determine its period and amplitude.

27. If the distance x of a point moving on a straight line measured from a fixed point on it and its velocity v are connected by the relation $4v^2 = 25 - x^2$. Show that the motion is SHM and find the period and amplitude of the motion.

28. The velocity of a particle moving in a straight line at a distance x from a fixed point on the line is given by $v = k\sqrt{a^2 - x^2}$. Where k and a are constants. Show that the motion is SHM and find the amplitude and periodic time.

29. A particle is moving with SHM in a straight line when the distance of the particle from the equilibrium position as the values x_1 and x_2 the corresponding values of the velocity are u_1 and u_2. Show that the period is $2\pi\sqrt{\frac{x_1^2 - x_2^2}{u_2^2 - u_1^2}}$.

30. A particle moving with a SHM as speed $v_1$and v_2 ($v_1 > v_2$) and accelerations with magnitude α_1 and α_2 at the point A and B which lie on the same side of the mean position O. show that $AB = \frac{V_1^2 - V_2^2}{\alpha_1 + \alpha_2}$.

TEN MARK QUESTIONS

31. In the simple harmonic motion whose equation is $\ddot{x} = -n^2 x$ to express

(i) $x \; in \; t$

(ii) $\dot{x} \; in \; t$

(iii) $\dot{x} \; in \; x$.

32. Composition of two simple harmonic motion of same period.

33. The displacement x of a particle moving along a straight line is given by $x = A\cos nt + B\sin nt$ where A, B, n are constant. Show that its motion is SHM. If A = 3, B = 4, n= 2.. Find its period amplitude maximum velocity and maximum acceleration.

34. A particle is moving with SHM and while moving from the mean position to one extreme position its distances at three consecutive seconds are x_1, x_2, x_3. Show that its period is $\frac{2\pi}{\cos^{-1}\left(\frac{x_1+x_3}{2x_2}\right)}$.

35. A particle is executing a SHM of period T with 'O' as the mean position. The particle passes through a point P with velocity v in the direction of OP. Show that the time which lapses before its return to P is $\frac{T}{\pi}\tan^{-1}\frac{VT}{2\pi OP}$.

36. The displacement x of a particle moving along a straight line is given by $x = a\,cosnt + b\,sinnt$. Show that the motion is SHM with amplitude $\sqrt{a^2+b^2}$ and period $2\pi/n$

37. A particle moving in a SHM has amplitude 8cm if its maximum acceleration is 2cm. Find

(i) Its period

(ii) Maximum velocity

(iii) Its velocity when it is 3cm from the extreme position.

38. A particle is moving in a straight line with a SHM of amplitude 'a' at a distance s from the centre of motion the particle receives a blow in the direction of motion which instantaneously doubles the velocity. Find the new amplitude.

39. The ends of an elastic string of natural length 'a' are fixed at points A and B distance 2a apart, on a smooth horizontal table. A particle of mass m is attached to the middle point of the string and slightly displaced along the direction perpendicular to AB. Show that the period of small oscillation is $\pi\sqrt{\frac{2am}{\lambda}}$.

40. Find the period of a small oscillation of a simple pendulum.

UNIT – V

CHOOSE THE CORRECT ANSWER:

1. When a particle is subject to the action of a force which is always either towards or away from a fixed point, the particle is said to be under the action of a ___?

a) Central force

b) Central orbit

c) Conic

d) None of these.

2. The velocity components radial direction in ___?

a) $\dot{r}$

b) $\ddot{r}$

c) r

d) None of these

3. The acceleration components transverse direction in ___?

a) $\frac{1}{r}\frac{d}{dt}(r^2\dot{\theta})$

b) $\frac{1}{r^2}\frac{d}{dt}(r^2\dot{\theta})$

c) $\frac{1}{r^3}\frac{d}{dt}(r^2\dot{\theta})$

d) None of these

4. The path described by a particle under a central force is called a ___?

a) Central orbit

b) Central force

c) Conic

d) None of these

5. A central force is a force whose line of action always passes through a fixed point. The fixed point is called the ____?

a) Centre of force

b) Central orbit

c) Central force

d) None of these

6. The velocity components transverse direction is ___?

a) $r\ddot{\theta}$

b) $\dot{r}\dot{\theta}$

c) $r\dot{\theta}$

d) $r\theta$

7. The acceleration components radial direction in ___?

a) $\ddot{r} - \dot{r}\dot{\theta}^2$

b) $\ddot{r} - r\dot{\theta}^2$

c) $\dot{r} - \dot{r}\dot{\theta}^2$

d) None of these

8. The central orbit in polar co-ordinates is___?

a) $\frac{du}{d\theta} + u = -\frac{\phi(r)}{hu}$

b) $\frac{d^2u}{d\theta^2} + u = -\frac{\phi(r)}{h^2u^2}$

c) $\frac{d^3u}{d\theta^3} + u = -\frac{\phi(r)}{h^3u^3}$

d) None of these

9. The quantity $\sqrt{\frac{2\mu}{r}}$ is called the ___ at the distance r.

a) Areal velocity

b) Angular velocity

c) Critical velocity

d) None of these.

10. The path is parabola, e = 1 and therefore

a) $u^2 = \mu \frac{1}{r}$

b) $u = \mu \frac{2}{r}$

c) $v^2 = \mu \frac{2}{r}$

d) $v = \mu \frac{2}{r}$.

ANSWERS:

1) a 2) a 3) a 4) a 5) a 6) c 7) b 8) b 9) c 10) c

TWO MARK QUESTIONS

11. Define Central force.

12. Define Centre of force.

13. Define Central orbit

14. Define Conic.

15. Define Equiangular spiral.

16. Define Areal velocity.

17. State the inverse square law.

18. Write the kepler's second laws of motion.

19. The position vector of a particle at time $\vec{r} = \vec{a}\ cosnt\ + \vec{b}\ sinnt$ where $\vec{a}$ and $\vec{b}$ are constant vector and n is the constant. Show that the particle is moving.

20. Define Critical velocity.

FIVE MARK QUESTIONS

21. Velocity of a particle along and perpendicular to the radius vector from a fixed origin are a and b. Find the path and the acceleration along and perpendicular to the radius vector.

22. If the angular velocity of a point moving on a plane curve is constant. Show that it's transverse acceleration is proportional its radial velocity.

23. If a point moves so that its radial velocity is equal k times its transverse velocity. Show that its path is an equiangular spiral.

24. A particle moves in a plane its velocity parallel to the Y axis is constant and its velocity parallel to the X axis proportional to ordinates. Show that its path is a parabola.

25. A particle describes a circular orbit under an attractive central force directed towards a point on the circle. Show that force varies as the inverse fifth power of the distance.

26. If a particle describes the curve $r = e^{\theta}$ under a central force at the pole. Show that the force varies inversely as the cube of the distance of the particle from the pole.

27. Obtain the pedal differential equation in a central orbit.

28. The particle moves along the path $r = e^{\theta}$ and the central force. Show that the force is $\frac{2mh^2}{r^3}$ speed of the particle $\frac{h}{r}\sqrt{2}$.

29. A point P describes an equiangular spiral with a constant angular velocity about the pole O. show that its acceleration varies as OP and is in a direction making with the tangent at P the same constant angle that OP makes.

30. When a central orbit is a conic with the centre of the force at one focus, to find the law of force and the speed of the particle.

TEN MARK QUESTIONS

31. The velocity of the particle along and perpendicular to the radius vector are λr and $\mu\theta$. Find the path and show that the acceleration component along and perpendicular to the radius vector are $\lambda^2 r - \frac{\mu^2\theta^2}{r}$, $\mu\theta(\lambda + \frac{\mu}{r})$.

32. The velocities of a particle along and perpendicular to the radius vector and λr^2 and $\mu\theta^2$ where μ and λ are constants. Show that the equation to the path of the particle is $\frac{\lambda}{\theta} + c = \frac{\mu}{2r^2}$. Where c is a constant.

33. A particle moves in the path given by the equation $r = ae^{\theta}$ with no force in the line joining the particle to the pole. Show that

(i) The angular velocity of the pole is constant.

(ii) The speed varies as its distance from the pole.

(iii) The acceleration is directly proportional to r in magnitude.

34. A particle of mass m moves along the curve $r = 1 + cos\theta$ under the action of a force P towards the pole and a force Q in the positive direction of the initial line. If the angular velocity of the particle about the pole is constant and equal to W, find the values of P and Q and show that the kinetic energy of the particle is $\frac{2P+3Q}{8}$ at any point of its path.

35. A particle moves with a uniform speed V along a cardioid $r = a\,(1 + cos\theta)$. Show that its angular velocity about the pole and the radial acceleration component are $\frac{V}{2a} sec\frac{\theta}{2}, \frac{-3v^2}{4a}$.

36. Obtain the differential equation force central orbit in polar co ordinates.

37. Show that the force towards the pole under which a particle describes the curve $r^n = a^n\ cosn\theta$. Varies inversely as the $(2n\ + 3)$ power the distance of the particle from the pole.

38. State and prove inverse square law.

39. Find the orbit of a particle moving under attractive central force varying inversely as the square of the distance.

40. A particle describes an elliptic orbit under a central force towards one focus S. If v_1 is the speed at the end B of the minor axis and v_2, v_3 the speeds at the ends A, A' of the major axis. Show that $V_1^2 = V_2 V_3$.