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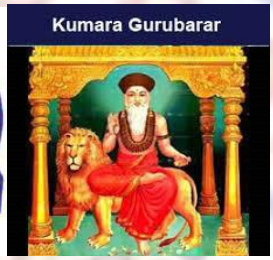

QUESTIONBANK

Title of the Paper

MECHANICS

Course:I B.Sc. Physics

Prepared by

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CORE COURSE II
MECHANICS

Objective:
An attempt is made to give a better insight of the change of position of any physical object or event and their consequences.

***UNIT I* Projectile, Impulse and Impact**

Projectile - particle projected in any direction - Path of a projectile is a parabola - Range of a projectile on plane inclined to the horizontal - Maximum range on the inclined plane - Impulse of a force - Laws of impact - Direct impact between two smooth spheres - oblique impact between two smooth spheres - Impact of a smooth sphere on a smooth fixed horizontal plane - Loss of KE due to direct impact - Oblique impact.

***UNIT II* Motion on a plane curve**

Centripetal and centrifugal forces - Hodograph - Expression for normal acceleration - Motion of a cyclist along a curved path - Motion of a railway carriage round a curved track- upsetting of a carriage - Motion of a carriage on a banked up curve - Effect of earth's rotation on the value of the acceleration due to gravity - Variation of 'g' with altitude, latitude and depth.

***UNIT III* Gravitation**

Newton's law of gravitation - Mass and density of earth - Inertial and Gravitation mass - Determination of G-Boy's experiment -Kepler's Laws of planetary motion -Deduction of Newton's law of gravitation from Kepler's Law - Gravitation - Field - potential -Intensity of Gravitational field - gravitational potential due to a point mass - Equipotential surface - Gravitational potential and field due to a spherical shell and solid sphere – Escape velocity –Orbital velocity.

***UNIT IV* Dynamics of rigid body and Friction**

Moment of Inertia - Kinetic energy and angular momentum of rotating body - Theorems of perpendicular and parallel axes - Acceleration of a body rolling down an inclined plane without slipping - Oscillations of a small sphere on a large concave smooth surface - Compound pendulum - Centre of suspension and centre of oscillation - Centre of percussion - Minimum period of a compound pendulum - Kater's pendulum.
Friction - Laws of friction - Resultant reaction - Angle and cone of friction - Equilibrium of a body on a rough plane inclined to the horizontal - The friction clutch.

***UNIT V* Centre of gravity, Centre of Pressure, Floating bodies,**

Atmospheric pressure

Centre of gravity of a body - Centre of gravity of a trapezoidal lamina - C.G. of a solid hemisphere - C.G. of a solid tetrahedron - C.G. of a solid cone.
Centre of pressure - rectangular lamina - triangular lamina - triangular lamina immersed in a liquid.
Conditions of equilibrium of a floating body - Stability of equilibrium of a floating body - Metacentre - Experimental determination of a metacentric height of a ship.
The barometer - Fortin's barometer - Correction for a barometer - Faulty barometer - Variation of atmospheric pressure with altitude.

Books for study:

1. M. Narayanamurthi and N. Nagarathinam, *Dynamics*, The National Publishing Company 2005, Chennai.

2. M. Narayanamurthi and N. Nagarathinam, *Statics, Hydrostatics and Hydrodynamics* - The National Publishing Company 2005, Chennai.

Books for reference:

1. R. Murugesan, *Mechanics and Mathematical Physics*, S. Chand & Company Ltd., New Delhi, 2008.

2. D.S. Mathur, *Mechanics*, S. Chand & Company Ltd., New Delhi - 1990.UNIT-I

UNIT- I

(PROJECTILE, IMPULSE AND IMPACT)

CHOOSE THE CORRECT ANSWER

1. A particle at rest starts moving in a horizontal straight line with uniform acceleration. The ratio of the distance covered during the fourth and the third second is
   a) $\frac{4}{3}$
   b) $\frac{26}{9}$
   c) $\frac{7}{5}$
   d) 2
2. The distance travelled by a body, falling freely from rest in one, two and three seconds are in the ratio
   a) 1:2:3
   b) 1:3:5
   c) 1:4:9
   d) 9:4:1
3. The displacement of the particle along a straight line at time t is given by, $x=a_0+a_1t+a_2t^2$ where a_0, a_1 and a_2 are constants. The acceleration of the particle is
   a) a_0
   b) a_1
   c) a_2
   d) $2a_2$
4. The acceleration of a moving body can be found from:
   a) Area under velocity-time graph
   b) Area under distance-time graph
   c) Slope of the velocity-time graph
   d) Slope of the distance-time graph
5. Which of the following is a vector quantity?
   a) Distance
   b) Temperature
   c) Mass
   d) Momentum
6. An object is thrown along a direction inclined at an angle 45° with the horizontal. The horizontal range of the object is
   a) Vertical height
   b) Twice the vertical height
   c) Thrice the vertical height
   d) Four times the vertical height

7. Two bullets are fixed at angle θ and (90-θ) to the horizontal with some speed. The ratio of their times of flight is a)
    1:1
    b) tan θ: 1
    c) 1: $tan\theta$
    d) $\tan^2\theta$:1
8. A stone is dropped from the window of a train moving along a horizontal straight track, the path of the stone observed by an observer on ground is
    a) Straight line
    b) Parabola
    c) Circular
    d) Hyperbola

9. A gun fires two bullets with same velocity 60° and 30° with horizontal the bullets strike at the same horizontal distance. The ratio of maximum height for the two bullets is in the ratio
    a) 2:1
    b) 3:1
    c) 4:1
    d) 1:1
10. Newton's first law of motion gives the concept of
    a) Energy
    b) Work
    c) Momentum
    d) Inertia

ANSWERS:

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

TWO MARKS

11. What is Projectiles?
12. State the vertical motion under gravity.
13. What is Impulse of a force?
14. Give the impact between two smooth bodies.
15. State and loss of kinetic energy due to oblique impact between two spheres.
16. Show that the cord becomes light after 1 second.
17. Give the velocities of the spheres after impact (e=1/2).
18. Give the velocities of the spheres before impact.
19. Define the laws of impact.
20. Define the oblique impact.

FIVE MARKS

21. Explain the motion of a particle projected horizontally from a point above the earth.
22. Explain the range of a projectile on a plane inclined to the horizontal.
23. Expression the maximum range on the inclined plane.
24. The velocity at any point in the path of a projectile is equal in magnitude to that acquired by it in falling freely from the directrix to that point.
25. Find the value of for which the height of the point on the wall struck by the particle is maximum.
26. Find the horizontal distance that will be reached by the particle from the food of the tower.
27. Find the greatest height to which any mud particle can rise above the ground.
28. Find the ratio between the velocity of the bird and the horizontal velocity of the stone. If the stone still hits the bird while descending.
29. Explain the ratio between the ranges when the stone is projected
    (i) Up and
    (ii) Down the plane
30. Show that in order to shell the Camp, the velocity of projection of the shell must not be less than $\sqrt{gh}(1 + \text{cosec} \propto)$

TEN MARKS

31. Discuss the particle projected in any direction.
32. Discuss the path of a projectile is a parabola.
33. Explain the direct impact between two smooth spheres.
34. Explain the oblique impact between two smooth spheres.
35. Briefly explain impact of a smooth sphere on a smooth fixed horizontal plane.
36. Discuss the loss of kinetic energy due to direct impact between two smooth spheres.
37. A mass moss m after falling through a height h freely raises a bigger mass M the two masses being connected by a light inextensible string after passing over a smooth light pulley. Discuss the resulting motion.
38. A sphere of mass m, impinges oblique on a sphere of M at rest. If m=eM, show that the directions of motion of the spheres after impact are at right angles.
39. Discuss the coefficient of restitution show that after the impact the direction of motion of each sphere is turned through a right angle.
40. Discuss the line joining the centre of the two balls at the instant of impact being perpendicular to the direction of motion of the second ball. If e be the coefficient of restitution, show that the direction of motion of the second ball after the impact is turned through an angle $\phi=\tan^{-1}(1+e/2)$.

UNIT - II
(MOTTION ON A PLANE CURVE)

CHOOSE THE CORRECT ANSWER

1. Inertia of a body has direct dependence on
   a) Velocity
   b) Mass
   c) Area
   d) Volume
2. The working of a rocket is based on
   a) Newton's first law of motion
   b) Newton's second law of motion
   c) Newton's third law of motion
   d) Newton's first and second law of motion
3. When three forces acting at a point are in equilibrium
   a) Each force is equal to the vector sum of the other two forces.
   b) Each force is greater than the sum of the other two forces.
   c) Each force is greater than the difference of the other two force.
   d) Each force is to produce of the other two forces.
4. For a particle revolving in a circular path, the acceleration of the particle is
   a) Along the tangent
   b) Along the radius
   c) Along the circumference of the circle
   d) Zero
5. If a particle travels in a circle, covering equal angles in equal times, its velocity vector
   a) Changes in magnitude only
   b) Remains constant
   c) Changes in direction only
   d) Changes both in magnitude and direction
6. A particle moves along a circular path under the action of a force. The work done by the force is
   a) Positive and non-zero
   b) Zero
   c) Negative and non-zero
   b) None of the above

7. A cylinder of mass m is taking a circular turn of radius R on a frictional level road with a velocity V. In order that the cyclist does not skid,
    a) $(mv^2/2)>\mu mg$
    b) $(mv^2/r)>\mu mg$
    c) $(mv^2/r)<\mu mg$
    d) $(v/r)=\mu g$
8. If a force F is applied on a body and the body moves with velocity V, the power will be
    a) F.V
    b) F/V
    c) FV^2
    d) F/V^2
9. For an elastic collision
    a) The kinetic energy first increases and then decreases
    b) Final kinetic energy never remains constant
    c) Final kinetic energy is less than the initial kinetic energy
    d) Initial kinetic energy is equal to the final kinetic energy

10. A bullet hits and gets embedded in a solid block resting on a horizontal frictionless table, which of the following is conserved?
    a) Momentum and kinetic energy
    b) Kinetic energy alone
    c) Momentum alone
    d) Potential energy alone

ANSWERS:

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

TWO MARKS

11. What is motion on a plane curve?
12. Give the Centripetal force.
13. Give the Centrifugal force.
14. What are the Hodograph?
15. State the forces of friction.
16. What is meant by banking of trucks?
17. Give the critical velocity of a body revolving in a vertical circle.
18. Give the Centripetal acceleration.
19. What is the cyclist takes a curved path?
20. Give the tension of the string.

FIVE MARKS

21. Explain the Tangential and normal acceleration of a particle moving on a circle.
22. Expression for normal acceleration by the Hodograph method.
23. Explain clearly the conical pendulum.
24. Derive motion of a cyclist along a curved path.
25. Derive motion of a railway carriage round a curved track.
26. Explain the upsetting of a carriage on a curved level track.
27. Explain the variation of 'g' with altitude.
28. Explain the variation of 'g' with latitude.
29. Explain the variation of 'g' with depth.
30. Calculate the number of revolutions per minute a conical pendulum can make if the length of the string is 100 cm, and the mass of the bob is 1 kg, given that the tension the string can bear is 80 kg weight Tm=80x9.8=784.

TEN MARKS

31. Derive an expression for the motion of a carriage on a banked up curve.
32. Describe the relative equilibrium of a particle inside a smooth rotating sphere.
33. Derive an expression for the motion of a particle sliding on a smooth curve.
34. Briefly explain motion outside a smooth vertical circle.
35. Briefly explain motion of a suspended particle along a vertical circle.
36. Discuss effect of the Earth's rotation on the value of the acceleration due to gravity.
37. In a conical pendulum, the length of string is 0.9 m and the inclination of the string to the vertical is 60°. Find the number of revolutions it can make per minute.
38. An elastic string of natural length l is extended by an amount a when, a mass, W is suspended from it. Find the length of the string when with the mass it makes "n" r. p. s. as a conical pendulum.
39. A particle is moving in a horizontal circle of radius 0.5 meter in a hemispherical cup rotating about its axis. Find the height of the particle above the bottom of the cup, if the cup makes 60 r. p. m.
40. A small heavy particle is projected inside the surface of a hollow vertical sphere from the lowest point with a velocity of 9.8 m/sec. Find its velocity and the reaction when it is 1 meter above the lowest point.

UNIT- III

(GRAVITATION)

CHOOSE THE CORRECT ANSWER

1. If the distance between two masses is doubled, the gravitational attraction between them
    a) Is reduced to half
    b) Is reduced to a quarter
    c) Is doubled
    d) Becomes four times

2. The acceleration due to gravity at a height (1/20)th the radius of the Earth above the Earth's surface is 9 ms^{-2}. Its value at a point at an equal distance below the surface of the Earth is
    a) 0ms^{-2}
    b) 9ms^{-2}
    c) 9.8ms^{-2}
    d) 9.5ms^{-2}

3. The weight of a body at Earth's surface is W, at a depth half way to the centre of the Earth, it will be
    a) W
    b) W/2
    c) W/4
    d) W/8

4. Force due to gravity is least at is latitude of
    a) 0°
    b) 45°
    c) 60°
    d) 90°

5. If the Earth stops rotating, the value of g at the equator will
    a) Increase
    b) Decrease
    c) Remain same
    d) Become zero

6. The escape speed on Earth is 11.2 Kms^{-1}. Its value for a planet having double the radius and eight times the mass of the Earth is
    a) 11.2 Kms^{-1}
    b) 5.6 Kms^{-1}
    c) 22.4 Kms^{-1}
    d) 44.8 Kms^{-1}

7. If represents the radius of orbit of satellite of mass m moving around a planet of mass M. The velocity of the Satellite is given by
    a) $v^2=GM/r$
    b) $v=GM/r$
    c) $v^2=GMm/r$
    d) $v=Gm/r$
8. If the Earth is at one fourth of its present distance from the Sun, the duration of the year will be
    a) One fourth of the present year
    b) Half the present year
    c) One-eighth the present year
    d) One-sixth the present year

9. Which of the following objects do not belong to the Solar system?
    a) Comets
    b) Nebulae
    c) Asteroids
    d) Planets

10. According to Kepler's law, the radius vector sweeps out equal areas in equal intervals of time. The law is a consequence of the conservation of
    a) Angular momentum
    b) Linear momentum
    c) Energy
    d) All the above

ANSWERS:

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

<u>TWO MARKS</u>

11. What are the basic forces of Nature?
12. State the gravitational field intensity of the field.
13. State the gravitational potential and gravitational potential energy.

14. Give the velocity of escape from the Solar system.
15. State an interesting consequence of escape velocity.
16. State the intensity and potential of the gravitational field at a point due to an Infinite plane.
17. What is the principle of equivalence?
18. Differentiate between inertial mass and gravitational mass.
19. What is escape speed? Obtain an expression for it.
20. What is orbit velocity? Obtain an expression for it.

FIVE MARKS

21. Explain the Newton's law of gravitation.
22. Deduce an expression for the advantages over Cavendish's method.
23. Explain the density of the Earth.
24. Explain mass of the Earth and the Sun.
25. Derive a law of gravitation and the theory of Relativity.
26. Explain the velocity of escape from the Earth.
27. Derive an expression for the equipotential surface.
28. Discuss the flux of gravitational intensity-Gauss's theorem.
29. Obtain an expression for the Inertial and gravitational mass.
30. Explain the potential energy or self-energy of a multi-particle system.

TEN MARKS

31. Experimental determination of the gravitational constant (G).
32. Determination of G-Boy's experimental method.
33. Explain the gravitational potential and field due to spherical shell.
34. Explain the comparison of gravitational potential and field due to a spherical shell with Electrostatic potential and field due to a charged spherical shell.
35. Explain the gravitational potential and field due to a solid sphere.
36. Briefly explain the comparison of gravitation at potential and field due to a solid sphere with Electrostatic potential and field due to a charged solid sphere.
37. Discuss the intensity and potential of the gravitational field at a point due to a circular disc.
38. Derive an expression for the gravitational self-energy of a Uniform solid sphere.
39. Discuss the 'Orbits'.
40. Derive an expression for the Newton's law of gravitation from Kepler's law.

UNIT- IV
(DYNAMICS OF RIGID BODY AND FRICTION)

CHOOSE THE CORRECT ANSWER

1. The moment of inertia of a body comes into play
    a) In linear motion
    b) In rotational motion
    c) In projectile motion
    d) In periodic motion

2. Rotational analogue of mass in linear motion is
    a) Weight
    b) Moment of inertia
    c) Torque
    d) Angular momentum

3. The moment of inertia of a body does not depend on
    a) The angular velocity of the body
    b) The mass of the body
    c) The axis of rotation of the body
    d) The distribution of mass in the body

4. A ring of radius r and mass m rotates about an axis passing through its centre and perpendicular to its plane with angular velocity w. its kinetic energy is
    a) $mr\omega^2$
    b) $1/2mr\omega^2$
    c) $I\omega^2$
    d) $\frac{1}{2} I\omega^2$

5. The moment of inertia of a disc having mass M and radius R, about an axis passing through its centre and perpendicular to its plane is
    a) $\frac{1}{2} MR^2$
    b) MR^2
    c) $\frac{1}{4} MR^2$
    d) $5/4\ MR^2$

6. Angular momentum is the vector product of
    a) Linear momentum and radius vector
    b) Moment of inertia and angular velocity
    c) Linear momentum and angular velocity
    d) Linear velocity and radius vector

7. The rate of change of angular momentum is equal to
    a) Force
    b) Angular acceleration
    c) Torque
    d) Moment of inertia

8. Angular momentum of the body is conserved
    a) Always
    b) Never
    c) In the absence of external torque
    d) In the presence of external torque

9. A man is sitting on a rotating stool with his arms outstretched. Suddenly he folds his arm. The angular velocity
    a) Decreases
    b) Increases
    c) Becomes zero
    d) Remains constant

10. An athlete diving off a high springboard can perform a variety of exercises in the air before entering the water below. Which one of the following parameter will remain constant during the fall. The athlete's
    a) Linear momentum
    b) Moment of inertia
    c) Kinetic energy
    d) Angular momentum

ANSWERS:

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

TWO MARKS

11. State and translator and rotatory motions of a rigid body.
12. What is moment of Inertia?
13. Give the Angular momentum and its conservation.
14. Define the Angular Impulse.
15. Give the moment of Inertia of a flywheel.
16. Define the centre of percussion.
17. What are the minimum periods of a compound pendulum?
18. What are the forces of friction?
19. State the laws of friction.

20. Why is the Angle of friction, resultant reaction and cone of friction?

FIVE MARKS

21. Obtain an expression for the kinetic energy of a body rotating about a fixed axis.
22. Deduce the Angular momentum of a rotating body.
23. Explain relation between the Torque and Angular acceleration of a rigid body.
24. Obtain an expression for the theorem of perpendicular axes.
25. Deduce the theorem of parallel axes.
26. Explain the centre of suspension and centre of oscillation.
27. Deduce an expression for the Kater's pendulum.
28. Deduce an expression for the Borda's pendulum.
29. Explain the Bifilar pendulum (parallel threads).
30. Explain the Ballistic pendulum.

TEN MARKS

31. Briefly explain moment of inertia of a uniform rod.
32. Discuss the moment of inertia of a rectangular Lamina about an axis through its C.G perpendicular to its plane:
33. Discuss the moment of inertia of a uniform circular ring.
34. Derive an expression for the moment of inertia of a uniform circular disc.
35. Briefly explain the acceleration of a body rolling down an inclined plane without slipping.
36. Briefly explain the oscillation of a small sphere on a large concave smooth surface.
37. Discuss the compound pendulum.
38. Derive an expressionfor the Bessel's modification.
39. Briefly explain the Bifilar's pendulum.
40. Discuss the equilibrium of a body on a rough plane under the action of a force when the inclination of the plane with the horizontal is greater than the angle of friction.

UNIT-V

(CENTRE OF GRAVITY, CENTRE OF PRESSURE, FLOATING BODIES, ATMOSPHERIC PRESSURE)

CHOOSE THE CORRECT ANSWER

1. The centre of gravity of a hollow hemisphere divides the symmetric axis in the ratio
   a) 1:1
   b) 1:2
   c) 3:4
   d) 3:8

2. The centre of gravity a solid hemisphere divides the symmetric axis is the ratio a) 1:1
   b) 1:2
   c) 3:1
   d) 3:8

3. The centre of gravity a solid cone divides the symmetric axis is the ratio a) 1:1
   b) 1:2
   c) 3:1
   d) 3:8

4. Metacentric height is the distance between
   a) C.G. and metacentric
   b) C.G. and centre of buoyancy
   c) Metacentric and centre of buoyancy
   d) None of the above

5. For the equilibrium of a ship, its metacentric should be
   a) Above the C.G
   b) Below the C.G
   c) Below its centre of buoyancy
   d) None of the above

6. If the weight of the body is equal to the force of buoyancy in a liquid, the body.
   a) Will float
   b) Will sink
   c) Will be just inside the surface of the liquid
   d) None of the above

7. The point through which the weight of the body acts is called
    a) Metacentric
    b) Centre of buoyancy
    c) Centre of gravity
    d) None of the above

8. The weight of the displaced liquid is equal to the weight of the
    a) Plumb line
    b) Tilting angle
    c) Weight of the ship
    d) Body

9. The distance between the centre of buoyancy and the centre gravity of the body is called
    a) Above the C.G
    b) Metacentric height
    c) Below its C.G
    d) below its Centre of Buoyancy

10. The angle of tilt in the ship is measured in the unit of
    a) Radian
    b) N/m^2
    c) Watts
    d) $Radians/S^2$

ANSWERS:

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

TWO MARKS

11. Define the centre of gravity of a body.
12. Define centre of gravity of a system of particles in a straight line.
13. What is centre of gravity of the remainder?
14. Give the centre of pressure-general case.
15. What are conditions of equilibrium of a floating body?
16. Write about Metacentric.
17. Give the distance between the centre of buoyancy and metacentre.
18. What is Atmospheric pressure?
19. Define the Barometer.
20. Give the Fortin's barometer.

FIVE MARKS

21. Explain the centre of gravity of a trapezoid lamina.
22. Explain the centre of gravity of a solid hemisphere.
23. Explain the centre of gravity of three uniform rods forming a triangle.
24. Explain the centre of pressure of a rectangular lamina, immersed in a homogenous liquid at rest with one side on the surface not subjected to any external pressure.
25. Explain the centre of pressure of a vertical circular area of radius a totally immersed in liquid with its centre at a given depth h below the surface, and not subjected to any external pressure.
26. Derive a stability of equilibrium of a floating body.
27. Describe the condition of stability.
28. Explain the correction for buoyancy while weighing in air.
29. Discuss the Barometer.
30. To find the difference to altitude between two stations from the harmonic heights.

TEN MARKS

31. Briefly explain the centre of gravity of a solid tetrahedron.
32. Briefly explain the centre of gravity of a right solid cone.
33. Briefly explain the centre of gravity of an arc of a circle.
34. Discuss the centre of pressure of triangle lamina immersed in a liquid with its vertex on the surface and base horizontal not subjected to any external pressure.
35. Discuss the centre of pressure of triangular lamina immersed in a liquid with one side on the surface not subjected to any external pressure.
36. Derive an expression for the effect on the centre of pressure of further immersion of a lamina.
37. Discuss the experimental determination of metacentric height of a ship-the inclining experiment.
38. Derive an expression for the Nicholson's hydrometer.
39. Discuss the variation of atmospheric pressure with altitude.
40. Briefly explain the correction for a Barometer reading.