

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-I Internal Examination, 2022

Paper – **PHSGCOR01T**

Mechanics

Time: 1 Hour

Full Marks: 20

1. Answer any ten questions from the following:

2×10=20

- (a) Determine a unit vector which is normal to the both $\mathbf{A} = \mathbf{i} + \mathbf{j} + \mathbf{k}$ and $\mathbf{B} = \mathbf{i} + \mathbf{j}$.
- (b) Find the projection of the vector $\mathbf{A} = 4\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}$ on the vector $\mathbf{B} = 7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$.
- (c) Find the angle between $\mathbf{A} = 3\mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and $\mathbf{B} = 4\mathbf{i} - 3\mathbf{j} + \mathbf{k}$.
- (d) Determine the value of 'p' so that $\mathbf{A} = \mathbf{i} + 4\mathbf{j} + p\mathbf{k}$ and $\mathbf{B} = 4\mathbf{i} + 2\mathbf{j} - 2\mathbf{k}$ are perpendicular.
- (e) If $\mathbf{A} = 2\mathbf{i} - 3\mathbf{j} + 7\mathbf{k}$, $\mathbf{B} = \mathbf{i} + 2\mathbf{k}$ and $\mathbf{C} = \mathbf{j} - \mathbf{k}$, find $\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})$.
- (f) State the principle of conservation of angular momentum.
- (g) Define centre of mass of a system of particles.
- (h) What is frame of reference in mechanics? In which frame of reference Newton's laws of motion is obeyed?
- (i) Write down the Galilean transformation equations between two inertial reference frame S & S' where S' is moving along the +ve X -axis with respect to S with velocity v .
- (j) State Kepler's laws of planetary motion.
- (k) What do you mean by escape velocity?
- (l) If all the particles of a system lie in a cube, is it necessary that the centre of mass be in the cube?
- (m) A circular disc of mass M and radius R is rolling without slipping on horizontal surface with a speed V . Determine its kinetic energy.
- (n) Show that the position of centre of mass of a rigid body is unique.
- (o) State the theorem of perpendicular axes on moment of inertia.
- (p) Show that when a conservative force acts on a particle of mass m , the sum of its potential energy and kinetic energy is constant.
- (q) Prove that if the total linear momentum of a system is conserved, then the Centre of mass is either at rest or in uniform motion.

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-I Internal Examination, 2021 held in 2022

Paper – **PHSACOR02T**

Mechanics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following:

2×5=10

- Determine the theoretically admissible range of values of the Poisson's ratio.
- Define co-efficient of viscosity of a liquid and find out its dimension.
- What is critical velocity? Upon what factors does it depend?
- Prove that purely internal forces have no effect on the motion of the centre of mass.
- A cylinder rolls without slipping down a plane inclined at an angle θ to the horizontal. Find the acceleration of its centre of mass.
- Prove that if the total linear momentum of a system is conserved, then the Centre of mass is either at rest or in uniform motion.
- Express angular momentum of a system as the sum of angular momentum of motion of the centre of mass and angular momentum of the motion about the centre of mass.
- Define centre of mass of a system of particles. In which case the centre of mass of a rod is certainly not at its centre?

2. Answer any two questions from the following:

5×2=10

- What is frame of reference in mechanics? In which frame of reference Newton's laws of motion is obeyed? Show that Newton's laws of motion remain invariant under Galilean transformation. 1+1+3
- Consider a pair of stars of equal mass M rotating about their common centre of mass. The attraction between the stars is gravitational and the stars keep a separation ' I ' between them. Show that the time period of rotation of this double stars system is given by $\pi I \sqrt{\frac{2I}{GM}}$; where G = universal gravitational constant.

Find the moment of inertia of a homogeneous cube of side a about any axis passes through its Centre of mass.

3+2

- A rigid body with principal moment of inertia at a point $I_X = 20$, $I_Y = 30$, $I_Z = 40$ in a.m.u A^{02} is rotating at the rate 50 r.p.s about an axis passes through the point and having directional cosine $(\frac{1}{2}, \frac{1}{2}, \frac{1}{\sqrt{2}})$. Calculate the kinetic energy of the body (a.m.u = 1.66×10^{-27} kg).

For a thin uniform square plate of side ' a ' and mass ' m ', what will be the principal axes of inertia.

- Show that a pure shear is equivalent to two equal and opposite strains at right angles to each other.

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B.Sc. Semester-I Internal Examination, 2021
Paper - PHSACOR02T
Mechanics

1. Answer any five

(5 × 2 = 10)

- a) A particle is at rest acted upon by a force $\vec{F} = \pi \sin 2\pi t \hat{x}$ Newton. Calculate the linear momentum of the particle after $t = 0.05$ sec.
- b) State and prove the WORK –ENERGY theorem.
- c) Use the WORK –ENERGY theorem. to prove that the kinetic energy of the particle remains constant. If a particle is moving under the action of a force $\hat{k} \times \vec{v}$ where $\hat{k}$ is the unit vector along Z axis and $\vec{v}$ is the velocity of the particle.
- d) Show that if the position vector of a particle is $\vec{r} = a \cos wt \hat{i} + b \sin wt \hat{j}$ where a, b, w are constant then force acting on the particle is directed towards the origin. Department of Physics
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- e) In the x-y plane a force has the Cartesian components $F_x = x^3 + xy^2$ & $F_y = y^3 + 3x^2y$. compute the work done in displacement from point (1,1) to (2,2), where the path is (i) a straight line from (1,1) to (2,2)
- f) Prove that if the total linear momentum of a system is conserved, then the Centre of mass is either at rest or in uniform motion.
- g) Define line integral of force. Show that it measures the change in kinetic energy.
- h) Show that if the position vector of a particle is $\vec{r} = a \cos wt \hat{i} + b \sin wt \hat{j}$ where a, b, w are constant then force acting on the particle is directed towards the origin.

2. Answer any two.

(2 × 5 = 10)

- a) Consider a vector $\vec{A}(t)$ in cylindrical coordinate (ρ, θ, z) . Show that
$$\frac{d\vec{A}}{dt} = \left(\frac{dA_\rho}{dt} - A_\theta \dot{\theta} \right) \hat{\rho} + \left(\frac{dA_\theta}{dt} + A_\rho \dot{\theta} \right) \hat{\theta} + \frac{dA_z}{dt} \hat{z}$$
 If $\vec{A}$ in the expression is the position vector of a particle then find the velocity that means $\frac{d\vec{A}}{dt}$ and acceleration $\frac{d^2\vec{A}}{dt^2}$. (3+1+1)
- b) A particle of mass 'm' at rest at (a,0,0) is subjected to a force $\vec{F} = -\frac{\alpha}{x^3} \hat{i}$; ($\alpha = \text{constant}$) find the time taken to reach the origin. ($a > 0, \alpha > 0$) 5
- c) Prove that $\vec{F} = (2xy + y^2) \hat{i} + (x^2) \hat{j} + (2xz) \hat{k}$ is a conservative force, hence find the corresponding scalar potential. (3+2)
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- d) Define conservative force. Show that for conservative force (i) $\vec{F} = -\vec{\nabla}\Phi$, where $\Phi = \Phi(x, y, z)$ and (ii) $\vec{\nabla} \times \vec{F} = 0$. (2.5+2.5)
- e) A particle of unit mass moves according to the equation $\vec{r} = (2+3t^2) \hat{i} + 5t^2 \hat{j} + t \hat{k}$, find the force acting on it. torque and angular momentum about the origin hence verify $\vec{N} = \frac{d\vec{L}}{dt}$. (2+1+1+1)

P. R. Thakur Govt. College
B.Sc Honours 1st Semester 1st Internal Examination, 2019
PHSACOR02T PHYSICS (CC2)
MECHANICS

Time: 1 Hour

Full Marks: 20

1. Answer *any five* questions from the following:

$2 \times 5 = 10$

- (a) Solve the differential equation of a simple harmonic oscillator subjected to an additional constant force.
- (b) Find the resultant motion of two S.H.M.'s that superpose along the same axis with same amplitude and frequency but differ in phase by α .
- (c) Explain how the damping force in damped simple harmonic motion is approximated to its simplest form.
- (d) Explain the critical damping motion.
- (e) Define Q factor in damped S.H.M. and give its formula.
- (f) Two charged particles of masses $2m$ and $4m$ are placed at a distance d apart on a smooth horizontal table. Because of their mutual attraction, they move towards each other and collide. Where will the collision occur with respect to the initial positions?
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- (g) Show that Newton's laws of motion are invariant under Galilean transformations.
- (h) Show that in case of a rocket moving in a constant gravitational field, shorter the burn time greater is the final velocity of the rocket.
- (i) State and prove the parallel axis theorem for moment of inertia of a rigid body.

2. Answer *any two* questions from the following:

$5 \times 2 = 10$

- (a) Write down the complete solution of forced vibration and explain each term. How do you get the expression of complex impedance?
- (b) Define sharpness of resonance. Explain it by the term of Q factor and bandwidth. Obtain the equation of damped S.H.M. from energy consideration.
- (c) Show that, in case an incident particle collides elastically with a target particle of equal mass at rest in the laboratory frame, both the particles move in directions perpendicular to each other.
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- (d) Obtain an expression for the moment of inertia of a uniform solid sphere about its diameter.

P. R. Thakur Govt. College
B.Sc Honours 1st Semester 2nd Internal Examination, 2019
PHSACOR02T-PHYSICS (CC2)
MECHANICS

Time: 1 Hour

Full Marks: 20

1. Answer *any ten* questions from the following:

$2 \times 10 = 20$

- (a) Write down the differential equation of motion of a S.H.M. subjected to an additional constant force P_0 and solve.
- (b) Find the resultant motion of two S.H.M.'s that superpose along the X and Y axes with amplitude a and frequency ω but differ in phase by α .
- (c) Deduce the expression for critical velocity of a Newtonian liquid from dimensional analysis.

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- (d) Deduce the equation of critical damping motion.
- (e) Show that the motion of an object under central force is confined in a plane.
- (f) Prove that central force is a conservative force.
- (g) A solid sphere and a hollow sphere of the same mass and same radius are allowed to roll down an inclined plane from the same position. Which one will come down with greater acceleration? Justify your answer.
- (h) What are conservative and non-conservative forces? Give examples of each.
- (i) Show that in case of a rocket moving in a constant gravitational field, shorter the burn time greater is the final velocity of the rocket.
- (j) Show that the position of the centre of mass of a rigid body is unique.
- (k) What is Coriolis force? Write an expression for this force in terms of the angular velocity of the rotating frame of reference.

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- (l) Can a particle rotate without experiencing any torque? Explain.
- (m) How much faster than its present angular velocity should the earth rotate so that bodies lying on the equator may fly off into space? 4
- (n) Define radius of gyration.
- (o) Show that the angular momentum of a system can be expressed as the sum of the angular momentum of motion of the centre of mass and the angular momentum of motion about the centre of mass. 4

P.R. Thakur Govt. College
First Internal Examination-2018
Subject-Physics
Paper- Core T-2 (Mechanics)

Time Allotted: 1 Hour

Full Marks: 20

The figures in the margin indicate full marks.
Candidates should answer in their own words
and adhere to the word limit as practicable.

All symbols are of usual significance.

1. Answer any **five** questions from the following: (2x5=10)
- (a) Show that if the momentum of a particle executing S.H.M. is plotted against its displacement, an elliptic curve is obtained.
 - (b) Calculate the ratio of the displacement to amplitude for a S. H.M. when the kinetic energy is 90% of the total energy.
 - (c) A weakly damped oscillator is driven by a constant force F_0 such that,
$$m\ddot{x} + k\dot{x} + sx = F_0.$$

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Solve the resulting differential equation. Symbols have their usual meanings.
 - (d) Show that if the damping force is of constant magnitude the frequency of vibration of a S.H.M. remains unaltered.
 - (e) Define Quality factor and explain sharpness of resonance in terms of it.
 - (f) Define logarithmic decrement and establish its connection with the damping of the medium.
 - (g) Show that Newton's 2nd law remains invariant in all inertial frames of reference.
 - (h) Define angular momentum and torque acting on a particle with diagram. What happens if the torque acting on a particle is zero?
2. Answer any **three** questions from the following: (2x3=6)
- (a) What do you mean by radius of gyration?
 - (b) Moment of inertia of a solid sphere about its diameter is I. If 64 equal smaller spheres are made out of this sphere, calculate moment of inertia of each of them about their diameter.
 - (c) A solid sphere and a hollow sphere, each of same mass and radius are allowed to roll down an inclined plane from the same position. Which will come down with greater acceleration? Justify your answer.
 - (d) Show that in case of elastic collision of two particles, velocity of separation(after collision) = velocity of approach (before collision)
 - (e) A block of mass m moving with speed v collides with another block of mass $4m$ at rest. The lighter block comes to rest after the collision. Find the coefficient of restitution.
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3. Answer any **one** question from the following (4x1=4)
- 3. Calculate the moment of inertia of a solid cylinder about the axis passing through its centre of mass and perpendicular to its own axis of symmetry.