

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-I Internal Examination, 2023-24

Paper – Minor 1

Mechanics

Time: 1 Hour

Full Marks: 20

1. Answer any ten questions from the following:

$2 \times 10 = 20$

- (a) Find out the dimension of Gravitational constant G .
- (b) Find the work done in moving an object from the point $(3, 2, -1)m$ to $(2, -1, 4)m$ in a force field given by $\mathbf{F} = (4\mathbf{i} - 3\mathbf{j} + 2\mathbf{k})N$.
- (c) Determine a unit vector which is normal to the both $\mathbf{A} = 2\mathbf{i} + \mathbf{j} + \mathbf{k}$ and $\mathbf{B} = \mathbf{i} - \mathbf{j}$.
- (d) Find the projection of the vector $\mathbf{A} = 2\mathbf{i} - \mathbf{j} + 4\mathbf{k}$ on the vector $\mathbf{B} = 3\mathbf{i} + 7\mathbf{j} + 5\mathbf{k}$.
- (e) Find the angle between $\mathbf{A} = \mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and $\mathbf{B} = \mathbf{i} - 3\mathbf{j} + \mathbf{k}$.
- (f) Show that $\mathbf{A} = \mathbf{i} + 2\mathbf{j} + 9\mathbf{k}$, $\mathbf{B} = 3\mathbf{i} + \mathbf{j} + 2\mathbf{k}$ and $\mathbf{C} = 2\mathbf{i} + \mathbf{j} + 3\mathbf{k}$ are co-planars.
- (g) For what value of ' p ', the vectors $\mathbf{A} = \mathbf{i} + \mathbf{j} + p\mathbf{k}$ and $\mathbf{B} = \mathbf{i} + 2\mathbf{j} - 2\mathbf{k}$ will be perpendicular to each other?
- (h) If $\mathbf{A} = \mathbf{i} - 2\mathbf{j} + 7\mathbf{k}$, $\mathbf{B} = 2\mathbf{i} + 2\mathbf{k}$ and $\mathbf{C} = 3\mathbf{j} - \mathbf{k}$, find $\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})$.
- (i) Show that the vector $\mathbf{A} = (x + 3y)\mathbf{i} + (y - 2z)\mathbf{j} + (x - 2z)\mathbf{k}$ is solenoidal.
- (j) Determine whether the force field $\mathbf{F} = 2zx\mathbf{i} + (x^2 - y)\mathbf{j} + (2z - x^2)\mathbf{k}$ is conservative or not.
- (k) Explain the term Gravitational potential and intensity at some particular point of the Gravitational field.
- (l) What is frame of reference in mechanics? In which frame of reference Newton's laws of motion is obeyed?
- (m) 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 .
- (n) State Kepler's laws of planetary motion.
- (o) What do you mean by escape velocity?

P. R. Thakur Govt. College
CBCS Semester-I First Internal Examination, 2019
Mechanics
Paper -GE-T1

Time: 1 Hour

Full Marks: 20

1. Answer *any five* questions:

$2 \times 5 = 10$

- (a) Show that the vectors $\vec{A} = \hat{i} + 4\hat{j} + 3\hat{k}$ and $\vec{B} = 4\hat{i} + 2\hat{j} - 4\hat{k}$ are mutually perpendicular.
- (b) Find the value of s such that the vectors $\vec{P} = 2\hat{i} - \hat{j} + \hat{k}$, $\vec{Q} = \hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{R} = 3\hat{i} + s\hat{j} + 5\hat{k}$ are coplanar.
- (c) Find the area of a triangle formed by the vectors $4\hat{i} - \hat{j} + \hat{k}$ and $\hat{i} + \hat{j} + \hat{k}$ as two sides of it.
- (d) Prove that for any three vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ in $\mathbf{R}^3$,
 $\vec{A} \cdot (\vec{B} \times \vec{C}) + \vec{B} \cdot (\vec{C} \times \vec{A}) + \vec{C} \cdot (\vec{A} \times \vec{B}) = 0$.
- (e) Write down the law of conservation of linear momentum in case of collision of two particles. Is the kinetic energy always conserved for such collisions?
- (f) Suppose a vector $\vec{A}(t)$ changes with t in a way its magnitude is constant. Prove that $\vec{A}(t)$ and $\frac{d\vec{A}(t)}{dt}$ are perpendicular to each other.
- (g) Show that the angular momentum of a particle under the influence of a central force is conserved.
- (h) Find the relation between intensity of gravitational field and gravitational potential.

2. Answer *any two* questions:

$5 \times 2 = 10$

- (a) Find the centre of mass of a rod of total mass M and length L whose linear mass density is given by $\lambda(x) = kx^2$, where k is a constant.
- (b) Solve the initial value problem $y'' + 4y = 2\sin x$. Given that $y(0) = 1$ and $y'(0) = 0$, where $y' = \frac{dy}{dx}$ and $y'' = \frac{d^2y}{dx^2}$.
- (c) A car is moving with a constant acceleration $\vec{a}$ along the X-axis. A pendulum is suspended from the ceiling of the car. Find the angle the pendulum makes with the vertical. Take g as the acceleration due to gravity.
- (d) Obtain an expression for the gravitational potential due to a thin uniform spherical shell at a point outside the shell.

P.R. Thakur Govt. College
First Internal Examination-2018
Subject-Physics
Paper-GENERIC (GE-T1) (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 **ten** questions from the following:

(2x10=20)

- (a) $\mathbf{U}$, $\mathbf{V}$ and $\mathbf{W}$ are three vectors such that $\mathbf{U} \times \mathbf{V} + \mathbf{V} \times \mathbf{W} + \mathbf{W} \times \mathbf{U} = \mathbf{0}$. Show that the vectors are coplanar.
- (b) What is the geometrical significance of the cross product of two vectors $\mathbf{A} \times \mathbf{B}$?
- (c) Show that $(\mathbf{W} \times \mathbf{R})^2 = \mathbf{W} \cdot [\mathbf{R} \times (\mathbf{W} \times \mathbf{R})]$. Where $\mathbf{W}$ and $\mathbf{R}$ are the angular velocity vector and position vector respectively.
- (d) The vector $\mathbf{B} = 4\hat{i} - 3\hat{j} + \hat{k}$. Find its direction cosine values.
- (e) For what values of μ the two vectors $\mathbf{a} = \hat{i} + \mu\hat{j} + \hat{k}$ and $\mathbf{b} = 3\hat{i} - 2\hat{j} - 2\hat{k}$ will be perpendicular?
- (f) Show by using the result of vector triple product (or otherwise) that the following vector identity holds:

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) + \mathbf{B} \times (\mathbf{C} \times \mathbf{A}) + \mathbf{C} \times (\mathbf{A} \times \mathbf{B}) = \mathbf{0}$$

- (g) A person is standing inside an elevator which is accelerating uniformly in the upward direction. Is there any change in his apparent weight? Give reason.
- (h) Locate the centre of mass of a uniform semi-circular wire of mass M and radius R . (Diameter itself is not considered).
- (i) Write down the equation of motion of a rocket moving in free space.
- (j) Define angular momentum of a particle w.r.t. a fixed point. What is its relation with torque?
- (k) A body is in pure rotation. The linear speed v of a particle of the body, which is at a distance r from the axis of rotation, and the angular velocity ω of the body are related as $\omega = v/r$. Is ω independent of r or not. Give reason.
- (l) Consider a system of two identical particles, one is at rest and the other has acceleration $\mathbf{a}$. What is the acceleration of the centre of mass of the system?
- (m) A satellite revolves in a circular orbit at a height 200Km from the surface of earth. If the period of revolution of satellite is 90 minutes, $G = 6.66 \times 10^{-11} \text{ Nm}^2\text{Kg}^{-2}$ and mean radius of earth is $6 \times 10^6 \text{ m}$. calculate the average density of earth.
- (n) No work is done in moving an object from one point to another along the surface of an uncharged sphere of mass M and radius R - explain.
- (o) Show that in a central force field the angular momentum of a particle is conserved.