

2023

B.Sc. (Honours)

B.Sc. First Semester End Examination - 2023

PHYSICS

PAPER - MJ-101T

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Group - A

1. Answer any 5 five questions out of 8 questions : $2 \times 5 = 10$

- (a) 'Two streamlines can't intersect' explain.
- (b) Show that $r^n \hat{r}$ is solenoidal vector if $n = -3$.
- (c) A particle of mass m is moving in x - y plane. At any given time t , its position vector is given by $\mathbf{r}(t) = A \cos \omega t \hat{i} + B \sin \omega t \hat{j}$, where A , B and ω are constants with $A \neq B$. Calculate the value of angular momentum.

(Turn Over)

(2)

- (d) Show that Newton's law are invariant under Galilian transformation.
- (e) Find the vector perpendicular to the surface $x^2+y^2+z^2=3$ at point (1,1,1)
- (f) Show that $x^2+y^2+z^2 - c^2t^2$ is invariant under Lorentz transformation.
- (g) An empty vessel with a small circular hole at the bottom is gradually immersed in a liquid. Calculate the depth at which liquid will start penetrating into the Vessel.
- (h) Calculate the terminal velocity of a water droplet of radius 1 mm falling through air [coefficient of viscosity of air 171×10^{-6} p].

Group - B

Answer any four questions.

4×5=20

2. (a) If ϕ is any scalar point function then show that

$$\iiint_v \nabla \phi \, dv = \iint_s \phi \hat{n} ds.$$

- (b) Do the points (4, -2,1), (5,1,6), (2,2,-5) and (3,5,0) lie in a plane? 3+2=5

(3)

3. (a) A frame of reference rotates with angular velocity $\vec{\omega}$.

Establish the identity $\frac{d}{dt} = \frac{d'}{dt} + \vec{\omega} \times$

- (b) A solid sphere rolls without slipping down a plane of inclination of 30° to the horizontal. Calculate its velocity after it has traversed a distance 5ft along the plane.

3+2

4. (a) At what speed does a meter stick move if its length is observed to shrink to 0.5m?

- (b) Define Inertial and Non-inertial frame. 2+3

5. Derive the formula $E^2=p^2c^2+m_0^2c^4$ and show that massless particle can exist only if they move with the speed of light.

3+2

6. Show that the general equation of central orbit of motion of a particle of mass m is

$$\frac{d^2r}{d\theta^2} + u = \frac{-mf \left(\frac{1}{u} \right)}{L^2 u^2}$$

[Symbols have their usual meanings]

(4)

7. A uniformly loaded beam elamped horizontally at both ends. Find out the expression for depression at the mid point of the bar. 5

Group - C

Answer any one question.

1×10=10

8. (a) Calculate the gravitational potential on the axis of a uniform circular ring of radius 'a'. Use the result to find the potential at any point (r, θ, ϕ).
(b) Find the gravitational potential at a point inside a solid sphere whose density increases linearly with depth.

2+4+4

9. (a) Show that $\vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ is a conservative force field. Find the potential.
(b) The potential energy of a particle is given by $V = x^4 - 8x^3 - 6x^2 + 24x$. Find the points of stable and unstable equilibrium.
(c) A particle is projected vertically upward from a point on the earth's surface at a latitude λN . Show that it

strikes the ground at a point $\frac{4}{3}w \cos\lambda \sqrt{\frac{8h^3}{g}}$ to the west.

Neglecting the air resistance and consider only small vertical heights. 4+2+4