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3 (Sem - 1) PHY M 1

2021

(Held in 2022)

PHYSICS

(Major)

Paper : 1.1

Full Marks : 60

Time : Three hours

***The figures in the margin indicate
full marks for the questions.***

GROUP-A

(Mathematical Methods)

Marks : 20

1. (a) The co-ordinates of the two points P and Q are $(3, 4, -6)$ and $(1, -2, 3)$. Find PQ . 2
- (b) What is the geometrical interpretation of the vector product of two vectors ? 2

Contd.

(c) Show that $\frac{d}{dt}\left(\bar{f} \times \frac{d\bar{f}}{dt}\right) = \bar{f} \times \frac{d^2\bar{f}}{dt^2}$ 2

(d) Show that $\text{grad}\left(\frac{1}{r}\right) = -\frac{\bar{r}}{r^3}$ 2

(e) Find a unit vector normal to the surface $z = x^2 + y^2$ at the point (1, 2, 5). 2

2. (a) The position vector of a particle is $\bar{r} = 6\hat{i}m$ and its velocity is

$$\bar{v} = (3\hat{i} + 5\hat{j})m/s.$$

Find (i) $\bar{r} \cdot \bar{v}$, and (ii) $\bar{r} \times \bar{v}$. 3

(b) Prove that if \bar{a} and \bar{b} are two proper non-collinear vectors and p and q are two scalars such that $p\bar{a} + q\bar{b} = 0$, then $p = q = 0$. 3

(c) Prove that

$$[\bar{A} \times (\bar{B} \times \bar{C})] + [\bar{B} \times (\bar{C} \times \bar{A})] + [\bar{C} \times (\bar{A} \times \bar{B})] = 0$$

4

Or

3. (a) Show that $\nabla(u+v) = \nabla u + \nabla v$. 2

(b) Electric field in a region is zero. What would you conclude about electric potential? 2

(c) Define curl of a vector. Show that when a body is in motion, the curl of its linear velocity \bar{v} at any point is twice the angular velocity. 1+5=6

GROUP-B

(Mechanics)

Marks : 40

4. (a) State work energy theorem. 1
- (b) Name the fictitious force obtained in the rotating frame of reference. 1
- (c) Give one property of a conservative force. 1
- (d) "When a rotating body contracts, its angular velocity increases." Give reason. 1
- (e) Write the physical interpretation of moment of inertia. 1
- (f) Can we have equipotential surfaces of the gravitational field of a point mass? 1
5. (a) Prove that force $F = x^2 y z \hat{i} - x y z^2 \hat{k}$ is a non-conservative force. 2

- (b) Show that the inertial masses and gravitational masses are equivalent to each other. 2

6. Answer **any two** questions : 5×2=10

- (a) Find the gravitational potential at an outside point of a spherical shell.
- (b) State and prove the parallel axis theorem in moment of inertia.
- (c) Find the C.M. of a semicircular disc of radius r .

7. Answer **any two** questions : 10×2=20

- (a) (i) What do you mean by inertial and non-inertial frame of references? 2
- (ii) A frame of reference a rotates with respect to another reference b with uniform angular velocity ω . Show that the fictitious force appearing in the accelerated frame of reference can be expressed as a combination of Coriolis force and centrifugal force. 8

- (b) (i) Show that the relationship between the angular momentum relative to C.M. frame of reference of a system of particles and the angular momentum relative to the laboratory frame is given by

$$\vec{L} = \vec{L}_{CM} + \vec{r}_{CM} \times \vec{P} \quad 6$$

- (ii) A body of mass 0.2 kg is revolving along a circular path of radius 1 m with a frequency 4 Hz . Determine the magnitude of orbital angular momentum. 4

- (c) Show that if a heavy (moving) particle collides elastically with a lighter particle at rest, the particle can never be scattered perpendicular to the initial direction. 10

- (d) Write the difference between a simple pendulum and a compound pendulum. Derive an expression for time period in a compound pendulum. Show that the centre of suspension and centre of oscillation for a compound pendulum are interchangeable. 2+5+3=10
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