3 (Sem–1) PHY M 1

Full Set. 1·2 — 1·2 old Course

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

(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

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

Find (i) $\bar{r}.v$, 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

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

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 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 $F = x^2yz\hat{i} - xyz^2\hat{k}$ 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 fictious 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

$$\bar{L} = \bar{L}_{CM} + \bar{r}_{CM} \times \bar{P}$$ 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
