Total No. of printed pages = 6

3 (Sem 1) PHY M1

2015

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) Show with convincing explanation that a scalar quantity can be represented as a vector quantity. 1+1=2

   (b) Show that the vector field $\vec{A}(\vec{r}) = \vec{r} \times \vec{\nabla}\phi(r)$ is orthogonal to both $\vec{r}$ and $\vec{\nabla}\phi(r)$. 1+1=2

[Turn over

(c) Give the diagrammatic representation that the components of a vector become different when the frame of reference from where the vector was observed is rotated by some angle. Is there any specific angle of rotation for which the components of vector do not change? 1+1=2

(d) Formulate the simplest differential operator from the concept of gradient that will not change the vectorial and parity properties of a field on which it operates. 2

(e) Show that

$$\nabla^2 r^2 = \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right) r^2 = 6 \qquad 2$$

where the symbols have the usual meaning.

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

(b) If the resultant of two forces is equal in magnitude to one of the components and perpendicular to it in direction, find the other components. 7

Or

3. (a) If $\vec{R}(u) = x(u)\,\hat{i} + y(u)\,\hat{j} + z(u)\,\hat{k}$, where x, y and z are differentiable functions of a scalar u, prove that $\frac{d\vec{R}}{dt} = \frac{dx}{du}\hat{i} + \frac{dy}{du}\hat{j} + \frac{dz}{du}\hat{k}$ 3

(b) A particle moves so that its position vector is given by $\vec{r} = \hat{i}\cos wt + \hat{j}\sin wt$ where w is a constant. Show that

(i) the velocity $\vec{v}$ of the particle is perpendicular to $\vec{r}$

(ii) the acceleration $\vec{a}$ is directed towards the origin and has magnitude proportional to the distance from the origin

(iii) $\vec{r} \times \vec{v} =$ a constant vector. 2+2+3=7

GROUP – B

(Mechanics)

Marks : 40

4. (a) Give the characteristics of inertial forces that distinguish them from real forces. 1

(b) In what respect the gravitational force cannot be considered as an inertial force ? 1

A rigid body of solid (spherical) symmetry is allowed to roll down an inclined plane without slipping. Show that the linear acceleration of the body is

$$\frac{g \sin \lambda}{1+\frac{k^2}{a^2}}$$

where g, is the acceleration due to gravity, k, the radius of gyration and a, the radius of the body rolling down the inclined plane making an angle λ with the horizontal.

3+7=10