

**B.A./B.Sc (General) Ist Semester (0001)
Examination
0046
PHYSICS
Paper : A
(Mechanics-I)**

Time : 3 Hours]

[Max. Marks : 22

- Note :-** (i) Attempt five questions in all, selecting two questions from each of sections I and II and Section III is compulsory.
- (ii) Use of non-programmable scientific calculaor is allowed.
- (iii) Logarithmic tables may be asked for if needed.

Section-I

1. (a) What are Cartesian and spherical polar coordinates? How are the coordinates of a point in two systems related to each other? 3
- (b) The motion of a particle can be expressed in terms of the equation $x = 5t - 9$, $y = 2 \cos 3t$ $z = 2 \sin 3t$. Find the magnitude of velocity after 2 seconds.

2. (a) Prove that velocity of a particle in spherical polar. Coordinate is given by :

$$\vec{v} = \dot{r} \hat{r} + r \dot{\theta} \hat{\theta} + r \dot{\phi} \sin\theta \hat{\phi} \quad 3$$

- (b) Determine the area of a circle of radius a by using plane polar coordinates. 3

3. (a) What is Isotropy of space ? Which law of conservation is explained by it ? Prove this law. 3

- (b) A bomb weighing 50 kg explodes into three parts in flight when its velocity is $20\hat{i} + 22\hat{j} + 10\hat{k} \text{ ms}^{-1}$. Two fragments of the bomb weighing 10 kg and 20 kg are found to have velocities $100\hat{i} + 50\hat{j} + 20\hat{k}$ and $30\hat{i} - 20\hat{j} - 10\hat{k} \text{ ms}^{-1}$ respectively. Find the velocity of the third fragment. 3

Section-II

4. (a) Prove that the shape of trajectory of a particle moving under inverse square law force depends on the relationship between the total energy and its angular momentum. 3

- (b) Prove that the centre of mass of two particles divides the line joining the particles in the inverse ratio of their masses. 1
5. (a) Write down Kepler's laws of planetary motion. Prove Kepler's second law of planetary motion. 2
- (b) If the average distance of mass from the sun is 1.52 times that of the earth from the sun. Find the period of revolution of mass around the sun. 1
6. What is Rutherford scattering ? Show that differential scattering cross-section for Rutherford scattering by an atomic nucleus is given by :

$$\sigma_{sc}(\theta) = \frac{1}{4} \left(\frac{ze^2}{E} \right)^2 \frac{1}{\sin^4 \left(\frac{\theta}{2} \right)}$$

Where symbols have their usual meaning. 4

Note :- Attempt any six parts. each part carries 1 mark.

7. (i) The Cartesian coordinates of a point are (1, 0,1). Find the spherical polar coordinates of this point.

(ii) Prove that :

$$\hat{r} \times \hat{\theta} = \hat{\phi}$$

(iii) Give two examples each of centred and non-central forces.

(iv) What are the dimensions of the quantity $\frac{L^2}{\mu r^2}$?

(v) In a carbon monoxide molecule (CO), if two atoms are separated by 5.6×10^{-10} m, locate centre of mass of the system w.r.t. carbon atom.

(vi) Mention the various forces in nature and which one of them is weakest force ?

(vii) How is collision between two balls different from a collision between α -particle and a nucleus ?

1x6=6