(i) Printed Pages: 4 Roll No. .....

(ii) Questions : 7 Sub. Code : 0 0 4 6

Exam. Code : 0 0 0 1

B.A./B.Sc. (General) 1st Semester

1128

PHYSICS

Paper-A : Mechanics-I

Time Allowed : Three Hours] **[Maximum Marks : 22**

Note :— (1) Attempt **five** questions in all, selecting **two** questions from each of Sections I and II and Section III is compulsory.

(2) Use of Non-programmable scientific calculator is allowed.

(3) All the questions in first and second section will carry 4½ marks each and the compulsory question will carry **4** marks.

SECTION—I

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

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

(b) Prove that solid angle subtended by sphere at its centre is 4π steradian. 1.5

2. (a) What are rectangular Cartesian and Spherical polar coordinates ? How are the coordinates of a point in two systems related to each other ? 3

(b) Motion of a particle is described by the equation :

$x = 2 \sin 4t$, $y = 2 \cos 4t$ and $z = 5t$.

Find the velocity and acceleration of the particle. 1.5

3. (a) What is rotational invariance of space ? Show that rotational invariance of space leads to conservation of angular momentum. 3

(b) If a particle of mass m is moving with velocity v. Then prove that :

$$\frac{\partial E}{\partial r} = ma$$

where E is the kinetic energy of the particle. 1.5

4. (a) Obtain the equation of the orbit of a particle moving under an inverse square force field. Explain how the shape of the orbit depends upon the angular momentum and the energy. 3

(b) A particle of mass m moves along a path given by $\vec{r} = a \cos \omega t \, \hat{i} + b \sin \omega t \, \hat{g}$. Find :

(i) the torque

(ii) the angular momentum about the origin. 1.5

SECTION—II

5. (a) Derive relationship between angle of scattering and angle of recoil during elastic collision between two particles in the Lab. system. Also show that if the two particles will be of equal mass then particles will fly apart at right angles to each other after collision. 3

(b) A particle of mass 2 kg moving with velocity 3 m/s is elastically scattered from another particle of mass m at rest. After collission the two particles move in opposite directions with equal speeds. Determine m. 1.5

6. What is Rutherford scattering ? Show that the differential scattering cross-section for the scattering of a α-particle by the 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 meanings. 4.5

SECTION—III

Note :— Attempt any **eight** parts. Each part carries ½ mark.

7. (i) The spherical polar coordinates of a point are (10, 60°, 30°). Find its Cartesian coordinates.

(ii) In case of spherical polar coordinates prove that :

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

(iii) Is the friction a conservative force ? Explain.

(iv) Two bodies of masses 2 g and 10 g have position vectors $3\hat{i} + 2\hat{j} - \hat{k}$ and $\hat{i} - \hat{j} + 3\hat{k}$ respectively. Find the position vector and distance of the centre of mass from the origin.

(v) Show that reduced mass of hydrogen atom is nearly equal to mass of electron.

(vi) Show that the scattering cross-section has dimensions of Area.

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(vi) Show that the scattering cross-section has dimensions of Area.

(vii) Can a particle moving under an inverse square repulsive force trace a closed orbit ? Explain.

(viii) Is the force experienced by an electron in an atom having many electrons central ? Explain.

(ix) Is the force $\vec{F} = (y^2 + x)\hat{i} + 3xy^2\hat{j}$ conservative or not ?

(x) What are the dimensions of $\frac{L^2}{\mu r^2}$? ½×8=4