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

1125

PHYSICS

Paper–A : Mechanics–I

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

Note : (1) Attempt **five** questions in all, selecting **two** questions each from of Unit I and Unit II.

(2) Unit III is compulsory.

(3) Use of non-programmable scientific calculator is allowed.

(4) Log tables may be asked for, if needed.

UNIT—I

1. (a) Prove that polar unit vectors $\hat{e}_\gamma$, $\hat{e}_\theta$ and $\hat{e}_\phi$ constitute a system of orthogonal vectors.   2½

(b) Path of a particle is defined by equations :

$$r = \left(3t - \frac{t^2}{30}\right) \text{ and } \theta^2 = \left(1600 - t^2\right)$$

Find velocity at time $t = 1/2$ min.   1½

2. (a) Discuss law of homogenity of space and show that it leads to law of conservation of linear momentum. 2½

   (b) Two particles of mass 'm' and '3m' are located at (1, 0) and (–3, 0). If particle of mass '3m' is displaced by '1' unit in –ve X direction, find by what distance and in which direction particle of mass 'm' is to be displaced so that centre of mass of system remains at same point. 1½

3. (a) Define solid angle and its SI unit. Find the solid angle subtended by a sphere at the centre. 2½

   (b) Why do we prefer spherical co-ordinate system ? ½

   (c) Determine the surface area of a sphere of radius 'r' by using spherical polar coordinates. 1

UNIT–II

4. (a) Find the polar equation of orbit of a particle of mass 'm' moving under the action of an inverse square force field about the fixed centre. 2½

   (b) Show that for an elliptical orbit eccentricity '$\in$' is given by

   $$\in = \frac{r_{max} - r_{min}}{r_{max} + r_{min}}.$$ 1½

5. (a) Prove that in Lab system the particles of same mass will move at right angle to each other after elastic collision if one of them were at rest before collision. 3

(b) The planet mars has aphelion distance 2.485×10^8 km and perihelion distance 2.06×10^8 km, w.r. to sun whose own radius is 7×10^6 km. Find its energy. Given :

mass of sun $= 2 \times 10^{30}$ kg, mass of mars $= 6.5 \times 10^{23}$ kg, $G = 6.67 \times 10^{-11}$ N^{2}kg^{-2}. 1

6. (a) What is Rutherford Scattering ? Obtain a relation between angle of scattering and impact parameter. 3

(b) In Lab system two particles each of mass 2 kg, are moving with velocities $\left(3\hat{i} = 4\hat{j} \right)$ ms^{-1} and $\left(5\hat{i} + 6\hat{j} \right)$ ms^{-1} and. Find total kinetic energy of system in centre of mass system. 1

UNIT—III

7. Attempt any **six** parts. Each part carries **1** mark.

(i) Is area scaler or vector ? What about volume ?

(ii) What do you mean by conservative force ? Give two examples.

(iii) The trajectory of a particle, moving in a plane, is a straight line passing through origin. What is transverse component of velocity of particle ?

(iv) Under what conditions property of flatness of (free) space holds good ?

(v) "Air friction increases the speed of a satellite". Comment.

(vi) What is difference between scattering and reaction when two particles collide ?

(vii) Define scattering cross-section. Prove that it has dimensions of area.