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 $\hat{e}_y, \hat{e}_\theta$ and $\hat{e}_\phi$ constitute a system of orthogonal vectors.   2½

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

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

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 '∈' 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}.
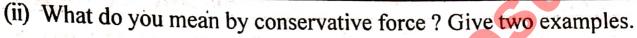
1

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.