Total No. of Questions : 9] [Total No. of Printed Pages : 4

(1049)

UG (CBCS) Ist Year Annual Examination

2007

B.Sc. PHYSICS

(Mechanics)

(Core)

Paper : PHYS 101

Time : 3 Hours] **[Maximum Marks : 50**

Note :– Attempt *five* questions in all, selecting *one* question each from Sections B, C, D and E respectively. Question No. **1** (Section A) is compulsory.

Section–A

(Compulsory Question)

1. (i) What do you mean by a differential equation ?

   (ii) The spherical coordinates of a point P are (8, 30°, 45°). Find its Cartesian coordinates.

   (iii) The potential energy of a particle under the action of a force is $U = 2x^4 + 3x^2$. Find the force acting on the particle.

(iv) What are inertial and non-inertial frames of reference ?

(v) What is central force ? Give some characteristics of central force.

(vi) What is the difference between elastic and inelastic collisions ?

(vii) What was the aim of Michelson-Morley experiment ? 7×2=14

Section–B

2. (a) Find the solution of differential equation :

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$$

(b) Show that the expression for fictitious force $\vec{F}_R$ in rotating frame is given by :

$$\vec{F}_R = \vec{F}_S - m\vec{\omega} \times (\vec{\omega} \times \vec{r}) - 2m\vec{\omega} \times \vec{v}_R$$ 4,5

3. (a) Prove that for motion of a particle in space at any time in spherical polar coordinates is :

$$\vec{V} = \dot{r}\hat{e_r} + r\dot{\theta}\hat{e_\theta} + r\sin\theta\dot{\Phi}\hat{e_\Phi}$$

(b) What is rotational invariance of space ? Show that it leads to the law of conservation of angular momentum. 5,4

Section–C

4. (a) State Kepler's law of planetary motion. Prove any *two* of them.

   (b) Reduce a two-body problem to an equivalent one-body problem. Hence derive the equation of motion for reduced mass. 5,4

5. (a) Derive the differential equation of the orbit in central force field.

   (b) The path of a particle moving under the action of force is given by $r = a \cos \theta$. Calculate the corresponding force law. 5,4

Section–D

6. What is Rutherford scattering ? Prove that the differential scattering cross-section for Rutherford scattering of α particles by a Nucleus is inversely proportional to square of the energy of the incident α particle. 9

7. (a) Prove that in lab system, if incident particle collides elastically with the target particle of equal mass at rest, then the two particles move at right angles to each other after collisions.

   (b) Show that in the CM system, the magnitudes of velocities of the particles remain unaltered in an elastic collision. 5,4

Section–E

8. What are the basic postulates of special theory of relativity ? Derive Lorentz space-time transformation equations for two inertial frames. Show that for $v << c$, Lorentz transformations reduce to the Galilean transformations.

9. (a) Prove the laws of relativistic addition of velocities. Hence, prove that no material body can move with a velocity greater than that of light.

   (b) Derive the relation, $E = mc^2$. Show that if $v << c$, it reduces to non-relativistic K.E $(\frac{1}{2}mv^2)$ expression. 5,4