Roll No. .....

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

(2036)

UG (CBCS) Annual Ist Year Examination

1407

B.Sc. PHYSICS

(Mechanics)

(Core)

Paper : PHYS–101

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

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

Section–A

(Compulsory Question)

1. (i) Is earth an inertial frame of reference ?

   (ii) No cyclones are set up at equator. Explain.

   (iii) Can a body have energy without having momentum ?

   (iv) In the northern hemisphere, a freely falling body is deviated to wards :

   (a) Along due east (b) Along due west

   (c) Along due north (d) None of these

(v) The principle of energy conservation implies that :

(a) Total kinetic energy is conserved

(b) Total potential energy is conserved

(c) Total mechanical energy is conserved

(d) Sum of all types of energy is conserved

(vi) The mass of a body will be maximum when it is :

(a) At rest

(b) Moving with a speed $v << c$

(c) Moving with a speed $v \approx c$

(d) None of these

(vii) The rest mass of a photon is :

(a) Zero (b) p/c

(c) E/c^2 (d) None of these

[2×7=14]

Section–B

2. (a) Solve the differential equation :

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$$

(b) What do you mean by rotational invariance ? Show that rotational invariance of space leads to conservation of angular momentum. [4,5]

3. (a) What do you understand by a fictitious force ? Show that the expression for the fictitious force F_{eff} in rotating frame is given by :

$$F_{eff} = \vec{F} - m\vec{R}_f - m\vec{\omega} \times (\vec{\omega} \times \vec{r}) - 2m(\vec{\omega} \times \vec{v}_r)$$

where the symbol have their usual meaning.

(b) Prove that Newton's Laws of motion are invariant under Galilean Transformation. Also show that under Galilean transformations velocity is invariant and acceleration is invariant. [5,4]

Section–C

4. (a) Derive equation of orbit in the inverse square force field. Determine turning points and shape of the trajectory.

(b) What are central forces ? Show that for a system of two particles moving under the action of central force, the total energy of the system remains conserved. [6,3]

5. (a) Explain the term reduced mass. How does it help to reduce the two body problem into one body problem ? Give examples.

(b) State Kepler's laws of planetary motion and prove Kepler's third law. [5,4]

Section–D

6. (a) If the angle of scattering in the CM system is θ, then show that it is related to the recoil angle α in lab system through $\alpha = \frac{(\pi - \theta)}{2}$. Show that during the elastic collision of two particles of equal masses, the directions of the scattered and recoil particles are at right angles to each other in the lab system.

   (b) Explain laboratory and center of mass system. What is the advantage of studying a collision process in center of mass system ? [6,3]

7. (a) What is Rutherford scattering ? Derive Rutherford scattering formula.

   (b) Define an impact parameter. Show that a larger impact parameter leads to a smaller scattering angle. [6,3]

Section–E

8. (a) Describe the Michelson-Morley experiment. Discuss the result obtained.

   (b) State the postulates of special theory of relativity and hence deduce Lorentz transformation equations. [5,4]

9. (a) Derive an expression for relativistic Doppler effect. What are red and blue shifts ?

   (b) Prove that the total energy, = $\sqrt{p^2c^2 + m_0^2c^4}$, where the symbols have their usual meanings. [5,4]