

B.Sc. F. Y. (CBCS Pattern) Semester-I
USPHT01 - Physics Paper-I - Mechanics and Relativity

P. Pages : 3

Time : Three Hours



GUG/S/25/11560

Max. Marks : 50

-
- Notes : 1. All questions are compulsory.
2. Draw neat and well-labeled diagrams wherever necessary.

Either:

1. A) i) State Newton's laws of Motion. Discuss the limitations of Newton's laws of Motion. **4**
ii) Obtain an expression for radial and transverse components of velocity. **3**
iii) Two bodies of masses 2 gram and 10 gram have position vectors $(3\mathbf{i} + 2\mathbf{j} - \mathbf{k})$ and $(\mathbf{i} - \mathbf{j} + 3\mathbf{k})$ respectively. Find the position vectors and the distance of the center of mass from the origin. **3**

OR

- B) a) Derive the equation of motion of the center of mass. **2½**
b) Find the total linear momentum of a system of particles about the Centre of mass. **2½**
c) Show that in the absence of external force, the momentum of the centre of mass remains constant. **2½**
d) The distance between the Carbon and Oxygen atoms in the CO molecule is 1.12\AA . Find the center of mass of the CO molecule for the C atom. **2½**

Either:

2. A) i) Derive an expression for velocity after collision in one dimension when the two bodies have an elastic collision between them. **4**
ii) Explains the terms elastic and inelastic collisions with examples. **3**
iii) Two objects of mass $m_1 = 2\text{gm}$ and $m_2 = 5\text{gm}$ possess velocity $u_1 = 10\text{cm/sec}$ and $u_2 = 5\text{cm/sec}$. They suffer an elastic collision. Find the velocities of both objects after collision. **3**

OR

- B) a) State and prove the law of conservation of linear momentum. **2½**
b) Explain the working principle of Single Stage Rocket. **2½**
c) What is a Multi-Stage Rocket? State the advantages of Multi-Stage Rocket. **2½**

- d) Find the work done by a force of 10N, applied to a lawn roller, when the force acts making an angle of 60° with the horizontal, moving the roller through a horizontal distance of 10m. 2½

Either:

3. A) i) Define moment of inertia. Give the physical significance of the moment of inertia. 3
- ii) Derive an expression for the moment of inertia of a rod about an axis passing through the center and perpendicular to its length. 4
- iii) Calculate the radius of gyration of a solid sphere rotating about its diameter if its radius is 5.0 cm. 3

OR

- B) a) Obtain the relation between torque and moment of inertia. 2½
- b) Distinguish between Homogeneity and Isotropy of space. 2½
- c) State principle of parallel axis theorem obtain an expression for moment of inertia of rod about an axis passing through it one end perpendicular to it length. 2½
- d) A torque of 1 Nm is applied to a wheel of mass 10 kg and a radius of gyration 50 cm. What is the resultant angular acceleration? 2½

Either:

4. A) i) Derive Lorentz space and time transformation equations. 4
- ii) Obtain an expression for length contraction in the case of the special theory of relativity. 3
- iii) If 1 gram of a substance is fully converted into energy, how much energy is produced in a kilowatt hour? (Given : $1 \text{ KWH} = 3.16 \times 10^6 \text{ J}$) 3

OR

- B) a) What is time dilation in the special theory of relativity? Derive an expression for time dilation. 2½
- b) Obtain the relation $E = m_0^2 c^4 + p^2 c^2$. 2½
- c) Obtain the Einstein relation $E = mc^2$. 2½
- d) Suppose the half-life of a certain particle is 10^{-7} seconds when it is at rest. What will be its half-life when it is traveling with a speed of $0.99c$? 2½

5. Attempt **any ten** from the followings.

- a) What is meant by Frame of reference? 1
- b) What is centrifugal force? 1

- c) What is the centre of mass? 1
- d) Define linear momentum. Write its S. I. unit. 1
- e) Define the term work. State its S. I. unit. 1
- f) Name the fuels that are used in single-stage rockets. 1
- g) State the theorem of perpendicular axes. 1
- h) Define angular acceleration. State its S. I. unit 1
- i) What is torque? 1
- j) What is meant by proper time? 1
- k) Write Lorentz Inverse Transformation equation. 1
- l) State the postulate of special theory of relativity. 1
