

B.Sc. F.Y. (C.B.C.S. Pattern) Sem-I  
**USPHT01 - Physics Paper-I (Mechanics and Relativity)**

P. Pages : 2

GUG/W/19/11560

Time : Three Hours



Max. Marks : 50

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

1. Either

- a) i) State Newton's laws of motion and write the limitations. 4  
ii) Derive an expression for radial and transverse components of velocity. 3  
iii) The path of projectile is given by equation  $x = \left( 3t^2 - \frac{t^2}{20} \right)$ . Find the velocity and 3  
acceleration after the time 10 second.

**OR**

- b) a) Distinguish between inertial and Non-inertial frame of reference. 2½  
b) What is centripetal force? Write its characteristics. 2½  
c) Derive the equation of motion of Centre of mass. 2½  
d) Two bodies of masses 10 gm and 20 gm constrained to move in horizontal plane collide. If their velocities are  $v_1 = 6$  cm/sec and  $v_2 = -7$  cm/sec respectively, then find the velocity of Centre of mass. 2½

2. Either

- a) i) Explain the terms elastic and inelastic collisions with examples. 3  
ii) Derive an expression for velocity after collision in one dimension when the two bodies have elastic collision between them. 4  
iii) If the two bodies having masses 10 kg and 8 kg and their respective velocities are 6 m/sec and 5 m/sec. Find its final velocities of two bodies-after elastic collision between them. 3

**OR**

- b) a) Write the drawbacks of single stage rocket. 2½  
b) State and prove the law of conservation of momentum. 2½  
c) Derive an expression for velocity of racket at any instant of time t. 2½  
d) A rocket of mass 20kg has 180 kg of fuel. The exhaust velocity of fuel is 1.60km/s. Calculate the ultimate vertical speed gained by the rocket when the rate of consumption of fuel is 20 kg/s. 2½

3. Either

- a) i) Explain the moment of inertia and radius of gyration. 3  
ii) Derive an expression for moment of energy of solid sphere about its diameter. 4  
iii) Assuming earth to be solid sphere of uniform density  $5520\text{kg/m}^3$  and radius 6400 km, calculate the moment of inertia about its axis of rotation. 3

**OR**

- b) a) State the principle of perpendicular and parallel axes about M.I. of body. Give their mathematical equations. 2½
- b) State and prove law of conservation of angular momentum. 2½
- c) Derive an expression for moment of inertia of thin ring about an axis passing through its Centre and perpendicular to its plane. 2½
- d) A thin uniform rod has a length 2m and mass 3kg. Find its moment of inertia about a axis passing through. 2½
- i) One end of the rod.
- ii) Centre of mass of the rod which is perpendicular to its length.

**4.** Either

- a) i) Derive Lorentz space time transformation equations and write its inverse transformation formulae. 4
- ii) Derive an expression for length contractions. 3
- iii) A rocket of rest mass  $10^4$  kg is travelling at a velocity of (0.6) C. Find its relativistic mass. What would be the mass when it travels with speed of light. 3

**OR**

- b) a) Obtain the relation 2½  

$$E = \sqrt{m_0^2 C^4 + p^2 c^2}.$$
- b) Obtain an expression for time dilation in case of special theory of relativity. 2½
- c) The total energy of particle is exactly twice of its rest mass energy. What is the velocity of particle. 2½
- d) Deduce the formula for relativistic variation of mass with velocity. 2½

**5.** Attempt **any ten** from following.

- a) What is Centre of mass? 1
- b) What is mean by frame of reference? 1
- c) Show that Newton's second law is a special case of first law. 1
- d) State the principle of rocket. 1
- e) State the principle of conservation of energy. 1
- f) What is jet propulsion in rocket? 1
- g) What is torque? 1
- h) Explain the isotropy and rotational invariance of space. 1
- i) What is angular momentum? 1
- j) Write the postulates of special theory of relativity. 1
- k) Define proper time. 1
- l) State the physical significance of  $E = mc^2$ . 1

\*\*\*\*\*