USPHT01 - Physics Paper-I : Mechanics and Relativity

P. Pages : 3

Time : Three Hours

8300

Max. Marks : 50

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Notes : 1. Draw neat, well labelled diagrams wherever necessary.
        2. All questions are compulsory.

Either :

1. **A)** i) State Newton's laws of motion and write its limitation. **3**

      ii) Obtain an expression for radial and transverse component of velocity. **4**

      iii) The path of projectile is given by $\left(3t^2 - \dfrac{t^2}{20}\right)$ meter. Find the velocity and acceleration **3**

          of time 10_s.

OR

  B) a) Derive equation of motion of centre of mass. **2½**

      b) Two particles of masses m_1 and m_2 and positions vectors r_1 and r_2 are moving with velocities v_1 and v_2 respectively. Obtain expression for velocity and acceleration. **2½**

      c) Derive an expression for linear momentum about centre of mass. **2½**

      d) Two bodies of masses 2gm and 10gm of position vector $3\bar{i} + 2\bar{j} - \bar{k}$ and $\bar{i} + \bar{j} + 3\bar{k}$. Find the position vector of centre of mass from the origin. **2½**

Either :

2. **A)** i) Discuss the phenomenon of Collision in one dimension between two particles when the Collision is elastic. Hence find velocities after collision. **6**

      ii) When masses of colliding particle are same and when one of the particle is initially at rest, then the velocities after collision. **2**

      iii) A gun of mass 10kg fires a bullet of 100gm with a velocity 1500 cm/s. Find the velocity with which gun is recoiled. **2**

OR

  B) a) State and prove law of conservation of linear momentum. **2½**

      b) State and prove the work-energy principle. **2½**

	c)	Explain the principle and working of multistage rocket.		**2½**
	d)	State and explain law of conservation of energy with suitable examples.		**2½**

Either :

3. **A)** i) Derive an expression for moment of inertia of a rod about an axis passing through: **6**
a) its centre   b) One end perpendicular to its length.

  ii) Define moment of Inertia and radius of gyration. **2**

  iii) Calculate the radius of gyration of a solid sphere rotating about its diameter where radius is 5 cm. **2**

OR

B) a) Explain isotropy and rotational invariance of space. **2½**

  b) Show that angular momentum of a particle remains conserved in the absence of an external torque. **2½**

  c) State the principle of perpendicular and parallel axes for moment of inertia. Give their mathematical equations. **2½**

  d) Define torque. Obtain the relation between torque and moment of inertia. **2½**

Either :

4. **A)** i) Derive Einstein's relativistic velocity addition formula. **6**

  ii) Prove the principle of constancy of speed of light. **2**

  iii) A Rocket of rest mass 8000kg is travelling with a velocity of 0.6C. Find the relativistic mass. **2**

OR

B) a) Derive an expression for time dilation. **2½**

  b) Obtain the Einstein relation, $E = mc^2$. **2½**

  c) Derive an expression for length contraction. **2½**

  d) An object in motion has a mass of a 12kg and travels in air with velocity 0.82C. What would be its rest mass? **2½**

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

  a) What is frame of reference? **1**

  b) Define centripetal force. **1**

c)   Write the names of forces acting on a moving particle in rotating frame. **1**

d)   Name the fuel used in the rocket. **1**

e)   What are the applications of elastic collision. **1**

f)   Write drawback of the single stage rocket. **1**

g)   What is torque. **1**

h)   Define angular impulse. **1**

i)   Write the relation between τ and L. **1**

j)   Write the Lorentz transformation equations. **1**

k)   What is meant by proper time? **1**

l)   What are the postulates of special theory of relativity. **1**

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