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S. No. of Question Paper : **66**

Unique Paper Code : **222161**   **G**

Name of the Paper : **Physics-I : Mechanics (PHPT-101)**

Name of the Course : **B.Sc. Physical Sciences/Applied Physical Sciences**

Semester : I

Duration : **3 Hours**   Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. 1 is compulsory.

Attempt any *four* questions from the rest of the paper.

1. Attempt any *five* of the following :   5×3=15

   (*a*) If $\vec{A}$ and $\vec{B}$ are irrotational, prove that $\vec{A} \times \vec{B}$ is solenoidal.

   (*b*) A flywheel in the form of a solid disc of 500 kg and 1 m radius is rotating making 120 rotations per minute. Compute its kinetic energy.

   (*c*) What are conservative forces ? Show that central force field is conservative in nature.

   (*d*) Calculate the energy equivalent of 1 amu.

   (*e*) What is recessional red shift ?

   (*f*) Calculate the velocity of a solid sphere rolling down an inclined plane when it reaches its bottom. .

(g) Prove :

$$\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$$

2. (a) Define angular momentum and torque. Show that angular momentum of a body moving under the effect of a central force is a constant.

(b) State and prove work energy theorem.

(c) If the centre of mass of three particles of masses 2, 4, 6 gm be at (1, 1, 1) then where should the fourth particle of mass 8 gm be placed so that the position of the centre of mass of the new system is at (3, 3, 3).   5,5,5

3. (a) Explain the terms stress and strain. Define Young's modulus (Y), Bulk modulus (K), modulus of rigidity (η) and Poisson's ratio (σ).

(b) Show that the bulk modulus (K), Young's modulus (Y) and the Poisson's ratio (σ) are connected by the relation $K = Y/[3(1 - 2\sigma)]$,   8,7

4. (a) State the postulates of the special theory of relativity. On its basis obtain the Lorentz transformation equations. Show that for low velocities Lorentz transformations reduce to Galilean transformations.

(b) What is the kinetic energy of a proton of rest mass 1.67×10^{-27} kg moving with velocity 2.7×10^8 m/s ?   10,5

5. (a) Deduce the relativistic transformation equations for velocities of a body along X, Y and Z axes.

(b) Calculate the length and orientation of a rod of length 5 m in a frame of reference which is moving with a velocity 0.6 c in a direction making an angle of 30° with the rod. 9,6

6. (a) State and prove Green's theorem in the plane.

   (b) Find the directional derivative of :   10.5

   $$\phi = x^2 yz + 4 xz^2$$

   at $(1, - 2, - 1)$ in the direction :

   $$2\hat{i} - \hat{j} - 2\hat{k}$$

7. (a) State and prove Stokes theorem.   10.5

   (b) Evaluate :

   $$\iint\limits_{S} (\vec{\nabla} \times \vec{A}) . \hat{n} \, dS$$

   $$\vec{A} = (2x - y) \, \hat{i} - yz^2 \, \hat{j} - y^2 \, z\hat{k}$$

   and S is the upper half surface of the sphere :

   $$x^2 + y^2 + z^2 = 16$$