

Sl. No. of Ques. Paper : 8382
Unique Paper Code : 222103
Name of Paper : PHHT-102 : Mechanics
Name of Course : B.Sc. (Hons.) Physics Part I
Semester : I
Duration : 3 hours

C

Maximum Marks : 75

Attempt five questions in all, including Question No. 1 which is compulsory.

1. Attempt any five: 5×3 = 15
- (a) Show that the element of volume $\Delta x \Delta y \Delta z \Delta t$ in space time coordinates is invariant under Lorentz transformation.
 - (b) A disc and a ring of same mass M and radius R are rolling down an inclined plane, both starting from rest. Which one will have more K.E. ? Explain.
 - (c) Calculate momentum of a photon of energy 6.2×10^{-19} J.
 - (d) A pendulum of length l has a bob of mass m and is hung from the ceiling of a car. If the car accelerates at $g/\sqrt{2}$ m/s², calculate:
 - (i) angle made by the string with vertical.
 - (ii) tension in the string.
 - (e) A flywheel with 15 kg mass and radius of gyration 0.15 m is rotating at the rate 1800 rpm. Calculate torque necessary to stop it in 5 sec.
 - (f) Calculate the height at which the P.E. of a mass m will reduce to half of its P.E. on the surface of the earth.
 - (g) In the surface Poiseuille's experiment, if the radius of the capillary is reduced by 50%, how will the coefficient of viscosity be affected? Explain.
2. (a) Show how a two body problem involving central force can be reduced to a one body problem. What would be the corresponding expressions for angular momentum and energy? 10
- (b) Plot and discuss the energy diagram for the planetary motion for all possible values of energy. 5
3. (a) Define viscosity of a fluid. Derive the Poiseuille's equation for the flow of viscous fluid through a capillary. State the assumptions involved. 8
- (b) Establish the relation between the elastic constants of a material:

P. T. O.

$$\frac{9}{Y} = \frac{3}{\eta} + \frac{1}{K}$$

7

4. (a) Show that for a body undergoing translation and rotation, its angular momentum is given by:

$$L_z = I_0 \omega + (\vec{R} \times M\vec{V})_z,$$

and hence explain the meaning of the two terms on R.H.S. of the equation. 8

- (b) Derive an expression for the moment of inertia of a rectangular lamina about an axis perpendicular to its plane and passing through one of its corners. 7
5. (a) Show that the expression for the force observed in rotating co-ordinate system is:

$$\vec{F}_{rot} = m\vec{a}_{in} - m [2\vec{\Omega} \times \vec{v}_{rot} + \vec{\Omega} \times (\vec{\Omega} \times \vec{r})].$$

Explain the different terms on the R.H.S. of the equation. 10

- (b) What is an inertial frame of reference? Derive the expressions for Galilean Transformation equations for space-time coordinates. Show that acceleration is invariant under Galilean Transformation. 5
6. (a) Find the expression for the momentum and velocity of two particles colliding elastically with each other in C.M. system. Show that the speed of each particle is same before and after the collision in C.M. system. 6
- (b) Find the limitations on laboratory scattering angle during elastic collision of two bodies. 4
- (c) The stages of a two stage rocket separately weigh 100 kg and 10 kg and contain 800 kg and 90 kg of fuel respectively. Calculate the final velocity attained by the rocket with an exhaust velocity 2 km/s. Neglect the gravitational attraction. ($\ln 5 = 1.609$, $\ln 10 = 2.3$). 5
7. (a) State postulates of Einstein's theory of relativity. Derive Lorentz transformation equation for space-time coordinates. 7
- (b) Explain the physical significance of null result of Michelson-Morley experiment. 3
- (c) A spaceship coasting in space detects an alien space probe. As the probe approaches, the frequency received by the ship is 130 MHz and 60 MHz when it recedes into distance. What is the intrinsic frequency of the transmitter and what is the relative speed of the two ships? 5