2025

(November-December)

PHYSICS

Paper: PHY-C-101

Mechanics and Relativity

Time: $2\frac{1}{2}$ Hours   **Total Mark: 60**   **Pass marks: 18**

(The figures in the right margin indicate full marks of the questions)

1. Choose the correct answer from the followings: $1\times6=6$

    (a) Which of the following quantities remain invariant under Galilean transformations?

    (i) Position   (ii) Velocity

    (iii) Acceleration   (iv) Angular momentum

    (b) Which of the following is a fictitious force ?

    (i) Coriolis force   (ii) Centrifugal force

    (iii) Both (i) and (ii)   (iv) None of the above

    (c) If $\omega = 1$ rad/sec, then the relation between moment of inertia (I) and kinetic energy (E) is-

    (i) $I = 2E$ (ii) $I = \dfrac{2}{3}E$

    (iii) $I = \dfrac{E}{2}$ (iv) $I = \dfrac{2}{E}$

    (d) Which of the following remains constant in Lorentz transformation?

    (i) Mass   (ii) Length

    (iii) Energy   (iv) None of the above

1

(e) If a simple harmonic motion is represented by $\dfrac{d^2x}{dt^2} + \alpha x = 0$, then time period is

(i) $\dfrac{2\pi}{\alpha}$

(ii) $2\pi\sqrt{\alpha}$

(iii) $\dfrac{2\pi}{\sqrt{\alpha}}$

(iv) $2\pi\alpha$

(f) Frame S' is moving with speed v along X-axis relative to S. A rod is stationary in frame S with length l along X-axis. The length as observed in frame S' is—

(i) $\dfrac{l}{\sqrt{1-\frac{v^2}{c^2}}}$

(ii) $l\sqrt{1-\dfrac{v^2}{c^2}}$

(iii) l

(iv) $\dfrac{l}{v}$

2. Answer the following questions in brief: 2×6=12

   (a) Find the unit vector perpendicular to each of the vectors $3\hat{i} + \hat{j} + 2\hat{k}$ and $2\hat{i} - 2\hat{j} + 4\hat{k}$.

   (b) What is an inertial frame of reference ?

   (c) Write down Poiseuille's equation. State its significance.

   (d) What is the angle between the two vectors $\dot{A}$ and B such that $\left|\dot{A} + B\right| = \left|\dot{A} - B\right|$?

   (e) State the postulates of special theory of relativity.

   (f) What is length contraction?

3. (a) Show that velocity is invariant under Galilean transformation equations.   2

   (b) Establish the relationship between the elastic constants Y, K and η. Where K is bulk modulus, Y is Young's modulus and η the modulus of rigidity.   4

2

Or

Obtain an expression for the strain energy in a twisted cylinder.

4. (a) A water drop has a diameter of 2×10^{5} m. Calculate the excess pressure inside the drop, if the surface tension of water is 0.072 N/m.   3

Or

Establish the relationship between surface tension and surface energy of a liquid.

   b) Obtain an expression for moment of inertia of a rectangular lamina about an axis passing through its centre and perpendicular to the plane of the lamina containing its length and breadth.

   (c) A circular disc of mass m and radius r is rolling with linear velocity v and angular velocity ω. Show that its total energy is given by $\dfrac{3}{4}mr^2\omega^2$.

Or

Obtain an expression for the acceleration of a spherical body rolling down in inclined plane.   4

   (d) State and prove work-energy theorem.

5. (a) Derive an expression for gravitational potential due to a solid sphere at a point inside the sphere.   4

Or

State and discuss Kepler's laws of planetary motion.

   (b) Reduce two body problems to an equivalent one-body problem and find the reduced mass.   2

   (c) What is coriolis force? What is the effect of coriolis force on a particle falling under earth's gravity?   2+3=5

3

25 + 9 + 36

(d) Show that total energy of a particle exhibiting simple harmonic motion is constant. 3

Or

Construct the differential equation of simple harmonic motion and find its solutions?

6. (a) Deduce Lorentz transformation equations. Under what condition do these equations reduce to Galilean form? 4+1=5

Or

Discuss Michelson-Morley experiment and explain its negative results. 4+1=5

(b) Derive Einstein's mass-energy equivalence relation. 4

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