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3 (Sem-1/CBCS) PHY HC 2

2022

**PHYSICS**

(Honours)

Paper : PHY-HC-1026

*(Mechanics)*

Full Marks : 60

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

1. Answer **any seven** of the following questions: 1×7=7
- (a) Write *one* limitation of Newton's law of motion.
  - (b) What is the relation between workdone and kinetic energy ?
  - (c) Define the co-efficient of restitution.
  - (d) What do you mean by radius of gyration ?

Contd.

- (e) Write the limiting value of Poisson's ratio.
- (f) Which of the following is used to calculate the rate of flow of a liquid through a capillary tube?
- (i) Stokes' law
  - (ii) Bernoulli's theorem
  - (iii) Pascal's law
  - (iv) Poiseuille's law
- (g) State the law of gravitation.
- (h) Define Sharpness of resonance.
- (i) What is fictitious forces?
- (j) Give *one* example of a massless particle.
- (k) What is wave number?
- (l) Write the relation between torque and angular momentum.

2. Answer **any four** of the following questions :  
2×4=8

- (a) What do you mean by non-conservative force? Give an example with justification.
- (b) A 10kg ball and 20kg ball approaches each other with velocities 20m/sec and 10m/sec respectively. What are their velocities after collision if the collision is perfectly elastic?
- (c) Establish the defining equation of simple harmonic motion.
- (d) The co-ordinates of an event in the moving frame  $S'$  moving with velocity 12m/sec along the  $x$ -axis are (5, 7, 5). Find the co-ordinates of the same event in the frame  $S$  if their origins co-incides 1/4 seconds later.
- (e) Write the difference between inertial mass and gravitational mass.
- (f) What is resonance? Write the condition of resonance.
- (g) State Kepler's third law of planetary motion.
- (h) Explain how the mass of a body varies with velocity.

3. Answer **any three** of the following questions : 5×3=15

- (a) Derive the expression of the final velocity of a Rocket considering the value of  $g$  is constant.
- (b) Draw and explain potential energy curve. What are stable and unstable equilibrium? 1+3+1=5
- (c) Obtain the velocity after one dimensional inelastic collision between two particles in centre of mass frame.
- (d) If a uniform rod of material having Poisson's ratio 0.5 suffers a longitudinal strain of  $1 \times 10^{-4}$ , find the % change in its volume.
- (e) Discuss how two body problem in central force motion is reduced to one body problem.
- (f) Consider a fluid having coefficient of viscosity  $\eta$  and density  $\rho$  flowing through a cylindrical tube of radius  $r$  and length  $l$ . If  $P$  is the pressure difference in the liquid at the two ends, show that the volume of fluid flowing in time  $t$  is

$$V = \frac{\pi Pr^4}{8\eta l} \cdot t$$

(g) Establish that centrifugal force produced as a result of earth's rotation, is

$$\vec{F} = -m\vec{\omega} \times (\vec{\omega} \times \vec{r})$$

where the symbols have their usual meanings.

(h) Write the Lorentz transformation equations. Under what condition the Lorentz transformation equations become Galilean transformation. 3+2=5

4. Answer **any three** of the following questions : 10×3=30

(a) Define the different types of frame of reference. Derive the Galilean transformation equation in inertial frame of reference. Show that velocity is variant and acceleration is invariant under Galilean transformation. 2+4+4=10

(b) Point out the difference between conservative and non-conservative forces. Prove that a conservative force  $\vec{F}$  is derivable from a potential  $\phi$ ,  $\vec{F} = -\vec{\nabla}\phi$  and hence obtain  $\vec{\nabla} \times \vec{F}$ . 2+6+2=10

- (c) Define Moment of inertia. Explain the *two* theorem of moment of inertia. Calculate the moment of inertia of a solid sphere about a diameter.

$$1+2+2+5=10$$

- (d) Derive an expression of acceleration in uniformly rotating frame of reference. Write *any two* applications of Coriolis force.

$$8+2=10$$

- (e) Define Young's modulus, bulk modulus and rigidity modulus of elasticity.

Deduce the relation

$$\frac{9}{Y} = \frac{1}{K} + \frac{3}{\eta}, \text{ where the symbols}$$

have their usual meaning.  $3+7=10$

- (f) What do you mean by gravitational potential and gravitational field intensity. Write their relation. Find out an expression for gravitational potential due to a solid sphere at an inside point.

$$2+1+7=10$$

- (g) State the basic postulates of special theory of relativity. Deduce Einstein's mass-energy relation  $E = mc^2$  and discuss it.

$$2+6+2=10$$

- (h) Write short notes on *any two* of the following :  $5 \times 2 = 10$

(i) Length contraction

(ii) Compound pendulum

(iii) Relativistic Doppler effect

(iv) Cantilever