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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 : $5 \times 3 = 15$

(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 1×10^{-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 η and density ρ 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

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

(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 : $10 \times 3 = 30$

(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 ϕ , $\vec{F} = -\vec{\nabla}\phi$ 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