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**63 (FY)SEM-1/MAJ/PHYMAJ1014**

**2025**

**PHYSICS**

(Major)

Paper : PHYMAJ1014

**(Mechanics)**

Full Marks : 50

Pass Marks : 20

Time : Two hours

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

1. Answer the following questions : **(all compulsory)** 1×5=5

(a) A ring, a disc, a solid sphere and a spherical shell has same mass and radius which one has least moment of inertia about its geometrical axis.

(i) Ring

(ii) Solid sphere

(iii) Disc

(iv) Spherical shell

(b) What is the rest energy,  $E$  of an object with a mass of 1.00g

(i)  $3.00 \times 10^5 J$

(ii)  $3.00 \times 10^{11} J$

(iii)  $9.00 \times 10^{13} J$

(iv)  $9.00 \times 10^{16} J$

(c) The frame attached to any point on earth's surface is -

(i) Non-inertial

(ii) Inertial

(iii) Neither inertial nor non-inertial

(iv) Newtonian frame of reference

(d) If the mechanical energy of a particle is conserved then the particle is acted upon by a

(i) non-conservative force

(ii) conservative force

(iii) friction

(iv) drag force

(e) The relation between quality factor  $Q$  and relaxation time  $\tau$  of an oscillator is

(i)  $Q = \frac{w}{\tau}$

(ii)  $Q = \frac{\tau}{w}$

(iii)  $Q = w\tau$

(iv)  $Q = \frac{1}{w\tau}$

2. Answer the following questions: **(any five)**  
2×5=10

(a) Explain net workdone by a centripetal force is zero using work-energy theorem.

(b) Show that "Length of a rod is invariant under Galilean transformation".

(c) Determine the Poisson's ratio of rubber, if due to pulling of the rubber its change in volume is negligible in comparison to its change in length.

- (d) Poiseuli's relation is true for stream lined flow only—Explain.
- (e) What will be the radius of gyration for a solid sphere, whose radius is half meter. The moment of inertia  $I$  is related to radius of gyration  $K$  as  $I = MK^2$ .
- (f) Show that the gravitational forces acting between two bodies exerted by each other are equal and opposite.
- (g) Show variation of kinetic energy and potential energy with displacement of a body executing SHM.

3. Answer the following questions : **(any five)**  
5×5=25

- (a) Calculate torsional couple per unit twist of the cylindrical rod.
- (b) What is conservative force? Show that the conservative force is equal to negative gradient of potential energy.  
1+4=5
- (c) (i) Find the angle of projection at which horizontal range and maximum height are equal.

(ii) Two bodies of masses 10kg and 2kg are moving with velocities  $2\hat{i} - 7\hat{j} + 3\hat{k}$  and  $-10\hat{i} + 35\hat{j} - 3\hat{k}$   $m/s$  respectively. Find the velocity of the centre of mass. 3+2=5

- (d) Show that the velocity of the particle in the inertial frame (.S frame) is the vector sum of its velocity in the rotating frame ( $S'$  frame) and the linear velocity due to rotation.
- (e) Using relation among elastic constants. Show that the limiting value of  $\nu$  lies between 0 and 0.5. Discuss - elastic after effect and elastic fatigue.  
3+2=5
- (f) Show that the time average value of potential energy of a harmonic oscillator is  $\frac{1}{4}mr^2\omega^2$ , where symbols have their usual meaning.
- (g) Show that the moon would depart for ever from the attraction of the earth if its orbital speed were increased by 42%.

(h) What is an artificial satellite? Derive an expression for its orbital speed.

1+4=5

4. Answer the following question : (**any one**)

10×1=10

(a) (i) Derive components of velocity and acceleration in cylindrical co-ordinate system. 2+2=4

(ii) An electron and a positron practically at rest come together and annihilate each other. Calculate the energy released. 2

(iii) Obtain expression for gravitational potential energy. 4

(b) (i) State the objective of Michelson and Morley experiment. Obtain difference in time between the two beams returning to glass plate after reflection from the mirrors in their path. 1+4=5

(ii) Define Coriolis force. What does the negative sign in the expression of coriolis force represents. Explain the note of coriolis force in the formation of cyclones.

1+1+3=5

