Sr. No. 321105

January, 2023

B.Sc. (H) Physics Semester-I (Reappear)

Mechanics (BPH-102)

Time: 3 Hours **Max. Marks:75**

Instructions:

1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Non-programmable simple calculators are allowed.*

PART -A

Q1 (a) Show that the volume element in space-time coordinates, $\Delta v = \Delta x \Delta y \Delta z \Delta t$ is invariant under Lorentz transformation. (1.5)

(b) State the postulates of Einstein's special theory of relativity. (1.5)

(c) 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. (1.5)

(d) Show that the theoretical limiting values of Poisson's ratio are -1 and 0.5. (1.5)

(e) Define gravitational potential energy. How does it vary with distance represent graphically? (1.5)

(f) Differentiate among free, damped and forced harmonic oscillations. (1.5)

(g) What are conservative and non-conservative forces? Explain with examples. (1.5)

(h) A flywheel of mass 15 kg and radius of gyration 0.15 m is rotating at the rate of 1800 rpm. Calculate torque necessary to stop it in 5 sec. (1.5)

(i) What was the main objective of the Michelson Morley experiment? (1.5)

(j) Define radius of gyration. How does a compound pendulum prove a better choice for the computation of 'g' in comparison to normal string and bob set-up (i.e. simple pendulum)? (1.5)

PART -B

Q2 (a) Explain briefly conservative and non-conservative forces. A force is given by: $\vec{F} = (y^2z^3 - 6xz^2)\,\hat{\imath} + 2xyz^3\,\hat{\jmath} + (3xy^2z^2 - 6x^2z)\hat{k}$. Check whether this force is conservative or not. (8)

(b) Considering the flow of mass and momentum, carefully derive the equation of motion of a rocket, stating all assumptions and conservations. Are this rocket equation and its solution applicable for a journey from Earth to Mars? (7)

Q3 Define Gravitational potential. Compute gravitational potential due to a spherical shell at *(a)* an external point, *(b)* on the surface, and *(c)* at an internal point. Show graphical representation of the variation of potential with distance. (15)

Q4 Establish the equation of motion for the damped harmonic oscillations and (15)

solve it for over-damped, critically damped and damped oscillations. Also compute time period and logarithmic decrement for the damped oscillations.

Q5 Explain laboratory and centre of mass frames of references. What is the advantage of studying a collision process in centre of mass system? Prove that in centre of mass system the magnitude of velocities of the particles remain unaltered in elastic collision. (15)

Q6 (a) What are elastic constants of an elastic material? Establish the relation between the elastic constants: Y (Young's Modulus), n (modulus of rigidity) and K (bulk modulus). (8)

(b) Find the expression for the moment of inertia of a solid cylinder of length L, radius R and mass M about an axis passing through its centre and perpendicular to its geometrical axis. (7)

Q7 (a) Describe the Michelson-Morley experiment and explain the physical significance of the negative results. (8)

(b) Explain the existence of Doppler effect on the basis of the special theory of relativity. (7)

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