(Pages : 4) ALL SAINTS COLLEGE LIBRARY NO. TRIVANDRUM **N – 7770**

Reg. No. : .....

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Fourth Semester B.Sc. Degree Examination, August 2022

First Degree Programme under CBCSS

Physics

Core Course III

PY 1441 : CLASSICAL AND RELATIVISTIC MECHANICS

(2019 Admission onwards)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer **all** questions in a word or one or two sentences. Each question carries **1** mark.

1. Define inertial frames of reference,
2. At what condition, the linear momentum of a body will be a constant?
3. Differentiate between external and internal forces.
4. What are inverse square forces?
5. Write the form of expression for potential energy in inverse square forces.
6. Write the expression for kinetic energy of an elastic collision between two particles.
7. Define holonomic constraints.

8. Write the conditions at which a coordinate becomes cyclic.

9. Write Galilean transformation equations.

10. Briefly explain twin paradox.

(10 × 1 = 10 Marks)

SECTION – B

Answer **any eight** questions, each question carries **2** marks.

11. Explain the concept of center of mass.

12. State and explain the law of conservation of angular momentum for a particle.

13. The value of the equivalent mass of a two-body system is always less than both of the individual masses. Why?

14. Define impact parameter in scattering.

15. What are the differences between elastic and inelastic collisions?

16. Define laboratory frames of references and centre of mass frame of reference

17. Explain law of a conservation of energy of a system of particles.

18. What is an Atwood machine? Write its Lagrangian.

19. Explain the significance of constraints in Lagrangian formulation.

20. Define generalized coordinates, with any one example.

21. In terms of generalized coordinates explain whether the motion of simple pendulum is one dimensional or two dimensional?

22. What are the differences between Lagrange's formulation and Hamiltonian formulation?

23. Define Hamiltonian H and explain its physical significance.

24. Write the Lorentz transformation equations and inverse Lorenz transformation equations.

25. Explain the postulates of the special theory of relativity.

26. Briefly explain any four consequences of special theory of relativity.

(8 × 2 = 16 Marks)

SECTION – C

Answer **any six** questions, each question carries **4** marks.

27. Calculate the deflection radius of an electron moving with a velocity of 1000 m/s perpendicular to a magnetic field of 1 T. $e = 1.602 \times 10^{-19}$ C.

28. Explain the inverse square laws of force and obtain the general form of potential in inverse square law of forces

29. Calculate the reduced mass of CO molecule, Given that atomic mass of C is 12 and that of O is 16. Calculate the mass in atomic unit.

30. Obtain the equation of motion of a compound pendulum using Lagrangian formulation.

31. What are generalized momenta? Explain its properties

32. Deduce the principle of virtual work.

33. Obtain Hamiltonian of a simple pendulum.

34. The kinetic energy and potential energy of a particle of mass m moving in a plane about a fixed point by an inverse square force $-k/r^2$ are $T = \frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2)$ and $V = -k/r$. Identify the cyclic co-ordinate of the system. Prove that angular momentum of the system is a constant.

35. Derive the Lagrangian and Hamiltonian of a harmonic oscillator in one dimension

36. Calculate the length of a rod of 2 m travelling in a speed of 0.8 c.

37. Calculate the change in mass of an electron moving with velocity of 2.4×10^8 m/s in space. Assume the standard mass of electron.

38. A space craft is moving relative to earth. An observer in the earth found that according to his clock 3603 seconds elapsed between 8.00 am and 9.00 am on the clock of the spacecraft. What is the speed of spacecraft relative to the speed of earth in terms of c?

($6 \times 4 = 24$ Marks)

SECTION – D

Answer **any two** questions, each question carries **15** marks.

39. Derive the laws of conservation of energy momentum and momentum for a system of particles.

40. Obtain Kepler's laws of planetary motion.

41. What are the significances of degrees of freedom in Lagrangian mechanics? Write and explain the Lagrange's equations motion and Solve the problem of simple pendulum using Lagrange's equations.

42. Derive Hamilton's equations of motion. Prove that a cyclic co-ordinate represents a law of conservation in Hamiltonian formulation.

43. Explain the Michelson-Morely experiment and the discuss the results of the experiment.

    (a) experimental setup and objectives of the experiment. 5

    (b) experiment 5

    (c) result and interpretation. 5

44. Derive the velocity addition equations in special theory of relativity. Explain the significance of velocity addition equations.

($2 \times 15 = 30$ Marks)
