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Reg. No. : .....

Name : .....

Fourth Semester B.Sc. Degree Examination, July 2024

First Degree Programme under CBCSS

Physics

Core Course III

PY 1441 : CLASSICAL AND RELATIVISTIC MECHANICS

(2018 Admission Onwards)

Time : 3 Hours Max. Marks : 80

SECTION – A

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

1. What is meant by constrained motion? Give two examples.
2. Write down the Hamiltonian function.
3. Give an example of a holonomic system.
4. Give the equation of motion of a simple pendulum in generalised coordinates.
5. Does the centre of mass of a body always lie in the centre of the object?
6. How does a charged particle move in a crossed electric and magnetic field?
7. What is conserved, if we assume linear uniformity of space?
8. Give an expression for conservation of energy in inelastic scattering of particles in a lab system.

9. Draw a labeled diagram showing elastic scattering of two particles of masses m and M.

10. What does Einstein's mass energy relation imply?

(10 × 1 = 10 Marks)

SECTION – B

Answer any **eight** questions, not to exceed a paragraph. Each question carries **2** marks.

11. What are Kepler's laws?

12. Discuss the results of Michelson-Morley experiment.

13. Consider a ship moving with a uniform velocity 18 m/s relative to the earth. Let a ball be rolled along the direction of motion of the ship at 2 m/s. What is the speed of the ball relative to the earth?

14. What are the postulates of the special theory of relativity?

15. What does the term 'rotational invariance' imply?

16. What is the significance of virtual work?

17. Give the Lagrange's equation. What are the parameters involved?

18. What is the core concept of using Thomson parabolas.

19. How will the orbiting earth appear, along its diameter, to a stationary observer relative to sun?

20. Briefly describe elastic scattering.

21. Give an expression for differential cross-section.

22. Distinguish laboratory and centre-of-mass systems, while studying scattering.

(8 × 2 = 16 Marks)

SECTION – C

Answer any **six** questions. Each question carries **4** marks.

23. A bead slides on a smooth rod, which is rotating about and end in a vertical plane with uniform angular velocity ω. Find the equation of motion via Lagrangian equation.

24. Show that an accelerated frame of reference is non-inertial.

25. Describe the outcome from Michelson – Morley experiment.

26. Deduce Newton's law of gravitation from Kepler's laws.

27. The potential energy of interaction between two particles at x_1 and x_2 on the x axis is given by $U = A(x_2 - x_1)^2 + B/(x_2 - x_1)^2$. Show that it satisfies linear uniformity of space and the particles obey Newton's third law.

28. A car driver claims that the signal light appeared green to him instead of red. Given the wavelengths of red and green lights, 6300 A° and 5400 A°, respectively, calculate the speed of the car.

29. Write a note on Lorentz-Fitzgerald contraction.

30. Rob goes to pole star (40 light years away from earth) and returns, leaving his twin brother, Tony, on earth. His velocity of travel is 4/5 c. Will Tony be younger or older than Rob? What will be the difference in age between Rob and Tony after the space travel?

31. A mass m_1 moving with a velocity u_1 is elastically scattered from another mass m_2 at rest Find the mass of the target in terms of the incident one, if both the masses travel at the same speed in opposite directions.

(6 × 4 = 24 Marks)

SECTION – D

Answer any **two** questions. **Each** question carries **15** marks.

32. Discuss how the law of conservation of energy follows from homogeneity of time and Newton's second law of motion.

33. Obtain Lorentz transformation equations.

34. Arrive at Hamilton's canonical equations of motion.

35. How will you explain slowing of moving clocks?

(2 × 15 = 30 Marks)
