BScPhysics

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Reg. No. : .....

Name : .....

Fourth Semester B.Sc. Degree Examination, March 2020

First Degree Programme Under CBCSS

Physics

Core Course III

PY 1441: CLASSICAL AND RELATIVISTIC MECHANICS

(2018 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

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

1. Determine the number of degrees of freedom for a mass less rod, moving freely in space with a particle which is constrained to move on the rod.
2. What are the two fundamental postulates of the special theory of relativity?
3. Why is the Hamiltonian formulation is preferred over the Lagrangian formulation?
4. What is generalized momentum?
5. What is inverse square law force?
6. The Lagrangian of a particle moving in a plane under the influence of a central potential is given by $L=\frac{1}{2}m\left(\dot{r}^2+r^2\dot{\theta}^2\right)-V(r)$. Find the generalized momenta corresponding to r and θ.

P.T.O.

7. What are inertial and non-inertial frames?

8. State Kepler's third law of planetary motion.

9. Write down the Hamilton's canonical equations of motion.

10. In the laboratory one particle A has the velocity v and another particle B had velocity - v opposite to each other. What is the velocity of A relative to B?

(10 × 1 = 10 Marks)

SECTION – B

Answer **any eight** questions in a paragraph each. **Each** question carries **2** marks.

11. Explain conservative and non-conservative forces with examples.

12. Prove that angular momentum is a constant to motion under central force.

13. What are the postulates of special theory of relativity? Mention the consequences of the postulates.

14. Explain the terms 'length contraction' and 'time dilation'.

15. What is a central force? Give two examples.

16. Write a note on holonomic and non-holonomic constraints with two examples of each type.

17. Show that work done by constraint forces in a rigid body is zero.

18. Moving clock appears to go slow. Explain.

19. Discuss the importance of negative results of Michelson – Morley experiment.

20. What type of difficulties arise due to the constraints in the solution of mechanical problems and how these are removed?

21. What do you understand by covariance of physical laws?

22. Briefly discuss the relativistic law of addition of velocities.

(8 × 2 = 16 Marks)

SECTION – C

Answer any **six** questions; not exceeding a paragraph. **Each** question carries **4** marks.

23. Derive Lagrange's equations of motion.

24. A clock keeps correct time. With what speed should it be moved relative to an observer so that it may seem to lose 2 minutes in 24 hours?

25. A hypothetical train moving with a speed of 0.6c passes by the platform of a small station without being slowed down, the observer on the platform note that length of the train is just equal to the length of the platform which is 200 m.
    (i) Find the rest length of the train.
    (ii) Find the length of the platform as measured by the observer in the train.

26. A beam of pions has velocity v = 0.6 c. The pion has a half-life of 1.8×10^{-8} sec. How long will it take for the pions to decay? How far will they travel in this time?

27. Write the Hamiltonian for a simple pendulum and deduce its equations of motion.

28. The Lagrangian for anharmonic oscillator is given by $L=\frac{1}{2}\dot{x}^2-\frac{1}{2}w^2x^2-\alpha x^3$. Find the Hamiltonian.

29. Write the Lagrangian for the following systems:
    (i) A mass m is suspended to a spring of force constant k and allowed to swing vertically.
    (ii) A uniform rod of mass m and length a, pivoted at a distance I from the centre of mass, swings in a vertical plane.

30. Obtain the equation of motion of a simple pendulum by using Lagrangian method and hence deduce the formula for its time period for small amplitude oscillations.

31. When a particle moves under a central force, show that its angular momentum is conserved and the areal velocity remains constant.

(6 × 4 = 24 Marks)

SECTION – D

Answer any **two** questions; not exceeding a paragraph. **Each** question carries **15** marks.

32. (i) Describe the Michelson-Morley's experiment. What was the purpose of this experiment and what was the conclusion?

    (ii) What significant change this experiment could introduce in the Galilean theory of relativity?

33. Using the Hamiltons principle of least action derive the Lagrange equations for system of particles.

34. (i) Explain what is meant by generalized coordinates, holonomic constraints and the principle of virtual work.

    (ii) Obtain the D'Alembert's principle in generalized coordinates and use it to obtain the Lagrange's equations of motion for a holonomic conservative system.

35. (i) Using Newton's laws of motion, deduce the conservation theorems of linear momentum, angular momentum and energy for the motion of a particle.

    (ii) What are first integrals of motion?

(2 × 15 = 30 Marks)
