B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, OCTOBER 2011

Fifth Semester

Core Course—CLASSICAL AND QUANTUM MECHANICS

(Common for (1) Model I Physics ; (2) Model II Physics ;(3) Physics-EEM ;
(4) Physics-Instrumentation)

Time : Three Hours   Maximum Weight : 25

Part A (Objective Type questions)

Answer all *questions.*
Each bunch of four questions carries a weight of 1.

Bunch I

Choose the most appropriate answer :

1. The degree of freedom for small oscillations of a simple pendulum is :

    (a) 4.   (b) 3.

    (c) 2.   (d) 1.

2. The number of independent standing waves, in a definite frequency interval per unit volume in a cavity :

    (a) Depends on the shape of the cavity.

    (b) Is independent of the shape of the cavity.

    (c) Depends on the wavelength.

    (d) None of these.

3. The functions that satisfy Schrödinger equations for the discrete energy states are called :

    (a) Validity functions.   (b) Eigenfunctions.

    (c) Eigenvalues.   (d) None of these.

4. The expectation value of a dynamic at quantity is the mathematical expectation for the result of :

    (a) A single measurement.   (b) More than two measurements.

    (c) Several measurements.   (d) None of these.

Bunch II

5. The forces of constraints in the motion of a bead sliding down a wire is :

    (a) Frictional forces.   (b) Reaction forces.

    (c) Gravitational forces.   (d) None of these.

6. . The wavelength of a 54 volt electron is :

    (a) 0.165 nm.   (b) 0.265 nm.

    (c) 1.165 nm.   (d) 2.165 nm.

7. Which of the following is energy operator ?

    (a) $\dfrac{ih}{2\pi}\dfrac{\partial}{\partial t}$.   (b) $\dfrac{1}{2\pi}\dfrac{\partial}{\partial t}$.

    (c) $-\dfrac{ih}{2\pi}\dfrac{\partial}{\partial t}$.   (d) None of these.

8. The spacing of the energy levels of a harmonic oscillator :

    (a) Depends on the oscillator.   (b) Is constant.

    (c) Can not be predicted.   (d) None of these.

Bunch III

9. In Lagrangian formulation, to eliminate the forces of constraints ———— are introduced.

10. The Compton wavelength depends on the ———— angle.

11. . Two ———— components of angular momentum do not commute among themselves.

12. The ———— work done by the applied forces acting on a system in equilibrium is zero, provided no frictional forces are present.

Bunch IV

13. The equations expressing ordinary co-ordinates as function of ———— ———— are the transformation equations.

14. The condition for standing waves in a cavity is that the ———— length from wall to wall must be a whole number of half wavelength.

15. The eigenvalues of Hermitian operators are ————.

16. Wave function by itself cannot be an ———— quantity.

$(4 \times 1 = 4)$

Part B (Short Answer Questions)

Answer any five questions.
Each question carries a weight of 1.

17. State the principle of virtual work.

18. What is meant by constraints ? Explain.

19. . Write down the Lagrange's equations.

20. State the important conclusions of Einstein on photoelectric experiment.

21. What is meant by expectation value of a quantity ?

22. What is group velocity ? Explain.

23. Write down time dependent Schrödinger equation for a particle in three dimensions.

24. What is zero point energy for a harmonic oscillator ? Explain.

$(5 \times 1 = 5)$

Part C (Short Essay/Problems)

Answer any four questions.
Each question carries a weight of 2.

25. A small rigid rod of length l is allowed to move in any manner inside a balloon of fixed radius $R > l$, the end parts of the rod always touching the balloon's surface. Obtain the equation of constraint in Cartesian co-ordinates.

26. Find the lowest energy levels of a dust particle of mass 10^{-10} kg. moving with a speed of 10^6 ms.$^{-1}$ in an infinite potential well of width 1.5 nm.

27. If an electron remains in an excited state for 10^{-12} seconds find the uncertainty in the energy.

28. In a television picture tube electrons are accelerated through 25 kilovolts. Calculate the de Broglie wavelength of one of these electrons.

29. Calculate the group and phase velocities of a proton whose de Broglie wavelength is one nm.

30. Find the zero point energy in electron volts of a pendulum whose period is one second.

$(4 \times 2 = 8)$

Part D (Essay)

Answer any two questions.
Each question carries a weight of 4.

31. Bring out Lagrange's equation from D'Alembert's principle.

32. Derive an expression for Compton shift and obtain the expression for the wavelength of scattered photon.

33. Starting from the angular momentum commutation relations obtain the eigenvalues of L^2 and L_z.

$(2 \times 4 = 8)$