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Reg. No......................................

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B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, OCTOBER 2013

Fifth Semester

Core Course—CLASSICAL AND QUANTUM MECHANICS

(Common for Model I and Model II Physics, B.Sc. Physics EEM and B.Sc. 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

1. The number of degrees of freedom of a rigid body is :

   (a) 3.   (b) 2.

   (c) 1.   (d) 6.

2. Generalized co-ordinates are useful for :

   (a) Holonomic constraints.   (b) Non-holonomic constraints.

   (c) Both (a) and (b).   (d) None of these.

3. For a conservative system, the Hamiltonian H is :

   (a) $T - V$.   (b) $T + V$.

   (c) $2T + V$.   (d) $2T - V$.

4. Einstein's photoelectric equation is based on the law of conservation of :

   (a) Momentum.   (b) Charge.

   (c) Mass.   (d) Energy.

BUNCH II

5. The wave velocity of a wave pachet is called :

   (a) Phase velocity.   (b) Wave velocity.

   (c) Group velocity.   (d) None of these.

6. Compton effect is associated with :

   (a) α-rays.   (b) β-rays.

   (c) X-rays.   (d) +ve rays.

7. The wavelength of a particle in a finite potential well is ——— that of the particle in a box.

   (a) Longer than.   (b) Smaller than.

   (c) Equal to.   (d) None of these.

Turn over

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8. The eigenvalue of the momentum of the particle in a box is :

    (a) Zero.

    (b) Continuous.

    (c) Descrete.

    (d) None of these.

BUNCH III

9. Linearity of Schrödinger equation in χ leads to ——————— principle.

    (a) Fermats.

    (b) Superposition.

    (c) Correspondence.

    (d) None of these.

10. The value of $[x, px]$ is :

    (a) $i\hbar$.

    (b) $-i\hbar$.

    (c) $-i/\hbar$.

    (d) $i/\hbar$.

11. The quantum mechanical operator for energy is :

    (a) $i\hbar \frac{\partial}{\partial t}$.

    (b) $-i\hbar \frac{\partial}{\partial x}$.

    (c) $-i\hbar \nabla$.

    (d) $-i\hbar (\nabla \times r)$.

12. For a conservative force :

    (a) grade $F = 0$.

    (b) curl $F = 0$.

    (c) div $F = 0$.

    (d) $F = ma$.

BUNCH IV

Fill in the blanks :

13. The de-Borgie wavelength of an electron having a kinetic energy of 10 ev is ——————.

14. The expectation value of energy is ——————.

15. The Lagrangian formulation, —————— are introduced to eliminate the forces of constraints.

16. The group velocity for a relativistic particle having a momentum 'p' and energy E is ——————.

                                         $(4 \times 1 = 4)$

Part B (Short Answer Type Questions)

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

17. State and explain D'Alembert's Principle.

18. What is meant by the principle of least action ?

19. What are constraints ? Give an example.

20. State Uncertainty Principle.

21. What is the physical significance of a wave function ?

22. Distinguish between wave velocity and grow velocity.

23. What is zero point energy ?

24. Write a note on degeneracy.

$(5 \times 1 = 5)$

Part C (Short Essays/Problems)

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

25. Obtain an expression for the Lagrange's equation for one dimensional harmonic oscillator.

26. Deduce Einstein's photoelectric equations.

27. Find the expectation value (x) of the position of a particle trapped in a box.

28. Using the operator representation of $\hat{p} = -i\hbar \dfrac{d}{dx}$ show that $\hat{x}\,\hat{p} - \hat{p}\,\hat{x} = i\hbar$.

29. Normalize the wave function $\psi(x) = e^{-x/a}$.

30. A harmonic oscillator is in the ground state. Where is probability density maximum ? What is the maximum probability density ?

$(4 \times 2 = 8)$

Part D (Essay Type Questions)

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

31. Starting from the angular momentum commutation relations, Obtain the eigenvalues of L^2 and L_z.

32. State and prove the Hamilton Principle for a conservative system.

33. What is meant by Compton Effect ? Derive an expression for the compton shift.

$(2 \times 4 = 8)$