Reg. No…….. Name…… **15U505**

B.Sc. DEGREE END SEMESTER EXAMINATION OCTOBER 2017

SEMESTER **–5: PHYSICS (CORE COURSE)**

COURSE: **15U5CRPHY05: CLASSICAL AND QUANTUM MECHANICS**

(For Regular 2015 admission)

Time: Three Hours Max. Marks: 60

PART A (Very short answer questions)

*(Answer **all** questions) Each question carries **1 Mark***

1. A rigid body possess …… degrees of freedom.

   (a) 1 (b) 2 (c) 4 (d) 6

2. The dimension of Hamiltonian is that of

   (a) time (b) momentum (c) angular momentum (d) energy

3. Assume that a co-ordinate is absent in Lagrangian. The momentum conjugate to that co-ordinate is (a) zero (b) conserved (c) canonical (d) finite

4. Wien's law matches with Planck's law at

   (a) low frequencies (b) high frequencies (c) all frequencies (d) none of these

5. The stopping potential for photoelectrons increases linearly with the …… of the incident radiation. (a) Velocity (b) wavelength (c) frequency (d) amplitude

6. For two anti-commuting operators *A* and *B*, which of the following statement is true?

   (a) $AB\psi = BA\psi$ (b) $[A,B]=0$ (c) $AB\psi = -BA\psi$ (d) $[A,B]=-1$

7. For a normalizable wave function, the norm is to be

   (a) finite (b) infinite (c) zero (d) complex

8. The quantum mechanical operator for energy is

   (a) $-i\eta\frac{\partial}{\partial x}$ (b) $i\eta\frac{\partial}{\partial x}$ (c) $-i\eta\frac{\partial}{\partial t}$ (d) $i\eta\frac{\partial}{\partial t}$

9. The potential energy associated with a free particle is

   (a) infinity (b) zero (c) negative (d) positive

10. An eigen function of the operator $\frac{d^2}{dx^2}$ is e^{2x}. What is the corresponding eigen value?

    (a) 1 (b) 2 (c) 4 (d) 6 (1 x 10 = 10)

PART B (Short answer)

*(Answer **any Seven** questions) Each question carries **2 Marks***

11. Is Newtonian formalism always defective in dealing with constrained systems? Why?
12. Discuss the D'Alembert's principle for a dynamic system.
13. State and explain the least action principle.
14. Draw the energy density versus frequency spectrum of a black body for any two temperatures.
15. What is the importance of Compton effect?
16. Discuss the probability interpretation of wave function.
17. What do you mean by the terms phase velocity and group velocity? Give expressions for the same.
18. What are orthogonal eigen functions? What is the nature of the corresponding eigen values?
19. Write down the expression for the energy levels of a rigid rotator and explain the terms involved.

(2 x 7 = 14)

PART C (Problem/Derivations)

*(Answer **any Four** question) Each question carries **4 Marks***

20. Using Lagrangian formalism, prove that angular momentum is conserved in a central force problem.
21. Prove that if Lagrangian is not an explicit function of time, Hamiltonian is conserved.
22. The work function for barium is 2.5 eV. Check whether barium can be used as a photo cell to detect visible light. Note that visible range of the electromagnetic spectrum is roughly 400- 700 nm.
23. The average period that elapses between the excitation of an atom and the time it emits radiation is 10^{-8} s. Determine the width of the excited state.
24. Determine the expectation value of the position of a particle trapped in a box of length L.
25. Verify the commutation relation $[L^2, L_x] = 0$. (4 x 4 = 16)

PART D (Long answer questions)

*(Answer **any Two** question) Each question carries **10 Marks***

26. Derive Hamilton's equations of motion from the relation connecting Lagrangian and Hamiltonian. Obtain the Hamilton's equations for a one dimensional harmonic oscillator.
27. Using calculus of variations, obtain the Euler-Lagrange equations of motion.
28. Discuss the Davisson-Germer experiment as a verification of the de Broglie hypothesis.
29. Obtain the Schrödinger equation for a particle moving in a time independent potential.

(10 x 2 = 20)

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