DPA – 520 (Phy)

M.Sc. Previous (Physics) Degree Examination, July/August 2011
Directorate of Distance Education
Paper – II : QUANTUM AND STATISTICAL MECHANICS

Time : 3 Hours Max. Marks : 75/85

Note : *i) Answer **FIVE** questions from Part **A**, **B** and **C** without omitting **any** Part. (Common to **all**)*
*ii) Part **D** is **only** for such candidates whose max. mark is **85**.*

PART – A

1. a) What is meant by expectation value of an observable ? Discuss the physical significance of eigenvalues and eigen functions of an observable.
   b) Define Dirac's delta function and give its important properties. **(10+5)**

2. a) Give the basic postulates of quantum mechanics. Develop time-dependent Schrodinger equation for a free particle.
   b) Explain Born's probabilistic interpretation of wave functions. **(10+5)**

3. a) Prove that commuting operators have common set of eigen functions.
   b) State Ehrenfest's theorem and obtain the equivalent of Newton's second law for momentum operator. **(6+9)**

PART – B

4. a) Discuss the reduction of two-body problem into two single body-problems.
   b) Solve the radial part of Schrodinger equation of an hydrogen atom to obtain energy eigenvalues. **(7+8)**

5. a) What are symmetric and antisymmetric wave functions ? Explain.
   b) Discuss Stern-Gerlach experiment and give its significance in the development of quantum mechanics.
   c) Show that $[L^2, L_z] = 0$. **(3+8+4)**

P.T.O.

6. a) Mention various methods of approximation in quantum mechanics. Discuss the theory of time-independent perturbation for non-degenerate systems. Obtain the expressions for first order corrections to energy and eigen function.

   b) Explain the Fermi Golden rule. **(10+5)**

PART – C

7. a) Give the postulate of equal a priori probability.

   b) State and prove Liouville theorem in phase space.

   c) Explain the criterion for distinguishability and indistinguishability of quantum particles. **(2+8+5)**

8. a) Explain Gibb's paradox. Discuss the necessary theory to obtain the expression for Sackur-Tetrode equation.

   b) Distinguish between fermion and boson statistics. **(10+5)**

9. a) State and prove the Boltzmann equipartition theorem. Apply this theorem to obtain the specific heat of solids.

   b) Write a note on the specific heat of Fermionic gas at low temperature and compare that with classical gas specific heat. **(9+6)**

PART – D

10. Answer **any TWO** of the following : **(5×2=10)**

    a) Define a self-adjoint operator. Give an example. State its properties.

    b) What are annihilation and creation operators ? Explain in the context of a one-dimensional simple harmonic oscillator.

    c) Write a note on Bose-Einstein condensation.

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