PG Odd Semester (CBCS) Exam., December—2016

PHYSICS

(1st Semester)

Course No. : PH–103 (C)

(Quantum Mechanics—I)

Full Marks : 75
Pass Marks : 30

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* Find the expression of Compton shift of wavelength. 10

(b) In a Compton scattering experiment the scattered wavelength is found as 1·827 Å. Find the wavelength of scattered radiation at 30 and also find the velocity of recoil electron. 5

2. *(a)* How does Heisenberg uncertainty principle protect quantum mechanics? 4

(b) Using uncertainty principle, prove that electron cannot reside inside nucleus. 5

(c) What is a wave packet? Construct a wave packet for a free particle. 6

UNIT—II

3. *(a)* State and prove Ehrenfest theorem. 10

(b) Prove that free particle momentum operator commutes with momentum operator. 5

4. With the help of uncertainty principle, find the form of minimum wave packet and identify its width. 15

UNIT—III

5. For the ground state hydrogen atom, calculate the expectation value of r, r^2 and $\frac{1}{r}$. 5+5+5=15

6. *(a)* Compare among Schrödinger, Heisenberg and Dirac pictures. 5

(b) Using unitary transformation, find the state vector of Heisenberg picture starting from Schrödinger picture. Also find the relation between operators in Schrödinger picture and Heisenberg picture. 10

UNIT—IV

7. What is Clebsch-Gordan coefficients? Calculate the C-G coefficients for $j_1 \quad j_2 \quad 1$. 15

8. *(a)* Find the matrix elements of the operator $\hat{J}_n$. 7

(b) What are Pauli spin matrices? Write their important properties. 4

(c) Evaluate $[L^2, L_x]$. 4

UNIT—V

9. *(a)* Define parity operator and find its eigenvalues. 4

(b) Prove that parity operator commutes with Hamiltonian operator. 7

(c) Find the generator of infinitesimal rotation. 4

10. *(a)* If a physical system is invariant under space translations, show that its linear momentum is a constant of motion or is conserved. 8

(b) Write a short note on 'time translation'. 7

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