

D 43527

(Pages : 2)

Name.....

Reg. No.....

**SECOND SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2018**

(CUCSS-PG)

Physics

PHY 2C 05—QUANTUM MECHANICS—I (4C)

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries 1 weightage.*

1. Explain what is meant by Hilbert space ?
2. When are two operators said to be same ?
3. What is meant by co-ordinate representation ?
4. What are ladder operators ? Why are they called so ?
5. What do you understand by spin of an electron ?
6. What are Clebsch-Gordon co-efficients ? Give their significance.
7. What is Slater determinant ? How does it incorporate Pauli principle ?
8. Bring out the meaning of time reversal invariance. Show that the time reversed state of  $\psi(r, t)$ , is not  $\psi(r, -t)$  but  $\psi^*(r, -t)$ .
9. What is phase shift ? Explain the nature of phase shift in the case of repulsive and attractive potentials.
10. Give the geometrical interpretation of scattering length.
11. What is the relevance of Green's function in the scattering problem in a central potential.
12. What are partial waves ?

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries 6 weightage.*

13. Establish the Schrödinger equation for a one-dimensional harmonic oscillator and solve it to obtain the energy eigen values and eigen functions. Also discuss the significance of zero point energy.
14. Obtain the eigen values and eigen functions of orbital angular momentum operators.

**Turn over**

15. (a) Explain the concept of symmetry and antisymmetry of wave functions for a system of identical particles.
- (b) Obtain the ground state wave function and energy of the Helium atom by considering the symmetry of wave functions.
- 16. What is Born approximation ? Explain. Also bring out the validity conditions for Born approximation.

(2 × 6 = 12 weightage)

### Section C

Answer any four questions.

Each question carries 3 weightage.

17. If  $\hat{A}$  and  $\hat{B}$  are two commuting operators, prove that they have a set of common eigen functions.
18. Show that angular momentum is conserved for a particle in a central potential.
19. Estimate the size of the hydrogen atom and its ground state energy using uncertainty principle.
20. For any vector  $A$ , show that  $[\sigma, A \cdot \sigma] = 2iA \times \sigma$ .
21. Find out the angular momentum matrices  $J^2$ ,  $J_+$ ,  $J_-$ ,  $J_x$ ,  $J_y$  and  $J_z$  corresponding to  $j = 1$  in a representation in which  $J^2$  and  $J_z$  are diagonal.
22. In a scattering experiment, the potential is spherically symmetric and the particles are scattered at such energy that only  $s$  and  $p$  waves need to be considered. (i) Show that the differential scattering cross-section can be expressed in the form  $\sigma(\theta) = a + b \cos\theta + c \cos^2\theta$ ; (ii) What are the values of  $a$ ,  $b$  and  $c$  in terms of phase shifts ?

(4 × 3 = 12 weightage)