C 23367 (Pages : 2) Name.....

Reg. No.....

SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2022

(CBCSS)

Physics

PHY 2C 05—QUANTUM MECHANICS–I

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 *short questions answerable within* 7.5 *minutes*)
(*Answer* **all** *questions, each carry weightage* 1).

1. Explain Dirac bra and ket vectors.
2. Explain linear vector space.
3. Give the basic features of interaction picture.
4. State and explain Ehrenfest's theorem.
5. Briefly explain addition of angular momenta.
6. Explain the properties of Pauli spin matrices.
7. Distinguish between symmetric wavefunction and antisymmetric wavefunction.
8. What are the applications of quantum harmonic oscillator ?

(8 × 1 = 8 weightage)

Turn over

Section B

(4 essay questions answerable within 30 minutes)
(Answer any **two** *questions, each carry weightage 5).*

9. Explain what is meant by a Hermitian operator. Show that :
   (a) The eigen values of a Hermitian operator are real and
   (b) Eigen functions of a Hermitian operator belongs to different eigen values are orth
10. Discuss the problem of addition if angular momentum in quantum mechanics. Cal Clebsch-Gordan co-efficients for $J_1 = \frac{1}{2}$ and $J_2 = \frac{1}{2}$.
11. Describe Schrödinger equation for central potentials and hence describe Hydrogen atom
12. Solve the problem of simple harmonic oscillator using operator method.

$(2 \times 5 = 10$ W

Section C

(7 problems answerable within 15 minutes)
(Answer any **four** *questions, each carry weightage 3).*

13. If $[A,L_x]=[A,L_y]=[A,L_x]=0$. What is the value of $[A^2,L^2]$?
14. Show that the expectation value of the momentum P for a bound state of a one particle zero for a stationary state.
15. Show that the zero-point energy of a linear harmonic oscillator is a manifestation of the un principle.
16. Prove that the spin matrices S_x matrix and S_y have $\pm\frac{\hbar}{2}$.
17. The position of an electron is measured with an accuracy of 10^{-6} m. Find the uncerta electron's position after 1 s. Comment on the result.
18. Show that the expectation value of an observable, whose operator does not depend on time is a constant with zero uncertainty.
19. For Pauli's matrices, prove that (i) $[\sigma_x,\sigma_y]=2i\sigma_z$. (ii) $\sigma_x\sigma_y\sigma_z = i$.

$(4 \times 3 = 12$ W