757 (Pages : 2) Name.....

Reg. No.....

SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2021

(CBCSS)

Physics

PHY 2C 05—QUANTUM MECHANICS—I

(2019 Admissions)

: Three Hours Maximum : 30 Weightage

General Instructions

. *In cases where choices are provided, students can attend* **all** *questions in each section.*

. *The minimum number of questions to be attended from the Section / Part shall remain the same.*

. *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 question carries weightage 1.

1. Prove that an operator in a linear vector space can be represented by a square matrix.
2. What is the quantum mechanical operator representing energy ?
3. What are Hermitian operators ? Give their important properties.
4. Briefly explain the features of interaction picture.
5. Are the rigid rotator energy levels degenerate ? Explain.
6. What are the admissibility conditions on a wavefunction ?
7. Explain the principle of indistinguishability in quantum mechanics.
8. Discuss the conservation law associated with space inversion symmetry.

(8 × 1 = 8 weightage)

Section B

4 *essay questions answerable within* 30 *minutes.*
Answer any **two** *questions.*
Each question carries weightage 5.

9. Describe the Sequential Stern-Gerlach experiment and the conclusions which lead to the basics of quantum mechanics.

Turn over

10. Establish the Schrodinger equation for one dimensional harmonic oscillator and s
the energy eigen values and eigen functions. Also discuss the significances of zer

11. Establish the addition of orbital angular momentum and spin angular momen
Clebsch-Gordan coefficients.

12. Discuss the importance of symmetry of the wavefunctions, taking the example of th
of Helium atom.

Section C

(2 × 5 =

7 problems answerable within 15 minutes.
Answer any **four** *questions.*
Each question carries weightage 3.

13. Show that $(\sigma . A)(\sigma . B) = A . B + i\sigma . (A \times B)$ where A and B are arbitrary vectors.

14. An electron has a speed of 500 m/s with an accuracy of 0.004%. Calculate the certainty
we can locate the position of the electron.

15. For an electron in a one-dimensional infinite potential well of width 1Å, calculate (i) the
between two energy levels (ii) the frequency and wavelength of the photon corresp
transition between these two levels (iii) in what region of the electromagnetic spectr
frequency wavelength ?

16. Evaluate the commutator (i) $\left[x, p_x^2\right]$; and (ii) $\left[xyz, p_x^2\right]$.

17. A beam of electrons is incident from left, normally, on a semi-infinite step potential 5.0 e
The incident electrons have kinetic energy E (when to the left of the step potential). W
relative probability that any given electron will be reflected back by the step potential
10.0 eV.

18. For the operators A, B and C show that [[A, B], C] + [[B, C], A] + [[C, A], B] = 0.

19. Prove that the spin matrices S_x matrix and S_y have $\pm\frac{\hbar}{2}$.

(4 × 3 = 12 wei