(b) What are Clebsch – Gordan coefficients ? Obtain their values when two angular momenta $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$. 8

OR

(p) Prove that Pauli matrices are unitary and any two Pauli matrices anticommute. 8

(q) If σ_x, σ_y and σ_z are Pauli spin matrices and A and B are any constant vectors, show that, $(\sigma \cdot \vec{A})(\sigma \cdot \vec{B}) = \vec{A} \cdot \vec{B} + i\sigma \cdot (\vec{A} \times \vec{B})$. 8

EITHER

5. (a) Distinguish between Schrodinger, Heisenberg and interaction picture. Obtain equation of motion in Heisenberg picture. 8

(b) Discuss WKB method. Discuss equation of validity. 8

OR

(p) Calculate ground state energy of He atom using variational method. 8

(q) What is interaction picture ? Prove that in special case interaction picture contains only unperturbed Hamiltonian, which is same as in Schrodinger picture. 8

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AQ – 813

First Semester M. Sc. 1 (Physics) (CBCS) Examination

1 PHY 3

QUANTUM MECHANICS – I

P. Pages : 4

Time : Three Hours]   [Max. Marks : 80

Note : All questions are compulsory and carry equal marks.

EITHER

1. (a) What is photoelectric effect ? Discuss the experimental arrangement to study the photoelectric effect. 4

(b) What is wavepacket ? Explain. 4

(c) Discuss the distribution of energy in the spectrum of a black body. 4

(d) Calculate the de Broglie wavelength associated with an electron of energy 5 MeV. (given $m = 9.1 \times 10^{-28}$ gm $h = 6.62 \times 10^{-27}$ erg. sec.) 4

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OR

(p) What are the failures of classical Mechanics ?

     3

(q) Show that the particle velocity is equal to the group velocity of the wave packet.   4

(r) Derive Schrodinger's wave equation for free particle.   4

(s) Show that a free particle in one dimensional box can have discrete positive energy Eigen values.   5

EITHER

2. (a) Show that Hermitian operator can be represented by diagonal matrix.   6

   (b) Prove that eigen values of Hermitian operator are real.   6

   (c) What do you mean by linear vector space and linear operators ?   4

OR

(p) Show that operator is equivalent to a matrix.

     6

(q) What is unitary transformations ? What are the important properties of unitary transformations ?   6

(r) Explain matrix representation of wave function.   4

EITHER

3. (a) State Schrodinger's equation for hydrogen atom in spherical coordinates and explain the significance of various quantum numbers. 8

   (b) Obtain eigen values of Harmonic oscillator using ladder operators.   8

OR

(p) Derive expression for angular momentum in spherical coordinate system.   8

(q) Obtain the Schrodinger's equation for a particle moving under a central force and carry out the separation of variables.   8

EITHER

4. (a) Show that

   (i) $[L_x \ L_y] = i\hbar \ L_z$ (ii) $[L^2 \ L_x] = 0.$ 8