K24P 1109

Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree (C.B.C.S.S. – OBE-Regular)
Examination, April 2024
(2023 Admission)
PHYSICS
MSPHY02C08/MSPHN02C08 : Quantum Mechanics – 1

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any five** questions, **each** carry **3** marks.

1. Compare the classical and quantum speeds of a free particle.
2. Write three properties of projection operator.
3. Evaluate [X, Lx], [Y, Ly] and [Z, Lz].
4. Write three points to distinguish between bosons and fermions.
5. What is Clebsch-Gordan coefficients ?
6. Write and explain three conservation laws and their corresponding symmetries. **(5×3=15)**

SECTION – B

Answer **any three** questions, **each** carry **six** marks.

7. For a Harmonic Oscillator derive the equation $(a_+ a_- + \frac{1}{2}\hbar\omega)\,\psi = E\,\psi$.
8. Explain the terms linearly dependent and linearly independent. Check whether the functions $f(x) = x$, $g(x) = 5x$, $h(x) = x^4$ are linearly independent.
9. Prove any three properties of Pauli's spin Matrixes.

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10. Two non-interacting particles are placed in an infinite square well. Their one particle states are given by $\psi_n(x) = (2/a)^{1/2}$ Sin $(n\pi x/a)$, with energy = n^2K, where K is a constant. Write the composite wave function.
    1) If the particles are distinguishable
    2) If the particles are bosons
    3) If the particles are fermions.

11. For an infinite square well, define the potential, write the Schrodinger equation, solve it in different regions of potential. **(3×6=18)**

SECTION – C

Answer **any three** questions, **each** carry **9** marks.

12. Solve the harmonic oscillator problem with analytic method.

13. Explain the basics of a Linear vector space and explain how it is related to Hilbert space.

14. Derive the relations
    1) $J^2 |j, m> = \hbar^2 j(j+1)| j, m>$
    2) $J_z |j, m> = \hbar m| j, m>$ and
    3) $J_+ |j, m> = \hbar[j(j+1) - m(m \pm 1)]^{1/2} |j, m \pm 1>$.

15. Discuss in detail the conservation laws behind the displacement in space, rotations in space and displacement in time.

16. Discuss the infinite square well problem, find the energy and normalized wavefunction. **(3×9=27)**

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