

N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI

END-OF-SEMESTER EXAMINATIONS : MAY – 2023

M.Sc. – PHYSICS

MAXIMUM MARKS: 50

II SEMESTER

TIME : 3 HOURS

FOUNDATION OF QUANTUM MECHANICS

SECTION – A

(10 X 1 = 10 MARKS)

ANSWER THE FOLLOWING QUESTIONS.

- The Ehrenfest theorem relates the time derivative of the expectation values of the position and momentum operators to the expectation value of _____.
 - Force
 - Momentum
 - Quantum mechanical operator
 - Eigen function
- If there are more than one quantum states with the same sharply-defined energy , then it is called _____.
 - Density of state
 - Stationary state
 - Degeneracy
 - Cartesian ordinate
- Which of the following represents the spatial inversion of the positions of all particles in an object through a fixed origin?
 - Ladder operators
 - Clebsch-Gordan Coefficients
 - Eigen value spectrum
 - Parity operator
- The ground-state of helium has overall electron spin _____.
 - +1/2
 - 1/2
 - $\pm 1/2$
 - Zero
- According to first-order perturbation theory, the energy shift of the states is given by the _____.
 - Transition amplitude
 - Expectation value
 - Perturbation solution
 - Propagator

ANSWER THE FOLLOWING IN ONE (OR) TWO SENTENCES

(K2)

6. What is the significance of Hilbert space?
7. Define quantum tunneling.
8. State Pauli's exclusion principle.
9. What is meant by alpha emission?
10. What is a propagator in quantum mechanics?

SECTION – B**(5 X 3 = 15 MARKS)****ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS.****(K3)**

11. a) Explain the completeness and normalization of eigen functions.
(OR)
b) Discuss the column representation of a wave function in quantum mechanics with an example.
12. a) Discuss the three dimensional harmonic oscillator.
(OR)
b) Write brief notes on potential barrier and potential well.
13. a) What are called symmetric and antisymmetric wave functions? Explain.
(OR)
b) Give an account of eigen value spectrum and its matrix representation.
14. a) Using the effect of electric field on ground state of hydrogen, explain the Stark effect in hydrogen.
(OR)
b) Write a short note on connection formula and give its validity conditions.
15. a) Obtain the perturbation solution for transition amplitude.
(OR)
b) What do you infer from sudden approximation? Explain.

SECTION – C**(5 X 5 = 25 MARKS)****ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS.****(K4 (Or) K5)**

16. a) Give a detailed note on Schrodinger, Heisenberg and Dirac representation of equations of motion.
(OR)
b) Write a brief note on (i) Max Born physical interpretation of the wave function.
(ii) Gram Schmidt orthogonalisation procedure.
17. a) Obtain expressions for eigen function for the rotator and rigid rotator in a fixed plane.
(OR)
b) Deduce Schrodinger equation in Cartesian and polar coordinates.
18. a) Discuss the procedure of addition of two angular momenta and deduce Clebsch-Gordan coefficients.
(OR)
b) What are Ladder operators? Explain their properties with relevant examples.
19. a) Discuss the perturbation theory for a system with non-degenerate energy levels.
(OR)
b) With relevant theory and diagram explain the WKB approximation method.
20. a) Write a detailed note on time-dependent perturbation Schrodinger equation and give its general solution.
(OR)
b) Using Fermi Golden rule deduce expression for scattering of a particle by a potential.
