S.No. 117 BATCH: 2013 – 2016 Reg.No:

END OF SEMESTER EXAMINATIONS, APRIL / MAY -2018
QUANTUM MECHANICS - I
SUBJECT CODE: 09P3PH03

MAJOR: M.SC (PHYSICS) SEMESTER : I
TIME : 3 HOURS 4 MAX.MARKS: 70

SECTION – A (10 X 1 = 10)

Answer ALL questions:

1. The energy of a three dimensional harmonic oscillator is given by
   a) $(n+1)\hbar\omega$ b) $n\hbar\omega$
   c) $(n+3/2)\hbar\omega$ d) $(n+3)\hbar\omega$
2. $\hat{a}^{+}$ means _____ operator.
   a) Annihilation operator b) Creation operator
   c) Linear operator d) Hermitian operator
3. Total angular momentum has a magnitude of _____
   a) $\hbar^2\ell(\ell+1)$ b) $\hbar\ell(\ell+1)$
   c) $\hbar^2\ell(\ell+1)^2$ d) $h/2\pi\ \ell(\ell+1)^2$
4. The first order perturbation energy eigen value is
   a) $E_n = \langle n|H'|n\rangle$ b) $E_n = \sum_m{}' \frac{\left(\langle m|H^{(1)}|n\rangle\right)^2}{E_n^{(o)} - E_m^{(o)}}$
   c) $E_n = \left(n + \frac{1}{2}\right)\hbar\omega$ d) $E_n = 0$
5. The Fermi's Golden rule is _____
   a) is non-zero only between continuum states of the same energy.
   b) is proportional to the square of $|H_{m\ell}^{(1)}|$ of the perturbation connecting the states.
   c) is proportional to the density of final states.
   d) All the above.
6. Define free axis rigid rotator with a neat diagram.
7. What is meant by schrodinger picture?
8. Write the eigen value and eigen function of L_2.
9. Mention the applications of variational method.
10. State stark effect.

SECTION – B (5 X 4 = 20)

Answer ALL questions:

11. a) Discuss in details of all Quantum numbers.
    (OR)
    b) Obtain the r-equation for a free particle in spherical polar coordinates.
12. a) State Hilbert space and obtain the Linear vector space in Hilbert space.
    (OR)
    b) Derive the equation of motion in Heisenberg picture.
13. a) Describe the commutation relations of angular momentum with various components.
    (OR)
    b) Show that the angular momentum of J^2 and J_2 are diagonal.

..2.,

14. a) Evaluate the energy of the Helium atom by the application of time independent perturbation theory.

(OR)

b) Obtain ground state of hydrogen atom by the application of variational method.

15. a) State and prove Fermi-Golden rule for the rate of transition.

(OR)

b) Write a note on sudden approximation.

SECTION – C (5 X 8 = 40)

Answer ALL questions:

16. a) Solve the schrodinger equation for the case of hydrogen atom. By the separation of variables, obtain the solution of θ and ϕ.

(OR)

b) Obtain the Bessel's and Neumann function in the case of spherically symmetric square well potential problem.

17. a) Discuss the problem of one dimensional Harmonic oscillator by matrix mechanical method.

(OR)

b) Explain the details of (i) Linear operators (ii) Matrix form of an operator (iii) Column representation of the wave function.

18. a) Obtain the generation of eigen function of (i) L_2 and L^2 and (ii) L^2 and L_2.

(OR)

b) Calculate C-G coefficients for $J_1 = 1$ and $J_2 = ½$ and tabulate their results.

19. a) Use perturbation theory of Harmonic oscillator, to find the interaction energy for x and x^2

(OR)

b) Outline W.K.B approximation method for one dimensional problem and give their validity condition.

20. a) What are Einstein's transition probabilities? And derive an expression for the transition probability per unit time by Quantum mechanical treatment.

(OR)

b) Discuss briefly the time dependent perturbation theory and derive an expression for the transition probability for first and second order perturbation.

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