Question Bank

Subject: **Quantum Mechanics**

- Dr. Sunita Mohanty, Lecturer (Physics), F. M.(auto) college

1. What is the Probability amplitude?
2. In which case growth of wave-packet is faster, micro- or macro-particle?
3. With which classical parameter, the Planck's constant can be correlated?
4. What is correspondence principle?
5. What is the value of average energy in Planck's black-body radiation distribution?
6. What is ultraviolet catastrophe?
7. What is de Broglie theorem, and which experiment did verify it in a crystal?
8. What is the limiting value of Planck's constant for classical particle?
9. What is zero-point energy?
10. For a free particle how are its phase velocity and group velocity related?
11. How do the wave functions of fermions and bosons differ?
12. If $|\psi_1\rangle$ and $|\psi_2\rangle$ be the wave functions of a classical bullet passing hole-1 and hole-2 in a Young's double-slit experiment, then what is the probability of locating the particle at a point on the screen?
13. What will happen to an electron in the ground-state of a hydrogen atom, if it is radiated by light of energy of 9 eV?
14. How is uncertainty in an operator related to its expectation value?
15. What is completeness theorem?
16. What is projection operator?
17. What is a good quantum number ?
18. How is a quantum oscillator different from a classical oscillator?
19. If $|\psi\rangle = \frac{1}{2}|\phi_1\rangle + \frac{\sqrt{3}}{2}|\phi_2\rangle$ then the probability of finding $|\psi\rangle$ in $|\phi_2\rangle$ is?
20. If $|\mathrm{a}\rangle = \frac{1}{3}\begin{pmatrix}1\\ \mathrm{i}\\ \mathrm{i}\end{pmatrix}$ then find the projection operator $\widehat{\mathrm{P}}$. Show that for Hamiltonian H, $\left[\widehat{\mathrm{P}}, \widehat{\mathrm{H}}\right] = 0$

21. If L_x, L_y and L_z are respectively the x, y and z components of angular momentum operator L. The commutator $[L_x L_y, L_z]$ is equal to?
22. What is the degeneracy of a particle in cubic box having energy E_{221}?
23. If the momentum and Hamiltonian operators for a particle are $\hat{P}$ and $\hat{H}$ respectively, then write the equation of motion for the particle.
24. What is space quantization?
25. A proton is confined to a cubic box, whose sides have length10^{-12} m . What is the minimum kinetic energy of the proton? The mass of proton is 1.67×10^{-27} kg and Planck's constant is 6.63×10^{-34} Js .
26. In a region of space, a particle with mass m and with zero energy has a time-independent wave function $\psi(x) = Axe^{-x2/L^2}$ where A and L are constants. Determine the potential energy $U(x)$ of the particle.
27. An electron is described by the wave function

$$\psi(x) = \begin{cases} 0, x < 0 \\ Ce^{-x}(1 - e^{-x}), x > 0 \end{cases}$$

28. If $\hat{a}^{\dagger}$and $\hat{a}$ are the creation and annihilation operator respectively, then create $|n\rangle$ state form an $|m\rangle$ state, n > m ?

    Then calculate the average position $\langle x \rangle$ of the electron.
29. For a spin-s particle, in the eigen basis of $\hat{S}^2$, $\hat{S}_x$ find the expectation value of $\langle sm|S_x^2|sm\rangle$
30. Explain Fermi's golden rule of electronic transition.
31. What is the basics difference between Schrodinger's picture and Heisenberg's picture?
32. For a charged oscillator placed in an electric field, E, so that

    $H|\psi\rangle = -\frac{\hbar}{2m}\frac{d^2|\psi\rangle}{dx^2} + \left(\frac{1}{2}m\omega^2x^2 + qEx\right)|\psi\rangle$ and the ground-state energy $E_n^0 = (n + \frac{1}{2})\hbar\omega$ then find the second order correction to energy.