

KATWA COLLEGE

Department of Physics

B.Sc 5th Sem Internal Assessment Examination-2022

Paper: Quantum Mechanics and Applications

Paper Code: CC-XI

Time: 30 minutes

Full Marks: 10

Answer any 5 questions:

1. Find the constant B which makes $e^{-\alpha x^2}$ an eigenfunction of the operator $(\frac{d^2}{dx^2} - Bx^2)$.
What is the corresponding eigenvalue ?
2. The energy of a linear harmonic oscillator in the third excited state is 0.1 eV. Find the frequency of vibration.
3. If ψ is an eigenfunction of both $\hat{\alpha}$ and $\hat{\beta}$, then prove that $[\hat{\alpha}\hat{\beta} - \hat{\beta}\hat{\alpha}] = 0$.
4. Show, by solving Schrödinger's equation, that a free particle cannot have negative energy.
5. The un-normalized wave function for the ground state of the hydrogen atom is $\psi = e^{-\frac{r}{a_0}}$, where a_0 is the Bohr radius. Find the expectation value of Coulomb force on an electron in this state.
6. If an atom in the 3D_3 state, calculate the angle between its orbital angular momentum \vec{L} and spin angular momentum vector \vec{S} .
7. Evaluate $[\hat{x}, \sin\hat{p}]$.