CL15_Q1. Why is Schrodinger's equation referred to as a linear equation?

Ans:

The Schrödinger's wave equation is $\frac{\partial^2\psi}{\partial x^2} + \frac{2m}{\hbar^2}(E - V)\psi = 0$.

Schrodinger equation is a linear, partial differential equation. An important property of the equation is that it is linear in the wave function ψ, i.e. all the terms in the equation contain ψ and there is no term independent of ψ. As a result, a linear combination of solutions of Schrodinger's equation for a given system is also itself a solution. Thus the wave equation is linear in ψ and obeys linear superposition implying if ψ_1 and ψ_2 are solutions of Schrodinger equation then $a_1\psi_1 + a_2\psi_2$ is also a solution for arbitrary a_1 and a_2.

CL15_Q2. Schrodinger's equation is an operator equation. Explain

Ans:

The energy expression can be written as $E = KE + V$

Multiplying throughout with the wave function ψ we get

$E\Psi(x,t) = KE\Psi(x,t) + V\Psi(x,t)$ **----- (1)**

This equation can be written in terms of the corresponding operators as $\hat{E}\Psi(x,t) = \widehat{KE}\Psi(x,t) + V\Psi(x,t)$

The total energy operator is $\left\{i\hbar\frac{d}{dt}\right\}$, the kinetic energy operator is $\{-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\}$.

Replacing the total energy and the kinetic energy terms with the respective operators, we can rewrite the expression (1) to obtain the time dependent form of Schrodinger's equation as $i\hbar\frac{d\Psi}{dt} = -\frac{\hbar^2}{2m}\frac{d^2\Psi}{dx^2} + V\Psi$

Therefore, Schrodinger's equation is an operator equation.