

CL12_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 .

CL12_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

$$E\Psi(x, t) = KE\Psi(x, t) + V\Psi(x, t) \text{ ----- (1)}$$

This equation can be written in terms of the corresponding operators as

$$\hat{E}\Psi(x, t) = \hat{K}\Psi(x, t) + V\Psi(x, t)$$

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

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

$$\text{Schrodinger's equation as } i\hbar \frac{d\Psi}{dt} = -\frac{\hbar^2}{2m} \frac{d^2\Psi}{dx^2} + V\Psi$$

Therefore, Schrodinger's equation is an operator equation.