Degree - III (H). paper - V, Group - C
Date:- 22/02/2024.
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Topic:- The Time-Independent Schrodinger Equation:—

When the potential $V(x)$ is time-independent, we can simplify the schrodinger equation by the method of separation of variables.

$$\boxed{\psi(x,t) = \phi(x)\,T(t)} \quad \text{——— (1)}$$

Substitute into the Schrodinger Equ.

$$\boxed{i\hbar\,\phi(x)\frac{\partial T}{\partial t} = T\tilde{H}\phi} \quad \text{——— (2)}$$

Dividing both sides by ϕT, we find

$$\boxed{i\hbar\,\frac{1}{T(t)}\cdot\frac{\partial}{\partial t}T(t) = \frac{1}{\phi(x)}\tilde{H}\phi(x)} \quad \text{——— (3)}$$

Since the L.H.S depends only on t and R.H.S only on x., the only way this equ can be true is if both sides equal a constant Say it E:-

$$i\hbar\,\frac{1}{T(t)}\cdot\frac{\partial}{\partial t}T(t) = E$$

Notes

$$\Rightarrow \boxed{\frac{1}{\phi x}\tilde{H}\phi(x) = E} \text{—— (4)}$$

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The first of these two defferential equ can be solved immediatley.

$$\boxed{T(t) = e^{-iEt/\hbar}} \quad \text{——} \quad (5)$$

the second equation,

$$\boxed{\hat{H}\phi = E\phi} \quad \text{——} \quad (6)$$

[Eigenvalue equation]

Or more explicitly

$$\boxed{\left[-\frac{\hbar^2}{2m}\cdot\frac{d^2}{dx^2} + V(x)\right]\phi(x) = E\,\phi(x)} \quad \text{—} (7)$$

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Above Equation is known as Time-Independent Schrodinger Equation.

In case of the Schrodinger equation, the constant E is called the "energy eigenvalue," and the function $\phi(x)$ is called "eigenfunction" or "energy eigenstate".

To each energy eigenvalue E there is at least one and sometimes more than one energy eigenstate, and to each eigenstate there corresponds a solution

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Notes

$$\boxed{\psi(x,t) = \phi(x)e^{-iEt/\hbar}} \quad \text{—} (8)$$

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Above equation are also known as stationary states. because the time the time-dependence is contained entirely in an overall phase. This means that the probability to find a particle in the neighbrohood of point x, i.e

$$\boxed{P_E(x) = \psi^*(x,t)\,\psi(x,t)_E = \phi^*(x)\,\phi(x)_E} \quad (9)$$

Now the general solution to the time-dependent Schrodinger equation is.

$$\boxed{\psi(x,t) = \sum_a c_a \phi_a(x)\, e^{-iE_a t/\hbar}} \quad (10)$$

~~of~~ the energy eigenvalue are a discrete set, then.

$$\boxed{\psi(x,t) = \int da\, c_a \phi_a(x)\, e^{-iE_a t/\hbar}}$$

~~of~~ the energy eigenvalue span a continuous range, or a combination.

$$\boxed{\psi(x,t) = \sum_a c_a \phi_a(x)\, e^{-iE_a t/\hbar} + \int da\, c_a \phi_a(x)\, e^{-iE_a t/\hbar}} \quad (11)$$