Assignment- II*

1. Which of the following wave functions can not be solutions of Schrödinger equation for all values of x? Give your comments.

(a) $\psi(x) = A\exp(-x^2)$

(b) $\psi(x) = A\tan(x)$

(c) $\psi(x)$ $A\sec(x)$

(d) $\psi(x)$ $A\exp(x^2)$

* Ref. Concepts of Mod. Phys. for help.

2. The wave function of a certain particle is

$$\psi(x) = A\cos^2 x, \quad -\pi/2 < x < \pi/2.$$

(a) Determine value of normalisation constant A.

(b) Calculate the probability that the particle be found between $x = 0$ to $x = \pi/4$.

3. Consider normalised eigen functions of a particle confined in a one dimensional box of length L:

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L} x\right), \quad \text{with}$$

$$E_n = \frac{n^2 \pi^2 \hbar^2}{2mL^2}, \quad n = 1, 2, 3, \ldots$$

(a) Calculate expectation values of position x, in $n = 1, 3$ and $n = 10$ states.

(b) Plot $|\psi_n|^2$ for $n = 1, 3$ & 10.

(c) Calculate probability of finding the particle in the regions $x = 0$ to $x = L$

and $x = 0$ to $x = L/2$

for an arbitrary value of n.

4. The state of a certain particle is given by

$$\Psi_A(x) = \frac{\sqrt{3}}{2}\psi_1(x) + \frac{i}{2}\psi_2(x)$$

Here ψ_1 and ψ_2 are normalised wave functions of a particle in a one dimensional box, as given in the Ex. 3.

(a) What is the probability that the particle be found in state ψ_1. [And State ψ_2]

(b) Calculate expectation value of energy in state ψ_A.

(c) Instead of Ψ_A if the state of the particle is described by $\Psi_B(x) = \frac{1}{2}\psi_1(x) + \frac{i\sqrt{3}}{2}\psi_2(x)$

then how results of (a) and (b) going to be affected? Give your comments.

5. Consider normalised eigenfunctions of a particle in a box as given in Ex 3. Calculate expectation value of momentum for an arbitrary state. Further verify this by expressing $\psi_n(x)$ as a linear superposition of momentum eigen states.

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