PHYS 451: Quantum Mechanics I
Homework #1, due Thursday August 28, in class

1. Consider a measurement of a quantity that takes discrete values, $k = 0 \ldots \infty$. The probability distribution of this measurement is given by

$$P(k) = N \frac{\mu^k}{k!},$$

where μ is some given positive real constant.

   (a) Find the normalization factor, N, which makes the total probability equal to unity.

   (b) Calculate the average value of k, k^2, and the standard deviation of k.

2. Consider the following wave function:

$$\psi(x,t) = A\, x\, e^{-\beta|x|+i\lambda t}$$

where β and λ are some real constants and $\beta > 0$.

   (a) Determine the normalization factor, A.

   (b) Compute the expectation values $\langle x \rangle$ and $\langle x^2 \rangle$.

   (c) Find σ, the standard deviation of x.

   (d) Sketch the graph of $|\psi|^2$ as a function of x, and mark the points $\langle x \rangle + \sigma$ and $\langle x \rangle - \sigma$, to illustrate how σ represents the "spread" of the distridution in x. What is the probability that the particle is found outside of this range?

3. Verify the Heisenberg uncertainty principle for the following two states of one-dimensional harmonic oscillator:

   (a) The ground state with the wave function $\psi_0(x) = \frac{\alpha^{1/4}}{\pi^{1/4}}\, e^{-\alpha x^2/2}$.

   (b) The first excited state with the wave function $\psi_1(x) = \sqrt{2}\frac{\alpha^{3/4}}{\pi^{1/4}}\, x\, e^{-\alpha x^2/2}$.

   In the above expressions $\alpha = \frac{m\omega}{\hbar}$, where m is the particle mass and ω is the angular frequency of the oscillator.

4. Problem 1.15 in Griffith.

Found an error or need a clarification? Email the instructor at sergiy.bubin@nu.edu.kz