1 Wavefunctions

*(2*2, 2*2 points)*

Consider the following wave functions, each describing a particle in one dimension and defined over all space (i.e., $-\infty < x < \infty$), not confined to an infinite square well.

$\psi_a(x) = Ae^{-x^2/3}$

$\psi_b(x) = B\frac{1}{x^2+2}$

For each wave function:

(a) Determine the normalization constant.

(b) If the particle's position is measured, what is the probability of finding it in the region $0 < x < 1$?

2 ISW Energy Measurement wave function form

*(2*7 points)*

A particle in an infinite square well potential has an initial state vector

$$|\Psi(t=0)\rangle = A\big(\,|\phi_1\rangle - |\phi_2\rangle + i\,|\phi_3\rangle\,\big)$$

where $|\phi_1\rangle, |\phi_2\rangle$, and $|\phi_3\rangle$ are the first three energy eigenstates (i.e., $n = 1, 2, 3$).

(a) Determine A.

(b) Write the initial state $|\Psi(t=0)\rangle$ in wavefunction from.

(c) At time $t = 0$, if an energy measurement is performed, what are the possible energy values, and with what probability would each possible value be obtained?

(d) What is the expectation value of the energy of this particle at $t = 0$?

(e) What is the quantum state of this particle at some later time t?

(f) At some later time t, write an expression (do not evaluate) for the probability that a position measurement yields a result in the first half of the well, $0 < x < \frac{L}{2}$.

(g) At time $t = \hbar/E_1$, if the energy of the particle is measured, what possible energy values may be obtained, and with what probability would each possible value be obtained? *Check Beasts:* Verify that $\hbar/E_1$ is a time.