

PHYS 4310 Study Guide for Test 1

Concepts that you should be very familiar with:

What is a wavefunction

What is probability density and how do you calculate it

The Bohr atom

De Broglie Relation

Einstein Relation

The Copenhagen interpretation

The Schrödinger equation

Heisenberg uncertainty relation

What is a stationary state

What does it mean to be orthonormal

What does it mean to be complete

How to assemble a time-dependent wavefunction from the time-independent Schrödinger Equation

The Infinite square well

The Harmonic oscillator

The concept of a wavepacket and a free particle

Fourier transforms

How to obtain energy eigenstates

Difference between bound and scattering states

Meaning of the probability current density

Specific techniques that you should know how to use:

How to solve the time-independent SE for the infinite well case

How to show orthogonality

How to use raising and lowering operators

How to find expectation values

How to integrate (and differentiate) the Gaussian wavefunction

How to perform a Fourier transform

How to use a delta function

Let's say a free particle has an initial wave function, $\Psi(x, 0) = Ae^{-a|x|}$ where A and a are positive and real.

- (a). Normalize to find A . Sketch $\Psi(x)$.
- (b). Find $\phi(k)$.
- (c). Construct $\Psi(x, t)$ in the form of an integral.
- (d). What happens as a becomes very large? What about when a becomes very small?

$\Psi(x, 0) = A[\psi_0 + 3\psi_1]$ where ψ_n is an eigenstate of the harmonic oscillator.

- (a). Find A from normalization.
- (b). Construct $\Psi(x, t)$ and $|\Psi(x, t)|^2$.
- (c). Find $\langle x \rangle$ and $\langle p \rangle$.