# Quantum Physics, Preparation for Friday, Mar. 15

## Finish Q10 except save Q10.4 for the next class

In Chapter Q10, Moore is just going to show you a lot of solutions to the Schrödinger equation. He is actually going to save the job of introducing and solving the Schrödinger equation until Q12.

In classical mechanics a problem that was important to us was the harmonic oscillator. There were very good reasons it was important, and it remains important in quantum mechanics. In Q10.5 Moore is going to give you the solutions of the the Schrödinger equation for the harmonic oscillator. When we get to Q12, and he gives you the Schrödinger equation for the harmonic oscillator, we can plug some of the solutions in and see that they work.

## Presentations

Hexi, Ethan, and Miles: building Gaussians out of the simple harmonic oscillator wave functions introduced in Section Q10.5

Emma and Trey: the fundamental quantum mechanics behind lasers

Ren and Rebecca (looking head to Section 11.5): using The Pauli Exclusion Principle to discover how much energy it requires to stuff 2 $N$ electrons in a 1-D or 3-D box, ignoring Coulomb repulsion

*These are all advanced topics, so please budget time to work with me to make high-quality presentations that will be useful for your classmates' understanding.*

## Planning

We have arrived at the point where we have to pick. Be prepared to advocate and then come to a decision on what the final four weeks will cover. Please note: we can't do both nuclear physics and special relativity. Life is short. There are no wrong choices. The trick is to embrace whatever choice you choose.

## Problem Set 11

On reverse.

# For Problem Set 11

Maybe I should assign more easy problems. Oh well, each of these teaches you a lot.

## Various Decently-Challenging and Instructive Problems

1. Q10M.2, p. 163, a nitrogen molecule at room temperature ($k_B\, T = 0.025$ eV).

2. Q10D.2, p. 164, orthogonality (see commentary below)

Physicists (and mathematicians) introduce a new kind of orthogonality. Two wave functions $\psi_1(x)$ and $\psi_2(x)$ are said to be orthogonal if and only if:

$$\int_{-\infty}^{\infty} \psi_1^*(x)\, \psi_2(x)\, d\, x = 0$$

NOTE 1: If the functions are real, then you can ignore the complex conjugation like Moore did when he wrote up Q10D.2, but in general, quantum-mechanical wavefunctions are not always real, and you must include it.

NOTE 2: If the wave functions are only defined in some range (like $x = 0$ to $x = L$), then you use that range for the limits of integration rather than $-\infty$ to $\infty$.

COMMENT: A wild and crazy fact is that energy eigenfunctions for two states with different energies are always orthogonal, and it is even pretty easy to prove.

3. Q10D.3, p. 164, integrals for normalizing the $n = 1$ harmonic oscillator wavefunction

## A Decently-Challenging Multi-Part Problem

4. Q10D.8, pp. 164-165, a way of deriving the particle-in-a-box wavefunctions — that you already worked with as Problem 2 on Exam 2! — pretending that you don't know Schrödinger's equation