Quantum (PHYS 290): Guide 6

Fall 2025 v1.7

Intro:

We're in the business of finding energy eigenstates and wavefunctions for 1D potentials, using "Schrödinger + boundary conditions" over and over again for different potentials.

Reading: ("T" stands for Townsend's text)

- T: Chapter 4 Sections 7 and 6. We will skip sections 4 and 5.
- Looking ahead - Principles of QM Chapter 5

Problems: Due Friday, October 24 at the beginning of class

(1) 4.1 Physical wavefunctions? Let's label the figures (i), (ii), (iii), (iv) from top left clockwise.

(2) 4.3 Physical wavefunction?

(3) 4.2 On energies and their properties

(4) 4.10 The half harmonic oscillator. Hint: Combine the infinite square well work with the harmonic potential wavefunctions.

(5) (2 pts.) 4.12 Time dependence in the harmonic oscillator

(6) 3.6 Time dependence for a particle in a box.

(7) Transforming the TISE into dimensionless units:

(a) Start from the usual form of the time independent Schrödinger equation for a particle of mass m and energy E in a finite depth potential well of width a. See section 4.1 for the potential. Make the substitution $x = ya$, where y is dimensionless position, and show that the equation above can be rewritten as

$$-\frac{d^2u}{dy^2} + Wu = \epsilon u \tag{1}$$

where

$$W = \frac{2ma^2V}{\hbar^2} \text{ and } \epsilon = \frac{2ma^2E}{\hbar^2}.$$

Hint: Consider d/dx as an operator (because it is one!). By the chain rule,

$$\frac{d}{dx} = \frac{dy}{dx}\frac{d}{dy}$$

(b) What are the units of measurement for W and ϵ? Show your result.

All useful stuff for lab this week.