NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 283 – Modern Physics Spring 2024

Problem Set #5

Problem Set Due: Thurs., Feb. 29, 2024
Read Krane: Chapter 5.6, Lecture Notes #1, #2

1. **OpenStax University Physics Vol. 3: Section 1.1:** Problem 27
2. **OpenStax University Physics Vol. 3: Section 1.2:** Problem 34
3. **OpenStax University Physics Vol. 3: Section 1.2:** Problem 35

4. **For the infinite square well potential:**

$$U(x)=\begin{cases}0 & \text{for} \quad 0\le x\le L\\ \infty & \text{for} \quad x<0, x>L\end{cases}$$

find the solution to the Schrodinger equation in the three regions:

(a) Region I: $x<0$

(b) Region III: $x>L$

(c) Region II: $0\le x\le L$.
Assume the general solution is $\psi(x)=A\sin kx+B\cos kx$ and apply the condition that $\psi(x)$ is continuous across any boundary.

(d) Find the allowed energies in the infinite square well potential.

(e) Draw the energy level diagram for the 1st 4 allowed energies.

(f) Draw the wavefunctions for the 1st 4 energy states.

(g) Normalize the wavefunction.

5. Krane: **Problem 33** page 175

(a) For Part (a) of this problem: *also* sketch the potential energy barrier and where the energy of the electron is relative to the barrier.
Note: *there is an error in the textbook:* The energy barrier is shown in **Figure 5.26** (not 5.25)

(b) Do Part (b)

(c) Do Part (c)

(d) Sketch the wavefunction representing a possible solution to the Schrodinger equation in each of the regions of this problem.

6. Krane: **Problem 36** page 175

in addition to each sketch, explain:
(a) how the wavelength changes in the well?
(i.e., does it increase or decrease as x increases?)—explain why.
(b) how the amplitude of the wave changes in the well?
(i.e., does it increase or decrease as x increases?)—explain why.
(c) how does the wavefunction behave outside the box?
(i.e., is it zero or can the particle exist in the classically forbidden region?)—explain why.

7. Krane: **Problem 37** page 175 (just show calculation)

use integral by parts (or any other method you learned in calculus) to solve the integral (do not just look up the integral in the integral tables).

8. Krane: **Problem 38** page 176 (just show calculation)