NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 283 – Modern Physics Spring 2023

Problem Set #9

Problem Set Due: Thurs., April 6, 2023
Read Krane: Chapter 7.1-7.8

There will be a Quiz #2 on Tuesday, April 11

1. Krane: **Problem 24** page 234 (sketch energy level diagram)
2. Krane: **Problem 26** page 234 (sketch energy level diagram)
3. Krane: **Problem 27** page 234 (sketch energy level diagram)
4. Krane: **Problem 35** page 234 (just show calculation)
5. Krane: **Problem 40** page 235 (just show calculation)
6. *Selection rules for an infinite square well potential:* Recall in Lecture that the general condition necessary for an atom in an excited state to radiate is that

$$\int_{-\infty}^{\infty} x\psi_i\psi_f^* dx \neq 0 \qquad \text{(allowed transitions)}$$

$$\int_{-\infty}^{\infty} x\psi_i\psi_f^* dx = 0 \qquad \text{(forbidden transitions)}$$

where i = initial state, f = final state. The wave function for an infinite square well potential is

$$\psi = A\sin\left(\frac{n\pi x}{L}\right) \qquad (n = 1,2,3,\ldots) \quad \text{and} \quad (0 < x < L)$$

(a) Show whether $\Delta n = \pm 1$ transitions are allowed by examining the $n = 2 \rightarrow n = 1$ transition.
(b) Show whether $\Delta n = \pm 2$ transitions are allowed by examining the $n = 4 \rightarrow n = 2$ transition.
(c) Show whether $\Delta n = \pm 3$ transitions are allowed by examining the $n = 4 \rightarrow n = 1$ transition.

Generalize the selection rules for any Δn, and show all the allowed transitions in the energy level diagram below: