Assignment 10
PHY114 (2023-24-I)
Week-7 (to be discussed on 12-10-2023)

Problems to be discussed, solved and submitted by Students –1, 3, 4, 5, 6

Problems to be solved in the tutorial – 2, 7, 8

1. The state of a harmonic oscillator is given as $\psi = \frac{1}{\sqrt{3}}\psi_0 - \frac{1}{\sqrt{6}}\psi_1 + \frac{1}{\sqrt{2}}\psi_2$, where ψ_0, ψ_1 and ψ_2 are the normalized wave functions of ground, first excited, and second excited states, respectively. Give the possible results when energy of the system is measured along with the probability of obtaining that result. What is the expectation value of the energy and what does it mean? (***Hint:*** *Use Born rule for wavefunction collapse*).

2. Find out the probability of measuring momentum between p and $p + \Delta p$ for a particle of mass m in the ground-state of (i) an infinite box of width L and (ii) a harmonic oscillator of angular frequency ω (***Hint:*** *Use Born rule for wavefunction collapse*).

3. Consider a particle in a quantum state

$$\psi(x) = \begin{cases} 0 \text{ for } x \le 0 \text{ and } x \ge L \\ x(x-L) \text{ for } 0 < x < L \end{cases}$$

for particle in an infinite box of width L. Notice that the state is not an eigenstate of the Hamiltonian. (i) What is the expectation value of its energy? (ii) What are the probabilities that a measurement of energy will give its value to be (a) $\frac{\hbar^2\pi^2}{2mL^2}$ and (b) $\frac{2\hbar^2\pi^2}{mL^2}$? (***Hint:*** *connect with problem 9 of Assignment 8 and use Born rule for wavefunction collapse*).

4. Problem 27 (Eisberg and Resnick, 2nd Edition Chapter 5).
5. Problem 27 (Eisberg and Resnick, 2nd Edition Chapter 5).
6. Problem 29 (Eisberg and Resnick, 2nd Edition Chapter 5).
7. Using uncertainty principle, argue mathematically that for a square well potential of depth V_0 and width L, the strength of the potential is given by V_0L^2. Higher strength implies that the number of states is going to be more (***Hint:*** *Compare the kinetic and potential energy of a particle if it is in the n^th bound state*).

8. What is the minimum strength of a square well potential of height V_0 and width $2L$ so that it has at least three bound states.