

# Problems

**Q.1** A particle of mass  $m$  is trapped in a one-dimensional box of width  $a$ . The wavefunction is known to be:

$$\Psi(x) = \frac{i}{2} \sqrt{\frac{2}{a}} \sin\left(\frac{\pi}{a} x\right) + \sqrt{\frac{1}{a}} \sin\left(\frac{3\pi}{a} x\right) - \frac{1}{2} \sqrt{\frac{2}{a}} \sin\left(\frac{4\pi}{a} x\right)$$

If the energy is measured, what are the possible results and what is the probability of obtaining each result? What is the most probable energy for this state?

## Q2

A particle in a one-dimensional box  $0 \leq x \leq a$  is in the state:

$$\Psi(x) = \sqrt{\frac{1}{10a}} \sin\left(\frac{\pi}{a} x\right) + A \sqrt{\frac{2}{a}} \sin\left(\frac{2\pi}{a} x\right) + \sqrt{\frac{9}{5a}} \sin\left(\frac{3\pi}{a} x\right)$$

- Find  $A$  so that  $\Psi(x)$  is normalized.
- What are the possible results of measurements of the energy, and what are the respective probabilities of obtaining each result?

## Q.3

A particle of mass  $m$  is confined in a one-dimensional box with dimensions  $0 \leq x \leq a$  and is known to be in the second excited state ( $n = 3$ ). Suddenly the width of the box is doubled ( $a \rightarrow 2a$ ), without disturbing the state of the particle. If a measurement of the energy is measured, find the probabilities that we find the system in the ground state and the first excited state.

## Q.4

Consider the basis of H-space as  $\Phi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi}{a} x\right)$ . Expand  $\Psi(x) = \cosh(x)$  in that space and determine the coefficients.