

PH 451: Capstone in Quantum Mechanics

Homework 1

Due 1/9/09

- 1) (Goswami 3.10) Calculate the uncertainty product $\Delta p \cdot \Delta x$ using the box wave functions

$$\psi_n(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$$

- 2) (Goswami 3.13) An electron is in the ground state of a box with sides at $x=0$ and $x=a$. Suddenly one wall is moved from $x=a$ to $x=2a$. What is the probability that the electron will be found in:
- the ground state of the new box?
 - the first excited state of the new box?

- 3) (Townsend 3.17) A spin-1 particle is in the state

$$|\psi\rangle \doteq \frac{1}{\sqrt{14}} \begin{pmatrix} 1 \\ 2 \\ 3i \end{pmatrix}$$

- What are the probabilities that a measurement of S_z will yield the values \hbar , 0 , $-\hbar$ for this state? What is $\langle S_z \rangle$?
- What is $\langle S_x \rangle$ for this state?
- What is the probability that a measurement of S_x will yield the value \hbar for this state?

4) Consider the differential equation

$$\left(\frac{d^2}{d\xi^2} + (\varepsilon - \xi^2) \right) \Phi(\xi) = 0$$

Make the change of independent variable:

$$\Phi(\xi) = h(\xi) e^{-\frac{\xi^2}{2}}$$

and find a new differential equation for the unknown function $h(\xi)$. Use series solutions to solve this new equation. Find values of ε such that one of the solutions has appropriate fall-off behavior as $x \rightarrow \pm\infty$.