Problem Set 6

Due: Wed 17 March 2010

Reading:

Fri 3/5: Please review Chapter 3 in Townsend.

Mon 3/15: Townsend Sec. 4.1.

Wed 3/17: Townsend Sec. 4.1.

Problems: Please do the following four problems as well as the problem you chose not to do last time.

1. Energy measurement and probability. Townsend Problem 3.5. In the description of this problem, the arguments of $\Psi(x,t)$, $\psi_1(x)$ and $\psi_2(x)$ were not given. Please interpret the equation as

$$\Psi(x,0) = \frac{i}{2} \psi_1(x) + \sqrt{\frac{3}{2}} \psi_2(x).$$

2. Energy measurement and time-dependence of the wavefunction. Townsend Problem 3.6. As in the previous problem, please interpret $\Psi(x)$ as $\Psi(x,0)$.


4. Particle in a box that suddenly doubles in size. Townsend Problem 3.12. (Hints continue on the next page.) Please assume that the box doubles in size so quickly that the wavefunction doesn’t have time to change. Therefore, your task is to expand the initial wavefunction

$$\Psi(x,0) = \psi(x) = \begin{cases} \sqrt{\frac{2}{L}} \sin \left( \frac{\pi x}{L} \right) & 0 < x < L, \\ 0 & \text{otherwise,} \end{cases}$$
in the new basis of energy eigenfunctions of the width-2L well,

\[
\psi_n(x) = \begin{cases} 
\sqrt{\frac{2}{2L}} \sin\left(\frac{n\pi x}{2L}\right) & 0 < x < 2L, \\
0 & \text{otherwise.}
\end{cases}
\]

Note carefully the range of \( x \) on which each of the functions is nonzero, it’s smaller for \( \psi(x) \) than for the basis \( \psi_n(x) \). (The nonzero ranges are \( 0 < x < L \) versus \( 0 < x < 2L \).) Also note that the argument of the \( \sin \) in \( \psi(x) \) is \( \pi x/L \), whereas for \( \psi_n(x) \) it’s \( n\pi x/(2L) \), with a factor of 2 downstairs.

7. Feedback. By Thursday, instead of our traditional feedback this week, please complete the Midsemester Course Questionnaire. (It was distributed in class and is also available on the Calendar and Assignments page.)