

Mid-Term 1

Quantum Mechanics I
Physics 342

Date: March 7th, 2008

NAME:

There are four problems, each worth 10 points. Show as much work as you can for all problems. You have 1 hour, and can use the front and back of a 3×5 (inch) card – the front and back covers of the book are provided separately.

Problem 1.1

a. For the attached movie, sketch a plausible potential, describe your motivation. Note that the movie runs forwards, then backwards. In addition, there are infinite walls at $x = -20$ and 20 that you should (try to) ignore.

b. Find the Fourier Transform of $\sin(\alpha x)$ for $\alpha \in \mathbb{R}$.

c. You are given the initial state $\bar{\psi}(x) = Ax(x - a)$ for the infinite square well potential, with $V(0) = V(a) = 0$. Find the probability that a particle is initially between $x = 0$ and $x = \frac{1}{2}a$.

Problem 1.2

Find the stationary states of the infinite step potential:

$$V(x) = \begin{cases} 0 & x < 0 \\ \infty & x > 0 \end{cases} \quad (1)$$

Problem 1.3

For the infinite square well with $V(0) = V(a) = \infty$, a particle of mass m starts in the initial state:

$$\bar{\psi}(x) = A (\psi_1(x) + 2\psi_2(x)). \quad (2)$$

- a. What outcomes are possible for a measurement of the particle's energy, and what is the probability of each?

- b.** What is the expectation value of position (as a function of time)? Note: This problem and the next are far more time-consuming than the actual midterm problems – they are meant to provide additional conceptual practice.

Problem 1.4

You measure a particle in the ground state of the SHO ($V(x) = \frac{1}{2} m \omega^2 x^2$). At time $t = 0$, you turn off the potential, wait Δt , then turn it back on. What is the probability of measuring the particle energy to be $\frac{1}{2} \hbar \omega$?