

PHYSICS 5455 — QUANTUM MECHANICS I — Fall 2009

Homework assignment 5, due September 29, 2009

The *Graduate Honor Code* applies to this assignment (see homework 1).

1. *Infinite potential well states and expectation values.* **(25 points)**
The energy eigenfunctions for a particle (mass m) in an infinite potential well (width a) are $\varphi_n(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$, with integer $n = 1, 2, \dots$
 - (a) Compute $\langle x \rangle$, $\langle p \rangle$, $\langle x^2 \rangle$, and $\langle p^2 \rangle$ in these eigenstates, and confirm that Heisenberg's uncertainty relation is satisfied.
 - (b) Consider the wave function $\psi(x) = C x(x-a) e^{ikx}$. Determine C , and find the coefficients c_n in the expansion $\psi(x) = \sum_{n=1}^{\infty} c_n \varphi_n(x)$.
 - (c) Determine the energy eigenfunctions $\phi_n(p)$ in momentum space, and thus confirm your result for $\langle p \rangle$ in (a).

First midterm exam: **Thursday, Sep. 24, 5.00 pm** (in class)

- Closed-book: no books, notes, calculators, electronic devices permitted.
- Please answer ALL questions, provide brief explanations.
- Material covered: Chap. 1 in the syllabus, pp. 1–26 in the lecture notes, homework assignments 1 through 4 (not the extra-credit problems).
- The graduate honor code pertains to the midterm exam.