Physics 412—Practice S–7 (Due Mar. 2, 4 pm) Name:

S–7: I can use the position space wave function to make predictions about measurements for a one-dimensional quantum systems with step potentials.

Unsatisfactory Progressing Acceptable Polished

(1) The wave functions for the energy eigenstates for the particle in an infinite well of width L centered at $L/2$ (so that $0 \le x \le L$ in the well) and their corresponding energies are

$$\psi_n(x) = \sqrt{\frac{2}{L}} \cos\frac{n\pi x}{L}, \quad (n \text{ odd}), \qquad \psi_n(x) = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L}, \quad (n \text{ even}), \qquad E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}.$$

A particle of mass m in an infinite square well is in state $|\Psi\rangle$ with wave function

$$\psi(x) = \frac{1}{\sqrt{5}}\Big[2\psi_1(x) + i\psi_2(x)\Big].$$

(a) You make a measurement of the energy of the particle. What are the possible results of this measurement, and what is the probability of each result?

(b) If the result of your energy measurement is the largest possible value, what is the wave function for the state after the measurement? Explain.

(c) After measuring the energy of the particle, you measure its position. What is the most probable result (or results, if more than one position is most probable) of this measurement?

(d) Does your answer to part (c) depend on how much time has elapsed between the energy measurement and the position measurement? Explain.

(2) A beam of particles of energy E is incident from the left on a downward step potential of depth $-2E$, as shown below.

What is the reflection coefficient for this beam? (Your answer should be a number.)