

NAME:

MIDTERM EXAM

PHYS851 Quantum Mechanics I, Fall 2009

1. Consider a potential consisting of a delta function at $x = 0$ and an infinite barrier at $x = W$,

$$V(x) = \begin{cases} g \delta(x); & x < W \\ \infty; & x > W \end{cases}, \quad (1)$$

where $g > 0$.

For the case of an incoming wave from the left with of the form $e^{ikx} + re^{-ikx}$, calculate the reflection amplitude r , and give an explicit expression for the wavefunction in the region $0 < x < W$.

2. Consider a standard two-level Rabi system characterized by a detuning Δ and a ‘bare Rabi frequency’ Ω_0 . Let $\{|1\rangle, |2\rangle\}$ be the physical basis, with $|1\rangle$ being the ground state for $\Omega_0 = 0$ and $\Delta > 0$.

The system is initially prepared in state $|1\rangle$, with $\Delta = 0$ and $\Omega_0 = 0$. At $t = 0$, the coupling strength, Ω_0 is suddenly switched to a real, positive value, and then held constant for a duration T .

- (a) What are the energy eigenvalues and eigenvectors during the interval $0 < t < T$?
- (b) What is the state of the system at time $t = T$?
- (c) If the observable $D = -i|1\rangle\langle 2| + i|2\rangle\langle 1|$ were measured at time $t = T$, what are the possible results of the measurement?
- (d) What are the probabilities of obtaining each possible result?
- (e) For each possible result, give the state of the system after the measurement.