

Physics 5810: Midterm II

NAME: _____

Chapter 5,6,7

1.)(a) For the 1-d potential shown, derive a transcendental equation (*i.e.* the quantization condition) for the energy of the BOUND states of a particle of mass m .

(b) Use part (a) to show that there can only be bound states if $a > \frac{\pi\hbar}{\sqrt{2mV_0}}$. (HINT: look at the simpler limiting case of $E = 0$ and reason from there).

2.) Suppose that a quantum system has two energy levels of energy 1 and 3 (and we label the associated normalized states as $|1\rangle$ and $|3\rangle$ respectively). Further, suppose that one can measure the momentum of the quantum system and find that it is either going right (“R”) or left (“L”) and that in terms of the energy eigenstates $|R\rangle = \alpha(|1\rangle + 2|3\rangle)$

a) The states $|R\rangle$ and $|L\rangle$ are normalized. Compute α and write down $|L\rangle$ in the energy eigenbasis.

b) Suppose that that a measurement of the energy gives the energy to be 3. What percentage of the time will a subsequent measurement of the momentum give “R”?

c) Suppose that we measure the momentum and get “R”. After $\pi/(3\hbar)$ of a second the energy is measured, and the momentum just after that. What is the chance of getting an “L” for that last measurement?

3.) a) For the potential given, find a pair of equations that relate the reflection amplitude, the transmission amplitude and the energy only.

b) Show that for energies of incident particles for which an integer number of the de Broglie half-wavelengths fit between the spikes, there is no reflection at all! This is a simple example of the celebrated Ramsauer-Townsend effect.