Additional problem on time-dependent perturbation theory.

1. (a) Suppose $H'$ is constant (except that it was turned on at $t=0$ and switched off again at some later time $t$). Find the probability of transition from state $N$ to state $m$ ($m \neq N$) as a function of $t$.

Answer: \[ \frac{4 |H'_{mN}|^2 \sin^2 \left[ \frac{(E_N - E_m)t}{2\hbar} \right]}{(E_N - E_m)^2} \]

(Note that this is the answer given by Liboff in Table 13.2, under the heading DC perturbation turned on at $t=0$).

(b) Now use the result of part (a) to find the solution to the following:

A particle of mass $m$ is initially in the ground state of the one-dimensional infinite square well. At time $t=0$, a "brick" is dropped into the well, so that the potential becomes

\[ V(x) = \begin{cases} V_o, & \text{if } 0 \leq x \leq a/2, \\ 0, & \text{if } a/2 < x \leq a, \\ \infty, & \text{otherwise} \end{cases} \]

where $V_o << E_1$. After a time $T$, the brick is removed, and the energy of the particle is measured. Find the probability (in first-order perturbation theory) that the energy is now $E_2$. 