PHY 362K Homework 7

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Since the particle is in infinite square well, the engergy is $E_n = \frac{n^2\pi^2\hbar^2}{2ma^2}$

$\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi}{a}x\right)$

Since the transition is from state $n = 1$ to state $n = 2$, we get $\omega_{21} = \frac{E_2 - E_1}{\hbar} = \frac{3\pi^2\hbar}{2ma^2}$

$H'_{21}(t) = \langle 2|H'|1\rangle = \int_0^a \psi_2^*(x) A x^2 e^{-\gamma t} \psi_1(x) dx = -\frac{16a^2 A e^{-t\gamma}}{9\pi^2}$ (Using Mathematica)

$\therefore c_2 = -\frac{i}{\hbar}\int_0^T e^{i\omega_{21}t} H'_{21}(t)dt = \frac{32ia^4 A\left(1 - e^{-T\gamma + \frac{3i\pi^2 T\hbar}{2a^2 m}}\right)m}{9\pi^2\hbar(2a^2 m\gamma - 3i\pi^2\hbar)}$

$\therefore P_{1\to 2} = |c_2|^2 = \frac{1024a^8 A^2 m^2}{81\pi^4\hbar^2(4a^4m^2\gamma^2 + 9\pi^4\hbar^2)}\left(1 - e^{-T\gamma + \frac{3i\pi^2 T\hbar}{2a^2 m}}\right)\left(1 - e^{-T\gamma - \frac{3i\pi^2 T\hbar}{2a^2 m}}\right)$

When $T \to \infty$, $\left(1 - e^{-T\gamma + \frac{3i\pi^2 T\hbar}{2a^2 m}}\right) \to 0$ and $\left(1 - e^{-T\gamma - \frac{3i\pi^2 T\hbar}{2a^2 m}}\right) \to 0$

Therefore in this case $P_{1\to 2} = \frac{1024a^8 A^2 m^2}{81\pi^4\hbar^2(4a^4m^2\gamma^2 + 9\pi^4\hbar^2)}$

2

(a)

(b)

(c)

3

(a)

(b)

4

5

(a)

(b)