# HW 3 Solution

1. (a) A

$$E_{(n_x, n_y, n_z)} = \underbrace{\frac{\pi^2 \hbar^2}{2mL^2}}_{\epsilon_0} \left( n_x^2 + n_y^2 + \left(\frac{n_z}{2}\right)^2 \right)$$

$$\epsilon_0 = 6.02 \times 10^{-19} \text{ erg}$$

lowest energy state. $(1\,1\,1)$ $\quad E = (1 + 1 + \frac{1}{2^2})\epsilon_0$

next $(1\,1\,2)$ $\quad E = (1 + 1 + 1)\epsilon_0$

difference $= \frac{3}{4}\epsilon_0$

$= 4.5 \times 10^{-19} \text{ erg} = 2.8 \times 10^{-7} \text{ eV} = 3.27 \text{ mK}$

(b) ratio of probabilities $= e^{-\Delta E / k_B T} \simeq e^{-0.0327}$

$\simeq 0.968$

B since $E \propto \frac{1}{L^2}$, then get immediately [$\Delta E = 10^2 \times$ previous answer]

$\Delta E = 4.5 \times 10^{-17} \text{ erg} = 2.8 \times 10^{-5} \text{ eV} = 327 \text{ mK}$

ratio of prob $= e^{-3.27} = 0.038$

(much smaller !! )

2.

$$E(n_x, n_y, k_z) = \underbrace{\frac{\pi^2 \hbar^2}{2mL^2}}_{\epsilon_0} \left( \left(\frac{n_x}{2}\right)^2 + 1 \right) + \frac{\hbar^2 k_z^2}{2m}$$

lowest : (1 1) : $E = \frac{5}{4}\epsilon_0 + \frac{\hbar^2 k^2}{2m}$

next (2 1) $E = 2\epsilon_0 + \frac{\hbar^2 k^2}{2m}$

3rd (3 1) $E = \frac{13}{4}\epsilon_0 + \frac{\hbar^2 k^2}{2m}$

{ (1 2) has $\frac{17}{4}\epsilon_0 + \frac{\hbar^2 k^2}{2m}$ is higher than (3 1) ]