Prelims Solutions

Problem J11T2

Valentin Skoutnev

1

There are 3 $S = 1$ states with energy ΔE and 1 $S = 0$ state with energy 0.

$$Z = 3e^{-\frac{\Delta E}{k_b T}} + 1$$

2

We have $P(S = 1) = .7 = \frac{3e^{\frac{-\Delta E}{k_b T}}}{Z}$ and $P(S = 0) = .3 = \frac{1}{Z}$ so $\Delta E = -k_b T ln(\frac{.7}{3*.3}) \approx 1.04 * 10^{-21} J$. Same as they give in part c.

3

The mass of an H_2 molecule is $2 * 1836 * m_{electron} = 2 * 1836 * 9 * 10^{-31} kg = 3 * 10^{-27} kg$. So $L = 445000 J/kg * 3 * 10^{-27} kg/H_2 = 1.5 * 10^{-21} J$. So it takes more than $\Delta E = 10^{-21} J$ energy to remove one H_2 molecule from the liquid. Hence, not all of the H_2 will boil off. I presume this is good for the thirsty experimenter.