Homework 3

Sean Eva

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Boltzmann Equation:

$$\frac{N_b}{N_a} = \frac{g_b e^{-\frac{E_b}{kT}}}{g_a e^{-\frac{E_a}{kT}}} = \frac{g_b}{g_a} e^{\frac{-(E_b - E_a)}{kT}}$$

Saha Equation:

$$P_e = n_e kT$$

$$\frac{N_{i+1}}{N_i} = \frac{2kTZ_{i+1}}{P_e Z_i} (\frac{2\pi m_e kT}{h^2})^{\frac{3}{2}} e^{\frac{-\chi_i}{kT}}$$

1.

$$5 = \frac{1}{(2^2)} e^{\frac{-(0-10.2)*(1.6*10^{-19})}{(1.381*10^{-23})T}}$$

$$ln(20) = \frac{-(0-10.2)*(1.6*10^{-19})}{(1.381*10^{-23})T}$$

$$T = \frac{-(0-10.2)*(1.6*10^{-19})}{(1.381*10^{-23})ln(20)}$$

$$T = 39450k$$

2.

	5000k	12000k
$n = 2$	$5.4 * 10^{-11}$	$5.29 * 10^{-5}$
$n = 3$	$6.83 * 10^{-13}$	$8.53 * 10^{-6}$
$n = 4$	$1.48 * 10^{-13}$	$4.51 * 10^{-6}$
$n = 5$	$7.27 * 10^{-14}$	$3.35 * 10^{-6}$
$n = 6$	$4.94 * 10^{-14}$	$2.86 * 10^{-6}$

3. (a) When the temperature is doubled the ionization ratio changes by a factor of about $3 * 10^5$

   (b) When the electron density is doubled, the ionization ratio changes by a factor of $\frac{1}{2}$.

(c) When the ionization potential is doubled, the ionization ratio is changed by a factor of $1 * 10^{-10}$

4. $T = 12000$
$\frac{N_{II}}{N_I} = \frac{2(1.381*10^{-23})(12000)(2)}{(0.2)(1)}(\frac{2\pi(9.109*10^{-31})(1.381*10^{-23})(12000)}{(6.626*10^{-34})^2})^{\frac{3}{2}} e^{\frac{-24.6(1.6*10^{-19})}{1.381*10^{-23}*12000}} = 0.510$
$\frac{N_{III}}{N_{II}} = \frac{2(1.381*10^{-23})(12000)(1)}{(0.2)(2)}(\frac{2\pi(9.109*10^{-31})(1.381*10^{-23})(12000)}{(6.626*10^{-34})^2})^{\frac{3}{2}} e^{\frac{-54.4(1.6*10^{-19})}{1.381*10^{-23}*12000}} = 4.07 * 10^{-14}$
$\frac{N_{II}}{N_{total}} = \frac{0.510}{1+0.510} = 0.338$