

NPRE200 HW 1

James Liu

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1. $P_f = \frac{800}{800 + 300} = \boxed{72.73\%}$
2. $\Sigma_f^{235} = \sigma_f^{235} N^{235} = 582 \times 10^{-24} \times 5 \times 10^{21} = 2.91$
 $\Sigma_a^{235} = \sigma_a^{235} N^{235} = 700 \times 10^{-24} \times 5 \times 10^{21} = 3.5$
 $\Sigma_a^{238} = \sigma_a^{238} N^{238} = 2.71 \times 10^{-24} \times 4.35 \times 10^{22} = 0.117885$
 $\eta = \frac{\nu \Sigma_f}{\Sigma_a} = \nu \frac{\Sigma_f^{235}}{\Sigma_a^{235} + \Sigma_a^{238}} = 2.42 \times \frac{2.91}{3.5 + 0.117885} = \boxed{1.9465}$
3. a) $3.5 \times 20^{-24} \times 4.2 \times 10^{23} = \boxed{1.47 \text{ cm}^{-1}}$
b) $\lambda = 1/\Sigma = \boxed{0.680272 \text{ cm}}$
4. $\rho_{atm} = \frac{\rho_{mas} A}{m} = \frac{0.79 \times 6.023 \times 10^{23}}{22.99} = \boxed{2.6967 \times 10^{22} \text{ atom/cm}^3}$
5. a) $1500 \times 0.2 = \boxed{300 \text{ kg}}$
b) $^{235}\text{U} : \frac{19.1 \times 0.2 \times 6.023 \times 10^{23}}{235} = \boxed{9.79058 \times 10^{21} \text{ cm}^{-3}}$
 $^{238}\text{U} : \frac{19.1 \times 0.8 \times 6.023 \times 10^{23}}{238} = \boxed{3.86687 \times 10^{22} \text{ cm}^{-3}}$
 $9.79058 \times 10^{21} \div (9.79058 \times 10^{21} + 3.86687 \times 10^{22}) = 20.2037\%$
6. $m = 0.025 \times 235 + 0.975 \times 238 = 237.925$
 $n = 19.0 \div 237.925 \times 6.023 \times 10^{23} = 4.80979 \times 10^{22}$
 $n_{235} = n \times 0.025 = \boxed{1.20245 \times 10^{21} \text{ cm}^{-3}}$
7. a) $m_u = 0.25 \times 235 + 0.75 \times 238 = \boxed{237.25 \text{ g/mol}}$
b) $m = m_u + m_c = 237.25 + 12 = 249.25$
 $n = \frac{\rho A}{m} = 13.6 \times 6.023 \times 10^{23} \div 249.25 = 3.28637 \times 10^{22}$
 $M_u = n_u \div A \times m_u = 12.9452 \text{ g/cm}^3$
 $m_{235} = 0.25 m_u = 3.23631$
 $n_{235} = 3.23631 \div 235 \times 6.023 \times 10^{23} = \boxed{8.29459 \times 10^{21}}$

$$\begin{aligned}
8. \quad m_u &= 0.035 \times 235 + 0.965 \times 238 = 237.895 \text{ g/mol} \\
m &= m_u + 2m_o = 237.895 + 2 \times 16 = 269.895 \text{ g/mol} \\
n &= \rho \div m = 0.040016 \text{ mol/cm}^3 \\
M_u &= n \times m_u = 0.040016 \times 237.895 = 10.8 \text{ g/cm}^3 \\
M_{235} &= M_u \times 0.035 = 10.8 \times 0.035 = 0.378 \text{ g/cm}^3 \\
n_{235} &= M_{235} \div m_{235} \times A = \boxed{9.68806 \times 10^{20} \text{ cm}^{-3}} \\
n_{238} &= M_{238} \div m_{238} \times A = \boxed{2.63747 \times 10^{22} \text{ cm}^{-3}}
\end{aligned}$$

9. QUESTION REMOVED

$$\begin{aligned}
10. \quad n_{Al} &= M_{Al} \div m_{Al} = 0.55 \times 2.66 \div 26.9815 = 0.05422 \text{ mol} \\
n_{Si} &= M_{Si} \div m_{Si} = 0.45 \times 2.66 \div 28.0855 = 0.04262 \text{ mol} \\
\Sigma &= \sigma_{Al} N_{Al} + \sigma_{Si} N_{Si} \\
&= 6.023 \times 10^{23} \times (0.23 \times 0.05422 + 0.16 \times 0.04262) \times 10^{-24} \\
&= 0.011618 \text{ cm}^{-1} \quad \lambda = \frac{1}{\Sigma} = \boxed{86.0715 \text{ cm}}
\end{aligned}$$

$$11. \quad \frac{1.3}{1.3-1.2} = \boxed{7.6923\%}$$

$$\begin{aligned}
12. \quad \sigma &= e\sigma^{235} + (1-e)\sigma^{238} + 2 \times \sigma_O \\
&= 0.2 \times 607.5 + 0.8 \times 11.8 + 2 \times 3.8 = 138.54 \text{ barn} \\
m &= 0.2 \times m^{235} + 0.8 \times m^{238} + 2 \times 16 = 269.4 \text{ g/mol} \\
n &= M/m = 10.5 \div 269.4 \times 6.023 \times 10^{23} = 2.34749 \times 10^{22} \\
\Sigma &= mn = 138.54 \times 10^{-24} \times 2.34749 \times 10^{22} = \boxed{3.2522 \text{ cm}^{-1}}
\end{aligned}$$