Midterm

Given: LTE hydrogen discharge, T_e=10000 and n_e=7 x 10e17

a) n_H & n_{H+} =?

$$\begin{cases} n_e = n_i \\ \dfrac{n_e n_{ion}}{n_a} = \dfrac{(2\pi m_e kT)^{3/2}}{h^3} \dfrac{2Z_{ion}}{Z_a} \exp\left(\dfrac{-e\chi_a}{kT}\right) = f(T) \end{cases}$$

$$\boxed{\begin{aligned} n_i &= n_e = 7\times10^{17} \quad [m^{-3}] \\ n_a &= 1.4\times10^{25} \quad [m^{-3}] \end{aligned}}$$

b) p=?

$$p = n_e k T_e + n_i k T_i + n_a k T_a$$

$$P = 1.96 \times 10^6 \text{ [Pa]}$$

c) $\bar{v} = ?$

$$v_m = \left(\frac{2kT}{m}\right)^{1/2} \qquad \bar{v} = \sqrt{\frac{8kT}{\pi m}} \qquad v_{rms} = \left(\frac{3kT}{m}\right)^{1/2}$$

$$\bar{v}_e = 6.21 \times 10^5 \quad [m/s]$$

$$\bar{v}_a = \bar{v}_i = 1.455 \times 10^4 \quad [m/s]$$

d) $\overline{E}_e = ?$

$$\overline{E}_e = \overline{\frac{1}{2} m_e v^2} = \frac{1}{2} m_e v_{rms}^2 = \frac{3}{2} k T_e$$

$$\boxed{\overline{E}_e = 2.07\times10^{-19} \quad [J] \quad or \quad = 1.29 \quad [eV]}$$

e) $E_6^{excitedstate} = ?$

n=7 $\qquad E_n = 13.5992\left(1 - \frac{1}{n^2}\right) \quad [eV]$

$$\boxed{E_6 = 13.32 \quad [eV] \quad or \quad = 2.132\times10^{-18} \quad [J]}$$

f) $n_{\max e, exite 6\to 0} = ?$

$$\frac{n_{\max e, exite 6\to 0}}{n_e} = 1 + \frac{2}{\sqrt{\pi}} U e^{-U^2} - erf(U)$$

$$\left\{ \begin{array}{l} U = \sqrt{\frac{mv^2}{2kT}} = \sqrt{\frac{\overline{E}_e}{kT}} = 3.93 \\ erf(3.93) = 1 - 2.73 \times 10^{-8} \end{array} \right.$$

$$\boxed{n_{\max e, exite 6\to 0} = 1.08 \times 10^{17}}$$

g) $n_6 = ?$

$$n_6 = \frac{g_6}{Z_a} n_a \exp\left(\frac{-E_6}{kT}\right)$$

$$\boxed{n_6 = 1.34 \times 10^{20} \quad [m^{-3}]}$$

8) $E_{6\to 0,radiation}$

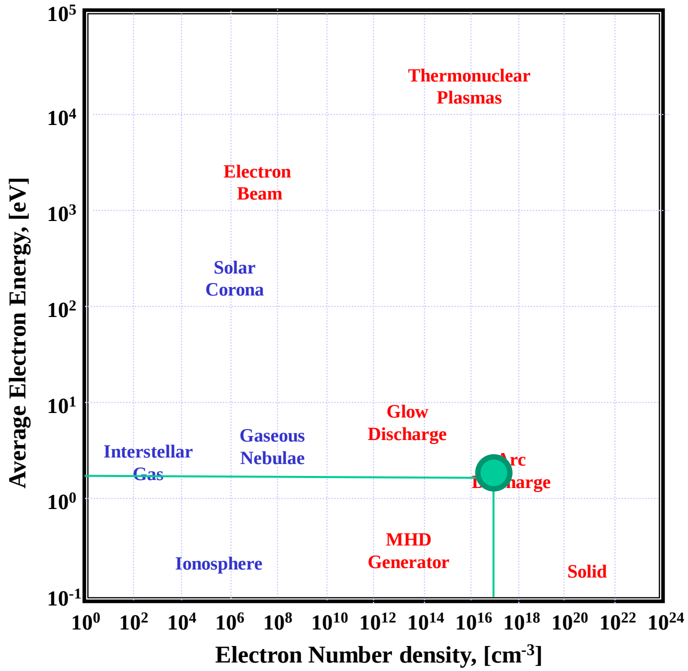
$$E_{6\to 0} = \frac{1}{4\pi} n_6 A_{6-1} E_6 = 3.63\times 10^7 \quad [J/m^3]$$

2- Show plasma type!

$$n_e = 1.2\times 10^{23} \quad [m^{-3}]$$

$$= 1.2\times 10^{17} \quad [cm^{-3}]$$

$$E_e = 1.29 \quad [eV]$$



3) $e \rightarrow H^{+}$ H^+ at rest.

Elastic or inelastic colission?
Maximum energy exchange?

$$eleastic: \qquad E_2 = \frac{4m_e m_{H^+}}{(m_e + m_{H^+})^2}$$

$$inelasic: \qquad U_{\max} = E_e \times \frac{m_{H^+}}{m_e + m_{H^+}}$$