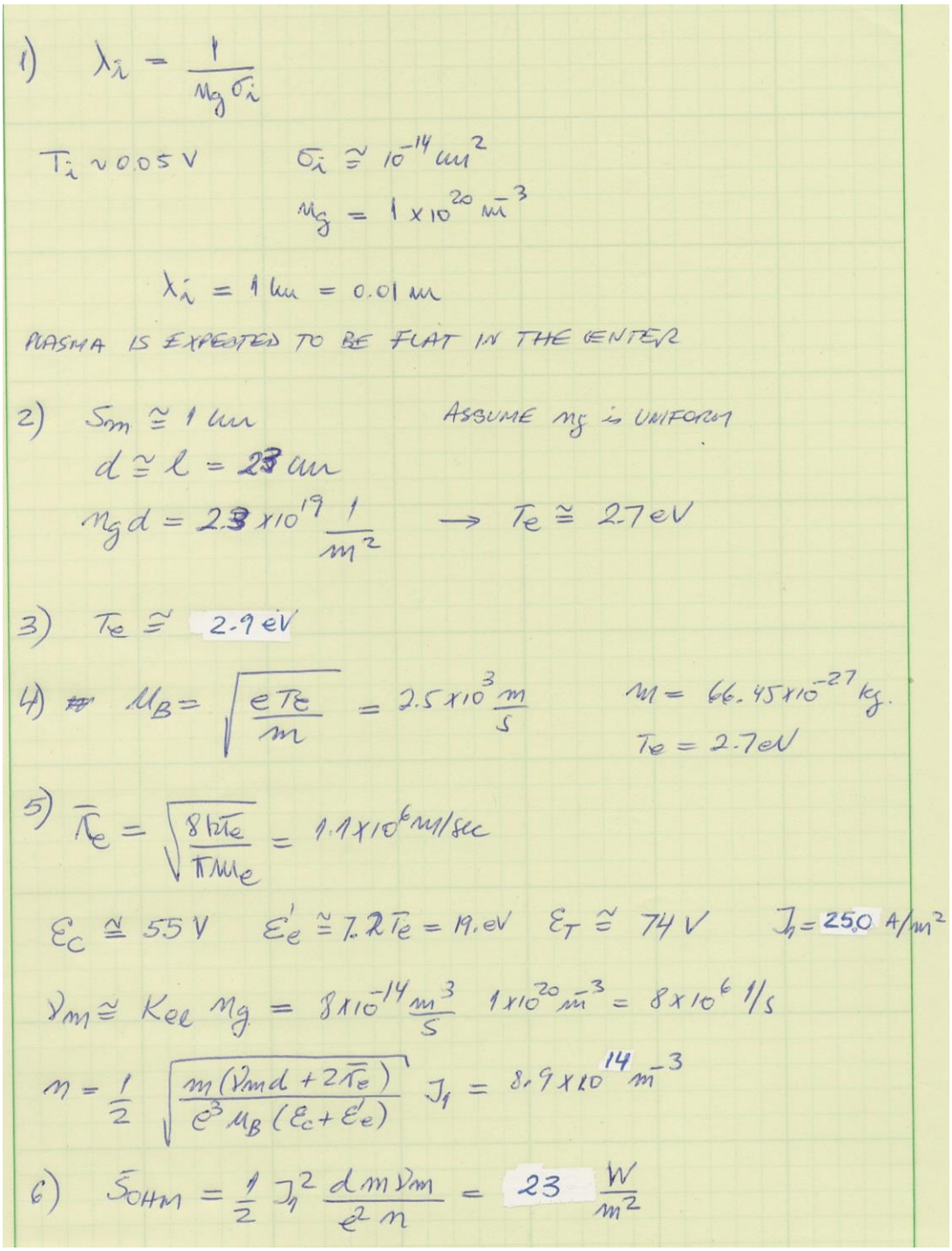
EE507 – Plasma Physics and Applications

Solutions to homework #6



1) $\lambda_i = \frac{1}{n_g \sigma_i}$

$T_i \sim 0.05\ V$ $\quad \sigma_i \cong 10^{-14}\ cm^2$

$n_g = 1 \times 10^{20}\ m^{-3}$

$\lambda_i = 1\ cm = 0.01\ m$

PLASMA IS EXPECTED TO BE FLAT IN THE CENTER

2) $s_m \cong 1\ cm$ $\quad$ ASSUME n_g is UNIFORM

$d \cong \ell = 23\ cm$

$n_g d = 2.3 \times 10^{19}\ \frac{1}{m^2} \rightarrow T_e \cong 2.7\ eV$

3) $T_e \cong 2.9\ eV$

4) $u_B = \sqrt{\frac{eT_e}{m}} = 2.5 \times 10^3\ \frac{m}{s}$ $\quad m = 66.45 \times 10^{-27}\ kg.$

$T_e = 2.7\ eV$

5) $\bar{v}_e = \sqrt{\frac{8 k T_e}{\pi m_e}} = 1.1 \times 10^6\ m/sec$

$\mathcal{E}_c \cong 55\ V$ $\quad \mathcal{E}_e' \cong 7.2\,\bar{T}_e = 19\ eV$ $\quad \mathcal{E}_T \cong 74\ V$ $\quad J_1 = 250\ A/m^2$

$\nu_m \cong K_{el}\, n_g = 8 \times 10^{-14}\ \frac{m^3}{s}\ 1 \times 10^{20}\ m^{-3} = 8 \times 10^6\ 1/s$

$n = \frac{1}{2}\sqrt{\frac{m(\nu_m d + 2\bar{v}_e)}{e^3 u_B (\mathcal{E}_c + \mathcal{E}_e')}}\ J_1 = 8.9 \times 10^{14}\ m^{-3}$

6) $S_{OHM} = \frac{1}{2} J_1^2 \frac{d\, m\, \nu_m}{e^2 n} = 23\ \frac{W}{m^2}$

$$\bar{S}_{STOCH} = \left(\frac{1}{2}\frac{m\bar{\nu}_e}{e^2 n_e} J_1^2\right) \times 2 =$$

$$= 27 \frac{W}{m^2}$$

7) $$\bar{V} = \frac{3}{4}\frac{en}{\varepsilon_0} s_0^2 = \frac{3}{4}\frac{J_1^2}{e\varepsilon_0 n \omega^2}$$

$\omega = 2\pi f = 8.5 \times 10^7 \frac{1}{s}$ $\quad \varepsilon_0 = 8.85 \times 10^{-12}$

$\bar{V} = 50\ V$

8) $$S_{ABS} = S_e + S_i \cong 2 e n_i \mu_B (\bar{V} + \varepsilon_e + \varepsilon_e') =$$

$= 88\ W/m^2$

$S_{TOTAL} = S_{ABS} \times A \cong 18\ W$

9) $$s_0 = \frac{J_1}{en\omega} = 0.2\ cm$$

10) $\varepsilon_i \sim 50V$