EE507 – Plasma Physics and Applications

Solutions to homework #6

HWK #6

1) b) $I_{SAT} \cong 0.7\ \mu A$

d) $V_f \cong 2.5\ V$

f) $V_P \cong 13.7\ V$

g) $I - I_{SAT} = I_e = j_e A\, e^{V-V_P/kT_e}$

$$\log\ -\ln(I_1) + \ln(I_2) = \frac{V_2 - V_P}{kT_e} - \frac{V_1 - V_P}{kT_e} = \frac{V_2 - V_1}{kT_e}$$

I CHOOSE $I_1 = 10\,\mu A$ AND $I_2 = 1\,\mu A \Rightarrow V_2 - V_1 \cong -7.5\ V$

$$\Rightarrow -2.3 = \frac{-7.5}{T_e} \Rightarrow T_e \cong 3.3\ eV$$

h) $$I_i = M_i\, e \sqrt{\frac{kT_e}{M_i}}\, A = 0.6\, M_0\, e \sqrt{\frac{kT_e}{M_i}}\, A$$

$$\Rightarrow M_0 = \frac{I_i}{0.6\, e \sqrt{\frac{kT_e}{M_i}}\, A} =$$

$$= \frac{0.0007}{0.6\ 1.6\times10^{-19} \sqrt{\frac{3.5 \times 1.6\times10^{-19}}{0.040/6.02\times10^{23}}}\ 0.137\times10^{-4}} = 1.9\times10^{17}\ m^{-3}$$

$$= 1.9\times10^{11}\ cm^{-3}$$

2) $E = \frac{\chi_{01}}{R}\sqrt{\frac{D_a \varepsilon_T}{\mu_e}}$ $\qquad \chi_{01} = 2.4$ $\qquad V \cong E \times \ell$

μ_e CAN BE WRITTEN AS $\mu_e = \frac{e}{m \nu_m}$ AND $\nu_m = \frac{\bar{v}}{\lambda_e}$ $\left(\text{OR } \lambda_e = \frac{\bar{v}}{\nu_m}\right)$

WITH $\bar{v} = \sqrt{\frac{8kT_e}{\pi m}}$. $\qquad n_0 = \frac{I}{2\pi e \left(\frac{R^2}{\chi_{01}}\right) J_1(\chi_{01})\, \mu_e E}$

3) SEE NOTES