EE507 – Plasma Physics and Applications

Solutions to homework #5

EE580 - HWK # 5

1)

$$I_{SAT} = M_S \, e \, A \sqrt{\frac{kT_e}{M}}$$

$$\Rightarrow n_p = \frac{I_{SAT}}{0.61 \, e \, A \sqrt{\frac{kT_e}{M}}} = \frac{100 \times 10^{-6} \, A}{0.61 \, 1.6\times10^{-19} \, 2\,(0.002)^2 \sqrt{\frac{1.6\times10^{-19} \, 2}{0.04/6.02\times10^{23}}}} =$$

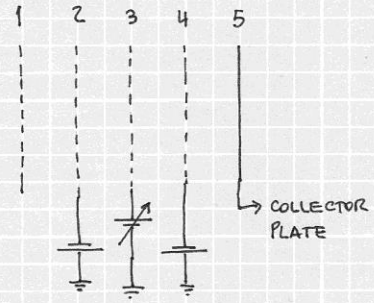
$$= 5.8 \times 10^{16} \, m^{-3}$$

2)

$$I_{SAT} = 0.61 \, 10^6 \, m^{-3} \, 1 \, m^2 \sqrt{\frac{1.6\times10^{-19} \, 1}{1.67\times10^{-27}}} \, 1.6\times10^{-19} \simeq 1 \, mA$$

3) SEE CHEN, PAGE 409

4)



THE MAXIMUM CURRENT IS GIVEN BY THE CHILD-LANGMUIR LAW

$$J = \frac{4}{9} \varepsilon_0 \sqrt{\frac{2e}{M_i}} \frac{V_0^{3/2}}{s^2} =$$

$$= \frac{4}{9} 8.85\times10^{-12} \sqrt{\frac{2 \times 1.6\times10^{-19}}{0.004/6.02\times10^{23}}} \frac{100^{3/2}}{(0.001)^2} = 27.3 \, \frac{A}{m^2}$$

$$I = JA = J \pi r^2 = 27.3 \, \frac{A}{m^2} \, \pi \, (0.002)^2 = 3.4\times10^{-4} \, A.$$