2002 Part II Q2A, B Exp

A.

a. $I_{is} \approx 1.7\,mA$

$I_{es} \approx -10.9\,mA$

b. $V_f \approx 5V$

$V_p \approx 20V$

c. $V_p - V_f = \frac{T_e}{e}(3.3)$ for H

$15\,V = \frac{T_e}{e} 3.3 \Rightarrow T_e \approx 4.5\,eV$

d. $A = \pi\frac{d^2}{4} + \pi d l = 7.85\cdot10^{-7}\,m^2 + 1.57\cdot10^{-5}\,m^2 = 1.65\cdot10^{-5}\,m^2$

$I_{is} = 0.6\,n e A\sqrt{\frac{T_e}{m_i}} = 1.7\,mA$

$\Rightarrow n \approx 5.2\cdot10^{16}\,m^{-3}$

Sheath expansion effects? $\lambda_D = \sqrt{\frac{\epsilon_0 T_e}{ne^2}} \approx 7\cdot10^{-5}\,m = .07\,mm$

$\frac{\lambda_D}{d} \sim \frac{.07}{1} \sim$ small, so sheath effects are small and **shouldn't** affect the accuracy of the density **estimate.**

B.1. The Paschen equation does not take into account effects like the internal modes of air, which can take energy without ionizing. **Also,** air can form negative ions, which removes free electrons and therefore increases the breakdown voltage

2. exponential decrease: Ambipolar diffusion to the wall

$\frac{dn}{dt} \sim -n$

$\frac{1}{e}$ decay: two-body recombination $\frac{dn}{dt} \sim -n^2$

3.