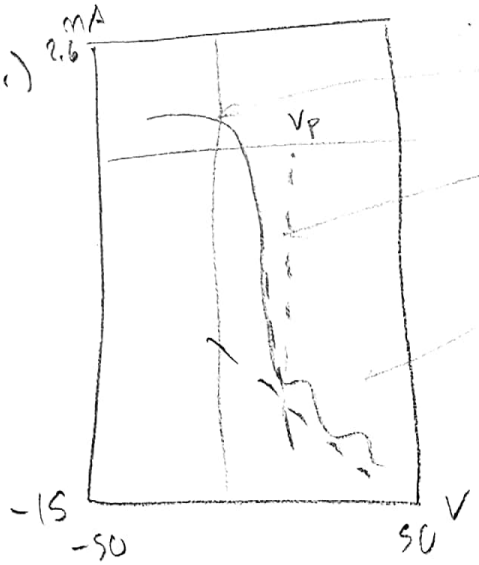
2015 II: Qs Exp

(a.)



(b.)

ion saturation ⟶ $V < -10V$

transition region ⟶ $-10V < V < 40V$

electron saturation ⟶ $V > 40V$

(c.) $V_f \sim 10V$

$V_p \sim 30V$

(d.) $I(v) = -I_{isat} + I_{esat} \exp\left(-\frac{e(V_p - V)}{kT}\right)$

$$\ln\left(\frac{I_{isat}}{I_{esat}}\right) = \frac{-e}{kT}(V_p - V_f)$$

$m_{Ar} = 40u$

$\Rightarrow \frac{m_e}{m_i} = \frac{1}{40 \cdot 1600}$

$$\frac{I_{isat}}{I_{esat}} \sim \sqrt{\frac{m_e}{m_i}} \Rightarrow kT = e(V_f - V_p)\left[\ln\left(\sqrt{\frac{m_e}{m_i}}\right)\right]^{-1}$$

$\sqrt{\frac{m_e}{m_i}} = \frac{1}{6 \cdot 40} = \frac{1}{240}$

$\frac{1}{\ln\left(\frac{1}{240}\right)} = \frac{1}{-\ln(240)}$

$e \approx 3$

$3^3 = 27 \sim 30$

$3^5 \sim 270$ ✓

$$kT = e(20V)\left(\frac{1}{5}\right)$$

$$\boxed{kT \sim 4eV}$$

(e.) $I_{isat} \sim e n_e \left(\frac{kT}{m_i}\right)^{1/2} A$ $\quad A = 5\ mm^2 = 50 \times 10^{-3}\ cm^2$

$1\ mA \Rightarrow n_e \approx \frac{(1 \times 10^{-3}\ C/s)}{(1.6 \times 10^{-19}\ C)} \frac{1}{(50 \times 10^{-3}\ cm^2)} \sqrt{\frac{4 \cdot 2 \times 10^{-27}\ kg}{20\ eV}}$

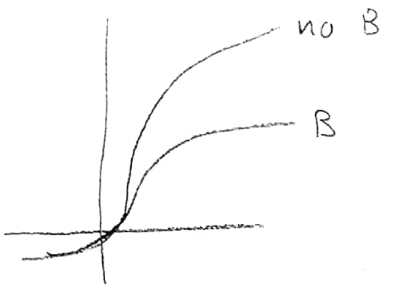
$4eV = 1.6 \times 10^{-19}\ J$

$-27 + 19 = -8$

$$n_e \approx \frac{1}{100 \times 10^{-19}\ C\,cm^{-2}} \sqrt{\frac{10 \times 10^{-8}\ s^2}{3 \times 10^{-4}}} \left(\frac{100\ cm}{1 \times 10^{-2}}\right)$$

$\Rightarrow n_e \approx 3 \times 10^{11}\ cm^{-3}$

f.) If the plasma is strongly magnetized we can assume motion is primarily along the field lines. This means you can only collect along flux tubes.



→ distorts I_{esat} because ↑ less e⁻ collected

Also changes A to projection along flux tube.

V_f stays same. I_{isat} changes a bit but ~ const.

g.) No, extra information would come from the electron saturation region but electron signal dominates there so you can't say much.