Magnetohydrodynamics · Homework 1

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1. (1) $B = 0.5\ G$, $E = 10\ keV = \frac{1}{2} m_p v_p^2 \Rightarrow v_p \approx 1384\ km/s$

$\therefore r_p = \frac{m_p v_p}{eB} \approx 288.99\ m \approx 2.89 \times 10^4\ cm$

$\omega_p = \frac{eB}{m_p} \approx 4789.4\ rad/s$

(2) $B = 5 \times 10^{-5}\ G$, $v_e = 300\ km/s$

$\therefore r_e = \frac{m_e v_e}{eB} \approx 341.14\ m \approx 3.41 \times 10^4\ cm$

$\omega_e = \frac{eB}{m_e} \approx 879.4\ rad/s$

2. (1) $n_e \approx 10^4\ cm^{-3}$, $T \approx T_e \approx T_i = 10^3\ K$

$\therefore \lambda_D = \sqrt{\frac{\varepsilon_0 k_B T}{n_e e^2}} \approx 2.18\ cm$

$\omega_p \approx \omega_e = \sqrt{\frac{n_e e^2}{m_e \varepsilon_0}} \approx 5.64 \times 10^6\ rad/s$

$f_p = \frac{\omega_p}{2\pi} \approx 8.98 \times 10^5\ s^{-1}$

(2) $n_e \approx 10^8\ cm^{-3}$, $T \approx T_e \approx T_i = 10^6\ K$

$\therefore \lambda_D \approx 0.69\ cm$, $\omega_p \approx 5.64 \times 10^8\ rad/s$, $f_p \approx 8.98 \times 10^7\ s^{-1}$