Assignment 2

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Task 1 The Hugoniot equation for an ideal gas

$$\frac{\rho_1}{\rho_0} = \frac{(\gamma+1)\frac{P_1}{P_0} + (\gamma-1)}{(\gamma+1) + (\gamma-1)\frac{P_1}{P_0}}, \quad \text{where } \gamma = \frac{5}{3}$$

$$\lim_{P_1 \to \infty} \frac{(\gamma+1)\frac{P_1}{P_0} + (\gamma-1)}{(\gamma+1) + (\gamma-1)\frac{P_1}{P_0}} =$$

$$= \lim_{P_1 \to \infty} \frac{(\gamma+1)\,P_1}{(\gamma-1)\,P_1} = \frac{\gamma+1}{\gamma-1} = \frac{5/3+1}{5/3-1} = \underline{4 \text{ times}}$$

We can get the equation

$$\frac{\rho_1}{\rho_0} = \frac{(\gamma+1)\,P_1/P_0 + (\gamma-1)}{(\gamma+1) + (\gamma-1)\,P_1/P_0}$$

from system of equations:

$$\begin{cases} \rho_0 u_0 = \rho_1 u_1 \\ P_0 + \rho_0 u_0^2 = P_1 + \rho_1 u_1^2 \\ \frac{P_0}{\rho_0} + e_0 + \frac{u_0^2}{2} = \frac{P_1}{\rho_1} + e_1 + \frac{u_1^2}{2} \\ e_0 = \frac{1}{\gamma-1}\frac{P_0}{\rho_0}, \quad e_1 = \frac{1}{\gamma-1}\frac{P_1}{\rho_1} \end{cases}$$

Task 2

Fermi energy

$$E_{Fermi} = 3.65 \times 10^{-15}\, n^{\frac{2}{3}}\, eV =$$

$$E_{Fermi} = 3.65 \times 10^{-15} \left(\frac{\rho}{m_{\text{protons or neutrons}}} \right)^{2/3} =$$

$$= 3.65 \times 10^{-15} \left(\frac{1,100}{1.67 \times 10^{-24}} \right)^{2/3} =$$

$$= 3.65 \times 10^{-15} (658)^{2/3} \times 10^{24 \frac{2}{3}} =$$

$$= 2,760\ eV < 150\ eV$$

If the material temperature is well bellow the Fermi temperature, then the Fermi preasure will dominate – and we consider that the material is <u>cold</u> (Fermi degenerate)