Θ1 $n = \frac{N}{V} = \frac{\rho N_i}{V} = \frac{4}{a^3} = 5.9 \cdot 10^{28}\ m^{-3}$

$T_F = \frac{E_F}{k_B} = \frac{\hbar^2 k_F^2}{2mk_B} = \frac{\hbar^2}{2mk_B}(3\pi^2 n)^{2/3} =$ **69000 K**

$n_i = \frac{n}{5} = 5.1 \cdot 10^{28}\ m^{-3}$ $\qquad c_0 = \sqrt{\frac{B}{\rho_M}} = \sqrt{\frac{B}{\frac{A}{N_A} n_i}} = 3089\ m/s$

$\Theta_D = \frac{\varepsilon_D}{k_B} = \frac{\hbar c_0 q_D}{k_B} = \frac{\hbar 0{,}58\, c_0 (6\pi^2 n_i)^{1/3}}{k_B} = 214\ K$

$C_{V_{el}} = C_{V_{ph}} \Rightarrow \frac{\pi^2}{2} N k_B \frac{T}{T_F} = \frac{12\pi^4}{5} N_i k_B \left(\frac{T}{\Theta_D}\right)^3$

$\Rightarrow T_c^2 = \frac{5}{24\pi^2} \frac{\Theta_D^3}{T_F} \Rightarrow$ **T = 1,7 K**

Θ2 $m \frac{dv}{dt} = -eE - \frac{mv}{\tau} - m\omega_0^2 x \Rightarrow$

$-m i\omega v = -eE - \frac{m}{\tau} v + \frac{i m \omega_0^2 v}{\omega} \Rightarrow$

$\left(i\omega m - \frac{m}{\tau} - i\frac{m\omega_0^2}{\omega}\right) v = eE \Rightarrow v = \frac{e}{m} \frac{1}{i\omega - \frac{1}{\tau} - \frac{i\omega_0^2}{\omega}} E$

$j = -nev \Rightarrow j = \frac{ne^2}{m} \frac{1}{\frac{1}{\tau} + \frac{i\omega_0^2}{\omega} - i\omega} E \qquad \omega_p^2 = \frac{ne^2}{m\varepsilon_0}$

$j = \frac{\varepsilon_0 \omega_p^2}{1/\tau + \frac{i\omega_0^2}{\omega} - i\omega} E \Rightarrow \sigma = \frac{\varepsilon_0 \omega_p^2}{1/\tau + \frac{i\omega_0^2}{\omega} - i\omega}$

$\varepsilon = \varepsilon_0 + \frac{i\sigma}{\omega} \Rightarrow \varepsilon(\omega) = \varepsilon_0 \left(1 + \frac{i\omega_p^2}{\omega(1/\tau + \frac{i\omega_0^2}{\omega} - i\omega)}\right)$

$\varepsilon(\omega) = \varepsilon_0 \left(1 - \frac{\omega_p^2}{\omega^2} \frac{1}{1 - \frac{\omega_0^2}{\omega^2} + \frac{i}{\omega\tau}}\right)$

Θ3 $c = \sqrt{\frac{K}{m_i}} a = \sqrt{\frac{K}{A/N_A}} a = 621\ m/s$

$\frac{2k_F}{2\pi/L} = \frac{N}{2} \Rightarrow k_F = \frac{\pi N}{2L} = \frac{\pi}{2a} \qquad v_F = \frac{\hbar k_F}{m} \Rightarrow v_F = \frac{\hbar \pi}{2ma} = 5{,}3 \cdot 10^6\ m/s$

Θ4 12 γείτονες, σε θέσεις $\vec{R} = n_1 \vec{a}_1 + n_2 \vec{a}_2 + n_3 \vec{a}_3$

$\vec{a}_1 = \left(\frac{a}{2}, \frac{a}{2}, 0\right)$, $\vec{a}_2 = \left(\frac{a}{2}, 0, \frac{a}{2}\right)$ $\vec{a}_3 = \left(0, \frac{a}{2}, \frac{a}{2}\right)$

n_1, n_2, n_3 = όλοι οι 12 συνδυασμοί των $-1, 0, 1$ με $|\vec{R}| = a\sqrt{2}/2$

(2,04 2,04 0), (2,04 0 2,04) (0, 2,04, 2,04)

(-2,04 -2,04 0) (-2,04 0 -2,04 (0, -2,04, -2,04) κλπ