

1. Express the thermodynamic potentials U , F and G for the ideal gas in terms of *natural variables*, i.e. $U(S, V, N)$, $F(T, V, N)$ and $G(T, p, N)$.
2. Show that it is consistent to assume that the heat capacity of the van der Waals gas is constant, $C_V = f/2k_B N$, as for the ideal gas. Calculate S , U , F , H and G for the van der Waals gas. What is the physical interpretation of the expression for U ?
3. Prove that for a substance obeying Curie's law, $M = \text{const.} \times H/T$, the internal energy and heat capacity depend only on temperature.
4. Show that $\kappa_T(C_p - C_V) = TV\alpha_T^2$ and $C_p/C_V = \kappa_T/\kappa_S$.