PHY304: Statistical Mechanics

Assignment 2

January 15, 2025

1. The fundamental relation is given by

$$S = \left(\frac{R^2}{v_0\theta}\right)^{1/3} (NVU)^{1/3},$$

where R, v_0 and θ are constants.

   (a) Find the fundamental equation in Gibbs Representation $G(T, P, N)$.

   (b) Calculate $\alpha(T, P)$, $\kappa_T(T, P)$ and $c_p(T, P)$.

2. Sometimes we refer to the "first TdS equation" and "second Tds equation" as:

$$TdS = Nc_v dT + \left(\frac{T\alpha}{\kappa_T}\right) dV \qquad (N \text{ constant})$$

$$TdS = Nc_p dT - TV\alpha dP \qquad (N \text{ constant})$$

   Derive these equations.

3. Show that:

$$c_P = c_v + \frac{TV\alpha^2}{N\kappa_T} \qquad \text{and} \qquad \kappa_T = \kappa_S + \frac{TV\alpha^2}{Nc_P},$$

   where α is the coefficient of thermal expansion, κ_T is the isothermal compressibility, c_P is the molar heat capacity at constant pressure, κ_S is the adiabatic compressibility and c_v is the molar heat capacity at constant volume.

4. Calculate $\left(\frac{\partial H}{\partial V}\right)_{T,N}$ in terms of the standard quantities c_P, α, κ_T, T, and P.