Homework

CML521: Molecular Thermodynamics

January 13, 2023

1. In our class, we derived an important relationship between C_P and C_V,

$$C_P - C_V = \left[P + \left(\frac{\partial U}{\partial V}_T\right)\right]\left(\frac{\partial V}{\partial T}\right)_P \tag{1}$$

Show that

$$C_V = C_P\left[1 - \mu_{JT}\left(\frac{\partial P}{\partial T}\right)_V\right] - V\left(\frac{\partial P}{\partial T}\right)_V \tag{2}$$

2. Find the value of $\left(\frac{\partial C_V}{\partial V}\right)_T$ for an ideal gas ($PV = RT$) and van der Waals gas $\left(PV = \frac{RT}{V-b} - \frac{a}{V^2}\right)$. Interpret your results with proper reasoning.

3. The Joule-Thomson coefficient is given as,

$$\mu_{JT} = -\frac{1}{C_P}\left(\frac{\partial H}{\partial P}\right)_T \tag{3}$$

Prove that the inversion temperature (T_i) for a gas obeying van der Waals equation of state $\left(PV = \frac{RT}{V-b} - \frac{a}{V^2}\right)$ is equal to $\frac{2a}{bR}$