Q4001 Thermodynamics of Materials **September, 2019**
Homework 4

1. Read the article by S. M. Blinder "Mathematical Methods in Elementary Thermodynamics".

2. Use what you learnt from your reading to calculate $(\partial\overline{V}/\partial T)_P$ and $(\partial\overline{V}/\partial P)_T$ for a van der Waals gas.
$$\left(P + \frac{a}{\overline{V}^2}\right)\left(\overline{V} - b\right) = RT$$

3. Two pieces of aluminum of equal mass, m, and with initial temperatures $T_{\mathrm{A},0} = 400\,K$ and $T_{\mathrm{B},0} = 300\,\mathrm{K}$ are placed in thermal contact with each other but otherwise isolated from their surroundings.
   (a) Calculate the equilibrium temperature of the system.
   (b) Calculate the change in internal energies for A, B and the total system.
   (c) Calculate the change in entropy for A, B and the total system.
   (d) Plot a graph of the change in total entropy with respect of a variable x, such that $T_\mathrm{A} = T_{\mathrm{A},0} - x$ or $T_\mathrm{B} = T_{\mathrm{B},0} + x$.
   Choose a reasonable range for x and discuss the implication of the plot obtained.

4. Calculate ΔS_A, ΔS_B, ΔS_surr and ΔS_univ for Problem 4 in Homework 2.

5. Calculate the entropy change for a mole of a perfect diatomic gas when it expands isothermally and reversibly from a volume of $0.3\,\mathrm{L}$ to $2.4\,\mathrm{L}$ at a temperature of $298\,\mathrm{K}$. What would be the change in entropy if it is considered now a van der Waals diatomic gas for which $a = 6.26\,\mathrm{atm\,L^2\,mol^{-2}}$ and $b = 0.052\,\mathrm{L\,mol^{-1}}$?

6. What will be the entropy change of 1 mol of liquid benzene if at 20 °C it is compressed from 1 atm to 100 atm? The coefficient of thermal expansion for benzene at this temperature is $12.4 \times 10^{-4}\,\mathrm{K}^{-1}$.

7. Calculate the change in the enthalpy and the change in entropy when 1 mole of SiC is heated from 25 °C to 1000 °C. The constant-pressure molar heat capacity of SiC varies with temperature as
$$\overline{C}_P = 50.79 + 1.97 \times 10^{-3}\,T - 4.92 \times 10^{6}\,T^{-2} + 8.20 \times 10^{8}\,T^{-3} \quad \mathrm{J/mol\,K}$$

Due date: Tuesday, september 10th