

Question #1 (25 points)

Show that $(C_p/P)_T = -VT[(\alpha/T)_P + \beta^2]$

where C_p is the heat capacity at constant pressure, α is the isobaric coefficient of thermal expansion, V is the volume, T is temperature and P is pressure.

Question #2 (25 points)

The temperature dependence of the vapor pressure of **solid** sulfur dioxide can be approximately represented by the relation $\log(P_s) = 10.5916 - 1871.2/T$. The temperature dependence of the vapor pressure of **liquid** sulfur dioxide can be approximately represented by the relation $\log(P_l) = 8.3186 - 1425.7/T$. (P is in torr and T in Kelvin and $760 \text{ torr} = 101,325 \text{ Pa}$, $R = 8.3145 \text{ S.I.}$).

- Assuming that the above two equations hold close to the triple point of sulfur dioxide, determine the pressure and the temperature at the triple point. (hint: draw the solid/liquid/vapor phase diagram in the (T,P) plane to find a condition defining the triple point)
- Determine the Enthalpy of Fusion of Sulfur Dioxide. (hint: first estimate the enthalpy of vaporization and the enthalpy of sublimation.)

Question #3 (25 points)

From the information given on the last page, calculate the standard Gibbs reaction free energy, $\Delta_r G^\circ$ and the equilibrium constant at a) 298K and b) 400K for the reaction :

$\text{PbO (solid, red)} + \text{CO (gas)} \rightleftharpoons \text{Pb(solid)} + \text{CO}_2 \text{ (gas)}$. Make sure you state all assumptions and approximations used to get to the result.

What will be the mole fraction of CO in the gas phase above these solids at the end of the reaction at 298K. Assume there is initially 1 mole of CO under a pressure of 10^5 Pa and 1.5 mole of PbO(solid, red)

Question #4. (25 points)

In all following questions, you must justify your answers with appropriate equation(s) and wording to get full credit.

- How does the entropy change with T at constant P in a reversible process?
- How does the entropy change during Crystallization under equilibrium conditions?
- How does the entropy change with V at constant T for a reversible process?
- How does the entropy change with P at constant T for a reversible process?
- What **can** you say about the entropy change of a system during an adiabatic process?