3.020 – Thermodynamics of Materials Recitation 4

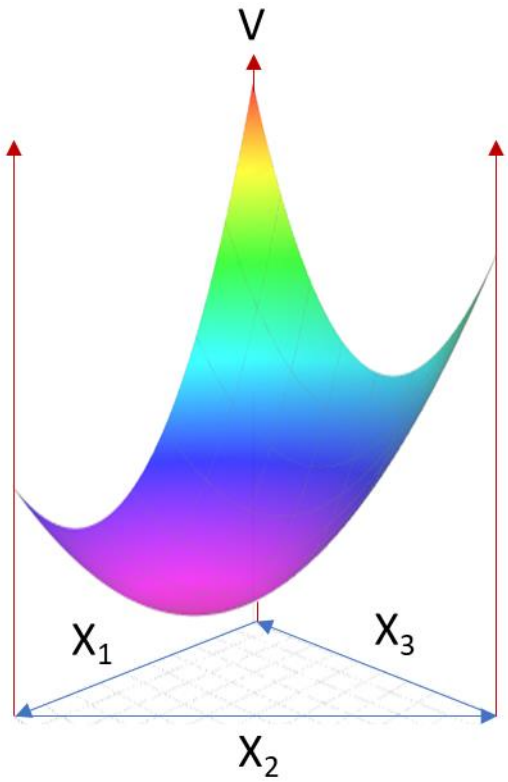
Problem 1

The molar volume of a ternary solution (1,2,3) is described by the equation: $V = 5X_1 + 10X_2 + 15X_3 - 2X_1X_2 - 2X_1X_3 - 2X_2X_3$ $[cm^3/mol]$. First, we will only consider the mixing of component 1 with component 2 in the absence of component 3.

a) Simplify the equation above to the binary solution and calculate the molar volume (V) at the composition $X_1 = X_2 = 0.5$
b) Calculate the volume of mixing (ΔV_{MIX}) at this particular composition. Is this quantity bigger or smaller than 0? What does it mean?
c) Calculate the partial molar volumes of mixing ($\Delta \bar{V}_2$ and $\Delta \bar{V}_1$) at this particular composition. Compare these quantities with the quantity found in (b). What does this mean?
d) Make a sketch of ΔV_{MIX} and V as a function of X_2 and indicate all important volumes.

Now, we leave the ratio of component 1 and component 2 untouched ($X_2/X_1 = 1$) and we start adding component 3 ($X_3 > 0$).

e) Calculate the partial molar volume of mixing $\Delta \bar{V}_3$ at the original composition ($X_3 = 0$), what does this mean?
f) Since we know from (e) that the volume of mixing will decrease by adding component 3, how much of component 3 do we need to add to minimize ΔV_{MIX}? What is the final composition of the three components?
g) What is this minimal ΔV_{MIX}, and what is the molar volume V at this final composition?



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