MATE 313

Fall 2019

Homework # 1

Due: October 10th, 2019

Group submission (up to 3 students per group) is allowed.

Question 1

The temperature at which pure iron transforms from BCC to FCC crystal structure on heating is 912°C at atmospheric pressure.
Use the data given below and calculate by how much the pressure (ΔP) must be increased in order to have this transformation at 812°C?

ΔH (BCC $\rightarrow$ FCC) = 7153 J/mole

$V_m(\alpha) = 7.061x[1 + 2.043x10^{-5}T + 1.52x10^{-8}T^2]$ cm³/mole

$V_m(\gamma) = 6.695x[1 + 2.043x10^{-5}T + 1.52x10^{-8}T^2]$ cm³/mole

Question 2

Calculate the heat (ΔH) required to form a Cu-Ag liquid solution at 1356K starting with 4 moles of solid Cu and 1 mol of solid Ag at 298K.

Data:

At 1356K the enthalpy of mixing for a Cu-Ag liquid solution is given by:

$\Delta H_{mix} = -20{,}590X_{Cu}X_{Ag}$ J/mol of solution.

Ag melts at 1234K where $\Delta H_{melt,Ag}$ = 11,090J/mol;

$Cp_{(Ag,s)} = 21.3 + 8.54x10^{-3}T$ J/mol.K; $Cp_{(Ag,l)}$= 30.5 J/mol.K

Cu melts at 1356K where $\Delta H_{melt,Cu}$ = 12,970J/mol;

$Cp_{(Cu,s)} = 22.64 + 6.28x10^{-3}T$ J/mol.K

Question 3:

Calculate a) the entropy of mixing b) the Gibbs free energy of mixing for 350 g of an equimolar ideal solid solution of Cu and Ni at 727°C.

Question 4:

Calculate the degrees of freedom for
(a) pure Pb at its melting point
(b) pure Pb below its melting point, and
(c) a single-phase solid solution of Sn dissolved in the solvent Pb,.

Question 5:

Based on the phase diagram given on the right, draw the free energy curves of the phases at a temperature
a) just above and
b) just below the peritectic temperature.