MT 201 Phase Transformations

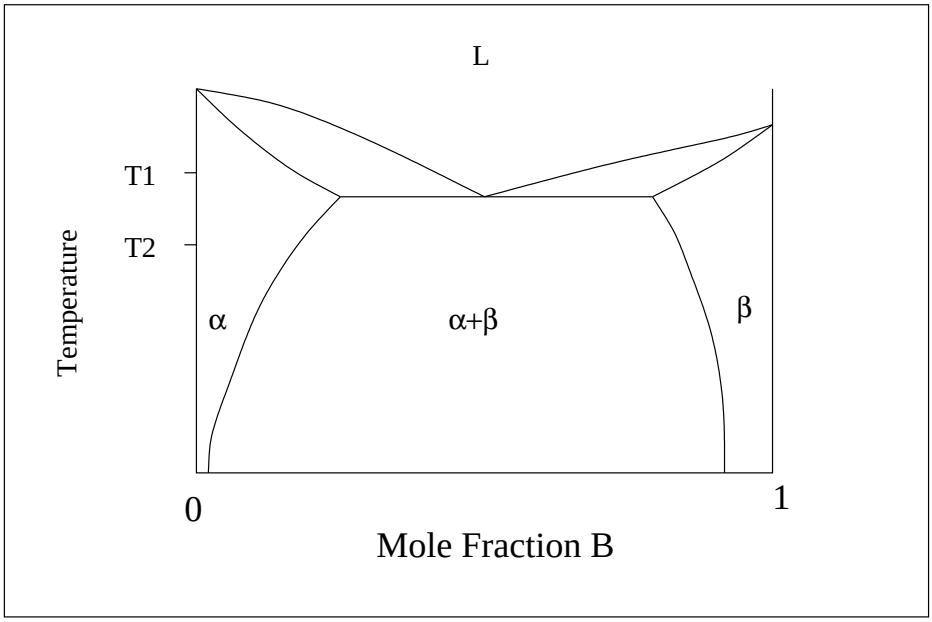
Spring 2007

Home Assignment 2

1. At constant temperature and pressure, the condition for multiphase equilibrium is that the chemical potential of each component be the same everywhere (*i.e.*, in all the phases) in the system.
   (a) For two-phase equilibrium in a binary system, show that this condition is equivalent to the common tangent construction (between the G_m *vs.* x curves for the two phases).
   (b) For two-phase equilibrium in a binary system, show that this condition is also equilvalent to the "minimum free energy" criterion.

2. Derive the 'lever rule': if an alloy of composition x exists in the form of a mechanical mixture of two phases of composition x^α and x^β, whose molar free energies are G_m^α and G_m^β, respectively, determine the mole fraction of each phase. Also, determine the free energy of one mole of the alloy.

3. (a) Draw the G *vs.* x diagrams at temperatures T_1 and T_2 for the binary system whose phase diagram is given below.
   (b) In the diagram for T_2, indicate the free energy change ΔG which drives the eutectic transformation in a eutectic alloy.
   (c) List all the invariant reactions (transformations) in this system.



4. For zinc, the melting point is 692.65 K and the boiling point, 1180 K. The entropy of fusion and vaporization are 2.53 and 23.36 cal/K-mol respectively. Calculate dT/dP for melting and boiling of zinc. Assume that the volume of liquid zinc is higher than that of solid zinc by 0.4 cm^3/mol at the melting point. You may also assume ideal behaviour for zinc vapour. Comment on your results.