Tutorial N°3:Thermodynamics of liquid-liquid and liquid-solid equilibrium

<u>Exercise 1</u>

A mixture of 50 g (0.59 mol) of hexane and 100 g (0.82 mol) of nitrobenzene was prepared at 273 K.

1//What are the compositions of the phases, and in what proportions are they found?

2/To what temperature must the sample be heated to obtain a single phase?

Exercise 2

The solid-liquid binary diagram of the silver-gold alloy under a pressure of 1 bar is represented in the following figure. The silver mole fraction is shown on the abscissa. 1. What are the names of curves (1) and (2) in this diagram? What do they correspond to?

2. Are silver and gold miscible in the solid state? Justify.

3. Plot the thermal analysis curve for isobaric cooling of an initially liquid mixture with a silver mole fraction equal to 0.5. Comment.

4. An initially solid mixture with a molar fraction $X_{Ag} = 0.6$ containing 10 moles of silver and gold is heated to 1000°C under 1 bar.

- How much silver, expressed in mol, is in liquid form?

- How much gold, expressed in mol, remains in the solid?

Exercise 3

The simplified liquid-solid binary diagram, under a pressure $p^{\circ} = 1$ bar, of an ethane-1,2-diol (C2H6O2) - water mixture is shown in the figure opposite.

1) Based on the appearance of the binary diagram, indicate whether miscibility is zero, partial, or total in the liquid state. The same question applies to the solid state.

2) Indicate the number and nature of the phases present in regionsI to IV of the diagram.







4) Consider a mixture composed of 5 mol of water and 5 mol of ethane-1,2-diol at -50°C, under $p^\circ = 1$ bar. Indicate in which region of the diagram the representative point of the system is located.

Data: MH = 1 g/mol; MC = 12 g/mol; MO = 16 g/mol.

Exercise 4

The binary solid-liquid isobaric equilibrium diagram for the **HNO3-H2O** system is shown opposite. The water mass fraction is plotted along the x-axis and the temperature along the y-axis. The x-axis coordinates of the defined compounds are 0.22 and 0.46.

The molar masses: 18 g.mol⁻¹ for H2O and 63.0 g.mol⁻¹ for HNO3.



a) What do points E1, E2, and E3 represent? Explain the formulas of the compounds defined in the form HNO3,XH2O. Specify the phases present at equilibrium in the different domains.

b) An aqueous nitric acid solution has a concentration of 8.44 mol.L⁻¹ of nitric acid and its density is 1.266 g.cm⁻³ (1266 g/l) at 20°C. Starting at 20°C, it is gradually cooled. Describe the phenomena observed and specify the specific temperatures.

c) 1 liter of the previous solution is slowly cooled. For temperatures $T = -35^{\circ}C$ and $T = -80^{\circ}C$, give the nature and mass of the phases present. Specify the coordinates of a point on the liquidus ($w_{H2O} = 0.62$; $T = -35^{\circ}C$).

BY Dr FZ. BOUTEBAKH