NAME, SURNAME, GROUP:

INSA Lyon **PCC2/AMERINSA2/SCAN2** **October 25th 2012**

CHEMISTRY TEST #1 (duration 1 h 30 min)

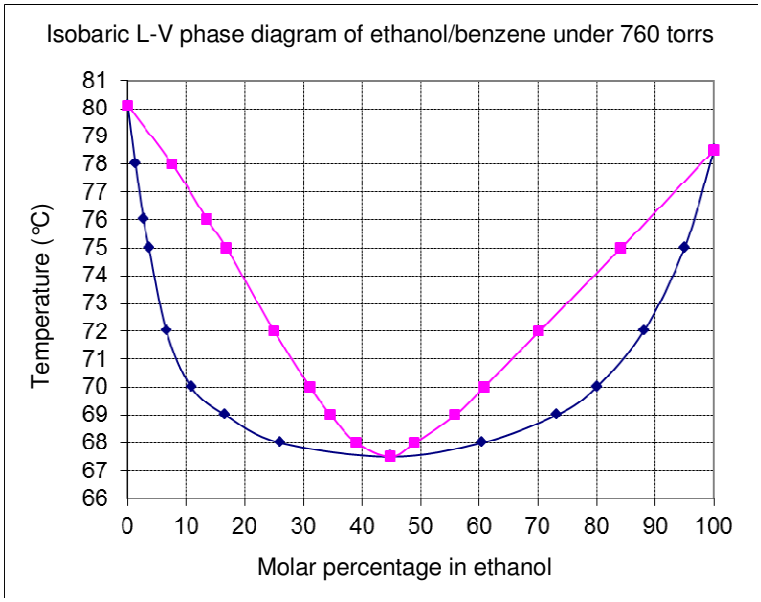
No document is allowed. Only non-programmable calculators are allowed.
Answers should be qualified. This paper must be returned with your copy.
Constants and conversion: R=8.314 J.mol^{-1}.K^{-1} and $T_{0°C}$ = 273 K, 1 atm=760 torrs = 101325 Pa = 1.013 Bar.
Vapors are considered as perfect gas.

Number of moles will be calculated to within ±0.1 mol and mass to within ± 0.1 mass unit

Exercise I : Ethanol (C_2H_5OH) – Benzene (C_6H_6) liquid-vapor diagram (10 points)

1/ Ethanol (E) and benzene (B) are fully miscible in the liquid state. Assuming that benzene and ethanol constitute an ideal solution, calculate at 79°C and under 760 torrs, the molar compositions in ethanol of the liquid and of the vapor in equilibrium, respectively denoted as x_E and y_E. The solved equations must be justified.

2/ Molar compositions in ethanol of liquid and vapor at the equilibrium have been determined for different temperatures under 760 torrs (see diagram and table below). Is it correct to consider that benzene-ethanol mixtures are ideal solutions? Justify your answer by discussing interactions between ethanol and benzene. Name the equilibrium curves and noteworthy points, as well as phases in each domains of the diagram. Calculate the variance in each domain and at the specific points.



$\theta_{boiling}$ (°C)	80.1	67.5	75.0	78.5
$X_{ethanol}$ (x_E) liquid (mol. %)	0	44.8	95.0	100
$Y_{ethanol}$ (y_E) vapor (mol. %)	0	44.8	84.2	100

3/ One ton of solution containing 15 weight % of benzene is heated to 75°C. Give the nature of the phases at the equilibrium, their mass and the quantities (in mol) of benzene and ethanol they contain.

4/ One of the constituents of the solution defined in question 3 has to be isolated. Which constituent can be obtained as pure by fractionated distillation? In which part of the distillation apparatus will it be collected and how much (in weight)?

5/ Schematically plot the isothermal phase diagram at 67.5°C. Locate equilibrium curves and noteworthy points, as well as phases in each domain.

Data :

Molar masses (g.mol^{-1}): $M_{Ethanol}$ = 46.0 $M_{Benzene}$ = 78.0.

Enthalpies of vaporization: Ethanol: $\Delta_{Vap}\overline{H_E^0}=38.6\ kJ.mol^{-1}$ Benzene: $\Delta_{Vap}\overline{H_B^0}=30.7\ kJ.mol^{-1}$

Boiling temperatures under p = 760 Torr: Ethanol: 78.5°C Benzene: 80.1°C

Exercise II : Magnesium (Mg) – Lead (Pb) solid-liquid phase diagram (10 points)

Magnesium (Mg) and lead (Pb) solid-liquid phase diagram under 760 torrs is plotted below. The composition in Pb is given in weight % (wt. %).

1/ Locate on this diagram the phases in each domain; name the equilibrium curves and noteworthy points.

2/ A defined compound can be found on this diagram. What type of fusion is exhibited by this compound? Determine its most simple chemical formula. Justify your answer.

3/ Indicate the coordinates and/or the domains at which the transformation is invariant. Variance calculations will be detailed.

4/ At which temperature the solubility of Pb in Mg is maximum? What is the value of this solubility expressed in gram of Pb per gram of Mg?

5/ 1 kg of a Mg-Pb mixture containing 51.5 mol. % of Pb is heated to 700°C.

a) Plot the thermal analysis curve when cooling from 700 to 100°C. Give the values for temperatures when slope is changing, the nature and the composition (in wt. %) of each phase which disappears or appears, as well as the variance on each curve segment.

b) What is the nature, the composition, the quantity in mol and the mass of each phase at 250°C + ε (i.e. at a temperature slightly higher than 250°C)?

6/ Let's consider now 150 kg of a Mg-Pb mixture containing 10 wt. % of Pb.

a) If the temperature is 465°C, which phase(s) is/are present? What is/are its/their composition(s) ?

b) Starting from this mixture, an industrial wants to produce the largest possible quantity of the defined compound. How should he proceed? Justify your answer.

Data: Molar masses ($g.mol^{-1}$): M_{Mg} = 24.3 ; M_{Pb} = 207.2.