Exercise #1

At 60°C the vapor pressure of ethanol is 352.7 mmHg and that of methanol is 625 mmHg. Ethanol and methanol form an ideal solution. For a liquid solution that contains 60% mole ethanol calculate:

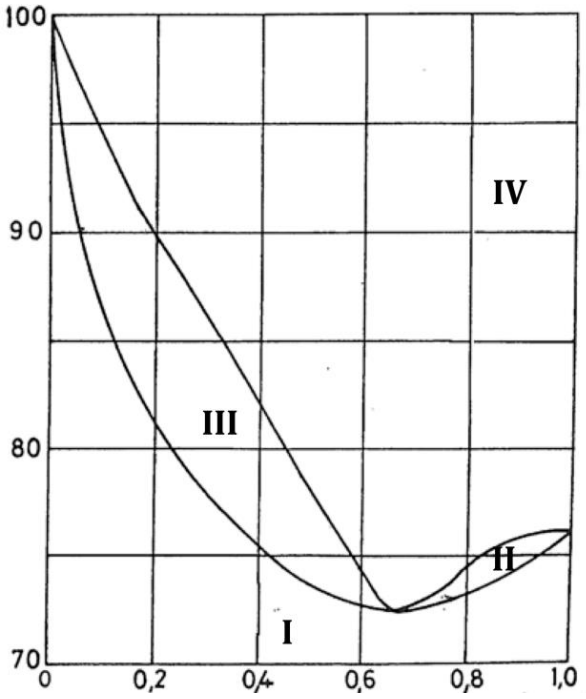
1. Vapor pressure of the mixture (P_{sol})
2. Composition of vaper in equilibrium with mixture
3. Composition of the last drop of liquid before vaporization become complete
4. Pressure at which the mixture will completely vaporize at 60° C

1. $P_{sol} = x_A P_A^* + x_B P_B^* = 0.6\,(352.7) + 0.4\,(625) = 461.6mm\,Hg$
2. $y_A = \frac{P_A}{P_{sol}} = \frac{x_A P_A^*}{x_A P_A^* + x_B P_B^*} = 0.6\frac{(352.7)}{461.6} = 0.458$
3. $y_A \cong 0.6 = \frac{x'_A P_A^*}{P_{sol}}$ and $P'_{sol} = x'_A P_A^* + x'_B P_B^* = x'_A P_A^* + (1 - x'_A)\,P_B^* \rightarrow y_A = \frac{x'_A P_A^*}{x'_A P_A^* + x'_A P_B^*}$ $x'_A = 0.727$
4. $P'_{sol} = x'_A P_A^* + x'_B P_B^* = 427mmHg$

Exercise 2

WATER/ETHYL ACETATE MIXTURE

Here, we have reproduced the liquid/vapor binary diagram of the water-ethyl acetate mixture under 1.013 bar.

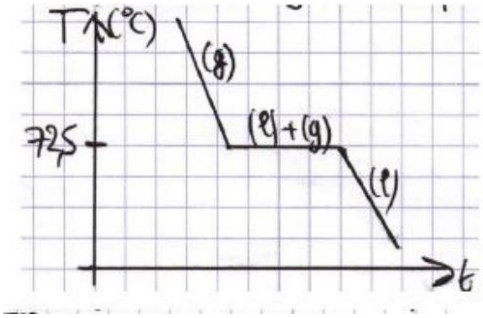


1. Are the two compounds miscible in the liquid state? Is the mixture ideal?

this diagram is an azeotrope so that it is a liquid the two compounds are completely miscible however the mixture is not ideal

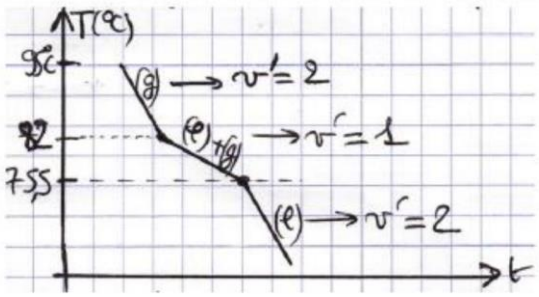
2. Specify the nature of the different regions of the diagram, as well as the name and significance of the curves
   - I homogeneous liquid phase at most ethanol ethanoate A + B
   - II and III liquid phase + gas phase
   - IV homogeneous gas phase om A + B
3. What are the boiling temperatures of pure water and pure ethyl acetate at P=1.013 bar?
4. Characterize the mixture with a mole fraction of $x = 66\%$. What will be the shape of its isobaric cooling curve starting from 95°C?

this mixture is the homo azeotrope at atmospheric pressure which boils at constant temperature and has constant and equal composition of the 2 phases during the change of state.



5. Let's consider 10 moles of a mixture with a mole fraction of 40% ethyl acetate. It is heated to 95°C under atmospheric pressure. What will be the shape of its isobaric cooling curve?

on the vertical x = 40% determines the dew point temperature = 82 and T boiling equal to 75.5 the isobar cooling curve deduced



When this mixture reaches the temperature of 80 °C, give the quantities of materials of the different species in the phases presentat 80 degrees we read it respectively on the boiling and dew curve horizontally x = 23% y = 45%

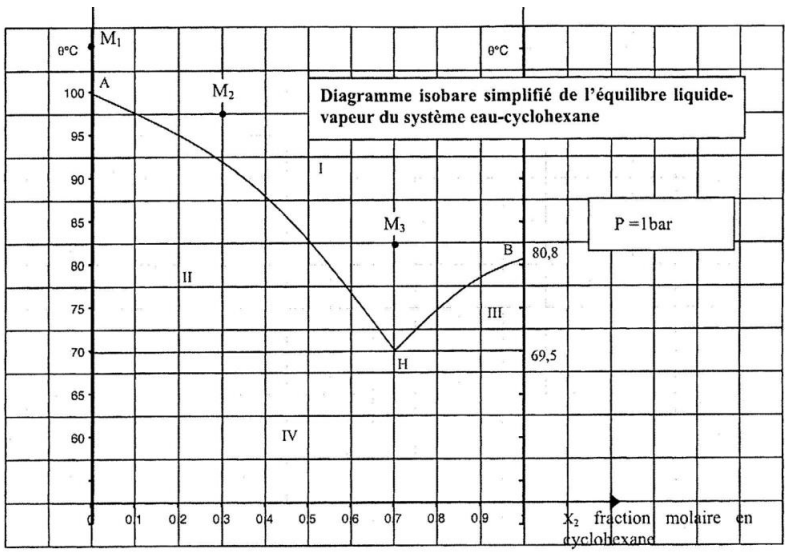
D'après le **théorème des moments** : $\frac{n^l}{n^g} = \frac{x^g_{ee} - x_{ee}}{x_{ee} - x^l_{ee}} \approx \frac{45-40}{40-23}$ soit $\frac{n^l}{n^g} \approx 0{,}29$.

Or, $n^l + n^g = 10$ mol. Donc : $\boldsymbol{n^l \approx 2{,}2}$ **mol** et $\boldsymbol{n^g \approx 7{,}8}$ **mol**. Au bilan :

- **phase liquide :** $\boldsymbol{n^l \cdot x^l_{ee} \approx 0{,}5}$ **mol et** $\boldsymbol{n^l \cdot \left(1 - x^l_{ee}\right) \approx 1{,}7}$ **mol d'eau** ;
- **phase gazeuse :** $\boldsymbol{n^g \cdot x^g_{ee} \approx 3{,}5}$ **mol et** $\boldsymbol{n^g \cdot \left(1 - x^g_{ee}\right) \approx 4{,}3}$ **mol d'eau.**

Exercise 3

The simplified isobaric binary phase diagram for the liquid-vapor equilibrium of the water-cyclohexane system is provided below. Water is denoted as B_1, and cyclohexane as B2.



1/ Indicate the nature of the phases present in each domain of the diagram. What type of mixture are we dealing with here?

On an azeotrope diagram corresponding to a completely immiscible liquid state mixture:
I: Homogeneous vapor mixture.
II and III: Homogeneous vapor + liquid phase.
IV: Homogeneous vapor phase plus liquid phase.
Heterogeneous liquid mixture.

2/ What is the name of the curve constituted by the branches AH and HB? What does it represent?

On a dew curve, the locus of temperatures at which the first drop of liquid appears from the corresponding gaseous mixture.

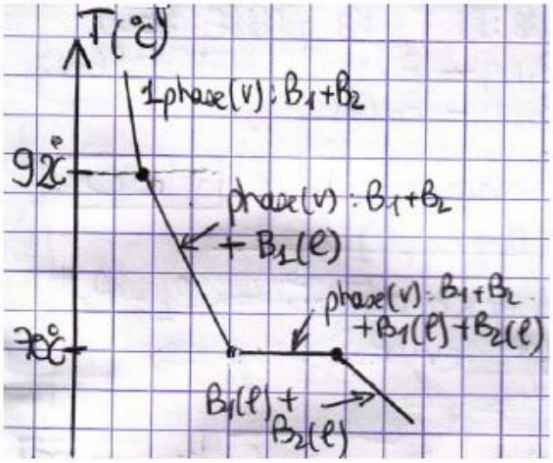
3/ What is the point H called on the diagram? How many degrees of freedom does the binary system represented by this point, which we will describe, have? Interpret the value found.

H is the heteroazeotropic or heteroazeotropic point. at this point two liquid phases (LA andLB) coexist with a vapor phase of composition x_H the overall composition of the liquid phases is also $x_B = x_B(H)$

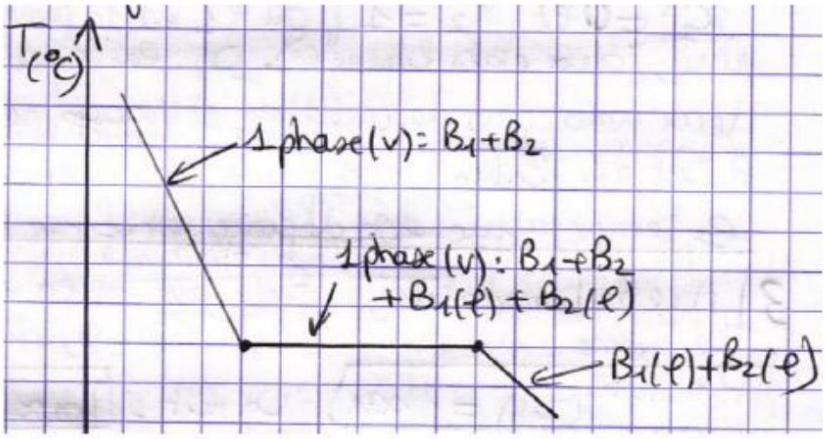
$$x_B = 0 \; for \; L_A and \; x_B = 1 \; for \; L_B$$

4/ Sketch the shape of the thermal analysis curves by cooling, up to 60°C, of the physicochemical systems represented by points M2 and M3. Indicate the phases present.

Refroidissement isobare de M_2



Refroidissement isobare de M_3



5/ In what physical state(s) are 11 moles of a mixture with a global molar fraction of cyclohexane of 0.30 at 80°C? What are the quantities of matter of the different constituent's present?

5,0 mol et $n^v \approx 6{,}0$ mol.

Au bilan : - phase liquide (l_1) : $n_{B_1}^{l_1} \approx 5{,}0$ **mol**

- phase vapeur (v) : $n_{B_2}^{v} = x_2^v \cdot n^v \approx 1{,}8$ **mol** $\qquad n_{B_1}^{v} = n^v - n_{B_2}^{v} \approx 4{,}2$ **mol**