17,5/20 Good job!

SINEUX Jules

group.71

Chemistry test

Exercise 1: 10

1)

?

2) Because of Clapeyron's equation, one has: $\frac{dP}{dT} = \frac{\Delta_{vap}H}{T(\bar{V}_g - \bar{V}_e)}$

which leads to $\ln P^*_{propOH} = \frac{A}{T} + B$ (with some hypothesis)

1 One has: $\begin{cases} \ln 100 = \frac{A}{326,17} + B \\ \ln 700 = \frac{A}{368,31} + B \end{cases} \Rightarrow \begin{cases} A = -5547,4 \text{ K} \\ B = 21,61 \end{cases}$

3) a) $V = N + n - \varphi = 2 + \underset{(P\,and\,T)}{2} - 2 = 2$

1 conclusion: if we fix 2 variables (P and T for instance) we are able to determine all other variables.

b) · $P = P_{PropOH} + P_{eth} \overset{\text{Raoult's law (because ideal solution)}}{=} P^*_{PropOH} \cdot x_{PropOH} + P^*_{eth}\, x_{eth}$

$\Rightarrow P = P^*_{PropOH} \cdot x_{PropOH} + P^*_{eth}(1 - x_{PropOH})$

1,5 $\Rightarrow \boxed{x_{propOH} = \frac{P - P^*_{eth}}{P^*_{PropOH} - P^*_{eth}}}$

· $y_{propOH} = \frac{P_{propOH}}{P} = \frac{P^*_{propOH} \cdot x_{propOH}}{P}$

Dalton's law (because ideal gas)

$\boxed{y_{propOH} = \frac{P^*_{propOH}}{P} \times \frac{P - P^*_{eth}}{P^*_{propOH} - P^*_{eth}}}$

0,5

c) These expressions show that if we determine P and we fix θ(°C), then x_{PropOH} and y_{PropOH} are determined.
Hence the variance is nil.

d) $T = 350 K \Rightarrow \ln P^*_{Prop\,OH} = -\frac{5547,4}{350} + 22,67$

$\Rightarrow \boxed{P^*_{Prop\,OH} = 317 \text{ Torr}}$

$T = 350 K \Rightarrow \ln P^*_{ethOH} = -\frac{4864,9}{350} + 20,32$

$\Rightarrow \boxed{P^*_{ethOH} = 614 \text{ Torrs}}$

1

- $x_{PropOH} = \frac{P - P^*_{ethOH}}{P^*_{PropOH} - P^*_{ethOH}} = \frac{425 - 614}{317 - 614} = 0,636$

- $y_{PropOH} = \frac{P^*_{PropOH} \cdot x_{PropOH}}{P} = \frac{0,636 \times 317}{425} = 0,474$

e) Using P^*_{PropOH} and P^*_{ethOH} ($P^*_{ethOH} > P^*_{PropOH}$), we know that ~~the~~ ethanol is more volatile than ~~the~~ 1-propanol.

0,5

At a steady equilibrium between liquid and vapor, there is more ethanol in the vapor than in the liquid phase.
Hence we must have $x_{ethOH} < y_{ethOH}$
and $\boxed{x_{PropOH} > y_{PropOH}}$

0,25

4) a) One has $\boxed{x_{PropOH} = 0,636 \text{ and } y_{PropOH} = 0,474}$

b) $M_{PropOH} = \frac{m_{PropOH}}{n_{PropOH}} \Rightarrow n_{PropOH} = \frac{3000}{60} = 50$ moles

$n_{ethOH} = \frac{2000}{46} = 43,5$ moles

0,5

Hence one has : $x_{PROP OH\,TOT} = \frac{n_{PROP OH}}{n_{prop OH} + n_{eth OH}} = \frac{50}{50 + 43,5}$

$\boxed{x_{PROP OH\,TOT} = 0,535}$

V ——— 0,535 (M) ——— L
0,474 ——— M ——— 0,636

lever rule : $n_V \overline{VM} = n_L \overline{ML} \Rightarrow n_L \overline{ML} = (n_T - n_L)\overline{VM}$

$\Rightarrow n_L = \frac{\overline{VM}}{\overline{VL}} n_T$

$\Rightarrow n_L = \frac{0,535 - 0,474}{0,636 - 0,474} \times (50 + 43,5)$

$\boxed{n_L = 35,2 \text{ moles}}$

0,75

$\boxed{n_V = n_T - n_L = 58,3 \text{ moles}}$

- $n_{PROP OH\,V} = y_{PROP OH} \times n_V = 27,6$ moles $\rightarrow$ $m_{PROP OH\,V} = 1656\,g$
- $n_{eth OH\,V} = y_{eth OH} \times n_V = 30,7$ moles $\rightarrow$ $m_{eth OH\,V} = 1412\,g$

2

- $n_{PROP OH\,L} = x_{PROP OH} \times n_L = 22,4$ moles $\rightarrow$ $m_{PROP OH\,L} = 1344\,g$
- $n_{eth OH\,L} = x_{eth OH} \times n_L = 12,8$ moles $\rightarrow$ $m_{eth OH\,L} = 588,8\,g$

c) $m_{TOT} = m_{PROP OH\,V} + m_{PROP OH\,L} + m_{eth OH\,V} + m_{eth OH\,L}$

$= 5000,8\,g$

$\simeq 5000 \pm 1\,g$

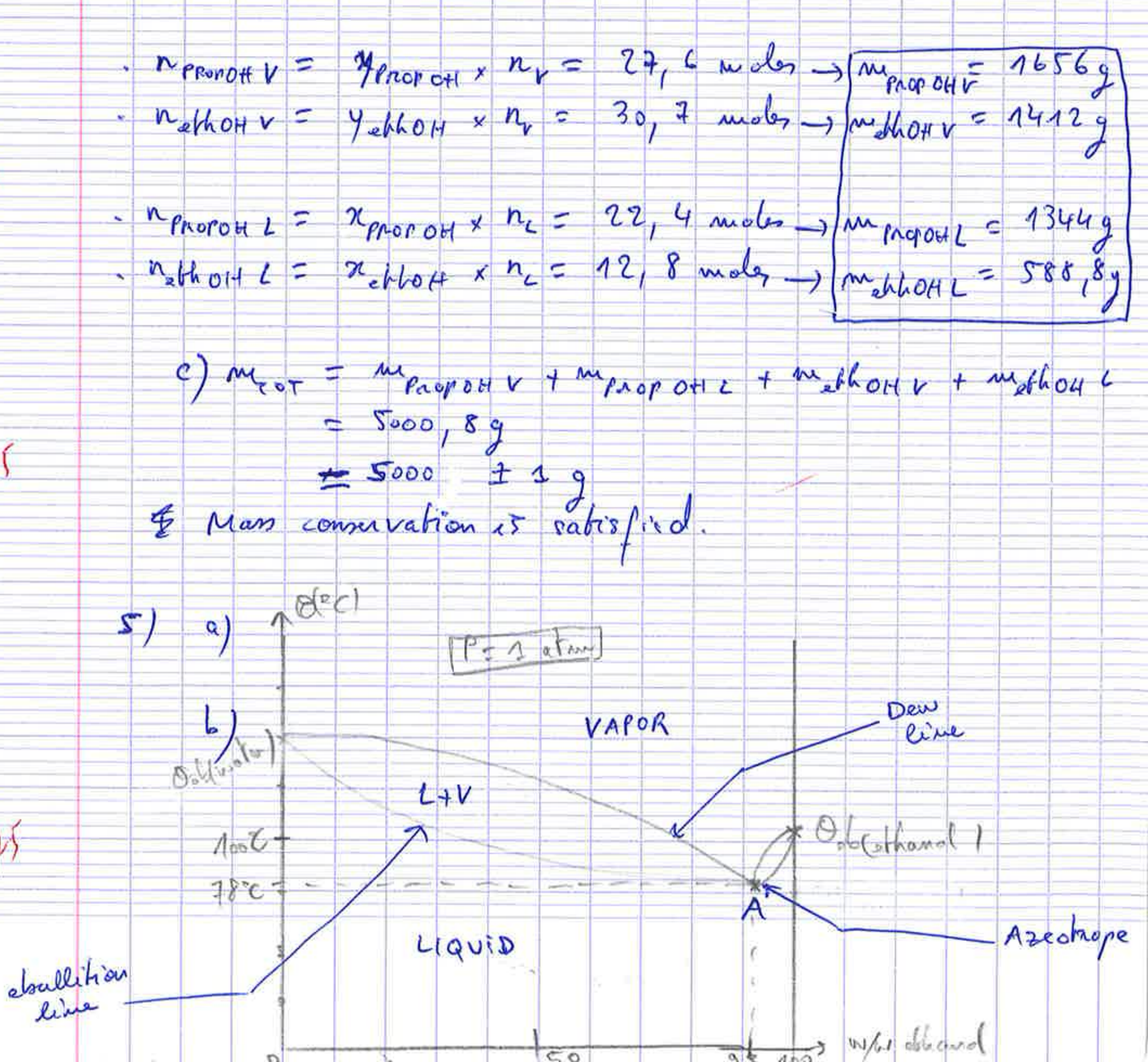
0,25

⇒ Mass conservation is satisfied.

5) a)

b)

0,75



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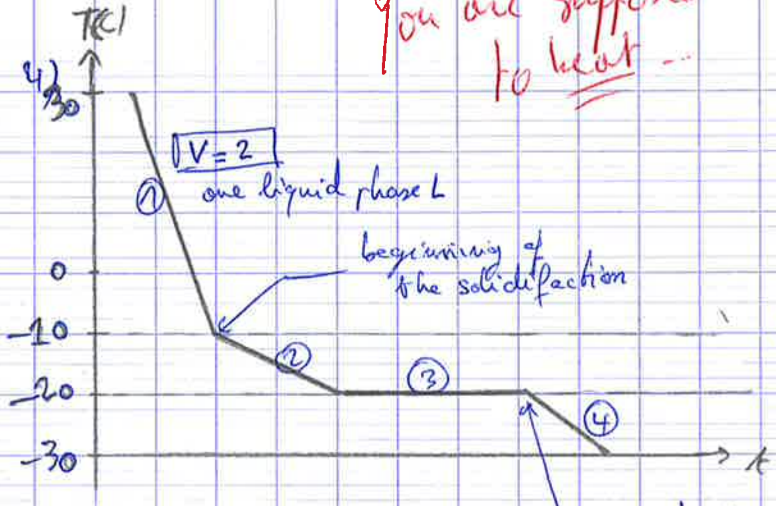
group 73

You are supposed to heat ...

$V = 3-4$

4)



end of solidification

② $\boxed{V=1}$ one liquid phase L + one solid phase $NaCl, 2(H_2O)_{(s)}$

③ $\boxed{V=0}$ Eutectic line one liquid phase L + two solid phases $NaCl, 2(H_2O)_{(s)}$ and $H_2O_{(s)}$

④ $\boxed{V=1}$ two solid phases: $H_2O_{(s)}$ and $NaCl, 2(H_2O)_{(s)}$

1

5) Below $-20°C$, NaCl is no more efficient since there is still ice ($H_2O(s)$).

0,25

6) ~~Graphically, we read that a minimal mass m_{in} =~~

Graphically, we must have $0,13 < w_{NaCl} < 0,25$ (at $-10°C$)

$$w_{NaCl} = \frac{m_{NaCl}}{m_{NaCl} + m_{H_2O}} \Rightarrow 0,13 < \frac{m_{NaCl}}{m_{NaCl} + 1} < 0,25$$

$$\Rightarrow \frac{0,13}{1-0,13} < m_{NaCl} < \frac{0,25}{1-0,25}$$

$$\Rightarrow \boxed{149\ g < m_{NaCl} < 333\ g}$$

1

7) a) By reading the diagram, the solidification begins at $\sim -5°C$.

0,25

b) At $-10°C$: S_1 — M_1 — L (0 — 0,10 — 0,13) $\longrightarrow$ $\boxed{L + H_2O_{(S)}}$

lever rule: $m_S \overline{SM} = m_L \overline{ML} \Rightarrow m_S = \frac{\overline{ML}}{\overline{SL}} m_{TOT}$

0,75

At $-30°C$: S_2 — M_2 — D $\longrightarrow$ $\boxed{H_2O_{(S)} + NaCl, 2(H_2O_S)}$