IE CHEMESTRY n° 2

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10,75
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12

# I- Partial miscibility at liquid state

## A- Liquid/vapor equilibria:

3- to obtain pure B by fractionated distilation we would have to have an initial liquid composition of B bigger than 0,4 such that once all the vapor is taken away through heating (of hetero hazeotropic proportions)      we will only have B left in the liquid state.

0,5

25°C        1000 moles of A and B with molar function of $B = 0,10$

4). under 1 bar the mixture will start boiling at 97°C (according to the graph)
the composition of the vapor formed initialy will be of
$Y_B = 0,26$ in molar fractions.
    hence

0,5

5) the composition of the distilate will be of $D_1 = 0,4$

0,5

6) in the residue we will only have A left. $R_1 = 0$

0,25

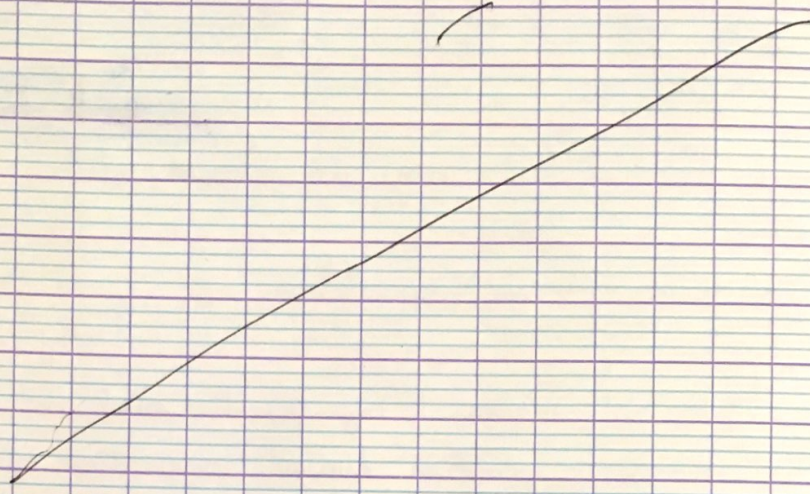7) we have initialy 900 moles of A and 100 moles of B

in the $D_1$ we would then have $\dfrac{100}{100+x} = 0,4 \Rightarrow 100 = 40 + 0,4x$

$$x = 150$$

$n_A = 150$ moles    and    $n_B = 150$ moles

1,75

1

in $R_1$ we would have $n_A = 750$ mol $n_B = 0$.



**B - liquid liquid equilibria**     $p = 1$bar

9) limit of solubility of A in B at $10°C$ is $x_B = 0,96$

10) limit of solubility of B in A at $10°C$ is $x_B < 0,10$
(found using the table)

11) $D_1$ is of composition $0,4$   we will use the lever rule
to find the number of moles in each phase $\alpha_{(\ell)}$ and $\beta_{(\ell)}$.

we know that   $n_\alpha . \overline{L_1 D_1} = n_\beta . \overline{D_1 L_2}$

$$n_\alpha = n_t - n_\alpha$$

$$n_t + \overline{D_1 L_2} - n_\alpha \overline{D_1 L_2}$$

$$n_R = \frac{\overline{D_1 L_2}}{\overline{L_1 D_1} + \overline{D_1 L_2}}$$

moreover :   $n_\alpha = \dfrac{\overline{D_1 L_2}}{\overline{L_1 L_2}} n_{total}.$

hence   $n_\alpha = \dfrac{0,96 - 0,4}{0,96 - 0,1} \times 250 = 162,8$ moles.

and   $n_\beta = \dfrac{\overline{L_1 D_2}}{\overline{L_1 L_2}} \times n_{total} = \dfrac{0,4 - 0,1}{0,96 - 0,1} = 87,2$ moles

now $n_{\alpha(\ell)}$ has $162,8$ moles

$n_{\beta(\ell)}$ has $87,2$ moles

we get for $\alpha(\ell)$ $\begin{cases} n_B = n_{\alpha(\ell)} \times (x_B) = 16,3 \text{ mol} \\ n_A = n_{\alpha(\ell)} \times (1-x_B) = 146,5 \text{ mol.} \end{cases}$

and $\beta(\ell)$ $\begin{cases} n_B = n_{\beta(\ell)} \times x_B = 83,7 \text{ mol} \\ n_A = n_{\beta(\ell)} \times (1-x_B) = 3,5 \text{ mol.} \end{cases}$

C - Second distillation :

12) we take $\beta(\ell)$ solution of $x_B = 0,96$ and with $n = 87,2$ moles

. same here we will have a distillate of composition of $0,4$.
—in the distillate which will have all of the A moles.

$n_A = 3,5$ moles and $\dfrac{n_B}{n_A + n_B} = 0,4 \Rightarrow n_B = 1,4 + 0,4 \, n_B$

$n_B = 4,3$

with $x_B = 0,4$

$\Rightarrow n_B = \dfrac{1,4}{0,6} = 2,3 \text{ mol}$

= in the remainder, $\begin{cases} n_A = 0 \\ n_B = 83,7 - 2,3 = 81,4 \\ \text{with } x_B = 1 \end{cases}$

13) $, 100 \times \dfrac{n_A \text{ recovered pure}}{n_A \text{ initial.}} = 100 \times \dfrac{750}{900} = 83,3$ } they

$, 100 \times \dfrac{n_B \text{ recovered pure}}{n_B \text{ initial}} = 100 \times \dfrac{81,4}{100} = 81,4$ } are quite similar.

Exercice n°2:

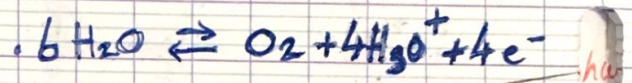1) since $E°(O_2/H_2O) = 1,23V$ and $E°(C_6H_{12}O_7/C_6H_2O_6) = 0,07(V)$

**0,5**

the electrons will travel from the highest to the lowest potential making the highest potential the anode and the lowest potential the cathode.

oxidation will take place at M'
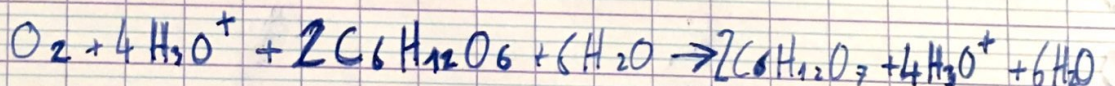reduction will take place at M

**0,5**

2) $6H_2O \rightleftharpoons O_2 + 4H_3O^+ + 4e^-$

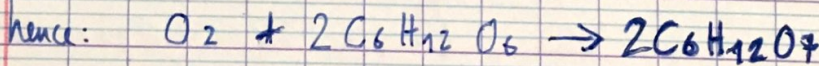3) anode: $E(O_2/H_2O) = E°(O_2/H_2O) + \frac{RT}{nF} \times \ln\left(\frac{[H_3O^+]^4[O_2]}{1}\right)$

**0,75**

cathode:

$E(C_6H_{12}O_7/C_6H_{12}O_6) = E°(C_6H_{12}O_7/C_6H_{12}O_6) + \frac{RT}{nF} \times \ln\left(\frac{[H_3O^+]^2[C_6H_{12}O_7]}{[C_6H_{12}O_6]}\right)$

4) overall redox reaction:

$O_2 + 4H_3O^+ + 2C_6H_{12}O_6 + 6H_2O \rightarrow 2C_6H_{12}O_7 + 4H_3O^+ + 6H_2O$

**0,5**

hence: $O_2 + 2C_6H_{12}O_6 \rightarrow 2C_6H_{12}O_7$

5) Find $K_{298}^° = K$ of this reaction:

since we have a redox reaction we can use that

$\Delta_r G_{TP}° = -\Delta E nF = -RT\ln K_T°$

$\Rightarrow \Delta E nF = RT \ln K_T°$

$K_T° = \exp\left(\frac{\Delta E nF}{RT}\right) = \exp\left(\frac{1,16 \times 4 \times 96500}{8,314 \times 298}\right)$

**1**

$= E°(O_2/H_2O) - E°(C_6H_{12}O_7/C_6H_{12}O_6)$

$K_T° = 3,076 \times 10^{42}$

(3,25)

4

Pierre .I find that $k'_T$ is too high to be true, but if it is
totally correct, it is over $10^4$ which makes the reaction complet
71 in the direct direction. ⟶ yes
0,5

electro motive force is around 0,8 V.

6) for 1 mole of glucose.

$$E(O_2/H_2O) - E(C_6H_{12}O_7/C_6H_{12}O_6) = 0,8 \text{ V}$$

1 mol will give out a total of ...

$$W_{elec} = -0,8 \times 4 \times 96500 \times 1 = -308800 \text{ J}$$

. for 1 liter of blood we have 1g of glucose hence

$$n = \frac{1}{180} = 5,56 \times 10^{-3} \text{ mol}$$

$$W_{elec}' = -0,8 \times 4 \times 96500 \times 5,56 \times 10^{-3} = 1716,928$$

7) the life span would be $\dfrac{W(got\ with\ 1L\ of\ blood)}{W = (uU}$ in s.

$$\frac{W_{elec}'}{10 \times 10^{-6}} = 171 \times 10^6 \text{ s}$$

↳ 5,4 years.

① S

8) advantages: we won't have to carry an external
battery.
disadvantages, it doesn't last forever.

literal expression: $V = N - r - r' + n - \varphi$

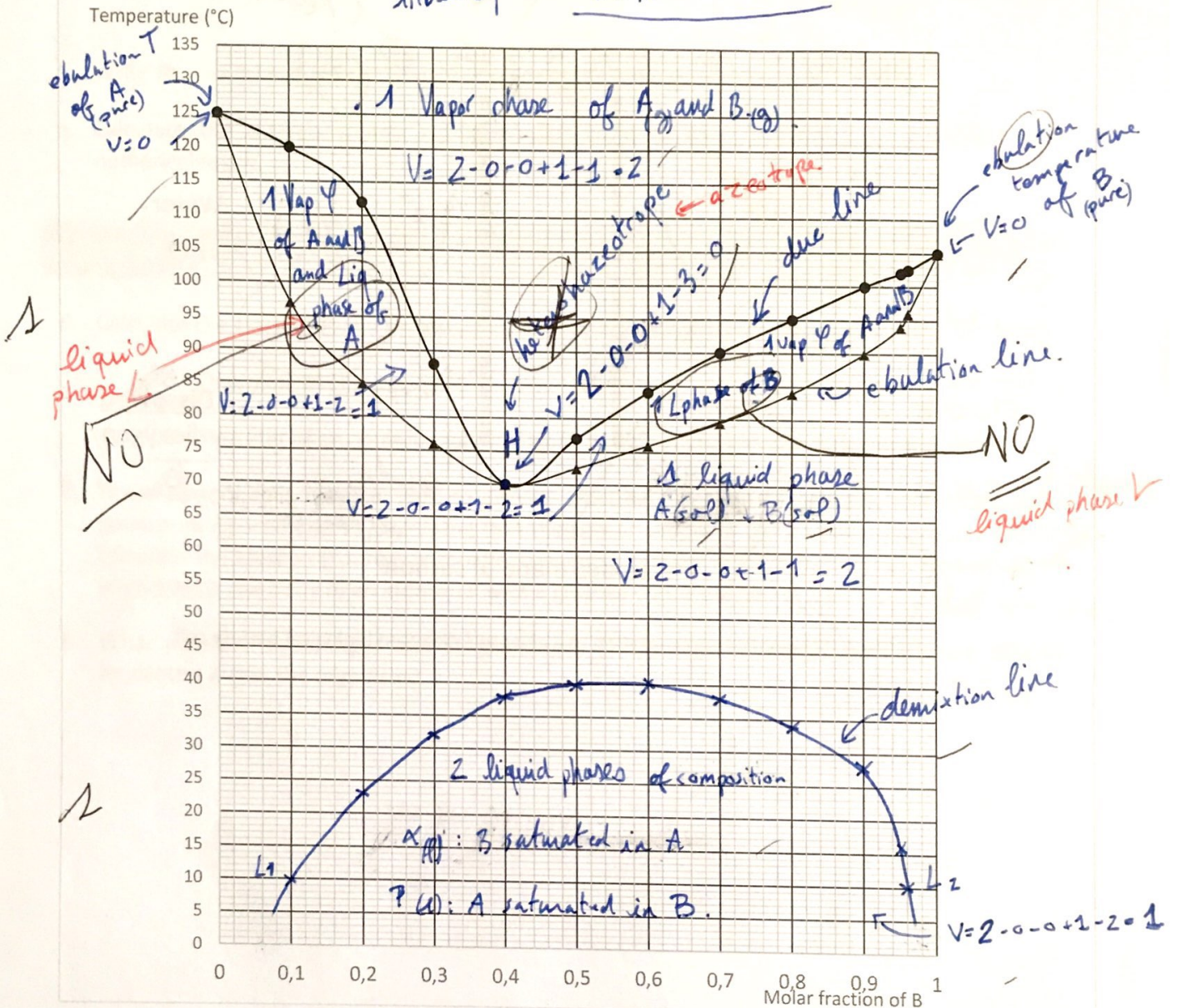Temperature (°C)

ebulation T of A (pure)  $V = 0$

1 Vap $\varphi$ of A and B and Liq phase of A

liquid phase $\downarrow$

$V = 2-0-0+1-2 = 1$

NO

• 1 Vapor phase of A(g) and B(g)

$V = 2-0-0+1-1 = 2$

hetero-azeotrope ← azeotrope

$V = 2-0-0+1-3 = 0$ dew line

$V = 2-0-0+1-2 = 1$

H

1 liquid phase A(sol) + B(sol)

$V = 2-0-0+1-1 = 2$

ebulation temperature of B (pure)  $\leftarrow V = 0$

1 Vap $\varphi$ of A and B

1 L phase of B  ebulation line.

NO

liquid phase $\downarrow$

demixtion line

2 liquid phases of composition

$\alpha_{(A)}$ : B saturated in A

? $(B)$ : A saturated in B.

$L_1$  $L_2$

$V = 2-0-0+1-2 = 1$

Molar fraction of B

**Figure 1 : Isobaric L/V equilibrium phase diagram of A-B binary system under P = 1 bar.**

**Exercice I – A – 2. Preliminary questions. Check the statements that you think are correct**

**At the liquid state, A and B mixtures can be considered as :**
- ☐ Ideal solutions
- ☒ Non-ideal solutions

**At the liquid sate, compared to A-A and B-B molecular interactions, A-B molecular interactions are :**
- ☐ Of the same order of magnitude
- ☐ Stronger
- ☒ Weaker

since more volatile.

Oxidation
(ANODE)  ⊖  ⊘ ⊕

$e^-$

$e^-$

Cathode
(Reduction)

$I$  [ R ]  $I$  ⊘ ⊕ ⊕

$II$

oxidation
→ gives
electrons-

Glucose
$C_6H_{12}O_6$

oxydation
hence

Gluconic
acid
$C_6H_{12}O_7$

Anode
oxidation
$O_2 + e^- →$ Red
reduction.

$e^-$

GO$_x$   M

cathode.
reduction

$e^-$

M'   BOD

anode
oxidization

Water
$H_2O$

**Dissolved**
dioxygen
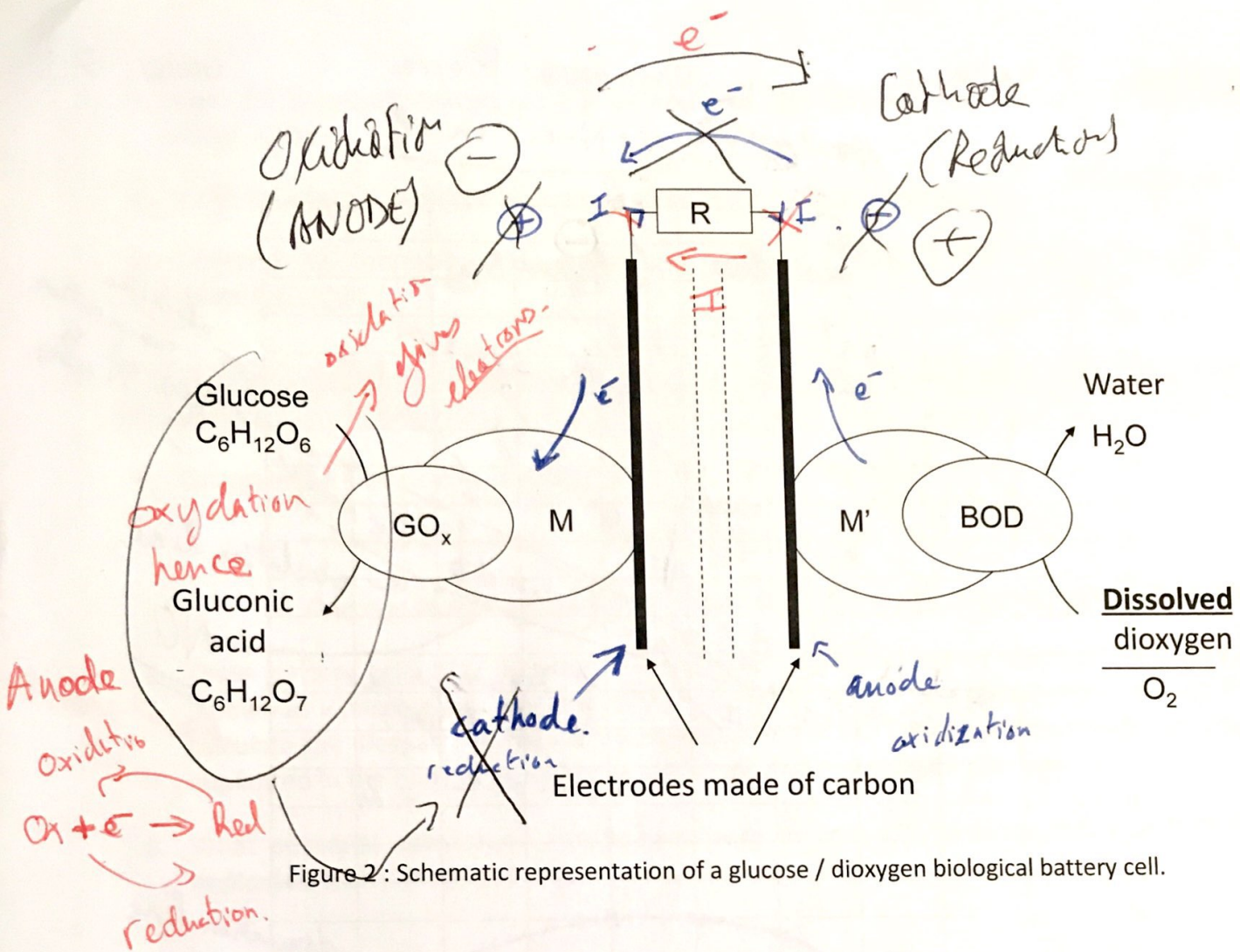$O_2$

Electrodes made of carbon

Figure 2: Schematic representation of a glucose / dioxygen biological battery cell.