DS#4 : A kinetic study of the permanganate

Part A : calibration of the calorimeter

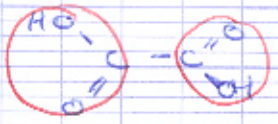
- Set the colorimeter at the wavelenght that corresponds to the max of absorbance
- Measure A different samples (set the colorimeter with the water).
- Plot the graph $A = f(c)$ which should be a straight line, passing by O. (Beer-Lambert law)
- modelisation by an affine fction on the computer

Experiment.

A bs / C_{mol}	$2,0 \times 10^{-4}$	$4,0 \times 10^{-4}$	$6,0 \times 10^{-4}$	$8,0 \times 10^{-4}$
Absorbance (A)	0,173	0,331	0,451	0,552

After tracing the line with Logger pro, (Analyse - regression) we obtain $A = 732 \times [MnO_4^-]$

Part B : Kinetic study of the reaction.

1.)  carboxylic group.

2.) It is a reducer, because, in the demi-equation, we can see that it gives e^-.

3.) $H_2C_2O_4 + 2H_2O = 2(CO_2, H_2O) + 2H^+ + 2e^-$ $\times 5$

$MnO_4^- + 8H^+ + 5e^- = Mn^{2+} + 4H_2O$. $\times 2$

$5H_2C_2O_4 + 10H_2O = 10(CO_2,H_2O) + 10H^+ + 10e^-$

$2MnO_4^- + 16H^+ + 10e^- = 2Mn^{2+} + 8H_2O$

$5H_2C_2O_4 + 10H_2O + 2MnO_4^- + 16H^+ + 10e^- \rightarrow 10(CO_2,H_2O) + 10H^+ + 10e^- + 2Mn^{2+} + 8H_2O$

$5H_2C_2O_4 + 2H_2O + 2MnO_4^- + 6H^+ \rightarrow 10(CO_2,H_2O) + 2Mn^{2+}$

4/ We have to had H^+ ions, and a strong acid, give that ions

5/ A catalyst is a chemical species that accelerate the reaction, but it isn't going to modified the final state.

Mn^{2+} is a catalyst. Mn^{2+} is in the products. That mean that the reaction produces itself Mn^{2+}, which is a catalyst for this reaction, so we can call it an autocatalytic.

6/ One of the reactifs is coloured. It is going to disappear while the reaction is going to advance, and that until the reaction is over. And if permanganate is the limiting reag the final solution will be colourless. But the solution is still coloured at different concentration. That's why we can use a colorimeter.

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	$2MnO_4^-$	$+ 6H^+$	$+ 2H_2O$	$+ 5H_2C_2O_4$	$\rightarrow 2Mn^{2+}$	$+ 10(CO_2;H_2O)$
$x=0$	4×10^{-4}	excès	excès	$5,0\times10^{-4}$	0	0
x	$4\times10^{-4}-2x$			$5,0\times10^{-4}-5x$	$2x$	$10x$
x_f	0			$5,0\times10^{-4}-5\times2,0\times10^{-4}$ $= 4,9\times10^{-4}$	$2\times2,0\times10^{-4}$ $= 4,0\times10^{-4}$	$10\times2,0\times10^{-4}$ $= 2,0\times10^{-3}$

Calculating the initial quantities.

$n(H_2C_2O_4) = C\times V = 8,0\times10^{-4}\times5,0\times10^{-3} = 4,0\times10^{-6}$ mol.

$n(H_2C_2O_4) = C \times V = 0,10 \times 5,0 \times 10^{-3}$

$= 5,0 \times 10^{-4}$ mol

If MnO_4^- is the limiting reagent:

$4,0 \times 10^{-6} - 2x_{max} = 0$

$x_{max} = \frac{4,0 \times 10^{-6}}{2}$

$x_{max} = 2,0 \times 10^{-6}$ mol

If $H_2C_2O_4$ is the limiting reagent

$5,0 \times 10^{-4} - 5x_{max} = 0$

$x_{max} = \frac{5,0 \times 10^{-4}}{5}$

$x_{max} = 1,0 \times 10^{-4}$

So, MnO_4^- is the limiting reagent and $x_{max} = 2,0 \times 10^{-6}$ mol.

8) $[MnO_4^-] = \frac{n(MnO_4^-)}{V}$ with $V = 10$ mL

$[MnO_4^-] = \frac{4,0 \times 10^{-6} - 2x}{10 \times 10^{-3}}$

$[MnO_4^-] \times 10 \times 10^{-3} = 4,0 \times 10^{-6} - 2x$

$2x = 4,0 \times 10^{-6} - [MnO_4^-] \times 10 \times 10^{-3}$

$x = \frac{4,0 \times 10^{-6} - [MnO_4^-] \times 10 \times 10^{-3}}{2}$

$A = 732 \times [MnO_4^-]$

$[MnO_4^-] = \frac{A}{732}$ $\quad x = \frac{4,0 \times 10^{-6} - \frac{A}{732} \times 10 \times 10^{-3}}{2}$

Experiment.

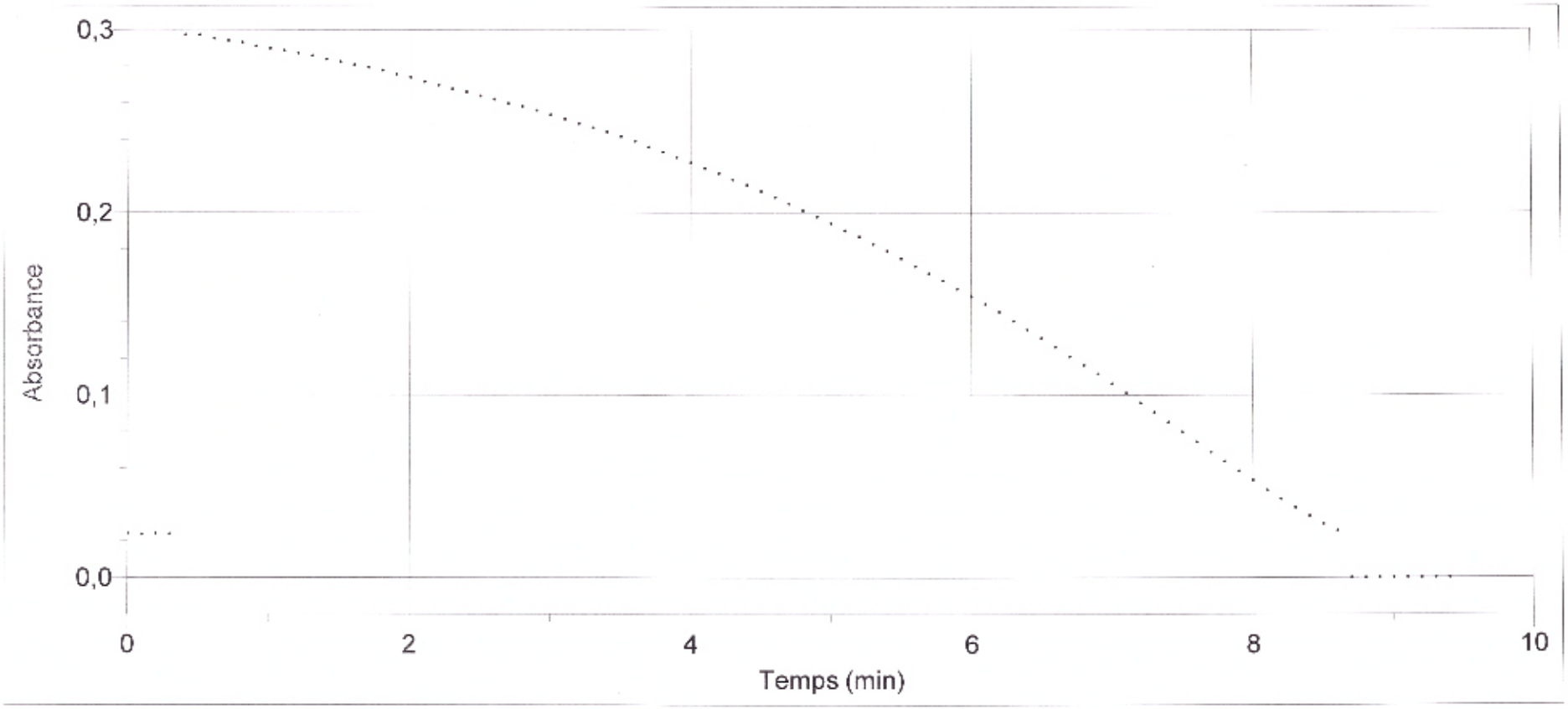
of graphs, $[MnO_4^-] = f(t)$ and $x = f(t)$.

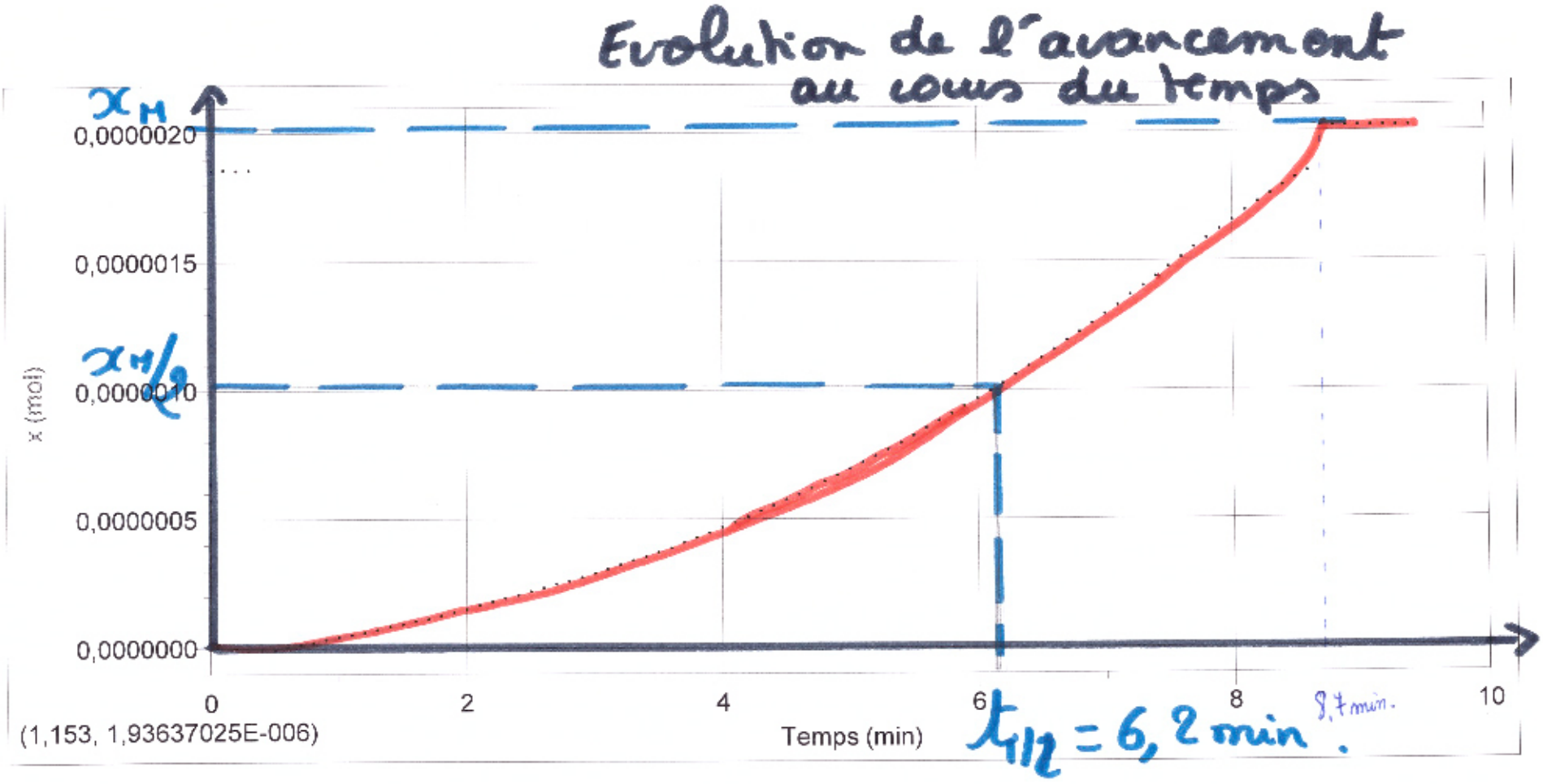
Exploitation.

1. With the experiment we can see that at the end of the reaction, the solution is colourless. So that means that all the MnO_4^- has been used in the reaction. So MnO_4^- is the limiting reagent.

2. With the graph, we can say that the reaction last 8,3 min.
$x_f = 2,03 \times 10^{-6}$ mol, so, with a graphic construction, we find the half-time of the reaction at 6,2 min

incomplet → voir graphique suivant.





graphique complet : les axes.
le titre
la courbe tracée à main levée.
les traits de construction légendés.