TB

Lab Work 2: Determination of the Ka of ascorbic acid

I- The molecule of ascorbic acid:

3) The molecular formula of ascorbic acid is $C_6H_8O_6$.

$M(C_6H_8O_6) = 6M(C) + 8M(H) + 6M(O)$

$M(C_6H_8O_6) = 6 \times 12{,}0 + 8 \times 1{,}0 + 6 \times 16{,}0 \ g.mol^{-1}$

$M(C_6H_8O_6) = 176{,}0 \ g.mol^{-1}$ (chiffres significatifs):

4) $m = M \times n$ or $n = c \times V$

$V = 250 \ mL$

$V = 250.10^{-3} \ L$

$V = 25{,}0.10^{-2} \ L$

donc $\boxed{\underset{g}{m} = \underset{g.mol^{-1}}{M} \times \underset{mol.L^{-1}}{c} \times \underset{L}{V}}$

$c = 1{,}0.10^{-2} \ mol.L^{-1}$

A.N: $m = 176 \times 1{,}0.10^{-2} \times 25{,}0.10^{-2} \ g$

$m = 0{,}44 \ g$

The mass of solid ascorbic acid that is necessary for this dissolution is 0,44 g.

II- Study of the "tableau d'avancement" and expression of the K_A:

2) $[H_3O^+] = \frac{n(H_3O^+)}{V}$

$[H_3O^+] = \frac{x_f}{V}$

3) At the equilibrium, H_3O^+ and $C_6H_7O_6^-$ have the same concentration: $[H_3O^+] = [C_6H_7O_6^-]$.

4) $[C_6H_8O_6] = \frac{m(C_6H_8O_6)}{V}$

$[C_6H_8O_6] = \frac{C \times V - x_f}{V}$

$[C_6H_8O_6] = \frac{CV}{V} - \frac{x_f}{V}$

$[C_6H_8O_6] = C - [H_3O^+]$

5) $K_A = \frac{[C_6H_7O_6^-][H_3O^+]}{[C_6H_8O_6]}$

$K_A = \frac{[H_3O^+][H_3O^+]}{C - [H_3O^+]}$

$K_A = \frac{[H_3O^+]^2}{C - [H_3O^+]}$

III- Conductivity of the solution:

1) $\sigma = \lambda_{C_6H_7O_6^-} \times [C_6H_7O_6^-] + \lambda_{H_3O^+} \times [H_3O^+]$

2) $\sigma = \lambda_{C_6H_7O_6^-} \times [H_3O^+] + \lambda_{H_3O^+} [H_3O^+]$

$\sigma = (\lambda_{C_6H_7O_6^-} + \lambda_{H_3O^+})[H_3O^+]$

3) a) $\sigma = (25{,}0 . 10^{-4} + 35{,}0 . 10^{-3})[H_3O^+]$ $S.m^{-1}$

$\sigma = 37{,}5 . 10^{-3} [H_3O^+]$ $S.m^{-1}$

$[H_3O^+] = \frac{\sigma}{37{,}5 . 10^{-3}}$ $mol.m^{-3}$

$$\boxed{\underbrace{[H_3O^+]}_{mol} = \frac{\overbrace{\sigma}^{S.m^{-1}}}{\underbrace{\lambda_{C_6H_7O_6^-} + \lambda_{H_3O^+}}_{S.m^2.mol^{-1}}}}$$

b) $1\,m^3 = 1000\,L$

so $[H_3O^+] = \dfrac{6}{\lambda_{C_6H_7O_6^-} + \lambda_{H_3O^+}} \times 10^{-3}\ mol.L^{-1}$

Lab work and conclusions:

2) a) $pH = 3{,}36$ so $[H_3O^+] = 10^{-3{,}36}$ mol/L

b) and $\boxed{K_A = \dfrac{[H_3O^+]^2}{c - [H_3O^+]}}$

A.N.: $K_A = \dfrac{(10^{-3{,}36})^2}{1{,}0.10^{-2} - 10^{-3{,}36}}$

$K_A \simeq 2{,}0.10^{-5}$

so $\boxed{pK_A = -\log K_A}$

$pK_A \simeq -\log 2{,}0.10^{-5}$

$pK_A \simeq 4{,}7$

c)

group	J-V-C	P-H-C	H-C	C-C-M	R-S	A-J	B-R	T-T
pH	3,4	2,9	2,9	3,3	3,4	3,2	3,5	3,4
pK_A	4,6	3,7	3,7	4,6	4,7	4,3	4,9	4,8

Average Value = 4

$$\boxed{\Delta pK_A = 2 \times \frac{S_{exp}}{\sqrt{n}}}$$

A.N: $S_{exp} = \sqrt{\dfrac{(4{,}6-4{,}4)^2 + (3{,}7-4{,}4)^2 + (3{,}7-4{,}4)^2 + \ldots + (4{,}8-4{,}4)^2}{7}}$

$S_{exp} = 0{,}47$ so $\Delta pK_A = 0{,}33$ so $pK_A = 4{,}4 \pm 0{,}4$

$\Delta pK_A \simeq 0{,}4$

conclusion: if we consider this error range, the value is in accordance with the data

3) a) $\sigma = 0{,}35 \ mS.cm^{-1}$

b) $\sigma = \dfrac{0{,}35 \ mS}{1 \ cm}$

$$\sigma = \frac{0{,}35.10^{-3} S}{1.10^{-2} m}$$

$$\sigma = 0{,}35.10^{-3}.10^{2} \ S.m^{-1}$$

$$\sigma = 0{,}35.10^{-1} \ S.m^{-1}$$

$$\sigma = 3{,}5.10^{-2} \ S.m^{-1}$$

c) $$\boxed{[H_3O^+] = \frac{\sigma}{\lambda_{H_3O^+} + \lambda_{C_6H_7O^-}} \times 10^{-3} \ mol.L^{-1}}$$

A.N : $[H_3O^+] = \dfrac{3{,}5.10^{-2}}{35.10^{-3} \times 25.10^{-4}} \times 10^{-3} \ mol.L^{-1}$

$$[H_3O^+] = 9{,}3.10^{-4} \ mol.L^{-1}$$

d) $$\boxed{K_A = \frac{[H_3O^+]^2}{c - [H_3O^+]}}$$

AN: $K_A = 9{,}6.10^{-5}$

~~so~~ $\boxed{pK_A = -\log K_A}$

A.N: $pK_A = 4{,}0$

4) $pK_A = -\log K_A$

$$pK_A = -\log \frac{[H_3O^+]^2}{c - [H_3O^+]}$$

this is not so obvious, because if c changes, $[H_3O^+]$ changes too...

and c is the concentration of the solute of the solution so if the concentration change, the pK_A change.

To verify it, we have to prepare an other solution with a different concentration and compare the value of pK_A. => see the results in the other report.

yes.