

Serie N°2

Ex 1.

Bronsted

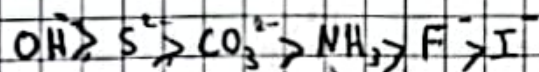
Acide	Base
NH_4^+	F^-
HSO_4^-	NH_3
CH_3NH_3^+	HSO_4^-
HS^-	HS^-
H_2PO_4^-	H_2PO_4^-
HF	

Lewis:

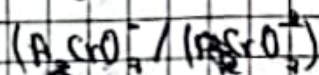
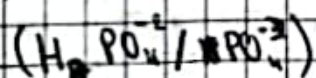
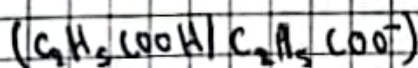
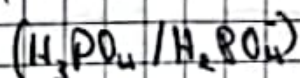
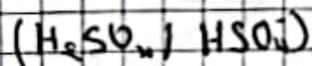
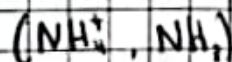
Acide	Base
BH_3	F^-
AlCl_3	NH_3

Les ampholytes : HSO_4^- , H_2PO_4^- , HS^-

Ex 2.



Ex 3.



Ex 4.

$$1) a) M = \frac{n}{V} = \frac{m}{MV} = \frac{4}{4 \times 350 \times 10^{-3}}$$

$$M = 0,286 \text{ mol/l}$$

$$b) C_1 V_1 = C_2 V_2$$

$$C_2 = \frac{C_1 V_1}{V_2} = \frac{2 \times 150}{500}$$

$$C_2 = 0,6 \text{ mol/l}$$

$$c) n_1 = C_1 V_1 = 0,003 \text{ mol}$$

$$n_2 = C_2 V_2 = 0,008 \text{ mol}$$

$$\Rightarrow n_T = 0,011$$

$$C = \frac{n_T}{V_T} = \frac{0,011}{200 \times 10^{-3}} = 0,055 \text{ mol/l}$$

$$d) C_m = 3 \text{ g/l}$$

$$C_m = \frac{m}{V}$$

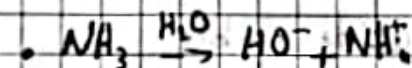
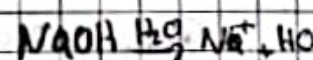
$$C.M = \frac{m}{M}$$

$$C = \frac{m}{MV} = \frac{C_m}{M}$$

$$C = \frac{3}{60} = 0,05 \text{ mol/l}$$

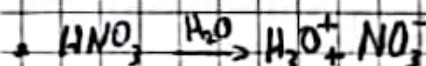
$$2) \text{pH} = 14 + \log(0,286) = 13,45$$

$$\boxed{\text{pH} = 13,45}$$



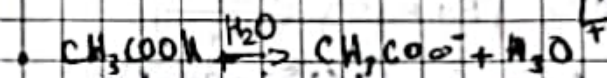
$$\text{pH} = 7 + \frac{1}{2} (\text{p}K_a + \log C_2) = 7 + \frac{1}{2} (9,25 + \log 0,286)$$

$$\boxed{\text{pH} = 11,77}$$



$$\text{pH} = -\log C_1 = -\log 0,055$$

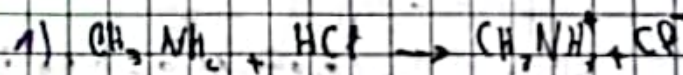
$$\boxed{\text{pH} = 1,25}$$



$$\text{pH} = \frac{1}{2} (\text{p}K_a - \log C_1) = \frac{1}{2} (4,76 - \log 0,055)$$

$$\boxed{\text{pH} = 3,03}$$

Ex 5.



2) nature :

$$V_{eq} = 100 \text{ ml}$$

$$V = \frac{1}{2} V_{eq} = 50 \text{ ml}$$

$$\rightarrow pH = pK_a = 10,7$$

$$3) a) pH = 7 + \frac{pK_a + \log C_b}{2}$$

$$\rightarrow [pH - 7 - \frac{1}{2} pK_a] = \log C_b$$

$$\log C_b = 2(11,85 - 7 - \frac{1}{2} \times 10,7)$$

$$C_b = 0,1 \text{ mol/L}$$

$$b) C_a V_a = C_b V_b$$

$$C_a = \frac{C_b V_b}{V_a} = \frac{0,1 \times 50}{100} = 0,05 \text{ M}$$

$$c) C_{salt} = \frac{n_a}{V_f} = \frac{n_b}{V_f} = \frac{0,1 \times 50}{150}$$

$$C_{salt} = 0,033 \text{ M}$$

H) a) Au point équivalent la nature de sel est acide faible

$$pH = \frac{1}{2} [pK_a - \log(C_{salt})]$$

$$pH = \frac{1}{2} [10,7 - \log(\frac{1}{30})]$$

$$pH = 6,08$$

b) • 80 ml of HCl (base faible)

$$pH = pK_a + \log \left(\frac{n_b - n_a}{n_a} \right)$$

$$pH = 10,7 + \log \left(\frac{0,1 \times 50 - 0,05 \times 80}{0,05 \times 80} \right)$$

$$pH = 10,1$$

• 150 ml of HCl (acide fort)

$$pH = -\log \left(\frac{n_a - n_b}{V_f} \right)$$

$$pH = -\log \left(\frac{0,05 \times 150 - 0,1 \times 50}{150} \right)$$

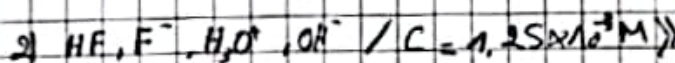
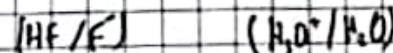
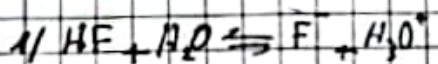
$$pH = 1,8$$

$$pH = 14 + \log C_b$$

$$\log C_b = pH - 14$$

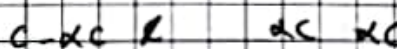
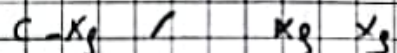
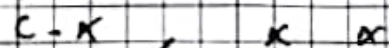
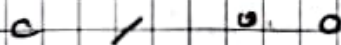
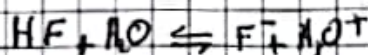
$$C_b = 0,063 \text{ M}$$

Ex 6 :



$$3,82 \times 10^{-3}$$

3) deduce the value of pK_a



$$K_a = \frac{[H_3O^+][F^-]}{[HF]}$$

$$K_a = \frac{(x_c)^2}{C - x_c} = \frac{x_c^2}{1 - x}$$

$$pK_a = -\log \frac{x_c^2}{1 - x}$$

$$pK_a = -\log C - \log \frac{x_c^2}{1 - x}$$

$$pK_a = 2,9 - \log \frac{0,5^2}{0,5} = 3,2$$

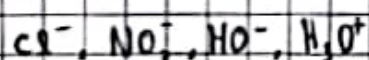
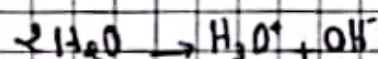
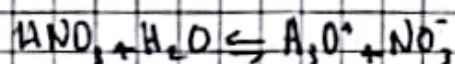
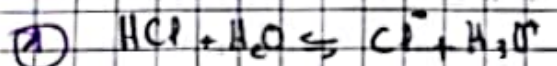
$$4) K_a = \frac{x_c^2}{1 - x}$$

$$C' = \frac{K_a (1 - x)}{x_c^2} = \frac{10^{-pK_a} (1 - x)}{x_c^2}$$

$$= \frac{10^{-3,2} (1 - 0,95)}{0,95^2} = 3,5 \times 10^{-5} \text{ mol/L}$$

$$5) pH = -\log x_c = -\log(0,95)$$

Ex 3:



B.M. $[\text{HCl}]_0 = [\text{Cl}^-]_f = C_1$

$[\text{HNO}_3]_0 = [\text{NO}_3^-]_f = C_2$

B.E. $[\text{Cl}^-] + [\text{OH}^-] + [\text{NO}_3^-] = [\text{H}_3\text{O}^+]$

$\hookrightarrow C_1 > 3.16 \times 10^{-2}$

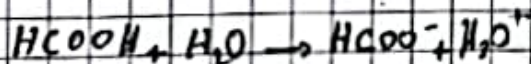
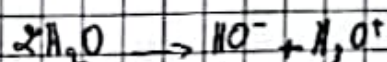
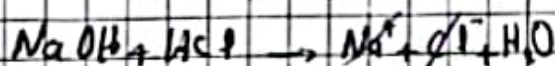
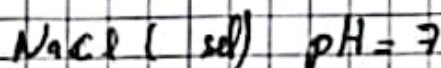
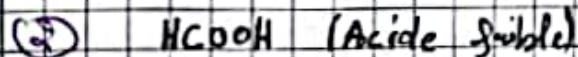
$C_1 + C_2 = [\text{H}_3\text{O}^+]$

$\frac{C_1 V_1}{V_T} + \frac{C_2 V_2}{V_T} = [\text{H}_3\text{O}^+]$

$[\text{H}_3\text{O}^+] = \frac{0.1 \times 50}{130} + \frac{0.02 \times 80}{130}$

$[\text{H}_3\text{O}^+] = 0.05 \text{ M}$

$\text{pH} = -\log [\text{H}_3\text{O}^+] = 1.3$



$K_a = \frac{[\text{H}_3\text{O}^+][\text{HCOO}^-]}{[\text{HCOOH}]}$

B.M. $[\text{HCOOH}]_0 = [\text{HCOO}^-]_f + [\text{HCOOH}]_f$

B.E. $[\text{HCOO}^-] + [\text{Cl}^-] + [\text{OH}^-] = [\text{Na}^+] + [\text{H}_3\text{O}^+]$

$[\text{HCOO}^-] + [\text{OH}^-] = [\text{H}_3\text{O}^+]$

$[\text{HCOOH}] > 3.16 \times 10^{-2}$

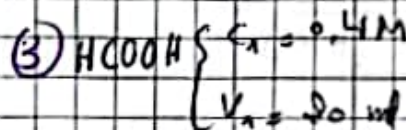
$[\text{HCOOH}] = \frac{C_1 V_1}{V_T} = \frac{0.2 \times 12}{22}$

$[\text{HCOOH}] = 6.48 \times 10^{-2}$

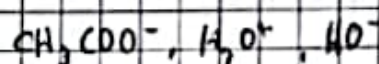
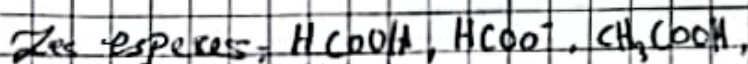
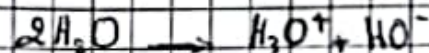
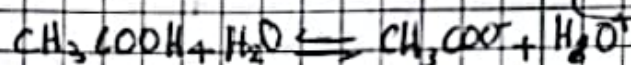
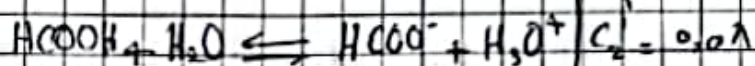
$\alpha < 0.1 \quad K_a = \alpha^2 C$

$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{10^{-4.75}}{0.2}}$

$\alpha = 0.03$



$\alpha < 0.1 \rightarrow 0.05$



B.M. $C_1' = [\text{HCOOH}] + [\text{HCOO}^-]$ ①

$C_2' = [\text{CH}_3\text{COOH}] + [\text{CH}_3\text{COO}^-]$ ②

B.E. $[\text{H}_3\text{O}^+] = [\text{HCOO}^-] + [\text{CH}_3\text{COO}^-] + [\text{OH}^-]$ ③

$K_{a1} = \frac{[\text{HCOO}^-][\text{H}_3\text{O}^+]}{[\text{HCOOH}]}$ ④

$K_{a2} = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$ ⑤

C_1' et $C_2' > 3.16 \times 10^{-2} \text{ M}$

$[\text{H}_3\text{O}^+] \gg [\text{OH}^-]$

2 acides faibles

$\alpha_1 = \sqrt{\frac{K_{a1}}{C_1'}} = \sqrt{\frac{10^{-3.75}}{0.11}} = 0.04$

$\alpha_2 = \sqrt{\frac{K_{a2}}{C_2'}} = \sqrt{\frac{10^{-4.75}}{0.01}} = 0.01$

$\alpha_1 = \alpha_2 < 0.05$

on néglige $[\text{CH}_3\text{COO}^-]$ et $[\text{HCOO}^-]$

$$(1) \rightarrow C_1' = [\text{HCOOH}]$$

$$(2) \rightarrow C_2' = [\text{CH}_3\text{COOH}]$$

$$(3) \rightarrow [\text{A}_3\text{O}^+] = [\text{CH}_3\text{COO}^-] + [\text{HCOO}^-]$$

$$(4) \rightarrow [\text{HCOO}^-] = \frac{K_{a1} [\text{HCOOH}]}{[\text{H}_3\text{O}^+]}$$

$$(5) \rightarrow [\text{CH}_3\text{COO}^-] = \frac{K_{a2} [\text{CH}_3\text{COOH}]}{[\text{H}_3\text{O}^+]}$$

$$[\text{A}_3\text{O}^+] = \frac{K_{a1} [\text{HCOOH}]}{[\text{H}_3\text{O}^+]} + \frac{K_{a2} [\text{CH}_3\text{COOH}]}{[\text{H}_3\text{O}^+]}$$

$$[\text{H}_3\text{O}^+]^2 = C_1' K_{a1} + C_2' K_{a2}$$

$$[\text{H}_3\text{O}^+] = \sqrt{C_1' K_{a1} + C_2' K_{a2}}$$

$$\text{pH} = -\frac{1}{2} \log(C_1' K_{a1} + C_2' K_{a2})$$

$$\text{pH} = 2.35$$

$$(16) \text{ NaOH} \left\{ \begin{array}{l} C_1 = 0.1 \text{ M} \\ V_1 = 100 \text{ ml} \end{array} \right. \quad \text{C}_2\text{H}_5\text{NH}_2 \left\{ \begin{array}{l} C_2 = 1 \text{ M} \\ V_2 = 25 \text{ ml} \end{array} \right.$$

$$C_1' = \frac{C_1 V_1}{V_f} \quad \text{NaOH} \rightleftharpoons \text{Na}^+ + \text{OH}^-$$

$$C_2' = \frac{C_2 V_2}{V_f} \quad \left\{ \begin{array}{l} \text{C}_2\text{H}_5\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_3^+ + \text{OH}^- \\ 2\text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^- \end{array} \right.$$

$$\text{BE: } [\text{Na}^+] + [\text{H}_3\text{O}^+] + [\text{C}_2\text{H}_5\text{NH}_3^+] = [\text{OH}^-]$$

BM:

$$[\text{NaOH}] = [\text{Na}^+] = C_1'$$

$$[\text{C}_2\text{H}_5\text{NH}_2]_0 = [\text{C}_2\text{H}_5\text{NH}_3^+] + [\text{C}_2\text{H}_5\text{NH}_2]_f = C_2'$$

on néglige $[\text{H}_3\text{O}^+]$

$$[\text{Na}^+]_f [\text{C}_2\text{H}_5\text{NH}_3^+] = [\text{OH}^-]$$

$$\alpha = \sqrt{\frac{K_b}{C_2'}} = \sqrt{\frac{K_e}{K_a C_2'}} =$$

$$\alpha = 0.04 \quad \text{c.05}$$

$$\text{donc } C_2' = [\text{C}_2\text{H}_5\text{NH}_2]$$

$$[\text{Na}^+] = C_1'$$

$$[\text{C}_2\text{H}_5\text{NH}_3^+] = \alpha C_2'$$

$$[\text{OH}^-] = C_1' + \alpha C_2'$$

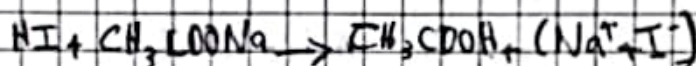
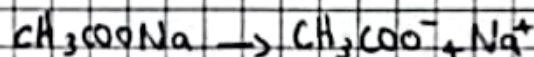
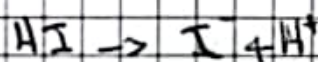
$$\frac{K_e}{[\text{H}_3\text{O}^+]} = C_1' + \alpha C_2'$$

$$[\text{H}_3\text{O}^+] = \frac{K_e}{C_1' + \alpha C_2'} \Rightarrow \text{pH} = -\log\left(\frac{K_e}{C_1' + \alpha C_2'}\right)$$

$$\text{pH} = 12.95$$

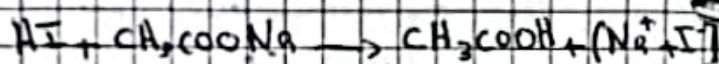
$$(5) \text{ HI et CH}_3\text{COONa}$$

$$\left\{ \begin{array}{l} 0.2 \text{ M} \\ 50 \text{ ml} \end{array} \right. \quad \left\{ \begin{array}{l} 10^{-2} \text{ M} \\ 100 \text{ ml} \end{array} \right.$$



$$C_1' = \frac{C_1 V_1}{V_f} = 0.066 \text{ M}$$

$$C_2' = \frac{C_2 V_2}{V_f} = 0.066$$



$$\begin{array}{ccccccc} C_1' & C_2' & & & & & \\ 0 & 0 & 0.066 & 0.066 & & & \end{array}$$

acide faible $\text{p}K_a = 4.76$

$$\text{pH} = \frac{1}{2} (\text{p}K_a - \log C) = 2.97$$

$$\bullet \text{ HI et CH}_3\text{COONa}$$

$$\left\{ \begin{array}{l} 2 \times 10^{-3} \\ 50 \text{ ml} \end{array} \right. \quad \left\{ \begin{array}{l} 10^{-2} \\ C_2 = 0 \end{array} \right.$$

$$pH = pK_a + \log \frac{[CH_3COO^-]}{[CH_3COOH]}$$

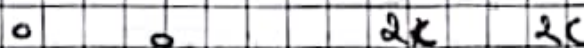
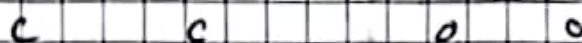
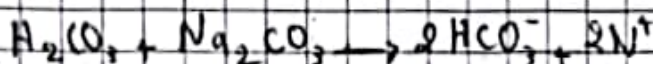
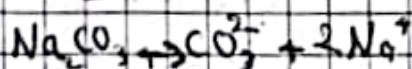
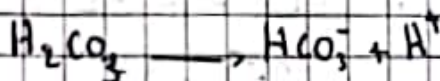
$$= 4.76 + \log \frac{4 \times 10^{-2}}{10^{-2}}$$

$$= 5.36$$

Ex

⑥ H_2CO_3 et Na_2CO_3

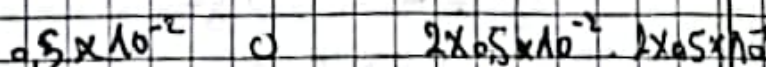
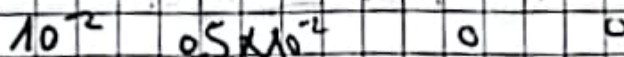
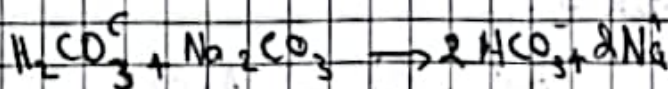
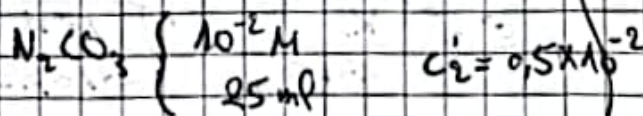
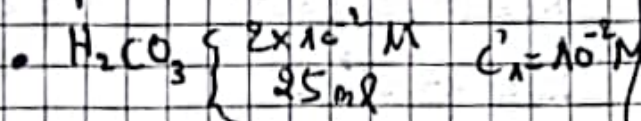
$$\begin{cases} 2 \times 10^{-2} M \\ 10 ml \end{cases} \quad \begin{cases} 10^{-2} M \\ 20 ml \end{cases} \quad \begin{cases} C_1 = 0.67 \times 10^{-2} M \\ C_2 = 0.67 \times 10^{-2} M \end{cases}$$



$$pH = (pK_{a1} + pK_{a2}) \frac{1}{2}$$

$$= (6.35 + 10.33) \times \frac{1}{2} \quad (\text{because it's a diacid})$$

$$pH = 8.34$$



$$pH = pK_a + \log \frac{C_b}{C_a}$$

$$= 6.35 + \log 2$$

$$pH = 6.65$$