

MOHAMED KHIDER UNIVERSITY OF BISKRA.

FACULTY OF EXACT SCIENCES AND NATURAL AND LIFE SCIENCES

DEPARTMENT OF BIOLOGY

**Semester2: THERMODYNAMICS AND CHEMISTRY OF
MINERAL SOLUTIONS**

CHAPTER I

Part 2

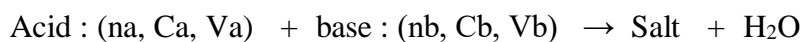
Level: 1st year LMD

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Academic year: 2025/2026

3. The pH of saline solutions:

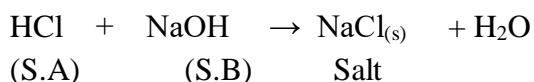
We call salt any neutral species which, in solution. They are always trained in neutralization by reaction between acid and base.



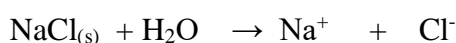
Examples: NaCl, NH₄NO₃.

3.1. The pH of a solution of strong acid and strong base:

Consider the following neutralization reaction:



In aqueous solution, there is total dissolution of the salt: NaCl(s) (Sodium chloride)



Cl⁻: Conjugate base (very weak) of a strong acid (HCl), Cl⁻: does not modify the pH of the solution: Cl⁻: is inactive (indifferent or spectator ion), it does not participate in any acid-equilibrium basic.

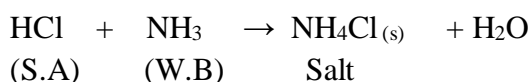
Na⁺: Conjugated acid (very weak) of a strong base (NaOH), Na⁺: does not modify the pH of the solution: Na⁺: is inactive (indifferent or spectator ion), it does not participate in any acid-base equilibrium.

$$\text{pH(NaCl)} = \text{pH(H}_2\text{O)} = \frac{1}{2} \text{p}K_e = 7 \quad \text{at } t=25 \text{ C}^\circ$$

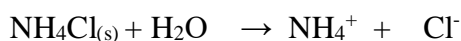
Conclusion: Salts of strong acids and strong bases dissociate in water without changing the pH, the solution remains neutral.

3.2. The pH of a solution of strong acid and weak base:

Consider the following neutralization reaction:



In aqueous solution, there is total dissolution of the salt: NH₄Cl(s) (Ammonium chloride)



Cl⁻: Conjugate base (very weak) of a strong acid (HCl), Cl⁻: does not modify the pH of the solution: Cl⁻: is inactive (indifferent or spectator ion), it does not participate in any acid-equilibrium basic.

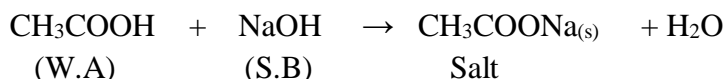
NH₄⁺: Conjugated acid (very weak) of a weak base (NH₃), it participates in acid-base equilibrium.

If: [H₃O⁺] >> [OH⁻] and [NH₄⁺] >> [NH₃] ⇒ the acid is weakly dissociated.

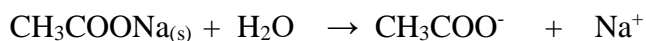
$$\text{pH(NH}_4\text{Cl)} = \text{pH(NH}_4^+) = \text{pH(Conjugate w. acid)} = \frac{1}{2} (\text{p}K_a - \log[\text{NH}_4^+]) \quad \text{at } t=25 \text{ C}^\circ$$

3.3. The pH of a solution of weak acid and strong base:

Consider the following neutralization reaction:



In aqueous solution, there is total dissolution of the salt: $\text{CH}_3\text{COONa}_{(s)}$ (Sodium acetate)



CH_3COO^- : Conjugate base (very weak) of a weak acid (CH_3COOH), it participates in acid-base equilibrium.

Na^+ : Conjugated acid (very weak) of a strong base (NaOH), Na^+ : does not modify the pH of the solution: Na^+ : is inactive (indifferent or spectator ion), it does not participate in any acid-base equilibrium.

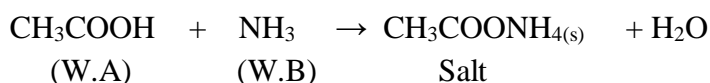
If: $[\text{OH}^-] \gg [\text{H}_3\text{O}^+]$ and $[\text{CH}_3\text{COO}^-] \gg [\text{CH}_3\text{COOH}] \Rightarrow$ the base is weakly protonated.

$$\text{pH}(\text{CH}_3\text{COONa}) = \text{pH}(\text{CH}_3\text{COO}^-) = \text{pH}(\text{Conjugate w. base}) = \frac{1}{2} (\text{p}K_e + \text{p}K_a + \log[\text{CH}_3\text{COO}^-])$$

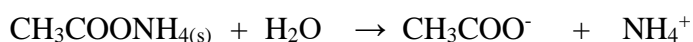
at $t=25\text{ }^\circ\text{C}$

3.4. The pH of a weak acid and weak base solution:

Consider the following neutralization reaction:



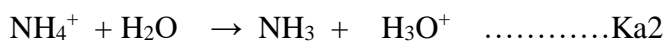
In aqueous solution, there is total dissolution of the salt: $\text{CH}_3\text{COONH}_{4(s)}$ (Ammonium acetate) of concentration = C



CH_3COO^- : Conjugate base (very weak) of a weak acid (CH_3COOH), it participates in acid-base equilibrium.



NH_4^+ : Conjugated acid (very weak) of a weak base (NH_3), it participates in acid-base equilibrium.



However, the mixture between a w. A and a w. B gives a weakly acidic or weakly basic solution \Rightarrow pH is close to 7.

If: $C \gg [\text{H}_3\text{O}^+]$ and $C \gg [\text{OH}^-] \Rightarrow$ by making the product Ka_1 . Ka_2

$\text{pH}(\text{CH}_3\text{COONH}_4) = \frac{1}{2} (\text{p}K_{a1} + \text{p}K_{a2})$, the pH is independent of the initial concentration C.

3.5. The pH of a buffer solution:

A buffer solution is defined as a mixture of a weak acid AH and their conjugates base A⁻ in equal or similar proportions.

The expression for the acidity constant K_a of the HA/A⁻ couple is:

$$K_a = \frac{[A^-] \cdot [H_3O^+]}{[AH]} \Rightarrow [H_3O^+] = \frac{K_a \cdot [AH]}{[A^-]}$$

$$pH = pK_a - \log \frac{[AH]}{[A^-]} \Leftrightarrow pH = pK_a - \log \frac{[Acid]}{[Base]}$$

Noticed:

A buffer solution can be obtained from:

- Weak acid AH + a weak base A.
- Weak acid HA + strong base.
- Weak base A⁻ (NaA salt) + strong acid.

Buffer solutions have the property of minimizing pH variations caused by:

- An addition of acid or base.
- An addition of solvent (dilution).