

Chapter 15: Acids and Bases

Acids:

1. have a sour taste.
2. Vinegar tastes due to citric acid. Citrus fruit contain citric acid.
3. Acid reacts with certain metals to produce hydrogen gas.
4. Acid reacts with carbonates and bicarbonates to produce carbon dioxide gas.

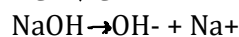
Bases:

1. have a bitter taste.
2. Many soaps contain bases.

◆ Arrhenius

Acid: substance gives H^+ in H_2O

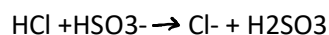
Base: substance gives OH^- in H_2O



◆ Brønsted-Lowry

Acid: substance donate (H^+).

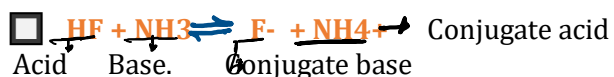
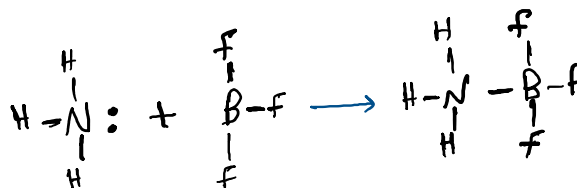
Base: substance accept (H^+).



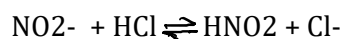
◆ Lewis

Acid: substance accept 2e

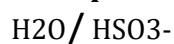
Base: substance donate 2e



Ex: Identify the conjugate acid-base pairs

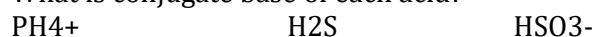


◆ **Amphotric** (امفوتريية)



□ **Acid conjugate = Base + H⁺**
Base conjugate = Acid - H⁺

What is conjugate base of each acid?



What is conjugate acid of each base?



◆ Autoionization of water:



K_w the **ion-product constant**: is product of molar concentration of **H⁺** and **OH⁻** ions at a particular temperature.

At 25°C, $K_w = [H^+][OH^-] = 1 \times 10^{-14} M$ → $M = \frac{Mole}{Volume}$

$[H^+] = [OH^-] = 1 \times 10^{-7} M$ → **Neutral**

$[H^+] > [OH^-]$ → **Acid**

$[H^+] < [OH^-]$ → **Base**

Ex: Calculate concentration of H⁺ in solution in which $[OH^-] = 0.01 M$?

جواب: $1 \times 10^{-12} M$

Ex: indicate whether each of the following (neutral, Acid, Base)?

$[H^+] = 2 \times 10^{-3}$ **Acid**

$[OH^-] = 3 \times 10^{-9}$ **Acid**

$[H_3O^+] = 1 \times 10^{-7}$ **Neutral**

PH- A Measure of Acidity

$$[H^+] = 10^{-PH}$$

$$PH = -\log[H^+]$$

(PH 0 to 14) If

PH=7 **Neutral**

PH<7 **Acidic**

PH>7 **Basic**

Ex: PH=5, PH=11, PH=7, finding [H+] and [OH-]?

◆ **Strong Acid:** (HCl, HBr, HI, HNO₃, HClO₄, H₂SO₄) غير هاي يعتبر أحماض ضعيفه

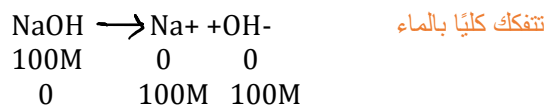


Ex: What is pH of 0.3M solutions H₂SO₄?

جواب : 0.22

◆ **Strong Base:** (NaOH, KOH, LiOH, BrOH, Ca(OH)₂, Ba(OH)₂, Sr(OH)₂, C₂OH)

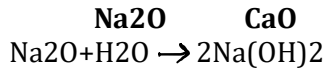
غير هاي يعتبر قواعد ضعيفه



Ex: What is PH of 0.012M solution of Ba(OH)₂?

الجواب : 12.38

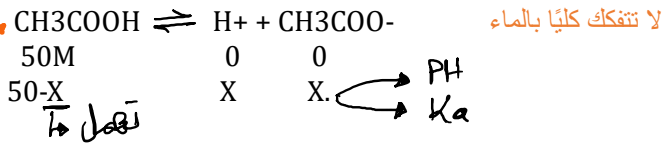
□ Strong base (Inic metal oxide)



Ex: 0.02M Na₂O react with water calculate pH?

الجواب: 12.6

◆ Weak Acid and Acid Ionization Constants (Ka)



◆ بما انو حمض ضعيف فانو العلماء وصلوا (Ka) وهو ثابت اتزان الحموض الضعيفه لانها لا تتفكك كليًا بالماء
تركيز النواتج/ تركيز الحمض نفسه = Ka

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} = \frac{x \cdot x}{50} = \frac{x^2}{50}$$

◆ علاقه طردية بين [H⁺] و Ka كلما زاد تركيز ال H⁺ زادت ال Ka، وتزداد قوته كحمض

◆ لكل حمض Ka خاصة فيه تعطى بالسؤال او يراد معرفتها .

◆ اذا طلب (percent ionisation) فانو حاصل قسمة تركيز H⁺ على تركيز الحمض نفسه ضرب 100% .

Ex: Calculate 0.1M CHOOH has pH=2.32.

1. Calculate Ka.
2. Calculate percent ionisation.

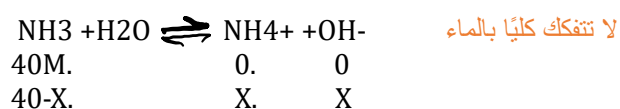
الجواب : ١. Ka=1.8*10⁻⁴
٢. 4.2%

Ex: Calculate PH of 0.3M of (CH₃COOH) $K_a=1.8 \times 10^{-5}$, then Calculate percent ionisation?

الجواب: pH=2.64

P.I=0.77%

◆ Weak Base and Base Ionisation Constant (K_b)



K_b= تركيز النواتج/ تركيز القاعدة نفسها.

- ◆ بما انو قاعدة ضعيفة فانو العلماء وصلوا (K_b) وهو ثابت اتزان القواعد الضعيفه لانها لا تتفكك كليًا بالماء
- ◆ لكل قاعده (K_b) خاصة فيه تعطى بالسؤال او يراد معرفتها .
- ◆ اذا طلب (percent ionisation) فانو حاصل قسمة تركيز OH⁻ على تركيز القاعدة نفسه ضرب 100% .

Ex: Calculate K_b to 0.25M of HSO₃⁻ has pH=0.99?

الجواب: 7.7×10^{-13}

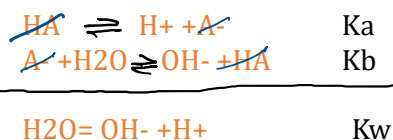
Ex: What is the pH of a 0.40M ammonia solution and present ionisation, $K_b=1.8 \times 10^{-5}$?

الجواب : pH=11.43

P.I= 0.68%

$$K_w = [\text{OH}^-][\text{H}^+] = 1 \times 10^{-14}$$

$$K_w = [K_a][K_b] = 1 \times 10^{-14}$$



◆ **Acid-Base Properties of salts**

1. Neutral Solutions (from strong base and strong acid), (PH=7)

NaCl

Ca(NO₃)₂

2. Basic Solutions (from strong base and weak base), (PH>7)

NaClO

Ba(CH₃COO)₋

3. Acidic Solutions (from strong acid and weak base), (PH<7)

NH₄Cl

Al(NO₃)₃

4. If weak acid and weak base according to (K_p, K_a)

K_a > K_b **Acidic** (pH < 7).

K_a < K_b **Basic** (pH > 7).

K_a = K_b **Neutral** (pH = 7)

Ex: NH₄CN

Ex: Predict whether the following solutions will be acidic, basic, or nearly neutral:

(a) NH₄I

(b) NaNO₂

(c) FeCl₃

(d) NH₄F

Ex: Calculate the pH of a 0.25 M solution of potassium fluoride (KF). What is the percent hydrolysis? (K_b = 1 × 10⁻¹¹).

الجواب : 0.00076%

س what is conjugate base of the Bronsted-lowry acid HPO_4^{2-}

- 1) H_2PO_4^-
- 2) PO_4^{3-}
- 3) HPO_4^{2-}
- 4) H_3PO_4

س Indicate all the Bronsted lowry acids in the following chemical reaction?



- 1) HI, I
- 2) HI, H_2O
- 3) HI, H_3O^+
- 4) HI, H_3O^+ , H_2O

س Given the following substances in order of increasing acid strength.

$\text{HOCl}(\text{aq}) < \text{HC}_2\text{H}_3\text{O}_2(\text{g}) < \text{HC}_2\text{O}_4^- < \text{HOCN} < \text{HNO}_2 < \text{HCl}$ which species listed below is the strongest base of that set?

- 1) Cl^-
- 2) $\text{C}_2\text{H}_3\text{O}_2^-$
- 3) $\text{C}_2\text{O}_4^{2-}$
- 4) NO_2^-

س An aqueous solution of - will produce a basic solution.

1. CsBr
2. $\text{Mg}(\text{ClO}_4)_2$
3. NaNO_2
4. NH_4NO_3
5. KNO_3

س What is the hydronium ion (H_3O^+) concentration of a 0.400M acetic acid ($\text{CH}_3\text{CO}_2\text{H}$), Solution with $K_a = 1.8 \times 10^{-5}$?

- 1) $4.2 \times 10^{-2}\text{M}$
- 2) $2.7 \times 10^{-2}\text{M}$

- 3) $4.2 \times 10^{-3} \text{M}$
4) $2.7 \times 10^{-3} \text{M}$

س The K_a of hydrazoic acid (HN_3) is 1.9×10^{-5} at 25.0°C . What is the pH of a 0.15 M aqueous solution of HN_3 -?

- 1) 1.95
2) 2.77
3) -3.46
4) 5.23

س Determine pH of a weak base that has $K_b = 3.78 \times 10^{-18}$?

- 1) 9.26
2) 7.00
3) 4.73
4) 3.42

س The acid-dissociation constant of hydrocyanic acid (HCN) at 25°C is 4.9×10^{-10} . What is the pH of an aqueous solution of 0.060 M sodium cyanide (NaCN)?

- 1) 11.04
2) 9×10^{-12}
3) 2.96
4) 1.1×10^{-3}

س Determine the pH of a 0.15M aqueous solution of CaF_2 . for hydrofluoric acid (HF), $K_a = 7 \times 10^{-4}$?

- 1) 1.32
2) 5.68
3) 8.32
4) 0.52
5) 5.01

س Aniline ($\text{C}_6\text{H}_5\text{NH}_2$, $K_b = 4.3 \times 10^{-10}$ at 25°C) is an Industrially important amine used in the making of dyes. Determine the pH of an aniline solution made by dissolving 5.9g of aniline in enough water to make 100 mL of Solution, (molar mass; (g/mol): $\text{H}=1$, $\text{C}=12/\text{N}=14$?

- 1) 10.56

- 2)4.78
- 3)9.56
- 4)9.22

س Calculate the PH of a 1.60M KBrO solution. Ka for hypobromous acid, HBrO, is 2.0×10^{-9} and. $K_w = 1.0 \times 10^{-14}$?

- 1)11.45
- 2)2.55
- 3)9.75
- 4)4.25

س What is the pH of a solution prepared by mixing 100ml of 0.020 M Ba(OH)2 with 50mL of 0.40 M NaOH?

- 1)13.20
- 2)13.17
- 3)13.38
- 4)13.68

س In which of the following aqueous solutions does the weak acid exhibit the highest percentage ionization?

- 1)0.01M H₂CO₃ (Ka= 4.5×10^{-7})
- 2)0.01M H₂SO₃ (Ka= 1.4×10^{-2})
- 3) 0.01M HCN (Ka= 6.2×10^{-10})
- 4)0.01M HOCl(Ka= 3.5×10^{-8})

س What is the percent dissociation of a benzoic acid solution with pH=2.0? The acid dissociation constant for the monoprotic acid is 6.5×10^{-5} ?

- 1)3.5%

- 2)1.5%
- 3)2.5%
- 4)0.65%

س The PH of a 0.5 M solution of NaBr is?

- 1)5.0
- 2)13.6
- 3)9.2
- 4)7.0

س the pH of a 2.0×10^{-8} M NaOH solution is?

- 1)11.7
- 2)7.7
- 3)8.7
- 4)7.1