

تم تحميل هذا الملف من موقع المناهج الإماراتية



شرح وحل الدرس الثاني Bases and acids of Strengths قوة الأحماض والقواعد منهج انسابير

موقع المناهج ← المناهج الإماراتية ← الصف الثاني عشر المتقدم ← كيمياء ← الفصل الثاني ← حلول ← الملف

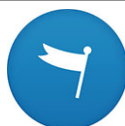
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المزيد من مادة
كيمياء:

إعداد: Mouad

التواصل الاجتماعي بحسب الصف الثاني عشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة كيمياء في الفصل الثاني

شرح وحل الدرس الأول Bases and Acids to Introduction مقدمة في الأحماض والقواعد منهج انسابير

1

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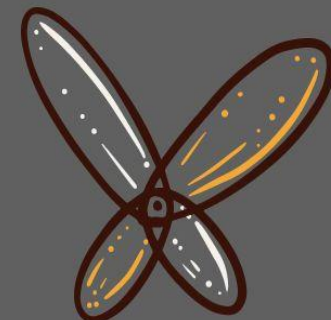
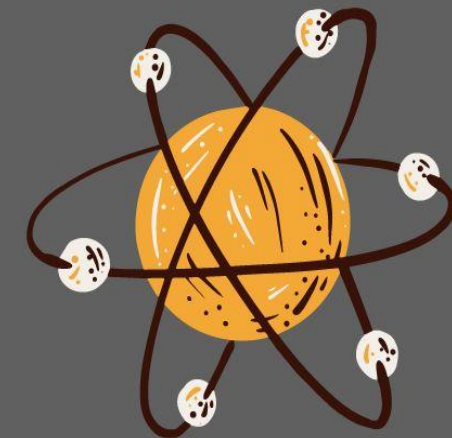
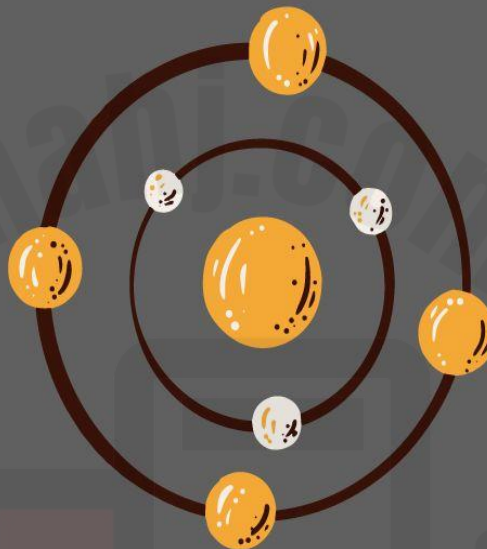
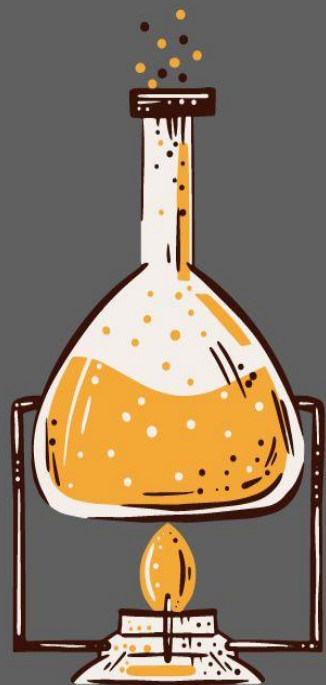
مذكرة أسئلة امتحانات سابقة حول وحدة الأحماض والقواعد

3

مذكرة شاملة وحدة الأحماض والقواعد

4

CHEMISTRY



EasyChemistry4all by Mr. Mouad

مناهج دولة الإمارات

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Inspire Chemistry

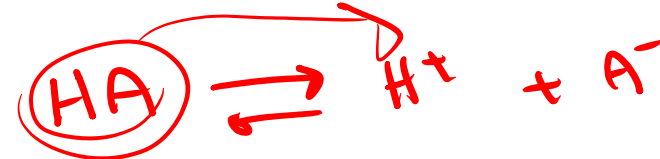
Module 17

“Acids & Bases”

McGraw Hill

Lesson 2: “Strengths of acids and Bases”

Learning Outcomes:



- Relate the strength of an acid or base to its degree of ionization.
- Compare the strength of a weak acid with the strength of its conjugate base.
- Explain the relationship between the strengths of acids and bases and the values of their ionization constants.

K_a and K_b



Part 1

Acids and Bases

Lesson 2: Strengths of acids and bases



Learning objectives:

Define strong and weak acids using “Bronsted-Lowery model”.

acid loses H^+ base gains H^+

Use ionization equations of acids to write the acidity constant equation K_a .

L1

Focus Question

What makes an acid or base strong or weak?

(aq)
MAIN IDEA In solution, strong acids and bases ionize completely, but weak acids and bases ionize only partially.

بیشکل چیزی
weak acid HY maybe only 20%
strong HX
 $\approx 100\% \rightarrow \text{H}^+$ and X^-
 H^+ Y^-

New Vocabulary

strong acid

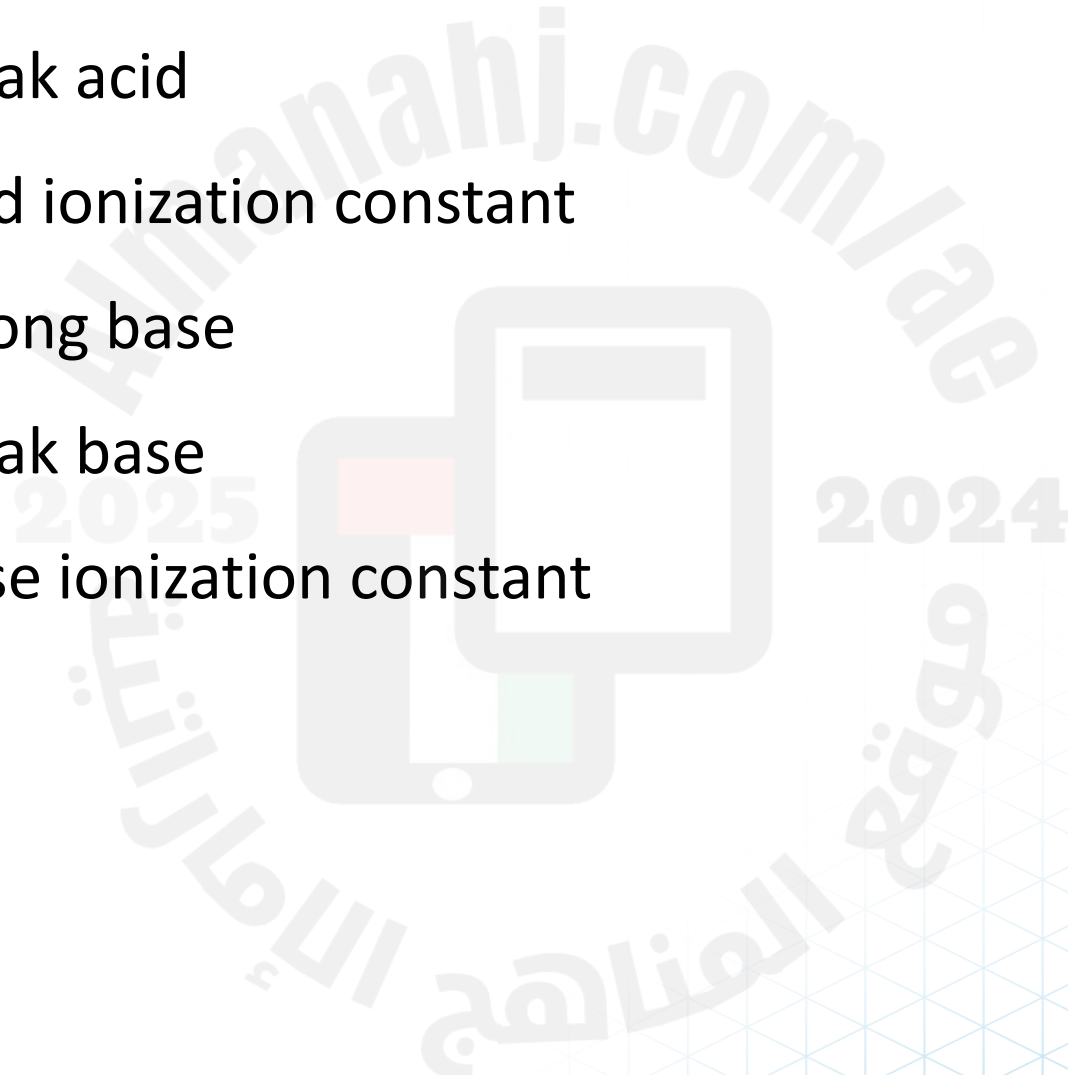
weak acid

acid ionization constant

strong base

weak base

base ionization constant



Review Vocabulary

electrolyte: an ionic compound whose aqueous solution conducts an electric current

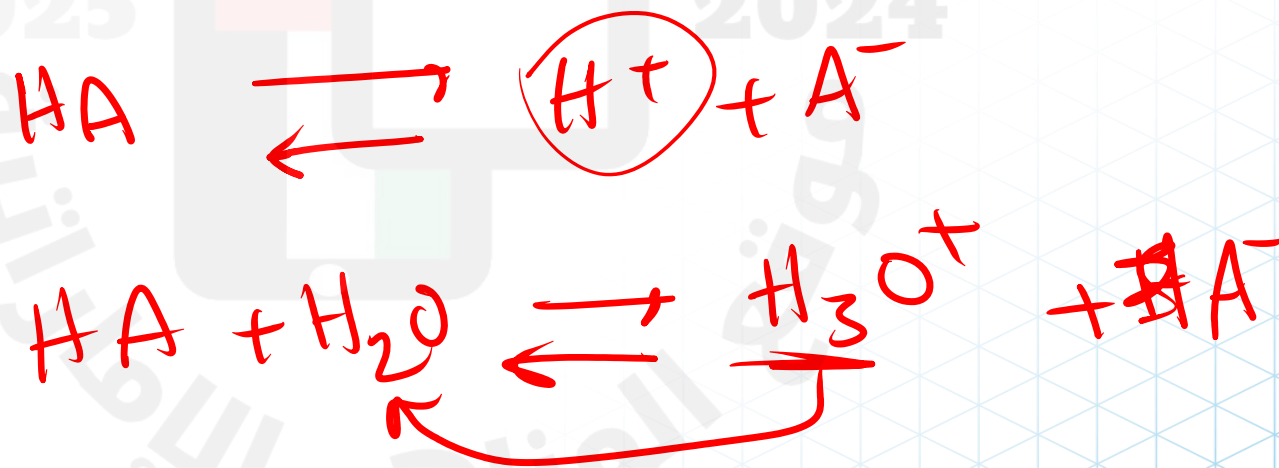
Remember: The ~~hydrogen~~ **ion** H^+ and the **hydronium ion** H_3O^+ mean the same thing and are usually used interchangeably.

electrolyte

Review Vocabulary

electrolyte: an ionic compound whose aqueous solution conducts an electric current

Remember: The **hydrogen ion H^+** and the **hydronium ion H_3O^+** mean the same thing and are usually used interchangeably.



Starter Activity

What is the K_{eq} for the following equilibrium?



$$\frac{[A^+][B^-]}{[AB]}$$

If the K_{eq} is 3.4×10^{-9}
or reactants?

At equilibrium, which is favored: products

Reactants (A^+ and B^-), because $K_{eq} < 1$

!!REMEMBER!!

The Equilibrium Constant (K_{eq})

- A value that relates the position of a reaction at equilibrium
- Calculated by inserting values into the equilibrium constant expression
- K_{eq} does NOT have units
- $K_{eq} > 1$
 - Product favored *more products > reactants*
- $K_{eq} \leq 1$
 - Reactant favored *// reactants > products*

Quick Revision on K_{eq}

we don't write (s) and (l)

$$K_{eq} = [C_2H_5OH(g)]$$



$$K = \frac{[C_2H_5OH(g)]}{[C_2H_5OH(l)]}$$

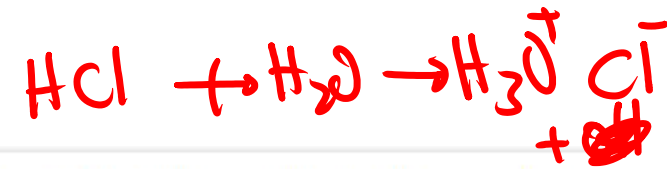
$$K[C_2H_5OH(l)] = [C_2H_5OH(g)] = K_{eq}$$

constant

(s)
constant

$$K_{eq} = [C_2H_5OH(g)]$$

Strengths of Acids Pages 98 & 99



Strong Acid = More ions = High electrical conductivity
in solution



Figure 11 The light glows brightly when electrodes are placed in 0.10M hydrochloric acid solution because all of the HCl is in the form of hydronium ions and chloride ions.

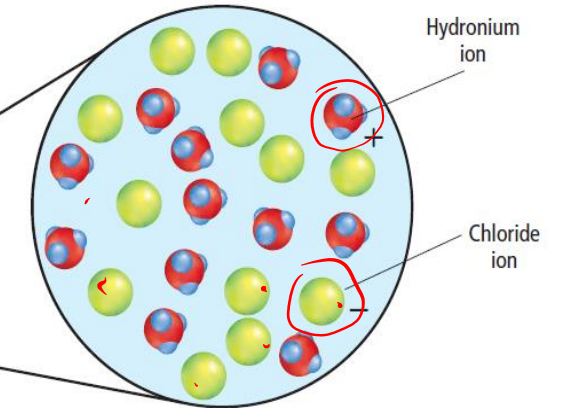
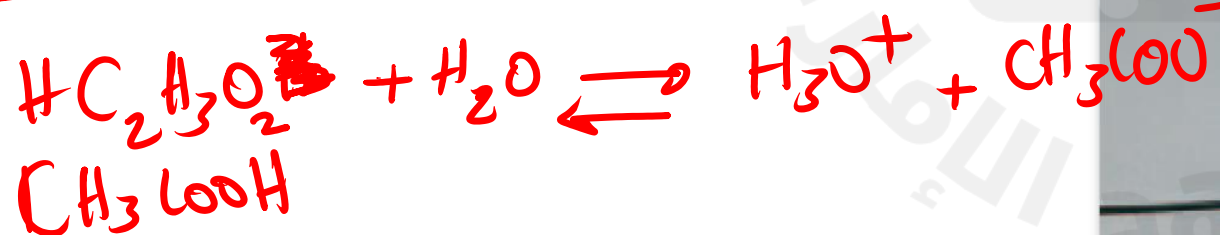
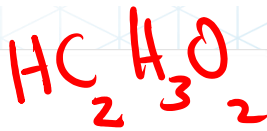
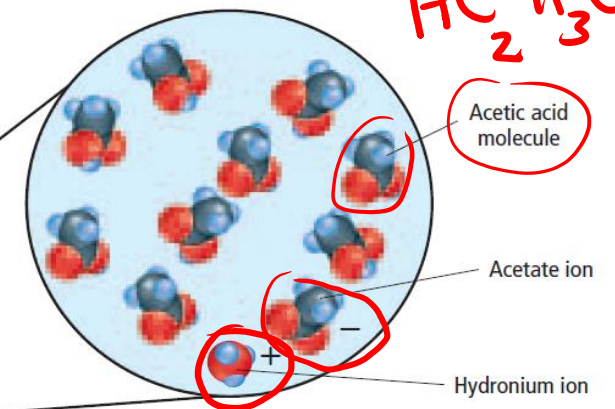


Figure 12 When electrodes are placed in 0.10M acetic acid solution, the light is dim. Compare this illustration with **Figure 18.11**.

Explain the difference in the brightness of the bulbs in terms of the concentration of ions in solution.



Weak Acid = Less ions = Low electrical conductivity

Strengths of Acids

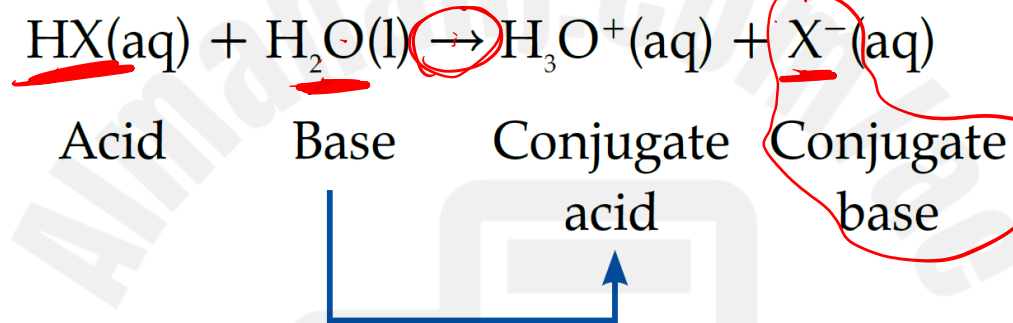
- Acids that تسأین بالکامد ionize completely are called **strong acids**.
- Because they produce the maximum number of hydrogen ions, strong acids are good conductors of electricity. H^+ or H_3O^+
- Acids that بیشکال جزئی ionize only partially in dilute aqueous solutions are called **weak acids.**

Strengths of Acids

Acid strength and the Brønsted-Lowry model

→ forward
← reverse

- With a **strong acid**, the conjugate base is a **weak base**.



base :- wants gains H^+
 H_2O stronger base X^-

- Equilibrium lies almost completely **to the right**, because the conjugate base has a weaker attraction for the H^+ ion than does the base in the forward reaction.
- Notice that the equation is **shown with a single arrow** to the right for **strong acids**. The reaction goes to completion (right).

weak acid
makes a stronger
conjugate base

Acid strength and the Brønsted-Lowry model

- $\text{HY(aq)} + \text{H}_2\text{O(l)} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{Y}^-(\text{aq})$
- Acid *weak* Base Conjugate acid Conjugate base *stronger than H₂O*
-

- equation is shown with equilibrium arrows for weak acids

Strengths of Acids

Try to Memorize them

CH₃COOH

Table 3 Ionization Equations

Strong Acids		Weak Acids	
Name	Ionization Equation	Name	Ionization Equations
Hydrochloric	$\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$	Hydrofluoric	$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$
Hydroiodic	$\text{HI} \rightarrow \text{H}^+ + \text{I}^-$	Acetic	$\text{HC}_2\text{H}_3\text{O}_2 \rightleftharpoons \text{H}^+ + \text{C}_2\text{H}_3\text{O}_2^-$
Perchloric	$\text{HClO}_4 \rightarrow \text{H}^+ + \text{ClO}_4^-$	Hydrosulfuric	$\text{H}_2\text{S} \rightleftharpoons \text{H}^+ + \text{HS}^-$
Nitric	$\text{HNO}_3 \rightarrow \text{H}^+ + \text{NO}_3^-$	Carbonic	$\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$
Sulfuric	$\text{H}_2\text{SO}_4 \rightarrow \text{H}^+ + \text{HSO}_4^-$	Hypochlorous	$\text{HClO} \rightleftharpoons \text{H}^+ + \text{ClO}^-$

Quiz

1. _____ acids **dissociate completely** in aqueous solutions.

A Only strong

B Only weak

C Both strong and weak

D Neither strong nor weak

Strengths of Acids

- The equilibrium constant, K_{eq} , provides a measure of the degree of ionization of an acid.

$$K_{eq} = \frac{[H_3O^+][CN^-]}{[HCN]}$$



$$K_{eq} = \frac{[H_3O^+][CN^-]}{[HCN][H_2O]}$$

- The **acid ionization constant**, K_a , is the value of the equilibrium constant expression for the ionization of a weak acid.

$$K_a = K_{eq} \times [H_2O] = \frac{[H_3O^+][CN^-]}{[HCN]} \times [H_2O]$$
$$= \frac{[H_3O^+][CN^-]}{[HCN]}$$

$$K_a = K_{eq} [H_2O] = \frac{[H_3O^+][CN^-]}{[HCN]} = 6.2 \times 10^{-10}$$

K_{eq} from term 1

Strengths of Acids

- K_a indicates whether products (Ions) or reactants (Acid) are favored (more) at equilibrium.
 - For weak acids, the products tend to be smaller compared to the un-ionized molecules (reactant).
 - Weaker acids have a smaller K_a . < 1 (More Acid and less ions)
- $K_a \gg 1$ strong Acid

Table 4 Ionization Constants for Weak Acids

Acid	Ionization Equation	K_a (298 K)
Hydrosulfuric, first ionization	$\text{H}_2\text{S} \rightleftharpoons \text{H}^+ + \text{HS}^-$	8.9×10^{-8} <u>< 1</u>
Hydrosulfuric, second ionization	$\text{HS}^- \rightleftharpoons \text{H}^+ + \text{S}^{2-}$	1×10^{-19} <u>< 1</u>
Hydrofluoric	$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$	6.3×10^{-4} <u>$\ll 1$</u>
Hydrocyanic	$\text{HCN} \rightleftharpoons \text{H}^+ + \text{CN}^-$	6.2×10^{-10} <u>$\ll 1$</u>
Acetic	$\text{CH}_3\text{COOH} \rightleftharpoons \text{H}^+ + \text{CH}_3\text{COO}^-$	1.8×10^{-5} <u>$\ll 1$</u>
Carbonic, first ionization	$\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$	4.5×10^{-7} <u>$\ll 1$</u>
Carbonic, second ionization	$\text{HCO}_3^- \rightleftharpoons \text{H}^+ + \text{CO}_3^{2-}$	4.7×10^{-11} <u>$\ll 1$</u>

Quiz

2. In the equation below, CH_3COOH is a _____.
Handwritten red notes above the equation: $\text{HC}_2\text{H}_3\text{O}_2$ with arrows pointing to the C and H atoms.



A strong acid

B weak acid

C strong base

D weak base

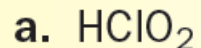
Practice Problems:

APPLICATIONS

Lesson 1

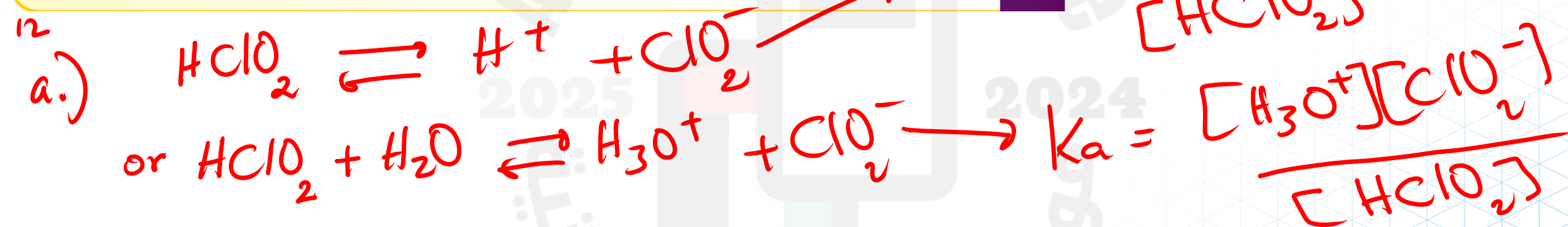
K_a

12. Write ionization equations and acid ionization constant expressions for each acid.



13. Write the first and second ionization equations for H_2SeO_3 .

14. **Challenge** Given the expression $K_a = \frac{[\text{AsO}_4^{3-}][\text{H}_3\text{O}^+]}{[\text{HAsO}_4^{2-}]}$, write the balanced equation for the corresponding reaction.



Answers: Applications

12. Write ionization equations and acid ionization constant expressions for the following acids.

✓ a. HClO_2



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{ClO}_2^-]}{[\text{HClO}_2]}$$

✓ b. HNO_2



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$$

✓ c. HIO



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

✓ 13. Write the first and second ionization equations for H_2SeO_3 .



✓ 14. **Challenge** Given the expression

$$K_a = \frac{[\text{AsO}_4^{3-}][\text{H}_3\text{O}^+]}{[\text{HAsO}_4^{2-}]}, \text{ write the balanced}$$

equation for the corresponding reaction.



Part 2

Module 17: Acids and Bases

Lesson 2: Strengths of acids and bases

Learning Objectives

Define strong and weak bases using “Bronsted-Lowery model”.

Use ionization equations of bases to write the basicity constant equation K_b .

Strengths of Bases_Self Study_102

- A base that dissociates completely into metal ions and hydroxide ions is known as a **strong base**.
- A **weak base** ionizes only partially in dilute aqueous solution.

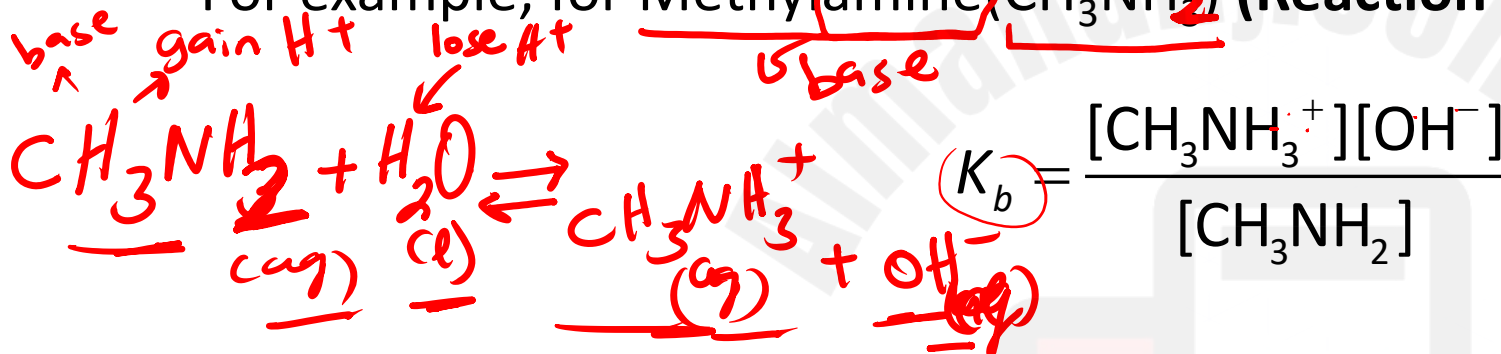
Table 5 Dissociation Equations for Strong Bases

$\text{NaOH(s)} \rightarrow \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$
$\text{KOH(s)} \rightarrow \text{K}^+(\text{aq}) + \text{OH}^-(\text{aq})$
$\text{RbOH(s)} \rightarrow \text{Rb}^+(\text{aq}) + \text{OH}^-(\text{aq})$
$\text{CsOH(s)} \rightarrow \text{Cs}^+(\text{aq}) + \text{OH}^-(\text{aq})$
$\text{Ca(OH)}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$
$\text{Ba(OH)}_2(\text{s}) \rightarrow \text{Ba}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$

Strengths of Bases_103

K_b } we don't
 K_a } put (s) or (l)
 K_{eq} }

- The **base ionization constant**, K_b , is the value of the equilibrium constant expression for the ionization of a base.
- For example, for Methylamine (CH_3NH_2) (Reaction is below in Table 6):



- The smaller the value of K_b , the weaker the base.

$\ll 1$

Table 6 Ionization Constants of Weak Bases

Base	Ionization Equation	K_b (298 K)
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	5.0×10^{-4}
Methylamine	$\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-4}
Ammonia	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$	2.5×10^{-5}
Aniline	$\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-10}

small
 0.0005

Strengths of Bases_Page 103

$$0 + 1 = +1 \text{ or } (+)$$

$$0 - 1 = -1 \text{ or } (-)$$

APPLICATIONS

15. Write ionization equations and base ionization constant expressions for the following bases.

a. hexylamine ($C_6H_{13}NH_2$)

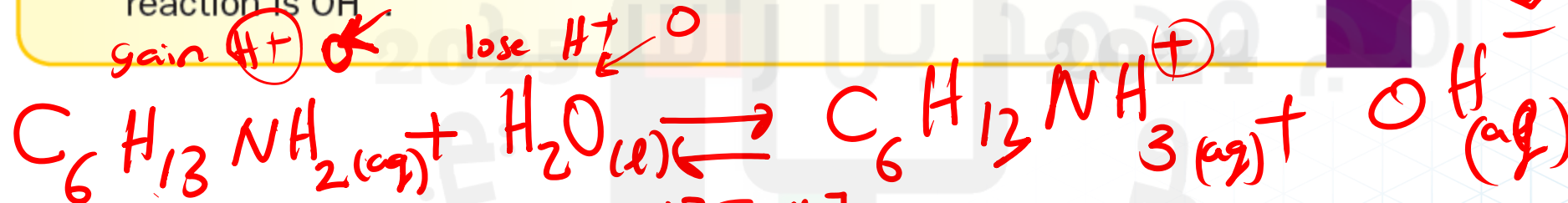
b. propylamine ($C_3H_7NH_2$)

c. carbonate ion (CO_3^{2-})

d. hydrogen sulfite ion (HSO_3^-)

16. **Challenge** Write an equation for a base equilibrium in which the base in the forward reaction is PO_4^{3-} and the base in the reverse reaction is OH^-

gain H^+ \rightarrow lose H^+ \leftarrow



$$K_b = \frac{[C_6H_{13}NH_3^+][OH^-]}{[C_6H_{13}NH_2]}$$

15a.

base

Strengths of Bases_Page 103

$$+1 - 2 = -1$$

$$\ominus = \ominus 1$$

APPLICATIONS

15. Write ionization equations and base ionization constant expressions for the following bases.

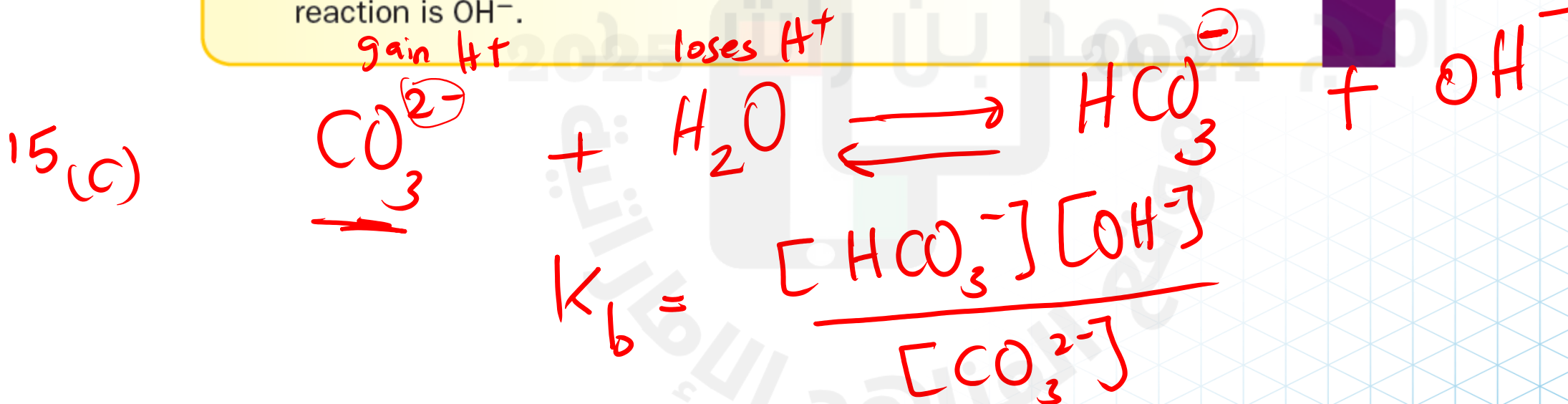
a. hexylamine ($\text{C}_6\text{H}_{13}\text{NH}_2$)

c. carbonate ion (CO_3^{2-})

b. propylamine ($\text{C}_3\text{H}_7\text{NH}_2$)

d. hydrogen sulfite ion (HSO_3^-)

16. **Challenge** Write an equation for a base equilibrium in which the base in the forward reaction is PO_4^{3-} and the base in the reverse reaction is OH^- .



APPLICATIONS

15. Write ionization equations and base ionization constant expressions for the following bases.

a. hexylamine ($\text{C}_6\text{H}_{13}\text{NH}_2$)

c. carbonate ion (CO_3^{2-})

b. propylamine ($\text{C}_3\text{H}_7\text{NH}_2$)

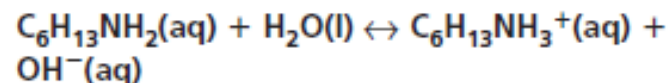
d. hydrogen sulfite ion (HSO_3^-)

16. Challenge Write an equation for a base equilibrium in which the base in the forward reaction is PO_4^{3-} and the base in the reverse reaction is OH^- .

Strengths of Bases_Page 103

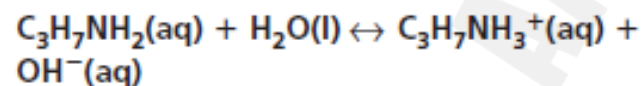
15. Write ionization equations and base ionization constant expressions for the following bases.

a. hexylamine ($\text{C}_6\text{H}_{13}\text{NH}_2$)



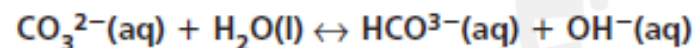
$$K_b = \frac{[\text{C}_6\text{H}_{13}\text{NH}_3^+][\text{OH}^-]}{[\text{C}_6\text{H}_{13}\text{NH}_2]}$$

b. propylamine ($\text{C}_3\text{H}_7\text{NH}_2$)



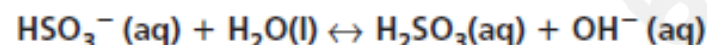
$$K_b = \frac{[\text{C}_3\text{H}_7\text{NH}_3^+][\text{OH}^-]}{[\text{C}_3\text{H}_7\text{NH}_2]}$$

c. carbonate ion (CO_3^{2-})



$$K_b = \frac{[\text{HCO}_3^-][\text{OH}^-]}{[\text{CO}_3^{2-}]}$$

d. hydrogen sulfite ion (HSO_3^-)



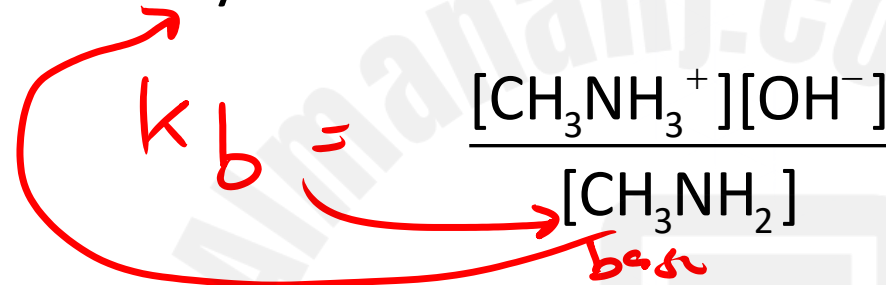
$$K_b = \frac{[\text{H}_2\text{SO}_3][\text{OH}^-]}{[\text{HSO}_3^-]}$$

16. Challenge Write an equation for a base equilibrium in which the base in the forward reaction is PO_4^{3-} and the base in the reverse reaction is OH^-



Quiz

3. The expression shown below is the _____ for methylamine.



- A** equilibrium constant **C** base ionization constant
- B** acid ionization constant **D** ionization equation

Strongest = highest K

Quiz

lowest K_b

4. Which is the weakest base shown in the table below?

Table 6 Ionization Constants of Weak Bases

Base	Ionization Equation	$K_b(298\text{ K})$
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	5.0×10^{-4}
Methylamine	$\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-4}
Ammonia	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$	2.5×10^{-5}
Aniline	$\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-10}

A ethylamine

C ammonia

B methylamine

D analine

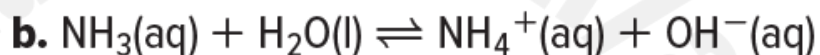
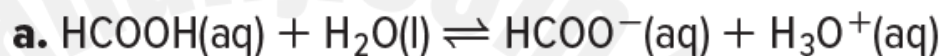
Section Summary

- Strong acids and strong bases are completely ionized in a dilute aqueous solution. Weak acids and weak bases are partially ionized in a dilute aqueous solution.
- For weak acids and weak bases, the value of the acid or base ionization constant is a measure of the strength of the acid or base.

17. MAIN IDEA Describe the contents of dilute aqueous solutions of the strong acid HI and the weak acid HCOOH.

18. Relate the strength of a weak acid to the strength of its conjugate base.

19. Identify the conjugate acid-base pairs in each equation.



20. Explain what the K_b for aniline ($\text{C}_6\text{H}_5\text{NH}_2$) tells you ($K_b = 4.3 \times 10^{-10}$).

21. Interpret Data Use the data in **Table 4** to put the seven acids in order according to increasing electrical conductivity.

SECTION 2 REVIEW

Answers

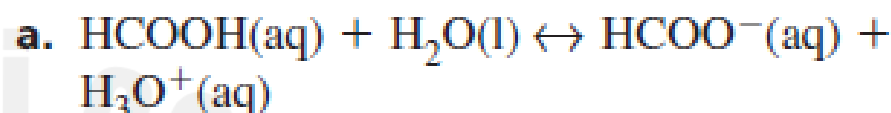
17. Describe the contents of dilute aqueous solutions of the strong acid HI and the weak acid HCOOH.

The solution of HI contains only H_3O^+ and I^- ions and water molecules. The solution of HCOOH contains H_3O^+ and HCOO^- ions, and HCOOH and H_2O molecules.

18. Relate the strength of a weak acid to the strength of its conjugate base.

The stronger the acid is, the weaker its conjugate base. The weaker the acid is, the stronger its conjugate base.

19. Identify the conjugate acid-base pairs in each equation.



acid: HCOOH; conjugate base: HCOO^- ; base: H_2O ; conjugate acid: H_3O^+ ;



acid: H_2O ; conjugate base: OH^- ; base: NH_3 ; conjugate acid: NH_4^+

20. Explain what the K_b for aniline tells you. ($K_b = 4.3 \times 10^{-10}$).

The size of aniline's K_b indicates that aniline is a weak base.

21. Interpret Data Use the data in Table 18.4 to put the seven acids in order according to increasing electrical conductivity.

HS^- , HCO_3^- , H_2S , H_2CO_3 , CH_3COOH , HCOOH, HF