

Acids and Bases

Electrolytes

Strong

Weak

Non-electrolyte

Acids and Bases are Electrolytes

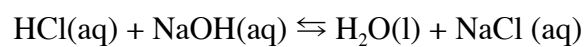
Acids

Bases

Arrhenius Model

Acid

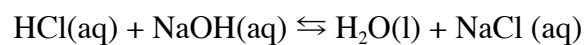
Base



Bronsted-Lowry Theory

Acid

Base



Lewis Acid/Base Theory

Acid

Base

Conjugate Acid and Bases

Acid

Example

Base

Example

Write the dissociation equations when the following electrolytes react with water:

1) HNO_3 2) $\text{HC}_2\text{H}_3\text{O}_2$ 3) HCN 4) HOCl 5) CH_3NH_2 6) F^- 7) NH_3 8) HCl 9) HBr 10) HI

Ka and Kb

What about Kw

Indicators:

Strong Acid

Acid Strength

Polyprotic Acid

reactions:

Amphoteric/Amphiprotic

A mathematical treatment of acids and bases

How do hydrogen and hydroxide relate to each other in a solution? We base everything on K_w .

Acids

Bases

Some Background from math class

Logarithms

pH is a measure of a substances acidity!

Are pH and pOH related to each other?

How about K_a and K_b ?

A square roadmap

Can you do significant digits with logs?

pH	pOH	H ⁺	OH ⁻
7			
	10		
		1.00×10^{-5}	
			1.00×10^{-3}
		2.00×10^{-9}	
	7.65		
1.23			
	0.05		
		1.00×10^{-14}	
			7.98×10^{-5}

Weak Acids

1. What is the pH of a 0.20 M HCN solution? The K_a for HCN is 6.5×10^{-10} .
2. The K_a for acetic acid is 1.75×10^{-5} . What is the H^+ and pH of a 0.10M solution of acetic acid in water?
3. What is the pH of some formic acid ($HCOOH$) whose original concentration was 0.50M? The K_a for formic acid is 1.772×10^{-4} .

4. What is the pH of a solution of HOCl whose original concentration was 0.25M if the K_a is 3.5×10^{-8} ?

5. What is the pH of a 0.10M HF solution. K_a is 6.5×10^{-4} ?

Weak Bases

We have the same basic problems here with pH exchanged for pOH!

6. Dimethyl amine is a weak base whose formula is $(\text{CH}_3)_2\text{NH}$. K_b for it is 5.9×10^{-4} . What is the pH of some 0.750 M dimethyl amine?

Salts

When HCl dissociates in water the two remaining ions have no affinity to react with water. What if the remaining ions DO react with water? What would determine this?

NaF

NH₄Cl

Acid Dissociation Constants

HClO ₄	large	H ₂ CO ₃	4.5×10^{-7}
HBr	large	NH ₄ ⁺	6.3×10^{-10}
HF	6.5×10^{-4}	HCN	6.3×10^{-10}
CH ₃ COOH	1.8×10^{-5}	H ₂ O	10^{-14}

Using the above hierarchy of acid/base strength determine if solutions of the following salts are acidic, basic, or neutral.

	Parent Acid/Strength	Parent Base/ Strength	Salt
KCl			

KF

NH₄Br

KClO₄

KCN

NH₄CN

KCH₃COO

NH₄CH₃COO

NH₄F

7. What is the pH of some LiCN in water if it is 0.10 M and K_a for HCN is 6.3×10^{-10} ?

8. What is the pH of some NH_4Cl in water? The solution is 0.250 M and K_b for ammonia is 1.8×10^{-5} ?

9. What is the pH of a NaF solution that is 0.10M? K_a is 6.5×10^{-4}

10. What is the pH of a KF solution that is 0.10M?

11. What is the pH of a 0.10 M solution of KCH_3COO ?

Polyprotic Acids

Write the two dissociations for H_2SO_4

K_a Values

	H_2SO_4	H_2CO_3	H_3PO_4
K_{a1}	Large	4.3×10^{-7}	7.5×10^{-3}
K_{a2}	1.2×10^{-2}	5.6×10^{-11}	6.2×10^{-8}
K_{a3}	none	none	4.8×10^{-13}

Size Matters

What is the pH of some 0.10 M H_2CO_3 ?

First Dissociation**Second Dissociation**

What is the pH of some 0.10 M H_2SO_4 ?

First Dissociation

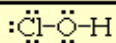
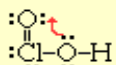
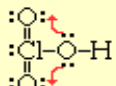
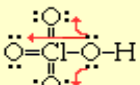
Second Dissociation

Determining the strengths of Acids and Bases

What makes a halogen acid stronger than another halogen acid? Why is HF a weak acid?


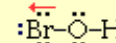
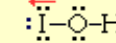
What happens in an oxyacid?

Table 14.3 Correlation of acid strength and oxidation number

Acid	Structure*	Oxidation number of chlorine atom	pK_a
hypochlorous acid, HClO		+1	7.52
chlorous acid, HClO ₂		+3	2.00
chloric acid, HClO ₃		+5	strong
perchloric acid, HClO ₄		+7	strong

* The red arrows indicate the direction of the shift of electron density away from the O—H bond.

Table 14.4 Correlation of acid strength and electronegativity

Acid, HXO	Structure*	Electronegativity of atom X	pK_a
hypochlorous acid, HClO		3.2	7.53
hypobromous acid, HBrO		3.0	8.69
hypoiodous acid, HIO		2.7	10.64

* The red arrows indicate the direction and magnitude of the shift of electron density away from the O—H bond.