

Acids and Bases

AP Chemistry • Unit 8

AP Chemistry



Acids and Bases

What we will cover

- 1 Bronsted-Lowry and pH
- 2 Strong acids and bases
- 3 Weak acid and base equilibria
- 4 Buffers and Henderson-Hasselbalch
- 5 Acid-base titrations
- 6 Structure and pKa



1 pH

Acids and Bases

↳ pH

Bronsted-Lowry and pH

Bronsted-Lowry 布朗斯特-劳里: an acid **donates** a proton, a base **accepts** one – forming **conjugate pairs** 共轭酸碱对.

Water and pH

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

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



pH measures acidity of a solution

2 Strong

Acids and Bases

↳ Strong

Strong acids and bases

A **strong acid** 强酸 ionizes **completely**, so $[\text{H}^+]$ equals its concentration.

Two logarithms

$$\text{pH} = -\log[\text{H}^+], \text{pOH} = -\log[\text{OH}^-]$$

$$\text{pH} + \text{pOH} = 14$$

Worked example

0.010 M HCl:

$$[\text{H}^+] = 0.010 \Rightarrow \text{pH} = 2$$

$$\text{pOH} = 12, [\text{OH}^-] = 10^{-12}$$

3 Weak

Acids and Bases
└ Weak

Weak acid and base equilibria

A **weak acid** 弱酸 only **partly** ionizes:

Ionization constant

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

Larger K_a = stronger. For a conjugate pair,
 $K_a K_b = K_w$.

Worked example

0.10 M, $K_a = 10^{-5}$;

$$K_a \approx \frac{x^2}{0.10} \Rightarrow x = 10^{-3}$$

$$pH = 3$$

A strong acid at 0.10 M would give pH 1.

4 Buffers

Acids and Bases
└ Buffers

Buffers and Henderson-Hasselbalch

A **buffer** 缓冲溶液 holds pH steady with **both** a weak acid and its conjugate base:

- added acid $\Rightarrow$ conjugate base soaks up H^+
- added base $\Rightarrow$ weak acid soaks up OH^-

Henderson-Hasselbalch

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

Equal amounts $\Rightarrow pH = pK_a$.
Capacity 缓冲容量 grows with total concentration.

5 Titrations

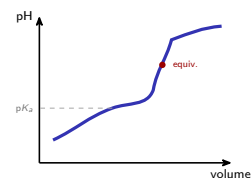
Acids and Bases
└ Titrations

Acid-base titrations

A **titration curve** 滴定曲线 plots pH against titrant volume:

- the **equivalence point** 等当点 is the steep jump
- at the **half-equivalence point** 半等当点, $pH = pK_a$

Strong-strong: equivalence at pH 7.
Weak acid-strong base: above 7.



6 Structure

Acids and Bases
└ Structure

Structure and pKa

Acid strength comes down to how easily the acidic H leaves, and how stable the **conjugate base** 共轭碱 is:

- **binary acids** 无氧酸: stronger *down* a group (weaker bond)
- **oxyacids** 含氧酸: more oxygens $\Rightarrow$ stronger

$$pK_a = -\log K_a$$

Smaller pK_a = stronger acid.

$pH < pK_a$: the acid form dominates; $pH > pK_a$: the conjugate base dominates.

7 Recap

Acids and Bases
└ Recap

Unit 8 – key takeaways

1 pH

$$pH = -\log[H^+]; \quad pH + pOH = 14$$

2 Weak acids

$$K_a \text{ equilibrium}; \quad K_a K_b = K_w$$

3 Buffers

weak acid + conjugate base;
$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

4 Titration

equivalence jump; half-equivalence $pH = pK_a$

Acids and Bases
└ Recap

Check yourself

- 1 What is the pH of 0.001 M HCl?
- 2 In Bronsted-Lowry terms, what does a base do?
- 3 A buffer needs which two species present?
- 4 At the half-equivalence point, pH equals what?



Answers 1. 3 2. accepts a proton 3. a weak acid and its conjugate base 4. pK_a