

28.5 Stability constants

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS stability constant 稳定常数 • complex 配合物 • ligand 配体 • complex ion 配离子 • ligand exchange 配体交换

Objective

Build the skills to answer exam questions on **stability constants** 稳定常数 (K_{stab}) — what they are, writing the expression, and using them.

You must be able to:

- define the stability constant of a complex
- write a K_{stab} expression (leaving out water)
- use K_{stab} values to compare stability and predict ligand exchange

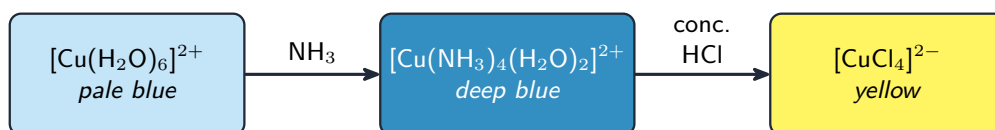
1 Worked examples

■ Stability constants

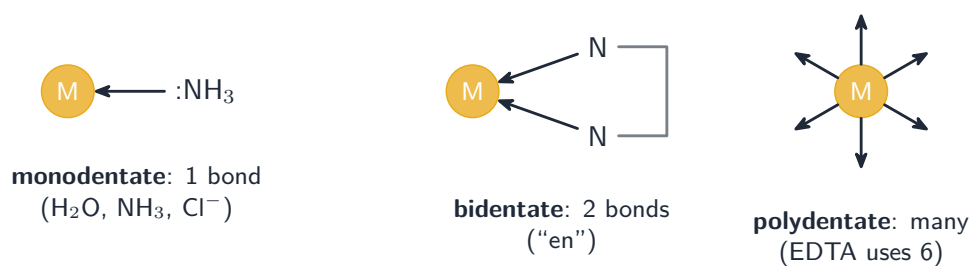
The **stability constant** K_{stab} is the equilibrium constant for forming a complex ion from the metal ion and its ligands in solution. **Water is left out** of the expression.

For $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 4\text{H}_2\text{O}$:

$$K_{\text{stab}} = \frac{[[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}]}{[[\text{Cu}(\text{H}_2\text{O})_6]^{2+}][\text{NH}_3]^4}$$



A **large** K_{stab} = a very stable complex; ligand exchange moves towards the larger K_{stab}



Ligand denticity affects stability constants

2 Practice

2.1 Define the **stability constant** of a complex. [1]

2.2 State what a large value of K_{stab} tells you about a complex. [1]

3 Exam-style questions

3.1 Which species is **omitted** from a K_{stab} expression in aqueous solution? [1]

- **A** the metal ion
 - **B** the incoming ligand
 - **C** water
 - **D** the complex ion
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3.2 In a ligand exchange, the equilibrium moves towards the complex with the: [1]

- **A** smaller K_{stab}
 - **B** larger K_{stab}
 - **C** smaller charge
 - **D** more water ligands
-

3.3 For $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 4\text{H}_2\text{O}$:

(a) Write the expression for K_{stab} . [2]

(b) The ammonia complex has a much larger K_{stab} than the water complex. Explain what this means for the ligand-exchange reaction. [2]

3.4 Explain why adding excess ammonia to $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ forms the ammonia complex. [2]

Solutions

2.1 the equilibrium constant for the formation of a complex ion from the metal ion and its ligands in solution.

2.2 the complex is very stable.

3.1 C. Water is omitted from the K_{stab} expression.

3.2 B. The equilibrium moves towards the complex with the larger K_{stab} .

3.3 (a) $K_{\text{stab}} = \frac{[[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}]}{[[\text{Cu}(\text{H}_2\text{O})_6]^{2+}][\text{NH}_3]^4}$.

(b) the ammonia complex is more stable, so the equilibrium lies far to the right and the exchange goes almost to completion.

3.4 the ammonia complex has a much larger K_{stab} (is more stable); so excess ammonia drives the equilibrium to replace the water ligands and form the ammonia complex.