A-LEVEL CHEMISTRY • EXERCISE SHEET

28.5 Stability constants

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

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

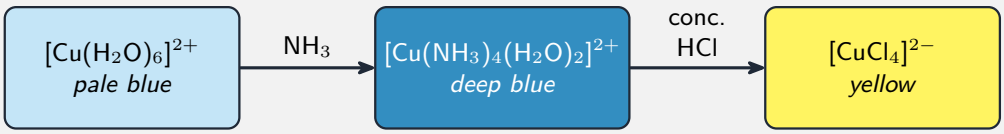
1 Worked examples

Stability constants

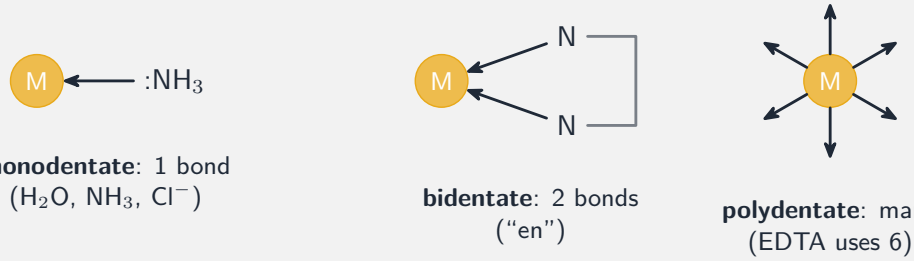
The **stability constant** K_{stab} is the equilibrium constant for forming a complex ion from the metal ion and its ligands in solution. **Water is left out** of the expression.

For $[Cu(H_2O)_6]^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4(H_2O)_2]^{2+} + 4H_2O$:

$$K_{stab} = \frac{[[Cu(NH_3)_4(H_2O)_2]^{2+}]}{[[Cu(H_2O)_6]^{2+}][NH_3]^4}$$



*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

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 $[Cu(H_2O)_6]^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4(H_2O)_2]^{2+} + 4H_2O$:

(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 $[Cu(H_2O)_6]^{2+}$ forms the ammonia complex.[2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **28.5 Stability constants** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/42 N25 —Q6 (stability constants)
- 9701/44 N25 —Q1 (stability constants)

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) $K_{\text{stab}} = \dfrac{[[Cu(NH_3)_4(H_2O)_2]^{2+}]}{[[Cu(H_2O)_6]^{2+}][NH_3]^4}$.
(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.