

Exercise walk-through

28.5

Stability constants, K_{stab}

A-Level Chemistry

Stability constants

K_{stab} : equilibrium for forming a complex

A **large stability constant** means a very stable complex – ligand exchange moves towards the larger K_{stab} .

Use $E^\ominus$ values to predict redox feasibility (e.g. $\text{MnO}_4^-/\text{Fe}^{2+}$ titrations, purple to colourless).

Topic 28 – key takeaways

1

Properties

variable states, catalysts,
complexes, colour

2

Ligands

donate a lone pair;
mono/bi/polydentate

3

Colour

split d orbitals; see the
complementary colour

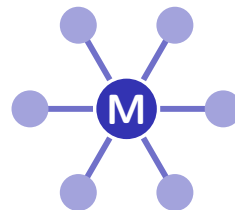
4

Isomerism

cis/trans & optical; stability
constants

Check yourself

- 1 What does a bidentate ligand form?
- 2 What shape has coordination number 6?
- 3 Why are transition complexes coloured?
- 4 A large stability constant means what?



Answers 1. two dative bonds 2. octahedral 3. electrons jump split d orbitals 4. a very stable complex

Exercises 2.1·2.2

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]

Exercises 2.1·2.2

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

2.1

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

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

2.2

- the complex is very stable

Exercises 3.1-3.2

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

Exercises 3.1-3.2

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

3.1 C

- Water is omitted from the K_{stab} expression

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

3.2 B

- The equilibrium moves towards the complex with the larger K_{stab}

Exercise 3.3 (a)

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]

Exercise 3.3 (a)

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]

(a)

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

Exercise 3.3 (b)

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

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

Exercise 3.3 (b)

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

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

(b)

- the ammonia complex is more stable, so the equilibrium lies far to the right and the exchange goes almost to completion

Exercise 3.4

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

Exercise 3.4

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

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