

28.3 Colour of complexes

Name: _____ Class: _____ Date: _____

Total: 9 marks

Objective

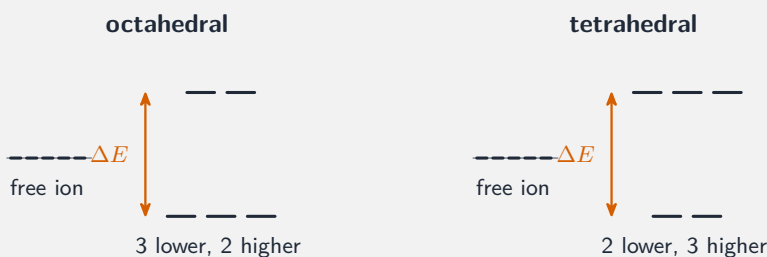
Build the skills to answer exam questions on the **colour of complexes** 配合物的颜色 —**d-orbital splitting** d 轨道分裂 and why transition complexes are coloured.

You must be able to:

- define degenerate and non-degenerate d orbitals
- describe the splitting in octahedral and tetrahedral complexes
- explain colour in terms of the frequency of light absorbed (ΔE)

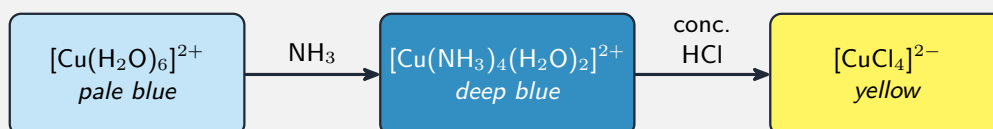
1 Worked examples

■ d-orbital splitting and colour



the complex absorbs light of energy ΔE , so we see the **complementary colour**

*Ligands split the five **degenerate** d orbitals into two **non-degenerate** sets separated by a gap ΔE*



Ligand exchange changes the complex colour

- **octahedral:** three lower + two higher.
- **tetrahedral:** two lower + three higher.

A complex absorbs light whose energy equals ΔE , promoting a d electron to the higher set. We **see** the **complementary colour** of the light absorbed. Different ligands give a different $\Delta E \rightarrow$ different colour (why ligand exchange changes colour).

2 Practice

2.1 Define **degenerate** d orbitals. [1]

2.2 State how the five d orbitals split in an **octahedral** complex. [1]

3 Exam-style questions

3.1 A transition-metal complex is coloured because an electron is promoted: [1]

- **A** out of the atom
 - **B** between two non-degenerate d orbitals
 - **C** into the nucleus
 - **D** between s orbitals
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3.2 The colour we see is: [1]

- **A** the colour of light absorbed
 - **B** the complementary colour of the light absorbed
 - **C** always green
 - **D** white
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3.3 Explain, in terms of d orbitals, why $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ is coloured. [3]

3.4 Explain why changing the ligand around a transition-metal ion changes the colour of the complex. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **28.3 Colour of complexes** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/41 N25 —Q5 (colour of complexes)
- 9701/42 N25 —Q5 (colour of complexes)
- 9701/44 N25 —Q1 (colour of complexes)

Solutions

2.1 d orbitals that have the same energy.

2.2 into a lower set of three and a higher set of two orbitals.

3.1 B. An electron is promoted between two non-degenerate d orbitals.

3.2 B. We see the complementary colour of the light absorbed.

3.3 the ligands split the d orbitals into two sets separated by ΔE ; the complex absorbs light of energy equal to ΔE , promoting a d electron to the higher set; the colour seen is the complementary colour of the light absorbed.

3.4 a different ligand gives a different splitting energy ΔE ; so a different frequency of light is absorbed, and a different complementary colour is seen.