

28.4 Stereoisomerism in transition element complexes

Name: _____ Class: _____ Date: _____ Total: 21 marks

KEY WORDS stereoisomerism in complexes 配合物的立体异构 • cis 顺式 • geometrical 几何
• optical 旋光 • optical isomerism 旋光异构

Objective

Build the skills to answer exam questions on **stereoisomerism in complexes** 配合物的立体异构 — **geometrical** 几何 (cis/trans) and **optical** 旋光 isomerism, and the polarity of complexes.

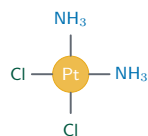
You must be able to:

- describe cis/trans isomerism in square planar and octahedral complexes
- describe optical isomerism in octahedral complexes with bidentate ligands
- deduce the overall polarity of such complexes

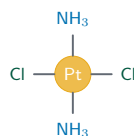
1 Worked examples

■ Geometrical and optical isomerism

square planar $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$

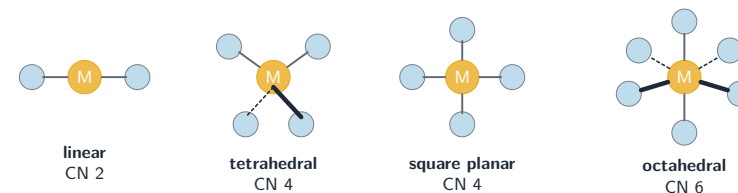


cis (same side)



trans (opposite)

Cis/trans in $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$: the two identical ligands are adjacent (cis) or opposite (trans)



Complex shapes underlie their stereoisomerism

- geometrical (cis/trans):** square planar (e.g. $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$) and octahedral (e.g. $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$).
- optical:** octahedral complexes with bidentate ligands (e.g. $[\text{Ni}(\text{en})_3]^{2+}$) have two non-superimposable mirror images.

Polarity: a *cis* form may be polar (dipoles do not cancel); the matching *trans* form is often non-polar.

2 Practice

2.1 Name the type of stereoisomerism shown by $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$. [1]

2.2 State what makes a complex show optical isomerism. [1]

3 Exam-style questions

3.1 Optical isomerism is shown by: [1]

A	B
C	D

- A $[\text{CuCl}_4]^{2-}$
B $[\text{Ni}(\text{en})_3]^{2+}$
C $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
D $[\text{Ag}(\text{NH}_3)_2]^+$

3.2 The *trans* isomer of a square planar complex is often: [1]

A	B
C	D

- A polar
B non-polar (dipoles cancel)
C optically active
D coloured only

3.3 (a) Draw the cis and trans isomers of the square planar complex $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$. [2]

(b) Explain why $[\text{Ni}(\text{en})_3]^{2+}$ shows optical isomerism. [2]

3.4 State, with a reason, which of the cis or trans form of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ is polar. [2]

3.5 The complex $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ is square planar; $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ is octahedral; $[\text{Ni}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$ is octahedral with three bidentate ligands.

(a) Draw the two geometrical isomers of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ and label each cis or trans. [3]

(b) Explain which of the two is polar, and why the other is not. [2]

(c) State how many geometrical isomers $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ has, and describe how they differ. [2]

(d) Explain what makes $[\text{Ni}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$ **optically** active, and describe how the two forms could be told apart. [4]
