

SYSTEMATIC NOMENCLATURE OF COORDINATION COMPOUNDS

Naming Coordination Compounds. IUPAC rules that have been developed for naming them are summarized below:

1. If the compound is a salt, the cation is named before the anion with space between them.

Example: $K_2[Pd(Cl)_6]$ potassium ??????? (once we learn how to name the complex ion, we can write it in the blank)

2. Within the complex ion or a neutral complex, the ligands are named first, followed by the metal ion. Ligands are listed in alphabetical order.
3. A) The names of anionic ligands end with the letter -o, by changing the anion endings as shown below:

ide' to -o (example: chloride becomes chloro)

ate to -ato and ite to -ito (oxalate becomes oxalato)

- b) neutral ligands names are usually the same as the names of the molecules. The exceptions are H_2O (aqua), CO (carbonyl), and NH_3 (ammine). Table 23.7 in the textbook lists the names of some common ligands.

Neutral		Anionic	
Name	Formula	Name	Formula
Aqua	H_2O	Fluoro	F^-
Ammine	NH_3	Chloro	Cl^-
Carbonyl	CO	Bromo	Br^-
Nitrosyl	NO	Iodo	I^-
		Hydroxo	OH^-
		Cyano	CN^-

- When several ligands of a particular kind are present, use the Greek prefixes di-, tri-, tetra-, penta-, and hexa.

Example: The ligands in $[\text{Pd}(\text{Cl})_6]^{2-}$ ion are hexachloro

The ligands in $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ are "tetraamminedichloro." (remember alphabetical order for the name of ligands and not their prefixes)

If the ligand itself contains a Greek prefix, use the prefixes bis (2), tris (3), and tetrakis (4) to indicate the number of ligands present.

The ligand ethylenediamine already contains the term di; therefore bis(ethylenediamine) is used to indicate two ethylenediamine ligands.

- The oxidation number of the metal **is written in Roman numerals** following the name of the transition metals (and 'A' group metals that can have more than one oxidation state)

In $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ ion, the metal is written as cobalt (III) to indicate its oxidation number.

- If the complex is an anion, attach the ending **-ate to the name of the metal** after dropping the ending of the metal name.

Metal	Name in Anion
Iron	Ferrate
Copper	Cuprate
Lead	Plumbate
Silver	Argentate
Gold	Aurate
Tin	Stannate

In $[\text{Pd}(\text{Cl})_6]^{2-}$ ion, the metal is written as palladate (IV) to indicate the oxidation number of palladium as +4, the metal is inside an anion –note from palladium 'ium is dropped and 'ate' is added.

RULES FOR WRITING FORMULAS:

- The cation is written first followed by anion.

- The total charge of a compound is zero, the charge of the cation(s) should be balanced by the charge of anion(s)
3. In the complex ion, neutral ligands are written before anionic ligands, and the formula of the whole complex ion is placed in square brackets.

EXERCISE:

Naming Coordination Compounds from formulas:

Give a systematic name for each of the following compounds:

- $[\text{Ag}(\text{NH}_3)_2]\text{Br}$
- $\text{Ni}(\text{CO})_4$
- $\text{K}_2[\text{Cd}(\text{CN})_4]$
- $[\text{Co}(\text{H}_2\text{O})_6][\text{Ag}(\text{CN})_2]_3$
- $[\text{CoCl}_3\text{Br}_3]^{4-}$
- $[\text{Ni}(\text{en})_2(\text{NH}_3)_2]^{2+}$.

Writing Formulas from the Names:

- diaquodicyanocopper(II)
- potassium hexachloropalladate(IV)
- dioxalatocuprate(II) ion
- Hexaamminechromium(III) tetrachlorocuprate(II)
- diammineoxalatocopper(II)
- potassium amminetrichloroplatinate(II)

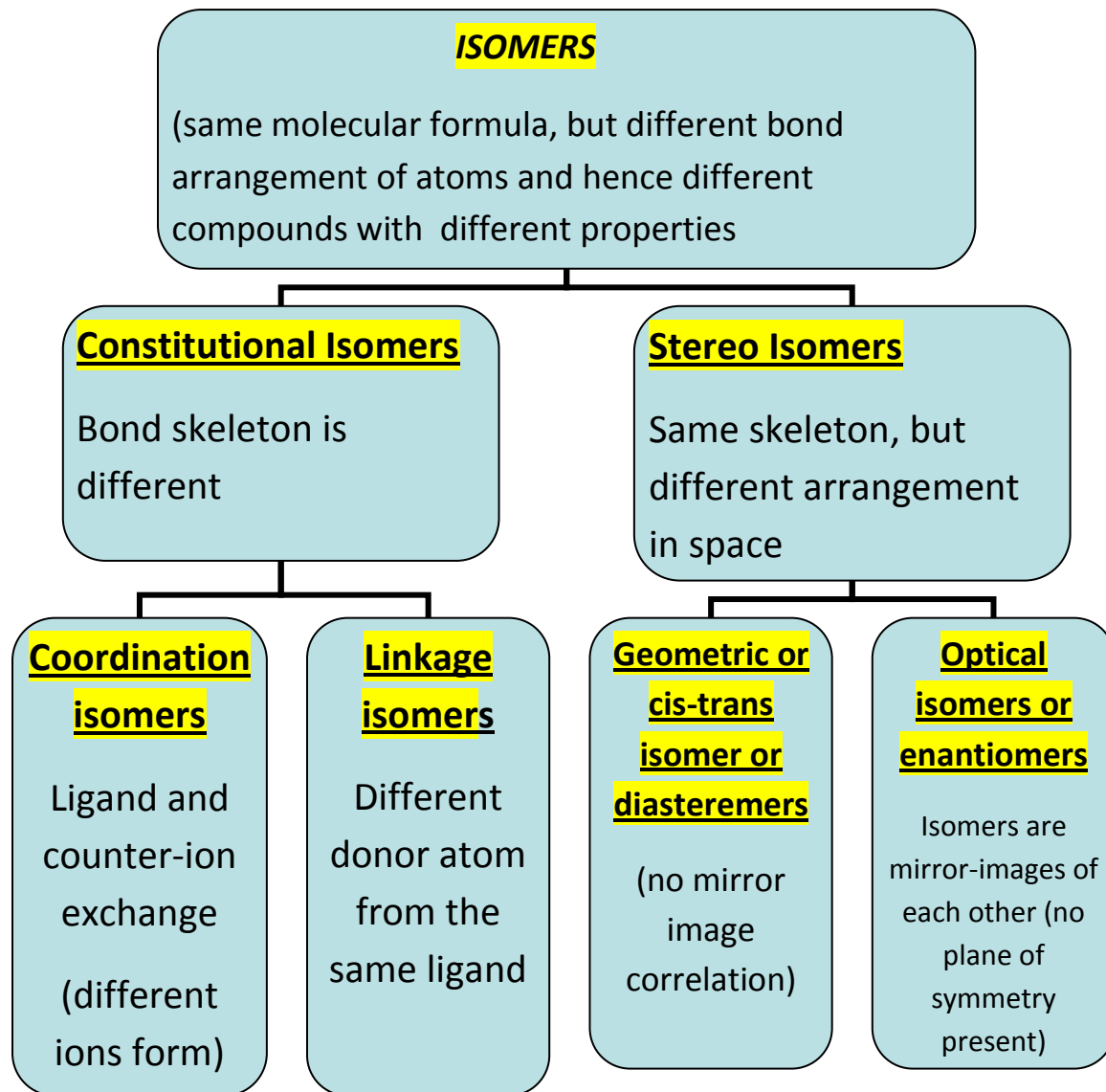
Names:

- diamminesilver(I) bromide. b) tetracarbonylnickel(0). c) potassium tetracyanocadmate(II)
- Hexaaquacobalt(III) dicyanoargentate(I)

Formulas:

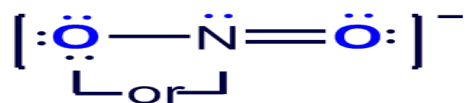
- a. $[\text{Cu}(\text{H}_2\text{O})_2(\text{CN})_2]$ b. $\text{K}_2[\text{Pd}(\text{Cl})_6]$ c. $[\text{Cu}(\text{C}_2\text{O}_4)_2]^{2-}$ d. $[\text{Cr}(\text{NH}_3)_6]_2 [\text{CuCl}_4]_3$

ISOMERISM IN COORDINATION COMPOUNDS

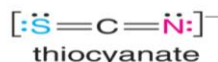
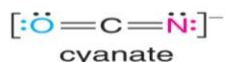


Coordination isomers : $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$

Linkage isomers: For example, the nitrite ion can bind either through the N atom or either one of the O atoms. (known as nitro isomer if linked through nitrogen and nitrito isomer if linked through oxygen)



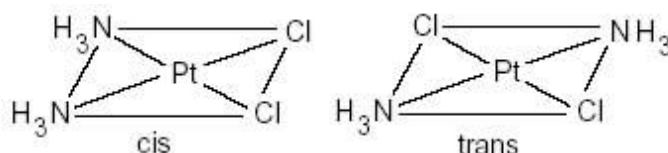
Other ions that can use different donor atoms are:



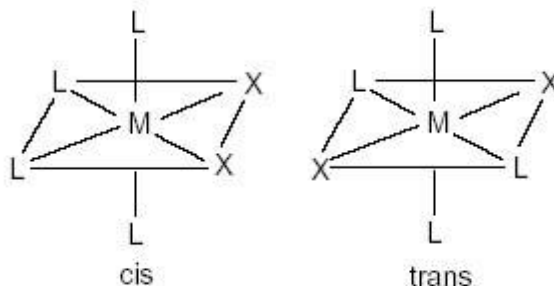
Geometric or cis-trans isomer or diastereomers:

These occur when atoms or groups can either be arranged on the *same* side (cis- isomer) or on *opposite* sides (trans isomer) of the compound relative to the central metal ion.

Two forms of the complex $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ have been prepared. Both have square planar structures. The trans form has no dipole moment, whereas the cis form has an appreciable dipole moment.



The simplest type of geometric isomerism of octahedral complexes occurs in cases where four of the six ligands of the complex are the same. Then the cis and trans forms correspond to those shown below. The two X ligands are closest to each other in the cis isomer. In the trans isomer they are across the complex ion from each other.



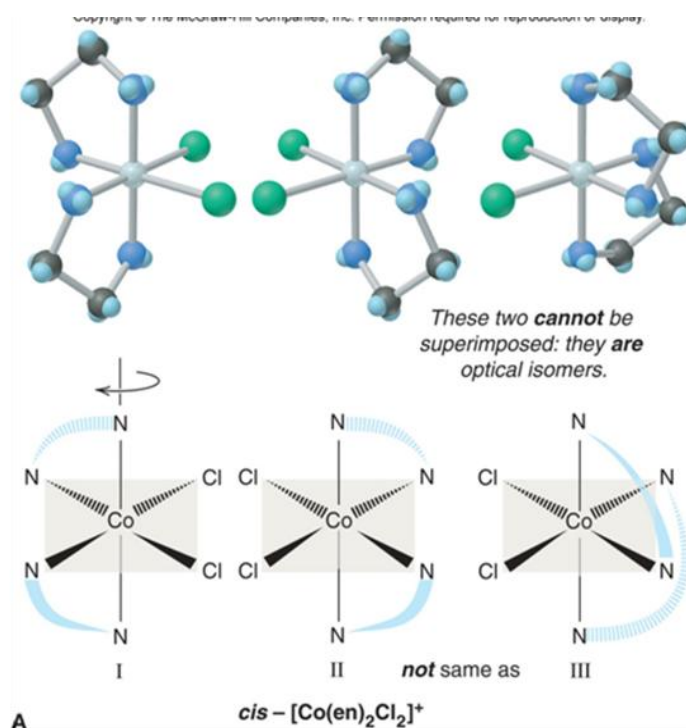
Sketch the geometric isomers of $[\text{Cr}(\text{en})_2\text{Br}_2]^+$.

Optical isomers or enantiomers:

Optical isomers are nonsuperimposable mirror images of one another. They are also called enantiomers. Enantiomers have the same relationship to one another as do your right and left hands. If you place your left hand parallel to your right hand facing each other, you get the same effect that you would get if you placed one hand in front of a mirror. Your left hand is the mirror image of your right hand. However, your left hand is not superimposable upon your right hand. Your hands are enantiomers, that is, nonsuperimposable mirror images of one another.

An object which is not identical with its mirror image is said to be chiral, from the Greek word for hand.

All chiral molecules lack plane of symmetry.



Structure I and its mirror image, structure II, are optical isomers of $cis-[Co(en)_2Cl_2]^+$.
