

Nomenclature for Compounds Containing Transition Metal Complex Ions:

1. As in any ionic compound, the cation is named before the anion.
2. **Naming a transition metal complex ion** (the part in []'s):
 - a. the ligands are named first; if there are two or more different ligands, they are named alphabetically
 - b. prefixes are used to denote the number of each ligand: di (2), tri (3), tetra (4), penta (5), hexa (6), etc. for monatomic ligands (and polyatomic ligands with short names). For polydentate ligands use bis (2), tris (3), tetrakis (4). Prefixes are **ignored** in alphabetizing ligands, e.g., **tribromo** comes before **dichloro**. If the ligand name is a composite name that itself contains a prefix (di, tri, etc.), as ethylenediamine, place parentheses around the name and precede it with bis, tris, tetrakis, etc. See examples 5) and 6) on the next page.
 - c. the metal ion is named last, although it is shown first in the structural formula
 - d. if the complex ion is **positive** (a **cation**) or **neutral**, the metal is named as usual, e.g. Fe = iron, Co = cobalt, Zn = zinc, etc.
 - e. if the complex ion is **negative** (an **anion**), an **ate** is added to the end of the metal's name, e.g. Zn = **zincate**, Co = **cobaltate**, etc.; in some cases common names must be used, e.g., Fe = **ferrate** (not "ironate"), Ag = **argentate** (not "silverate"), Cu = **cuprate** (not "copperate"), Au = **aurate** (not "goldate"), Sn = **stannate** (not "tinate"), Pb = **plumbate** (not "leadate"),
 - f. **in all cases**, the oxidation state for a metal is denoted by a Roman numeral in parentheses after the name of the metal, e.g., Fe²⁺ = **iron(II)** in a cationic or neutral complex, **ferrate(II)** in an anionic complex
 - 1). Sometimes a metal may have a neutral charge, in which case a zero is put in parentheses, as tungsten(0).

3. Ligand names

- a. monodentate ligands: attach to central metal atom in only one place
 - (1) Anions as ligands are named by using the ending **o**.
If the anion name ends in **-ite** or **-ate**, the **-e** is changed to an **-o**:
e.g., when it is a ligand, SO₃²⁻ = **sulfito** (not "sulfite")
e.g., when it is a ligand, CO₃²⁻ = **carbonato** (not "carbonate")
 - (2) For most cases, when the anion name ends in **-ide**, the **ide** is changed to **-o**
when it is a ligand, e.g., F⁻ = **fluoro** (not "fluoride"), Cl⁻ = **chloro** (not "chloride"), OH⁻ = **hydroxo** (not "hydroxide") etc.
Therefore,
ide ⇒ o
ite ⇒ ito
ate ⇒ ato

- (3) Linkage isomers: In some cases the ligand can be attached to the metal by different atoms. Know at least numbers 1) and 2) listed below:
- 1) NO_2^- when seen as (ONO) in complex = **nitrito-O-** (O of ligand attaches to metal)
seen as (NO_2) in complex the ligand = **nitrito-N-** (N of ligand attaches to metal).
(Sometimes you will see NO_2 simply as **nitro** and ONO simply as **nitrito**.)
 - 2) SCN^- when seen as (SCN) its thiocyanato (S of ligand attaches to metal)
when seen as (NCS), its thiocyanato-N (N of ligand attaches to metal) (also called isothiocyanato)
 - 3) CN^- when seen as (CN) is cyano (C of ligand attaches to metal);
when seen as (NC), it is called isocyano (N of ligand attaches to metal)
- (4) neutral ligands generally carry their unmodified (free molecule) name:
 CH_3NH_2 = methyamine, $\text{C}_5\text{H}_5\text{N}$ = pyridine, $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ = ethylenediamine
Exceptions: H_2O = aqua, NH_3 = ammine, NO = nitrosyl, CO = carbonyl

b. bidentate ligands: attach to central metal atom at **two** places

- (1) $\text{C}_2\text{O}_4^{2-}$ = **oxalato** (not "oxalate;" See Rule 3a(1) above). Note the negative two.
- (2) $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ = **ethylenediamine** (en) (attaches at the two nitrogens)
(carries unmodified name; Rule 4 above). Note that en has no net charge.

c. tridentate ligand attaches to central metal ion at **three** places:

$\text{NH}_2\text{CH}_2\text{CH}_2\text{NHCH}_2\text{CH}_2\text{NH}_2$ = **diethylenetriamine** (dien)
(attaches at the three nitrogens) (Spelled with one **m**)

d. hexadentate ligand attaches to central metal ion at **six** places:

ethylenediaminetetraacetato = EDTA^{4-}

Examples:

- 1) $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$ diamminesilver(I) chloride (Note that the ligand name for ammonia, NH_3 , is ammine and is spelled with two **m**'s.)
- 2) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ diamminedichloroplatinum(II) (Note: No space between ligand names; underlines are just to help you see the alphabetizing here; they are not part of proper naming.)
- 3) $[\text{Co}(\text{NH}_3)_3\text{Br}_2\text{ONO}]\text{NO}_3$ triamminedibromonitrito-O-cobalt(IV) nitrate (the **mon** can be left out)
- 4) $\text{K}_2[\text{Cu}(\text{NH}_3)_2(\text{NC})_4]$ potassium diamminetetrakisocyanocuprate(II)
- 5) $[\text{Cu}(\text{en})_2(\text{H}_2\text{O})_2]\text{CO}_3$ diaquabis(ethylenediamine)copper(I) carbonate (Note that the ligand name for ethylenediamine is spelled with one **m**.)
- 6) $\text{Na}_2[\text{Fe}(\text{C}_2\text{O}_4)_2(\text{NO})_2]$ sodium dinitrosyldioxalatoferrate(II) (Note: not **bisoxalato**)
- 7) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$: tetraamminedichlorocobalt(III) chloride

8) $(\text{NH}_4)_2 [\text{Pt}(\text{NCS})_6]$ ammonium hexaisothiocyanatoplatinate(IV) (or thiocyanato-N- for isothiocyanato)

9) $[\text{Cu}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_2]\text{SO}_4$ bis(ethylenediamine)copper(II) sulfate (Note: not **di**ethylenediamine)

10) $[\text{Ag}(\text{NH}_3)_2][\text{Mn}(\text{OH}_2)_2 (\text{C}_2\text{O}_4)_2]$ diamminesilver(I) diaquadioxalatomanganate(III)

When writing the formula of a transition metal complex:

The transition metal complex is placed inside brackets ([]). The chemical symbol of the metal center is first, followed by the formula of the anions, and then the neutral molecules. If there are two or more anions or neutral ligands, they are alphabetized with the first chemical **symbol** of their formula.

Example:

7) For tetraamminechloronitrito-N-cobalt (III) bromide, the Cl^- precedes NO_2 , and these anions both precede NH_3 . The formula is: $[\text{CoCl}(\text{NO}_2)(\text{NH}_3)_4]\text{Br}$