

# THE PERIODIC TABLE

	1 IA																	18 VIIIA
1	<b>H</b> 1 1.008 Hydrogen																	<b>He</b> 2 4.00 Helium
2	<b>Li</b> 3 6.94 Lithium	<b>Be</b> 4 9.01 Beryllium											<b>B</b> 5 10.81 Boron	<b>C</b> 6 12.01 Carbon	<b>N</b> 7 14.01 Nitrogen	<b>O</b> 8 16.00 Oxygen	<b>F</b> 9 19.00 Fluorine	<b>Ne</b> 10 20.18 Neon
3	<b>Na</b> 11 22.99 Sodium	<b>Mg</b> 12 24.31 Magnesium											<b>Al</b> 13 26.98 Aluminum	<b>Si</b> 14 28.09 Silicon	<b>P</b> 15 30.97 Phosphorus	<b>S</b> 16 32.07 Sulfur	<b>Cl</b> 17 35.45 Chlorine	<b>Ar</b> 18 39.95 Argon
4	<b>K</b> 19 39.10 Potassium	<b>Ca</b> 20 40.08 Calcium	<b>Sc</b> 21 44.96 Scandium	<b>Ti</b> 22 47.88 Titanium	<b>V</b> 23 50.94 Vanadium	<b>Cr</b> 24 52.00 Chromium	<b>Mn</b> 25 54.94 Manganese	<b>Fe</b> 26 55.85 Iron	<b>Co</b> 27 58.93 Cobalt	<b>Ni</b> 28 58.69 Nickel	<b>Cu</b> 29 63.55 Copper	<b>Zn</b> 30 65.39 Zinc	<b>Ga</b> 31 69.72 Gallium	<b>Ge</b> 32 72.61 Germanium	<b>As</b> 33 74.92 Arsenic	<b>Se</b> 34 78.96 Selenium	<b>Br</b> 35 79.90 Bromine	<b>Kr</b> 36 83.80 Krypton
5	<b>Rb</b> 37 85.47 Rubidium	<b>Sr</b> 38 87.62 Strontium	<b>Y</b> 39 88.91 Yttrium	<b>Zr</b> 40 91.22 Zirconium	<b>Nb</b> 41 92.91 Niobium	<b>Mo</b> 42 95.94 Molybdenum	<b>Tc</b> 43 (97.9) Technetium	<b>Ru</b> 44 101.07 Ruthenium	<b>Rh</b> 45 102.91 Rhodium	<b>Pd</b> 46 106.42 Palladium	<b>Ag</b> 47 107.87 Silver	<b>Cd</b> 48 112.41 Cadmium	<b>In</b> 49 114.82 Indium	<b>Sn</b> 50 118.71 Tin	<b>Sb</b> 51 121.75 Antimony	<b>Te</b> 52 127.60 Tellurium	<b>I</b> 53 126.90 Iodine	<b>Xe</b> 54 131.29 Xenon
6	<b>Cs</b> 55 132.91 Cesium	<b>Ba</b> 56 137.33 Barium	<b>La</b> 57 138.91 Lanthanum	<b>Hf</b> 72 178.48 Hafnium	<b>Ta</b> 73 180.95 Tantalum	<b>W</b> 74 183.85 Tungsten	<b>Re</b> 75 186.21 Rhenium	<b>Os</b> 76 190.2 Osmium	<b>Ir</b> 77 192.22 Iridium	<b>Pt</b> 78 195.08 Platinum	<b>Au</b> 79 196.97 Gold	<b>Hg</b> 80 200.59 Mercury	<b>Tl</b> 81 204.38 Thallium	<b>Pb</b> 82 207.2 Lead	<b>Bi</b> 83 208.98 Bismuth	<b>Po</b> 84 (209) Polonium	<b>At</b> 85 (210) Astatine	<b>Rn</b> 86 (222) Radon
7	<b>Fr</b> 87 223.02 Francium	<b>Ra</b> 88 226.03 Radium	<b>Ac</b> 89 227.03 Actinium	<b>Rf</b> 104 (261) Rutherfordium	<b>Db</b> 105 (262) Dubnium	<b>Sg</b> 106 (263) Seaborgium	<b>Bh</b> 107 (262) Bohrium	<b>Hs</b> 108 (265) Hassium	<b>Mt</b> 109 (266) Meitnerium	Unsettled Discovery 110 Nov. 1994	Unsettled Discovery 111 Rev. 1994	Unsettled Discovery 112 1995		Unsettled Discovery 114 1995		Unsettled Discovery 116 1995		Unsettled Discovery 118 1995

**H** — SYMBOL  
1 — ATOMIC NUMBER  
1.008 — ATOMIC WEIGHT  
Hydrogen — NAME

( ) = ESTIMATES

8 9 10  
VIII B

HALOGENS  
NOBLE  
GASES

LANTHANIDES

ACTINIDES

<b>Ce</b> 58 140.12 Cerium	<b>Pr</b> 59 140.91 Praseodymium	<b>Nd</b> 60 144.24 Neodymium	<b>Pm</b> 61 (145) Promethium	<b>Sm</b> 62 150.36 Samarium	<b>Eu</b> 63 152.07 Europium	<b>Gd</b> 64 157.25 Gadolinium	<b>Tb</b> 65 158.93 Terbium	<b>Dy</b> 66 162.50 Dysprosium	<b>Ho</b> 67 164.93 Holmium	<b>Er</b> 68 167.26 Erbium	<b>Tm</b> 69 168.93 Thulium	<b>Yb</b> 70 173.04 Ytterbium	<b>Lu</b> 71 174.97 Lutetium
<b>Th</b> 90 232.04 Thorium	<b>Pa</b> 91 231.04 Protactinium	<b>U</b> 92 238.03 Uranium	<b>Np</b> 93 237.06 Neptunium	<b>Pu</b> 94 (244) Plutonium	<b>Am</b> 95 243.06 Americium	<b>Cm</b> 96 (247) Curium	<b>Bk</b> 97 (248) Berkelium	<b>Cf</b> 98 (251) Californium	<b>Es</b> 99 252.08 Einsteinium	<b>Fm</b> 100 257.10 Fermium	<b>Md</b> 101 (261) Mendelevium	<b>No</b> 102 259.10 Nobelium	<b>Lr</b> 103 262.11 Lawrencium

Week 3

## Naming according to IUPAC

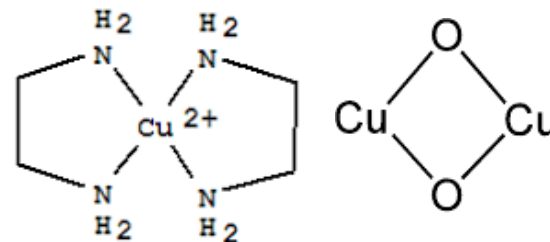
1. The name of the cation comes before the anion.
- |  |  |    |                                       |
|--|--|----|---------------------------------------|
|  | [Ag(NH <sub>3</sub> ) <sub>2</sub> ]Cl | or | K <sub>3</sub> [Fe(CN) <sub>6</sub> ] |
|  | 1st    2nd                             |    | 1st    2nd                            |

2. The names of the ligands in the inner coordination sphere come before the metal.



bis(ethylenediamine)copper...  
bis( $\mu$ -oxo)copper....

3. Ligand or ion names are placed in alphabetical order.



4. The number of species of one kind is often given by two sets of prefixes.

Always use the 1<sup>st</sup> set of prefixes unless:

- If the name includes already the first set of prefixes
- If the ligand is polydentate
- If there are multiple bridges of the same kind

**Note:** 2<sup>nd</sup> set of prefixes is used in conjunction with parenthesis for the name of the ligand.

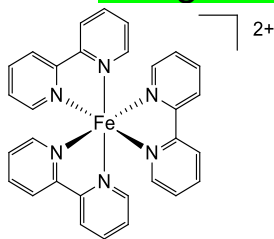
Number of ligands	First set of prefixes	Second set of prefixes
2	di	bis
3	tri	tris
4	tetra	tetrakis
5	penta	pentakis
6	hexa	hexakis
7	hepta	heptakis

# Naming according to IUPAC

5. There are two possibilities for designating the charge or the oxidation state.

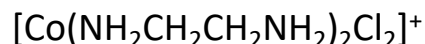
(a) Put the **oxidation state** as a **Roman numeral** in parenthesis after the name of the metal.

(b) Put the **charge of the coordination sphere** in parenthesis after the name of the metal



= tris(bipyridine)iron(II)

= tris(bipyridine)iron (2+)



Dichlorobis(ethylenediamine) cobalt(III)

Dichlorobis(ethylenediamine) cobalt(1+)

6. If complex charge is negative, the suffix –ate is added to the name of the metal name.

$[\text{Pt}(\text{NH}_3)_4]^{2+}$       tetraammineplatinum(II) or  
tetraammineplatinum(2+)

$[\text{PtCl}_6]^{2-}$       hexachloroplatinate(IV) or  
hexachloroplatinate(2-)

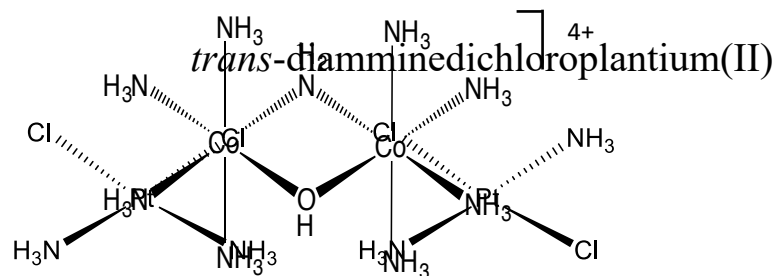
metal	changed to
cobalt	cobaltate
aluminum	aluminate
chromium	chromate
vanadium	vanadate
copper	cuprate
iron	ferrate
platinum	platinate
silver	argentate
gold	Aurate

7. Prefix *cis-* and *trans-* designate adjacent and opposite geometric locations.

*fac-* and *mer-* or  $\Delta$  or  $\Lambda$

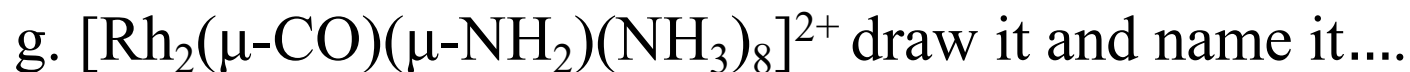
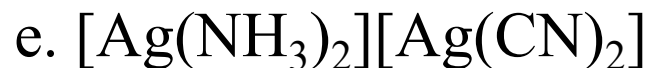
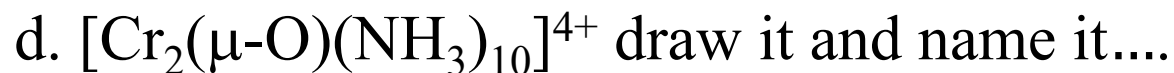
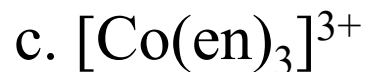
8. Bridging ligands between metal ions have the prefix " $\mu$ -"

**$\mu$ -amido- $\mu$ -hydroxobis(tetraamminecobalt)(4+)**



*cis*-diamminedichloroplatinum(II)

## Name these compounds...



# Name these compounds...

a.  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$  tetraamminecopper(II) sulfate or tetraamminecopper(2+) sulfate

b.  $[\text{PtCl}_4]^{2-}$  tetrachloroplatinate(II) or tetrachloroplatinate(2-)

c.  $[\text{Co}(\text{en})_3]^{3+}$  tris(ethylenediamine)cobalt(III) or tris(ethylenediamine)cobalt(3+)

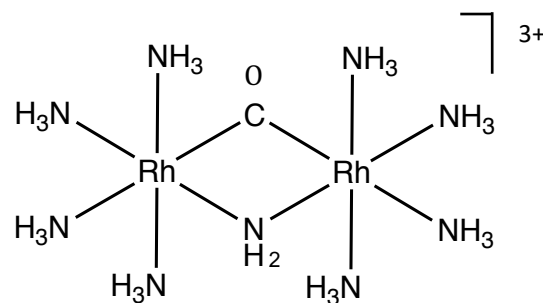
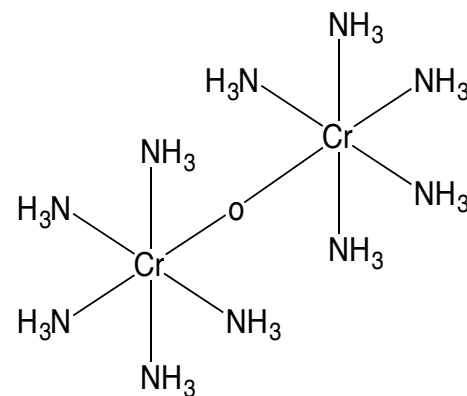
d.  $[\text{Cr}_2(\mu\text{-O})(\text{NH}_3)_{10}]^{4+}$  m-oxo-bis(pentaamminechromium (III)) or m-oxo-bis(pentaamminechromium) (4+)

e.  $[\text{Ag}(\text{NH}_3)_2][\text{Ag}(\text{CN})_2]$   $[\text{Ag}(\text{NH}_3)_2]$  is +1 and  $[\text{Ag}(\text{CN})_2]$  is -1.  
diamminesilver(I)dicyanoargentate(I) or diamminesilver(1+)dicyanoargentate(1-)

f.  $[\text{Fe}(\text{CO})_5]$  pentacarbonyliron(0)

g.  $[\text{Rh}_2(\mu\text{-CO})(\mu\text{-NH}_2)(\text{NH}_3)_8]^{3+}$

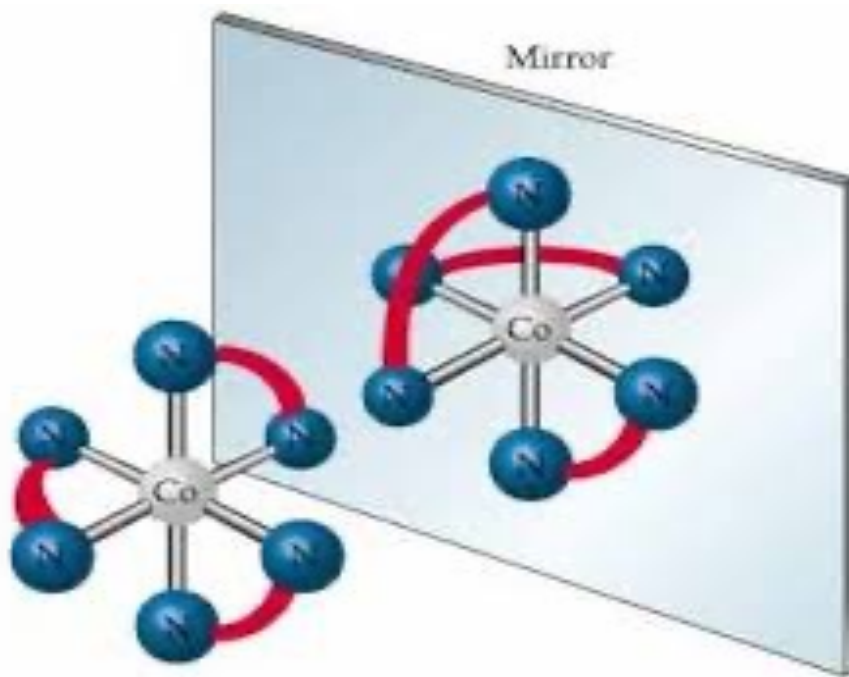
$\mu$ -amido- $\mu$ -carbonylbis(tetraamminerhodium)(3+) or  $\mu$ -amido- $\mu$ -carbonylbis(tetraamminerhodium(II))



# Symmetry Elements

Symmetry element	Symmetry operation	Symbol
axis of rotation	rotation by $360^\circ/n$	$C_n$
mirror plane	reflection	$\sigma$
center of inversion*	inversion	$i$
improper axis of rotation	rotation of $360^\circ/n$ followed by mirror reflection that is perpendicular to the rotational axis.	$S_n$

\*For  $S_1$  and  $S_2 = \sigma$  and  $i$ , respectively.



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Symmetry elements of water, which has a  $C_2$  axis of rotation and two mirror planes,  $\sigma$

