Coordination Chemistry 3min 30

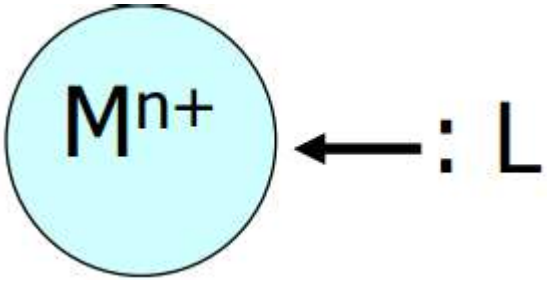
Sunday, 18 October 2015 11:48 AM

Metal Cation

- Metals have a tendency to form ions (ores)
- Metal cation acidity depends largely on polarising power of M^{n+} or the value of n and the ion size
    - Higher n results in a lower pKa and a stronger acid

Ligands

- Neutral molecule or ion with a lone electron pair that can be used to bond to a metal ion
- Ligand properties change with coordination to a metal which is the principles of a catalyst
- Donor Atom: The atom in the ligand which supplies the electron pair



Hard Metals

- Carry a high charge
- Favour bonding to small, electronegative donor atoms
- Has a high degree of ionic character when bonded to a hard ligand
- Form more stable complexes with hard ligands

Soft Metal

- Have a low charge
- Large and polarisable
- Favour bonding with large, more polarisable donor atoms
- High degree of covalent character when bonded to a soft ligand
- Form more stable complexes with soft ligands

Hard Ligand

- A small, electronegative donor atom
- Has a high degree of ionic character when bonded to a hard metal
- Form more stable complexes with hard metals

Soft Ligand

- Large, polarisable Donor atom
- Has a high degree of covalent character when bonded to a soft ligand
- Form more stable complexes with soft metals

Complex Ion

- A transition metal with a ligand attached
- Denoted by [Metal, Ligand]^{Charge}
    - Eg. $[Co(NH_3)_5Cl]^{2+}$
    - Complex ions are always in square brackets
- The metal in a complex ion can be considered a Lewis acid (electron acceptor) while the Ligand can be considered a Lewis base (electron donor)
- Complex ion can be positively or negatively charged

Coordination Compound

- A complex ion with counter ion/s attached making a neutral molecule
- Denoted by [Metal, Ligand] Counter-ion
    - $[Co(NH_3)_5Cl]Cl_2$

Coordination Number

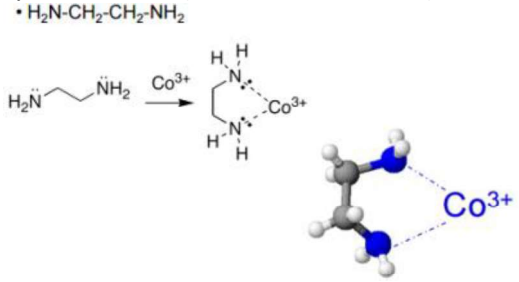
- Denoted by CN
- The number of bonds that a metal forms with ligands
    - CN = # of ligands x # of bonds per ligand
- Most common CN is 4 and 6

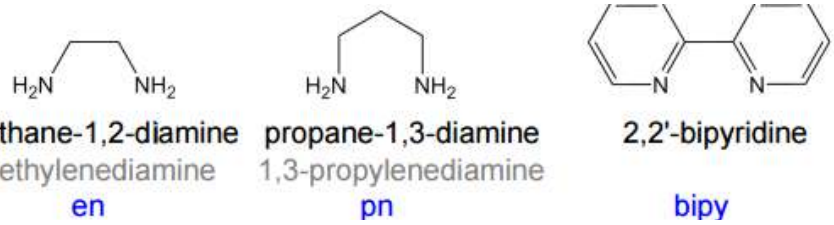
Denticity

- The number of donor atoms formed by metal ion to a single ligand in a complex ion
    - Number of bonds formed between a single ligand and a metal ion
- The higher the denticity the stronger and more stable the complex ion
- Monodentate: One bond per ligand

Molecule/Atom	Formula	Bonded Ligand Atom	Coordinated name
Water	H_2O	O	Aqua
Ammonia	NH_3	N	Ammine
Carbon Monoxide	CO	C	Carbonyl
Nitric Oxide	NO	N	Nitrosyl
Fluoride	F^-	F	Fluoro
Chloride	Cl^-	Cl	Chloro
Bromide	Br^-	Br	Bromo
Iodide	I^-	I	Iodo
Hydroxide	OH^-	O	Hydroxo
Cyanide	CN^-	$M:CN^-$	Cyano
Cyanide	CN^-	$M:NC^-$	Isocyano
Thiocyanate	SCN^-	$M:SCN^-$	Thiocyanato
Thiocyanate	SCN^-	$M:NCS^-$	Isothiocyanato
Oxide	O^{2-}	O	Oxo
Nitrite	NO_2^-	$M:NO_2^-$	Nitro
Nitrite	NO_2^-	$M:ONO^-$	Nitrito

    - NEED TO KNOW
- Bidentate: Two bond per ligand
    - Eg. Ethylenediamine (ethane-1,2-diamine) abbreviated to 'en'
        - $H_2N\text{-}CH_2\text{-}CH_2\text{-}NH_2$

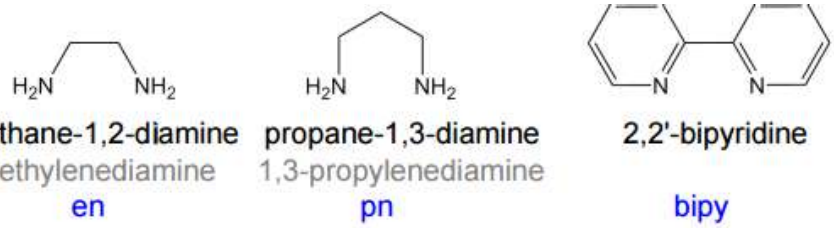


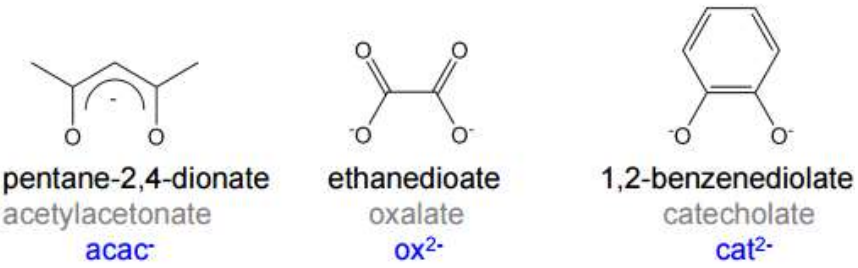


ethane-1,2-diamine
ethylenediamine
en

propane-1,3-diamine
1,3-propylenediamine
pn

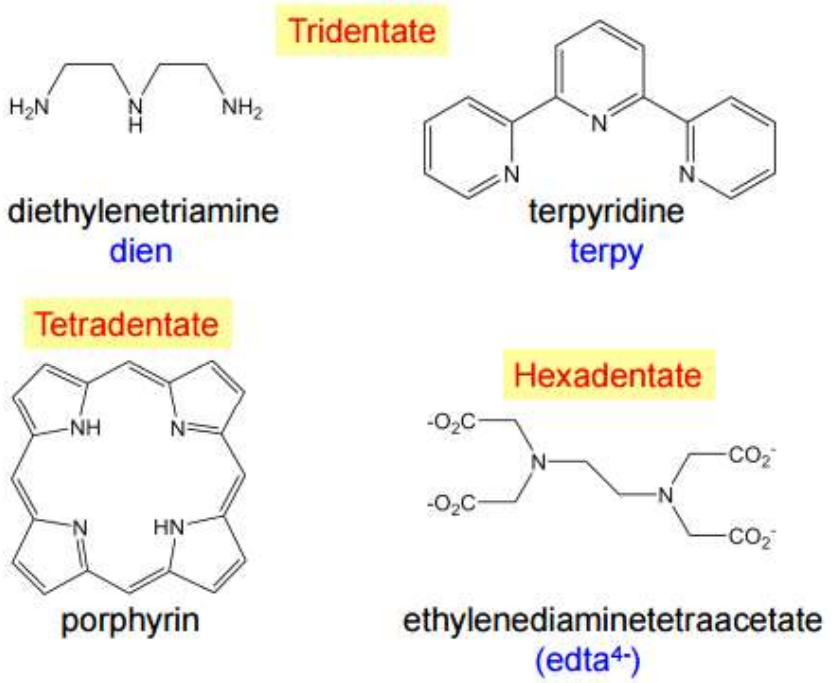
2,2'-bipyridine
bipy



- 

  - NEED TO KNOW

- Tridentate/Terdentate: Three bond per ligand
- Tetradentate: Four bond per ligand
- Pentadentate: Five bond per ligand
- Hexadentate: Six bond per ligand
- Polydentate: More than one bond per ligand

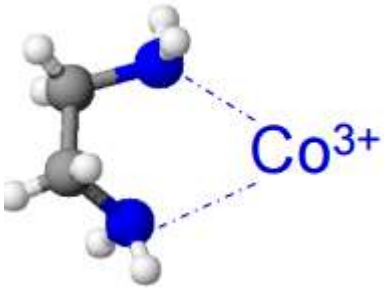
- 

  - NEED TO KNOW

- Ambidentate: Ligands that can bond through two or more atoms such as Nitrite, Thiocyanate or Cyanide
  - Not ambidentate if it is the same atom in another position such as with H_2O

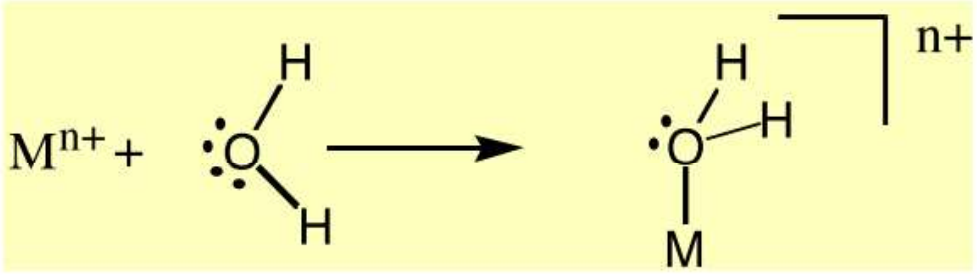
Chelating Ligands

- Polydentate ligands are chelating ligands
- From chelating rings in chelate complexes
- Very stable complexes



Counter Ions

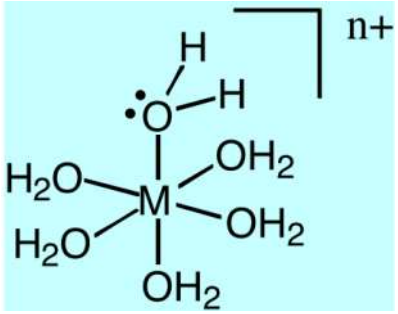
- Counter complex ion charge
- Attaches to the complex ion to create a neutral molecule
- Eg. Cl^-



Lewis acid + Lewis base → Complex

Aqua Ions

- Mostly 2+ or 3+ transition metal ions which coordinate with H_2O to give a fully hydrated complex ion
- Eg. $[M(OH_2)_6]^{n+}$

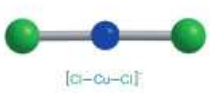


Oxo-ion

- Highly charged ions push equilibrium
  - $H_2O + OH^- <=> O^{2-} + H_3O^+$
- Metals with a charge greater than 4+ exist as oxo-ions

Coordination Geometry

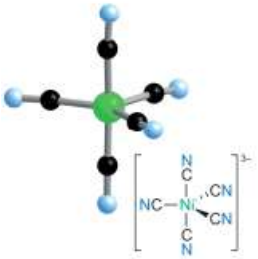
- Shape of a coordination complex



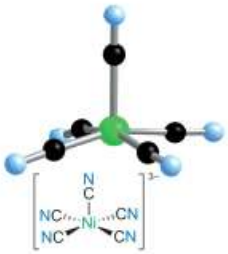
linear

tetrahedral

square planar



trigonal bipyramidal



square pyramidal

octahedral