

Classification of ligands :

Depending on the number of sites at which one molecule of a ligand is coordinated to the central metallic atom, the ligands have been classified as monodentate (Unidentate) and polydentate (multidentate) ligands.

1. Monodentate (Unidentate) ligands

The ligands which have only one donor atom or, are coordinated to a metal ion through one electron pairs are called monodentate ligand. Examples are shown below:

$(C_2H_5)_3N$	Triethyl amine	(0)	Neutral ligand	
CH_3NH_2	Methyl amine	(0)	=	=
NH_2OH	Hydroxylamine	(0)	=	=
$(CH_3)_2NH$	Dimethyl amine	(0)	=	=
C_5H_5N or Py	Pyridine	(0)	=	=
$(C_6H_5)_3P$	Triphenyl phosphine	(0)	=	=
CH_3CN	Acetonitrile	(0)	=	=
$(C_2H_5)_3P$	Triethyl phosphine	(0)	=	=
CO	Carbonyl	(0)	=	=
CS	Thio Carbonyl	(0)	=	=
H_2O	Aqua	(0)	=	=
NO	Nitrosyl	(0)	=	=
NS	Thionitrosyl	(0)	=	=
NH_3	Ammine	(0)	=	=

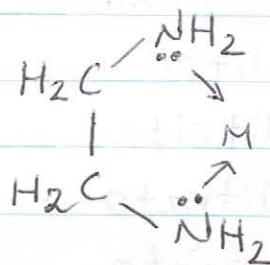
$C_2H_5O^-$	Ethoxo	(-1)	=	=
F^-	Fluoro	(-1)	Anionic	ligand
Cl^-	Chloro	(-1)	"	"
Br^-	Bromo	(-1)	"	"
I^-	Iodo	(-1)	"	"
H^-	Hydro or Hydrido	(-1)	"	"
NH_2^-	Amido	(-1)	"	"
N_3^-	Azido	(-1)	"	"
CH_3COO^-	Acetato	(-1)	"	"
OH^-	Hydroxo	(-1)	"	"
CN^-	Cyano	(-1)	"	"
HS^-	Mercapto	(-1)	"	"
CH_3O^-	Methoxo	(-1)	"	"
NO_2^-	Nitro	(-1)	"	"
ONO^-	Nitrito	(-1)	"	"
NO_3^-	Nitrato	(-1)	"	"
OCN^-	Cyanato	(-1)	"	"
NCO^-	Iso cyanato	(-1)	"	"
SCN^-	Thio cyanato	(-1)	"	"
NCS^-	Iso thio cyanato	(-1)	"	"
CH_3^-	Methyl	(-1)	"	"
O^{2-}	Oxo	(-2)	"	"
S^{2-}	Sulphido or thio	(-2)	"	"
NH^{2-}	Imido	(-2)	"	"
N^{3-}	Nitrido	(-3)	"	"
O_2^-	Superoxo	(-1)	"	"

2. Polydentate ligands

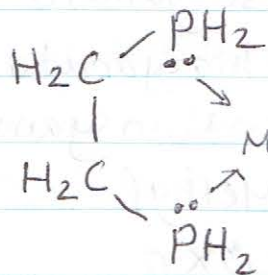
These may be bidentate, tridentate, tetradentate, pentadentate and hexadentate, if the number of donor atoms present in one molecule of the ligand attached with the central metallic atom is 2, 3, 4, 5 and 6 respectively (one molecule of these ligands makes 2, 3, 4, 5 and 6 metal-ligand coordinated bonds respectively).

Examples of bidentate ligands:

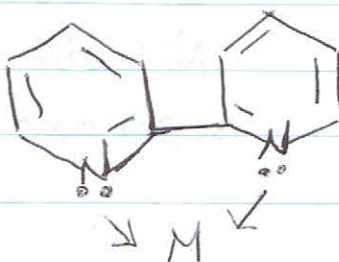
Ethylenediamine
(en)



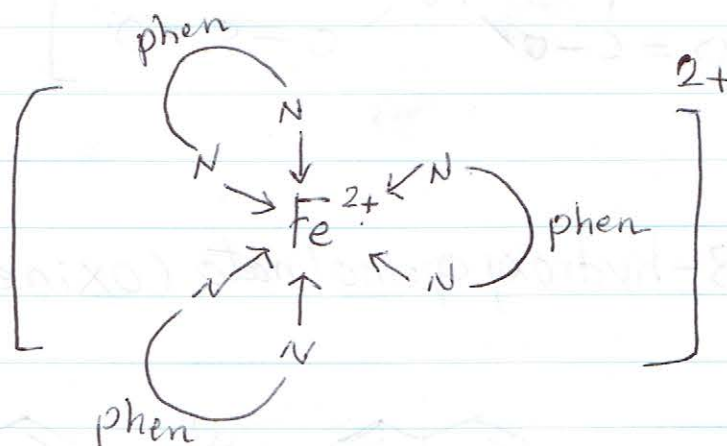
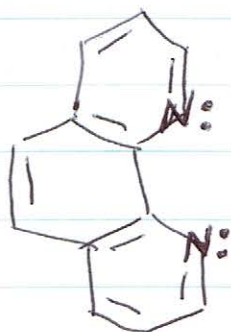
Ethylenediphosphine
(diphos)



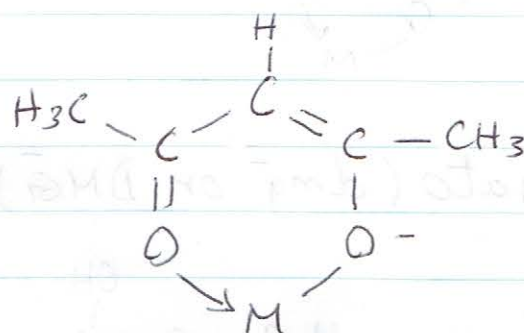
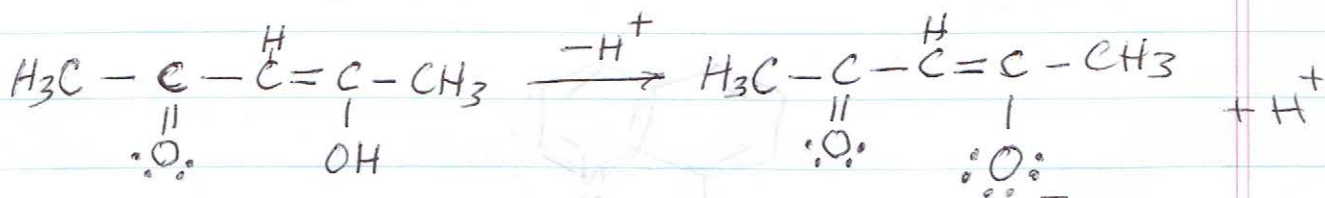
2,2-bipyridine
(bipy)



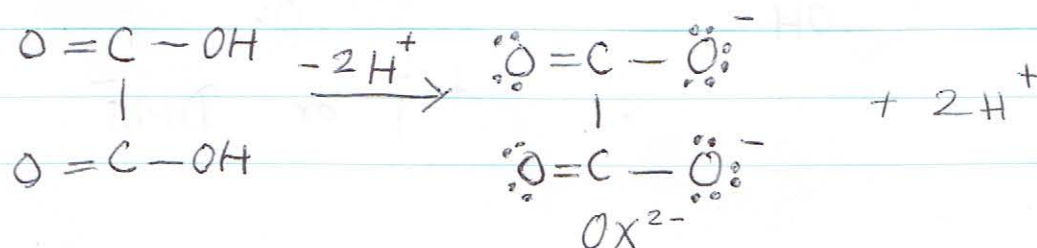
O-phenanthroline or 1,10-phenanthroline
(O-phen or phen or phenan)

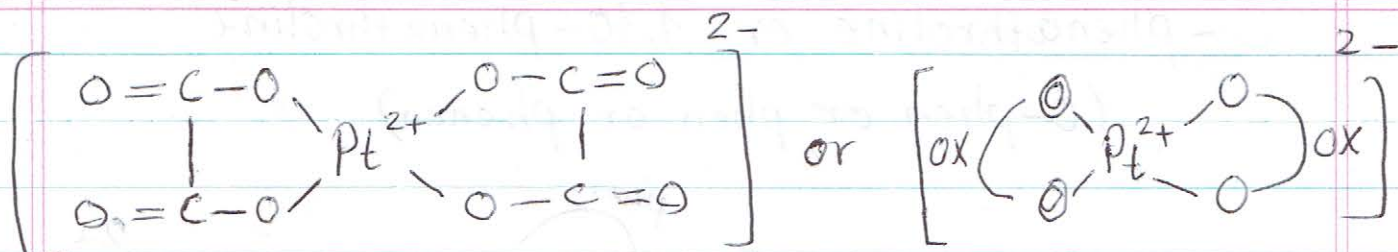


Acetylacetonato

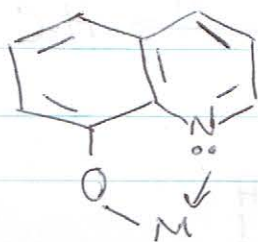
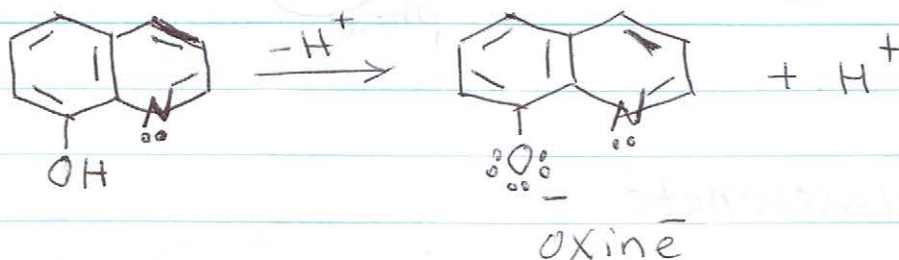


Oxalato ($\text{C}_2\text{O}_4^{2-}$ or OX^{2-})

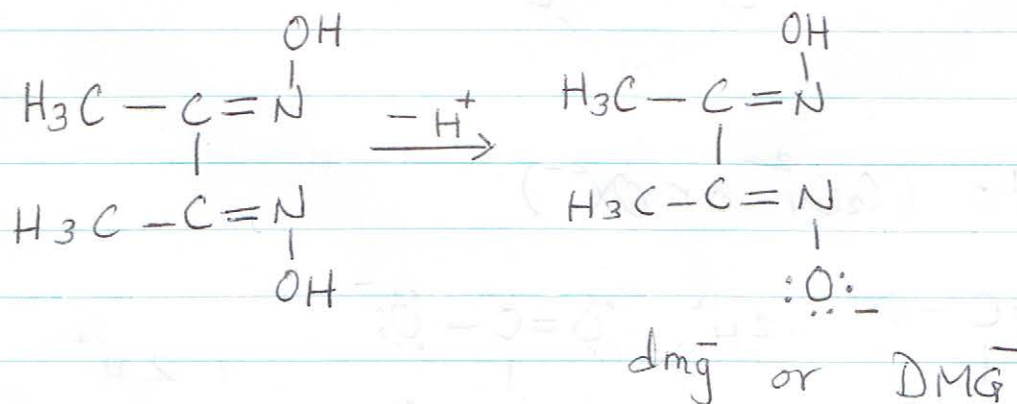


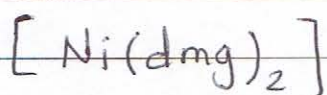
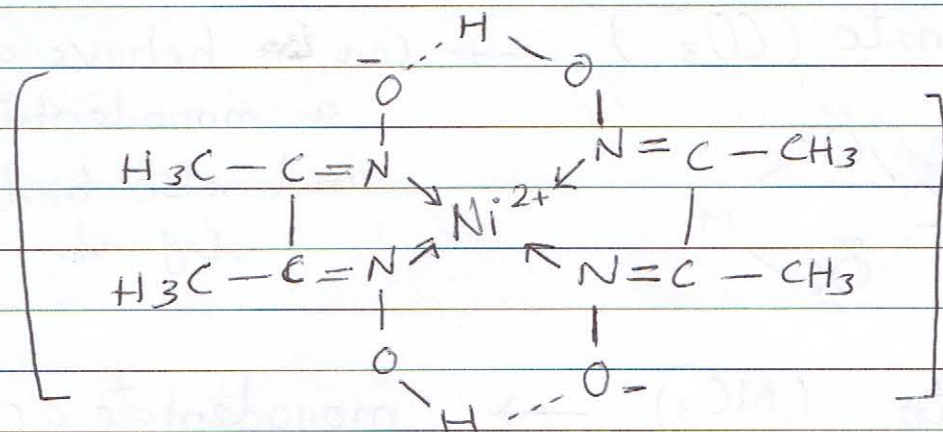


8-hydroxy quinolinato (oxine⁻)

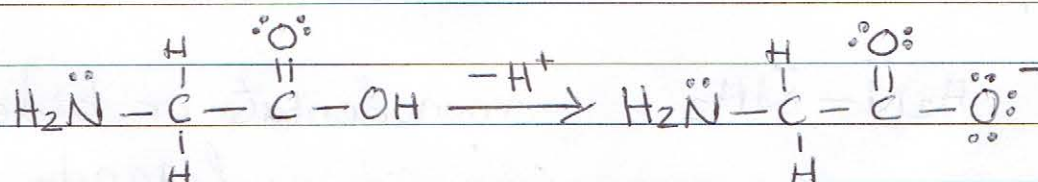


Dimethyl glyoximato (dmg⁻ or DMG⁻)



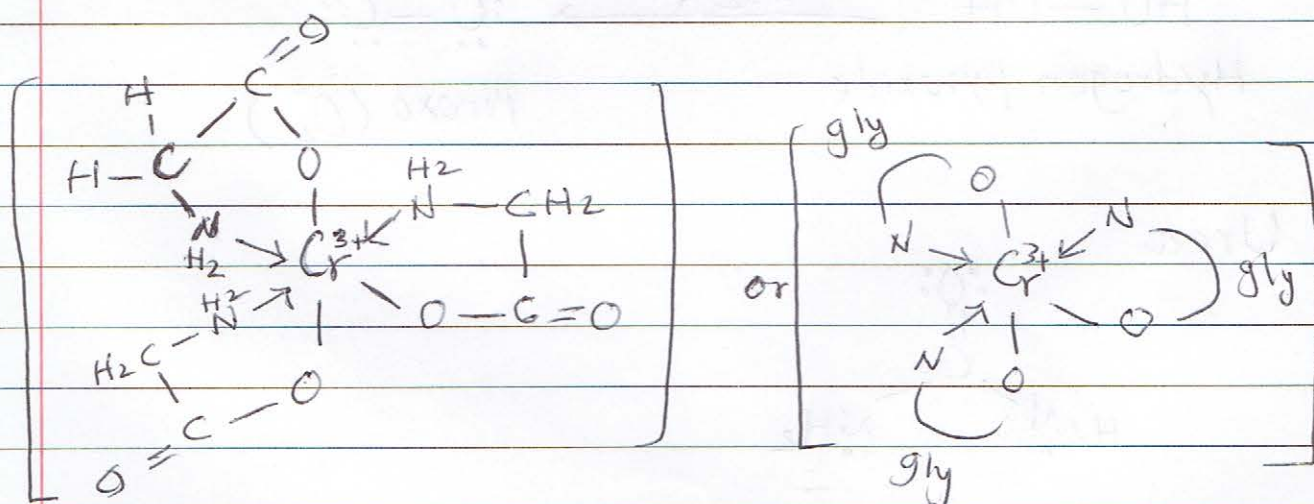


Glycinato (gly^-)

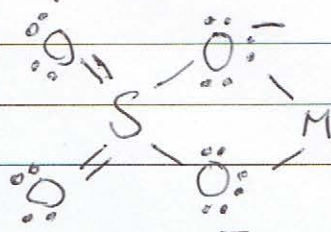


Glycine ($Hgly$)

Glycinato (gly^-)

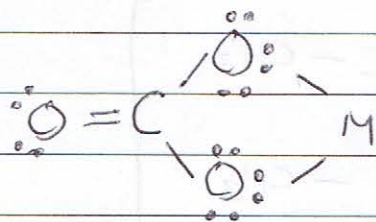


Sulphato (SO_4^{2-})

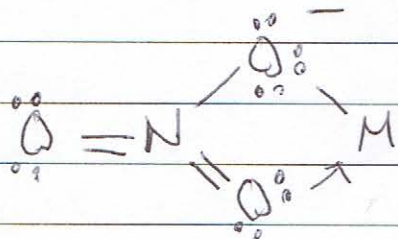


Monodentate or
bidentate ligand

Carbonato (CO_3^{2-}) $\rightarrow$ Can ~~be~~ behave as
a monodentate ligand
and also bidentate
ligand



Nitrato (NO_3^-) $\rightarrow$ monodentate or bidentate
ligand



Hydrazine

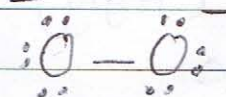
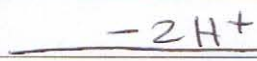


monodentate or bidentate
ligand

Hydrogen peroxide (H_2O_2)

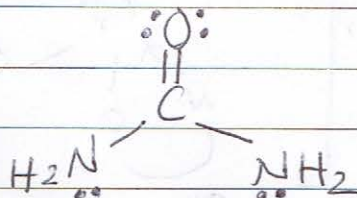


Hydrogen pyroxide

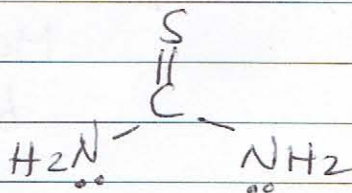


Peroxo (O_2^{2-})

Urea

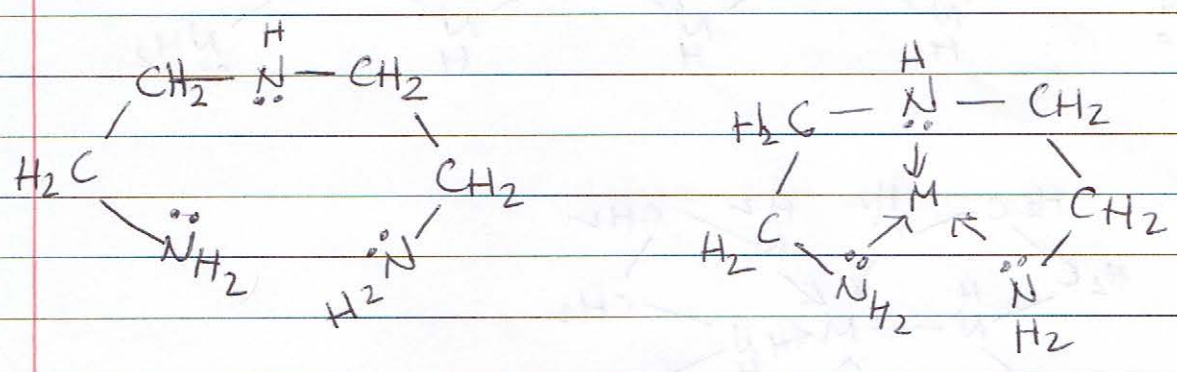


Thiourea

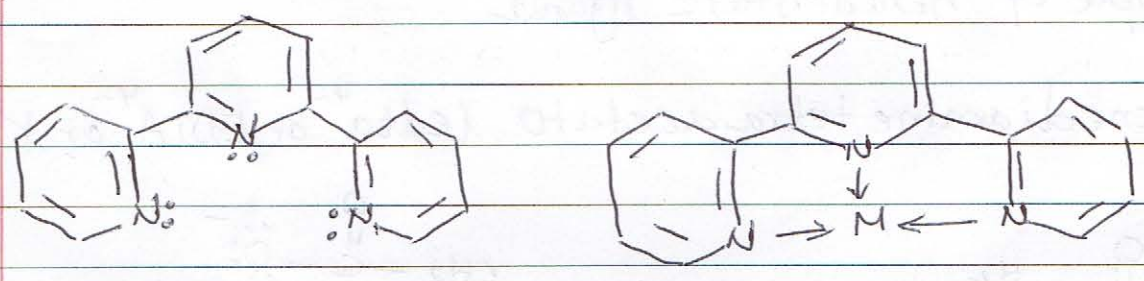


Examples of tridentate ligands

Diethylenetriamine (dien)

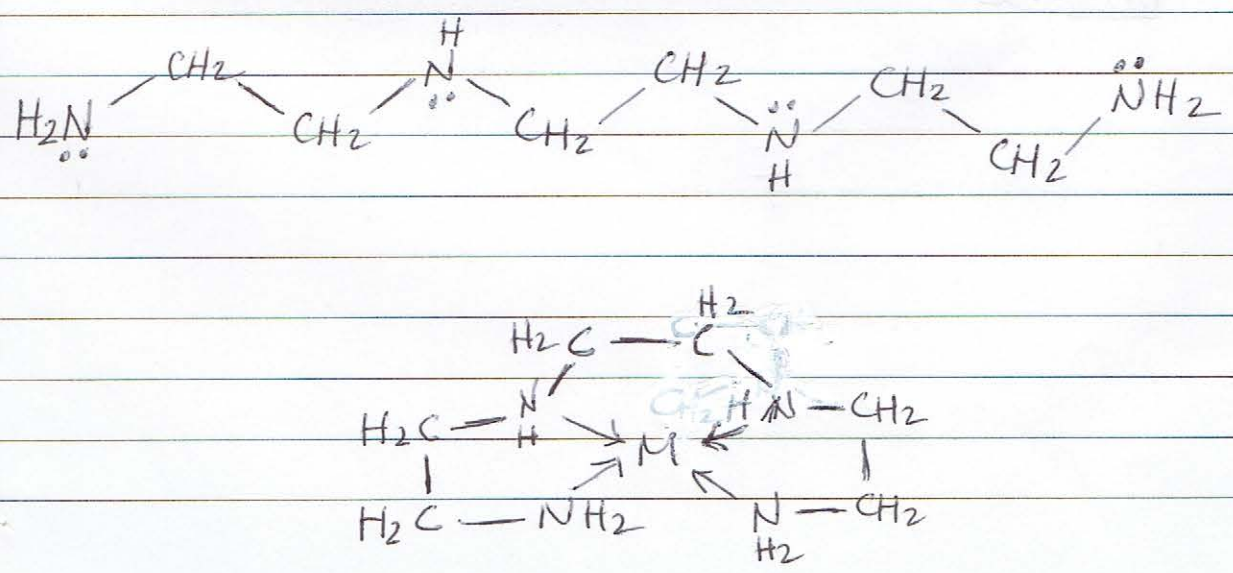


2,2'-Terpyridine or terpyridyl (terpy)



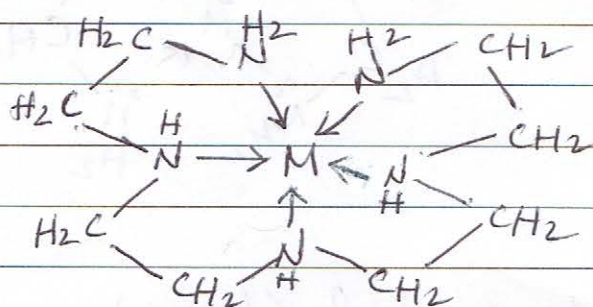
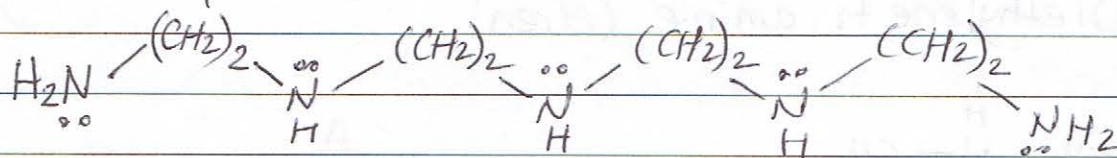
Examples of tetradentate ligands

Triethylenetetraamine (trien)



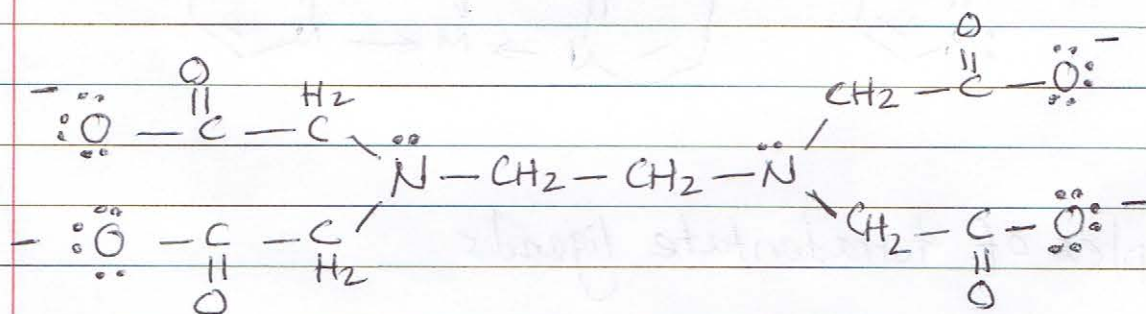
Example of pentadentate ligand

Tetraethylene pentaamine (tetraen)



Example of hexadentate ligand

Ethylenediamine tetraacetato (edta^{4-} or EDTA^{4-} or Y^{4-})



H.W

Bridging Ligands and Bridged Complexes

Although the ligands like OH^- (hydroxo), NH_2^- (amido), NH^{2-} (imido), F^- , Cl^- , SO_4^{2-} , NO_2^- , CO -- etc. are monodentate ligands, they also act as bidentate ligands when they are attached with two separate metal ions, making a bridge between them. Such ligands are called bridging ligands, while the complexes thus formed are called bridged (or polynuclear) complexes. Each ligand makes two σ -bonds with two metal ions. A bridging ligand must have at least two lone pairs of electrons which the ligand uses to get coordinated to two metal atoms. The polynuclear complex may be binuclear, trinuclear, tetranuclear -- etc.

