B. Classification based on denticity (number of donor atoms present in the ligands)

1. Monodentate (Unidentate) Ligands:

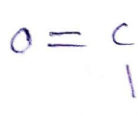
Ligands which donate only one pair of electrons and can thus coordinate to the central metal (or ion) through only one atom are known as monodentate or unidentate ligands.

eg. H_2O	aqua	NH_3	ammine
CO	carbonyl	NO	nitrosyl
CS	thiocarbonyl	NS	thionitrosyl
Cl^-	chlorido	I^-	iodido
CN^-	cyano	OH^-	hydroxo
CH_3COO^-	acetato	SCN^-	thiocyanato
NO_2^-	nitrito	NCS	isothiocyanato
H^-	hydrido	py	 pyridine

2. Bidentate (didentate) Ligands:

Ligands which have two donor atoms and, have the tendency to attach to the central ion through two donor atoms are called bidentate ligands.

eg: (a) $H_2N-CH_2-CH_2-NH_2$ (en) ethylenediamine

(b)  (ox^{2-}) oxalato

Symmetrical bidentate ligands have two same coordinating atoms.

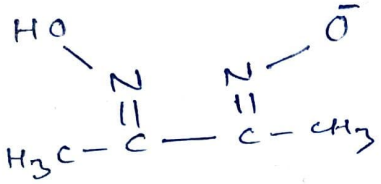
e.g. (a) $H_2N-CH_2-CH_2-NH_2$ ⟹ both donor atoms are N

(b)  ⟹ donor atoms are O (i.e. O^-)

Unsymmetrical bidentate ligands have different coordinating atoms.

$H_2N-CH_2-\overset{O}{\overset{\|}{C}}-O^-$ (gly$^-$) glycinato ⟹ donor atoms are N and O

* one neutral donor (N) and an anionic donor (O^-)

 (DMG) Dimethylglyoximato

* symmetrical bidentate ligands ⟹ donor atoms are N

Polydentate ligands: ligands which coordinate with the central metal atom or ion through more than two donor atoms are called polydentate ligands. These are called tridentate, tetradentate, pentadentate and hexadentate ligands with 3, 4, 5 and 6 number of donor atoms respectively.

Example:

Tridentate ligands: (a) $H_2N-(CH_2)_2-NH-(CH_2)_2NH_2$

diethylene triamine

(b) 

1, 2, 3-triamino propane

Hexadentate ligands

$(EDTA)^{4-}$ or Y^{4-}

Ethylene diaminetetraacetato

* Two neutral donor atom (N)
four ~~anionic~~ negative donor atom (O^-)

Ambidentate ligands: The ligands which have two or more donor atoms but in forming complexes only one donor atom is attached to the metal ion at a given time are called ambidentate ligands,

eg (a) NO_2^- ion

$M \leftarrow NO_2$ Nitro

$M \leftarrow ONO$ Nitrito

(b) CN^-

$M \leftarrow CN$ cyano

$M \leftarrow NC$ Isocyano

(c) NCS^-

$M \leftarrow SCN$ thiocyanato

$M \leftarrow NCS$ isothiocyanato

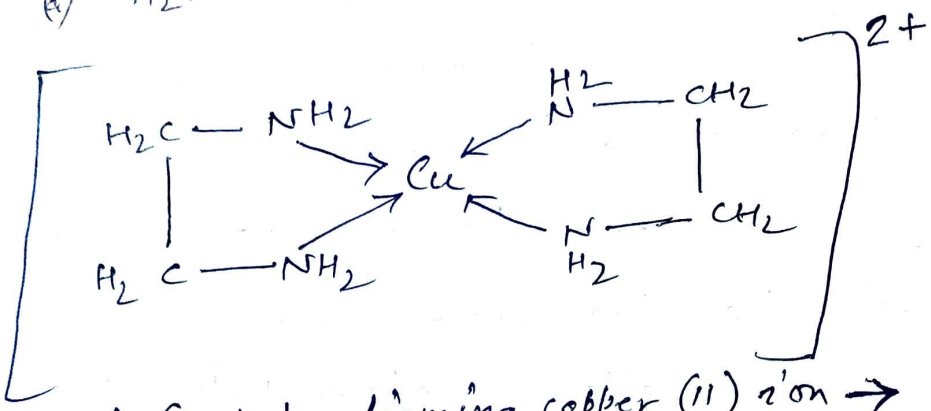
(d) $S_2O_3^{2-}$

$M \leftarrow SSO_3$ thiosulphato-S

$M \leftarrow OSO_2S$ thiosulphato-O

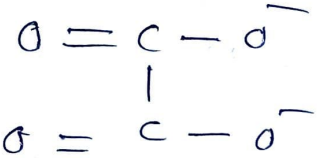
chelating ligands : when a bidentate or a polydentate ligand is attached through two or more donor atoms to the central ion forming a ring structure, the ligand is called a chelating ligands. The complex thus formed is called chelate (or chelate rings)

eg. (a) $H_2N-CH_2-CH_2-NH_2$ is a chelating ligand

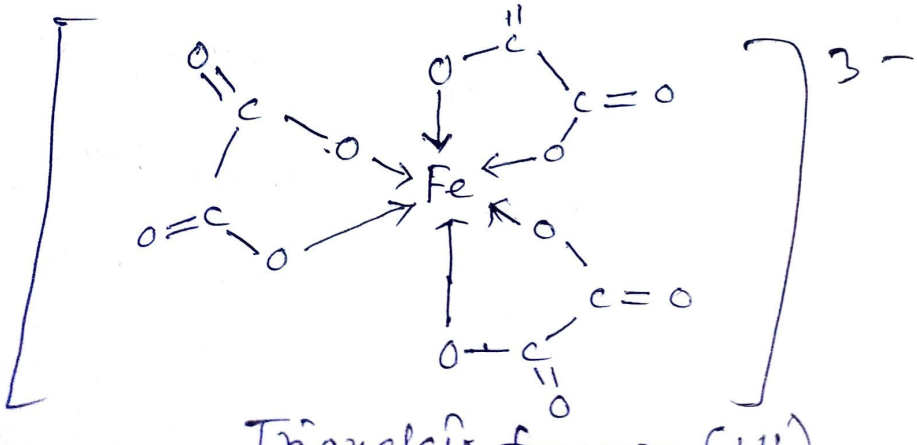


Bis (ethylenediamine copper (II) ion → chelate

(b) Oxalate anion acts as a ligand in the formation of $[Fe(C_2O_4)_3]^{3-}$



chelating ligand ⇒ oxalato.



Trioxalato ferrate (III)