CLASSIFICATION OF LIGANDS

On the Basis of Charge on Ligands

(i) Anionic ligands are characterized by their negative charge. Examples of atomic anions include halide ions, oxides, and nitrides.

(ii) Neutral ligands possess a lone pair of electrons that they can offer to the metal. Common examples of neutral ligands include water, carboxyl, nitrosyl, and others.

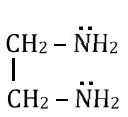
(iii) Cationic ligands refer to ligands that carry a positive charge. Examples of such ligands include NO^+, $NH_2\overset{+}{N}H_3$, and others with similar properties.

On the Basis of Denticity

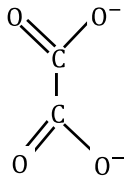
Denticity refers to the quantity of coordinate bonds established by a single ligand.

(i) Monodentate ligands feature a solitary donor atom, such as Cl, H_2O, NH, NH, NH, etc., and are commonly termed unidentate ligands.

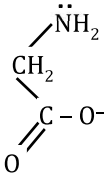
(ii) Bidentate ligands have the capability to bind through two donor atoms simultaneously.



en(ethylene-1,2-diamine)



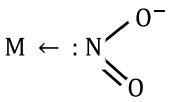
ox (oxalate)



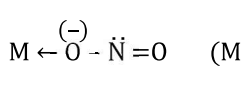
gly (glycinate)

(iii) Polydentate ligands are molecules that coordinate with a central ion by utilizing more than two donor atoms. These ligands vary in their dentate nature, being tridentate, pentadentate, or hexadentate, possessing three, five, or six donor sites, respectively. A prominent example of a hexadentate ligand is ethylenediamine tetra acetic acid (EDTA). In the case of EDTA, the central metal ion forms bonds with two nitrogen atoms and four oxygen atoms from the four COOH groups of the molecule. Other notable polydentate ligands include terpyridine and diethylenetriamine.

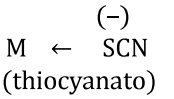
(iv) Ambidentate ligands are characterized by their ability to form coordinate bonds through two distinct atoms, albeit only one at a time. Examples of such ligands include NO_2 and SCN-.



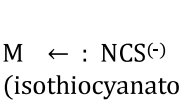
(nitrito-N)



(nitrito-O) (M = Central metal atom/ion)



(thiocyanato)



(isothiocyanato

(v) Flex dentate ligands are ligands that exhibit variable denticity, meaning their ability to form a certain number of coordinate bonds depends on the nature of the metal ion they are interacting with. An example of a flex dentate ligand is EDTA, which can exhibit a denticity of either 4 or 6 depending on the specific conditions and the metal ion involved in the coordination complex.

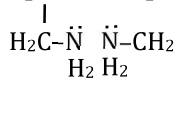
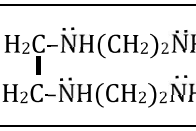
On the Basis of Type of Donation of Lone Pair

(i) σ-donor ligands are those that donate a lone pair of electrons to the central atom/ion, forming a σ-bond directly between the ligand and the central atom/ion. Examples of such ligands include H_2O and NH_3.

(ii) σ-donor π-acceptor ligands, also known as π-acid ligands, are ligands that donate a lone pair of electrons to the central atom/ion via a σ-bond while simultaneously accepting a significant amount of electron density from the metal atom/ion into its vacant π or π* orbital. Common examples of these ligands include CO and NO.

(iii) π-donor π-acceptor ligands are characterized by their ability to donate and accept π-electrons through π-bonds with the central atom/ion. Examples of such ligands include HC≡CH, C_2H_4, and C_6H_6.

List of Ligands

Denticity	Name	Ligand	Charge	Name of the ligand in the complex	Donor atom
Neutral ligands	Water	H_2O	0	Aqua/aquo	O
	Ammonia	NH_3	0	Ammine	N
	Carbon monoxide	CO	0	Carbonyl	C
	Nitrogen oxide	NO	0	Nitrosyl	N
	Thiocarbonyl	CS	0	Thiocarbonyl	S
	Thionitrosyl	NS	0	Thionitrosyl	N
Monodentate	Pyridine (py)	C_5H_5N	0	Pyridine (py)	N
	Methyl amine	CH_3NH_2	0	Methylamine	N
	Dinitrogen	N_2	0	Dinitrogen	N
	Dioxygen	O_2	0	Dioxygen	O
	Phosphine	PH_3	0	Phosphine	P
Bidentate	Ethylenediamine (en)	$NH_2(CH_2)_2NH_2$	0	Ethylenediamine (en)	2 N-atoms
Tridentate	Diethylene triamine		0	Diethylene triamine (diene)	3 N-atoms
Tetradentate	Tri ethylene tetramine		0	Tri ethylene tetramine (trien)	4 N-atoms
		Positive ligands			
Monodentate	Nitrosonium ion	$NO^{\oplus}$	+1	Nitrosonium	N
	Nitronium ion	$NO_2^{\oplus}$	+1	Nitronium	N
	Hydrazinium ion	$NH_2NH_3^{\oplus}$	+1	Hydrazinium	N
		Negative ligands			
Monodentate	Hydride ion	$H^{\oplus}$	−1	Hydrido	H
	Oxide ion	0^{2-}	−2	Oxo	O
	Peri oxide ion	O_2^{2-}	−2	Peroxo	O
	Nitrido ion	N^{3-}	−3	Nitrido	N
Bidentate	Sulphate ion	SO_4^{2-}	−2	Sulphato	2 O-atoms
	Thiosulphate ion	$S_2O_3^{2-}$	−2	Thiosulphato	2 O-atoms