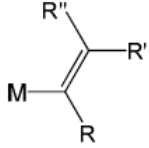
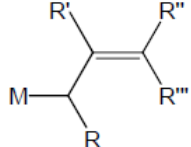
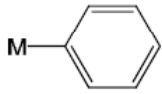
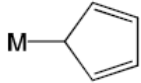
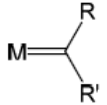
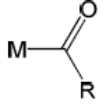
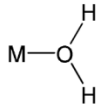
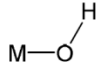
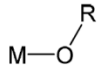
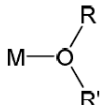
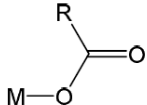
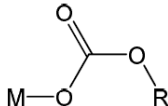
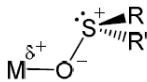
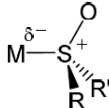
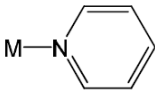
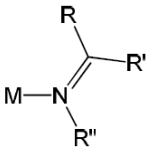

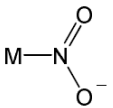
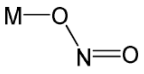
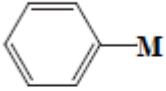
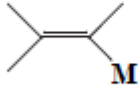
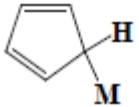

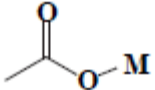


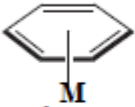
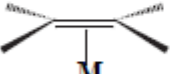

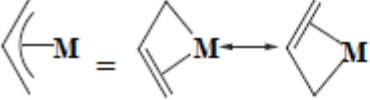
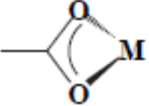
(n/a = not applicable)

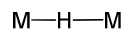
η^1		<u>ionic model</u>		<u>covalent model</u>	
		formal charge	# of e ⁻ donated	formal charge	# of e ⁻ donated
Hydride	M—H	-1	2	0	1
Alkyl (e.g. methyl)	M—CH ₃	-1	2	0	1
Alkenyl		-1	2	0	1
Alkynyl	M—C≡R	-1	2	0	1
Allyl		-1	2	0	1
Aryl		-1	2	0	1
Cyclopentadienyl		-1	2	0	1
Carbene		0	2	n/a	n/a
Carbyne	M≡R	0	4	n/a	n/a
Acyl		-1	2	0	1
Carbon monoxide	M—C≡O	0	2	n/a	n/a
Nitrile	M—C≡N	-1	2	0	1
Fulminate	M—C≡N ⁺ —O ⁻	-1	2	0	1

<u>η^1 contd.</u>		<u>ionic model</u>		<u>covalent model</u>	
		formal charge	# of e ⁻ donated	formal charge	# of e ⁻ donated
Aqua		0	2	n/a	n/a
Hydroxyl		-1	2	0	1
Oxo	$M=O$	-2	4	n/a	n/a
Alkoxide (Thiolate O = S)		-1	2	0	1
Ether (Sulfide/Thioether O = S)		0	2	n/a	n/a
Carboxylate		-1	2	0	1
Carbonate		-1	2	0	1
Cyanate (Thiocyanate O = S)	$M-O-C\equiv N$	-1	2	0	1
Sulfoxide		0	2	n/a	n/a
		0	2	n/a	n/a

η^1		<u>ionic model</u>		<u>covalent model</u>	
		formal charge	# of e ⁻ donated	formal charge	# of e ⁻ donated
Isocyanate (Isothiocyanate O = S)	M—N=C=O	-1	2	0	1
Nitrogen	M—N≡N	0	2	n/a	n/a
Amine	M—NR ₃	0	2	n/a	n/a
Pyridyl	M—N 	0	2	n/a	n/a
Imine	M—N 	0	2	n/a	n/a
Amide	M—NR ₂	-1	2	0	1
Isonitrile	M—N ⁺ ≡C ⁻	0	2	n/a	n/a
Nitrosyls	M—N 	-1	2	0	1
	M—N≡O ⁺	+1	2	n/a	n/a
Nitro	M—N 	-1	2	n/a	n/a
Nitrito	M—O 	-1	2	0	1
Phosphine	M—PR ₃	0	2	n/a	n/a
Phosphide	M—PR ₂	-1	2	0	1
Halide (e.g. Cl)	M—Cl	-1	2	0	1

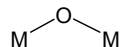
η^1 -coordination	Formal charge	# of e-donated
 η^1 -aryl	-1	2
 η^1 -alkenyl	-1	2
$R \equiv M$ η^1 -alkynyl	-1	2
 η^1 -Cp (cyclopentadienyl)	-1	2
 η^1 -allyl	-1	2
 η^1 -acetate	-1	2

η^x -coordination	Formal charge	# of e-donated
 η^6 -arene	0	6
 η^2 -alkene	0	2
$R \equiv H$ η^2 -alkyne	0	2
 η^5 -Cp (cyclopentadienyl)	-1	6
 η^3 -allyl	-1	4
 η^2 -acetate	-1	4

Bridging ligands (multidentate non-chelating)**ionic model**Formal charge # of e⁻ donated**μ-hydride**

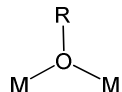
-1

1/metal

μ-oxo

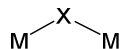
-2

2/metal

μ-alkoxide

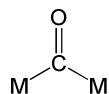
-1

2/metal

μ-halide

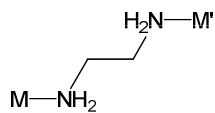
-1

2/metal

μ-CO

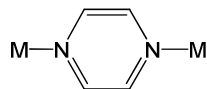
0

1/metal

**μ- ethylene diamine
(μ- en)**

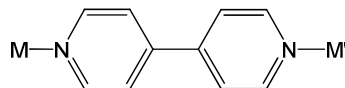
0

2/metal

μ-pyrazine

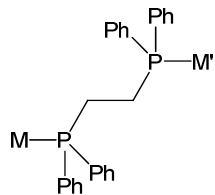
0

2/metal

μ-4,4'-bipyridine

0

2/metal

**μ-1,2-bis(diphenyl phosphino)ethane
(μ-dppe)**

0

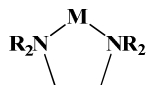
2/metal

η^2 Multidentate chelating ligands

ionic model

Formal charge # of e⁻ donated

R = H: Ethylenediamine (en)



0

4

1-amino-2-(bisphenylphosphino)ethane



0

4

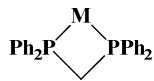
R = Ph : 1,2-di(bisphenylphosphino)ethane (dppe)
R = Me : 1,2-di(bismethylphosphino)ethane (dmpe)



0

4

1,2-di(biphenylphosphino)methane (dppm)



0

4

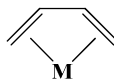
allyl



-1

4

butadiene



0

4

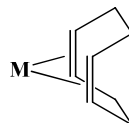
cyclobutadiene



0

4

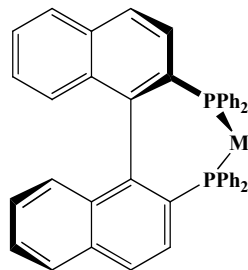
Cyclooctadiene (cod)



0

4

2,2'-bis(diphenylphosphino)-1,1'-binaphthyl



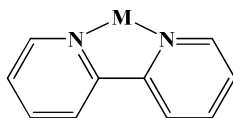
0

4

η^2 Multidentate chelating ligands

ionic model

2,2'-bipyridine (bpy)



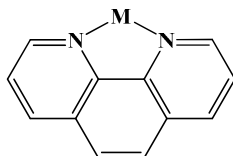
Formal charge

0

of e⁻ donated

4

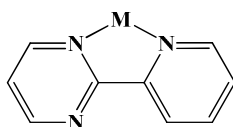
Phenanthroline (phen)



0

4

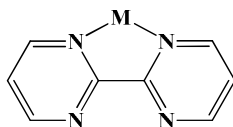
2-pyrimidylpyridine



0

4

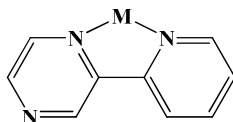
2,2'-bipyrimidine (bpm)



0

4

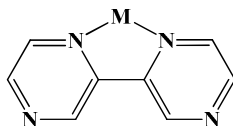
2-pyrazylpyridine



0

4

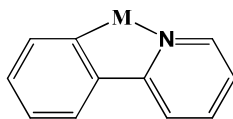
2,2'-bipyrazine (bpz)



0

4

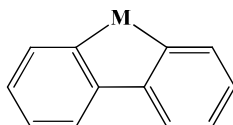
2-phenylpyridine (phpy)



-1

4

biphenyl (biph)



-2

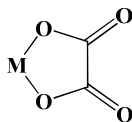
4

η^2 Multidentate chelating ligands

ionic model

Formal charge # of e⁻ donated

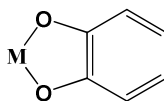
Oxalate



2-

4

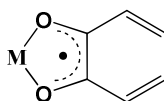
Catecholate



2-

4

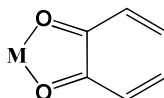
ortho-semiquinone



1-

4

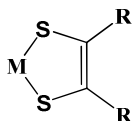
Orthoquinone



0

4

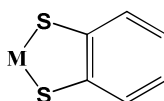
Dithiolate



2-

4

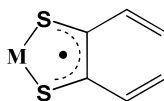
Dithiocatecholate



2-

4

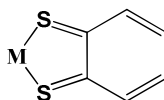
Dithioortho-semiquinone



1-

4

Dithioquinone



0

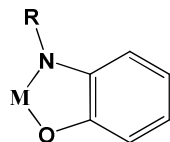
4

η^2 Multidentate chelating ligands (contd.)ionic model

Formal charge

of e⁻ donated

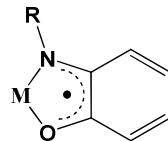
Orthoiminophenolate



2-

4

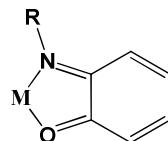
Orthoimino-semiquinone



-1

4

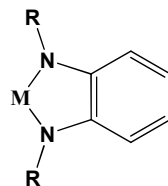
Orthoiminoquinone



0

4

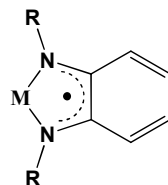
Phenylenediamido



2-

4

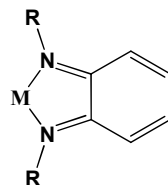
Phenylenediimino-semiquinone



1-

4

benzoquinonediimine



0

4

Common ions

Chloride



Coordinating

Bromide



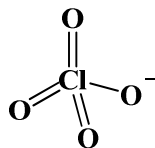
Coordinating

Iodide



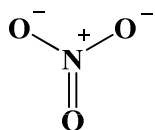
Coordinating

Perchlorate (ClO_4^-)



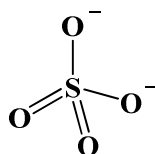
Coordinating

Nitrate (NO_3^-)



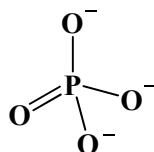
Coordinating

Sulfate (SO_4^{2-})



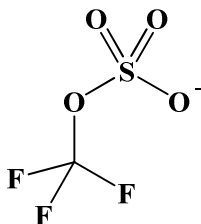
Coordinating

Phosphate (PO_4^{3-})



Coordinating

Trifluoromethane sulfonate
aka Triflate (TfO^-)

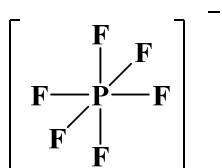


Weakly coordinating

Common ions

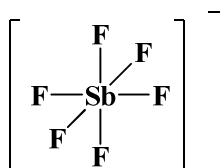
Description

Hexafluorophosphate (PF_6^-)



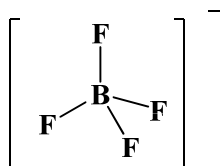
Weakly coordinating

Hexafluoroantimony (SbF_6^-)



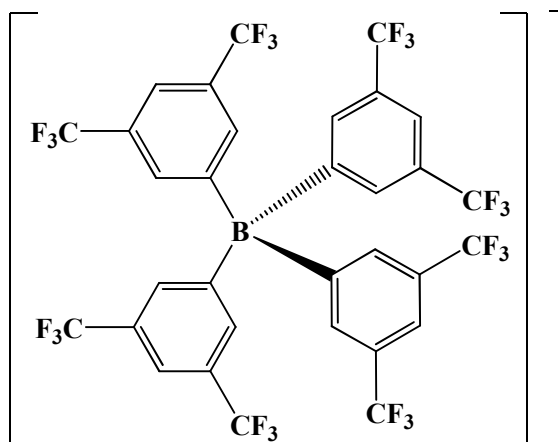
Weakly coordinating

Tetrafluoroborate (BF_4^-)



Weakly coordinating

Tetra(3,5-ditrifluoromethyl phenyl)borate
aka BARF : $[\text{B}(\text{Ar}^{\text{F}})_4]^-$



Non-coordinating

Weakly coordinating anions generally have: 1. low charge, 2. high degree of charge delocalization (*i.e.* no individual atom has a high concentration of charge), 3. steric bulk.