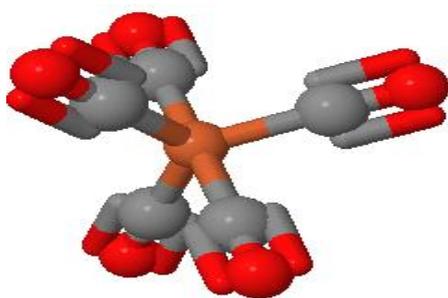


Definition: A transition metal has incompletely filled d orbitals.

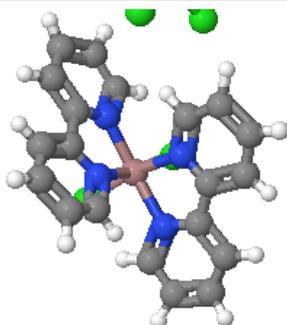
Transition metals are widely used materials in many different areas in science including biology and catalysis. The properties of transition metals arise from their d-orbitals. Transition metals complexes are formed when the metal centre is bound to ligands or anions. These complexes can take many shapes and forms.

The bonding in these transition metal complexes is called coordinate bonding or dative covalent bonding. Unlike normal covalent bonding both electrons are provided from a **lone pair** on the atom binding to the metal. The species that binds is called a **ligand**.

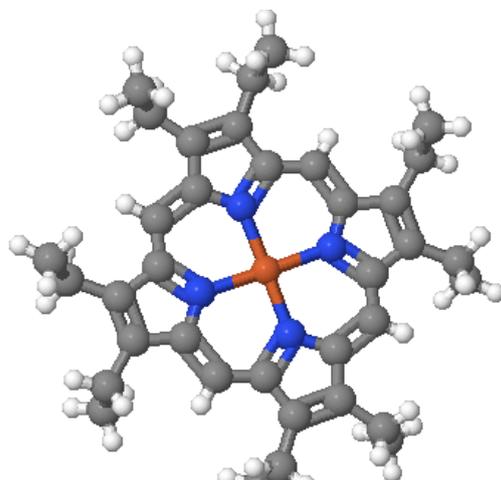
Some common types of ligand are OH^- , NH_3 and CO . Ligands can be unidentate/monodentate (single atom attachment), bidentate (A molecule with 2 atoms that bond to the metal) and multidentate/polydentate (A molecule with multiple atoms that bond).



Fe complex with 5 monodentate CO molecule. Bonded by dative covalent bonds. (FOJBOV01)



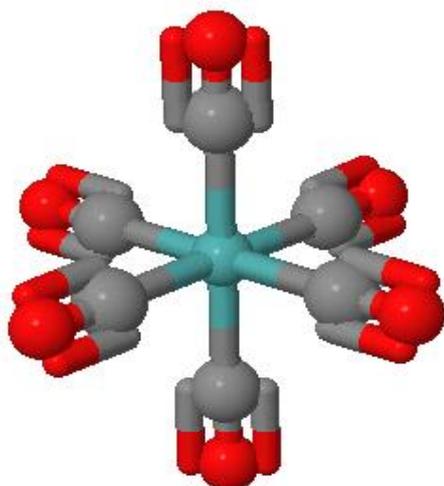
Fe complex with 2 bidentate bipyridine ligands (BIPYGA10)



Polydentate ligand (macrocycle) bound to Fe via 4 N atoms. This is very similar to how iron is bonded in haemoglobin. This is a vital component in red blood cells and without this oxygen transport wouldn't take place. (DEDWUE)

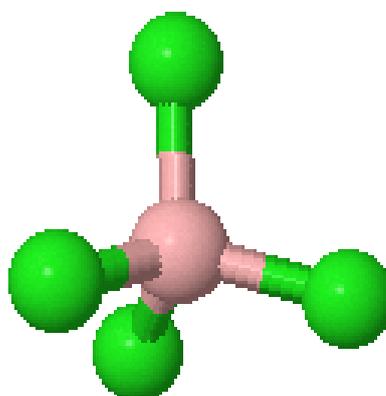
Complex Geometries

Metal complexes form many different geometries. The main ones of these are octahedral, square planar, tetrahedral and square planar. These will be shown on the next page.



Octahedral: One of the most common geometries is octahedral which comes from it having 8 faces. There are 6 atoms around the atom in total, 4 atoms in one plane with the other 2 above and below this plane. All bond angles should be 90° .
(FUBYIK)

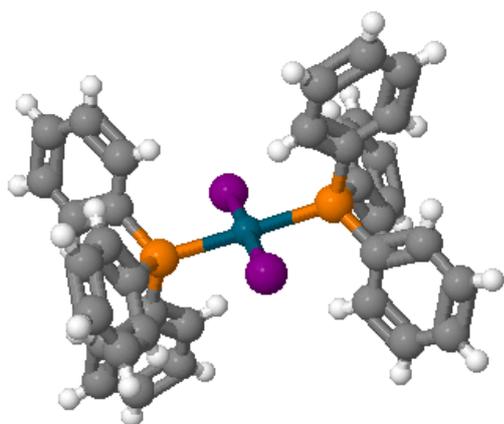
Octahedral molecules can form isomers such as cis/trans and fac/mer. These isomers arise depending on the type and amount of each group around the metal. (See extension sheet)



Tetrahedral: Has the same shape as molecular carbon atoms. The bond angles should be 109.5° . Tetrahedral means it has 4 faces
(PETKAB)



Linear: A linear complex consists of only 2 ligands. The molecule is straight in one plane with an 180° bond angle.
(OKAJOZ)



Square Planar: Square planar complexes have 4 ligands all in the same plane usually 90° bond angles. The molecule in the diagram is trans because the same groups are on opposite sides of the Pt **(GODGIP)**

The complex in the diagram is platinum in a square planar conformation. The square planar complex cisplatin $[(\text{NH}_3)_2\text{PtCl}_2]$ is an important anti-cancer drug. It is Cis because the chlorines and the ammonia molecules are on the same side. (See extension sheet)