

Chemistry - Topic 15 - Transition Metals

TRANSITION METAL \Rightarrow elements that form one or more stable ions with incompletely filled d-orbitals
LIGAND \Rightarrow a species with one or more lone pairs of electrons that surrounds a transition metal ion using coordinate bonding to form a complex ion

THE 3d SERIES OF THE PERIODIC TABLE

\hookrightarrow you need to know how to work out the electronic configuration for any atom or ion.

SCANDIUM and **ZINC** only form one ion each and their ions have no incomplete d-orbitals:

Scandium Sc $4s^2 3d^1$	Titanium Ti $4s^2 3d^2$	Vanadium V $4s^2 3d^3$	Chromium Cr $4s^1 3d^5$	Manganese Mn $4s^2 3d^5$	Iron Fe $4s^2 3d^6$	Cobalt Co $4s^2 3d^7$	Nickel Ni $4s^2 3d^8$	Copper Cu $4s^1 3d^9$	Zinc Zn $4s^2 3d^{10}$
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$Zn^{2+} = 4s^0 3d^{10}$
 $Sc^{3+} = 4s^0 3d^0$
 no d transition metals

GENERAL IDEAS ABOUT TRANSITION METALS

- They are hard solids with high melting and boiling temperatures
- Can have variable oxidation numbers so they make good catalysts
- They form coloured ions when in solution as they absorb some light.

REMEMBER: Copper and Chromium disobey the Aufbau principle, it is simply more stable for the electrons to fill like this.

REMEMBER: Electrons from the 4s orbital are lost before those in 3d!

OTHER IONS



WHY DO TRANSITION METALS HAVE VARIABLE OXIDATION STATES?

The compound formed is the one where the most energy is released, as the more energy that is released, the more stable the compound becomes. You need lots of energy to ionise the metal but then more energy is released in hydration or lattice formation. As most of the electrons being removed in transition metals are in the d-orbital, it is not too 'costly' to increase the oxidation state if it is going to 'pay-off' during lattice formation.

COMPLEX IONS	COMMON LIGAND	MORE INFORMATION
	Water H_2O	There are two lone pairs of electrons on the oxygen atom, water often forms octahedrons.
	Ammonia NH_3	One lone pair of electrons on the nitrogen atom. Ammonia is small so forms octahedral structures.
	Hydroxide ion OH^-	Forms hydroxo complexes, charge on the ion will reduce the charge of the complex ion.
	Chloride ion Cl^-	Cl^- ions are large so often cannot form octahedral complexes so form tetrahedral complexes.

MORE ON VARIABLE OXIDATION STATES

Transition metals can donate and receive electrons and are able to act as oxidising agents and as transition reducing agents. The sub-shells of the d-orbital can easily gain or lose electrons meaning the energy differences between the oxidation states is small.

- +2 state stability with respect to the 3+ state increases across a period.
- Compounds with high oxidation states tend to be oxidising agents e.g. MnO_4^- (Mn is 7+)
- Compounds with low oxidation states tend to be reducing agents e.g. V^{2+} , Fe^{2+} (2+ and 2+)

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