

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

- $V^{3+} = 4s^0 3d^2$
- $Mn^{2+} = 4s^0 3d^5$
- $Fe^{3+} = 4s^0 3d^5$
- $Fe^{2+} = 4s^0 3d^6$
- $Ni^{2+} = 4s^0 3d^8$

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

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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1. Understanding the eBook A Level Chemistry Revision Notes
 - The Rise of Digital Reading A Level Chemistry Revision Notes
 - Advantages of eBooks Over Traditional Books
2. Identifying A Level Chemistry Revision Notes
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an A Level Chemistry Revision Notes
 - User-Friendly Interface
4. Exploring eBook Recommendations from A Level Chemistry Revision Notes

- Personalized Recommendations
 - A Level Chemistry Revision Notes User Reviews and Ratings
 - A Level Chemistry Revision Notes and Bestseller Lists
5. Accessing A Level Chemistry Revision Notes Free and Paid eBooks
 - A Level Chemistry Revision Notes Public Domain eBooks
 - A Level Chemistry Revision Notes eBook Subscription Services
 - A Level Chemistry Revision Notes Budget-Friendly Options
 6. Navigating A Level Chemistry Revision Notes eBook Formats
 - ePub, PDF, MOBI, and More
 - A Level Chemistry Revision Notes Compatibility with Devices
 - A Level Chemistry Revision Notes Enhanced eBook Features
 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of A Level Chemistry Revision Notes
 - Highlighting and Note-Taking A Level Chemistry Revision Notes
 - Interactive Elements A Level Chemistry Revision Notes
 8. Staying Engaged with A Level Chemistry Revision Notes
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers A Level Chemistry Revision Notes
 9. Balancing eBooks and Physical Books A Level Chemistry Revision Notes
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection A Level Chemistry Revision Notes
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine A Level Chemistry Revision Notes
 - Setting Reading Goals A Level Chemistry Revision Notes
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of A Level Chemistry Revision Notes

- Fact-Checking eBook Content of A Level Chemistry Revision Notes
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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