

**B.Sc. Semester-IV  
Core Course-VIII (CC-VIII)  
Inorganic Chemistry-III**



**II. Transition Elements**

**2. Variable Oxidation States of Transition Elements-I**



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## **Transition Elements:**

**12 Lectures**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Coverage:

2. Variable Oxidation States of Transition Elements-I

## Oxidation States of Transition Elements

<b>Sc</b>	<b>Ti</b>	<b>V</b>	<b>Cr</b>	<b>Mn</b>	<b>Fe</b>	<b>Co</b>	<b>Ni</b>	<b>Cu</b>	<b>Zn</b>
							<b>+1</b>	<b>+1</b>	
	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>	<b>+2</b>
<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	<b>+3</b>	
	<b>+4</b>	<b>+4</b>	<b>+4</b>	<b>+4</b>	<b>+4</b>		<b>+4</b>		
		<b>+5</b>	<b>+5</b>	<b>+5</b>	<b>+5</b>				
			<b>+6</b>	<b>+6</b>	<b>+6</b>				
				<b>+7</b>					

# Oxidation States and Species for Vanadium in Aqueous Solution

Oxidation State of Vanadium	Species in Aqueous Solution
+5	$\text{VO}_2^+$ (yellow)
+4	$\text{VO}^{2+}$ (blue)
+3	$\text{V}^{3+}(\text{aq})$ (blue-green)
+2	$\text{V}^{2+}(\text{aq})$ (violet)

## Typical Chromium Compounds

Oxidation State of Chromium	Examples of Compounds (X = halogen)
+2	$\text{CrX}_2$
+3	$\text{CrX}_3$ $\text{Cr}_2\text{O}_3$ (green) $\text{Cr}(\text{OH})_3$ (blue-green)
+6	$\text{K}_2\text{Cr}_2\text{O}_7$ (orange) $\text{Na}_2\text{CrO}_4$ (yellow) $\text{CrO}_3$ (red)

## Some Compounds of Manganese in Its Most Common Oxidation States

Oxidation State of Manganese	Examples of Compounds
+2	Mn(OH) <sub>2</sub> (pink) MnS (salmon) MnSO <sub>4</sub> (reddish) MnCl <sub>2</sub> (pink)
+4	MnO <sub>2</sub> (dark brown)
+7	KMnO <sub>4</sub> (purple)

## Typical Compounds of Iron

Oxidation State of Iron	Examples of Compounds
+2	FeO (black) FeS (brownish black) FeSO <sub>4</sub> · 7H <sub>2</sub> O (green) K <sub>4</sub> Fe(CN) <sub>6</sub> (yellow)
+3	FeCl <sub>3</sub> (brownish black) Fe <sub>2</sub> O <sub>3</sub> (reddish brown) K <sub>3</sub> Fe(CN) <sub>6</sub> (red) Fe(SCN) <sub>3</sub> (red)
+2, +3 (mixture)	Fe <sub>3</sub> O <sub>4</sub> (black) KFe[Fe(CN) <sub>6</sub> ] (deep blue, “Prussian blue”)

## Typical Compounds of Cobalt

Oxidation State	Examples of Compounds
+2	CoSO <sub>4</sub> (dark blue) [Co(H <sub>2</sub> O) <sub>6</sub> ]Cl <sub>2</sub> (pink) [Co(H <sub>2</sub> O) <sub>6</sub> ](NO <sub>3</sub> ) <sub>2</sub> (red) CoS (black) CoO (greenish brown)
+3	CoF <sub>3</sub> (brown) Co <sub>2</sub> O <sub>3</sub> (charcoal) K <sub>3</sub> [Co(CN) <sub>6</sub> ] (yellow) [Co(NH <sub>3</sub> ) <sub>6</sub> ]Cl <sub>3</sub> (yellow)



# Typical Compounds of Nickel

Oxidation State of Nickel	Examples of Compounds
+2	NiCl <sub>2</sub> (yellow) [Ni(H <sub>2</sub> O) <sub>6</sub> ]Cl <sub>2</sub> (green) NiO (greenish black) NiS (black) [Ni(H <sub>2</sub> O) <sub>6</sub> ]SO <sub>4</sub> (green) [Ni(NH <sub>3</sub> ) <sub>6</sub> ](NO <sub>3</sub> ) <sub>2</sub> (blue)

## Typical Compounds of Copper

Oxidation State of Copper	Examples of Compounds
+1	Cu <sub>2</sub> O (red) Cu <sub>2</sub> S (black) CuCl (white)
+2	CuO (black) CuSO <sub>4</sub> · 5H <sub>2</sub> O (blue) CuCl <sub>2</sub> · 2H <sub>2</sub> O (green) [Cu(H <sub>2</sub> O) <sub>6</sub> ](NO <sub>3</sub> ) <sub>2</sub> (blue)

# Thank You



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