

Redox & Complex Ion Reactions

Redox Reactions

- Most redox reactions are simple
 - Synthesis (metal + non metal)
 - Single Replacement
 - Combustion
- Some are more complex
- We will call these non simple redox

MEMORIZE!			
Oxidizing Agent	Turns into	Reducing Agent	Turns into
NO_2^- (in acid)	Mn^{+2}	Free metals	Metal Cations
MnO_4^- (in neutral or base)	MnO_2	Halide ions	Free Halogens
MnO_2 (in acid)	Mn^{+2}	Free halogens (in dilute basic)	Hypohalite ions
$\text{Cr}_2\text{O}_7^{2-}$ (in acid)	Cr^{+3}	Free halogens (in conc. basic)	Halite ions
HNO_3 (Concentrated)	NO_2	NO_2^-	NO_3^-
HNO_3 (dilute)	NO	$\text{S}_2\text{O}_3^{2-}$	$\text{S}_4\text{O}_6^{2-}$
H_2SO_4 (hot & conc)	SO_2	SO_3^{2-} or SO_3	SO_4^{2-}
Highly charged metal cations	Lower charged metal cations	Lower charged metal cations	Highly charged metal cations
Free Halogens	Halide ions	H_2	H^+
H_2O_2 (in acid)	H_2O	H_2O_2 (in basic)	$\text{H}_2\text{O} + \text{O}_2$

Redox Reaction Types

- **Watchout for:**
- Keywords "acidified solution" or an acid included in the reactants.
- Anytime you see a neutral element, Cu^0 , O_2 , H_2 , etc. it must be redox.
- When you recognize great oxidizers like $\text{Cr}_2\text{O}_7^{2-}$, MnO_4^- , and MnO_2

Reaction Example 1

- Solid copper reacts with **dilute** nitric acid solution

Reaction Example 2

- A solution of potassium permanganate is mixed with an **alkaline solution** of sodium sulfite

Reaction Example 3

- Hydrogen peroxide is added to a solution of iron (II) sulfate

Naming Complex Ions

- Although the names of complex ions can look crazy, the formula are simply knowing the patterns, much like naming hydrocarbons

Naming Ligands

H ₂ O	aqua
NH ₃	ammine
OH ⁻	hydroxo
Cl ⁻	chloro
F ⁻	fluoro
CN ⁻	cyano
CO	carbonyl
NO ₂ ⁻	nitrito
NO	nitrosyl

Prefixes for Ligands

2	di
3	tri
4	tetra
5	penta
6	hexa

Example

- Name [Cu(H₂O)₆]²⁺
- hexaaquacopper(II)
- The (II) is the charge of the copper NOT the charge on the complex ion!

Example

- Name [Al(H₂O)₆]³⁺
- hexaaquaaluminium

Negative Complex Ions

- A negatively charged complex ion is called an **anionic complex**.
- In this case the name of the metal is modified to show that it has ended up in a negative ion.
- This is shown by the ending **-ate**.

Negative Names

cobalt	cobaltate
aluminum	aluminate
chromium	chromate
vanadium	vanadate
copper	cuprate
Iron	ferrate
silver	argenate

Example

- $[\text{CuCl}_4]^{2-}$
- tetrachlorocuprate(II)

Example

- $[\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4]^-$
- diaquatetrahydroxoaluminate

Name these compounds

- $[\text{Fe}(\text{H}_2\text{O})_6]\text{Cl}_2$
- hexaquoiron (II) chloride
- $[\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3]$
- triaquotrihydroxochromium (III)
- $\text{K}_2[\text{CoCl}_4]$
- potassium tetrachlorocobaltate (II)

Colors

Formula	Color
$[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$	Blue
$[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$	Blue/Violet
$[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$	Very pale pink
$[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$	Pale green
$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	Yellow/brown
$[\text{Co}(\text{H}_2\text{O})_6]^{2+}$	Pink
$[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$	Green
$[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$	Blue

Reactions

- Be on the lookout for the words concentrated, NH_3 with transition metals, and aluminum

Complexation Reactions

- a solution of Nickel (II) ions reacts with excess or **concentrated** ammonia
- $\text{Ni}^{2+} + 4\text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)_4]^{2+}$
- Use twice the number of ligands as the charge

Another Reaction

- tetraamminecopper (II) sulfate is added to hydrochloric acid.
- $[\text{Cu}(\text{NH}_3)_4]^{2+} + \text{H}^+ \rightarrow \text{NH}_4^+ + \text{Cu}^{2+}$
- Balance
- $[\text{Cu}(\text{NH}_3)_4]^{2+} + 4\text{H}^+ \rightarrow 4\text{NH}_4^+ + \text{Cu}^{2+}$

On the test last year!!!

- Aqueous sodium hydroxide is added to a saturated solution of aluminum hydroxide, forming a complex ion
- $\text{Al}(\text{OH})_3 + 3\text{OH}^- \rightarrow [\text{Al}(\text{OH})_6]^{3-}$