Cu

$[Cu(H_2O)_6]^{2+} + 2OH^- \rightarrow [Cu(H_2O)_4(OH)_2] + 2H_2O$

Blue — Blue ppt.

Acid & Base Reaction. Reversible.
Amphoteric Behaviour.

$[Cu(H_2O)_6]^{2+} + 2NH_3 \rightarrow [Cu(H_2O)_4(OH)_2] + 2NH_4^+$

A and B

$[Cu(H_2O)_4(OH)_2] + 4NH_3 \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 2H_2O + 2OH^-$

Deep Blue Solution

$[Cu(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CuCl_4]^{2-} + 6H_2O$

Blue — Yellow

Change in Coordination Number
From blue to green then yellow

Co

$[Co(H_2O)_6]^{2+} + 2OH^- \rightarrow [Co(H_2O)_4(OH)_2] + 2H_2O$

Pink — Pink ppt

A and B

$[Co(H_2O)_6]^{2+} + 2NH_3 \rightarrow [Co(H_2O)_4(OH)_2] + 2NH_4^+$

Precipitate will redissolve in excessive ammonia.

$[Co(H_2O)_4(OH)_2] + 6NH_3 \rightarrow [Co(NH_3)_6]^{2+} + 4H_2O + 2OH^-$

$[Co(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CoCl_4]^{2-} + 6H_2O$

Pink — Blue

Gradually change from pink to blue. Ligand Exchage

$2[Co(NH_3)_6]^{2+} + H_2O_2 \rightarrow 2[Co(NH_3)_6]^{3+} + 2OH^-$

Oxidation. Solution becomes dark red.

Fe

$[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow [Fe(H_2O)_6(OH)_2] + 2H_2O$

Green — Green ppt ↓ oxidation O_2

$[Fe(H_2O)_6]^{3+} + 3OH^- \rightarrow [Fe(H_2O)_3(OH)_3] + 3H_2O$

Yellow — Orange

$[Fe(H_2O)_6]^{2+} + 2NH_3 \rightarrow [Fe(H_2O)_4(OH)_2] + 2NH_4^+$

Same for $[Fe(H_2O)_6]^{3+}$

$[Fe(H_2O)_6]^{2+} + CO_3^{2-} \rightarrow FeCO_3$ (Yellow ppt)

$2[Fe(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Fe(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$

Fe^{3+} is slightly more acidic than Fe^{2+}

$[Fe(H_2O)_6]^{3+}$ can lose $3H^+$, and then becomes ppt, while $[Fe(H_2O)_6]^{2+}$ $2H^+$.

$[Fe(H_2O)_6]^{3+} + SCN^- \rightarrow [Fe(SCN)(H_2O)_5]^{2+} + H_2O$

Blood Red

Test for Fe^{3+}.

$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

(Buette) — (Pink)

$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$

$N_2(g) + 3H_2(g) \overset{Fe}{\rightleftharpoons} 2NH_3(g)$

$S_2O_8^{2-} + 2Fe^{2+} \rightarrow 2SO_4^{2-} + 2Fe^{3+}$

$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

$S_2O_8^{2-} + 2I^- \rightarrow 2SO_4^{2-} + I_2$

Fe has 2 oxidation states. Positive ions facilitate the collision between 2 negative ions.

Cr

$[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow [Cr(H_2O)_3(OH)_3] + 3H_2O$

Green — Green ppt

$[Cr(H_2O)_3(OH)_3] + 3OH^- \rightarrow [Cr(OH)_6]^{3-} + 3H_2O$

Green Solution

$[Cr(H_2O)_6]^{3+} + 3NH_3 \rightarrow [Cr(H_2O)_3(OH)_3] + 3NH_4^+$

$[Cr(H_2O)_3(OH)_3] + 6NH_3 \rightarrow [Cr(NH_3)_6]^{3+} + 3H_2O + 3OH^-$

Purple Solution

Acid and Base

Oxidation from +3 to +6

$2Cr(OH)_3 + 4OH^- + 3H_2O_2 \rightarrow 2CrO_4^{2-} + 8H_2O$

Yellow

Reduction from +6 to +3

$Cr_2O_7^{2-} + 14H^+ + 3Zn \rightarrow 2Cr^{3+} + 7H_2O + 3Zn^{2+}$

Orange

Reduction from +3 to +2

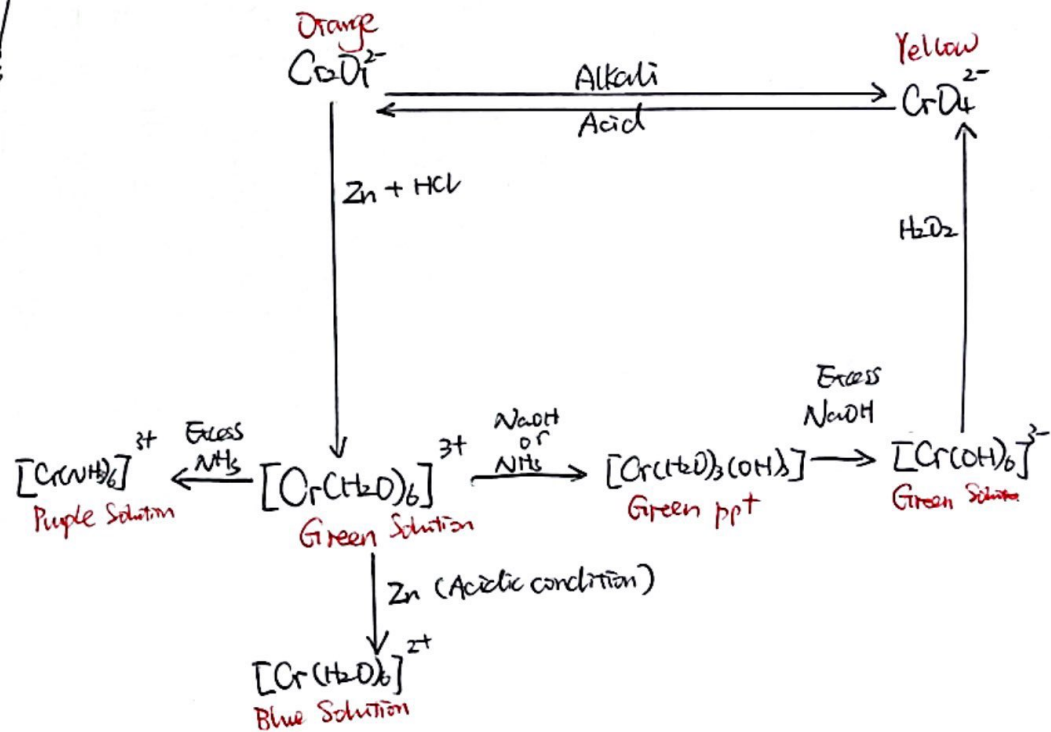
$2Cr^{3+} + Zn \rightarrow 2Cr^{2+} + Zn^{2+}$

Blue

Equilibrium between $Cr_2O_7^{2-}$ and CrO_4^{2-}

$2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$

Not redox. Acid and Base.



V

Reduction from +5 to +4

$2VO_2^+ + 4H^+ + Zn \longrightarrow 2VO^{2+} + Zn^{2+} + 2H_2O$

Reduction from +4 to +3

$2VO^{2+} + 4H^+ + Zn \rightarrow 2V^{3+} + Zn^{2+} + 2H_2O$

Reduction from +3 to +2

$2V^{3+} + Zn \longrightarrow 2V^{2+} + Zn^{2+}$

Reduction from +2 to 0.

Zn is not powerful enough to reduce V^{2+} to V.

+5	VO_2^+	Yellow
+4	VO^{2+}	Blue
+3	V^{3+}	Green
+2	V^{2+}	Violet

Catalyst.

$SO_2 + \frac{1}{2}O_2 \xrightarrow{V_2O_5} SO_3$

$$\begin{cases} SO_2 + V_2O_5 \longrightarrow SO_3 + V_2O_4 \\ V_2O_4 + \frac{1}{2}O_2 \rightarrow V_2O_5 \end{cases}$$