Transition metal ions and colour

Metal(II) salts

Iron(II)

$FeSO_4.7H_2O \rightarrow FeSO_4 + 7H_2O$ e.g. gentle heating of the solid
green solid white solid

$[Fe(H_2O)_6]^{2+} + H_2O \rightleftharpoons [Fe(H_2O)_5(OH)]^+ + H_3O^+$ e.g. dissolving salt in water
green soln green soln

$[Fe(H_2O)_5(OH)]^+ + H_2O \rightleftharpoons [Fe(H_2O)_4(OH)_2] + H_3O^+$ e.g. adding NH_3 or NaOH
green soln white ppt (turns grey-green in air)

Adding CO_3^{2-} ions to solutions of iron(II) ions produces a white precipitate of $FeCO_3$

Cobalt(II)

$CoCl_2.6H_2O \rightarrow CoCl_2 + 6H_2O$ e.g. gentle heating of the solid
red solid blue solid

$[Co(H_2O)_6]^{2+} + H_2O \rightleftharpoons [Co(H_2O)_5(OH)]^+ + H_3O^+$ e.g. dissolving salt in water
pink soln pink soln

$[Co(H_2O)_5(OH)]^+ + H_2O \rightleftharpoons [Co(H_2O)_4(OH)_2] + H_3O^+$ e.g. adding NH_3 or NaOH
pink soln blue-green ppt

$[Co(H_2O)_4(OH)_2] + 6NH_3 \rightarrow [Co(NH_3)_6]^{2+} + 4H_2O + 2OH^-$ e.g. adding excess NH_3
blue-green ppt pale yellow straw-coloured soln (turns dark brown in air)

$[Co(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CoCl_4]^{2-} + 6H_2O$ e.g. adding excess conc HCl
pink soln blue soln

Copper(II)

$[Cu(H_2O)_6]^{2+} + H_2O \rightleftharpoons [Cu(H_2O)_5(OH)]^+ + H_3O^+$ e.g. dissolving salt in water
blue soln blue soln

$[Cu(H_2O)_5(OH)]^+ + H_2O \rightleftharpoons [Cu(H_2O)_4(OH)_2] + H_3O^+$ e.g. adding NH_3 or NaOH
blue soln light blue / turquoise ppt

$[Cu(H_2O)_4(OH)_2] + 4NH_3 \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 4H_2O$ e.g. adding excess NH_3
light blue ppt Royal blue soln

$[Cu(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CuCl_4]^{2-} + 6H_2O$ e.g. adding excess conc HCl
blue soln olive-green soln

Adding CO_3^{2-} ions to solutions of copper(II) ions produces a green precipitate of $CuCO_3.Cu(OH)_2$

Metal(III) salts

Iron(III)

$[Fe(H_2O)_6]^{3+} + 3H_2O \rightleftharpoons [Fe(H_2O)_3(OH)_3] + 3H_3O^+$ e.g. adding NH_3 or NaOH
pale violet soln brown ppt

Note: $[Fe(H_2O)_3(OH)_3]$ actually exists as $Fe_2O_3.xH_2O$ and forms FeO(OH) ("rust") when dry.

$2[Fe(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Fe(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$ e.g. adding carbonate ions
brown ppt

Note: $Fe_2(CO_3)_3$ is not formed in solution by adding carbonate solutions.

Chromium (III)

$[Cr(H_2O)_6]^{3+} + 3H_2O \rightleftharpoons [Cr(H_2O)_3(OH)_3] + 3H_3O^+$ e.g. adding NH_3 or NaOH
blue-violet soln green ppt

Note: $[Cr(H_2O)_6]^{3+}$ solutions which contain chloride ions or sulphate ions will appear green.

$[Cr(H_2O)_3(OH)_3] + 3OH^- \rightleftharpoons [Cr(OH)_6]^{3-} + 3H_2O$ e.g. adding excess NaOH
green ppt green soln

$[Cr(H_2O)_3(OH)_3] + 3OH^- \rightleftharpoons [Cr(NH_3)_6]^{3+} + 3H_2O$ e.g. adding excess NH_3
green ppt purple soln

$2[Cr(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Cr(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$ e.g. adding carbonate ions
blue-violet soln green ppt

Note: $Cr_2(CO_3)_3$ in solution is not formed by adding carbonate solutions.

Aluminium

This is not a transition metal, but is included because its hydroxide is amphoteric like chromium hydroxide, and its chemistry is similar in this respect.

$[Al(H_2O)_6]^{3+} + 3H_2O \rightleftharpoons [Al(H_2O)_3(OH)_3] + 3H_3O^+$ e.g. adding NH_3 or NaOH
colourless soln white ppt

$[Al(H_2O)_3(OH)_3] + OH^- \rightleftharpoons [Al(OH)_4]^- + 2H_2O$ e.g. adding excess NH_3 or NaOH
white ppt colourless soln

$2[Al(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Al(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$ e.g. adding carbonate ions
colourless soln white ppt

Note: $Al_2(CO_3)_3$ in solution is not formed by adding carbonate solutions.

Other ions

You also need to know some redox reactions of vanadium, chromium and manganese.