SOLUBILITY PATTERNS FOR IONIC COMPOUNDS

Comprehensive data on solubility of a wide variety of ionic compounds in water have been available for centuries. Although *quantitative* data can be accessed as required, it is very important at an i/GCSE stage and beyond to know the likelihood of a particular ionic compound being soluble in water. Exceedingly useful generalizations are available in the shape of SOLUBILITY RULES.

Solubility Rules

1. All compounds containing **Group I metal ions** (*e.g.,* Na^{1+} and K^{1+}) or ammonium ions (NH_4^{1+}) are soluble in water.

2. All **nitrates** (NO_3^{1-}) and all common ethanoates ($CH_3CO_2^{1-}$) are soluble in water.

All hydrogencarbonates ($HOCO_2^{1-}$ or HCO_3^{1-}) are soluble in water.
(N.B. only those of Group I metals are obtainable in the solid state).

3. **Chlorides** are soluble in water except those of lead (Pb^{2+}), silver (Ag^{+}).
(N.B. $PbC\ell_2$ is fairly soluble in *hot* water).
Bromides (Br^{-}) and iodides (I^{-}) follow a *similar* pattern.

4. **Sulphates** (SO_4^{2-}) are soluble in water except those of barium (Ba^{2+}) & lead (Pb^{2+}).

Calcium sulfate, $CaSO_4$, is sparingly soluble.

Chromates (CrO_4^{2-}) follow a similar pattern to sulphates.
N.B. silver chromate, Ag_2CrO_4, is insoluble in water.

5. **Oxides** (O^{2-}) and **hydroxides** (OH^{1-}) are insoluble in water except where rule 1. applies - *i.e.,* those of Na^{1+}, K^{1+} and NH_4^{1+} are soluble in water.
N.B. Calcium hydroxide, $Ca(OH)_2$, is *sparingly soluble* in water, with $Sr(OH)_2$ and $Ba(OH)_2$ becoming increasingly soluble such that $Ba(OH)_{2(aq)}$ is a strong alkali.

6. **Carbonates** (CO_3^{2-}) & **sulphides** (S^{2-}) are insoluble in water except where rule 1. applies - *i.e.,* those of Na^{1+}, K^{1+} and NH_4^{1+} are soluble in water.
N.B. Group 2 metal sulfides, *e.g.,* MgS, tend to hydrolyze in water with the formation of the metal hydroxide and hydrogen sulphide gas, $H_2S_{(g)}$.

7. The *only* common soluble salts of lead (Pb^{2+}) are its nitrate (NO_3^{1-}) and ethanoate ($CH_3CO_2^{1-}$). N.B. Silver ethanoate, $AgCH_3CO_2$, is *insoluble*.

8. The common mineral acids ($HC\ell$, H_2SO_4, HNO_3, *etc.*) are soluble in water.