4.13 Salts and Hydrolysis

① Salts dissociate 100% in water

② The ions from the salt will either:

- Undergo "Hydrolysis"
- Be Spectator Ions

a) What is "Hydrolysis"?

i) Reaction between an ion from the salt with water.

ii) **The ion will react with water to form a basic solution if the ion is on the base (right) side of the Table of Relative Strengths p.334.**

eg. $Na_2SO_{3\,(s)} \rightarrow Na^+_{(aq)} + SO_3^{-2}{}_{(aq)}$

Na^+ is not on the table. It is a spectator ion.

SO_3^{-2} is found on the base side

$SO_3^{-2} + H_2O \rightleftharpoons HSO_3^- + OH^-$

Therefore, Na_2SO_3 added to water will form a basic solution.

iii) **The ion will react with water to form an acidic solution if the ion is on the acid (left) side of the Table of Relative Strengths p.334.**

eg. $NH_4Br_{(s)} \rightarrow NH_4^+{}_{(aq)} + Br^-{}_{(aq)}$

Br^- is not on the table. It is a spectator ion.

NH_4^+ is found on the acid side

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

Therefore, NH_4Br added to water will form an acidic solution.

b) Spectator Ions

i) Ions that do not react with water (***not*** found on Table of Relative Strengths)

ii) Most common spectator ions:

- alkali and alkaline earth metals
- Cl^-, Br^-, I^-, NO_3^-, ClO_4^-

iii) KI salt in water:

$KI_{(s)} + H_2O_{(l)} \rightarrow K^+_{(aq)} + I^-_{(aq)}$

Solution is neutral because no hydrolysis occurs

c) Will the Following Salts be Acidic, Basic or Neutral in Water?

i) KF

$KF \rightarrow K^+ + F^-$

K^+ is a spectator; F^- is found on the base side

$F^- + H_2O \rightleftharpoons HF + OH^-$

Solution is **basic**

ii) $MgSO_4$

$MgSO_4 \rightarrow Mg^{+2} + SO_4^{-2}$

Mg^{+2} is a spectator; SO_4^{-2} is on base side

$SO_4^{-2} + H_2O \rightleftharpoons HSO_4^- + OH^-$

Solution is **basic**

iii) $Cr(H_2O)_6Br_3$

$Cr(H_2O)_6Br_3 \rightarrow Cr(H_2O)_6^{+3} + 3Br^-$

Br^- is spectator; $Cr(H_2O)_6^{+3}$ is on acid side

$Cr(H_2O)_6^{+3} + H_2O \rightleftharpoons Cr(H_2O)_5(OH)^{+2} + H_3O^+$

Solution is **acidic.**

iv) $(NH_4)_2SO_4$

$(NH_4)_2SO_4 \rightarrow 2NH_4^+ + SO_4^{-2}$

NH_4^+ is on acid side; SO_4^{-2} is on base side

Must compare whether NH_4^+ produces more H_3O^+ than SO_4^{-2} produces OH^-. (Compare Ka and Kb)

$Ka(NH_4^+) = 5.6 \times 10^{-10}$

$Kb(SO_4^{-2}) = Kw / Ka(HSO_4^-)$

$Kb(SO_4^{-2}) = 1.0 \times 10^{-14} / 1.2 \times 10^{-2} = 8.3 \times 10^{-13}$

Ka > Kb so solution is **acidic**.

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