Species in solution

Don't forget the water

(After all these are aqueous solutions…….)

$2H_2O \rightleftharpoons H_3O^+ + OH^-$ or more simply $H_2O \rightleftharpoons H^+ + OH^-$

- This is called the self-ionisation of water **AND** $K_w = [H^+]\,[OH^-]$
- If the solution is neutral $[H^+] = [OH^-]$
- If the solution is acidic $[H^+] > [OH^-]$
- If the solution is basic/alkaline $[H^+] < [OH^-]$

- Since $[H^+]\,[OH^-] = 10^{-14}$ if $[H^+]\Uparrow$ then the $[OH^-]\Downarrow$
- (so that $[H^+] \times [OH^-] = 10^{-14}$)

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Salts e.g. NaCl, KCl, $MgCl_2$, $MgSO_4$, CH_3COONa, NH_4Cl; these dissolve completely in water and ionise completely

$NaCl(s) + aq \rightarrow Na^+(aq) + Cl^-(aq)$

- $Na^+ = Cl^- > H_3O^+ = OH^-$
- pH will be 7 ($H_3O^+ = OH^-$)
- will be a good conductor of electricity / good electrolyte as lots of Na^+ & Cl^-

$MgCl_2(s) + aq \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$

- $Cl^- > Mg^{2+} > H_3O^+ = OH^-$
- pH will be 7 ($H_3O^+ = OH^-$)
- will be a good conductor of electricity / good electrolyte

$NH_4Cl(s) + aq \rightarrow NH_4^+(aq) + Cl^-(aq)$

$NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$

- $Cl^- > NH_4^+ > NH_3 = H_3O^+ > OH^-$ OR
- $Cl^- \approx NH_4^+ > NH_3 = H_3O^+ > OH^-$
- pH will be less than 7 due to $H_3O^+ > OH^-$
- will be a good conductor of electricity / good electrolyte as lots of NH_4^+ & Cl^-

$CH_3COONa(s) + aq \rightarrow CH_3COO^-(aq) + Na^+(aq)$

$CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$

- $Na^+ > CH_3COO^- > CH_3COOH = OH^- > H_3O^+$ OR
- $Na^+ \approx CH_3COO^- > CH_3COOH = OH^- > H_3O^+$
- pH will be more than 7 due to $OH^- > H_3O^+$
- will be a good conductor of electricity / good electrolyte as lots of CH_3COO^- & Na^+

Strong acids e.g. HCl, HBr, HNO_3, H_2SO_4 ; react fully with water / fully ionise

$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

- $H_3O^+ = Cl^- > OH^-$
- pH will be much much less than 7 (it's a strong acid!!)
- will be a good conductor of electricity / good electrolyte

$H_2SO_4(l) + 2H_2O(l) \rightarrow 2H_3O^+(aq) + SO_4^{2-}(aq)$

- $H_3O^+ > SO_4^{2-} > OH^-$ (note: $H_3O^+ > SO_4^{2-}$ since H_2SO_4)
- pH will be much much less than 7 (it's a strong acid!!)
- will be a good conductor of electricity / good electrolyte

Strong bases e.g. NaOH, KOH, $Ca(OH)_2$; fully ionise / dissociate

$NaOH(s) + aq \rightarrow Na^+(aq) + OH^-(aq)$

$Na^+ = OH^- > H_3O^+$

- pH will be much much more than 7 (it's a strong base!!)
- will be a good conductor of electricity / good electrolyte

$Ca(OH)_2(s) + aq \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$

- $OH^- > Ca^{2+} > H_3O^+$
- pH will be much much more than 7 (it's a strong base!!)
- will be a good conductor of electricity / good electrolyte
- Note: $Ca(OH)_2$ is only slightly soluble in water but will still be more basic and a better conductor than a weak base.

Weak acids e.g. CH_3COOH, HCOOH, HOBr, HF; incomplete reaction with water

$CH_3COOH(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$

$CH_3COOH > H_3O^+ = CH_3COO^- > OH^-$

- pH will be less than 7 (it's a weak acid!!)
- will be a poor conductor of electricity / poor electrolyte

Weak bases e.g. NH_3, CH_3NH_2; incomplete reaction with water

$NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

$NH_4^+ = OH^- > H_3O^+$

- pH will be more than 7 (it's a weak base!!)
- will be a poor conductor of electricity / poor electrolyte