CAIE IGCSE Chemistry

7.1 The characteristic properties of acids and bases

Notes

Describe the characteristic properties of acids in terms of their reactions with: (a) metals (b) bases (c) carbonates

- An acid is a chemical that has a pH value less than 7
- A salt is a compound formed when the metals ions replace the hydrogen ions ,H^+ ,in an acid, e.g. sodium chloride (NaCl)
- Examples of dilute acids: hydrochloric acid HCl (aq), sulfuric acid H_2SO_4 (aq) and nitric acid HNO_3 (aq)

Acids and metals

- Only metals that are above hydrogen in the reactivity series will react with dilute acids
- When a dilute acid reacts with a metal, a salt and hydrogen are formed:
  E.g. Sodium + Hydrochloric acid -> Sodium chloride + hydrogen
  2Na (s) + 2HCl (aq) -> 2NaCl (aq) + H_2 (g)

Acids and bases

- Metal oxides and metal hydroxides act as bases
- When an acid and base react, a neutralisation reaction occurs, forming water
- When an acid reacts with a metal oxide, a salt and water is formed
  E.g. Magnesium oxide + Sulfuric acid -> Magnesium sulfate + Water
  MgO (s) + H_2SO_4 (aq) -> $MgSO_4$ (aq) + H_2O (l)

- When an acid reacts with a metal hydroxide, a salt and water is also formed
  E.g. Sodium hydroxide + Hydrochloric acid -> Sodium chloride + Water
  NaOH (aq) + HCl (aq) -> NaCl (aq) + H_2O (l)

Acids and carbonates

- When an acid reacts with a metal carbonate, a salt, water and carbon dioxide are formed
  E.g. Magnesium carbonate + Hydrochloric acid -> Magnesium chloride + Water + Carbon dioxide
  $MgCO_3$ (s) + 2HCl (aq) -> $MgCl_2$ (aq) + H_2O (l) + CO_2 (g)

Describe acids in terms of their effect on: (a) litmus (b) thymolphthalein (c) methyl orange

To test for acids, an indicator can be used. These change colour in different solutions according to their acidity/alkalinity. Litmus, thymolphthalein and methyl orange are all examples of indicators.

Litmus

- Litmus is available in aqueous solution form or more commonly as paper strips, in blue and red litmus paper
- When an acid is added, the **blue litmus paper** -> **red**
- When an acid is added, the red litmus paper stays red

Thymolphthalein

- When an acid is added, thymolphthalein will stay colourless

Methyl orange

- When an acid is added, methyl orange turns **red**

State that …

- Bases are oxides and hydroxides of metals
- Alkalis are bases that are soluble (dissolve in aqueous solution)
- Examples of alkalis: Sodium hydroxide NaOH (aq), Potassium hydroxide KOH (aq) and Ammonia NH_3 (aq)

Describe the characteristic properties of bases in terms of their reactions with: (a) acids (b) ammonium salts

Acids and bases

- See above

Ammonium salts

- When an ammonium salt is warmed with a base, it undergoes thermal decomposition forming a salt, water and ammonia gas
  E.g. Ammonium chloride + sodium hydroxide -> sodium chloride + water + ammonia gas
  NH_4Cl (s) + NaOH (aq) ->NaCl (aq)+ H_2O (l) + NH_3 (g)

Describe alkalis in terms of their effect on: (a) litmus (b) thymolphthalein (c) methyl orange

Litmus

- When an alkali is added, the blue litmus paper stays blue
- When an alkali is added, the **red litmus paper** -> **blue**

Thymolphthalein

- When an alkali is added, thymolphthalein will change from colourless to **blue**

Methyl orange

- When an alkali is added, methyl orange turns **yellow**

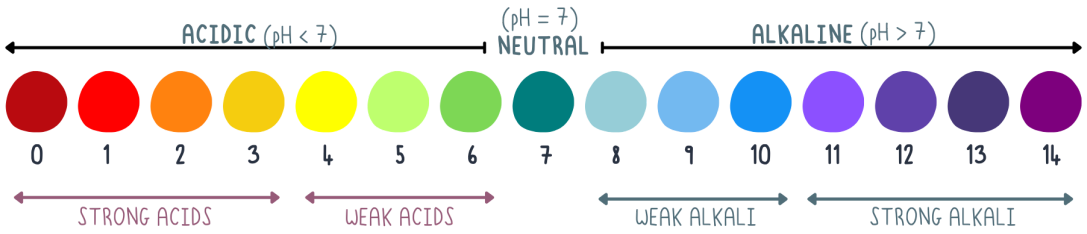
State that …

- Aqueous solutions of acids contain H^+ ions
- Aqueous solutions of alkalis contain OH^- ions

Describe how to compare hydrogen ion concentration, neutrality, relative acidity and relative alkalinity in terms of colour and pH using universal indicator paper

- A pH scale is used to measure how acidic or alkaline a solution is, with values between 0 - 14. 0 being the most acidic and 14 being the most alkaline.
- An acid has a pH value less than 7 and a high concentration of hydrogen ions (H^+ ions)
- An alkali has a pH value above 7 and a low concentration of hydrogen ions (H^+ ions) but high concentration of hydroxide ions (OH^- ions)
- Neutral solutions, such as pure water, has a pH value of 7
- The higher the pH value, the more alkaline a solution is
- The lower the pH value, the more acidic a solution is

- Universal indicator paper can be used to test the relative acidity/alkalinity of a solution by adding a spot of the unknown solution to the paper and waiting for a colour change
- Universal indicator paper will show colour changes according to the pH scale
    - Colours like yellow, orange and red indicate acidity
    - Colours like blue and violet indicate alkalinity
    - Neutral solutions will show as green



Describe the neutralisation reaction between an acid and an alkali to produce water

- When an acid and base react, a neutralisation reaction occurs, forming water
- The symbol equation for this can be shown:
  $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

(Extended only) Define acids and bases as …

- Acids are known as proton donors (releases hydrogen ions)
- Bases are known as proton acceptors (accepts hydrogen ions)
- A proton is the same as a hydrogen ion (H^+)

(Extended only) Define a strong acid and a weak acid …

- A strong acid is an acid that completely dissociates in aqueous solution
- A weak acid is an acid that only partially dissociates in aqueous solution
  - A weak acids will usually be indicated in a symbol equation of its dissociation by the reversible sign ⇌

(Extended only) State that hydrochloric acid is a strong acid, as shown by the symbol equation, HCl(aq) ⟶ H+ (aq) + Cl – (aq)

- An example of a strong acid is hydrochloric acid
- This is shown in the symbol equation for its dissociation:
  $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

(Extended only) State that ethanoic acid is a weak acid, as shown by the symbol equation, CH3COOH(aq) ⇌ H+ (aq) + CH3COO– (aq)

- An example of a weak acid is ethanoic acid
- This is shown in the symbol equation for its dissociation:
  $CH_3COOH\ (aq) \rightleftharpoons H^+\ (aq) + CH_3COO^-\ (aq)$