Cambridge (CIE) A Level Chemistry

Your notes

The Reactions of Chlorine

Contents

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Reaction of Chlorine

- A **disproportionation reaction** is a reaction in which the same species is both oxidised and reduced
- The reaction of **chlorine** with **dilute alkali** is an example of a disproportionation reaction
- In these reactions, the chlorine gets oxidised and reduced at the same time
- Different reactions take place at different **temperatures** of the dilute alkali

Chlorine in cold alkali (15 ◦C)

- The reaction that takes place is:

$$Cl_2\,(aq) + 2NaOH\,(aq) \rightarrow NaCl\,(aq) + NaClO\,(aq) + H_2O\,(l)$$

- The ionic equation is:

$$Cl_2\,(aq) + 2OH^-\,(aq) \rightarrow Cl^-\,(aq) + ClO^-\,(aq) + H_2O\,(l)$$

- The ionic equations show that the chlorine undergoes disproportionation, i.e. gets both oxidised and reduced
- Chlorine gets oxidised as there is an increase in oxidation number from 0 in Cl_2 (aq) to +1 in ClO^- (aq)
  - The half-equation for the oxidation reaction is:

$$\tfrac{1}{2}Cl_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO^-\,(aq) + H_2O\,(l) + e^-$$

- Chlorine gets reduced as there is a decrease in oxidation number from 0 in Cl_2 (aq) to –1 in Cl^- (aq)
  - The half-equation for the reduction reaction is:

$$\tfrac{1}{2}Cl_2\,(aq) + e^- \rightarrow Cl^-\,(aq)$$

Chlorine in hot alkali (70 ◦C)

- The reaction that takes place is:

$$3Cl_2\,(aq) + 6NaOH\,(aq) \rightarrow 5NaCl\,(aq) + NaClO_3\,(aq) + 3H_2O\,(l)$$

- The ionic equation is:

$$3Cl_2\,(aq) + 6OH^-\,(aq) \rightarrow 5Cl^-\,(aq) + ClO_3^-\,(aq) + 3H_2O\,(l)$$

- The ionic equations show that the chlorine undergoes disproportionation, i.e. gets both oxidised and reduced
- Chlorine gets oxidised as there is an increase in oxidation number from 0 in Cl_2 (aq) to +5 in ClO_3^- (aq)

- The half-equation for the oxidation reaction is:

$$\frac{1}{2}Cl_2\,(aq) + 6OH^-\,(aq) \rightarrow ClO_3^-\,(aq) + 3H_2O\,(l) + e^-$$

- Chlorine gets reduced as there is a decrease in oxidation number from 0 in Cl_2 (aq) to −1 in Cl^- (aq)
  - The simplified half-equation for the reduction reaction is:

$$\frac{1}{2}Cl_2\,(aq) + e^- \rightarrow Cl^-\,(aq)$$

Chlorine in Water Purification

- Chlorine can be used to clean water and make it drinkable
- The reaction of chlorine in water is a **disproportionation reaction** in which the chlorine gets both **oxidised** and **reduced**

$$Cl_2\,(aq) + H_2O\,(l) \rightleftharpoons HCl\,(aq) + HClO\,(aq)$$

- The ionic equations show that the chlorine undergoes disproportionation, i.e. gets both oxidised and reduced
- Chlorine gets oxidised as there is an increase in oxidation number from 0 in Cl_2 (aq) to +1 in ClO^- (aq)
  - The half-equation for the oxidation reaction is:

$$\frac{1}{2}Cl_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO^-\,(aq) + H_2O\,(l) + e^-$$

- Chlorine gets reduced as there is a decrease in oxidation number from 0 in Cl_2 (aq) to −1 in Cl^- (aq)
  - The half-equation for the reduction reaction is:

$$\frac{1}{2}Cl_2\,(aq) + e^- \rightarrow Cl^-\,(aq)$$

- Chloric(I) acid (HClO) **sterilises** water by killing **bacteria**
- Chloric acid can further dissociate in water to form ClO^- (aq):

$$HClO\,(aq) \rightarrow H^+\,(aq) + ClO^-\,(aq)$$

- ClO^-(aq) also acts as a **sterilising agent** cleaning the water

Examiner Tips and Tricks

Adding chlorine to a water supply is an effective way to make the water safe to drink as it forms the sterilising agent HClO which in turn dissociates in water into another sterilising agent, ClO^- (aq)

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