

# Chapter 7: Redox reactions

## Homework questions

- 1 When chlorine is bubbled into sodium hydroxide solution the following reaction takes place:
- $$2\text{NaOH}(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow \text{NaCl}(\text{aq}) + \text{NaOCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- a
- Explain why this is a redox reaction. [3]
  - Give the ionic equation for the reaction. [1]
  - What volume of  $0.1 \text{ mol dm}^{-3}$  sodium hydroxide solution will react exactly with  $1800 \text{ cm}^3$  of chlorine gas at room temperature and pressure? [3]
- b When sodium chloride solution is electrolysed following reaction takes place:
- $$2\text{H}_2\text{O}(\text{l}) + 2\text{NaCl}(\text{aq}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{Cl}_2(\text{g}) + \text{H}_2(\text{g})$$
- Give the electrode half-equation for the formation of hydrogen at the negative electrode. [1]
  - Give the electrode half-equation for the formation of chlorine at the positive electrode. [1]
  - Which of the above reactions involves oxidation? Explain your answer. [1]
  - If  $200 \text{ cm}^3$  of  $6 \text{ mol dm}^{-3}$  sodium chloride solution is completely electrolysed, what volume of hydrogen would be produced at room temperature and pressure? [3]
  - What volume of chlorine will also be produced? [1]
  - Explain why this volume of chlorine is not collected. [1]
- c Chlorine forms oxy-anions. Some of their reactions are given below. Complete these equations and explain why both reactions are examples of disproportionation reactions by explaining the oxidation number changes that take place.
- A  $\text{ClO}^- \rightarrow \text{ClO}_3^- + \text{Cl}^-$
- B  $\text{ClO}_3^- \rightarrow \text{ClO}_4^- + \text{Cl}^-$  [4]
- Total = 19

- 2 In a blast furnace for extracting iron from iron ore, several reactions take place. Two of these reactions are shown below.
- $$\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$$
- $$\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightarrow 2\text{CO}(\text{g})$$
- a What are the oxidation states of carbon in carbon, carbon dioxide and carbon monoxide? [3]
- b The next step in the reaction is represented by the following empirical equation:
- $$\text{CO}(\text{g}) + \text{Fe}_2\text{O}_3(\text{s}) \rightarrow \text{CO}_2(\text{g}) + \text{Fe}(\text{s})$$
- Write out the complete **balanced** equation. [1]
- c Iron is a transition element and because of this can exist in different oxidation states. Write down the oxidation state of iron in each of the following compounds:
- $\text{Fe}_2\text{O}_3$  [1]
  - $\text{FeCl}_2$  [1]
  - $\text{Na}_2\text{FeO}_4$  [1]
- d The  $\text{FeO}_4^{2-}$  ion is very reactive and in acid solution it readily forms the  $\text{Fe}^{3+}$  ion. Copy and complete the equation:
- $$\text{FeO}_4^{2-}(\text{aq}) + \text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{3+}(\text{aq}) + 4 \underline{\hspace{1cm}}$$
- [2]
- e In the presence of the  $\text{FeO}_4^{2-}$  ion ammonia is converted to nitrogen gas. Copy and complete the equation:
- $$\underline{\hspace{1cm}}\text{NH}_3(\text{g}) \rightarrow \underline{\hspace{1cm}}\text{N}_2(\text{g}) + \underline{\hspace{1cm}}\text{H}^+(\text{aq}) + \underline{\hspace{1cm}}\text{e}^-$$
- [2]
- f Using your answers to **d** and **e**, complete the full equation for the reaction between the  $\text{FeO}_4^{2-}$  ion and ammonia. [3]
- Total = 14

- 3 The element sulfur exists in several oxidation states.
- a Give the oxidation state of sulfur in the following substances:
- i H<sub>2</sub>S
  - ii S
  - iii SO<sub>2</sub>
  - iv S<sub>2</sub>Cl<sub>2</sub>
  - v H<sub>2</sub>SO<sub>4</sub> [5]
- b When hydrogen sulfide and sulfur dioxide react, sulfur is formed. Write a balanced equation for this reaction and explain why it is a redox reaction. [4]
- c When magnesium is added to sulfuric acid the following reaction takes place:  
 $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
- i Give **two** reasons for stating that magnesium is oxidised in this reaction. [2]
  - ii A student was provided with 20 cm<sup>3</sup> of 0.1 mol dm<sup>-3</sup> sulfuric acid and some magnesium ribbon. Calculate the mass of magnesium ribbon required to exactly react with this quantity of sulfuric acid. (Note: the student has a top-pan balance that reads to the nearest 1 mg.) [3]
- d The compound SOCl<sub>2</sub> is very useful in organic chemistry as a reagent to introduce chlorine atoms into molecules containing the –OH group.
- i Draw a dot-and-cross diagram to show the bonding in this compound. Show outer electrons only. [3]
  - ii What is the oxidation state of sulfur in this compound? Show your working. [2]
  - iii Draw the molecule and give the bond angle. [2]
  - iv When this compound is added to water, sulfur dioxide is one of the products. Write the balanced symbol equation for the reaction. [2]

Total = 23