

## CHAPTER 7 REDOX REACTIONS

- 1 (a) In terms of electron transfer, what does the reducing agent do in a redox reaction?

.....  
(1 mark)

- (b) What is the oxidation state of an atom in an uncombined element?

.....  
(1 mark)

- (c) Deduce the oxidation state of nitrogen in each of the following compounds.

(i)  $\text{NCl}_3$  .....

(ii)  $\text{Mg}_3\text{N}_2$  .....

(iii)  $\text{NH}_2\text{OH}$  .....  
(3 marks)

- (d) Lead(IV) oxide,  $\text{PbO}_2$ , reacts with concentrated hydrochloric acid to produce chlorine, lead(II) ions,  $\text{Pb}^{2+}$ , and water.

(i) Write a half-equation for the formation of  $\text{Pb}^{2+}$  and water from  $\text{PbO}_2$  in the presence of  $\text{H}^+$  ions.

.....

(ii) Write a half-equation for the formation of chlorine from chloride ions.

.....

(iii) Hence deduce an equation for the reaction which occurs when concentrated hydrochloric acid is added to lead(IV) oxide,  $\text{PbO}_2$

.....  
(3 marks)

2 Chlorine and bromine are both oxidising agents.

(a) Define an *oxidising agent* in terms of electrons.

.....  
(1 mark)

(b) In aqueous solution, bromine oxidises sulphur dioxide,  $\text{SO}_2$ , to sulphate ions,  $\text{SO}_4^{2-}$

(i) Deduce the oxidation state of sulphur in  $\text{SO}_2$  and in  $\text{SO}_4^{2-}$

$\text{SO}_2$  .....

$\text{SO}_4^{2-}$  .....

(ii) Deduce a half-equation for the reduction of bromine in aqueous solution.

.....

(iii) Deduce a half-equation for the oxidation of  $\text{SO}_2$  in aqueous solution forming  $\text{SO}_4^{2-}$  and  $\text{H}^+$  ions.

.....

(iv) Use these two half-equations to construct an overall equation for the reaction between aqueous bromine and sulphur dioxide.

.....

(5 marks)

3 (a) By referring to electrons, explain the meaning of the term *oxidising agent*.

.....  
(1 mark)

(b) For the element **X** in the ionic compound **MX**, explain the meaning of the term *oxidation state*.

.....  
(1 mark)

(c) Complete the table below by deducing the oxidation state of each of the stated elements in the given ion or compound.

	Oxidation state
Carbon in $\text{CO}_3^{2-}$	
Phosphorus in $\text{PCl}_4^+$	
Nitrogen in $\text{Mg}_3\text{N}_2$	

(3 marks)

(d) In acidified aqueous solution, nitrate ions,  $\text{NO}_3^-$ , react with copper metal forming nitrogen monoxide,  $\text{NO}$ , and copper(II) ions.

(i) Write a half-equation for the oxidation of copper to copper(II) ions.

.....

(ii) Write a half-equation for the reduction, in an acidified solution, of nitrate ions to nitrogen monoxide.

.....

(iii) Write an overall equation for this reaction.

.....

(3 marks)

4 Nitrogen monoxide,  $\text{NO}$ , is formed when silver metal reduces nitrate ions,  $\text{NO}_3^-$ , in acid solution.

(a) Deduce the oxidation state of nitrogen in  $\text{NO}$  and in  $\text{NO}_3^-$

$\text{NO}$  .....

$\text{NO}_3^-$  .....

(b) Write a half-equation for the reduction of  $\text{NO}_3^-$  ions in acid solution to form nitrogen monoxide and water.

.....

(c) Write a half-equation for the oxidation of silver metal to  $\text{Ag}^+(\text{aq})$  ions.

.....

(d) Hence, deduce an overall equation for the reaction between silver metal and nitrate ions in acid solution.

.....

5 Iodine reacts with concentrated nitric acid to produce nitrogen dioxide (NO<sub>2</sub>).

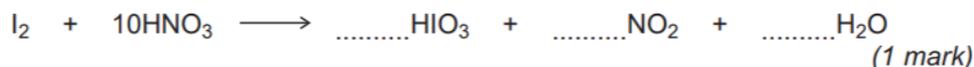
(a) (i) Give the oxidation state of iodine in each of the following.

I<sub>2</sub> .....

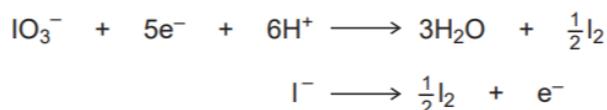
HIO<sub>3</sub> .....

(2 marks)

(ii) Complete the balancing of the following equation.



(b) In industry, iodine is produced from the NaIO<sub>3</sub> that remains after sodium nitrate has been crystallised from the mineral Chile saltpetre. The final stage involves the reaction between NaIO<sub>3</sub> and NaI in acidic solution. Half-equations for the redox processes are given below.



Use these half-equations to deduce an overall ionic equation for the production of iodine by this process. Identify the oxidising agent.

Overall ionic equation

The oxidising agent .....

(2 marks)

(c) When concentrated sulfuric acid is added to potassium iodide, solid sulfur and a black solid are formed.

(i) Identify the black solid.

.....

(1 mark)

(ii) Deduce the half-equation for the formation of sulfur from concentrated sulfuric acid.

.....

(1 mark)

- (d) When iodide ions react with concentrated sulfuric acid in a different redox reaction, the oxidation state of sulfur changes from +6 to -2. The reduction product of this reaction is a poisonous gas that has an unpleasant smell. Identify this gas.

.....  
(1 mark)

- (e) A yellow precipitate is formed when silver nitrate solution, acidified with dilute nitric acid, is added to an aqueous solution containing iodide ions.

- (i) Write the **simplest ionic** equation for the formation of the yellow precipitate.

.....  
(1 mark)

- (ii) State what is observed when concentrated ammonia solution is added to this precipitate.

.....  
.....  
(1 mark)

- (iii) State why the silver nitrate is acidified when testing for iodide ions.

.....  
.....  
(1 mark)

- (f) Consider the following reaction in which iodide ions behave as reducing agents.



- (i) In terms of electrons, state the meaning of the term *reducing agent*.

.....  
.....  
(1 mark)

- (ii) Write a half-equation for the conversion of chlorine into chloride ions.

.....  
(1 mark)

**(iii)** Explain why iodide ions react differently from chloride ions.

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*(2 marks)*