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# TOPIC 6.2: REDOX REACTION



## **CHAPTER ANALYSIS**





- Relatively straight forward chapter ٠
- Closely linked to chapters like Metals (Displacement ٠ reactions) & Periodic Table & Acid Bases



• Usually tested in MCQs Tested as add-on to other chapters Chemical Equations



• Constitute to **2.5%** of marks for past 5 year papers



### KEY CONCEPT

## REDOX REACTION OXIDATION REDUCTION IONIC HALF EQUATIONS



# REDOXREACTION

In fact, the best way to identify if a substance had undergone oxidation or reduction is to check its **oxidation state**.

Gaining of oxygen, loss of hydrogen, loss of electrons will lead to the increase in oxidation state. Hence, they can be considered a subset of increase in oxidation state.

Similarly, losing oxygen, gain in hydrogen, gain in electrons will lead to the decrease in oxidation state. Once again, they can be considered a subset of decrease in oxidation state.

Hence, by **identifying the change in oxidation state is the most accurate way of deducing whether the substance had undergone oxidation or reduction.** 



### **REDOX REACTION**

A redox reaction refers to the chemical reaction where one substance undergoes reduction, while another substance undergoes oxidation. Both processes always occur together.

### Oxidation happens when:

- Gaining of oxygen
- Loss of hydrogen
- Loss of electrons
- Increase in oxidation state

### Reduction happens when:

- Loss of oxygen
- Gaining of hydrogen
- Gaining of electrons
- Decrease in oxidation state



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### **IONIC HALF-EQUATIONS**

<u>Steps:</u>

1) Write out the balanced chemical equation for the reaction.

Mg (s) + CuSO<sub>4</sub> (aq)  $\rightarrow$  MgSO<sub>4</sub> (aq) + Cu (s)

2) Convert the chemical equation to its ionic equation.

Mg (s) + Cu<sup>2+</sup> (aq)  $\rightarrow$  Mg<sup>2+</sup> (aq) + Cu (s)

3) Identify the substance that undergoes oxidation and reduction respectively.

Oxidation: Mg (s)  $\rightarrow$  Mg<sup>2+</sup> (aq) Reduction: Cu<sup>2+</sup> (aq)  $\rightarrow$  Cu (s)

4) Balance the number of charges on both sides of each halfequation using electrons.

> Oxidation: Mg (s)  $\rightarrow$  Mg<sup>2+</sup> (aq) + 2e<sup>-</sup> Reduction: Cu<sup>2+</sup> (aq) + 2e<sup>-</sup>  $\rightarrow$  Cu (s)

# OXIDISING & REDUCING AGENTS



### **OXIDISING AGENTS**

An **oxidising agent** refers to a reagent that **causes another substance to be oxidised**.

An oxidising agent itself would undergo reduction instead.

**1) Acidified potassium manganate (VII), KMnO<sub>4</sub>** is an **oxidizing agent.** Hence, it will undergo reduction in the reaction.

 $MnO_{4^{-}}(aq) + 8 H^{+}(aq) + 5e^{-} \rightarrow Mn^{2+}(aq) + 4 H_{2}O(l)$ 

The **oxidation state** of manganese **decreases** from **+7** in the manganite (VII) ion to **+2** in the manganese (II) ion.

The colour of the solution will turn from **purple to colourless.** 

**2) Acidified potassium dichromate (VI), K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> is an <b>oxidizing agent**. Hence, it will undergo reduction in the reaction.

 $Cr_2O_7^{2-}$  (aq) + 14 H<sup>+</sup> (aq) + 6e<sup>-</sup>  $\rightarrow$  2 Cr<sup>3+</sup> (aq) + 7 H<sub>2</sub>O (l)

The **oxidation state** of chromium **decreases** from **+6** in the dichromate (VI) ion to **+3** in the chromium (III) ion.

The colour of potassium dichromate (VI) solution will turn from **orange to green**.

\*The job of an oxidising agent is to oxidise another substance.

In the process, the agent itself would undergo reduction.

The best way to check if a substance is an oxidising agent is to check whether the substance has undergone reduction.

## OXIDISING AGENTS



\*The job of an reducing agent is to reduce another substance.

In the process, the agent itself undergoes oxidation.

The best way to check if a substance is an reducing agent is to check whether the substance has undergone oxidation.

### **REDUCING AGENT**

A reducing agent refers to a reagent that causes another substance to be reduced.

A reducing agent itself would undergo oxidation instead.

1) Potassium iodide, KI is an **reducing agent**. It will undergo oxidation in the reaction.

 $2l^{-}(aq) \rightarrow l_{2}(aq) + 2e^{-}$ 

The **oxidation state** of iodine has **increased** from **-1** in iodide to **0** in iodine.

The colour of the solution will turn from **colourless to brown**.

## REDUCING AGENTS

## Try it yourself! (TYS Question)

13. In which reaction is substance X reduced?

(N2019/P1/Q19)

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- A Acidified potassium manganate(VII) is decolourised on addition to an aqueous solution of X.
- **B** Adding aqueous potassium iodide to an aqueous solution of X gives a brown colour.

$$C \quad X \rightarrow X^{2+} + 2e^{-}$$

$$\mathbb{D} \quad \mathrm{XO}^{-} + \mathrm{O}_{2} \rightarrow \mathrm{XO}_{3}^{-}$$

**Answer:** 

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13. **B** 

KI has been oxidised to produce  $I_2$  which is brown in colour. In order for a redox reaction to occur, X must be an oxidising agent which has been reduced in the reaction by KI.

## Try it yourself! (TYS Question)

- Colour changes are often observed when redox reactions occur.
  Which colour change is due to the reduction of the named reagent? (N2020/P1/Q18)
  - A Black solid copper(II) oxide changes to blue aqueous copper(II) sulfate.
  - B Colourless aqueous potassium iodide changes to become a brown solution.
  - C Green aqueous iron(II) chloride changes to yellow/brown aqueous iron(III) chloride.
  - D Purple acidified potassium manganate(VII) changes to become colourless.

### **Answer:**

### 14. **D**

The change in colour of potassium manganate(VII) is due to the reduction of the manganate(VII) ion to manganese(II) ion.



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