A-LEVEL CHEMISTRY • EXERCISE SHEET

6.1 Redox processes: electron transfer and oxidation number

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

Objective

Build the skills to answer exam questions on **redox processes** 氧化还原过程—**oxidation numbers** 氧化数, electron transfer, **disproportionation** 歧化, and **oxidising/reducing agents** 氧化剂/还原剂.

You must be able to:

- calculate oxidation numbers in compounds and ions
- use changes in oxidation number to balance redox equations
- explain redox, oxidation, reduction, disproportionation, and oxidising/reducing agents

1 Worked examples

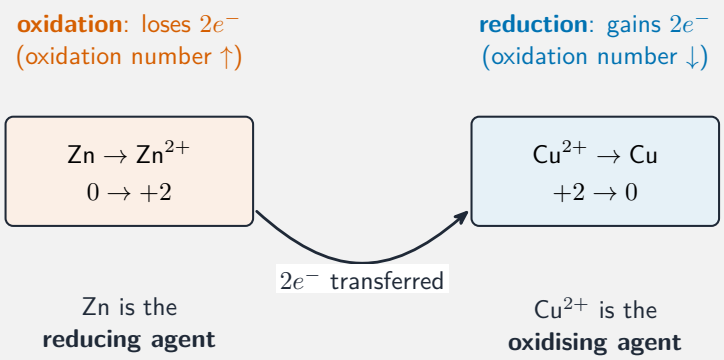
Oxidation number

Rules: element = 0; simple ion = its charge; Group 1 = +1, Group 2 = +2; H = +1 (−1 in hydrides); O = −2 (−1 in peroxides); F = −1; sum to 0 (compound) or the charge (ion).

known	unknown	known
K	Mn	O_4
+1	+7	$4 \times (-2)$

they sum to 0: $(+1) + \text{Mn} + (-8) = 0$, so $\text{Mn} = +7$

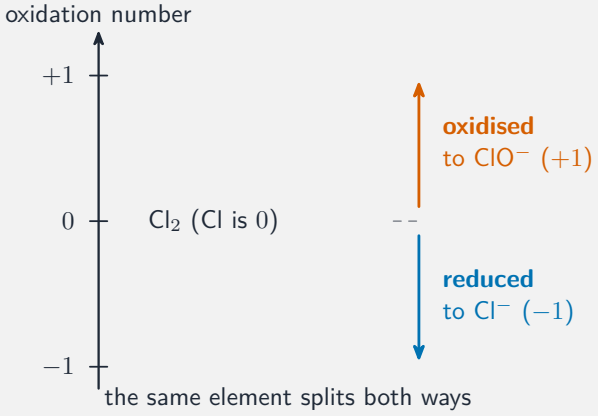
Fix the known atoms, then use "they sum to zero" to find the unknown (Mn = +7)



Oxidation Is Loss, Reduction Is Gain. The reducing agent is oxidised; the oxidising agent is reduced

Oxidation = loss of electrons (number up); **reduction** = gain (number down). An **oxidising agent** takes electrons (is itself reduced); a **reducing agent** gives electrons (is itself oxidised).

Disproportionation



The same element is both oxidised and reduced: Cl (0) → ClO (+1) and Cl (−1)

2 Practice

2.1 Calculate the oxidation number of (a) S in SO_4^{2-} and (b) N in NO_3^-. [2]

2.2 Complete: "Oxidation is the _____ of electrons; the oxidation number goes _____." [2]

3 Exam-style questions

3.1 What is the oxidation number of chromium in $Cr_2O_7^{2-}$? [1]

- **A** +3
- **B** +6
- **C** +7
- **D** +12

3.2 In the reaction $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$, the reducing agent is: [1]

- **A** Zn
- **B** Cu^2
- **C** Zn^2
- **D** Cu

3.3 When chlorine reacts with cold water it forms Cl and ClO .

(a) State the oxidation number of chlorine in Cl_2, in Cl^- and in ClO^-. [3]

(b) Explain why this is a disproportionation reaction. [2]

3.4 In acidic solution, MnO_4^- (Mn = +7 → +2) oxidises Fe^{2+} (→ Fe^3). Use oxidation-number changes to deduce the ratio of MnO_4^- to Fe^{2+}. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **6.1 Redox processes** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/11 N25 —Q9 (oxidation numbers)
- 9701/12 N25 —Q11 (redox)
- 9701/22 N25 —Q1 (redox, structured)

Solutions

2.1 (a) S: $x + 4(-2) = -2 \Rightarrow x = +6$; (b) N: $x + 3(-2) = -1 \Rightarrow x = +5$.

2.2 loss; up.

3.1 B. $2x + 7(-2) = -2 \Rightarrow 2x = 12 \Rightarrow x = +6$.

3.2 A. Zn loses electrons (is oxidised), so it is the reducing agent.

3.3 (a) $Cl_2 = 0$; $Cl^- = -1$; $ClO^- = +1$.
(b) the same element (chlorine) is both oxidised ($0 \rightarrow +1$) and reduced ($0 \rightarrow -1$) in one reaction.

3.4 Mn falls by 5 ($+7 \rightarrow +2$); Fe rises by 1 ($+2 \rightarrow +3$); so 5 Fe^2 are needed per MnO_4^- —ratio 1 : 5.