

4.9 Oxidation-Reduction (Redox) Reactions

Name: _____ Class: _____ Date: _____ **Total: 12 marks****KEY WORDS** oxidation 氧化 • oxidation numbers 氧化数 • reduction 还原 • redox 氧化还原

Objective

Build the skills to answer exam questions on **oxidation-reduction (redox) reactions**.**You must be able to:**

- assign **oxidation numbers** 氧化数
- identify what is **oxidized** (loses electrons) and **reduced** (gains electrons)
- name the **oxidizing** and **reducing agents**

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Oxidation numbers

Assign each atom an oxidation number: free element = 0; a monatomic ion = its charge; O usually -2 ; H usually $+1$; the sum equals the overall charge.

■ OIL RIG

Oxidation Is Loss of electrons; **Reduction Is Gain**. Oxidation raises the oxidation number; reduction lowers it.

■ A worked redox

 $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$: Zn goes $0 \rightarrow +2$ (**oxidized**, loses e^-); Cu goes $+2 \rightarrow 0$ (**reduced**, gains e^-).

■ Agents

The **reducing agent** is the species that is oxidized (it gives electrons away); the **oxidizing agent** is the species that is reduced (it takes electrons). Here Zn is the reducing agent, Cu^{2+} the oxidizing agent.

2 Practice

Now apply the methods above.

2.1 State the oxidation number of an element in its free (uncombined) form. [1]**2.2** Find the oxidation number of S in SO_4^{2-} (O is -2). [2]**2.3** In $\text{Mg} \rightarrow \text{Mg}^{2+} + 2e^-$, is Mg oxidized or reduced? [1]

3 Exam-style questions

3.1 Oxidation is defined as the [1]

- **A** gain of electrons
- **B** loss of electrons
- **C** gain of protons
- **D** loss of protons

3.2 Consider $\text{Fe} + \text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + \text{Cu}$.

(a) State the oxidation number change for Fe and for Cu. [2]

(b) Identify which is oxidized and which is reduced. [2]

3.3 For $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$, identify the oxidizing agent and the reducing agent.[3]

Solutions

2.1 0.

2.2 $S + 4(-2) = -2 \Rightarrow S = +6$.

2.3 Oxidized (loses electrons).

3.1 B — loss of electrons.

3.2 (a) Fe: $0 \rightarrow +2$; Cu: $+2 \rightarrow 0$. (b) Fe is oxidized; Cu^{2+} is reduced.

3.3 Zn is oxidized ($0 \rightarrow +2$), so Zn is the reducing agent; H^+ is reduced ($+1 \rightarrow 0$), so HCl is the oxidizing agent.