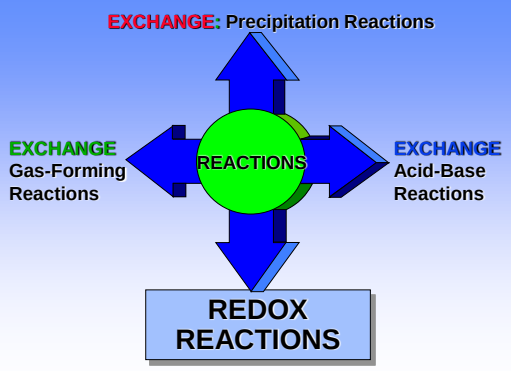
1

Oxidation-Reduction Reactions

Thermite reaction

$Fe_2O_3(s) + 2\ Al(s) \longrightarrow 2\ Fe(s) + Al_2O_3(s)$

2



3

REDOX REACTIONS

Redox reactions are characterized by **ELECTRON TRANSFER** between an electron donor and electron acceptor.

Transfer leads to—

1. **increase in oxidation number** of some element = **OXIDATION**
2. **decrease in oxidation number** of some element = **REDUCTION**

LEO the lion says GER

Where LEO = loss of electrons is oxidation &

Where GER = gain of electrons is reduction

(OIL RIG for boys)

OXIDATION NUMBERS

4

The electric charge an element APPEARS to have when electrons are counted by some arbitrary rules:

1. **Each atom in free element has Oxidation # = 0.**
   Zn O_2 I_2 S_8
2. **In simple ions, oxidation # = charge on ion.**
   -1 for Cl^- +2 for Mg^{2+}

OXIDATION NUMBERS

5

3. **O has oxidation # = -2**

(except in peroxides: in H_2O_2, O = -1)

4. **Oxidation # of H = +1**

(except when H is associated with a metal as in NaH where it is -1)

5. **Algebraic sum of oxidation numbers = 0 for a compound**
   = overall charge for an ion

OXIDATION NUMBERS

6

NH_3	N = 3-
ClO^-	Cl = 1+
H_3PO_4	P = 5+
MnO_4^-	Mn = 7+
$Cr_2O_7^{2-}$	Cr = 6+
C_4H_8	C = 2-

7

Recognizing a Redox Reaction

Corrosion of aluminum

$2\ Al_{(s)} + 3\ Cu^{2+}_{(aq)} \rightarrow 2\ Al^{3+}_{(aq)} + 3\ Cu_{(s)}$

$Al(s) \rightarrow Al^{3+}(aq) + 3\ e^-$

- Oxidation number of Al increases as e^- are donated by the metal.
- Therefore, **Al is OXIDIZED**
- **Al** is the **REDUCING AGENT** in this balanced **half-reaction.**

8

Recognizing a Redox Reaction

Corrosion of aluminum

$2\ Al_{(s)} + 3\ Cu^{2+}_{(aq)} \rightarrow 2\ Al^{3+}_{(aq)} + 3\ Cu_{(s)}$

$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$

- Oxidation number of Cu decreases as e^- are accepted by the ion.
- Therefore, **Cu is REDUCED**
- **Cu^{2+}** is the **OXIDIZING AGENT** in this balanced **half-reaction.**

9

Recognizing a Redox Reaction

Notice that the 2 half-reactions add up to give the overall reaction —if we use 2 mol of Al and 3 mol of Cu^{2+}.

$2\ Al(s) \rightarrow 2\ Al^{3+}(aq) + 6\ e^-$

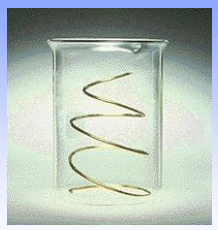
$3\ Cu^{2+}(aq) + 6\ e^- \rightarrow 3\ Cu(s)$

$2\ Al(s) + 3\ Cu^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Cu(s)$

Final equation is balanced for **mass** and **charge**.

10

REDOX REACTIONS



$Cu(s) + 2\ Ag^{+}(aq)$
$---> Cu^{2+}(aq) + 2\ Ag(s)$

In all reactions if something has been oxidized then something has also been reduced

11

Recognizing a Redox Reaction

Reaction Type	Oxidation	Reduction
In terms of oxygen	gain	loss
In terms of halogen	gain	loss
In terms of electrons	loss	gain

12

Identify the element oxidized and the oxidizing agent…

1. Magnesium + hydrochloric acid→ magnesium chloride + hydrogen gas
2. Lead (II) oxide + Carbon monoxide→ lead solid and carbon dioxide
3. Methane + oxygen → carbon dioxide and water

Identify the element oxidized and the oxidizing agent…

13

1. **Magnesium + hydrochloric acid → magnesium chloride + hydrogen gas**

   Mg^0 → Mg^{2+} = element oxidized

   HCl → oxidizing agent

2. **Lead (II) oxide + Carbon monoxide → lead solid and carbon dioxide**

   C^{2+} → C^{4+} = element oxidized

   PbO → oxidizing agent

3. **Methane + oxygen → carbon dioxide and water**

   C^{4-} → C^{4+} = element oxidized

   O_2 → oxidizing agent