Redox Reactions

Oxidation-Reduction Reactions

Oxidation-reduction reactions (REDOX reaction) occur when electrons are transferred from one reactant to another during a chemical reaction. There is a change in oxidation number for both substances

<u>Oxidation State/oxidation number:</u> Theoretical charge on atom

<u>Oxidation</u> is the process where the oxidation number increases.

Electrons are lost from the substance

<u>Reduction</u> is the process where the oxidation number decreases.

Electrons are gained by the substance

Oxidation and reduction always accompany each other;

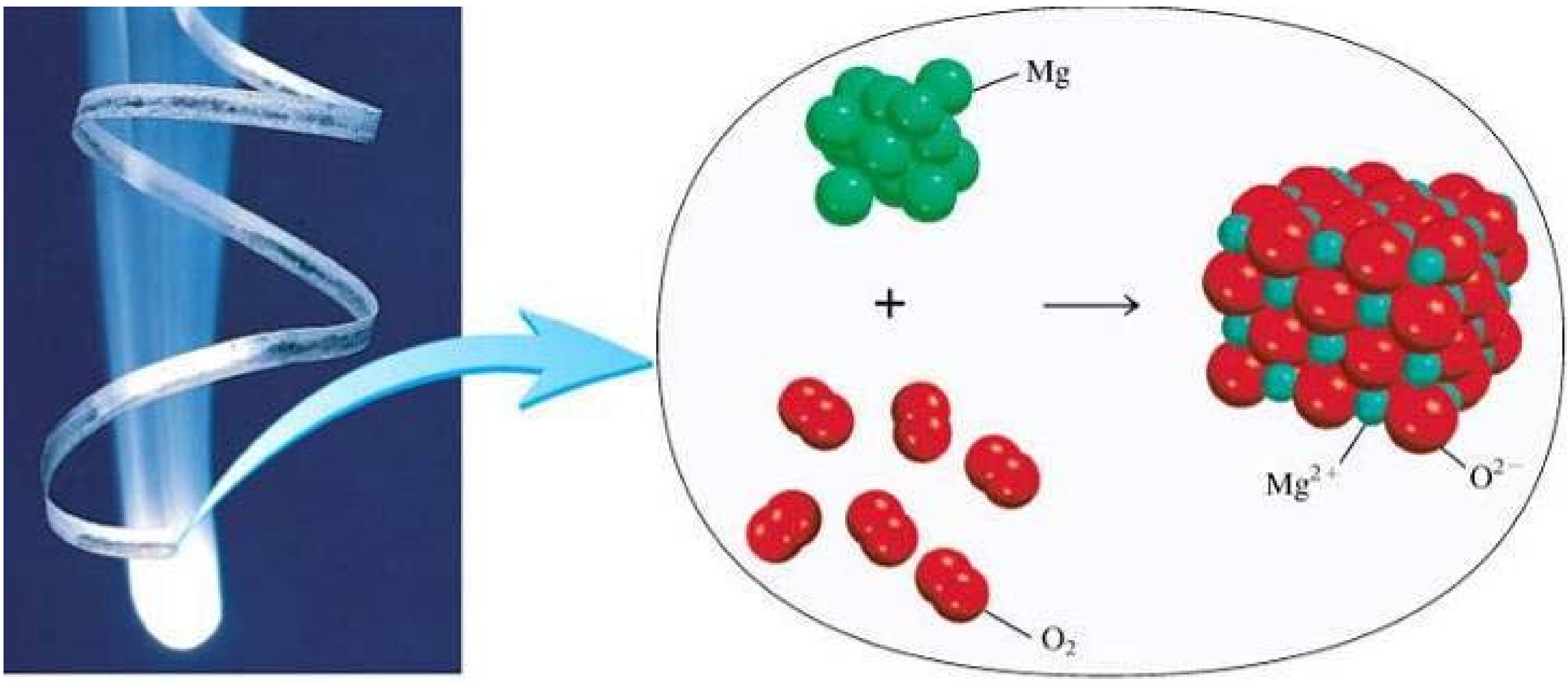
Neither can occur alone

Redox Reaction: Half-reactions

Oxidation half-reaction: $Mg\ (s) \rightarrow Mg^{2+} + 2e^-$

Reduction half-reaction: $1/2O_2(g) + 2e^- \rightarrow O^{2-}$

Sum of half-reactions: $Mg\ (s) + 1/2O_2(g) \rightarrow MgO(s)$



LEO the lion says GER

LEO

Lose
Electrons
Oxidation

GER

Gain
Electrons
Reduction

Oxidation Number Rules

The rule earlier in the list always takes precedence.

1) ON = 0 for a compound or ionic charge for an ion

2) ON = +1 for IA elements and H
   ON = +2 2A elements

3) ON= -2 for oxygen

4) ON= -1 for 7A elements
   If both elements in 7A, then the one higher in the list is -1

5) ON = -2 for 6A elements other than oxygen

6) ON = -3 for 5A elements (very shaky!!!)

Elemental Oxidation Numbers

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 **H** +1 −1																	2 **He**
3 **Li** +1	4 **Be** +2											5 **B** +3	6 **C** +4 +2 −4	7 **N** +5 +4 +3 +2 +1 −3	8 **O** +2 $-\frac{1}{2}$ −1 −2	9 **F** −1	10 **Ne**
11 **Na** +1	12 **Mg** +2											13 **Al** +3	14 **Si** +4 −4	15 **P** +5 +3 −3	16 **S** +6 +4 +2 −2	17 **Cl** +7 +6 +5 +4 +3 +1 −1	18 **Ar**
19 **K** +1	20 **Ca** +2	21 **Sc** +3	22 **Ti** +4 +3 +2	23 **V** +5 +4 +3 +2	24 **Cr** +6 +5 +4 +3 +2	25 **Mn** +7 +6 +4 +3 +2	26 **Fe** +3 +2	27 **Co** +3 +2	28 **Ni** +2	29 **Cu** +2 +1	30 **Zn** +2	31 **Ga** +3	32 **Ge** +4 −4	33 **As** +5 +3 −3	34 **Se** +6 +4 −2	35 **Br** +5 +3 +1 −1	36 **Kr** +4 +2
37 **Rb** +1	38 **Sr** +2	39 **Y** +3	40 **Zr** +4	41 **Nb** +5 +4	42 **Mo** +6 +4 +3	43 **Tc** +7 +6 +4	44 **Ru** +8 +6 +4 +3	45 **Rh** +4 +3 +2	46 **Pd** +4 +2	47 **Ag** +1	48 **Cd** +2	49 **In** +3	50 **Sn** +4 +2	51 **Sb** +5 +3 −3	52 **Te** +6 +4 −2	53 **I** +7 +5 +1 −1	54 **Xe** +6 +4 +2
55 **Cs** +1	56 **Ba** +2	57 **La** +3	72 **Hf** +4	73 **Ta** +5	74 **W** +6 +4	75 **Re** +7 +6 +4	76 **Os** +8 +4	77 **Ir** +4 +3	78 **Pt** +4 +2	79 **Au** +3 +1	80 **Hg** +2 +1	81 **Tl** +3 +1	82 **Pb** +4 +2	83 **Bi** +5 +3	84 **Po** +2	85 **At** −1	86 **Rn**

Determining Oxidation Numbers

Determine the oxidation number of each element in:

NH_3	H has ON = +1	N has ON = -3
CO_3^{2-}	0 has ON = -2	C has ON = +4
$H_2 0_2$	H has ON = +1	0 has ON = -1
NH_4^+	H has ON = +1	N has ON = -3
NO_3^-	0 has ON = -2	N has ON = +5

If composed of polyatomic ions, break down the compound into ions before determining the oxidation state of each element.

NH_4NO_3

N in NH_4^+ has ON = -3 N in NO_3^- has ON=+5

Oxidizing and Reducing Agents

Oxidizing agent: reactant that promotes oxidation

Electrons are gained so oxidizing agent is reduced.

Characteristic of nonmetals: ex: fluorine, oxygen.

High electron affinity: easily gains electrons

Within a group, ion with highest ON is better oxidizing agent.

Reducing agent: reactant that promotes reduction

Electrons are lost, so reducing agent is oxidized

Characteristic of an active metal, such as sodium.

Low ionization energy: easily loses electrons

Within a group, ion with lowest ON is better reducing agent.

Redox Titration

Determine the molarity of a potassium permanganate solution if 25.32 mLs are needed to react completely with 0.724 g $Na_2C_2O_4$ (s).

$2KMnO_4 + 5Na_2C_2O_4 + 8H_2SO_4 \rightarrow 10CO_2 + 8H_2O + 2MnSO_4 + 5Na_2SO_4 + K_2SO_4$

First determine amount in moles of $KMnO_4$.

$$0.724g_{Na_2C_2O_4} x \frac{1mol_{Na_2C_2O_4}}{134g_{Na_2C_2O_4}} x \frac{2mol_{KMnO_4}}{5mol_{Na_2C_2O_4}} = 2.16x10^{-3} mol_{KMnO_4}$$

g $Na_2C_2O_4$ > mol Na_2C_2O > mol $KMnO_4$

Determine concentration (Molarity!) of $KMnO_4$

$$\frac{2.16x10^{-3} mol_{KMnO_4}}{25.32mL_{KMnO_4}} X \frac{1000ml_{KMnO_4}}{1L_{KMnO_4}} = 0.854M_{KMnO_4}$$