Oxidation-Reduction Reactions

Oxidation-Reduction Rxns

Also known as 'redox' reactions.

These reactions always occur as a pair where electrons are transferred from one atom to another.

"**L**oss of **e**lectrons is **o**xidation, **g**ain of **e**lectrons is **r**eduction"

LEO the lion says GER

OILRIG

Consider the single displacement reaction:
$Zn(s) + CuSO_4(aq) \dashrightarrow Cu(s) + ZnSO_4(aq)$

Write the total ionic equation:
$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \dashrightarrow Zn^{2+}(aq) + Cu(s) + SO_4^{2-}(aq)$
Excluding the spectator ion:

Cu^{2+} has accepted electrons. Cu^{2+} is an oxidizing agent.

Zn has donated electrons. Zn is a reducing agent.

Example #1

Identify the atoms being oxidized or reduced.

a) $Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$

Ag Gained, reduced

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

Cu Lost, oxidized

c) $2\ Na + Cl_2 \rightarrow 2\ NaCl$

Na Lost, oxidized; Cl gained, reduced

Redox Reactions

These reactions may also be interpreted as one reactant causing a change in the other reactant.

oxidizing agent – the reactant which caused the other to be oxidized (this reactant is reduced)

reducing agent – the reactant which caused the other to be reduced (this reactant is oxidized)

Example #2

For the following reactions:

i. Which element is oxidized? reduced?
ii. Identify the oxidizing agent. Reducing agent.

a) $2\ Ca + O_2 \rightarrow 2\ CaO$

b) $2\ Mg + Br_2 \rightarrow 2\ MgBr$

OXIDATION NUMBERS

Oxidation Numbers

Oxidation numbers are used to keep track of electrons during reactions.

It is an arbitrary system based on:

a) ions charge of an atom
b) electronegativity

For any neutral compound, the oxidation numbers of the atoms must add up to zero.

Atom or Ion	Oxidation Number	Examples
compounds containing a single type of atom	0	Na Cl_2
H in most compounds	+1	HCl
H in a hydride	-1	LiH
O in most compounds	-2	H_2O
O in a peroxide	-1	H_2O_2
monatomic ions	charge of ion	$Na^+ = +1$ $S^{2-} = -2$

Oxidation Numbers

General steps to assign oxidation numbers:

1) Assign common oxidation numbers.
   - use your periodic table!!

2) The total oxidation number of a molecule or an ion is the value of the charge of the molecule or ion.

3) Unknown oxidation numbers can be assigned algebraically.

Example #3

Determine the oxidation numbers for:

a) MoS_2 S: 2−, Mo: 4+

b) H_2O O: 2−, H: 1+

c) ClO_2^- O: 2−, Cl: 3+

Example #3

d) SO_3^{2-} O: 2−, S: 4+

e) N_2O_4 O: 2−, N: 4+

f) H_2O_2 O: 1−, H: 1+

Determine the oxidation number of each element in each of the following species.

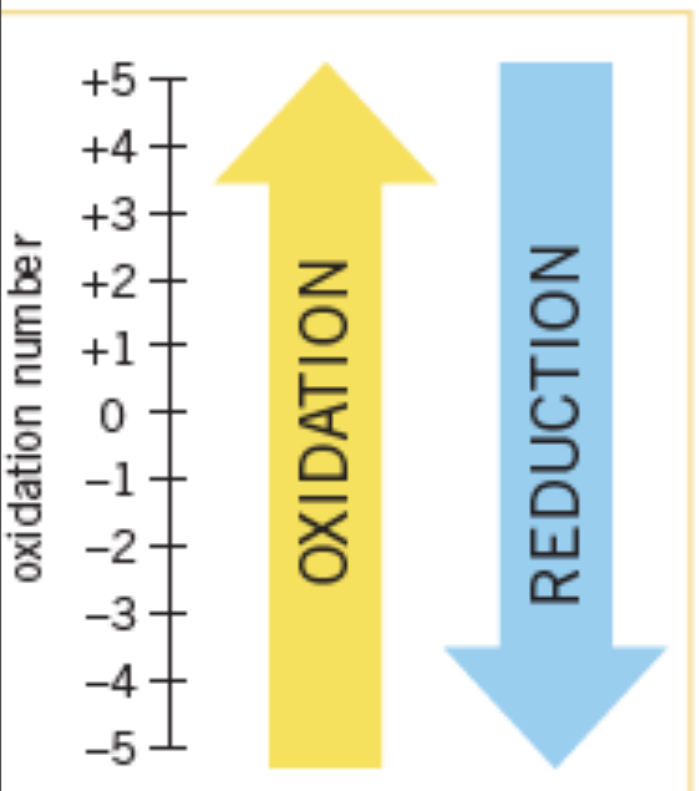
a MgO **b** H_2O **c** HPO_4^- **d** C_2H_4

e N_2O_4 **f** $KMnO_4$

Determine the oxidation number of the metal in each of the following metal oxides and hence write the name of the compound using Roman numerals to show the oxidation number of the metal.

a CuO **b** Cu_2O **c** MnO_2 **d** V_2O_5

Oxidation Numbers



In a redox reaction, the oxidation numbers of atoms are expected to change.

Oxidation is an increase in oxidation number.

Reduction is a decrease in oxidation number.

Example #4

For the following reaction:

i. identify the substance oxidized / reduced
ii. oxidizing / reducing agents

$$2\ KCl + MnO_2 + 2\ H_2SO_4 \rightarrow$$

$$K_2SO_4 + MnSO_4 + Cl_2 + H_2O$$

HALF-REACTIONS

Half-Reactions

All redox reactions may be divided into half-reactions. One half represents the oxidation, while the other is the reduction. (handout)

Half-reactions are always written for a single mole of a substance.

Example #5

a) Will iodine be able to oxidize zinc metal to Zn^{2+} ions?

b) Name an oxidizing agent that can oxidize Br^- to Br_2, but cannot oxidize Cl^- to Cl_2.