

Oxidation-Reduction Reactions

- Reactions that involve the transfer of electrons are called **oxidation-reduction** or **redox** reactions
- Oxidation is the loss of electrons by a reactant
- Reduction is the gain of electrons by a reactant

- Oxidation and reduction always occur together
- The total number of electrons lost by one substance is the same as the total number of electrons gained by the other
- For a redox reaction to occur, something must accept the electrons that are lost by another substance
- The substance that accepts the electrons is called the **oxidizing agent**

- The substance that lost the electrons is called the **reduction agent**
- Note that the *oxidizing agent* is **reduced** and the *reducing agent* is **oxidized**
- For example:
 $2 \text{Na} + \text{Cl}_2 \rightarrow 2 \text{NaCl}$
 - Na is the *reducing agent* because it lost electrons and was *oxidized*
 - Cl_2 is the *oxidizing agent* because it gained electrons and was *reduced*

• Oxidation numbers RULES

- 1) The oxidation number of alkali metals is always +1.
- 2) The oxidation number of alkaline earth metal is always +2
- 3) The oxidation number of any free element is zero.
- 4) The oxidation number of any simple, monoatomic ion is equal to the charge on the ion.
- 5) The sum of all oxidation numbers of the atoms in a molecule or polyatomic ion must equal the charge on the particle.
- 6) In its compounds, fluorine has an oxidation number of -1.
- 7) In its compounds, hydrogen has an oxidation number of +1.
- 8) In its compounds, oxygen has an oxidation number of -2.

- If there is a conflict between two rules *apply the rule with the lower number and ignore the conflicting rule*
 - In binary ionic compounds with metals, the nonmetals have oxidation numbers equal to the charges on their anions
- Example: What is the oxidation number of Fe in Fe_2O_3 ?

ANALYSIS: This binary compound is ionic.
Apply rule 3 and 6

Fe: $2x$

O: $3(-2) = -6$

$0 = 2x + (-6)$ or $x = +3 = \text{ox. number of Fe}$

- Note that fractional values of oxidation numbers are allowed
- In terms of oxidation numbers:
 - Oxidation is an *increase* in oxidation number
 - Reduction is a *decrease* in oxidation number
- This provides a simple way to follow redox reactions