Oxidation-Reduction (Redox) Reactions

L A reaction in which one species transfers electrons to another is an ***oxidation-reduction reaction***, also called a ***redox reaction***.

$$2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s) \;/\; 2[Fe^{3+}][Cl^-]_3$$

$2(Fe^0 \rightarrow Fe^{3+} + 3e^-)$ Fe^0 "pushes" *e*'s L oxidation
$3(Cl_2 + 2e^- \rightarrow 2Cl^-)$ Cl_2 "pulls" *e*'s L reduction

T Oxidation is the ***loss*** of electrons by a substance.
T Reduction is the ***gain*** of electrons by a substance.

K ***There is never an oxidation without a reduction, and vice versa!***

Oxidizing Agents and Reducing Agents

T An ***oxidizing agent*** (or ***oxidant***) is a substance that causes another substance to be oxidized and is itself reduced.

T A ***reducing agent*** (or ***reductant***) is a substance that causes another substance to be reduced and is itself oxidized.

L In these terms, all redox reactions take on the general form

$$Ox_1 + Red_2 \rightarrow Red_1 + Ox_2$$

Rules for Assigning Oxidation Numbers

L ***Oxidation numbers*** are real or hypothetical charges on atoms, assigned by the following rules:

1. Atoms in elements are assigned 0.

2. All simple monatomic ions have oxidation numbers equal to their charges. (e.g., all Group IA ions are +1; all group IIA ions are +2; all the following ions have oxidation numbers given by their charges - Fe^{2+}, Al^{3+}, S^{2-}, N^{3-})

3. Fluorine is always -1 in its compounds.

4. Halogens are usually -1, except when a central atom or when combined with a more electronegative element (e.g., assign I as -1 in NI_3, but +3 in ICl_3).

5. Oxygen is -2 in most of its compounds, except in cases like peroxides (H_2O_2, Na_2O_2) where it is -1.

6. Hydrogen is usually +1, except in hydrides with electropositive elements, particularly with metal cations, where it is -1 (e.g., NaH, CaH_2, BH_4^-).

7. The sum of all oxidation numbers for a neutral compound is zero; the sum is the charge on the species for a complex ion.

Oxidation-Reduction and Oxidation Numbers

P When a species is oxidized, one of its atoms goes to a higher (more positive or less negative) oxidation number.

P When a species is reduced, one of its atoms goes to a lower (less positive or more negative) oxidation number.