OXIDATION AND REDUCTION

Oxidation is (with examples):

- a loss of electrons (OIL)
  $Na\cdot \rightarrow Na^{+} + e^{-}$
- a more positive oxidation number
  $\underset{ox\# = 0}{Na\cdot} \rightarrow \underset{ox\# = +1}{Na^{+}} + e^{-}$
- a loss of hydrogen atoms (see carbon or oxygen)
  $CH_3\text{-}CH_3 \rightarrow CH_2{=}CH_2$
  $2H_2O \rightarrow 2H_2 + O_2$
- the addition of oxygen atoms (see oxygen)
  $2H_2 + O_2 \rightarrow 2H_2O$
- more bonds to oxygen (see carbon)
  $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$

Reduction is (with examples):

- a gain of electrons (RIG)
  $:\ddot{C}l: + e^{-} \rightarrow :\ddot{C}l:^{-}$
- a less positive oxidation number (*more negative*)
  $\underset{ox\# = 0}{:\ddot{C}l:} + e^{-} \rightarrow \underset{ox\# = -1}{:\ddot{C}l:^{-}}$
- a gain of hydrogen atoms (see carbon)
  $CO_2 + 2H_2O \rightarrow CH_4 + O_2$
- the loss of oxygen atoms (see carbon)
  $CO_2 + 2H_2O \rightarrow CH_4 + O_2$
- the loss of bonds to oxygen (see carbon)
  $CO_2 + 2H_2O \rightarrow CH_4 + O_2$

HOW TO DETERMINE OXIDATION NUMBERS

The determination of the oxidation number (or oxidation state) of chemical compounds can be made by following a few simple rules.

1. The oxidation numbers of an atom (an element, e.g., Fe) or the atoms in a neutral molecule must add up to zero.
2. If an atom (Cl^-) or molecule is ionic its oxidation number must add up to its overall charge. $Cl^- = -1$
3. Alkali metal atoms (Group I) have an oxidation number equal to +1 within compounds. Alkali earth atoms (Group II) have an oxidation number of +2 within compounds.
4. All halogens in compounds have a -1 oxidation number.
5. Hydrogen is always assigned a +1 oxidation number in compounds.
6. Oxygen is assigned an oxidation number of -2 in compounds.

Examples:

What is the oxidation numbers for all the atoms in CH_3OH

A) Using *Rules 5 and 6* hydrogen is +1 and oxygen is -2.

B) Using *Rule 1* : 4H = +4 and 1O=-2; therefore C must be -2 because all the oxidation numbers must add to zero:

4H + 1O + 1C

(+4) + (-2) + (-2) = 0

Oxidation numbers for carbon atoms can also be determined as follows:

(a) **Carbon oxidation numbers: each C-C = 0, C-H = -1 and each C-O = +1**
(b) **Add them up to determine the oxidation number of the carbon atom.**

What are the oxidation numbers for the carbons in the following compounds?

$$\begin{array}{c} CH_3 \\ | \\ CH_3\text{-}C\text{-}OH \\ | \\ CH_3 \end{array} \qquad \begin{array}{c} CH_3\text{-}C{=}O \\ | \\ H \end{array} \qquad \begin{array}{c} O \\ \| \\ CH_3\text{-}C\text{-}OH \end{array}$$

Try these:

	CH_4	CO_2	CH_3OH
carbon is:	**-4**	**+4**	**-2**