Chem 151 Drilling Question Set #4
Assigning Oxidation Numbers and Identifying Redox Reactions/Reagents

Oxidation Number is a bookkeeping number of the electrons gained or lost of an atom when this atom bonds with other atoms in a molecule/ion. We assume the more electronegative atom gains electrons (and has negative oxidation number) while the more electropositive atom loses electrons (and has positive oxidation number). Hence, the oxidation number of an atom is affected by other atoms in the molecule/ion. Follow the following steps to assign oxidation numbers.

How to Assign Oxidation Numbers

1. **The oxidation number of any free element is zero. The oxidation number of a monoatomic ion is the same as its charge.**
2. **The oxidation number of the more electronegative atom in a molecule is negative, and the oxidation number of the more electropositive atom is positive.**
3. **The algebraic sum of the oxidation numbers of all atoms equals zero for an electrically neutral molecule. For an ionic species, the sum equals the overall charge.**
4. **Without exception, the oxidation number of an alkali metal (Li, Na, K, ··· etc.) <u>in a compound</u> is always +1; of the alkaline earth metals (Be, Mg, Ca,··· etc.) is always +2; of fluorine is always −1.**
5. **The oxidation number of hydrogen is +1 in most compounds but is -1 in metal hydrides (because hydrogen is more electronegative than the metals but less electronegative than most nonmetals).**
6. **The oxidation number of oxygen is -2 in most compounds but is -1 in peroxides and -½ in superoxides. Only Group I and Group II elements form peroxides or superoxides. Therefore, when the oxygen atom is not bound to Group IA or IIA elements, its oxidation number is most likely -2.**
7. **The polyatomic ions can also be used as references to determine the oxidation number of other elements in the molecule. Therefore, knowing the charges of common polyatomic cations and anions is helpful.**

Example: **Assign oxidation number to Mn in $K\underline{Mn}O_4$:**

K is assigned +1 (K is an alkali metal, which is always +1 in any compound).

O is assigned -2 (since Mn is not a Group I element, this would not be a peroxide or superoxide). Thus, the oxidation number of Mn has to be +7 so that the algebraic sum of the oxidation numbers of all the atoms equals zero.

Redox reaction is a reaction involving transferring of electrons from one reagent to another reagent. Transferring of electrons leads to changes of oxidation numbers. If one finds the oxidation numbers of an element before and after the reaction are different, electron transfer must have occurred and the reaction must be a redox reaction.

In a redox reaction, the reducing agent loses electrons to the oxidizing agent. As the reducing agent loses electrons, the oxidation number of one or more atoms in the reducing agent will increase (becoming more positive or less negative). As the oxidizing agent gains electrons, the oxidation number of one or more atoms in the oxidizing agent will decrease (becoming less positive or more negative). Refer to Experiment 3 to learn more about oxidation numbers and redox reactions.

1. Assign Oxidation numbers to each element in the following species:

   a. $SrBr_2$

   b. CH_4

   c. $NaNO_3$

   d. K_2O

   e. KO_2

   f. KH

   g. K_2O_2

   h. $Zn(OH)_4^{2-}$

   i. CN^-

   j. Mg_3N_2

   k. Na_3PO_4

   l. $Fe(CN)_6^{4-}$

   m. Cl_2O_7

   n. NH_4NO_3

   o. Hg_2SO_4

   p. $S_4O_6^{2-}$

   q. B_2H_6

   r. $PbCl_2$

   s. OF_2

   t. XeF_6

   u. PCl_6^-

   v. $Al_2(SO_4)_3$

   w. KI_3

   x. $V(H_2O)_4O_2^+$

   y. $KSCN$

   z. CH_3CH_2OH

2. Identify the redox reactions in the following. For each redox reaction, put a circle around the reducing agent(s) and a rectangle around the oxidizing agent(s).

a. $NaHCO_3\,(aq) + HCl\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l) + CO_2\,(g)$

b. $2\ Bi(OH)_3 + 3\ SnO_2^{2-} \rightarrow 3\ SnO_3^{2-} + 2\ Bi + 3\ H_2O$

c. $Tl_2O_3 + 4\ NH_2OH \rightarrow 2\ TlOH + 2\ N_2 + 5\ H_2O$

d. $HCl + NH_3 \rightarrow NH_4Cl$

e. $Si + 3\ HCl \rightarrow SiHCl_3 + H_2$

f. $2\ NO + Br_2 \rightarrow 2\ NOBr$