HW15. Redox reactions

A little something to help to remember what oxidation and reduction is.

O xidation
I s
L oss of electrons
R eduction
I s
G ain of electrons

How to identify if we have redox reduction? You should look if the elements changed their oxidation numbers:

$C^{0} + O_2{}^{0} \rightarrow C^{+4}O_2{}^{-2}$

4 electrons move from C towards the two O atoms. We say C is oxidized. The carbon had oxidation number 0, in the product (CO_2) carbon loses the electrons, oxidation number of the carbon +4). Oxygen is reduced, the oxidation number is going down from 0 in O_2 to -2 in CO_2.

Remember that the number of electron lost has to be equal to the number of electron gained in the reaction. We cannot create electrons from nothing. Balancing the number of electrons can help us to find out the coefficients to balance the whole chemical equation.

Redox chemical reactions can be balances by looking at the transfer of electrons:

$Al + O_2 \rightarrow Al_2O_3$

$Al - 3e \rightarrow Al^{+3}$ | 4

$O_2 + 4e \rightarrow 2O^{-2}$ | 3

$4Al + 3O_2 \rightarrow 2Al_2O_3$

We can break redox reaction into two half- equations, where we show the oxidation and reduction process separately. Al loses 3 electrons, we have oxidation half of the reaction. Oxygen gains 4 electrons in the reduction half of the equation (if we have homonuclear molecule like O_2, H_2, Cl_2, we can use coefficient 2 right away to balance number of atoms), each O in O_2 gains 2 electrons, 2x2=4. To balance the number of electrons we have to multiply the first half-reaction by 4, and the second half-reaction by 3, that way we lost and gained the same number of electrons 12.
4 and 3 our main coefficient numbers, 4 for Al, 3 for O_2.

This method of finding coefficients can work well for balancing complicated reactions:

$$2\,KMn^{+7}O_4 + 10KCl^{-1} + 8H_2SO_4 \rightarrow$$

$$\rightarrow 5Cl_2^{0} + 2Mn^{+2}SO_4 + 6K_2SO_4 + 8H_2O$$

$$Mn^{+7} + 5e \rightarrow Mn^{+2} \quad | \; 2$$

$$2Cl^{-1} - 2e \rightarrow Cl_2 \quad | \; 5$$

Mn gains electrons

Cl loses electrons

The number of electrons gained and lost should be equal. We can do it by multiplying "Mn" half of the reaction by 2 and "Cl" half of the reaction by 5. That way we know our coefficients for Mn and Cl in the chemical equation.

Most commonly in the text books you will see that the number of lost electrons will be written down on the right side of the equation:

$$Al^{0} + O_2^{0} \rightarrow Al_2^{+3}O_3^{-2}$$

$$Al \rightarrow Al^{+3} + 3e$$

$$O_2 + 4e \rightarrow 2\,O_3^{-2}$$

Oxidation numbers help us to identify if the reaction is redox or not. Example of redox reaction:
$P_4 + F_2 \rightarrow 4PF_5$ If we write down oxidation numbers for the elements we will see that elements P and F changed their oxidation number, so this reaction is not only synthesis reaction, but redox reaction as well :

$P^0{}_4 + F^0{}_2 \rightarrow 4P^{+5} F^{-1}{}_5$

Here is example of a double replacement reaction:

$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

With oxidation numbers it looks like this:

$2Na^{+1} Cl^{-1} + H^{+1}{}_2S^{+6}O^{-2}{}_4 \rightarrow Na^{+1}{}_2S^{+6}O^{-2}{}_4 + 2H^{+1} Cl^{-1}$

Oxidation numbers do not change, it is not the redox reaction.

Questions

1. Insert the missing equation coefficients and determine if it is redox reaction or not:

$?Mg+O_2 \rightarrow 2MgO$

$?Fe+3Cl_2 \rightarrow ?FeCl_3$

$K_2SO_4 + HCl \rightarrow KCl + H_2SO_4$

$Cu + O_2 \rightarrow CuO$

2. Insert the missing equation coefficients, use the electron balance and show your work:

$P + N_2O = N_2 + P_2O_5$

$NH_3 + O_2 = NO + H_2O$