Chemistry 112 Spring 2006

from Prof. Paul Fischer

Balancing Oxidation-Reduction Equations: A Ten Step Process

1. Assign oxidation states to all atoms, both reactants and products.

2. Write down an unbalanced reduction half reaction by writing only the reactant that gains electrons (that contains the atom whose oxidation state decreases) and a product that contains the same atom.

   Write down an unbalanced oxidation half-reaction by writing only the reactant that loses electrons (that contains the atom whose oxidation state increases) and a product that contains the same atom.

3. For each of the half-reactions: balance the atoms that are not oxygens and hydrogens by inspection. You may need to use other reactants and products in the process. Any atom of compound that is presented as part of the reaction can be included in the half reactions at this point.

4. Show the electrons gained or lost explicitly in each half-reaction. The oxidation half reaction will generate electrons (electrons will be a product). The reduction half reaction will utilize electrons (electrons will be the reactant). The number of electrons generated or used will be clear from the oxidation state changes of the involved atoms.

5. The balanced overall process must generate and utilize the same number of electrons. Multiply the half reactions by appropriate coefficients so that as many electrons as are generated by the oxidation are utilized by the reduction.

6. Add the two half reactions together. The electrons will no longer show because there will be the same number on each side, so they can be cancelled.

7. Balance the total charges found on each side of the reaction. If the reactants have a net charge of -1, so must the products. Add an appropriate number of hydronium ions ($H_3O^+(aq)$) to the side having too negative a charge. If the reaction is known to occur in alkaline (basic) solution, balance the charges by adding an appropriate number of hydroxide ions ($OH^-(aq)$) to the side that is too positive.

8. Balance hydrogen and oxygen atoms by adding the appropriate amount of water molecules to one side of the reaction. As water molecules are neutral this will not disrupt the charge balance already maintained.

9. Check for a common factor among the coefficients (are they all divisible by 2, *etc.*?). Simplify if possible. In general we will try to avoid fractional coefficients.

10. Re-check your final answer for mass and charge balance.