Name: _____ Date: _____

IB Chemistry Assignment

Oxidation & Reduction Reactions

ESSENTIALS: Know, Understand, and Be Able To…

- ▫Define valence electrons. Draw a Lewis dot structure of an atom.
- ▫Explain that atoms of elements will lose or gain electrons to form ions which contain a stable filled orbit of 2 (H) or 8 (all other elements).
- ▫Identify ions with a positive charge as having lost electrons. These are called cations.
- ▫Identify ions with a negative charge as having gained electrons. These are called anions.

Reduction/oxidation (*redox*) reactions are an important class of chemical reactions since they are the driving force behind a vast range of process, both desirable (breathing in mammals) and undesirable (rusting of iron). A redox reaction is characterized by the fact that electrons are transferred between atoms. An oxidation reaction must always be paired with a reduction reaction, as the oxidation reaction produces the electrons required by the reduction reaction.

The electrons transferred in a redox reaction arise from the change of the valence state of materials in the redox reaction. If a material gives up or loses an electron, then its valance state becomes more positive (since an electron has a negative charge) and the reaction is called an oxidation reaction.

Since an oxidation reaction gives up electrons, it will always have electrons as one of its products. By definition, the oxidation reaction occurs at the anode (of an electrochemical cell). The chemical reaction shown below is an oxidation reaction where zinc metal (with a neutral valance state or valance charge = 0) is oxidized to give a zinc ion, which has a 2+ valence charge. The two electrons lost by the zinc metal are products of the oxidation reaction. The zinc ion does not exist as a separate entity, and therefore must form either a solid salt (in which case its mobility and availability is not useful for redox reactions) or a dissolved salt in a solution. The (aq) after the zinc ion indicates that it is aqueous. Note that since the overall aqueous solution must be electrically neutral, there must also be ions with positive charge in the solution. In examining only the behavior of the battery reaction, these may not be specified.

We call these types of reactions REDOX reactions. Remember that the overall charge of the equation must be balanced. The following examples are only 1/2 half reactions to emphasize the loss or gain of electrons.

Oxidation

Valence charge 0 2+

$$Zn\ (s) \longrightarrow Zn^{2+}\ (aq) + 2e^-$$

Oxidation reaction (the valence state of the reactant increases) of zinc metal to a zinc ion. The (s) after the zinc indicates that it is in solid form. The zinc ion has (aq) after to indicate that it is aqueous, (i.e. in solution).

Reduction

Valence charge 2+ 0

$$Cu^{2+}\ (aq) + 2e^- \longrightarrow Cu\ (s)$$

If a material gains an electron then its valence state decreases or reduces due to the negative charge of the electrons and the reaction is a reduction reaction. The reaction above is a reduction reaction in which a copper ion with a valance state of 2+ is

$$Cu^{2+}\ (aq) + 2e^- + Zn\ (s) \longrightarrow Cu\ (s) + Zn^{2+}\ (aq) + 2e^-$$

$$Cu^{2+}\ (aq) + Zn\ (s) \longrightarrow Cu\ (s) + Zn^{2+}\ (aq)$$

reduced to copper metal, with a valence state of zero. Since a reduction reaction requires electrons, it will always have electrons as one of the reactants. The reduction reaction occurs at the cathode.

The total redox reaction consists of both of the two reactions together. For the example of copper and zinc above, the total reaction is shown above. Since the reaction with zinc metal (i.e. the reactant of the oxidation reaction) is providing the electron required to reduce the copper, the zinc is the reducing agent and the zinc itself is oxidized. Don't forget, Dr. G loves rainbows!! Copper ions in this case are the oxidizing agent - they oxidize the zinc and are themselves reduced. Note that since the electrons appear on both sides of the chemical equation, they may be omitted when writing the redox reaction. Further note that for redox reaction, it is important to balance not only the elements in the chemical reactions, but also the electrons.

Name: _____ *Date:* _____

Assignment: Oxidation - Reduction Reactions

For #s 1 – 6, consider each of the following atom/ion pairs and indicate how many electrons have been gained or lost, balance the reaction if necessary, and tell if that represents oxidation or reduction:

1) $Mn^{+7} \rightarrow Mn^{+2}$

2) $Cl_2 \rightarrow Cl^-$

3) $Fe^{+2} \rightarrow Fe^{+3}$

4) $S^{-2} \rightarrow S$

5) $Cu^{+} \rightarrow Cu^{+2}$

6) $Br^- \rightarrow Br_2$

For #s 7 – 10: (1) assign oxidation numbers to each atom in the following reactions; (2) write the oxidation and reduction half reactions; (3) identify the oxidizing agent & reducing agent.

7) $\mathbf{Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{+2}_{(aq)} + Cu_{(s)}}$

oxidation half reaction:

reduction half reaction:

oxidizing agent:

reducing agent:

8) $Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(s)$

oxidation half reaction:

reduction half reaction:

oxidizing agent:

reducing agent:

9) $Mg(s) + Ca^{2+}(aq) \rightarrow Mg^{+2}(aq) + Ca(s)$

oxidation half reaction:

reduction half reaction:

oxidizing agent:

reducing agent:

10) $Fe(s) + Ni^{3+}(aq) \rightarrow Fe^{+3}(aq) + Ni(s)$

oxidation half reaction:

reduction half reaction:

oxidizing agent:

reducing agent: