Oxidation Numbers and Redox Reactions

Electrochemistry is all about the movement of electrons in chemical reactions. Sometimes electrons move from one atom or molecule to another and form a chemical bond in the process:

$$Na + Cl_2 \longrightarrow 2\ NaCl$$

$$4\ Fe + 3\ O_2 \longrightarrow 2\ Fe_2O_3$$

and sometimes electrons move from one atom or molecule to another without forming a bond:

$$3\ Cu^{2+} + 2\ Al \longrightarrow 3\ Cu + 2\ Al^{3+}$$

When no bond is formed, you can actually put the reactants in separate containers so the electrons have to move through a wire to get from one reactant to the other. This is how batteries work. Which reactants you use and what their concentrations are will determine the voltage of the battery.

Oxidation Numbers

In order to follow the movement of electrons, we're going to make one big simplifying assumption – we're going to treat *all* compounds as if they're ionic compounds. This is wrong, of course – covalent compounds share electrons and don't form ions – but by assigning each electron to one and only one atom it's much easier to keep track of how the electrons are moving around.

The "ionic charge" on each atom in a compound that results from this assumption isn't a real ionic charge, and is called an *oxidation number*. In this class you'll see atoms with oxidation numbers all the way from –4 to +7. An atom can also have an oxidation state of 0, even in a compound.

The first thing we need to do is learn how to assign an oxidation number to each atom in any compound, whether the compound is ionic or covalent. For ionic compounds the oxidation number is the same as the ionic charge. For covalent compounds there are a few simple rules to follow.

How to Calculate Oxidation Numbers Introduction (13:25)
https://www.youtube.com/watch?v=-a2ckxhfDjQ

How to Calculate Oxidation Number Practice Problems (15:24)
https://www.youtube.com/watch?v=zpCy7KwqDO8

Redox Reactions

A chemical reaction where electrons are moving from one reactant to another is called an oxidation-reduction reaction, or a *redox reaction* for short. When a reactant loses electrons we call that *oxidation*, and when a reactant gains electrons we call that *reduction*.

Introduction to Oxidation-Reduction (Redox) Reactions (13:04)
https://www.youtube.com/watch?v=5rtJdjas-mY&t=7s

The Oxidation Reduction Question that Tricks Everyone! (6:18)
https://www.youtube.com/watch?v=JYc4Blcxmps

An *oxidizing agent* is a reactant that oxidizes another atom or ion by stealing electrons from it (and becoming reduced in the process). A *reducing agent* is a reactant that gives up electrons to another atom or ion, thereby reducing the other atom or ion, but becoming oxidized itself.

Oxidizing Agents and Reducing Agents (14:55)
https://www.youtube.com/watch?v=kEJUYDHhuCg&t=412s

Balancing Redox Reactions

Redox reactions can sometimes be difficult to balance by just looking at them, but there's a method for balancing redox reactions that doesn't even require that you know any chemistry.

Many redox reactions include H_2O and either H^+ or OH^- among the reactants or products, so you'll sometimes be told to balance a reaction in acidic solution or in basic solution. (You don't need to know any acid-base chemistry to do this.) Balancing a redox reaction in basic solution is just like balancing one in acidic solution, there are just a couple extra steps added to the end.

How to Balance Redox Equations in Acidic Solution (15:00)
https://www.youtube.com/watch?v=lZ1tKxsqV74

How to Balance Redox Equations in Acidic Solution Example 1 (14:45)
https://www.youtube.com/watch?v=pESvgnP64ME&list=PL3hPm0ZdYhyycIQ3TiRApJRTFPPEvJ1uX&index=7

Balance Redox Equations in Acid Example 2 (Advanced) (15:54)
https://www.youtube.com/watch?v=i9s9Qv4EcI0&list=PL3hPm0ZdYhyycIQ3TiRApJRTFPPEvJ1uX&index=8

How to Balance Redox Equations in Basic Solution (18:00)
https://www.youtube.com/watch?v=v5sDNmYCaqo&list=PL3hPm0ZdYhyycIQ3TiRApJRTFPPEvJ1uX&index=9

Tyler DeWitt's YouTube channel is at https://www.youtube.com/channel/UCj3EXpr5v35g3peVWnVLoew