Welcome to our module on Electrochemical Energy

We've reviewed some chemistry principles, particularly the overview of chemistry and its branches, its relationship to other sciences and to industry, re-examination of the concept of matter, its properties, classification, states and the changes it undergo. Now in this module, you will explore the concept of batteries and corrosion as important applications of redox equations. Moreover, you will be able to distinguish oxidation and reduction, assign oxidation numbers, and balance redox equation in acidic and basic solution.

Learning Outcomes:

At the end of the module, you should be able to:

1. explain the difference between oxidation and reduction;
2. use oxidation numbers to identify elements that gain or lose electrons in a reaction;
3. balance half-reactions for redox processes;

In this module, you are recommended to have:

- Desktop, laptop or mobile phone to view this file and watch a review lesson after this module; and
- Steady internet access.

You are also expected to:

- Read the entire module as it may help you to answer several self-assessments, activities or quizzes at the end of this lesson.
- Accomplish the self-assessments on your own. It is designed to gauge your understanding of the lesson and it will not be recorded. If you have any clarifications, you may contact me through our Google Classroom.

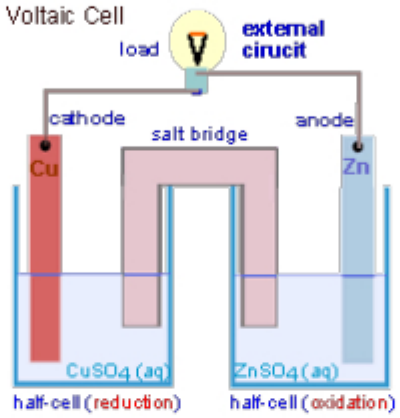
Content:

1. Important applications of redox equations are batteries and corrosion.

Redox reaction is used to produce electricity in a voltaic cell (most common example is battery). The most basic example would be by building a voltaic cell through a laboratory simulation (which we will discuss in our synchronous

session). Place a piece of zinc metal in a beaker containing Zinc sulfate solution. On a separate beaker, place a piece of Copper metal in a Copper sulfate solution. Connect the two pieces of metal through a wire. The Zinc metal will gradually oxidize into Zinc ions and would give off electrons. Electrons move from a more reactive metal (Zinc) to a less reactive metal (Copper) and that flow of electrons produces electricity.

It contains two electrodes: anode and cathode. Anode is where oxidation happens while cathode is the site of reduction. Oxidation is the loss of electrons while reduction is the gain of electrons.



Source: Department of Chemistry, University of Wisconsin-Madison

As Zinc metals are being oxidized into Zinc ions, positive charge builds up in the oxidation half cell making the charge unbalanced. The reduction half cell undergo the same but with an accumulation of negative charge. The battery won't be producing electricity if this build up continues so a salt bridge is necessary to balance out the charge.

Another reaction which can be explained by redox equation is corrosion, wherein metals degrade by chemical reactions with the environment. The formation of rust, or Iron oxide, is the most common example.

Same as the electrochemical reaction happening in voltaic cells which can then generate electricity, an iron nail can be rusted when exposed to weather. Iron is oxidized and oxygen from the air is reduced.

2. Rules in Assigning Oxidation Numbers[1]

1. The oxidation number of an element in an elementary substance is 0.
2. The oxidation number of an element in a monoatomic ion is equal to the charge of that ion.
3. Certain elements have the same oxidation number in all their compounds.

   Group 1 elements always have an oxidation number of +1.

   Group 2 elements always have an oxidation number of +2.

   Fluorine (F) always has an oxidation number of -1
4. Hydrogen in a compound has an oxidation number of +1, unless it is combined with a metal and Boron, in which case it is -1.
5. The sum of the oxidation numbers in a neutral species is 0 and in a polyatomic ion is equal to the charge of the ion.
6. Oxygen in a compound has an oxidation number of -2 (except with Fluorine), unless it is combined with peroxides in which case it is -1 Solve algebraically for the oxidation number of oxygen.
7. For Group 7 elements, oxidation number is -1 in combiation with metals and non-metals (except Oxygen).

3. Balancing Redox equations using Half-reactions Method in Acidic Solution.[2]

1. Assign oxidation numbers to each element and identify what is being oxidized and reduced.
2. Split the equation into two falf-reactions, one for reduction, the other for oxidation.
3. Balance atoms other than Oxygen and Hydrogen.
4. Add H_2O to balance Oxygen and H^+ to balance Hydrogen.
5. Add electrons to balance charges.
6. Multiply half reactions to make the number of electrons equal in both.

1 modified from Atkins, P. & Jones, L. (2010)
2 modified from Atkins, P. & Jones, L. (2010)