

Chapter 20 Concepts and Formulas

Electrochemistry is the relationship between electricity and chemical reactions.

Remember LEO goes GER! (Losing electrons is oxidation, gaining electrons is reduction)

When we balance redox (oxidation-reduction) equations, we look at the change each of the species has undergone. We look at half-reactions. We apply this basic method:

- 1) Balance each half-reaction, leaving H and O for last, unless H^+ and H_2 are involved.
- 2) Balance the O by adding H_2O to one side and H^+ to the other, then add e^- as needed.
If done in basic solution, OH^- ions are to be added afterwards.
- 3) Multiply each half-reaction by an integer so that the number of e^- are the same and cancel out when the two half-reactions are added together.
- 4) Simplify by cancelling, if possible, and check to see everything is balanced.

Voltaic cells ---> Anode -- where oxidation occurs -- “a negative electrode”
Cathode -- where reductions occurs

Two metals can pass electrons via a conducting salt “bridge.”

Voltage, or electromotive force, the electrical potential, sometimes called the potential difference between two points in a circuit. It is analagous to gravitational potential; that is, electrons flow from a higher potential to a lower one.

One volt (V) is the potential difference required to impart one joule (J) of energy to one coulomb (C) of electrons. That is

$$1 \text{ V} = \frac{1\text{J}}{1\text{C}}$$

One coulomb is 6.25×10^{18} electrons....one electron's charge is 1.6×10^{-19} C.

Unless noted, all electrochemical reactions are considered at 25°C (298 K).

The standard cell potential is given as $E^\circ_{\text{cell}} = E^\circ(\text{cathode}) - E^\circ(\text{anode})$. The little o represents standard state conditions.

We define the half-cell potential of hydrogen as 0 volts ----> $2H^+ + 2e^- \rightleftharpoons H_2$

The more negative the half-cell potential, the more active a half-reaction is and will reduce any less negative than it...for example, Zn is -0.76 V and Cu is $+0.34$ V. Thus zinc metal will reduce copper ions to copper metal spontaneously. Any overall positive E° means the reaction is spontaneous.

To get the reverse to take place, you would need to impart an external voltage greater than
 $.34 - (-.76) = 1.10 \text{ V}$.

Another way to look at it is, the more positive the half-cell potential, the greater is its oxidizing power.

We relate spontaneity and electromotive force through Faraday's constant, usually written as a script capital F, in the equation $\rightarrow \Delta G = -n \mathcal{F} E$

Here ΔG is the Gibbs Free Energy, n is a dimensionless positive number representing the number of electrons transferred in the equation at hand, \mathcal{F} = about 96,500 coulombs per mole or 96,500 joules per mol-volt.

We can look at non-standard conditions and concentrations that differ via the Nernst equation:

$$E = E^{\circ} - \frac{.0592 \text{ V}}{n} \log Q \quad (\text{that's common, base 10 logs here of the reaction quotient})$$

Electrolysis is the process by which a voltage is applied to an anode and a cathode and the ions in a solution are oxidized or reduced. Silver-plating onto a negatively charged cathode is a common practice, as is chroming car parts.