Corrosion

Corrosion

- Corrosion-An oxidization of a metal, and the oxide flaking off.
- Oxidized metal is commonly called rust
- Most commonly oxygen will oxidize a metal.
- Either by
- [Metal] + $O_2 \rightarrow$ [Metal]O
- Or
- [Metal] + $H_2O \rightarrow$ [Metal]O + H_2

Resisting corrosion

- Most metals resist corrosion by an oxide layer forming on the outside that protects the metal inside.
- It protects the inside metal by preventing the oxygen (or other oxidizing agent) from being able to reach it.

Statue of Liberty

Examples

- Aluminum very readily loses electrons.
- You would expect it to “rust” easily.
- However, aluminum is a very useful metal because it doesn’t corrode like other metals can.
- An aluminum oxide layer forms on the outside, stopping further oxidation from occurring.
- This oxide gives aluminum a dull color.

Steel

- Steel corrodes very readily because iron oxide doesn't stick to the surface.
- It instead falls off exposing new metal to be oxidized.
- This makes iron less useful and explains why ancient people would prefer other metals.
- However, the abundance and other properties of iron have made it useful.

Preventing oxidation

- Iron can be protected by painting the surface or coating it with a different material to prevent the corrosion.
- Galvanized steel is steel coated with zinc to prevent oxidation.
- Zinc actually oxidizes more readily than iron.

Galvanic corrosion

- Two different metals placed next to each other with an electrolytic solution connecting will cause an oxidation reduction reaction to occur.
- Just like the galvanic cell.
- Electrons will flow from a more active metal to a less active metal.
- One metal will end up oxidizing the other, but in the process will itself become reduced.
- This rapidly oxidized or rusts the one metal but prevents the less active metal from oxidizing (rusting)

Galvanic corrosion

Flint Michigan

- This is root of the problem with the water crisis in Flint, Michigan.
- The pipes that deliver water to the city run underground. Corrosion is always a problem. The pipes used in Flint used lead to prevent corrosion. There was a protective layer that stopped any lead from getting into the drinking water.
- They switched water sources to the Flint river which was more acidic. This dissolved the protective layer which then allowed the lead to get into the water supply.

Galvanic corrosion

- You can also see galvanic corrosion on a battery.
- Batteries that are hooked up to a circuit for an extended period of time tend to become rusted.

High temperature corrosion

- An oxidation reaction like any other reaction occurs faster when heated.
- Metals that are constantly heated tend to rust more quickly.

Noble metals

- There are certain metals that don't form an oxide.
- Gold and silver are noble metals.
- Silver will oxidize with sulfur, but not with oxygen.
- Gold does not readily oxidize in nature.
- Ruthenium, Rhodium, Palladium, Osmium, Iridium, and Platinum are also noble metals

Electrolysis

Electrolysis

- Electrolysis-Forcing a current through to produce a chemical reaction.
- Water can be electrolyisized
- $H_2O \rightarrow H_2 + O_2$
- This reaction is very important for fuel cell cars.
- This is a redox reaction that produces electric current, that can be refueled like an internal combustion engine

Refining metals

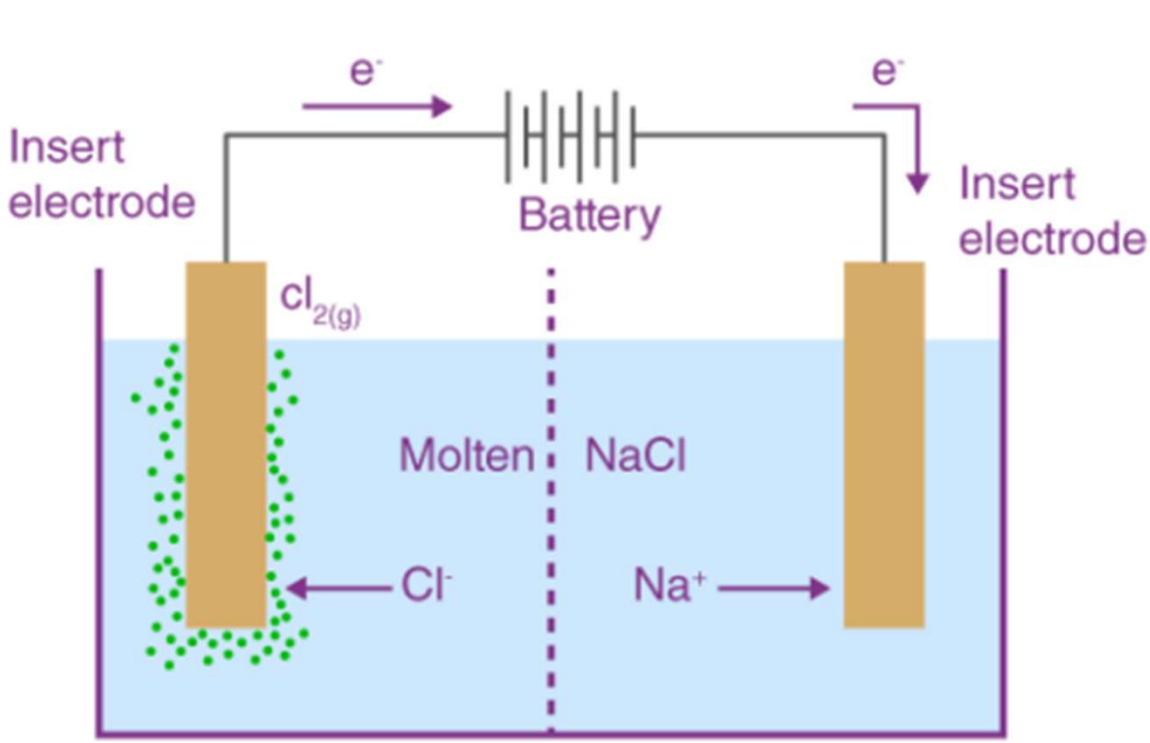
- Metals are found as metal oxides (ores) in nature commonly.
- An electrolysis reaction is commonly used to produce metals from these ores.
- Sodium metal can be produced by melting sodium chloride and passing an electric current through the melt.

Electrolytic Cells

- In electrolytic cells, everything is reversed from a galvanic cell.
- Instead of a voltmeter, you have a power source.
- Instead of a positive cell potential, you have a negative cell potential.
- That means instead of the reaction producing a voltage (positive value), the reaction requires this much voltage (negative value) to run.

Electrolysis of NaCl

- $2\ NaCl\ (l) \rightarrow 2\ Na(l) + Cl_2\ (g)$



Notice

- $Na^+ + e^- \rightarrow Na$ $\quad E^o = -2.17$ V
- $2Cl^- \rightarrow Cl_2 + 2\ e^-$ $\quad E^o = -1.36$ V

- $2\ Na^+ + 2Cl^- \rightarrow 2\ Na + Cl_2$
- $E^o = -3.53$ V
- A negative value, this means the reaction won't run with less than 3.53 V from the power source.

Hall-Heroult Process

- Before 1886 aluminum was a very expensive metal.
- Even though it is very abundant on the Earth's surface, it is only found as bauxite, an oxide.
- Since aluminum is so reactive no reducing agent could easily turn the ore into a metal.
- It was so valuable the Napoleon served his honored guests aluminum silverware and gave the others gold or silver.

Charles Hall

- A student in a chemistry course at Oberlin College in Ohio was told by his professor, that if anyone could a cheap method to manufacture aluminum from bauxite they could make a fortune.
- Using crude galvanic cells Charles Hall was able to achieve this using an electrolysis reaction.
- Yes, he did make a fortune with it.