Corrosion

- Corrosion is a huge problem for society, on an industrial level and on an individual level. But how is corrosion related to electrochemistry?
- **Corrosion** is a *spontaneous redox reaction* of material with substances in their environment (usually oxygen and water). → O.A. is higher than R.A.
  - Many metals are strong reducing agents and will spontaneously react with oxygen and water, which act as a strong oxidizing agent
- EXAMPLE: Illustrate the rusting/corrosion of iron ($Fe_{(s)}$) in terms of electrochemistry.
  - As electrons leave the anode (ie. iron), the iron will break down and "rust"

list all species present: $Fe_{(s)}$, $H_2O_{(\ell)}$, $O_{2(g)}$

strongest R.A. — strongest O.A.

oxidation: $2Fe_{(s)} \longrightarrow 2Fe^{2+}_{(aq)} + 4e^-$ (x2)

copied from pg. 7 of data book

reduction: $O_{2(g)} + 2H_2O_{(\ell)} + 4e^- \longrightarrow 4OH^-_{(aq)}$

overall redox rxn: $2Fe_{(s)} + O_{2(g)} + 2H_2O_{(\ell)} \longrightarrow 2Fe^{2+}_{(aq)} + 4OH^-_{(aq)}$

$2Fe(OH)_{2(s)}$

iron solid breaks down into iron ions ie. is said to be rusting

- One method used to prevent corrosion is to apply a *protective coating* to the metal, such as paint, enamel, grease/oil, and plastic.
  - This protective coating prevents air and water from actually reaching the surface of the metal; therefore preventing corrosion from actually taking place.
  - A protective coating is only effective if the entire metal surface is covered.
- Another method used to prevent corrosion is *cathode protection*. ← stronger R.A.
  - **Cathode protection** involves attaching a more reactive metal to the iron object you are trying to protect. The more reactive metal will act as the anode and will slowly corrode and break down due to the oxidation reaction.
  - This more reactive metal is called the **sacrificial anode** because it is being destroyed to protect the iron.
  - Unlike a protective coating, the metal in cathodic protection does not need to cover the entire surface; the sacrificial anode will just need to be replaced periodically.

*****Now try pg. pg. 500 #14, 16 & pg. 501 #14, 15*****

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Q14. Aluminium provides cathodic protection on an iron object because it is a better reducing agent than iron. This means that the aluminium reacts first, saving the iron from rusting.

Q15. The corrosion problems most likely showed up in the Atlantic provinces due to high volumes of precipitation throughout the year (both rain and snow), coupled with the use of salt on winter roads. Taken together, these factors encourage corrosion.

Q16. (a) Given the cell potential of the following half-reaction

$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(\ell)$

$E^\circ = 1.23\ V$

Elemental oxygen is a much better oxidizing agent under acidic conditions.

(b) Acid rain greatly increases oxygen's ability to act as an oxidizing agent and contributes to rusting.

Section 13.2 Review Answers

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12. The use of salt lowers the melting point of snow, causing more water to be mobile and reactive. Furthermore, the salt also provides electrolytes required for the salt bridge.

13. When the steel cans corrode, they produce aqueous ions. However, the aluminum cans produce solid aluminium oxide, which slows down the corrosion process.

14. Zinc is a more reactive metal than iron, as noted by its cell potential, so it will react before iron does.

15. (a) Two metals that do not react in the presence of oxygen and water are silver and gold, as noted by their cell potentials being higher than that of the oxygen and water half-reaction.

(b) Since these metals are quite resistant to corrosion they are useful for industrial processes that take place under extremely adverse conditions that promote corrosion, such as high temperatures or acidic environments, like the aerospace or petroleum industry.