

Corrosion and Cells

- **Corrosion** is a chemical reaction in which the surface of a metal changes from an element to a compound.
- Different metals will corrode at different rates.
- *Corrosion results in metals forming compounds so is an example of oxidation.*
- **Rusting** is the word used to describe the corrosion of iron. It requires the presence of oxygen (from air) and water.
- The water must contain dissolved carbon dioxide or some other electrolyte.
- Ferroxyl indicator, which turns blue in the presence of Fe^{2+} ions can be used to show the extent of rusting.
- Salt acts as an electrolyte and so salt, spread on the roads in winter, increases the corrosion of car bodywork.
- Iron reacts faster if acid is present so acid rain speeds up corrosion.

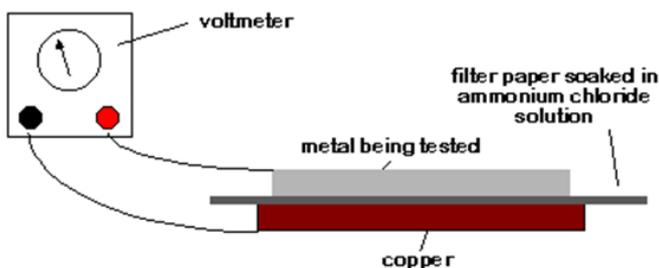
Corrosion / Rusting Prevention

- Iron does not rust when connected to the **negative terminal** of a battery because the electrons flowing onto the iron prevent it from losing electrons.
- When a cell is set up with iron and a metal higher in the Electrochemical Series then the electrons can flow to the iron. When a cell is set up with iron and a metal lower in the Electrochemical Series then electrons flow from the iron.
- With a metal higher in the Electrochemical Series than iron (say Mg) then reactions taking place are:
 - (oxidation) $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$ and
 - (reduction) $\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}$
- With a metal lower in the Electrochemical Series than iron (say Cu) the reactions taking place are:
 - (Oxidation) $\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$ and
 - (Reduction) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
- **Electroplating** occurs when a metal is plated by another metal. This takes place when the piece of metal to be coated is made the negative electrode in the electrolysis of a solution, containing the ions of the metal to be plated on.
- **Galvanising** occurs when a piece of steel (or iron) is coated with zinc.
- **Tin-plating** occurs when a piece of steel (or iron) is coated with tin.
- Putting a surface barrier over a piece of metal will provide **physical protection** against corrosion, since it will not allow air and water to come in contact with the metal. Examples are: painting, greasing, electroplating, galvanising, tin-plating and coating with plastic.

- **Sacrificial protection** can be used to protect a metal. If a piece of metal is connected to a more active metal then electrons will flow from the more active metal to the less active. In this way the more active metal will corrode in preference to the less active metal. An example of this is the protection of the Finart-Grangemouth oil pipe by the connection of bags of scrap magnesium. Galvanising is another example.

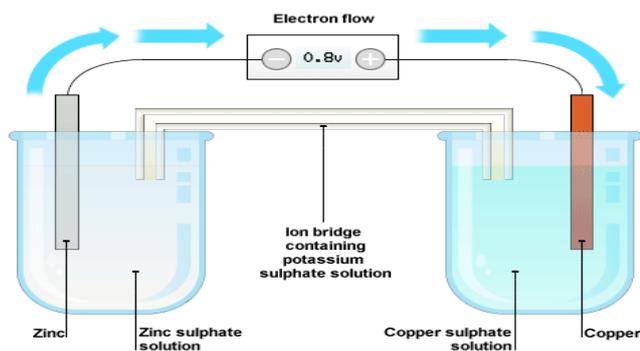
Electrochemical Cells

- **Oxidation** is the loss of electrons by a reactant in a chemical reaction. When a metal reacts to form a compound it undergoes oxidation.
- **Reduction** is the gain of electrons by a reactant in a chemical reaction. When a metal compound reacts to form a metal it undergoes reduction.
- A cell is made by connecting two different metals together with an electrolyte. The purpose of an electrolyte (for example ammonium chloride) is to complete the circuit. The voltage generated between different pairs of metals varies, and this gives rise to the **Electrochemical Series**.



Electrons flow from the metal higher up in the ECS to the metal lower down through the wires. Ions flow through the filter paper soaked in an electrolyte.

Two half cells:



- Any metal, in an Electrochemical Series, will displace a metal below it from one of its compounds. This reaction will usually produce some visible signs.