

Corrosion

- **Corrosion** is a process that occurs when metals react with substances in the environment, which weakens the metal. There are different types of corrosion, one of which is rusting.
- Corrosion occurs only when the metal is exposed to the environment, meaning it takes place on the metal's surface.

Rusting

- Rusting is a chemical reaction that occurs when Iron reacts with oxygen and water, forming hydrated Iron (III) oxide ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$), which is known as rust. (In the compound $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, the 'x' represents a variable amount of water.)
- **Oxygen** and water must be present for rusting to occur.



- Rust is a soft solid substance that **flakes** off the surface of iron easily, exposing fresh iron below which then undergoes rusting.
- This means that over time all of the iron rusts and its structure becomes weakened.
- This is a major concern as iron is used extensively in industries such as **transport** and **construction**

Corrosion of Aluminium

- Aluminium is another metal that undergoes corrosion. However, when aluminium is exposed to air, it reacts with oxygen to form a tough protective outer layer of aluminium oxide (Al_2O_3).
- Unlike the soft layer formed during rusting, this layer acts as a shield and prevents the aluminium underneath from further corrosion.

Experiment : Investigating Rusting

- Both oxygen and water are required for rusting to occur, as demonstrated in the following experiment.

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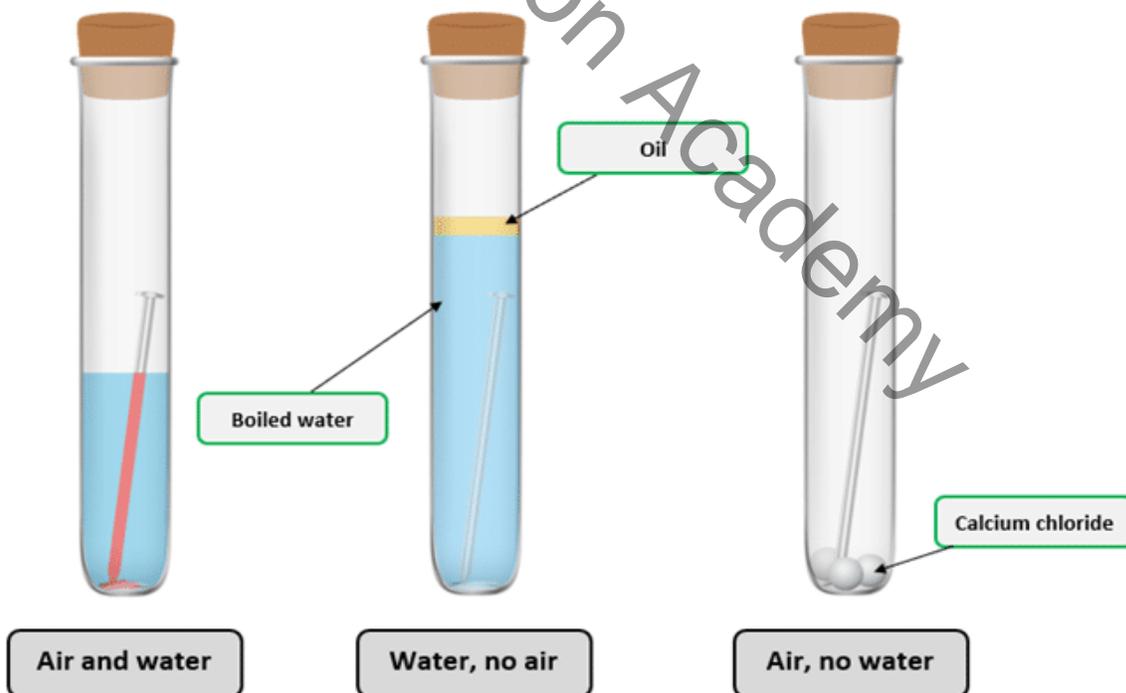
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► There are three test tubes:

1. An iron nail in distilled water, with the nail exposed to air.
2. An iron nail in boiled distilled water (to remove dissolved air) and then covered in oil to prevent the reintroduction of air.
3. An iron nail in the presence of calcium chloride, which is a drying agent that absorbs any water molecules present.

Results:

- After leaving these setups undisturbed for several days and observing the changes:
- The first test tube's nail is covered in rust
 - The second and third test tubes show no signs of rust
- The only nail that rusted was in the test tube containing both air and water, which means that rusting requires the presence of both oxygen and water.



Preventing Corrosion

1. Coating:

- To stop metals from corroding, a **protective coating** can be applied to them as a barrier to water and oxygen. This coating can be done by 3 ways

I. **Greasing with oil:** For kitchen items like cast-iron skillets, a simple oil coating can keep rust at bay. Grease is also used to coat iron items on vehicles and bicycles, like bearings, nuts, bolts, and chains, to prevent rust.



II. **Painting:** Traditionally paint such as Hammerite has been used fairly successfully to protect iron from rusting.



III. Electroplating with a different metal:

- ▶ **Electroplating works by the process of electrolysis.** Electrolysis allows a thin layer of metal to be placed on the object. At the cathode is the object and at the anode is the plating metal. The electrolyte is made up of ions of the plating metal.
- ▶ **Aluminium oxide protects aluminium.** Aluminium oxide is a coating on aluminium. This oxide layer on the surface of aluminium prevents further corrosion from affecting the metal.
- ▶ **Electroplating has different uses.** Electroplating reduces the risk of metals being exposed to **corrosion** or damage. It also improves the aesthetic and **appearance** of metals, for example in silver plated cutlery.

Disadvantages of coating :

A disadvantage is that any damage to the coating will lead to the metal becoming exposed and so corrosion will take place.

2. Sacrificial protection

- ▶ **Sacrificial protection** involves using a metal that is **more reactive than iron**, for example magnesium or zinc
- ▶ The more reactive metal will corrode first, it 'sacrifices' itself to protect the iron
- ▶ Rusting occurs due to iron atoms **losing** electrons, being oxidised, to form iron (III) ions



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- In sacrificial protection, the more reactive metal will lose electrons more easily as they are more readily oxidised

Sacrificial corrosion

- Sacrificial corrosion occurs when a more reactive metal is intentionally allowed to corrode.
- An example of this occurs with ships' hulls which sometimes have large blocks of magnesium or magnesium alloys attached.
- The blocks slowly corrode and provide protection to the hull in the same way the zinc does by pushing electrons onto the iron which prevents it from being reduced to iron(III) ions

3. **Galvanizing:**

- **Galvanising** is a process where the iron is protected specifically by a layer of zinc. ZnCO_3 is formed when zinc reacts with oxygen and carbon dioxide in the air and protects the iron by the barrier method
- If the coating is damaged or scratched, the iron is **still protected** from rusting because zinc preferentially corrodes as it is higher up the reactivity series than iron, acting as a sacrificial metal.
- Compared to iron the zinc loses its electrons more readily