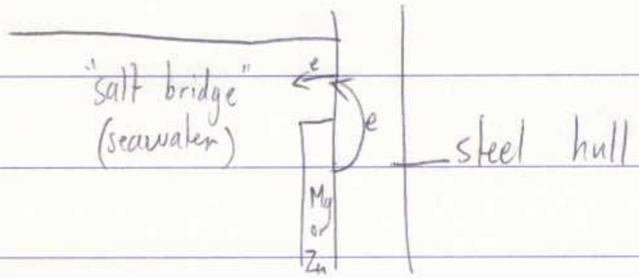
Q29

(a) (i) The main metal used to construct ships is steel. Which is an alloy containing less than 2% carbon.

(ii) Aluminium is a passivating metal, which forms an oxide layer / coating impervious to sulfur, oxygen gas and water. Thus creating an impermeable barrier to prevent further corrosion of the metal underneath the layer.

(b) (i) Magnesium is commonly used as a sacrificial anode

(ii) Sacrificial anodes are placed onto the hulls of ships to provide cathodic protection. A more reactive metal such as magnesium or zinc is often used to protect the steel hull of the ship



As in the diagram, as the seawater facilitates

The movement (transfer) of electrons from the steel hull and sacrificial anode. The electron lost by the steel hull is replaced by an electron from the Mg or Zn plate. Thus, protecting the hull of the ship, from corrosion

(c) 100% Fe, gives a malleable metal, but does not provide the hardness needed to construct ships and other materials, and corrodes very quickly

98% Fe, 2% C, gives a malleable but relatively brittle steel metal which is often used as a structure or foundation for the construction of ships, but is still not resistant to corrosion

As the % composition of Fe is lowered, and various elements such as Carbon, Manganese, Tin are added and increase in their respective % composition The steel becomes more harder and malleable, but is still not resistant to corrosion. This steel is often used to be shapened onto the structure of the hull of a ship.

As % composition of Fe falls to around 70%, and Nickel and Chromium are added at % of just above 15%. Stainless steel is formed, which is malleable, hard and resistant to corrosion as well as having a shiny lustre about the metal. It is often used as cutlery, knives and other small hand goods.

d) (i) Corrosion is the process of undergoing a simultaneous reduction and oxidation of a typically metallic structure, by altering it chemically, through the reactions

(ii) A test tube rack could be setup with each test tube containing the same water or electrolyte solution in equivalent amounts. Each test tube, however, containing a different metal or alloy to the other. The rack could then be set aside for a period of time, and observed for a qualitative change. However a control of each respective metal is needed in a stoppered test tube – containing an identical piece of metal to the one tested – that is not filled with water.

(iii) To improve accuracy and reliability, controls of the initial state of the metals and alloys are needed to make a definitive qualitative observation of the corrosion of the metal/alloys.

The temperature of water, as well as the amount of water must be equivalent for all test tubes prior to setting them aside.

Also ensure that the electrolyte solution is completely homogenous and that the test tube rack is placed somewhere, where each test tube will undergo the same 'environment' or 'treatment'.

The length and surface areas of the metal samples should also be kept as strictly the same as possible, minimising any differences. Also be ensuring the test tubes are fully clean and that there are no particles already present in the test tube or could fall into the test tubes as they are put aside.

(e) For silver artefacts recovered from a shipwreck. Silver artifacts often collect carbonates on them, especially $CaCO_{3(s)}$ whilst submerged in the ocean. In order to remove this build-up, the silver is cleaned by physical removal of carbonates such as with mechanical scrubbing, until a minimal coating remains. Then the silver artefacts are left to soak in dilute acid to remove the carbonates.

ie. $2HNO_{3(aq)} + CaCO_{3(s)} \longrightarrow H_2CO_{3(aq)} + Ca(NO_3)_{2(aq)}$

Then the silver artefacts are rinsed in non-ionised distilled water. The artefacts are then placed into a solution of $NaOH_{(aq)}$ to be electrolysed as the cathode. In order to remove the silver sulfide formation. An inert electrode such as platinum can be used, with $NaOH_{(aq)}$ as the electrolyte and a relatively small voltage is applied to gradually break down the sulfide formation on the silver artefacts.

Once electrolysis has been completed, the silver artefacts are once again, rinsed in non-ionised, distilled water and preserved in their current state. Usually a thin coating of lacquer is applied to create an impermeable barrier to oxygen, sulfur and water which would facilitate further corrosion on the artefact.