Question 29 - Shipwrecks and Salvage

(a) (i) Galvanic cell

(ii) $Fe^{2+}_{(aq)} + 2e^- \rightleftharpoons Fe_{(s)}$ $\quad -0.44\ V$

$Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$ $\quad 0.34\ V$

for an electrolytic cell (Inverse of galvanic cell)

$Emf_{std} = 0.44 - (-0.34)$

$= 0.78\ V$

(b) Galvani, in his study of electrochemical processes, connected the ends of 2 different metal wires onto the muscle of a frog and noticed that an electric current flows through. Galvani wrongly concluded that it was the muscle that produced the

electricity. For his work on electrochemistry, electrochemical cells are also known as galvanic cells.

Alexandro Volta is credited to the production of Volta's piles which were used to study electro-chemical processes and produce electricity.

Sir Humphry Davy made improved versions of Volta's piles and was the first to conclude the these processes involved the transfer of electrons. His discoveries were also important as he suggested that all acids contained hydrogen which helped us to understand the concept of acids.

Michael Faraday, too, made very useful contributions to electrolysis. He invented the sulfuric acid coulometer which was used to determine the amount of substance from an electrochemical cells. This study also led to 'Faraday's law of electrolysis', which states that the amount of substance produced during electrolysis is directly dependant on the amount of current that is passed through.

(d) (i) The ~~prod~~ procedure involved taking 2 ~~no~~ petridishes and adding distilled water to one and 0.1 M HCl to the other. 2 iron nails were weighed seperately and added to the petridishes (one each). This was left undisturbed for a ~~week~~ week under the same conditions. After this, the nails were taken out of the petridishes and weighed again to determine which one underwent more corrosion.

(ii) The hypothesis that acidic environments accelerate the corrosion of shipwrecks holds true. ~~This can be proved~~ This is because acidic environments are better agents for the transfer of ions. This can be proved by conducting the experiment ~~and~~ in d(i). On taking the iron nails out of the 2 solutions and weighing them again, it can be seen that the loss in weight

in the ~~nail~~ nail that was put in the acid is more than the loss in weight of the nail put in water. This proves that the nail in the acid underwent more corrosion than that in the water (since it lost more mass).

(e) The depth of the ocean affects the corrosion of shipwrecks in 2 ways. The corrosion of metallic objects requires the presence of oxygen. Oxygen is abundant in plenty on the surface of oceans as it is in this region that photosynthesis occurs maximum due to the presence of sunlight. Because of this, metal objects corrode pretty quickly if kept in this region.
But as you go deeper into the ocean, the level of oxygen is reduced due to 2 reasons ① The photosynthesis process does not occur at such depths ② Oxygen that is already present is used up for respiration

by living organisms. Due to these reasons, oxygen is not available for corrosion at such depths. It was hypothesised that corrosion of metal objects does not occur at great depths. But this hypothesis was proved false when the remains of the wreck of the Titanic was recovered from the Atlantic. Further researches showed that at the ocean floor, corrosion of metal objects occured due to bacterial corrosion. Hence, the depth of the ocean play a role in determining not only the rate of corrosion taking place on metal objects but also the type of corrosion.

(c) (i) The salt from an artefact can be removed by placing the artefact in distilled water for a certain period of time allowing for the salt to dissolve into the water.

(ii) One of the main procedures used in cleaning and preserving artefacts is by electrolysis and electroplating. Electrolysis can be used in order to restore parts of the metal that have been corroded in the shipwreck. Also, electroplating can be used to coat the surface of the metal with a very ~~[illegible]~~ less reactive metal such that further corrosion does not occur.

Another process is dipping the artefact into distilled water or a ~~[illegible]~~ dilute acidic solution so that the salts and other impurities ~~[illegible]~~ coated on the metal surface can be removed by dissolving them in the solution. On this way, the artefact is clean of impurities.