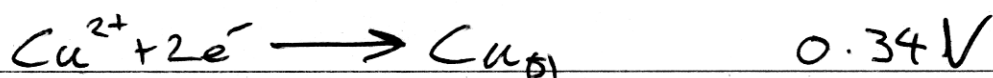
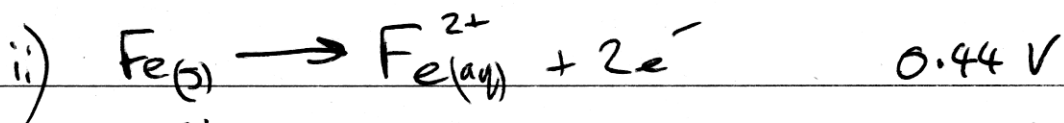




29

a)

i) Galvanic cell.



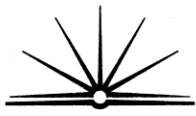
$$E^{\circ}_{\text{cell}} \quad 0.44 + 0.34 = 0.78 \text{ V}$$

0.78 V is the spontaneous direction voltage

To operate this cell as in the non-spontaneous direction would require at least 0.78V in the opposite direction. (e) The iron electrode is made the negative ~~the~~ cathode.

A power source (DC) would be required.

b) Galvani produced the first current. He used two wires of different metals connected at one end. The open ends were probed into a dead frog. The frog's muscles twitched giving Galvani the impression that the frog generated the current. He was able to adjust the level of twitching of the frog using



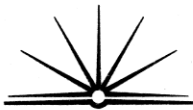
different combinations of metal wires.

He did not understand what was actually moving in the frog.

His ideas, however, were important in gaining interest of other scientists. Volta used copper & tin to create a current. He used cardboard soaked in brine sandwiched between each pair of metals. He showed that the frog did not generate the current. He thought the contacts of metal wires made ^{current}.

Davy used Volta's idea for some useful experiments involving electrolysis. He created many variations of Volta's pile to produce various currents. He noticed a decomposition ~~or~~ reaction occurring and correctly stated that this was causing the current. Davy is known for reducing sodium & potassium hydroxide to the relative metals. He also gained Faraday's interest in electricity.

Faraday quantised electrolysis. His laws of electrolysis give us the understanding today



evolved & dissolved.
of how ~~current~~ and substance produced at the electrode are directly proportional to the ~~the~~ current ~~passing~~ the amount passing through the cell. Faraday's ideas are put to use ~~to~~ to this day.

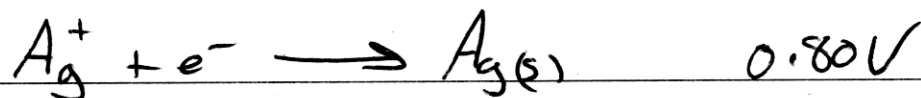
i) The artefact may be soaked in fresh water to dissolve out the salts. This step is repeated until salt concentrations are below a set level. ie) the water must be changed.

ii) With silver coins, Crustation may be dissolved using dilute HCl. This method protects engravings on the coins as opposed to chipping off the shells. $\text{CaCO}_3(\text{s}) + \text{HCl}(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Cl}^-$. The coins may ^{have} been covered also, with hydrogen sulfide. This may



be removed via electrolysis, once again, to avoid abrasive, damaging methods.

The silver is made the cathode.



At the anode $2\text{OH}^- \rightarrow \frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- - 0.4\text{V}$.

(Inert electrode at the anode)

$$E^\ominus_{\text{cell}} = -0.4\text{V}$$

0.4V is required for the process.

Sodium hydroxide solution is used as the electrolyte.

The coins may then be coated with a lacquer for lasting protection.

d) Equipment: - Test tubes, test tube racks.

method: - Set up a series of test tubes each

with: - ① dilute HCl ② tap water ③ salt water

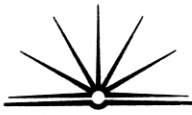
④ boiled water ⑤ air (no water) . ⑥ $\frac{1}{2}$ filled tap water.

Place an iron nail in each tube after cleaning the nail surface.

This process is repeated for various other metals (ie) Stainless Steel, Zinc, Fe coated in zinc, Fe coated in copper, Carbon Steel.

The tubes are left for several days and the effects of corrosion observed and compared to a control (ie) tube with water only.
(tube with air + metal.)

(ii) The tubes containing hydrochloric acid were timed with a stop watch. The faster reactions indicated that acid speeds up the corrosion process however, only for the more reactive metals. It was also noted that other factors speed up the process. Salt water caused more corrosion than tap water which showed more than oxygen depleted water. The tube with air only didn't hardly rust, it needed water as well. Water and oxygen are

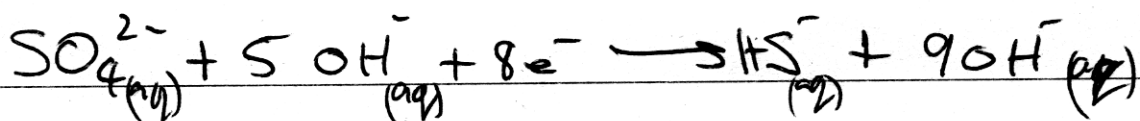


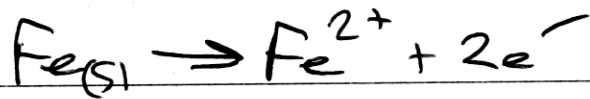
both essential for corrosion to occur.

Only the tubes with HCl were indicative of effects of acid as the other tubes did not contain any significant concentration of acid.

② At ocean depths it is thought that low temperatures may slow corrosion. Also that temp. and pressure may ~~not~~ enable more dissolved oxygen. In fact, there is little mixing of surface water and therefore little oxygen available at these depths. Biological processes, however, allow for the oxidation process to occur.

anaerobic bacteria reduce sulfur.

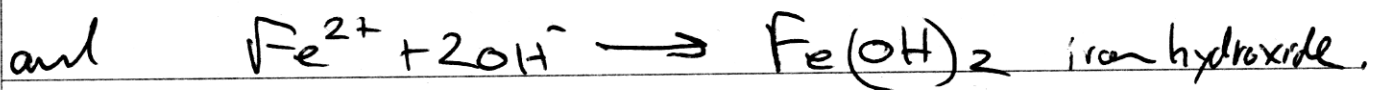
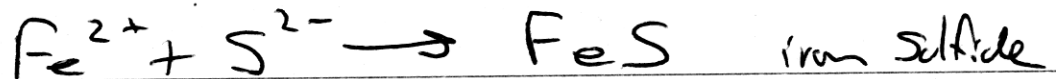




Iron is oxidised in this way.

It ~~does~~ does not form rust though.

It reacts to form



These bacteria also are capable of creating an acidic environment as a by-product of metabolism. This in turn accelerates corrosion as it reacts OH^{-} to speed up the process.