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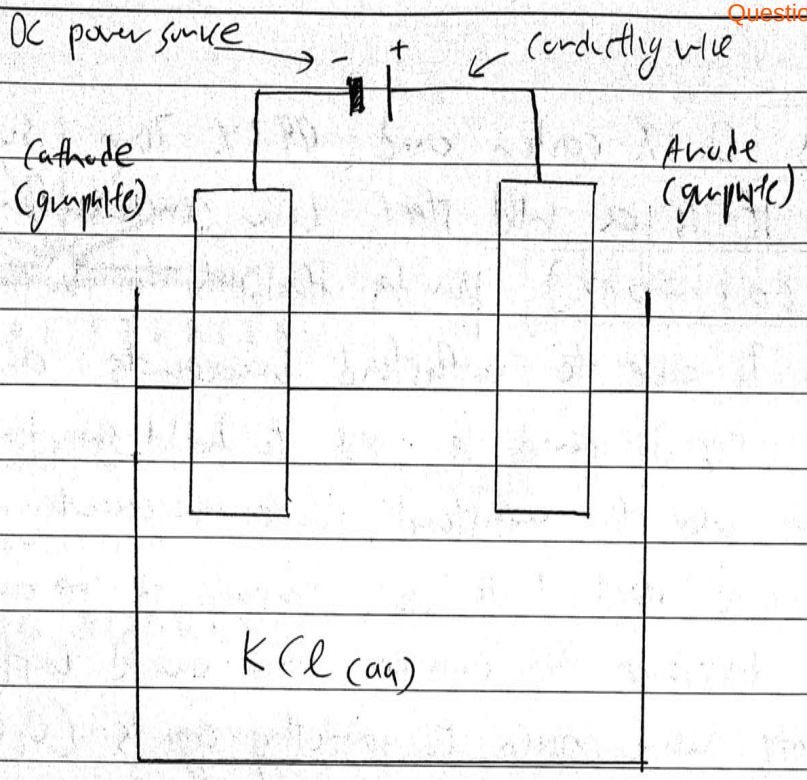
(a) The artefact consists of wood and metal. strips.
- Salts (Cl^-, SO_4^{2-} ions) dissolved in the sea water would saturate and saturate the wood. Salt solution would penetrate into the plant cells of the wood, causing weakening of the structure cell walls become weak, thus the artefact would break easily after 150 years of saturation. Also, encrustating marine organisms and various worms would reside on the wood. Such results in visual holes on the surface of wood.

If incase the salt saturation to occur we significantly, as the solution is able to penetrate deeper into the wood.
- Salt solutions also penetrate into the cracks on the metal strips (i.e. salt saturation). Continuous exposure to the oxidating agents of $H_2O_{(l)}$ and $O_{2(g)}$ under the ocean would have caused corrosion of the metal. Black metal sulfides (e.g Ag_2S, PbS) would be on the surface of the metal. If it is iron strips, hydrated would be found ($Fe_2O_3 \cdot 2H_2O_{(s)}$) The corrosion causes weakening of the metal structures, making it easily broken and brittle. Encrustation would also be found on the metal.

(b) i)



$8H^+ + 4C$

Anode: $2H_2O_{(\ell)} \rightarrow O_{2(g)} + 4H^+ + 4e^-$ $E^\circ = +1.23V$

Cathode: $2H_2O_{(\ell)} + 2e^- \rightarrow H_{2(g)} + 2OH^-$ $E^\circ = -0.83V$

Overall: $6H_2O_{(\ell)} \rightarrow O_{2(g)} + 2H_{2(g)} + 4H_2O_{(\ell)}$ $E^\circ = -2.06V$ ✓

ii) In an electrolytic cell, electricity is put in for non-spontaneous reaction (redox) since cathode is where reduction occurs (gaining of electrons), the electrode to which negative terminal of the DC electricity is connected is the cathode i.e. negatively charged

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(c)

- Steel 1 has 0.2% carbon and 99.8% Iron. Such suggests that it is a mild steel. Low concentration of carbon (0.1 ~ 0.3%) provides flexibility to the steel. Thus the alloy is able to withstand movements as it is flexible e.g. it could be used to build ship hulls, which must be able to withstand water movements. However because steel 1 is only composed of Fe and C, it has low resistance to corrosion, thus would rust relatively rapidly when exposed to oxidising agents (O_2, H_2O). Therefore, steel used in ship building must be protected from corrosion.
- Steel 2 has 1.5% C, which makes it much harder than mild than steel 1. Such type of steel is used to make tools such as hammer because it is very strong. However its lack of flexibility (high C) makes it unsuitable for ship or building construction (unable to withstand movements)
- Steel 3 contains manganese and silicon, which provide a degree of protection from corrosion. However its high carbon concentration makes it very brittle. Such steel which contains Mn and Si has its distinctive appearance as silicon gives it the shiny metallic to other iron alloys. Thus steel 3 could be used to make artefacts to provide aesthetic aspects, as well as it strong and hard nature

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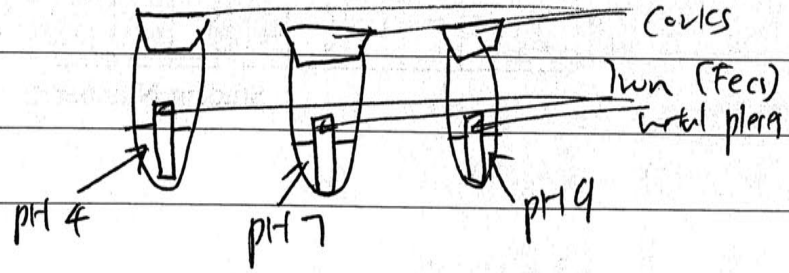
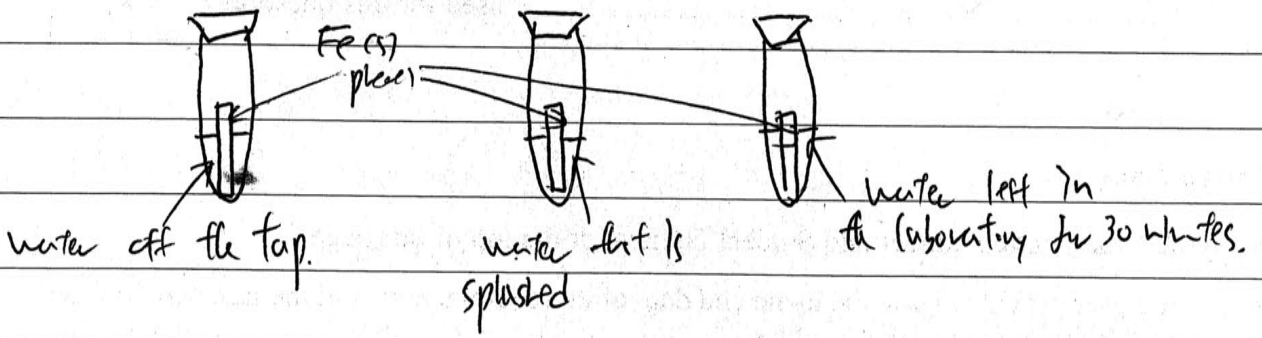
(d)

1/o pH of the water in which iron is submerged.



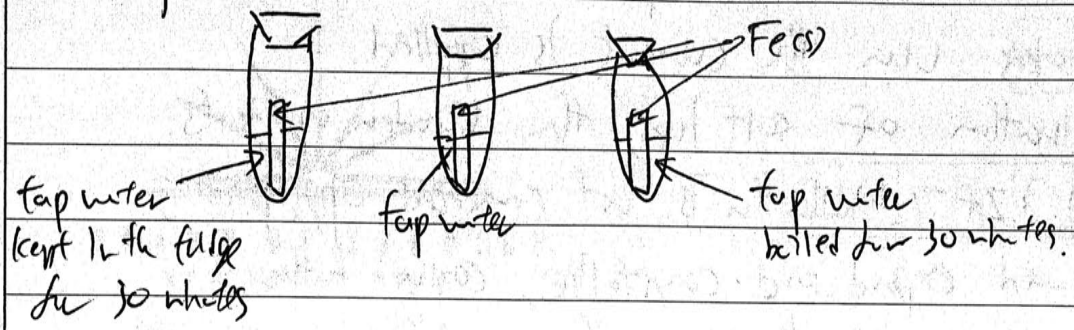
- Set up the above apparatus.
- Observe the changes made to the iron pieces over a 5 day period. Rate the degree of corrosion from 1: no corrosion to 5: significant corrosion.
- All the other variables must be kept the same e.g. weight of each piece, temperature, amount of water used

o Concentration of oxygen O_2 in the water.



- Set up the above apparatus
- Observe the changes made over 5 day period, and ~~[illegible]~~ grade the level of corrosion from 1 to 5
- All the other variables kept the same
  Eg pH of the water, weight of each iron piece, temperature etc

o Temperature of water



e set up the above apparatus, & observe the changes for 5 day period. Rate the level of corrosion from 1 to 5

o other variables: pH, concentration of O_2, etc must be kept the same

7)/ Iron could be surfaced alloyed using chromium. It forms an impervable layer of oxide, which prevents the O_2 (g) from coming in touch with the Fe (s). Thus, the rate of corrosion would be decreased.

(e)

o Wooden artefacts.

- When wooden artefacts are recovered from the sea water, it must be placed in distilled water to diffuse salt ions which have saturated into the organic materials. The water must be replaced regularly, until an equilibrium is reached i.e. no more ions. The process can be monitored using conductivity probe, as ions (Cl^-, SO_4^{2-}) are able to conduct electricity i.e. ↓ conductivity → ↓ salt ions.
- Wooden artefacts are not suitable for electrolysis. When the current is put into the objects, it cause further

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damages to the structure as plant cells in wooden artefacts breakes when the current is applied.
– After desalination of salt ions, the wooden artefacts can be dried. If desalination is not conducted appropriately, the salts would expand and crystalise, causing further damages to the artefacts. When the artefacts are completely dry, PEG can be applied to the objects. It provides physical barrier to the wooden objects to prevent further weakening of the structure. It also ~~strengths~~ strengthens the cell wall and help the artefacts to maintain their shapes.
→ Evaluate: Techniques used in desalting and consolidating wooden artefacts are very suitable, because they prevents the further damages due to the structure and also helps to preserve by limiting the access of oxidising and salt agents.

o Copper artefacts
– Salt solution in the sea water would have saturated the copper artefacts. If it is hot dry, salts crystallise and expand, causing damages to the artefacts as cracks widens. Therefore Copper artefacts are stabilised in dilute NaOH solutions, which differs the salt ions. Also, it prevents the artefacts from being exposed to acidic environment which would accelerate the corrosion.
($O_{2(g)} + 4H^+ + 4e^- \rightarrow 2H_2O \quad E^\circ = 1.23\,V$)
– Encrustation formed on the surface of the artefacts

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