

Start here.

(a) The artefact consists of wood and metal strips.

o Salts ( $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ) dissolved in the sea water

would saturate and saturate the wood. Salt solutions would penetrate into the plant cells of the wood, causing

weakening of the structure. Cell walls become weak,

therefore 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 water the salt saturation to occur more significantly,

as the solution is able to penetrate deeper into the wood.

o Salt solutions also penetrate into the cracks on the metal

strips (i.e. salt saturation). Continuous exposure to

the oxidizing agents of  $\text{H}_2\text{O}$  (aq) and  $\text{O}_2$  (g) under the

ocean would have caused corrosion of the metal. Black

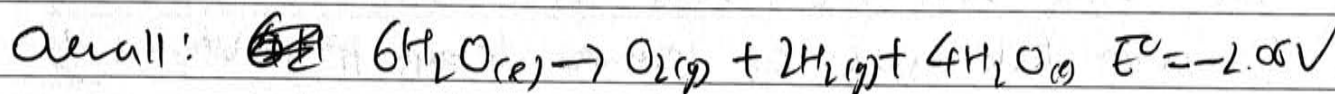
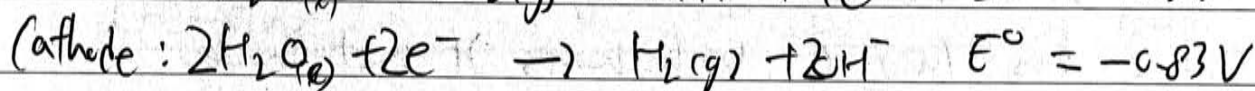
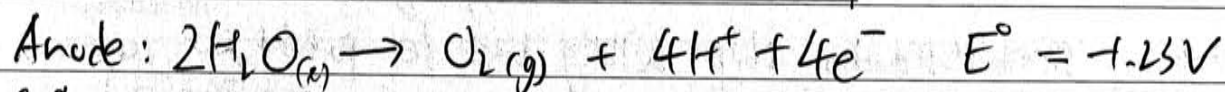
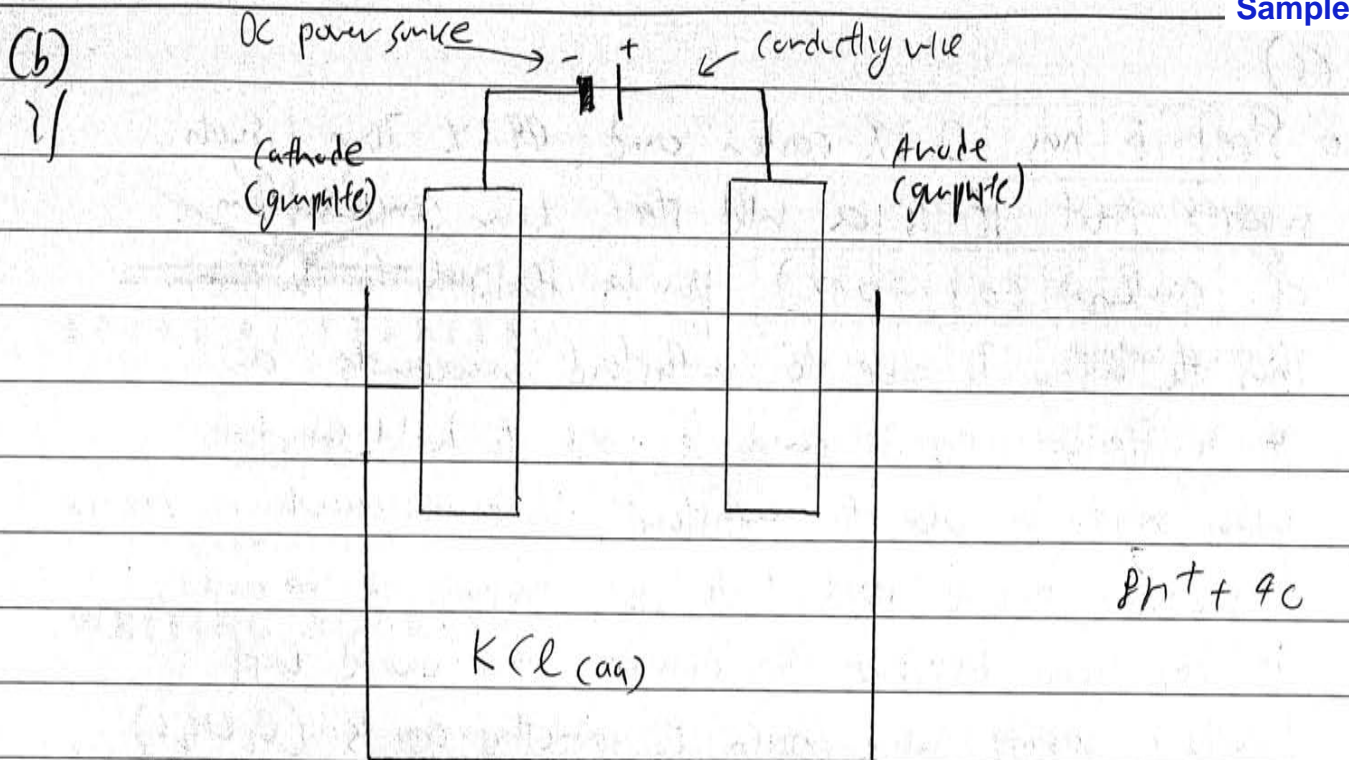
metal sulfides (e.g.  $\text{Ag}_2\text{S}$ ,  $\text{PbS}$ ) would be on the surface

of the metal. If it is iron strips, rusting would be

found ( $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ ). The corrosion causes weakening

of the metal structures, making it easily broken and

brittle. Encrustation would also be found on the metal.



71/ Zn 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 ~~anode~~ cathode i.e. negatively charged.

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(c)

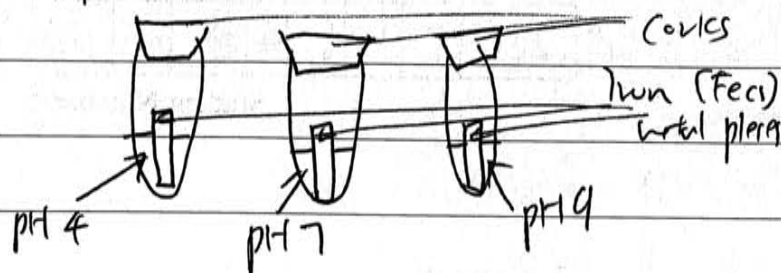
- o Steel 1 has 0.2% carbon and 99.8% Fe. Such suggests that it is a mild steel. Low concentration of carbon (0.1 ~ 0.5%) provides flexibility to the steel. Thus the alloy is able to withstand moments as it is flexible e.g. it could be used to build ship hulls, which must be able to withstand water moments. However because steel 1 is only composed of Fe and C, it has low resistance to corrosion, this would last relatively rapidly when exposed to oxidizing agents ( $O_2$ ,  $H_2O$ ). Therefore, steel used in ship building must be protected from corrosion.
- o 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 hammers because it is very strong. However its lack of flexibility (high C) makes it unsuitable for ship or building construction (unable to withstand moments).
- o 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 makes it more shiny relative to other iron alloys. Thus steel 3 could be used to make cutlery to provide aesthetic aspects, as well as its strong and hard nature.

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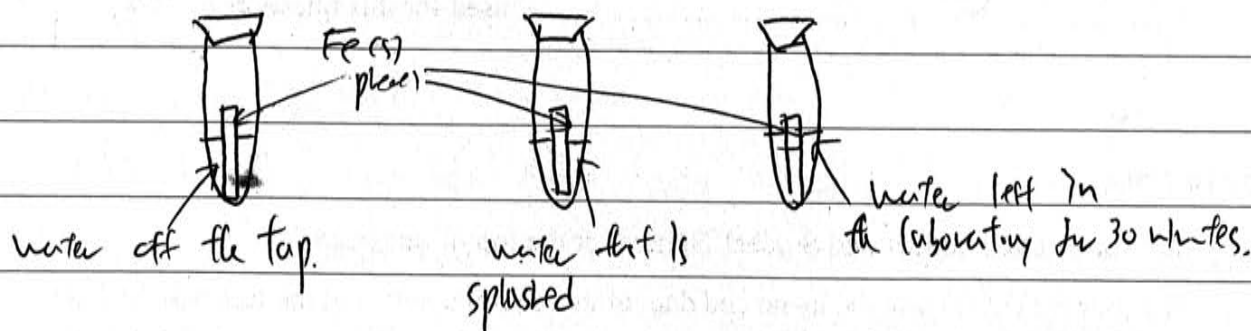
(d)

1/0 pH of the water in which iron is submerged.



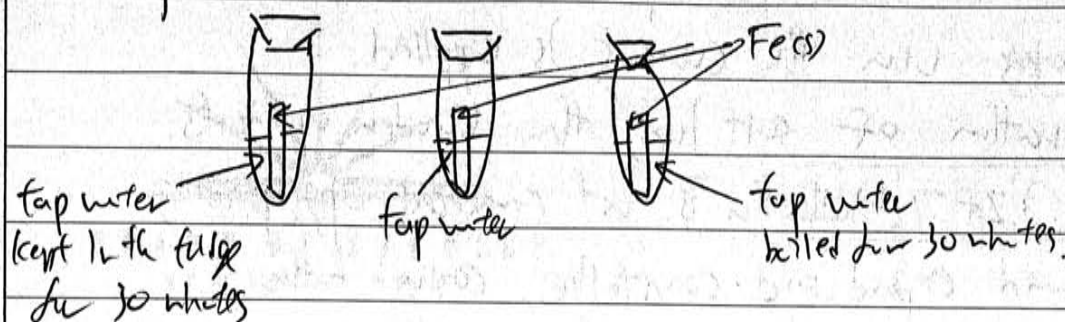
- Set up the above apparatus.
- Observe the changes made to the iron plates over a 5 day period. Rate the degree of corrosion from 1: no corrosion to 5: significant corrosion.
- All the other variables must be kept the same e.g. weight of each plate, temperature, amount of water used

o Concentration of oxygen  $O_2$  in the water.



- Set up the above apparatus
- Observe the changes made over 5 day period, and ~~rate~~ grade the level of corrosion from 1 to 5
- All the other variables kept the same e.g. pH of the water, weight of each iron plate, temperature etc

o Temperature of water



o set up the above apparatus, & observe the changes for

5 day period. Measure the level of corrosion from 1 to 5

o other variables: pH, concentration of  $O_2$ , etc. will be kept the same

7) Iron could be surface alloyed using chromium.

It forms an impermeable layer of oxide, which prevents the  $O_2$  from coming in touch with the Fe(s).

Thus, the rate of corrosion would be decreased.

(c)

o Wooden artefacts.

- When wooden artefacts are recovered from the sea water,

it will 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.  $\downarrow$  conductivity  $\rightarrow$   $\downarrow$  salt ions.

- Wooden artefacts are not suitable for electrolysis.

When the current is put into the objects, it causes further

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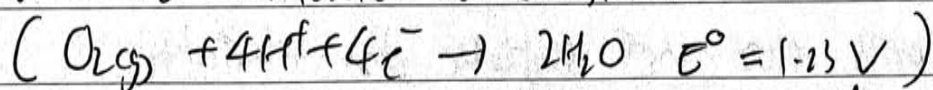
damages to the structure as plant cells in wooden artefacts breaks when the current is applied.

- After desalination of salt ions, the wooden artefacts can be dried. If desalination is not conducted appropriately, the salts would expand and crystallise, 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 walls and help the artefacts to maintain their shape.

→ Evaluate: Techniques used in restoring and conserving 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 not 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 will accelerate the corrosion.



- Encrustation formed on the surface of the artefacts

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