a i The main metal used in the construction of ships is iron

ii Aluminium is a passivating metal. This means that upon exposure to oxygen it forms a tough, protective outer layer. This protective layer prevents corrosion, increasing the longevity of the metal and therefore the structure.

b i Zinc is a metal commonly used as a sacrificial anode

ii Sacrificial anodes protect the hull of the ship from corrosion. Without the anode, the iron hull becomes anodic leading to the formation of iron hydroxide, and further, iron oxide, which can severely damage the hull of the ship.

The sacrificial anode oxidises preferentially to the iron, preventing the iron from corroding. In this way the sacrificial anodes is destroyed by oxidation rather than the iron of the hull of the ship.

c Iron is rarely found alone. The addition of other elements to form various alloys makes it very versatile.

Pure iron does not corrode, but since this metal

is rarely found alone, other elements must be added. Stainless steels can be created by the addition of nickel and chromium. Not only does this make the steel corrosion resistant, it also increases the alloys Tensile strength, hardness and appearance. This makes this alloy useful in cutlery and kitchen sinks.

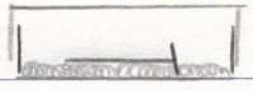
The percentage carbon can also affect the properties of steel. The more carbon present the less ductile the metal is & the less malleable. It becomes harder and more brittle, as well as more prone to corrosion. Some examples include wrought iron and pig iron, which can be used in minor building structures and also other objects such as beds, lampstands and other artworks.

Iron can also be made magnetic by the addition of the elements aluminium, nickel and cobalt. This forms the 'Alnico' magnet which has a variety of uses.

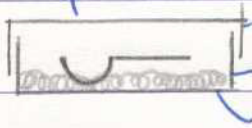
Many other elements can be added, but the main objective in making an alloy is to increase the properties for its particular use, mainly to increase hardness & decrease ductility.

d i Corosion is the oxidation of a metal, and reduction of other chemicals (for example oxygen & water), to create a a substance that affects the structure (eg $Fe(OH)_2$ & FeO) of the object.

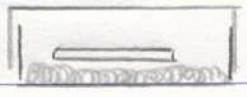
ii The equipment was set up as follows:



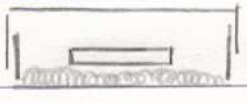
iron nail



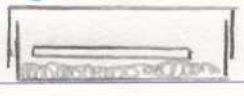
stainless steel



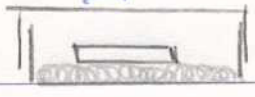
zinc



magnesium



aluminium



copper

The cotton wool was only slightly moistened. The petri dishes were left in the cupboard for approximately three days before observed

note: the lids were not sealed, each dish had adequate exposure to air.

iii To increase accuracy and reliability the class should split into seved groups. This allows repetition, which allows easy identification of any inaccurate results.

Another way is to compare experimental results

to theoretical results. This ensures that the experimental procedure is relatively accurate.

Thirdly, the experiment should be performed in a variety of environmental conditions to eliminate any bias. For example, different temperatures, different exposures to sunlight and different concentrations of oxygen. These measures will ensure that the results are quite accurate in all conditions, eliminating the possibility of a fluked result.

e The restoration of iron artefacts:

Iron artefacts that have been long submerged in wrecks will be covered in sulfates and chlorides.

1 Initially the artefact will be placed in a solution of sodium hydroxide ~~and~~ or sodium carbonate. This prevents the salts from crystallising and expanding which has the potential to destroy the structure of the artefact, and therefore, the artefact.

2 The artefact is X-rayed to identify regions

of concretions. This allows for the concretions to be chiselled off, or for more accurate work a pneumatic chisel is used. The removal of concretions allows for the next step of electrolysis.

3. Electrolysis is performed to stabilise the artefact as well as to remove any chlorides or sulfates. This is achieved by making the iron artefact the cathode & a steel mesh the anode with a dilute solution of $NaOH$ as the electrolyte. Iron is reduced and the bubbles of gas produced at the anode allow for further removal of rust flakes. This process continues for weeks & during this time chloride ion concentration in the electrolyte must be monitored and occasionally replaced.

4. After electrolysis the artefact is washed with water and ethanol to remove any remaining ions. To preserve the artefact it is coated with lacquer or wax.

While the steps used to clean, stabilise and preserve artefacts are quite useful, restoration to

initial properties is unlikely rather the aim of recovered artefacts is to obtain stability & allow for preservation