(a) (i) iron (and steel)

(ii) Aluminium is what is known as a passivating metal. This means that it forms an unreactive and impermeable oxide coating which prevents further corrosion. Thus it can be used as a protective coating for other metal structures.

(b) (i) Magnesium

(ii) sacrificial anodes are added to metal-hulled ships as they prevent the corrosion of iron by becoming the anode of a galvanic cell (as they are more readily oxidised than iron). The iron is consequently made the cathode of the reaction and any Fe^{2+} ions are converted back to iron. In this way, corrosion of the iron is prevented because the iron is

prevented from losing electrons as it becomes the cathode.

(c) The addition of other elements to iron changes the properties of steels and thus makes different steels with different properties more appropriate for certain uses. For example, all steel contains some carbon. If the percentage composition of carbon is increased, the steel becomes harder, less ductile and more brittle. Other elements such as Chromium and ~~Steel~~ Silicon can also be added to increase the hardness and the tensile strength of steel. Other elements can be added to improve the malleability of steel or to increase the mechanical strength. Thus, depending on the elements added, steel can

be used for a variety of purposes.

d) (i) corrosion is the oxidation of metals ~~which then react~~ to metal ions which then react with oxygen to form a metal oxide. This alters the structure of the metal, making it weaker.

(ii) Various metals including iron, carbon, magnesium, aluminium and copper could be placed in test tubes in various conditions including: - in water, open to the air
- in salt water, open to the air
- in water sealed from air with oil

then they could be left for a certain amount of time and then compared in terms of corrosion.

Alternatively, the corrosion rates of one metal in various conditions could be measured, for example, an iron nail could be placed in each of the above conditions, both straight and bent, this also illustrating the fact that corrosion is more likely to occur in places of tension.

(iii) The accuracy and reliability could be improved by ensuring that each of the metals tested are placed in exactly the same conditions - thus it would be necessary to measure

the amounts of salt and water placed in the test tubes. It would also be necessary to ensure that the size and surface area of each of the metal samples was approximately equal so that the comparison of the corrosion rates would be more accurate.

(e) Electrolysis can be used to restore Silver artefacts recovered from shipwrecks. As the silver artefacts (generally coins) would be encrusted with such things as Calcium Carbonate, this would first need to be removed (as much as possible through chemical cleaning). However, as the

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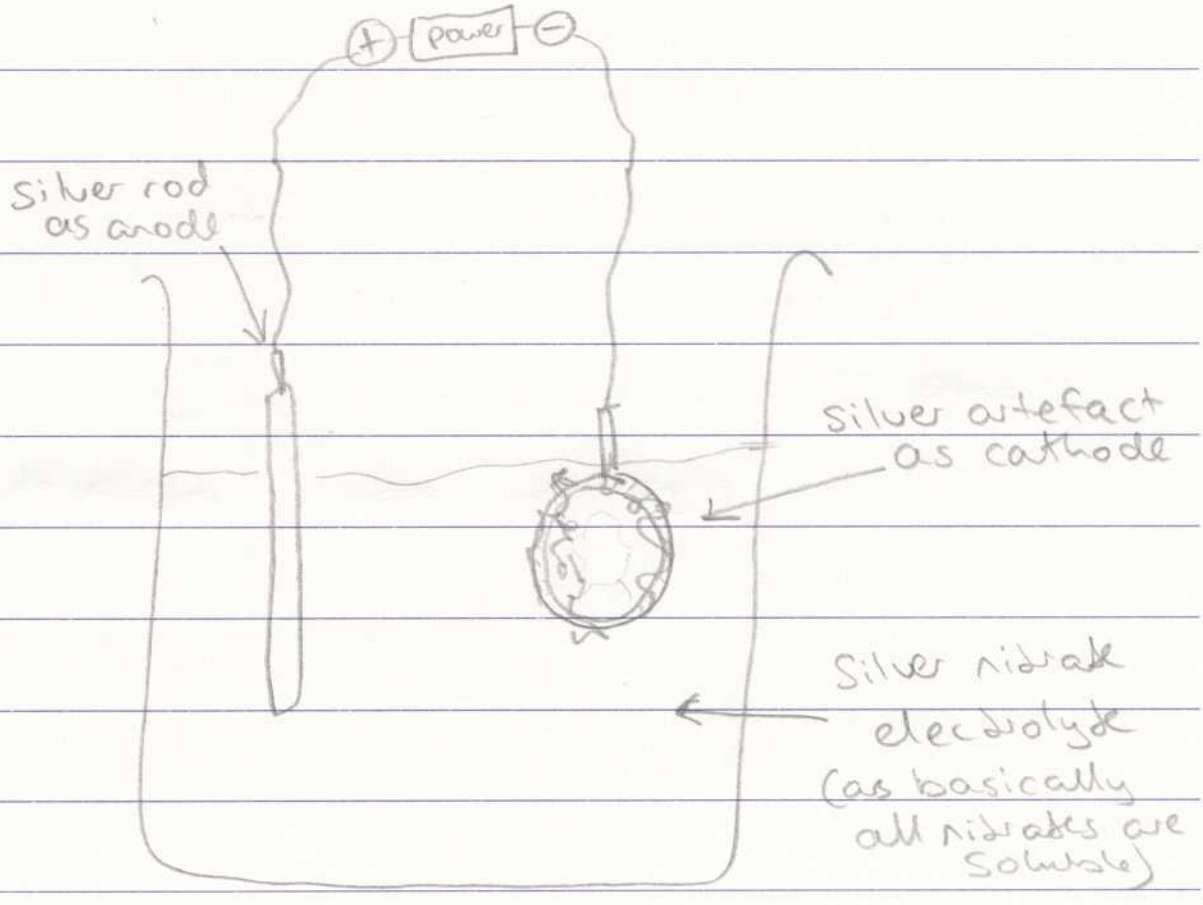
Encrustation normally contains some of the details from the artefact, electrolysis is a better way to restore it as it allows minimal loss of the details.

The silver artefact is placed at the cathode and a silver rod is used as an anode.



During electrolysis the silver ions are reduced to silver metal

$Ag^+ + 1e^- \rightleftharpoons Ag_{(s)}$ and the

Silver artefact is restored. Electrolysis is the most appropriate for the restorations of silver artefacts as it is a very delicate process. Once restored, the artefact may be coated in a protective preservative but due to the details this may not be the case, and may not be necessary. Possible preservatives include polyethylene glycol although this is more often used for the preservation of wood and leather artefacts.