9.6 Option — Shipwrecks, Corrosion and Conservation

1. The chemical composition of the ocean implies its potential role as an electrolyte

- identify the origins of the minerals in oceans as:
  - leaching by rainwater from terrestrial environments
  - hydrothermal vents in mid-ocean ridges
- outline the role of electron transfer in oxidation-reduction reactions
- identify that oxidation-reduction reactions can occur when ions are free to move in liquid electrolytes
- describe the work of Galvani, Volta, Davy and Faraday in increasing understanding of electron transfer reactions

2. Ships have been made of metals or alloys of metals

- account for the differences in corrosion of active and passivating metals
- identify iron and steel as the main metals used in ships
- identify the composition of steel and explain how the percentage composition of steel can determine its properties
  - describe the conditions under which rusting of iron occurs and explain the process of rusting
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3. Electrolytic cells involve oxidation-reduction reactions

- describe, using half-equations, what happens at the anode and cathode during electrolysis of selected aqueous solutions
- describe factors that affect an electrolysis reaction
  - effect of concentration
  - nature of electrolyte
  - nature of electrodes

4. Iron and steel corrode quickly in a marine environment and must be protected

- identify the ways in which a metal hull may be protected including:
  - corrosion resistant metals
  - development of surface alloys
  - new paints
- predict the metal which corrodes when two metals form an electrochemical cell using a list of standard potentials
- outline the process of cathodic protection, describing examples of its use in both marine and wet terrestrial environments
  - describe the process of cathodic protection in selected examples in terms of the oxidation/reduction chemistry involved

5. When a ship sinks, the rate of decay and corrosion may be dependent on the final depth of the wreck

- outline the effect of:
  - temperature
  - pressure

  on the solubility of gases and salts
- identify that gases are normally dissolved in the oceans and compare their concentrations in the oceans to their concentrations in the atmosphere
- compare and explain the solubility of selected gases at increasing depths in the oceans

- predict the effect of low temperatures at great depths on the rate of corrosion of a metal
- 6. Predictions of slow corrosion at great depths were apparently incorrect

- explain that ship wrecks at great depths are corroded by electrochemical reactions and by anaerobic bacteria
- describe the action of sulfate reducing bacteria around deep wrecks
- explain that acidic environments accelerate corrosion in non-passivating metals
- **7. Salvage, conservation and restoration of objects from wrecks requires careful planning and understanding of the behaviour of chemicals**
- explain that artefacts from long submerged wrecks will be saturated with dissolved chlorides and sulfates
- describe the processes that occur when a saturated solution evaporates and relate this to the potential damage to drying artefacts
- identify the use of electrolysis as a means of removing salt
- identify the use of electrolysis as a means of cleaning and stabilising iron, copper and lead artefacts
    - discuss the range of chemical procedures which can be used to clean, preserve and stabilise artefacts from wrecks and, where possible, provide an example of the use of each procedure

PRACTICAL TASKS

1. The chemical composition of the ocean implies its potential role as an electrolyte

process information from secondary sources to outline and analyse the impact of the work of Galvani, Volta, Davy and Faraday in understanding electron transfer reactions

2. Ships have been made of metals or alloys of metals

- identify data, select equipment, plan and perform a first-hand investigation to compare the rate of corrosion of iron and an identified form of steel
- use available evidence to analyse and explain the conditions under which rusting occurs

gather and process information from secondary sources to compare the composition, properties and uses of a range of steels

3. Electrolytic cells involve oxidation-reduction reactions

- plan and perform a first-hand investigation and gather first-hand data to identify the factors that affect the rate of an electrolysis reaction

- **4. Iron and steel corrode quickly in a marine environment and must be protected**

- identify data, gather and process information from first-hand or secondary sources to trace historical developments in the choice of materials used in the construction of ocean-going vessels with a focus on the metals used
- identify data, choose equipment, plan and perform a first-hand investigation to compare the corrosion rate, in a suitable electrolyte, of a variety of metals, including named modern alloys to identify those best suited for use in marine vessels
- plan and perform a first-hand investigation to compare the effectiveness of different protections used to coat a metal such as iron and prevent corrosion

gather and process information to identify applications of cathodic protection, and use available evidence to identify the reasons for their use and the chemistry involved

4. When a ship sinks, the rate of decay and corrosion may be dependent on the final depth of the wreck

- perform a first-hand investigation to compare and describe the rate of corrosion of materials in different :
  - oxygen concentrations
  - temperatures
  - salt concentrations

use available evidence to predict the rate of corrosion of a metal wreck at great depths in the oceans and give reasons for the prediction made

5. Predictions of slow corrosion at great depths were apparently incorrect

perform a first-hand investigation to compare and describe the rate of corrosion of metals in different acidic and neutral solutions

6. Salvage, conservation and restoration of objects from wrecks requires careful planning and understanding of the behaviour of chemicals

- perform investigations and gather information from secondary sources to compare conservation and restoration techniques applied in two Australian maritime archaeological projects

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