Section Three : Metals

Unit twelve: Corrosion of Metals and their Protection

IV. Which method to use?

Object	Suggested Method(s)
Rust-proof iron nails	Stainless steel, plating
Bus stop sign	Painting
Steel scissors blades	Stainless steel, oiling
Food can	Tin plating
Lock	Plating, stainless steel
Oil tanker	Painting, sacrificial protection
Car exhaust pipe	Plating, stainless steel
Refrigerator shelves	Plastic coving, stainless steel, plating

Supplementary Exercise

1. (a) Iron nail with zinc strip:

Observation: Around zinc strip - no observable change

Explanation: Zinc is higher or more electropositive than iron in the electrochemical series.

$$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$$

Iron nail with copper strip:

Observation: Around iron nail - blue colour is developed

Explanation: Iron is higher than copper in the electrochemical series.

$$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$$

The Fe^{2+} forms a blue colour with the rust indicator.

(b) Coating the iron object with zinc can prevent rusting.

Advantage: Even if part of the coating is scratched, it is the zinc which corrodes as it is higher than iron in the electrochemical series.

Disadvantage: Zinc is poisonous, galvanized iron cannot be used in food containers.

2. (a) (1) $Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$

(2) $2H_2O(l) + O_2(g) + 4e^- \longrightarrow 4OH^-(aq)$

(b) to test the presence of Fe(II) ion

(c) from colourless to blue

(d) test-tube C.

Since copper is below iron in the electrochemical series, iron gives up electrons more readily.

(e) (1) Since zinc is higher than iron in the electrochemical series, zinc gives up electrons to iron and prevents the latter from rusting / sacrificial protection by zinc.

(2) Since the iron nail is connected to the negative pole of the battery, it is made negative and therefore does not rust readily.

3 A: A blue colour, indicating rust around the iron rod.
As silver is lower than iron in the reactivity series, the iron rusts rapidly.

B: No blue colour observed. No rusting as zinc (higher in the reactivity series than iron) reacts instead of the iron (sacrificial protection).

4 (a) Refer to Experiment of Rusting in Note.

(b) C. Both air and water are present.

(c) In C, the indicator turns blue as rust forms.

(d) Nail E rusts faster due to the presence of sodium chloride.

5 (a) Because steel is an alloy containing iron.

(b) (i) Oxygen from the air is used up during rusting.
Water rises to replace the oxygen.

(ii) The oxygen combines with the iron in the steel to form rust.

(c) (i) The gas does not contain oxygen.

(ii) nitrogen.

6. (a) Air and water.

(b) Salt and dilute acid.

(c) Dilute acid. (Speed of rusting is about the same with acid alone or salt and acid.)

(d) Air at Repulse Bay contains a lot of salt from sea spray.

7 (a) Iron and carbon.

(b) Handlebars - chromium plating.
Frame - painting.
Chain - oil.
Wheel rim - chromium plating. (On some bicycles, wheel rims are aluminium and not iron).

(c) Handlebars use chromium plating to look attractive.
Moving parts, such as the chain, need oil.

8 A. c B. a C. e
D. b E. d F. f

9 (a) Steel covered with zinc. Water and air prefer to react with the zinc rather than the iron as zinc is higher in the reactivity series than iron.

(b) Tin is less likely to react with liquids in a can than zinc. Any tin that dissolves is not toxic.

(c) Paint can easily peel off, allowing the iron to rust.

10 (a) Place a nail and muddy water in one test tube. In a control test tube, place a nail and tap water .

(b) After a time, the nail in the muddy water will show more rust.