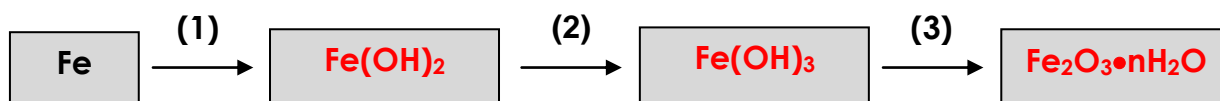
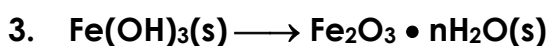


Suggested Answers on Note (Chapter 11) P.1



Equations:



Overall Equation:



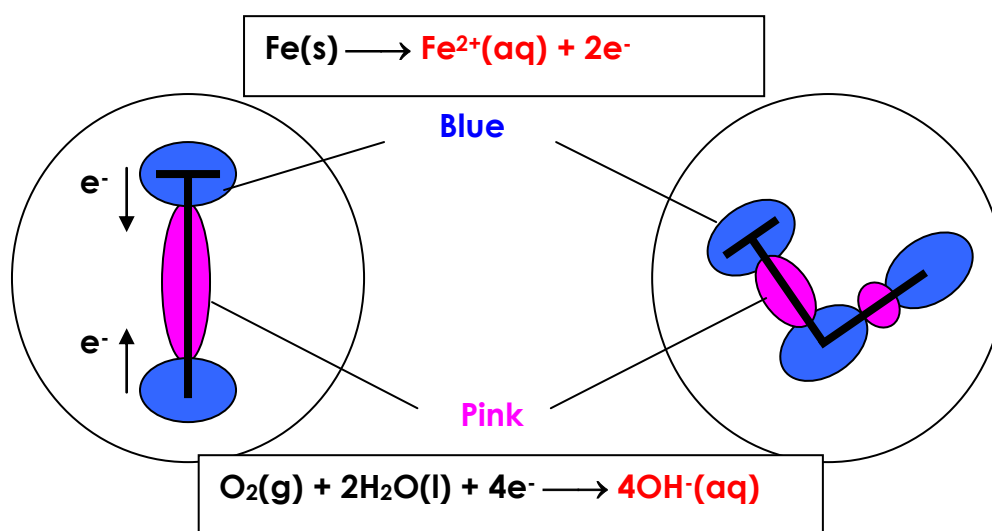
Suggested Answers on Note (Chapter 11) P.7

- There is very little water moisture in the air.
 - The temperatures are low in North and South Pole.
 - There is very little oxygen in the water near the seabed.
- Rate of rusting: B < A
Negative pole releases electrons which slow down rusting.
Positive pole gains electrons which increase the rate of rusting.
- Tube A.
The presence of sodium chloride (an ionic substance) speeds up the rusting process.

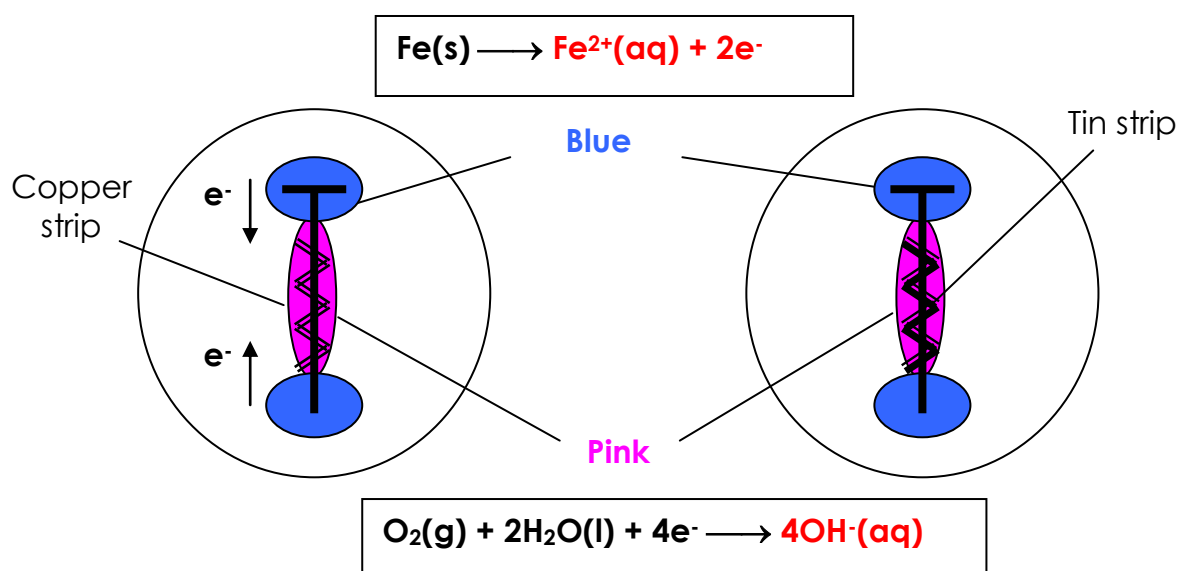
Suggested Answers on Note (Chapter 11) P.8 – 9

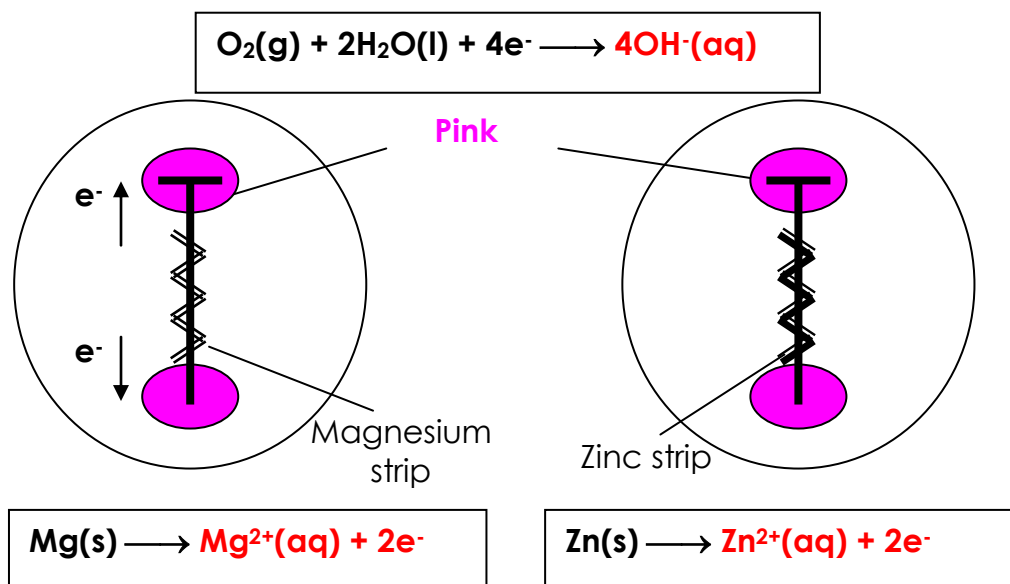
	Component	Presence of	Resulting colour
Rust indicator	Potassium hexacyanoferrate(II) $K_3[Fe(CN)_6]$	Iron(II) ion $Fe^{2+}(aq)$	Blue
	Phenolphthalein	Hydroxide ion $OH^-(aq)$	Pink

A. Showing rusting at sharp and bent regions (Refer to Experiment 11.2)



B. Showing rusting by wrapping with more and less reactive metals (Refer to Experiment 11.2)





Suggested Answers on Note (Chapter 11) P.14 – 18

1.

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

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

Iron nail with copper strip:

Observation: Around iron nail - blue colour is developed

Explanation: Iron is higher than copper in the electrochemical series.
 $\text{Fe}(\text{s}) \longrightarrow \text{Fe}^{2+}(\text{aq}) + 2\text{e}^-$
 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, 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.

3 (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.

4. (a) • Painting on the chain would wear off.
• Grease on the frame would be messy.
• Handlebar is chromium plated to make it more attractive.

(b) Plastic is lighter and does not rust.

5. (a) There was no oxygen in the boiled distilled water. The nail was in contact with water only. Therefore it did not rust.

(b) Sea water contains ionic substances such as sodium chloride. This speeded up the rusting process.

(c) Zinc loses electron more readily than iron. (Zinc is more reactive than iron.) It corroded instead of iron.

6. (a) To prevent the iron body from rusting.

(b) Tin loses electron less readily than iron. (Tin is less reactive than iron.) When the tin coating is scratched, the iron rusts more quickly than when it is alone.

(c) Zinc ions are poisonous and thus zinc cannot be used to coat the iron body of the can.

(d) Aluminium is softer than iron. It is easier to pull off the ring-pull.

Suggested Answers on Note (Chapter 11) P.20

There is no single right answer for this type of exercises. It is more important that students are able to support their choice with sensible reason(s) rather than giving the right answer in this type of exercises. The following answers are just for reference.

	Article	Choice and Reason
1.	To protect a bus stop sign.	Painting is used because it is low cost.
2.	To protect the base of an electric iron.	Chromium plating is used because both good protection and shiny appearance are important.
3.	To protect the steel frame of a swing in a park.	Painting is used because it is low cost.
4.	To protect the body of an old car.	Painting is used because it is low cost.
5.	To protect steel scissor blades.	Chromium plating is used because both good protection and shiny appearance are important.
6.	To protect a steel pencil-sharpener.	Zinc plating or tin plating is used because both methods give good protection with medium cost.
7.	To protect steel railings along the pavement.	Painting is used because it is low cost.
8.	To protect a food can.	Tin plating is used because tin is non-poisonous and the method gives fairly good protection with medium cost.

Suggested Answers on Note (Chapter 11) P.23

- (a) The thickness of the aluminium oxide layer is increased by a process called aluminium anodization. Anodized aluminium is much more resistant to corrosion.
Iron is painted to prevent both oxygen and water from reaching the iron.
 - (b) As soon as the paint on iron is scratched, rusting starts. On the other hand, aluminium reacts with oxygen in the air to give an even coating of oxide. This protects the metal from further attack.
- Rust is not firmly attached to the iron surface and tends to fall off. A fresh iron surface is exposed and rusting goes on. This causes disintegration of the metal. Hence rusting is a destructive process.
When aluminium reacts with oxygen in the air, an even coating of aluminium oxide forms. This oxide layer sticks to the surface of the metal. It protects the metal underneath from further attack. Hence corrosion of aluminium is a useful process.

Suggested Answers on Note (Chapter 11) P.25 – 33

- 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).
- (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.
- (a) (i) $\text{Fe}(s) \longrightarrow \text{Fe}^{2+}(aq) + 2e^{-}$
(ii) $2\text{H}_2\text{O}(l) + \text{O}_2(g) + 4e^{-} \longrightarrow 4\text{OH}^{-}(aq)$
 - (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) (i) 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.
(ii) Since the iron nail is connected to the negative pole of the battery, it is made negative and therefore does not rust readily.
4. (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.
5. (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.
6. A. c B. a C. e
D. b E. d F. f
7. (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.
8. (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.
9. (a) Its surface layer of oxide prevents the metal corroding.
- (b) Iron and steel are strong and much cheaper.
- (c) Stainless steel is very expensive.

10 (a) Test tubes (3) and (4)

In test tube (3), the iron nail was in contact with water only. There was no air (oxygen). Rusting would not occur.

In test tube (4), the iron nail was in contact with dry air only. There was no water. Rusting would not occur.

(b) Test tube (1)

The sodium chloride solution speeds up the rusting process.

(c) (i) To stop oxygen from dissolving in the water again.

(ii) To absorb moisture in the air inside the test tube.

(d) (i) Yes

(ii) It will rust faster in the gases given off from an industrial plant.

It is because the gases are probably acidic and form acids with moisture in the air. The rusting process is speeded up.

11. (a) Magnesium is a sacrificial metal.

It corrodes instead of the steel tank.

(b) Tin is less reactive than iron. Once the tin coating of the can is damaged, the iron rusts more quickly than when it is alone.

Zinc is more reactive than iron. Even when the zinc coating of the iron rubbish bin is damaged, the zinc corrodes instead of the iron.

12. (a) Both oxygen and water are present in the soil.

(b) (i) Attach a lump of zinc / magnesium to the tank.

(ii) Zinc / magnesium is more reactive than iron.

When it is attached to the steel tank, it corrodes instead of the steel. This method is called sacrificial protection.

(c) (i) Stainless steel does not corrode easily.

(ii) Stainless steel is very expensive. It is cheaper to protect the steel tank from rusting and replace the tank when necessary.

13. (a) Aluminium oxide layer

When aluminium reacts with oxygen in the air, an even coating of aluminium oxide forms.

This oxide layer sticks to the surface of the metal.

It protects the metal underneath from further attack.

(b) (i) Aluminium anodization

(ii) The positive electrode