Metal questions

1. What are the chief chemical properties that distinguish from non metal?

2. Describe the 3 main methods of extraction for their ores?

3. Describe briefly how metals may be separated from their sulphide and from their carbonate ores?

4. How is the oxidation of the surface of aluminium articles different to the oxidation of articles made of iron?

5. What is galvanizing? How does it protect steel?

6. Why does rusting occur at a greater rate near the seaside?

7. Iron is known to rust faster in confined spaces than in expose air situation. Suggest a reason for this?

8. Zinc an iron reacts with dilute nitric acid, forming ammonium nitrates. This reaction occurs in three steps. First, atomic hydrogen is produced. Next the atomic hydrogen reacts with the nitric acid to produce ammonia. Finally, ammonia reacts with nitric acid producing ammonium nitrate. Write balanced equations to represent these steps?

9. What are the functions of the limestone in the blast furnace for the extraction of iron?

10. List the main properties and uses of copper. How is each of its property related to its use?

11. Why is copper added to gold when making jewellery?

12. Metals that do not react with cold water often react with hot water or steam. Suggest a reason for this?

13. Why is rusting inhibited in an alkaline environment?

Metal questions Solutions

1. The tendency for metals to lose their electrons and become electropositive and the tendency of non-metals to gain electrons and become electronegative determines the chemical behaviour of metals and non-metals. Low values of ionization potentials, electronegativity and electron affinity explain the chemical behaviour of metals. Reactions with water, acids, alkalis and carbonates are some of the typical chemical behaviour that distinguishes metals from non-metals.

2. The main methods of extraction involves a) concentration of the ore, b) preliminary treatment of the ore to remove earthly impurtities, c) reduction of the treated ore to get the crude metal, and d) the refining of the crude metal. Metals which are high in the reactivity series are obtained by electrolytic reduction (e.g. Na, K, Ca, etc.). Medium reactivity metals such as Pb, Cu and Hg mainly occur as sulfide ores. These are first oxidized to get their oxides and then reduced using suitable reducing agents. Metals, like iron, which are slow to react, are obtained by direct carbon reduction, using coke.

3. Metal sulfides are first roasted to oxidize the sulfur to sulfur dioxide. In that process the metals get oxidized to their oxide forms. These oxides are then reduced, using suitable oxidizing agents. Metal carbonates are roasted to remove carbon dioxide first and then reduced using suitable reducing agents:

$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$ $\quad$ $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

$ZnCO_3 \rightarrow ZnO + CO_2$ $\quad$ $ZnO + Cu \rightarrow Zn + CO$

4. When the surface of aluminium is oxidized it forms an impenetrable layer of Al_2O_3 on the surface of the aluminium article which prevents the exposure of any fresh metallic surface to oxygen and stops any further corrosion. Furthermore, the oxidized layer itself is shiny and unreactive with oxygen or moisture from the air.

5. Galvanising is the process of dipping steel in molten zinc to form a coating. Steel which has been galvanized is protected from further corrosion by the zinc coating. Even if the coating gets chipped or cracked, the exposed iron surface will not oxidize until all the zinc has been completely oxidized.

6. Salt water spray and the presence of moisture provides an ideal environment to carry ions produced at the reduction site to other parts of the material. The simulated galvanic conditions speed up the rusting process.

7. In a confined space, the trapped air and oxygen are forced to react in a galvanic cell environment. An iron tray covered with a loose plastic sheet and left out in the moist air will corrode much faster compared to a similar tray left uncovered.

8. $Fe(s) + 2HNO_3(aq) \rightarrow Fe(NO_3)_2(aq) + 2H(g)$
$2HNO_3(aq) + 4H(g) \rightarrow 2NH_3(g) + 3O_2(g)$
$NH_3(g) + HNO_3(g) \rightarrow NH_4NO_3(g)$

9. The limestone first decomposes by heat to give CaO and CO_2.
The CO_2 gas then reacts with the coke (C) to produce CO gas.
The CO gas reacts with the iron ore Fe_2O_3 to produce crude iron and CO_2.

10. Copper is a good electrical and heat conductor and has a high melting point of 1083°C. This makes it ideal for electrical cables and boilers and cooking utensils. It is a valuable constituent of many alloys which are strong and durable because alloying reduces the malleability of copper. It is also used in alloying gold to reduce the malleability of both gold and copper.

11. This is done mainly to reduce its malleability and ductility.

12. Hot water or steam brings in the required activation energy for the reaction to proceed to completion.

13. A key step in the rusting process is the reduction of oxygen. This reaction is given as:

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

An increase in the concentration of OH^- ions in a basic environment will shift the equilibrium to the left and will inhibit the process of rusting.