# Metals and Non-Metals

## Periodic Test

**Q.1. Name one metal and one non-metal that exists in liquid state at room temperature.**

**Answer:** Mercury is a metal that exists in liquid state at room temperature. Bromine is the non-metal that exists in liquid state at room temperature.

**Q.2. Why metals can act as reducing agents while non-metal cannot?**

**Answer:** Metals act as reducing agents because highly reactive metals have the ability to displace low reactivity metals from their compounds. Non-metals do not display this property.

**Q.3. What type of oxides are formed by?**

**(a) Metals**

**(b) Non-metals?**

**Answer:** (a) Metals form oxides (metallic oxides) which are basic in nature. Some examples are $Na_2O$, $K_2O$ etc.

(b) Non-metals form oxides (non-metallic oxides) which are acidic in nature. Some non-metallic oxides are $NO_2$, $SO_2$.

**Q.4. Name two non-metals which are lustrous.**

**Answer:** Iodine and carbon are non-metals which are lustrous. Note that carbon is lustrous only in certain forms like diamond, and graphite.

**Q.5. Name two metals:**

**(a) which have very low melting points,**

**(b) which are so soft that they can be cut with a knife.**

**Answer:** (a) Gallium and Caesium are two metals which have very low melting points. The melting point is so low that they start to melt if kept in our palms.

(b) Sodium and potassium are two metals which are soft and can be cut with a knife. They belong to the group of alkali metals. (Group 1 elements)

**Q.6. Name two metals:**

**(a) which are best conductors of heat,**

**(b) which are comparatively poor conductors of heat.**

**Answer:** (a) Silver and copper are the best conductors of heat.

(b) Mercury and lead are two poor conductors of heat.

**Q.7. What is meant by malleability? Name two most malleable metals.**

**Answer:** The property of metals which allow them to be beaten into thin sheets is called malleability. Gold and silver are the most malleable metals.

**Q.8. What is meant by ductility? Name two most ductile metals.**

**Answer:** The ability of the metals to be drawn into thin wires is known as ductility. Gold and platinum are the most ductile metals.

**Q.9. Name two metal oxides which are:**

**(a) water soluble**

**(b) insoluble in water.**

**Answer:** (a) Sodium oxide ($Na_2O$), potassium oxide ($K_2O$) are metal oxides which are water soluble.

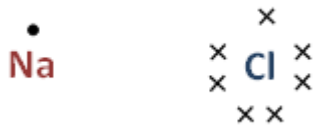
(b) Copper (II) oxide ($Cu_2O$), Beryllium oxide (BeO) are metal oxides which are water insoluble.

**Q.10. What is meant by anodising? Why is it done?**

**Answer:** The process of coating an oxide layer over a metal is called anodizing. Usually, aluminium is selected as the metal, and the oxide coating will be aluminium oxide. Anodising is done to make the metal resistant to further corrosion.

**Q.11. Write the electron-dot structure for Na and Cl atoms. How do these form a chemical bond? Name the type of bond so formed. Why does a compound so formed have high melting point?**

**Answer:** The reactivity of the elements is determined by the tendency to have a completely filled valence shell. The electron dot structure of Na (sodium) and Cl (chlorine) atoms are shown in the figure below.




Electron dot structure of Na and Cl

To attain completely filled valence shell, Na has to lose the outermost electron, and Cl needs one electron to complete the valence shell.

By losing an electron, Na becomes $Na^+$ (cation) and this electron is accepted by Cl to form $Cl^-$ (anion). The oppositely charged ions attract each other and form NaCl. They are held together by strong electrostatic forces of attraction. The bond existing between them is called an ionic bond.

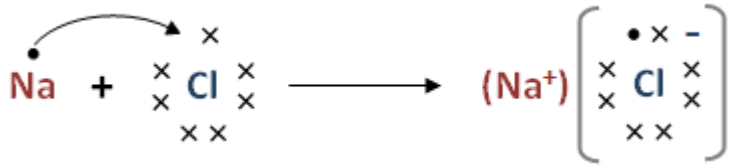



Figure 1: Formation of sodium chloride

Since the inter-ionic forces are very strong, it requires a considerably large amount of energy to break the bond. Hence, ionic compounds have high melting point.

**Q.12. Differentiate between metals and non-metals with respect to their chemical properties.**

**Answer:** The properties of metals and non-metals are given in the form of a table shown below. The properties mentioned here apply to the metals and non-metals generally. However, all metals and non-metals may not obey the given properties; there might be exceptions.

| **Metals** | **Non-metals** |
|---|---|
| Contain 1-3 electrons in their valence shell | Contain 4-8 electrons in their valence shell |
| Lose electrons to achieve stable electronic configuration | Accept electrons to achieve stable electronic configuration |
| Possess low electronegativity | Possess high electronegativity |
| Combine with oxygen to form metallic oxides which are generally basic in nature. | Combine with oxygen to form non-metallic oxides which are acidic or neutral in nature. |
| Metal + Water → Metal oxide + Hydrogen | Non-metal +Water → No reaction |
| Metal + Acid → Salt + Hydrogen | Non-metal + Water → No reaction |

**Q.13. Differentiate between roasting and calcination.**

**Answer:** The process of heating a sulphide ore strongly in the presence of excess air is called roasting.

The process of heating a carbonate ore strongly in the presence of limited air is called calcination.

**Q.14. Define the following terms:**

**(a) Alloy**

**(b) Corrosion.**

**Answer:** (a) An alloy is a homogenous mixture of two or more metals, mixed in a suitable proportion.

(b) Corrosion is the process of destruction of a material caused by chemical reactions between the material and the surrounding environment.

**Q.15. What happens when:**

**(a) iron reacts with steam?**

**(b) calcium and potassium are put in water?**

**Answer:** (a) Iron (II) oxide (FeO), as well as iron (III) oxide (Fe2O3), are oxides of iron. When iron reacts with steam, both oxides are formed and the product is in a combined form ($FeO.Fe_2O_3$ or $Fe_3O_4$).

$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

(b) Calcium and potassium are two highly reactive metals in the reactivity series.

Potassium reacts very violently with water, and hydrogen is released. The reaction is so exothermic that the evolved hydrogen catches fire immediately.

$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g) + \text{heat energy}$

The reaction of calcium with water is not as violent as the above reaction. The heat evolved is not sufficient for the hydrogen to catch fire. Also, calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of calcium.

$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$

**Q.16. Show the formation of:**

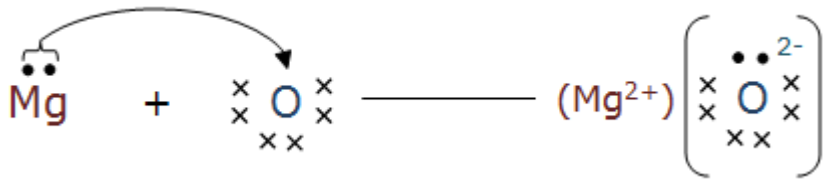
**(a) MgO**

**(b) $Na_2O$ by the transfer of electrons.**

**Answer:** (a) Magnesium loses two electrons to attain a noble gas configuration, whereas oxygen gains two electrons to completely fill the valence shell.

$Mg \rightarrow Mg^{2+} + 2e^-$

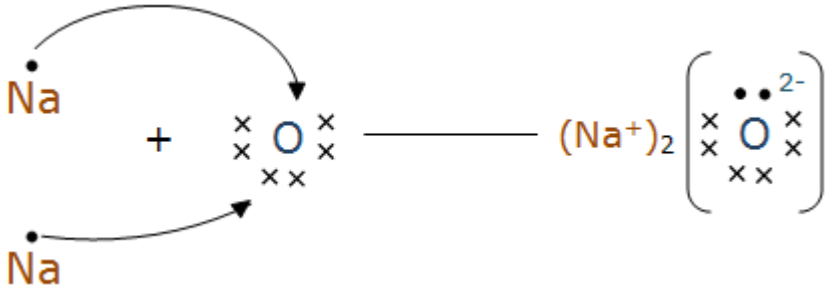
$O + 2^{e-} 1\rightarrow O^{2-}$




(b) Sodium loses one electron to have a completely filled valence shell, whereas oxygen gains two electrons to complete the valence shell.

$Na \rightarrow Na^+ + e^-$

$O + 2e^- \rightarrow O^{2-}$




**Q.17. Why do ionic compounds:**

**(a) are hard and solids?**

**(b) conduct electricity in their aqueous solution form or molten state?**

**Answer:** (a) Ionic compounds are made up of oppositely charged ions which are held together by strong electrostatic force of attraction. Due to this reason, they are hard solids. When large pressure is applied, they tend to break into pieces.

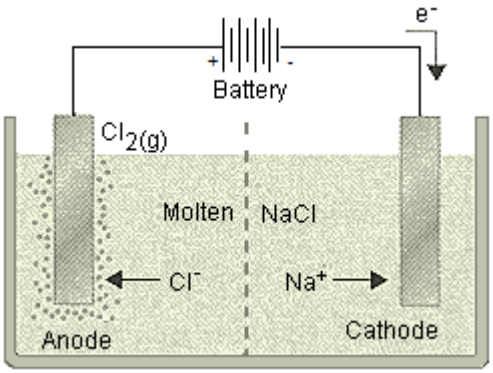
(b) Conduction of electricity is achieved by the movement of charged particles. In the molten state or in their aqueous solution form, ionic compounds contain ions which can move throughout the solution/molten solid, which helps in conducting electricity.

**Q.18. How are the following metals reduced:**

**(a) Metals which are highly reactive?**

**(b) Metals which are in the middle of the reactivity series?**

**Answer:** (a) Highly reactive metals (e.g., sodium, potassium) are reduced from their compounds by electrolytic reduction. By electrolyzing the chlorides or oxides of these metals, the pure metal is deposited at the cathode.




Electrolysis of molten sodium chloride

(b) Metals which come in the middle of the reactivity series are reduced from their compound using any of the following techniques.

i. If the compound is a metal oxide, then it is reduced to the corresponding metals by reduction using carbon (coke) in the presence of heat.

ii. If the compound is a metal carbonate, then it is converted into corresponding metal oxide by strongly heating it in the limited air (calcination). Later, metal oxides are reduced to metals using carbon.

iii. If the compound is a metal sulphide, then it is converted into corresponding metal oxide by strongly heating it in excess air (roasting). Then the metal oxide obtained is reduced to metal using carbon.

**Q.19. How you will obtain the following metals:**

**(a) mercury from cinnabar?**

**(b) Copper from its ore copper glance?**

**Answer:** (a) Cinnabar (HgS – mercury (II) sulphide or mercuric sulphide) is an ore of mercury. It is heated in air to give mercuric oxide (HgO). Mercuric oxide is further heated to get mercury. The reactions involved are,

$$2HgS(s) + 3O_2(g) \xrightarrow{heat} 2HgO(s) + 2SO_2(g)$$

$$2HgO(s) \xrightarrow{heat} 2Hg(s) + O_2(g)$$

(b) Copper glance is a sulphide ore of copper ($Cu_2S$). So it is converted to cuprous oxide ($Cu_2O$) by just heating in air. Cuprous oxide is reduced to copper using carbon. The reactions involved are,

$$2Cu_2S(s) + 3O_2(g) \xrightarrow{heat} 2Cu_2O(s) + 2SO_2(g)$$

$$2Cu_2O(s) + Cu_2S(s) \xrightarrow{heat} 6Cu(s) + SO_2(g)$$

**Q.20. What happens when:**

**(a) manganese dioxide is heated with aluminium powder?**

**(b) iron (III) oxide is heated with aluminium powder?**

**Answer:** (a) When manganese dioxide ($MnO_2$) is heated with aluminium powder, displacement reaction takes place, and manganese is obtained as the product along with aluminium oxide. It is an exothermic reaction and hence Mn is obtained in molten form.

$3MnO_2(s) + 4Al(s) \rightarrow 3Mn(l) + 2Al_2O_3(s) + heat$

(b) Iron (III) oxide is heated with aluminium powder to form iron and aluminium oxide. This is another example of a displacement reaction and is highly exothermic. This reaction is also known as thermit reaction.

$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s) + Heat$

**Q.21. How will you extract metal M from its enriched sulphide ore, if M is in the middle of the reactivity series? Write various steps used in extracting this metal.**

**Answer:** For a metal in the middle of the reactivity series, having a sulphide ore, the following processes are done to extract the metal M.

i. The ore might contain impurities (also called gangue) which must be removed before the extraction of metal.

ii. The metal sulphide ore is subjected to strong heating in excess air. This process is called roasting, and it converts the metal sulphide to the corresponding metal oxide. The reaction can be represented as:

$$\text{Metal sulphide} + \text{Oxygen} \xrightarrow{\text{heat}} \text{Metal oxide} + \text{Sulphur dioxide}$$

iii. Now, the metal oxide is reduced to the metal M using suitable reducing agents like C (coke) in the presence of heat.

$$\text{Metal oxide} + C \rightarrow M + CO$$

iv. Once the extraction is complete, M is subjected to various refining processes to remove impurities from the metal.

**Q.22. What is a reactivity series? Describe an activity to develop a reactivity series.**

**Answer:** A reactivity series is a list of metals which are arranged in the order of their decreasing activity. This means the metal at the top of the series is the most reactive and the metal at the bottom of the list is the least reactive metal.

To develop a reactivity series, take pieces of different metals (e.g., iron, copper, zinc etc) and the salt solutions of those metals (i.e., iron sulphate, copper sulphate, zinc sulphate etc).

Add a metal piece to a different metal salt solution. Check for any colour changes in the solution or to the metal piece and record your observations.

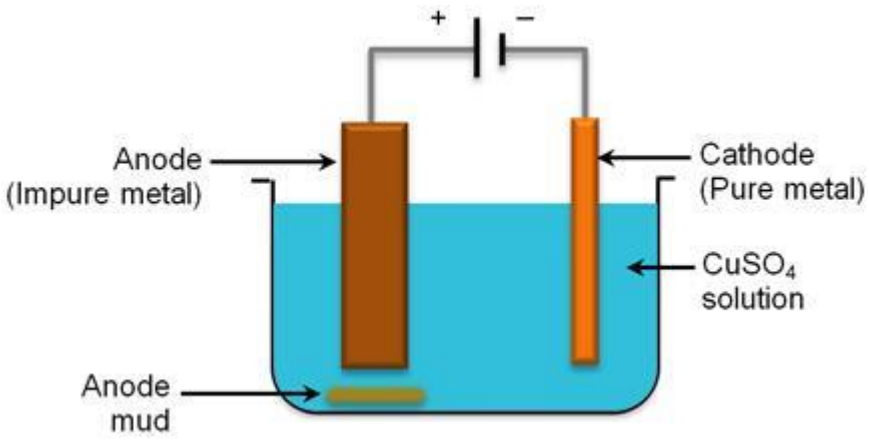
One can tell that for metals A and B if the following reaction occurs,

Metal A + salt solution of B → metal B + salt solution of A

Then, metal A is more reactive than B. Similarly by trying out various combinations of metals with metal salt solutions, one can create a reactivity series.

**Q.23. How electrolytic refining of copper is carried out? Explain in detail.**

**Answer:** The electrolytic refining of copper is done using the apparatus shown in the figure below.




This is a standard electrolysis setup, where the impure copper (the sample to be refined) is placed as anode and a thin strip of pure copper is placed as cathode. The electrolyte used is copper sulphate solution. When current is passed through the electrolyte, pure copper content from anode dissolves into the electrolyte, and the same amount of copper is deposited on the cathode. One can see that the thickness of the cathode increases.

The soluble impurities present in the anode goes into the solution when the current flows through the setup. The insoluble impurities present in the anode settle down at the bottom of the anode and is called anode mud. Thus, one can refine copper electrolytically.

**Q.24. Define the following:**

**(a) Amalgam**

**(b) Ore**

**(c) Mineral.**

**Answer:** (a) An alloy of mercury with another metal is called amalgam.

(b) Mineral which contains a very high percentage of a metal and from which the metal can be economically extracted is called an ore.

(c) An element or compound which occurs naturally in the Earth’s crust is called a mineral.

**Q.25. What is meant by corrosion? How corrosion is caused? How it can be prevented? What is the effect of corrosion on:**

**(a) copper?**

**(b) silver?**

**Answer:** Corrosion refers to the destruction or deterioration of a substance due to its interactions with the surrounding environment. Corrosion is a natural process and occurs when the substance is in contact with air, water, chemicals like acid etc. Corrosion can damage metals causing it to lose properties such as strength and conductivity of heat/electricity.

Corrosion can be prevented by various techniques like painting the surface of the material, galvanizing, oiling, greasing etc.

(a) Copper when in contact with moist carbon dioxide in air gains a green coloured coat over copper. This coat is nothing but copper carbonate formed by the reaction of copper and moist carbon dioxide.

(b) Silver reacts with sulphur present in the air to form a black coating of silver sulphide over the surface of silver.

**Q.26. (a) Make a flowchart to explain the various steps involved in the extraction of metals from ores.**

**(b) Give four characteristics of ionic compounds.**

**OR**

**Give reasons only:**

**(a) Na, K and Li are stored under oil.**

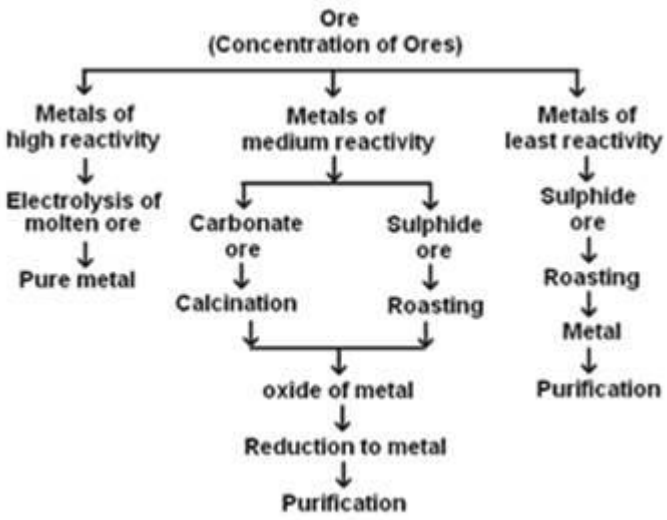
**(b) Pt, Au and Ag are used to make jewellery.**

**(c) Hydrogen gas is not evolved when metals react with nitric acid.**

**(d) Aluminium is a reactive metal, yet it is used to make utensils for cooking.**

**(e) Aqueous copper sulphate solution should not be stored in an iron container.**

**Answer:**




Flowchart: Extraction of metals from ores

(b) The characteristics of ionic compounds are,

i. Ionic compounds are hard solids. They are brittle in nature.

ii. They have high melting and boiling point.

iii. They are generally soluble in water, but they do not dissolve in solvents like kerosene, petrol etc.

iv. Ionic compounds conduct electricity in their molten/dissolved form. They do not conduct electricity in their solid form.

**OR**

(a) Na, K and Li react vigorously with air and water. Hence they cannot be kept in open or in water. They do not react with oil or kerosene. They are stored under oil to avoid contact with air and water.

(b) Pt, Au and Ag are lustrous. They shine brightly when light falls on them. Besides, these metals are easily malleable and ductile to make chains, rings, and so on. Thus they are used in jewellery.

(c) Nitric acid is a strong oxidizing agent. The hydrogen gas obtained from the reaction is quickly oxidized to water ($H_2O$).

(d) Aluminium is a light metal. It is a good conductor of heat. It has a relatively high melting point. Due to the reactivity of aluminium, it combines with oxygen to form a layer of aluminium oxide over the surface of aluminium. This oxide layer prevents it from further reactivity of the metal. All these reasons make aluminium useful in making cooking utensils.

(e) Iron is more reactive than copper. So iron would displace copper from its salt solutions. In this case, the following reaction will occur:

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

Hence, there will no longer be copper sulphate solution in the container. It is advised to store chemicals with containers made of less reactive metals.

## Comprehensive Exercises (MCQ)

**Q.1. Which of the following pairs will give displacement reactions?**

**A. NaCl solution and copper metal**

**B. $MgCl_2$ solution and aluminium metal**

**C. $FeSO_4$ solution and silver metal**

**D. $AgNO_3$ solution and copper metal**

**Answer:** A metal which has high reactivity can displace a metal with low reactivity from its salt solution. By looking at the reactivity series one can write the order of reactivity:

Na>Mg>Ca>Al>Fe>Cu>Ag

**Q.2. Which of the following methods is suitable for preventing an iron frying pan from rusting?**

**A. Applying grease**

**B. Applying paint**

**C. Applying a coating of zinc**

**D. All of these**

**Answer:** Strictly speaking, all the above-mentioned methods would prevent iron from rusting. Since it is a frying pan, the most suitable method would be to apply a coating of zinc.

**Q.3. An element reacts with oxygen to give a compound with a high melting point. This compound is also soluble in water. The element is likely to be:**

**A. Calcium**

**B. Carbon**

**C. Silicon**

**D. Iron**

**Answer:** Metal oxides have relatively high melting points. Here both iron and calcium are metals, but iron oxide is insoluble in water.

**Q.4. Food cans are coated with tin and not with zinc because:**

**A. Zinc is costlier than tin**

**B. Zinc has a higher melting point than tin**

**C. Zinc is more reactive than tin**

**D. Zinc is less reactive than tin.**

**Answer:** Zinc is a highly reactive metal, and it might react with the contents of the can. Metals of low reactivity are used as food cans.

**Q.5. The electrical conductivity and melting point of an alloy is:**

**A. Less than that of pure metal**

**B. More than that of pure metal**

**C. Equal to that of pure metal**

**D. Electrical conductivity is less and melting point is more than that of pure metal.**

**Answer:** An alloy is composed of different metals mixed in a certain proportion. So the properties exhibited by one “full” metal cannot be seen in alloys.

**Q.6. Brass is an alloy of:**

**A. Copper and zinc**

**B. Copper and tin**

**C. Copper and nickel**

**D. Copper and lead.**

**Answer:** Brass is an alloy of copper and zinc and is used in making locks, gears, etc.

**Q.7. Solder is an alloy of lead and tin. It has a:**

**A. Low melting point and is used for welding electrical wires together.**

**B. Low melting point and is used for welding heavy iron machinery.**

**C. High melting point and is used for welding electrical wires together.**

**D. High melting point and is used for welding heavy iron machinery.**

**Answer:** Solder has a low melting point, and upon giving a small amount of heat, it turns into liquid and solidifies on cooling.

**Q.8. Galvanisation is a method of protecting:**

**A. Steel and copper from rusting**

**B. Steel and silver from rusting**

**C. Steel and iron from rusting**

**D. Steel and tin from rusting.**

**Answer:** Galvanisation is the process of applying a protective coating of zinc over the surfaces of steel and iron.

**Q.9. The metals which are mixed with iron to make stainless steel are:**

**A. Copper and nickel**

**B. Nickel and chromium**

**C. Copper and chromium**

**D. Copper and silver**

**Answer:** Nickel and chromium are mixed with iron to make stainless steel which does not rust.

**Q.10. Bronze is an alloy of:**

**A. Copper and zinc**

**B. Copper and lead**

**C. Copper and tin**

**D. Copper and nickel**

**Answer:** Bronze is an alloy of copper and tin and is commonly used in industries.

**Q.11. Which of the following metals are obtained by electrolysis of their chlorides in molten state?**

**(i) Na (ii) Ca**

**(iii) Fe (iv) Cu**

**A. (i) and (iv)**

**B. (iii) and (iv)**

**C. (i) and (iii)**

**D. (i) and (ii)**

**Answer:** Metals at the top of the reactivity series are obtained by the electrolysis of their chlorides and oxides.

**Q.12. Which among the following statements is incorrect for magnesium metal?**

**A. It burns in oxygen with a dazzling white flame.**

**B. It reacts with cold water to form magnesium oxide and evolves hydrogen gas.**

**C. It reacts with hot water to form magnesium hydroxide and evolves hydrogen gas.**

**D. It reacts with steam to form magnesium hydroxide and evolves hydrogen gas.**

**Answer:** Magnesium does not react with cold water.

**Q.13. An electrolytic cell consists of:**

**(i) Positively charged cathode**

**(ii) Negatively charged anode**

**(iii) Positively charged anode**

**(iv) Negatively charged cathode**

**A. (i) and (ii)**

**B. (iii) and (iv)**

**C. (i) and (iii)**

**D. (ii) and (iv)**

**Answer:** (iii) and (iv)

**Q.14. During electrolytic refining of zinc, it gets:**

**A. Deposited on cathode**

**B. Deposited on anode**

**C. Deposited on cathode as well as anode**

**D. Remains in the solution.**

**Answer:** Impure metal is kept as anode, and a thin strip of pure metal is kept as cathode. The pure metal content present in anode is dissolved into the electrolyte and the same amount of copper gets deposited in cathode.

**Q.15. An element A is soft and can be cut with a knife. This is very reactive to air and cannot be kept open in air. It reacts vigorously with water. Identify the element from the following:**

**A. Mg**

**B. Na**

**C. P**

**D. Ca**

**Answer:** Na is one of the metals that can be cut with a knife. It is highly reactive to air and water.

**Q.16. Which one of the following properties are not generally exhibited by ionic compounds?**

**A. Solubility in water**

**B. Electrical conductivity in solid state**

**C. High melting and boiling points**

**D. Electrical conductivity in molten state.**

**Answer:** Ionic compounds do not conduct electricity because, in solid form, the ions are not freely moving.

**Q.17. Which of the following metals exist in their native state in nature?**

**(i) Cu**

**(ii) Au**

**(iii) Zn**

**(iv) Ag**

**A. (i) and (ii)**

**B. (ii) and (iii)**

**C. (ii) and (iv)**

**D. (iii) and (iv)**

**Answer:** Gold (Au) and Silver (Ag) are also known as Noble metals as they are less reactive and exist in their native state in nature.

**Q.18. Metals are refined by using different methods. Which of the following metals are refined by electrolytic refining?**

**(i) Au (ii) Cu**

**(iii) Na (iv) K**

**A. (i) and (ii)**

**B. (i) and (iii)**

**C. (ii) and (iii)**

**D. (iii) and (iv)**

**Answer:** (i) and (ii)

**Q.19. Silver articles become black on prolonged exposure to air. This is due to the formation of:**

**A. $Ag_3N$**

**B. $Ag_2O$**

**C. $Ag_2S$**

**D. $Ag_2S$ and $Ag_3N$**

**Answer:** Silver when exposed to sulphur in air forms a black coat of silver sulphide.

**Q.20. Galvanisation is a method of protecting iron from rusting by coating with a thin layer of:**

**A. Gallium**

**B. Aluminium**

**C. Zinc**

**D. Silver**

**Answer:** Zinc is more reactive than iron. Hence zinc acts a protective metal to prevent direct contact of iron with moisture, air etc.

## Comprehensive Exercises (T/F)

**Q.1. Write true or false for the following statements:**

**Non-metals react with acids to give a salt and hydrogen gas.**

**Answer:** False

Metals generally react with acids to give a salt and hydrogen gas.

**Q.2. Write true or false for the following statements:**

**At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide which protects the metal from further oxidation.**

**Answer:** True

**Q.3. Write true or false for the following statements:**

**Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of the burner.**

**Answer:** True

**Q.4. Write true or false for the following statements:**

**Copper does not burn in air, but the hot metal is coated with a black coloured layer of copper (II) oxide.**

**Answer:** True

**Q.5. Write true or false for the following statements:**

**Silver and gold react with oxygen at high temperatures.**

**Answer:** False

Silver and gold do not react with oxygen at high temperatures.

**Q.6. Write true or false for the following statements:**

**Hydrogen gas is evolved when a metal reacts with nitric acid.**

**Answer:** False

The hydrogen gas obtained from the reaction of metal and nitric acid is oxidized to water by nitric acid.

**Q.7. Write true or false for the following statements:**

**Copper reacts vigorously with dilute HCl.**

**Answer:** False

Copper is below hydrogen in the reactivity series. Therefore copper cannot displace H from HCl.

**Q.8. Write true or false for the following statements:**

**A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution.**

**Answer:** True

**Q.9. Write true or false for the following statements:**

**The elements or compounds, which occur naturally in the earth's crust, are known as minerals.**

**Answer:** True

**Q.10. Write true or false for the following statements:**

**Those minerals which contain a very high percentage of a particular metal and from which metal can be profitably extracted are called ores.**

**Answer:** True