Metals and Non-Metals

Check Point 01

Q. 1. What are metalloids?

Answer: Metalloids refer to those class of material which possess properties of both the metals and non-metals. Examples of such materials are silicon, germanium etc. They possess fair conductivity of electricity or heat and are brittle in nature etc.

Q. 2. Which metal has highest melting point?

Answer: Among all the metals in their pure form, Tungsten has the highest melting point which is around 3422° C and this is the reason why it is used in the making of incandescent bulb filaments.

Q. 3. Some metals melt on keeping them on palm. Why? Also give an example.

Answer: Some metals melt on keeping them on palm because such metals have very low melting point compared to other metals. Examples of such metals are Gallium and caesium.

Q. 4. To avoid accidental fires, some metals are kept immersed in kerosene oil. Why?

Answer: Reactive metals like sodium and potassium react very violently with oxygen or water and hence the reaction can even catch fire. To prevent such an accidental reaction or fires, metals are kept immersed in kerosene oil.

Q. 5. An element X is soft and can be cut with a knife easily. This is very reactive with air and cannot be kept open with air. It reacts vigorously with water. Name the element X.

Answer: Based on the description of the metal that it is reactive with water or air and it can be cut with a knife, the metal X is surely sodium as sodium possess all these properties.

Q. 6. Write a chemical reaction for metals with dil. HCl.

Answer: Less reactive metals do not displace hydrogen from the acids. Reactive metals like sodium, magnesium etc displace hydrogen from acids to form respective chlorides.

Reaction:

$2Na + 2HCl \rightarrow 2NaCl + H_2$

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

Q. 7. Name the reagent which is able to dissolve gold and platinum.

Answer: Gold and Platinum belong to class of noble metals in the sense that gold and platinum do not react with almost any chemical reagent.

Aqua Regia is the chemical mixture which consists of 3 parts of concentrated hydrochloric acid and 1 part of concentrated nitric acid and this mixture can dissolve gold and platinum. The reaction is as follows:

$Au + HNO_3 + 4\ HCl \rightarrow HAuCl_4 + NO + 2\ H_2O$

Check Point 02

Q. 1. Do non-metals possess lustre? Give two exceptions of this property of non-metal.

Answer: Lustre means the shine which is possessed generally by all the metals. Non-metals generally do not possess any kind of lustre.

Example of non-metals which possess lustre are carbon as diamond and iodine.

Q. 2. Give an example of a non-metal which is

a. hardest known substance.
b. a good conductor of heat and electricity.

Answer: (a) Diamond is the hardest known naturally occurring non-metalic substance.

(b) Graphite, an allotrope of carbon is a non-metal which is a good conductor of heat and electricity.

Q. 3. Non-metals do not evolve hydrogen gas when react with water, steam or dilute acids. Why?

Answer: Except for carbon all the non-metals are below hydrogen in the activity series of the elements because of which Non-metals do not evolve hydrogen gas when react with water, steam or dilute acids.

Q. 4. Write a displacement reaction for non-metal.

Answer: The best example of a displacement reaction for a non-metal is the reaction in which the more reactive halogen replaces the less reactive ones. The reaction is as follows:

$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$

Q. 5. Write the product by giving balanced chemical equation

(i) When sulphur reacts with conc. nitric acid.
(ii) When phosphorus reacts with conc. sulphuric acid.
(iii) When phosphorus reacts with conc. nitric acid.

Answer: (i) When Sulphur reacts with concentrated nitric acid, sulphuric acid, nitrogen dioxide and water are formed as the products. The reaction is as follows:

$S + 6HNO_3 \rightarrow H_2SO_4 + 6NO_2 + 2H_2O$

(ii) When white phosphorous reacts with concentrated sulphuric acid the products formed are phosphorous acid and Sulphur dioxide. The reaction is as follows:

$P_4 + 6H_2SO_4 \rightarrow 4H_3PO_3 + 6SO_2$

(iii) When phosphorous reacts with concentrated nitric acid formation of phosphoric acid, nitrogen dioxide and water takes place. The reaction is as follows:

$P + 5HNO_3 \rightarrow H_3PO_4 + 5NO_2 + H_2O$

Check Point 03

Q. 1. A non-metal gains electrons to form anions. What do you mean by this statement?

Answer: Non-metals typically have larger sizes as compared to the metals because of which to attain a stable noble gas configuration, it is difficult for a non-metal to lose electrons and on the other hand they can easily accept electrons with less energy involved to fill the octet.

Hence non-metals gain electrons to form anions.

Q. 2. What do you mean by ionic bond?

Answer: Ionic Bond is a type of chemical bond which exists between two oppositely charged species and the bond is mainly formed between electron donor element and electron acceptor element.

Example- NaCl, KBr etc.

In example of NaCl, Sodium atom donate one electron to chlorine atom to form ionic bond.

Q. 3. Water helps in separation of oppositely charged ions from their ionic compound. Give reason.

Answer: Water helps in separation of oppositely charged ions from their ionic state because when an ionic is dissolved in water the ions get attracted by the water molecules which leads to the dissociation of ionic compound.

Q. 4. Ionic compounds are crystalline solids and brittle. Why?

Answer: In Ionic compounds, ions are held tightly together by strong electrostatic forces of attraction making them quite rigid and hence even when a small force is applied to the compound, the force causes the ions to get displaced from the lattice and they suffer repulsion from similar charged ions in the lattice causing the ionic solids to shatter.

Q. 5. Why ions move freely and conduct electricity in the molten form?

Answer: In Ionic compounds, ions are held tightly together by strong electrostatic forces of attraction making them quite rigid. So these ions do not conduct electricity in solid state due to the immobility of the ions. But in molten state the ions get some free space to move as the electrostatic force of attraction weakens and hence allow the conduction of electricity.

Check Point 04

Q. 1. What is calcination?

Answer: Calcination is one of the processes of metallurgy in which the metals are heated at high temperatures in the absence or limited supply of air to get rid of the volatile substances and to convert the metal to its oxide.

Carbonates, Bicarbonates and hydroxide ores generally undergo calcination.

Reaction:

$$\underset{\text{Limestone}}{CaCO_3} \rightarrow \underset{\text{Quick Lime}}{CaO} + CO_2$$

Q. 2. In electrolytic reduction of NaCl, metal is deposited at the ……. and chlorine is liberated at the …….

Answer: In electrolytic reduction of NaCl, metal is deposited at the cathode and chlorine is liberated at the anode.

Sodium being electropositive in nature gets attracted to the negative electrode cathode and chlorine being electronegative in nature gets attracted to positive electrode anode.

Q. 3. Name any two elements which can be refined electrolytically.

Answer: The two metals which can be refined electrolytically are copper and zinc.

Q. 4. What is electroplating?

Answer: The word electroplating can be broken into two words electro which means using electricity and plating means to coat.

Hence electroplating is a process of coating a metal object with another metal like zinc, chromium etc by the process of electrolytic deposition in order to protect the base metal.

Q. 5. Why should we paint on a metal surface?

Answer: Metal surface when exposed to environment, there are chances that the oxygen or moisture present in the environment to react with the metal making the metal corroded.

In order to protect the metal from environmental factors the metal is painted.

Q. 6. What is galvanization? Name the element used in the process.

Answer: Galvanization is a process of coating a metal especially iron object with zinc metal.

Zinc is the metal which is used for coating and iron objects are generally galvanized to protect them from rust.

Q. 7. Name the elements which are resistant to corrosion.

Answer: Noble metals like gold and platinum which are unreactive under normal conditions are the elements which are resistant to corrosion.

Q. 8. What is the special quality of iron pillar near Qutub Minar?

Answer: The special quality of the iron pillar at Qutub Minar is that the pillar is not rusted or rather the pillar is rust resistant which depicts the high-quality craftsmanship of Indian craftsman.

Chapter Exercise

Q. 1. Which of the following elements is a metal?

$^{7}_{3}X, ^{3}_{1}Y, ^{10}_{9}Z$

Answer: Atomic Number of X = 3

Atomic Number of Y = 1

Atomic Number of Z = 9

Among the given elements, element X is a metal as it can easily lose one electron to achieve the stable noble gas configuration of helium. Element X is Lithium.

Element Z will be a non-metal as it can easily accept an electron to achieve the stable noble gas configuration of neon.

Q. 2. Name one metal and one non-metal which are obtained on a large scale from sea water.

Answer: Sea water contains many dissolved salts but the slat which is abundant in seawater is sodium chloride.

So Sodium and chlorine are obtained on a large scale from sea water.

Other salts in sea water are $MgCl_2$, $CaCl_2$ etc.

Q. 3. Name the process used for the concentration of the sulphide ore.

Answer: Concentration is a process of removal of impurities from the ores. Sulphide ores are normally concentrated by the process of Froth Flotation as these ores possess good wetting and froth forming properties when mixed with frothing agents.

Q. 4. For the reduction of metal oxide to metal, suggest a reducing agent cheaper than aluminium.

Answer: Element which is cheaper than aluminium and can be used for the reduction purposes is carbon. Carbon reacts with metallic oxides to form carbon dioxide and metal is obtained.

Q. 5. What is the purpose of adding carbon (C) to molten iron?

Answer: Carbon is added to the molten iron to improve the properties of iron and it basically enhances the strength, hardness and corrosion resistance property of iron.

Q. 6. Aluminium occurs in combined state the, whereas gold is found in free-state in nature. Why?

Answer: Noble metals like gold and platinum which are unreactive under normal conditions and hence are found in free-state.

On the other hand, aluminium is reactive in nature and hence react with environmental factors like oxygen or moisture to form corresponding products.

Q. 7. What is the difference between sodium atom and sodium ion?

Answer: Sodium atom contains total 11 electrons whereas sodium ion is formed by the loss of one electron and hence sodium ion contain total 10 electrons which is similar to the noble gas configuration of neon.

Q. 8. Why is it that non-metals do not displace hydrogen from dilute acids?

Answer: Except for carbon all the non-metals are below hydrogen in the activity series of the elements because of which Non-metals do not evolve hydrogen gas when reacting with water, steam or dilute acids. To displace hydrogen from the non-metal should be placed above hydrogen in the activity series.

Q. 9. Answer the following:

(i) Name a metal which does not stick to glass.
(ii) What is the nature of zinc oxide?
(iii) What is deposited at the cathode, a pure or impure metal?
(iv) Will carbon monoxide (CO) change the colour of blue litmus?

Answer: (i) Mercury is a metal which does not stick to glass as mercury lacks adhesive forces.

(ii) Zinc Oxide is amphoteric in nature which means it can act as an acid as well as a base in a chemical reaction depending upon the reaction conditions.

(iii) A pure metal will be deposited at cathode because cathode is a negative electrode and hence it attracts the positive metal ions from the electrolyte.

(iv) Carbon Monoxide will change the color of the blue litmus if the litmus paper is moist as carbon monoxide will dissolve in the water molecules to form weak acid.

Q. 10. Zn is more electropositive than Fe. Therefore, it should get corroded faster than Fe. But it does not happen. Instead, it is used to galvanize iron. Explain why does it happen so?

Answer: Though zinc is more reactive than iron but when a layer of zinc is exposed to the atmosphere zinc reacts with the oxygen in the atmosphere to form zinc oxide. This zinc oxide forms a protective layer on the surface of zinc which prevents the further attack. Hence zinc is used to galvanize iron.

Q. 11. Write the equations for the reactions of

(i) Iron with steam
(ii) Calcium with water
(iii) Potassium with water

Answer: (i) The reaction is as follows:

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

(ii) The reaction is as follows:

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

(iii) The reaction is as follows:

$2K + 2H_2O \rightarrow 2KOH + H_2$

Q. 12. Why Al metal cannot be obtained by the reduction of Al_2O_3 with coke? Explain.

Answer: Aluminium has far greater affinity for oxygen as compared to carbon because of which carbon cannot separate oxygen from aluminium oxide. Hence Al metal cannot be obtained by the reduction of Al_2O_3 with coke.

Q. 13. A solution of $CuSO_4$ was kept in an iron pot. After few days, the iron pot was found to have a number of holes in it. Explain the reason in terms of reactivity. Write the equation of the reaction involved.

Answer: In terms of reactivity o iron and copper, iron is more reactive than copper because of which iron reacts with the copper sulphate solution to form ferrous sulphate leaving holes in the iron pot. The reaction is as follows:

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

Q. 14. List three properties of sodium in which it differs from the general physical properties of most of the metals.

Answer: The three properties of sodium are as follows:

1. Sodium is very soft in nature and it can be easily cut with the help of a knife.

2. It is non-sonorous metal which means it does not make sound on being hit by hard object.

3. It has low melting and boiling points.

Q. 15.A. An ore, on heating in air, give Sulphur dioxide gas. Name the method in each metallurgical step that will be required to extract this metal from its ore.

Answer: Since the ore on heating in air gives Sulphur dioxide which means that the ore is a sulphide ore. The various methods involved in the extraction of metals from sulphide ores are as follows:

1. The ore is concentrated by the process of froth flotation to remove the impurities.

2. The concentrated ore is then heated in presence of air to convert the ore to corresponding metal oxide.

3. The metal oxide is then made to react with carbon to reduce the metal oxide to corresponding metal.

4. The metal is then purified by electrolytic reduction.

Q. 15. B. State which of the following reactions will take place or which will not, giving a suitable reason for each?

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

$Fe(s) + ZnSO_4(aq) \rightarrow FeSO_4(aq) + Zn(s)$

Answer: In the first reaction zinc is more reactive than copper and hence the above reaction is possible as zinc can replace copper from copper sulphate to form zinc sulphate.

In the second reaction, it is known that iron is less reactive than zinc and hence iron cannot replace zinc from zinc sulphate.

Q. 16. A non-metal A which is the largest constituent of air, when heated with H_2 in 1:3 ratio in the presence of catalyst (Fe) gives a gas B. On heating with O_2, it gives an oxide C. If this oxide is passed into water in the presence of air, it gives an acid D which acts as a strong oxidizing agent.

(i) Identify A, B, C and D.
(ii) To which group of the periodic table, does this non-metal belongs?

Answer: The non-metal which is the largest constituent of air is Nitrogen.

When nitrogen is heated with hydrogen in the ratio of 1:3 in presence of iron as a catalyst we get ammonia as the product. This process of ammonia production is called as Haber's process. The reaction is as follows:

$N_2 + 3H_2 \rightarrow 2NH_3$

When nitrogen is heated with oxygen, it gives nitrogen dioxide. The reaction is as follows:

$N_2 + 2O_2 \rightarrow 2NO_2$

When nitrogen dioxide is dissolved in water, it gives nitric acid which is a strong oxidizing agent. The reaction is as follows:

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

(i) Therefore from above reactions we can easily state that,

A is Nitrogen B is Ammonia

C is Nitrogen Dioxide

D is Nitric Acid

(ii) The non-metal that is nitrogen belongs to the group 15 of the periodic table.

Q. 17. Noble gases, which have a completely filled valence shell, show little chemical activity. At ordinary temperature they do not show chemical reactivity. However, a large number of compounds of these gases particularly those of xenon and krypton have been prepared. Read the above passage and answer the following questions.

(i) Write one use of each Ar and Kr.
(ii) What are the values associated with the use of helium in artificial respiration in deep sea diving?

Answer: (i) The use of argon is as follows:

Argon is inert in its nature and hence it is used in filament bulbs to provide the inert medium and to avoid the burning of the metal.

The use of Krypton is as follows:

Krypton is also used in fluorescent bulbs, flashbulbs and lasers. Lamps filled with krypton are used as approach lights at airports as the light from these lamps can travel far even in dense fog.

(ii) Helium is generally added to protect the divers from the toxic effects of nitrogen and the percentage of helium is 11.7%.

Challengers

Q. 1. In each test tubes A, B, C and D, 2mL of solution of Al2(SO4), in water was filled. Clean pieces of zinc were placed in test tube A, clean iron nail was put in test tube B, silver (Ag) was placed in test tube C and a clean copper wire was placed in test tube D.

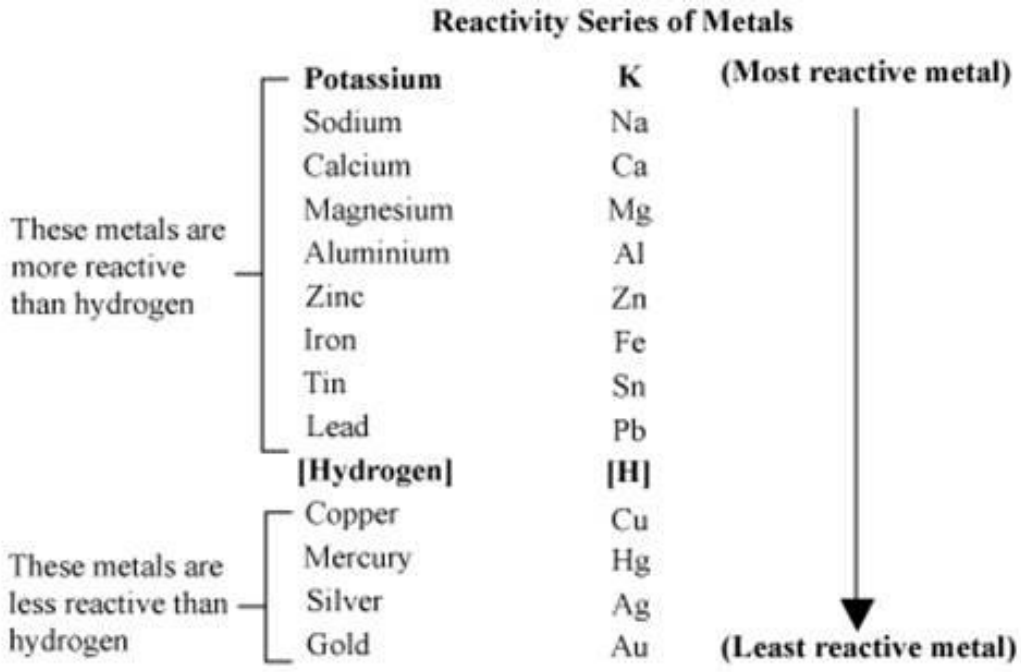
Which of the following option (s) is/are correct about above experiment?

A. Zinc is more reactive than aluminium
B. Copper is more reactive than aluminium
C. Zinc is more reactive than copper
D. Zinc, iron, silver and copper are less reactive than aluminium.

Answer: Zinc, Copper as well as silver are less reactive as compared to aluminium and hence cannot displace aluminium from its salt as they are placed below aluminium in activity series.

So the correct answer is d.

The activity series of metals is as follows:



Q. 2. On the basis of the sequence of the given reactions identify the most and least reactive elements:

X+ YA → XA + Y ...(i)
X + YB → XB + Y ...(ii)
Z + XA → ZA + X

A. X and Z
B. Y and Z
C. Z and X
D. Z and Y

Answer: From the sets of reactions i, ii, iii, it can be observed from i and ii that X is more reactive than Y and hence it displaces Y from its salt.

From reaction iii it can be observed that Z is more reactive than X as it displaces X from its salt.

So the most reactive element is Z and the least reactive is Y.

So correct answer is d [Z and Y].

Q. 3. A metal M has electronic configuration 2, 8, 3 and occurs in earth's crust and its oxide M_20_3. It is more reactive than zinc. Which of the following options (s) is/are correct?

A. The metal M is iron
B. The metal M is lead
C. The ore from which metal M is extracted in haematite.
D. The ore from which metal M is extracted is bauxite.

Answer: The element with atomic number of 13 [2 + 8 + 3 = 13] is Aluminium and it is more reactive than zinc.

The ore of aluminium is called as bauxite and the oxide of aluminium is Al_2O_3.

So the correct answer is d.

Q. 4. Metal M reacts with oxygen to form metallic oxide MO. This oxide reacts with moisture and carbon dioxide of the atmosphere to form a basic carbonate metal M. The metal 'M' is

A. Cu
B. Fe
C. Zn
D. Cr

Answer: The metallic oxide of type MO which reacts with moisture and carbon dioxide of atmosphere to form basic carbonate is copper oxide. Copper metal on exposed to atmosphere reacts with oxygen, moisture and carbon dioxide to form a green coloured coating of copper carbonate and copper hydroxide.

So the correct answer is a.

Q. 5. Beakers A, B and C contain zinc sulphate, silver nitrate and iron (II) sulphate solutions respectively. Copper pieces are added to each beaker. Blue colour will appear in case of

A. beaker A
B. beaker B
C. beaker C
D. all the beakers.

Answer: Among all the available metal solutions, copper is more reactive as compared to silver only. Copper cannot displace zinc or iron from its salt as it is less reactive as compared to both the metals. So blue colour will appear only in the beaker which has Silver nitrate solution in it.

So the correct answer is b.

Q. 6. A student puts one big iron nail each in four test tubes containing solutions of zinc sulphate, aluminium sulphate, copper sulphate and iron sulphate. A reddish brown coating was observed only on the surface of iron nail which was put in the solution of

A. zinc sulphate
B. iron sulphate
C. copper sulphate
D. aluminium sulphate

Answer: Iron is more reactive than copper and hence it can displace only copper from its salt. Iron is less reactive as compared to aluminium or zinc so they will not be displaced from their salts. Also iron will not react with its own salt. So the reddish brown coating on surface of nail is of copper deposition which will be observed only in case of iron nail dipped in copper sulphate solution.

So the correct answer is c.

Q. 7. Which of the following reactions not occur?

A. $2AgNO_3(aq) + Zn(s) \rightarrow Zn(NO_3)_2(aq) + 2Ag(s)$
B. $CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s)$
C. $2AgNO_3(aq) + Fe(s) \rightarrow Fe(NO_3)_2(aq) + 2Ag(s)$
D. $CuSO_4(aq) + 2Ag(s) \rightarrow Cu(s) + Ag_2SO_4(aq)$

Answer: Among all the reactions, the reaction d is only not possible because silver is less reactive as compared to copper and hence it cannot displace copper from its salt.

So correct answer is d.

Q. 8. Hydrogen gas is not widely used as a reducing agent because

A. hydrogen decomposes to atomic hydrogen at higher temperature
B. risk of explosion with water
C. hydrogen isomerises to ortho hydrogen at higher temperature.
D. many metals form hydrides at lower temperatures.

Answer: Many of the metallic oxides react with the hydrogen to form respective hydrides and hence hydrogen is not widely used as reducing agent in metallurgy.

So the correct answer is d.

Q. 9. Alloys are homogeneous mixtures of a metal with a metal or non-metal. Which among the following alloys contain non-metal as one of its constituents?

A. Brass
B. Bronze
C. Amalgam
D. Steel

Answer: Among all the available options Steel is the alloy of iron which contains the non-metal carbon in it.

Bronze consists primarily of copper and 12% tin

Brass is an alloy of copper and zinc.

Amalgam is an alloy of mercury.

So the correct answer is d.

Q. 10. E is an element that's ore is rich in E_2O_3. E_2O_3 is not affected by water. It forms two chlorides, ECl_2 and ECl_3 The element E is

A. copper
B. zinc
C. aluminium
D. iron

Answer: The metallic oxide of the form E_2O_3 is Iron [III] Oxide. Iron reacts with chlorine to form different Iron [II] Chloride and Iron [III] Chloride. The ore of Iron that is Fe_2O_3 Haematite does not react with water.

So the correct answer is d.