Metals and Non-Metals

Introduction

There are 18 chemical element known at present. On the basis of their properties, all these elements can be broadly divided into two main group: Metals and Non-Metals. A majority of the known elements are metals. All the metals are solids, except **mercury**, which is a liquid metal. There are 22 non-metals, out of which, 10 non-metals are solids, one non-metal (bromine) is a liquid and the remaining 11 non-metals are gases.

Occurrence

Metals and non-metals occur in nature in Free State as well as in combined state. The metals like gold, platinum, copper, silver are not affected by water and air and so these are found in Free State. Most of the metals and non-metals are found in the form of compounds. These are associated with different types of impurities. The metals occur as oxides, sulphides, carbonates, halides, sulphates, silicates and phosphates.

Occurrence of Metals

S. No.	Compounds	Minerals
1.	Oxides	Bauxite ($Al_2O_3.2H_2O$), Magnetite (Fe_3O_4)
2.	Sulphides	Copper Pyrites ($CuFeS_2$), Cinnabar (HgS)
3.	Carbonates	Magnesite ($MgCO_3$), Limestone ($CaCO_3$), Calamine ($ZnCO_3$)
4.	Halides	Common salt (NaCl), Horn silver (AgCl)
5.	Sulphates	Gypsum ($CaSO_4.2H_2O$), Epsom salt ($MgSO_4.7H_2O$)
6.	Phosphates	Rock Phosphate [$Ca_3(PO_4)_2$]
7.	Silicates	China clay ($Al_2O_3.2SiO_2.2H_2O$)

S. No.	Non-metals	Free State	Combined state
1.	Oxygen	Air (21%)	Water, earth's crust
2.	Nitrogen	Air (78%)	Animal kingdom, nitre, Chile salt petre.
3.	Hydrogen	Coal gas	Water, cells of plants and animals, natural gas, petroleum, coal
4.	Phosphorus	-	Rocks, bones, teeth, blood
5.	Carbon	Diamond, graphite, coal	Air (0.03%), natural gas, marsh gas, rocks.
6.	Sulphur	Rocks near active and dormant volcanoes	Metallic ores
7.	Silicon	-	Sand, flint, quartz, opal, mica, feldspar

Physical properties of Metals

The important physical properties of metals are discussed below:

(i) Physical State: All metals (except mercury) are solids at room temperature. Mercury, gallium (at 30°C), caesium and francium occur in liquid state in nature.

(ii) Metals are malleable: Metals are generally malleable. This means that the metals can be beaten with a hammer into very thin sheets without breaking.

(iii) Metals are ductile: It means that metals can be drawn (stretched) into thin wires. This property of metals is called ductility.

(iv) Metals are good conductors of heat and electricity

(v) Metals are lustrous and can be polished

(vi) Metals have high densities: Most of the metals are heavy and have high densities.

For example, the density of mercury metal is very high (13.6 g cm^{-3}). However, there are some exception. Sodium, potassium, magnesium and aluminium have low densities. Densities of metals are generally proportional to their atomic masses.

(vii) Most of the metals are rigid hard

(viii) Metals have high melting and boiling points

(ix) Metals are sonorous

Chemical properties of Metals

The atoms of the metals have usually 1,2 or 3 electrons in their outermost shells.

$$\underset{(2,8,1)}{Na} \longrightarrow \underset{(2,8)}{Na^+} + e^-$$

$$\underset{(2,8,2)}{Mg} \longrightarrow \underset{(2,8)}{Mg^{2+}} + 2e^-$$

$$\underset{(2,8,3)}{Al} \longrightarrow \underset{(2,8)}{Al^{3+}} + 3e^-$$

Since the metal atoms lose electrons and form positively charged ions, therefore, the metals are called electropositive elements.

Some of the important chemical properties of metal are discussed below:

Reaction with Oxygen

Metals react with oxygen to form oxide. These oxides are basic in nature.

$$4Na + O_2 \longrightarrow \underset{Sodiumoxide}{2Na_2O}$$

$$2Mg + O_2 \longrightarrow \underset{Magnesium\ oxide}{2MgO}$$

Reaction with Water

Different metals behave differently in their chemical reaction with water.

(i) $\underset{\text{Sodium}}{2Na} + \underset{\text{Cold water}}{2H_2O} \longrightarrow \underset{\text{Sodium hydroxide}}{2NaOH} + \underset{\text{Hydrogen}}{H_2}$

(ii) $\underset{\text{Potassium}}{2K} + \underset{\text{Water}}{2H_2O} \longrightarrow \underset{\text{Potassium hydroxide}}{2KOH} + \underset{\text{Hydrogen}}{H_2}$

(iii) $\underset{\text{Calcium}}{Ca} + \underset{\text{Water}}{2H_2O} \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2} + \underset{\text{Hydrogen}}{H_2}$

(iv) $\underset{\text{Magnesium}}{Mg} + \underset{\text{boiling water}}{2H_2O} \longrightarrow \underset{\text{Magnesium hydroxide}}{Mg(OH)_2} + \underset{\text{Hydrogen}}{H_2}$

(v) $\underset{\text{Zinc}}{Zn} + \underset{\text{Steam}}{H_2O} \xrightarrow{\text{Heat}} \underset{\text{Zinc oxide}}{ZnO} + \underset{\text{Hydrogen}}{H_2}$

(vi) $\underset{\text{Iron}}{3Fe} + \underset{\text{Steam}}{4H_2O} \xrightarrow{\text{Heat}} \underset{\substack{\text{Ferro–ferric oxide}\\ \text{or iron (II, III) oxide}}}{Fe_3O_4} + \underset{\text{Hydrogen}}{4H_2O}$

Reaction with Dilute acids

Reaction with Dilute acids (Displacement reactions0: Sulphuric acid, hydrochloric acid and nitric acid are called mineral acids. These acids in dilute form react with metals to form their respective salts and hydrogen gas. Many metals react with dilute acids and liberate hydrogen gas. **Only less reactive metals such as copper, silver, gold etc. do no liberate hydrogen from dilute acids. For example:** (i) Sodium, magnesium and calcium react violently with dilute hydrochloric acid (HCl) or dilute sulphuric acid liberating hydrogen gas corresponding metal salt.

$\underset{\text{Sodium}}{2Na(s)} + 2HCl(aq) \longrightarrow \underset{\text{Sodium chloride}}{2NaCl(aq)} + H_2(g)$

$\underset{\substack{\text{Sodium}\\ \text{Similarty}}}{2Na(s)} + H_2SO_4(aq) \longrightarrow \underset{\text{Sodium Sulphate}}{2Na_2SO_4(aq)} + H_2(g)$

$\underset{\text{Magnesium}}{Mg(s)} + 2HCl(aq) \longrightarrow \underset{\text{Magnesium chloride}}{MgCl_2(aq)} + H_2(g)$

$Mg(s) + H_2SO_4(aq) \longrightarrow \underset{\text{Magnesium sulphate}}{MgSO_4(aq)} + H_2(g)$

$\underset{\text{Zinc}}{Zn(s)} + 2HCl(aq) \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + H_2(g)$

$\underset{\substack{\text{Zinc}\\ \text{Similarly}}}{Zn(s)} + H_2SO_4(aq) \longrightarrow \underset{\substack{\text{Zinc}\\ \text{Sulphate}}}{ZnSO_4(aq)} + H_2(g)$

$\underset{\text{Aluminium}}{2Al(s)} + 6HCl(aq) \longrightarrow \underset{\text{Aluminium chloride}}{2AlCl_3(aq)} + 3H_2(g)$

$\underset{\text{Aluminium}}{2Al(s)} + 3H_2SO_4(aq) \longrightarrow \underset{\text{Aluminium sulphate}}{Al_2(SO_4)_3(aq)} + 3H_2(g)$

(ii) Iron reacts slowly with dilute HCl or dil. H_2SO_4 and therefore, it is less reactive that zinc and aluminium.

$\underset{\text{Iron}}{Fe(s)} + 2HCl(aq) \longrightarrow \underset{\text{Ferrous chloride}}{FeCl_2(aq)} + H_2(g)$

$Fe(s) + H_2SO_4(aq) \longrightarrow \underset{\text{Ferrous sulphate}}{FeSO_4(aq)} + H_2(g)$

$Cu(s) + HCl(aq) \longrightarrow No\ reaction$

$Cu(s) + H_2SO_4(aq) \longrightarrow No\ reaction$

Therefore copper is ever less reactive than iron.

Note: Dilute nitric acid (HNO_3) is an oxidising agent. Although it oxidizes metals, but does not produce hydrogen gas.

Reactions of Metals with Bases

Some metals react with alkalies;

$\underset{\text{Aluminium}}{2Al} + \underset{\text{Sodium hydroxide}}{2NaOH} + \underset{\text{Water}}{2H_2O} \longrightarrow \underset{\substack{\text{Sodium meta}\\ \text{Aluminate}}}{2NaAlO_2} + \underset{\text{Hydrogen}}{3H_2}$

$\underset{\text{Zinc}}{Zn} + \underset{\text{Sodium hydroxide}}{2NaOH} \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + \underset{\text{Hydrogen}}{H_2}$

$\underset{\text{Tin}}{Sn} + \underset{\text{Sodium hydroxide}}{2NaOH} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Sodium Stannate}}{Na_2SnO_3} + \underset{\text{Hydrogen}}{2H_2}$

Reactions of Metals with Salt Solutions

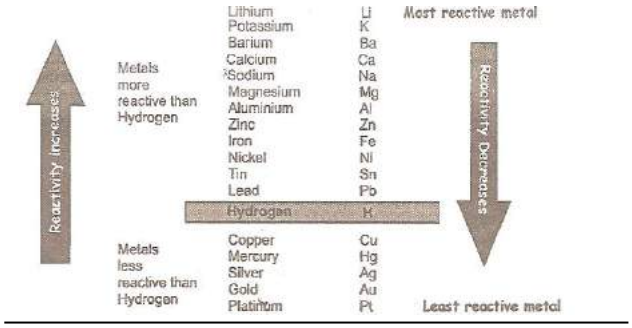
When a more reactive metal is placed in a salt solution of less reactive metals, then the more reactive metal displaces the less reactive metal from its salt solution.

$\underset{\substack{\text{Copper sulphate}\\ \text{(Blue solution)}}}{Zn(s) + CuSO_4(aq)} \longrightarrow \underset{\substack{\text{Zinc sulphate}\\ \text{(Colourless solution)}}}{ZnSO_4(aq)} + Cu(s)$

In the above reaction zinc displaces copper form its solution therefore zinc is more reactive than copper.

Reactivity series of Metals

The arrangement of metals in the order of decreasing reactivity is called the reactivity series or activity of metals.



Utility of Activity Series

The activity series is very useful as it gives the following informations:

(i) The metal which is higher in the activity series is more reactive than the other. Lithium is the most reactive an platinum is the least reactive metal.

(ii) The metals which have been placed above hydrogen are more reactive than hydrogen and can displace hydrogen from its compounds like water and acids to liberate hydrogen gas.

(iii) The metals which are placed below hydrogen are less reactive than hydrogen and cannot displace hydrogen from its compounds like water and acids.

(iv) A more reactive metal (placed higher in the activity series) can displace the less reactive metal from the solution of its salt.

(v) Metals at the top of the series are very reactive and, therefore, they do not occur free in nature, while the metals at the bottom of the series are least reactive and, therefore, they normally occur free in nature.

Use of common Metals

(i) Mercury is used in thermometers, barometers and to prepare amalgams.

(ii) Gold, platinum and silver are used in making jewellery.

(iii) Zinc is used for galvanization of iron to protect it from rusting and for making alloys.

(iv) Platinum is use to make electrodes and crucibles. It is also used in making jewellery.

(v) Iron is used in making machines, heavy duty parts, factory equipments, utensils and for construction purposes.

(vi) Copper is used in making electric wires, cables, utensils, boilers, calorimeters, coins, statues, electroplating and in alloys.

(vii) Aluminiumis used in making electric wires, cables, utensils, wrapping material, aeroplanes, ships, cars, buses, trains and in thermite process.

(viii) Some metals play an important role in the functioning of living systems in animals and human beings. Iron is a constituent of hemoglobin in blood which carries oxygen in nerves and in contraction of muscles.

(ix) Zinc in used in making dry cells.

(x) Lead is used in making automobile batteries, type metal, bullets, protective screens for X-rays and sanitary fittings.

Minerals and Ores

The natural substances in which metals or their compounds occur either in native state or combined stat are called minerals.

The minerals are not pure and contain different types of other impurities. The impurities associated with minerals are collectively known as gangue or matix.

The mineral from which the metal can be conveniently and profitably extracted, is called an ore.

e.g. Aluminium occurs in the earth's curst in the form of two minerals, bauxite ($Al_2O_3.2H_2O$) and clay ($Al_2O_3.2SiO_2.2H_2O$). Out of these two, aluminium can be conveniently and profitably extracted from bauxite. So, bauxite is an are of aluminium.

Metallurgy

The process of extracting metals from their ores and then refining them for use is called metallurgy.

The process of metallurgy depends upon the nature of the ore, nature of the metal and the types of impurities present. Therefore, there is not a single method for the extraction of all metals. However, most of the metals can be extracted by a general procedure which involves the following steps.

(a) Crushing are grinding of the ore.

(b) Concentration of the ore or enrichment of the ore.

b Extraction of metal from the concentrated ore.

(d) Refining or purification of the impure metal.

These steps are briefly discussed below-

(a) Crushing and Grinding or Ore:

Most of the ores occur as big rock in nature. They are broken into small pieces with the help of crushers. These pieces are then reduced to fine powder with the help of a ball mill or a stamp mill.

(b) Concentration of Ore or Enrichment or Ore:

The process of removal of unwanted impurities (gangue) from the ore is called ore concentration or ore enrichment.

Various methods used for concentration of an ore are:-

(i) Hydraulic washing (washing with water):

Principle: This method is based upon the difference in the densities of the ore particles and the impurities (gangue).

Ores or iron, tin and lead are very heavy and, therefore, they are concentrated by this method.

(ii) Forth floatation process:

Principle: This method is based on the principle of difference in the wetting properties of the ore and gangue particles with water and oil.

The froth floatation process is commonly used for the sulphide ores of copper, zinc, lead etc.

(iii) Magnetic separation:

Principle: The method depends upon the difference in the magnetic properties of the ores and gangue.

This method is used for the concentration of oxides ores of iron, nickel and cobalt.

Calcinations

It is the process of heating the concentrated ore in the absence of air. The calcinations process is used to carbonate ores into metal oxide.

e.g.

$$\underset{\text{Zinc carbonate}}{ZnCO_3(s)} \xrightarrow{\text{Calcination}} \underset{\text{Zinc oxide}}{ZnO(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)}$$

$$\underset{\text{Siderite}}{FeCO_3(s)} \xrightarrow{\text{Calcination}} \underset{\text{Iron(II) oxide}}{FeO(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)}$$

Roasting

It is the process of heating the concentrated ore strongly in the presence of excess air.

This process is used for converting sulphide ores to metal oxide

e.g.

$$\underset{\substack{\text{Zinc sulphide}\\(\text{Zinc blendeore})}}{2ZnS} + \underset{\text{Oxygen}}{3O_2} \xrightarrow{\text{Roasting}} \underset{\text{Zinc oxide}}{2ZnO(s)} + \underset{\text{Sulphur dioxide}}{2SO_2(g)}$$

$$\underset{\text{Iron pyrites}}{4FeS_2(s)} + \underset{\text{Oxygen}}{11O_2(g)} \xrightarrow{\text{Roasting}} \underset{\text{Ferric oxide}}{2Fe_2O_3(s)} + \underset{\text{Sulphur dioxide}}{8SO_2(g)}$$

Smelting

The metal oxide formed after calcinations or roasting is converted into metal by reduction. The method used for reduction of metal oxide depends upon the nature and chemical reactivity of metals. Smelting is done in ballast furnace. During smelting either the metal oxide is smelted or reduce in to metal.

Reduction with carbon: The oxides of moderately reactive metals (occurring in the middle of reactivity series) like zinc, copper, nickel, tin, lead etc. can be reduced by using carbon as reducing agent.

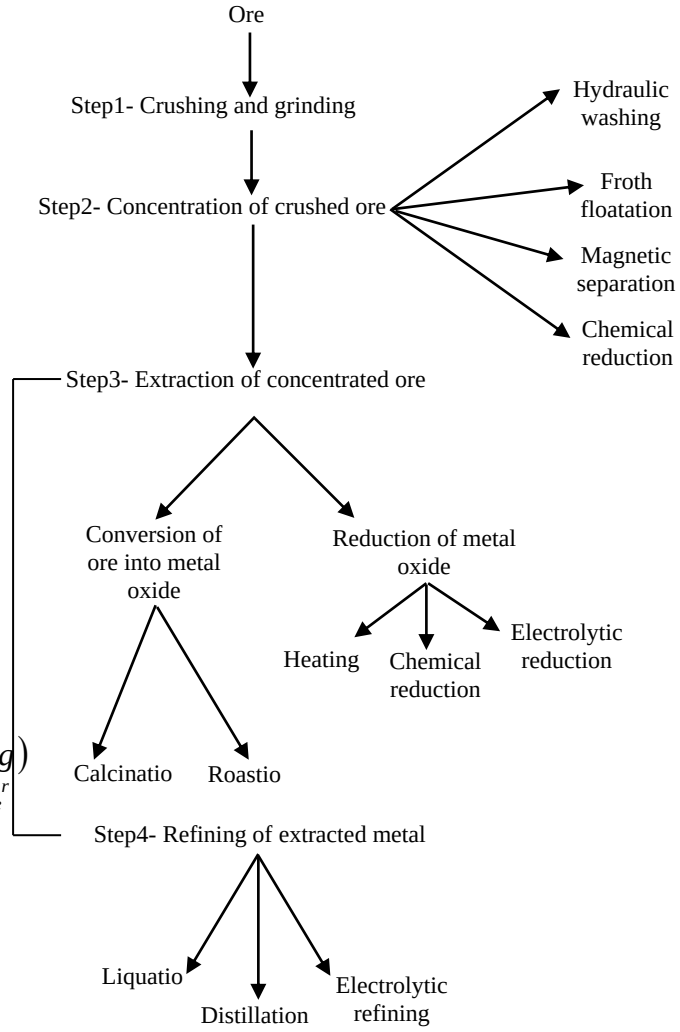
$$\underset{\text{Zinc oxide}}{ZnO(s)} + \underset{\text{Carbon}}{C(s)} \xrightarrow{\text{Heat}} \underset{\text{Zinc metal}}{Zn(s)} + \underset{\text{Carbon monoxide}}{CO(g)}$$

$$\underset{\text{Ferric oxide}}{Fe_2O_3(s)} + \underset{\text{Carbon}}{3C(s)} \longrightarrow \underset{\text{Iron metal}}{2Fe(s)} + \underset{\text{Carbon monoxide}}{3CO(g)}$$

Reduction by heating: Metals placed low in the reactivity series are very less reactive. They can be obtained from their oxides by simply heating in air.

$$\underset{\text{Ferric oxide}}{2HgS(s)} + \underset{\text{Carbon}}{3C(s)} \longrightarrow \underset{\text{Iron metal}}{2Fe(s)} + \underset{\text{Carbon monoxide}}{3CO(g)}$$

$$\underset{\text{Mercuric oixide}}{2HgO(s)} \xrightarrow{\text{Heat}} \underset{\text{Mercury metal}}{2Hg(\ell)} + \underset{\text{Oxygen}}{O_2(g)}$$



Purification or refining of Metal

The metal obtained by any of the above methods is usually impure and is known as crude metal. The process of purifying the crude metal is called refining. Following methods are used to refine the metal.

(a) Liquation: (tin, lead, bismuth)

(b) Distillation: (mercury, zinc)

(c) Electrolytic Refining: (copper, silver, aluminium)

Alloys

An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal.

Objects of Alloy Making: Alloy are generally prepared to have certain specific properties which are not possessed by the constituent metals. The main object of alloy-making are:

(i) to increase resistance to corrosion.
(ii) to modify chemical reactivity.
(iii) to increase the hardness.
(iv) to increase tensile strength.
(v) to produce good casting
(vi) to lower the melting point

Corrosion of Metals

Corrosion is a process of deterioration of metal as a result of its reaction with air or water (present in environment) surrounding it.

Rusting: The slow conversion of iron into its hydrated oxide, in the presence of moisture and air is called rusting, whereas the hydrated oxide of iron is called rust.

$$\underset{Iron}{4Fe} + \underset{Oxygen}{3O_2} \longrightarrow \underset{Ferric\ oxide}{2Fe_2O_3}$$

$$\underset{Ferric\ oxide}{Fe_2O_3} + \underset{Water}{xH_2O} \longrightarrow \underset{Ferric\ oxide}{Fe_2O_3.xH_2O}$$

The brownish residue ($Fe_2O_3.xH_2O$) is commonly called rust and the phenomenon is called rusting. The rust so formed is flaky and easily crumbles from the surface of metal. Thus, fresh iron is exposed to the attack of moist air, to form more rust.

Amalgam

Amalgams are homogeneous mixtures of a metal and mercury.

e.g. Sodium amalgam contains sodium and mercury.

Different amalgams are prepared according to their uses. For example,

(i) Sodium amalgam is produced to decrease the chemical reactivity of sodium metal. It is also used as a good reducing agent.

(ii) Tin amalgam is used for silvering cheap mirrors.

Non-metals and their general properties

Non-metals except hydrogen, are present on the right hand side of the periodic table.

Physical Properties of Non-Metals:

The important physical properties of non-metals are listed below:

(i) Non-metals are brittle

(ii) Non-meals are not ductile

(iii) Non-metals are bad conductor of **head** and **electricity.**

Exception: Graphite is a good conductor because of the presence of free electron. It is used as positive electrode in dry cells.

(iv) Non-metals are not lustrous and cannot be polished.

Exception: Graphite and Iodine are lustrous non-metals.

(v) Non-metals may be solid, liquid, or gases at room temperature.

Solid: Carbon, sulphur and iodine.

Gases: Oxygen, hydrogen, nitrogen etc.

Bromine is the only non-metal which exists as a liquid at room temperature.

(vi) Non-metals are generally soft.

(vii) Non-metals have generally low melting and boiling points.

Exception: Graphite, another allotropic form of carbon, has a melting point of about 3730°C. Other exceptions are C,B, Si which have high melting and boiling points.

(viii) Non-metals have low densities.

Exception: Iodine ahs high density and diamond which is almost as heavy as Al.

(ix) Non-metals are not malleable i.e. sheets cannot be made from non-metals.

(x) Non-metals do not have the property of tensile strength.

Exception: Carbon fibre is as tensile as steel.

(xi) Non-metals are non-sonorous, i.e., when struck with a hammer they do not produce sound.

Chemical properties of Non-metals

Reaction with oxygen:

Non-metals react with oxygen to form acidic or neutral oxides. The acidic oxides dissolve in water to give acids.

(i) Acidic Oxides: The oxides of Carbon, Sulphur, Phosphorus etc. are acidic and they turn blue litmus solution red.

e.g.

(A) Carbon reacts with oxygen or air to form carbon dioxide gas which dissolves in water to form an acid called carbonic acid

$$\underset{Carbon}{C(s)} + \underset{Oxygen}{O_2(g)} \rightarrow \underset{Carbon\ dioxide}{Ca_2(g)}$$

$$\underset{Carbon\ dioxide}{CO_2(g)} + \underset{Water}{H_2O(\ell)} \rightarrow \underset{Carbonic\ acid}{H_2CO_3(aq)}$$

(B) Sulphur burns in air to form sulphur dioxide gas which dissolves in water to form an acid called sulphurous acid.

$$\underset{Sulphur}{S(s)} + \underset{Oxygen}{O_2(g)} \longrightarrow \underset{Sulphur\ dioxide}{SO_2(g)}$$

$$\underset{Sulphur\ dioxide}{SO_2(g)} + \underset{Water}{H_2O(\ell)} \longrightarrow \underset{Sulphurous\ acid}{H_2SO_3(aq)}$$

(C) When phosphorus is burnt in air, it reacts with oxygen of air to form phosphorus pentoxide which dissolves in water to form phosphoric acid.

$$\underset{\text{Phosphorus}}{P_4(s)} + 5\underset{\text{Oxygen}}{O_2(g)} \longrightarrow \underset{\text{Phosphorus pentoxide}}{2P_2O_5(s)}$$

$$\underset{\text{Phosphorus pentoxide}}{2P_2O_5(s)} + 6\underset{\text{Water}}{H_2O(\ell)} \longrightarrow \underset{\text{Phosphoric acid}}{H_3PO_4(aq)}$$

(ii) Neutral oxides: Some oxides of non-metals are neutral. For example, carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N_2O), water (H_2O), etc. These oxides do not turn blue litmus solution red.

Reaction with water:

Non-metals do not react with water or steam to give hydrogen gas. This is because non-metals cannot give electrons to reduce the hydrogen ions of water into hydrogen gas.

Reaction with dilute acids:

Non-metals do not react with dilute acids an so, hydrogen gas is not liberated when non-metals are treated with dilute acids.

Reaction with bases:

Some non-metals react with alkalies-

$$\underset{\text{Phosphorus}}{P4} + 3\underset{\text{Sodium hydroxide}}{NaOH} + 3\underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Sodium hypophosphite}}{3NaH_2PO_2} + \underset{\text{Phosphine}}{PH_3}\uparrow$$

$$\underset{\text{Sulphur}}{4S} + 6\underset{\text{Sodium hydroxide}}{NaOH} \rightarrow \underset{\text{Sodium thiosulphate}}{Na_2S_2O_3} + 2\underset{\text{Sodium sulphide}}{Na_2S} + 3\underset{\text{Water}}{H_2O}$$

$$\underset{\text{Chlorine}}{Cl_2} + 2\underset{\text{Sodium hydroxide}}{NaOH} \rightarrow \underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Sodium hypochlorite}}{NaClO} + \underset{\text{Water}}{H_2O}$$

Uses of Non-metals:

(i) Silicon is used in making semi-conductors, different alloys, glass, cement etc. It is also used in the ceramic industry as binder.

(ii) Silicon carbide is used in cutting and grinding of hard substances like diamond.

(iii) Phosphorus is used in the manufacture of safety matches, fertilizers, rat poison, smoke screens and fire works.

(iv) Sulphur is used in the manufacture of sulphuric acid.

(v) Sulphur is used a an antiseptic in making skin ointments and in a number of medicines. It is also used in the rubber industry for the vulcanization of rubber.

(vi) Graphite is used as a dry lubricant.

(vii) Hydrogen and oxygen can be used as oxy-hydrogen flame for cutting and welding metals.

(viii) Oxygen is used for artificial respiration.

(x) The silicones are used in making water proof clothes, greases, polishes, electrical appliances and insulating material.

Important Minerals/Ores of Underlined elements

	Name	Formula
1.	Alumina	Al_2O_3
2.	Alunite	$K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3$
3.	Apatite	$3Ca_3(PO_4)_2CaF_2$
4.	Azurite	$2CuCO_3.Cu(OH)_2$
5.	Anhydrite	$CaSO_4$
6.	Argentite	Ag_2S
7.	Anglesite	$PbSO_4$
8.	Bauxite	$Al_2O_3.2H_2O$
9.	Borax	$Na_2B_4O_7.10H_2O$
10.	Calaverite	$AuTe_2$
11.	Chile salt petre	$NaNO_3$
12.	Cinnabar	HgS
13.	Calcia	CaO
14.	Chlorapatite	$Ca_5(PO_4)Cl$ or $3Ca_3(PO_4)_2CaCl_2$
15.	Carnallite	$KCl.MgCl_26H_2O$
16.	Calamine	$ZnCO_3$
17.	Cassiterite	SnO_2
18.	Copper pyrites (Chalcopyrite)	$CuFeS_2$
19.	Copper glance	Cu_2S
20.	Cuprite (Ruby copper)	Cu_2O
21.	Corundum	Al_2O_3
22.	Cryolite	Na_3AIF_6
23.	Zinc blende	ZnS
24.	Chalk (marble, Aragonite)	$CaCO_3$
25.	Cerussite	$PbCO_3$
26.	Diaspore	$Al_2O_3.H_2O$
27.	Dolomite	$MgSO_4.7H_2O$
28.	Epsom Salt (Epsomite)	$MgSO_4.7H_2O$
29.	Fluorspar	CaF_2
30.	Fluorapatite	$3Ca_3(PO_4)_2CaF_2$
31.	Greenockite	CdS
32.	Gypsum	$CaSO_4.2H_2O$
33.	Galena	PbS
34.	Heavy spar	$BaSO_4$
35.	Horn silver (Chlorargyrite)	AlCl
36.	Haematite (Red)	Fe_2O_3
37.	Iron pyrite	FeS_2
38.	Kieserite	$MgSO_4.H_2O$
39.	Limonite (Brown)	$Fe_2O_3.3H_2O$
40.	Magnesite	$MgCO_3$

41.	Malachite	$CuCO_3.Cu(OH)_2$
42.	Magnetite	Fe_3O_4
43.	Pyrargyrite or Ruby silver	Ag_3SbS_3
44.	Pyrolusite	MnO_2
45.	Phosphorite	$Ca_3(PO_4)_2$
46.	Sylvine	KCl
47.	Schonite	$K_2SO_4.MgSO_4.6H_2O$
		$(AgAu)T_4$
48.	Sylvanite	KNO_3
49.	Salt peter (Indian)	$FeCO_3$
50.	Siderite	$BaCO_3$
51.	Witherite	ZnO
52.	zincite	

Important facts of remember

1	Lowest electro negativity	Cs
2	Highest electronegativity	F
3	Highest ionization potential	He
4	Lowest ionization potential	Cs
5	Highest electron affinity	Chlorine (Cl)
6	Lowest electron affinity	Noble gas (zero)
7	Least electropositive element	Fluorine (F)
8	Lowest m.pt. (metal)	Mercury (Hg) (m.pt)=38.9°C
9	Highest m.pt. (metal)	Tungsten (W) (m.pt)=3410°C
10	Lowest m.pt. and b.pt (non-metal)	He (b.pt-268.9°C)
11	Most reactive solid element	U
12	Most reactive liquid element	Cs
13	Most reactive gaseous element	F
14	Most stable element	Te (Tellurium) Half life = $2x10^{21}$ year
15	Smallest atomic size	He
16	Largest anion	Cs
17	Largest anion	At^{-1}
18	Smallest anion	H
19	Most electropositive element	Cs Fr (In stable element) (In all element)
20	Element with electro negativity	Oxygen next of fluorine
21	Group containing maximum no of gaseous element in periodic table	Zero group
22	Total number of gaseous elements	11(H_2, He, N_2, F_2, Ne, O_2, Cl_2, Ar, Kr, Xe, Rn) in periodic table
23	Total number of liquid elements	4(Ga, Br, Cs, Hg) (Fr and Uub are also liquid)
24	Total number of solid elements	89 in periodic table
25	Liquid element of radioactive nature	Francium (Fr)
26	Total number of radioactive elements In periodic table	42
27	Volatie d-block elements	Zn,Cd,Hg
28	Element containing neutron	$_1H^1$
29	Most abundant element on earth	Oxygen (O) followed with Si
30	Rarest element on earth	Astatine (At)
31	Most abundant metal on earth	Al followed with Fe
32	Element having maximum tendency for catenation	Carbon
33	Non-metal having highest m.pt. b.pt.	Diamond
34	Metal showing highest tensile strength	Ru, Os
35	Element having highest tensile strength	Boron
36	Most electrovalent compound	CsF
37	Most stable carbonate	Cs_2CO_3
38	Liquid silver	Hg
39	Strongest alkali	CsOH
40	Strongest basic oxide	Cs_2O
41	Best electricity conductor among metals	Ag followed with Cu, Au, Al
42	Best electricity conductor among non-metal	Graphite
43	Most poisonous element	Pu
44	Liquid non-metal	Br_2
45	Liquid metals	Hg, Ga, Cs, Fr
46	Element kept in water	P
47	Element kept in kerosene	Na, K
48	Elements sublime on heating	I
49	Bridge metals	Na, Mg
50	Noble metals	Au, Pt
51	White gold	Pt
52	Mosaic gold	SnS_2
53	Elements showing diagonal relationship	Li-Mg, Be-Al, B-Si
54	Metalloids elements	B, Si, Ge, As, Sb, Te
55	Non-metals having metallic lusture	Iodine, graphite, diamond
56	Lightest elements	H
57	Heaviest naturally occurring element	U^{236}
58	Poorest conductor of current	Pb (metal), S (non-metal)
59	Hardest naturally occurring element	Diamond
60	Most abundant gas	N_2
61	Lightest solid metal	Li
62	Lightest liquid metal	Cs

63	Heaviest solid metal	Os (highest density 22.6 g/cm_3)
64	Lightest solid non-metal	Boron
65	Heaviest solid non-metal	Astatine
66	Lightest gaseous non-metal	H
67	Lightest metalloid	Rn
68	Lowest refractive index	B
69	Heaviest metalloid	Te
70	Lowest refractive index	Vacuum (1)
71	Highest refractive index	Diamond (2.4)
72	90% of sun mass	H_2
73	Coolant in nuclear reactors	D_2O
74	Fool's gold	FeS_2
75	Amphitricha oxides	ZnO, PbO, Al_2O_3, SnO, BeO, As_2O_3, Sb_2O_3
76	Neutral oxides of non-metals	CO, N_2O, NO, H_2O
77	Dry bleacher	O_3
78	Natural explosive	NCl_3
79	Dry ice	CO_2 (Solid)
80	Artificial explosive	Dynamite
81	Oldest known organic acid	Acetic acid
82	First nobel prize of chemistry was given to	Vant Hoff
83	Feron (a refrigerant)	CF_2Cl_2
84	Tincture iodine (antiseptic)	I_2 in alcohol
85	Some polymorphic elements	O, S, P
86	Some isomorphism substances	$FeSO_4.7H_2O$, $MgSO_4.7H_2O$, $ZnSO_4.7H_2O$
87	Some efflorescent substances	$Na_2CO_3.10H_2O$, $Na_2SO_4.10H_2O$, $MgSO_4.7H_2O$, $Na_2S_2O_3.5H_2O$
88	Some commonly used oxidants	H_2O_2, SO_2, SO_3, Cl_2, H_2SO_4, HNO_3
89	Some commonly used reductants	SO_2, H_2S, Cl_2 Bleaching powder
90	Three most abundant elements	O, Si, Al
91	Rolled gold	Alloy of Cu and Al
92	Gold fulminate	H_2N-Au=NH

Industrially important process

Ammonia soda	Manufacture of $NaHCO_3$
Bosch	Manufacture of H_2
Baeyer's process	Manufacture of Al
Birkeland-Eyde process	Manufacture of HNO_3
Castner process	Manufacture of NaOH
Solvay process	Manufacture of Na_2CO_3
Cyanide process or Mac Arthur forrest process	Manufacture of Ag
Cupellation process	Purification of Ag
Cartner process	Manufacture of basic lead carbonate (white lead)
Contact process	Manufacture of H_2SO_4
Down process	Manufacture of Na
Dow's process	Manufacture of phenol
Deacon's process	Manufacture of Cl_2
Frecht (Magnesia) process	Manufacture of K_2CO_3
Gold smidt process	Thermite welding, extraction of metals
Hoope's process	Purification of Al
Haber process	Manufacture of NH_3
Hasenclever process	Manufacture of bleaching powder
L.D. process	Manufacture of steel
Lead chamber process	Manufacture of H_2SO_4
Merch process	H_2O_2
Nelson cell process	Manufacture of Ag
Ostwald process	Manufacture of HNO_3
Parke process	Manufacture of Ag
Pattinson process	Manufacture of Ag
Serpeck's process	Manufacture of Al

Common Absorbent for Gases

Solution	Gas Absorbed
NaOH or KOH	$CO_2.SO_2$
Solution	
F_eSO_4 Solution	NO
Alkaline pyragallol	O_2
Heated palladium	N_2,O_2
Heated magnesium	Moisture, NH_3
Conc. H_2SO_4	Moisture, NH_3
Terpentine oil	Ozone

Some important Alloys

	Alloy	Compounds
1	Aluminium bronze	Cu + Al
2	Brass	Cu + Zn
3	Bronze	Cu + Sn
4	Bell metal	Cu + Sn
5	Coin alloy (Red)	Cu + Zn + Sn
6	Coin alloys (White)	Cu + Ag + Zn + Ni
7	Duralumin	Al + Cu + Mg + Mn
8	Electron	Mg + Zn (95.5%)
9	German silver	Cu + Zn + Ni
10	Gun metal	Cu + Zn + Zn
11	Muntz metal	Cu + Zn
12	Magnalium	Al + Mg
13	Pewter	Pb + Sn
14	Solder	Pb + Sn

15	Type metal	Pb + Sb + Sn
16	Wood metal	Bi + Pb + Sn + Cd (Low m.pt 71°C)
17	Y-alloy	Cu + Al

Important compounds and their formula

1	Active nitrogen	N (atomic nitrogen)(
2	Alums	
3	Asbestos	$CaMg_3(SiO_3)_4$
4	Arsine	AsH_3 s
5	Aqua-regia	Conc. HNO_3 + Conc. HCl (1:3)
6	Anhydrone	$Mg(ClO_4)_2$
7	Argentoferrous galena	PbS + Ag_2S
8	Borax	$Na_2B_4O_7.10H_2O$
9	Blue vitriol	$CuSO_4.5H_2O$
10	Barites	$Ba(OH)_2$
11	Barites water	$Ba(OH)_2$ Solution
12	Brimstone	S_8
13	Baryta	BaO
14	Baking powder	$NaHCO_3$
15	Bleaching powder	$CaOCl_2$
16	Boranes	Hydride of borone
17	Brine	NaCl solution
18	Calgon	$Na_2[Na_4(PO_3)_6]$
19	Crystal carbonate	$Na_2CO_3.H_2O$
20	Coinage metals	Cu, Ag and Au
21	Carborundum	SiC
22	Cementite	FeC
23	Chinese white	ZnO
24	Caliche	$NaNO_3$ + $NaIO_3$
25	Caustic soda	NaOH
26	Caustic potash	KOH
27	Calomel	Hg_2Cl_2
28	Corrosive sublimate	$HgCl_2$
29	Deuterium	H_2 or D
30	D.D.T.	p-Dichloro dipheny trichloroethane
31	Zinc white	ZnO
32	Freon	CF_2Cl_2
33	Ferric Alum	$K_2SO_4.Fe_2(SO_4)_3.24H_2O$
34	Fenton's reagent	H_2O_2 + few drops of $FeSO_4$
35	Fusion mixture	Na_2CO_3 + K_2CO_3
36	Fluid magnesia	12% solution of Mg $(HCO_3)_2$
37	Fehling solution	$CuSO_4.4H_2O$ + NaOH + Na, K tartarate
38	Green vitriol	$FeSO_4.7H_2O$
39	Graphite	An allotrope of carbon
40	Gun powder	75% KNO_3 + 12%$_S$ + 13% charcoal (explosive)
41	Glauber salt	$Na_2SO_4.10H_2O$
42	Hydrolith	CaH_2
43	Heavy water	D_2O
44	Hypo	$Na_2S_2O_3.5H_2O$
45	Heavy hydrogen	D_2
46	King of chemicals	H_2SO_4
47	Killed spirits	$ZnCl_2$ + ZnO
48	Kainite	$KCl.MgSO_4.3H_2O$
49	Kaolinite	$Al_2O_3.2SiO_2.2H_2O$
50	Lime (or quick lime or burnt lime)	CaO
51	Pencil lead	graphite
52	Lime water	$Ca(OH)_2$
53	Laughing gas	N_2O
54	Lunar caustic	$AgNO_3$
55	Litharge (Messote)	PbO
56	Lithopone	(ZnS + $BaSO_4$), apigment
57	Leuna salt petre	[NH_4NO_3 + $(NH_4)_2SO_4$] a fertilizer
58	Lanakite	$PbO.PbSO_4$
59	Martar	Slaked lime + Silica (1:3 in water)
60	Magnesia alba	$(MgCO_3)\times[Mg(OH)_2.ZH_2O]$
61	Yperite	Mustard gas
62	Mohr salt	$FeSO_4.(NH_4)_2.SO_4.6H_2O$
63	Matte	Cu_2S + FeS
64	Milk of lime	$Ca(OH)_2$ in water
65	Minium	Pb_3O_4
66	Mircro cosmic salt	$NaNH_4.HPO_4$ (used in test of silicates)
67	Milk of magnesia	Paste of $Mg(OH)_2$ in water (Antacid)
68	Magnesia	MgO

69	Marsh gas	CH_4
70	Nitro chalk	$[NH_4NO_3 + (NH_4)_2(CO_3)]$ (a fertilizer)
71	Nitrolim	$CaCN_2$ (a fertilizer)
72	Nitrophos	$Ca(H_2PO_4)_2 + 2Ca(NO_3)_2$
73	Nascent hydrogen	H at the moment of generation
74	Nessler's reagent	$(K_2HgI_4 + KOH)$ aqueous solution
75	Nitre salt	$NaHSO_4$
76	Oil of vitriol	$Conc.H_2SO_4$
77	Ozone	O_3
78	Oleum	$H_2S_2O_7$
79	Permutit (Zeolite)	$Na_2Al_2SiO_3.\times H_2O$
80	Tritium	${}_1H^3$ (an isotope of H)
81	Plaster of pairs	$CaSO4.\frac{1}{2}H_2O$
82	Washing soda	$Na_2CO_3.10H_2O$
83	Phosgene	$COCl_2$
	Phosphene	PH_3
85	Pharaoh's serpents	$Hg(CNS)_2$
86	Pig-iron	Impure form of iron
87	Producer gas	A mixture of $CO + N_2 + H_2$
88	Quartz	SiO_2
89	Quick silver	Hg
90	Refrigerants	CO_2,NH_3,CF_2Cl_2 etc.
91	Red lead	Pb_3O_4
92	Rochelle salt	Sodium – potassium tartarate
93	Rust	$Fe_2O_3\times H_2O$
94	Sorel's cement (magnesia cement)	$Mg(OH)Cl$ or $MgCl_2.5MgO.\times H_2O$
95	Soda-lime	$NaOH + CaO$
96	Soda ash	Na_2CO_2
97	Slaked lime	$Ca(OH)_2$
98	Salammoniac	NH_4Cl
99	Stainless steel	An alloy of Fe, Cr and C
100	Salt cale	Na_2SO_4 (anhydrous)
101	Sal volatile	$(NH_4)_2.CO_3$
102	Supper phosphate	$Ca(HPO_4)_2$+$2CaSO_4$
103	TNT	Trinitrotoluene (an explosive)
104	TNB	Trinitrobenzene (an explosive)
105	Tincal	$Na_2B_4O_7.10H_2O$
106	Tal	$3MgO.4SiO_3.H_2O$ or $Mg_2(Si_2O_3)7\ Mg(OH)_2$
107	Water glass	Na_2SiO_3
108	Water gas	$CO + H_2$
109	White vitriol	$ZnSO_4.7H_2O$
110	Wrought iron	Pure from of iron1

Some Common Gases and their characteristics

Formula	Name	Characteristics
HCN	Hydrogen cyanide	Very toxic, slight odour of bitter almonds
HCl	Hydrogen chloride	Toxic, corrosive, choking odour
H_2S	Hydrogen sulphide	Very toxic, odour of rotten egg
CO	Carbon monoxide	Toxic, colourless, odourless
CO_2	Carbon dioxide	Colourless, odourless
CH_4	Methane	Colourless, odourless,
N_2O	Nitrous oxide	Colourless, odourless, inflammable, marsh damp laughing gas
NO_2	Nitrogen dioxide	Red brown, sweet odour,
NH_3	Ammonia	Colourless, irritating odour
SO_2	Sulphur dioxide	Colourless, irritating odour

EXERCISE

1. Rusting of iron can be prevented by
(A) alloying (B) painting
(C) galvaning (D) all of these

2. Which of the following is a good conductor of heat and electricity?
(A) graphite (B) oxygen
(C) chlorine (D) nitrogen

3. Metals are-
(A) malleable (B) ductile
(C) none (D) both

4. Metals can be obtained economically from
(A) minerals (B) ores
(C) earth's crust (D) none

5. Which of the following have low melting and boiling points?
(A) phosphorus (B) sodium
(C) iron (D) (a) and (b)

6. Which of the following metals catch fire on reaction …… waer?
(A) sodium (B) potassium
(C)magnesium (D) (a) and (b)

7. A metal, which forms a protective layer of its oxide on reactin with water, on its surface is-
(A) sodium (B) aluminium
(C) potassium (D) magnesium

8. Reactivity series gives-
(A) arrangement of metals in the order of decreasing reactivity.
(B) arrangement of non-metals in the order of decreasing reactivity
(C) arrangement of metals in the order of increasing reactivity
(D) arrangement of non-metals in the order of increasing reactivity

9. Metals like gold, platinum which do not easily react are called-
(A) active metals
(B) dull metals
(C) noble metals
(D) bright metals

10. When MgO is dissolved in water, $Mg(OH)_2$ is obtained. A rd litmus paper dipped in this solution turns blue, this shows that the solution is _____ in nature.
(A) acidic (B) neutral
(C) alkaline (D) reactive

11. Calgon is a substance which is used to remove the hardness of water. The formula of calgon is-
(A) $Na_2\left[\left(Na_4(PO_3)_6\right]\right.$
(B) $Na_2Al_2Si_2O_8$
(C) $FeSO_4\left(NH_4\right)_2.SO_4.6H_2O$
(D) $Na_2S_2O_3.5H_2O$

12. Type metal is an alloy of-
(A) Pb and Sn (B) Pb, Sn and Sb
(C) Cu and Zn (D) Cu, Sn and Sb

13. Lightest liquid metal is-
(A) Hg (B) Cs
(C) Ga (D) none of these

14. 90% of sun's mass it-
(A) He (B) H_2
(C) O_2 (D) Ar

15. Carnallite ($KCl.MgCl_2.6H_2O$) is an ore of-
(A) chlorine (B) iodine
(C) astatine (D) bromine

16. Magnetite is an oxide of metal X. The metal is-
(A) Mn (B) Mg
(C) Fe (D) Cu

17. Hoope's process is used for the purification of-
(A) Cu (B) Fe
(C) Al (D) At

18. Mercury is also called-
(A) liquid gold (B) liquid copper
(C) liquid silver (D) none of these

19. Nitric acid can be prepared by which of the following method?
(A) Birkeland –eyde process
(B) Ostwald process
(C) Contact process
(D) (a) & (b) both

20. Which of the following is/are used as bleaching agent?
(A) SO_2 (B) H_2S
(C) Cl_2 (D) all

21. Which of the following element is not found is free state in the nature?
(NTSE-Stage-I/Raj/2007)
(A) Silver (B) Copper
(C) Sodium (D) Gold

22. When agma cools below the surface of the earth, the granite is formed which is used in buildings. It mainly consists of-
(NTSE-Stage-II/2007)
(A) quartz and haematite
(B) quartz and felspar
(C) bauxite and calcamine
(D) felspar and silver glance

23. Minerals generally have the following characteristics **(NTSE-Stage-I/Raj/2007)**
(a) They occur naturally
(b) They have characteristics chemical composition
(c) They do not have specific chemical properties
(d) They do not have a specific chemical composition.
Which of the following statements are correct?
(A) a and b (B) a, c and d
(C) c and d (D) a and d

24. The percentage of gold present in 20 carat gold is-
(NTSE-Stage-II/2008)
(A) 83.33 (B) 100
(C) 50 (D) 73.3

25. Which of the following elements is non-metal?
(NTSE-Stage-I/Raj/2007)
(A) Na (B) Fe
(C) Cu (D) S

26. When a compound A is heated, a gas B is evolved which turns lime water milky. Compound A is used in the manufacture of glass. Gas B has a property of extinguishing fire and it does not support animal life. The compound A and B are respectively.
(NTSE-Stage-II/2007)
(A) $NaHCO_3$ and CO
(B) $CaCO_3$ and CO
(C) Na_2CO_3 and CO_2
(D)$NaHCO_3$ and CO_2

27. Which of the following non-metal is found is liquid state at room temperature?
(NTSE-Stage-I/Raj/2008)
(A) Sulphur (B) Carbon
(C) Iodine (D) Bromine

28. Match the following-

(A) CH_4	(i) Neither combustible nor supports combustion
(B) CO_2	(ii) Combustible
(C) N_2	(iii) Supports combustion
(D) O=	(iv) Extinguishes fire

Which of the following indicates the correct matching? **(NTSE-Stage-II/2008)**

(A) a,(i); b,(ii); c(iii); d,(iv)
(B) a,(ii); b,(iv), c(i); d,(iii)
(C) a,(ii); b,(iii); c(i); d,(iv)
(D) a,(iii); b,(iv); c(ii); d,(i)

29. Which of the following displacement reactions is possible?
(NTSE-Stage-II/2009)
(A) Copper + Sodium chloride $\longrightarrow$ Copper chloride + Sodium
(B) Lead + Potassium nitrate $\longrightarrow$ Lead nitrate + Potassium
(C) lron + Lead nitrate $\longrightarrow$ lron nitrate+ Lead
(D) Silver + Copper nitrate $\longrightarrow$ Silver nitrate + Copper

ANSWER – KEY

METALS AND NON - METALS

Q.	1	2	3	4	5	6	7	8	9	10
A.	D	A	D	B	D	D	B	A	C	C
Q.	11	12	13	14	15	16	17	18	19	20
A.	A	B	B	B	D	C	C	C	D	D
Q.	21	22	23	24	25	26	27	28	29	
A.	C	B	B	A	D	C	D	B	C	