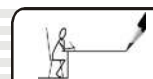


2

METALS & NON-METALS



THEORY

2.1 INTRODUCTION

The progress of man towards civilisation is linked up with the discovery of metals and non-metals. Even today, the index of prosperity of a nation depends upon the amount of metals and non-metals it produces and uses. The metallic resources of a nation are of immense value. The discovery of bronze, the alloy of copper, and tin resulted in the bronze age in history. This period was followed by the iron age with the discovery of superior quality of iron.

Every material has a specific use depending upon its physical and chemical properties.

2.2 ELEMENTS

A pure substance that consists of only one kind of atoms is called an **element**. The smallest unit of an element is **atom**. Elements cannot be broken down into smaller units and the building blocks of a variety of substances.

There are about 118 elements known to us today, out of which 92 are found in nature while the remaining elements have been prepared artificially. Of all the naturally occurring elements, 22 are non-metals and 70 are metals.

2.3 CLASSIFICATION

Classification of Elements

Lavoisier classified all the known elements into three groups: **metals**, **non-metals** and **metalloids**.

➤ **Metals**

The elements which are hard, lustrous, malleable, ductile, sonorous, and good conductors of heat and electricity are called **metals**.

Examples: iron, copper, gold, silver, aluminium etc.

➤ **Non-metals**

The elements which are brittle, non-lustrous, non-malleable, non-ductile, and poor conductors of heat and electricity are called **non-metals**.

Examples: nitrogen, sulphur, phosphorus, carbon, oxygen.

➤ **Metalloids**

The elements which possess the characteristics of both metals and non-metals are called **metalloids**.

Examples: boron, silicon, arsenic, germanium.

2.4 OCCURRENCE OF METALS AND NON-METALS

Metals can occur in free or elemental state or in the form of compounds in nature inside the earth's crust. Reactive metals generally occur in combined form, and less reactive metals in both free as well as combined form. Highly unreactive elements occur in free state in nature. Examples of metals that occur in nature as compounds include aluminium (bauxite), copper (copper pyrites), iron (as haematite), and silver (as argentite). Of these, silver and copper occur in both free state and combined form. Gold is found in nature only in free state.

Like metals, non-metals also occur in the free (oxygen, nitrogen) as well as in combined state (silicon, phosphorus) in nature.

2.5 PHYSICAL PROPERTIES OF METALS AND NON-METALS

Let us now learn about the physical properties of metals and non-metals.

2.5.1 Physical State

Metals are generally solid at room temperature except mercury and gallium, francium, caesium, rubidium, which exist in liquid form at room temperature.

Non-metals can exist in all three states but generally they are solid or gas at room temperature. Hydrogen, chlorine and oxygen are gases. Iodine, silicon, carbon and phosphorus are solids but bromine is found in liquid state.

2.5.2 Hardness

Metals are generally hard. Hardness varies from metal to metal. Metals like sodium and potassium are soft and can be easily cut with a knife.

Non metals are generally soft except diamond which is very hard.



Sodium can be cut with a knife



ACTIVITY - 1

Carefully take out a piece of sodium (Na) and a piece of potassium (K) with the help of a pair of tongs and dry them between the folds of a filter paper. Cut each of them with a sharp knife. What do you observe? They can be cut with a knife, so they are soft metals.

Now try to cut metal pieces such as those of magnesium (Mg), lead (Pb), aluminium (Al), copper (Cu), iron (Fe), etc., and write your observations.

2.5.3 Lustre

Metals shine in their pure state. This shining property (Glitter) of metals is called **metallic lustre**. Gold is yellow and copper is reddish brown. Magnesium, aluminium and silver appear white. Because of the ability of metals to shine and reflect light they are used for making jewellery, statues and decorative pieces.

Non-metals are non-lustrous or dull except graphite and iodine which are lustrous.



Lustre of gold



ACTIVITY - 2

Metals are Lustrous : Collect some pieces of pure iron, copper, aluminium, gold, silver and magnesium ribbons. Rub the surface of each sample with sand paper and note their appearance. Do they shine? Yes, their surfaces have a shining appearance.

2.5.4 Density

Metals generally have a high density. Some metals like sodium, potassium, calcium, aluminium and magnesium have low densities. Lithium is the lightest metal.

Non-metals have low density.

2.5.5 Melting and Boiling Points

Metals generally have high melting and boiling points. Tungsten has the highest melting point. Sodium and potassium have low melting points. Mercury has a low boiling point.

Non-metals usually have low melting and boiling points except graphite which has a high melting point. Silicon and boron too have high boiling points.

2.5.6 Malleability

Metals the property by which metals can be beaten into sheets or foils is called **malleability**.

Gold and silver are among the best malleable metals.

This is what helps jewellery designers create intricately carved bangles, chains and decorative articles in gold and silver.

You must have seen that halwais (sweetmakers) use silver papers to decorate barfi and rasgullas. They are actually using **silver foil** for decoration. At home we use aluminium foils for packing chapatis and idlis. This shows that silver and aluminium can be beaten into thin foils.

Non-metals are non-malleable. They break into pieces when hammered, so they are brittle.



Malleable metal forming sheets

2.5.7 Ductility

Metals : Most metals can easily be drawn into thin wires, which have a wide range of applications. The property by virtue of which metals can be drawn into thin wire is called **ductility**. Gold and silver are two of the most ductile metals known. Other metals that can be drawn into wires include copper, aluminium and tungsten.



Ductile metal forming wires

Non-metal : None metals are brittle and cannot be drawn into wires.



ACTIVITY - 3

Take an incandescent bulb and observe it carefully. What material is used to make the filament of the bulb which glows and gives you light? The bulb does not glow if the filament breaks. The filament is made of very thin wires of tungsten metal which breaks easily when there is an overflow or short-circuit of current. This shows that tungsten metal is highly ductile.



An incandescent bulb has tungsten filament

2.5.8 Tensile Strength

Metals : Generally metals have a high tensile strength. They can be stretched to some degree without breaking. Zinc and arsenic are exceptions. Metals are very strong. This is the reason that iron is widely used in construction of buildings, bridges and railway lines, etc.

Non-metals : Non metals have low tensile strength.

2.5.9 Thermal Conductivity

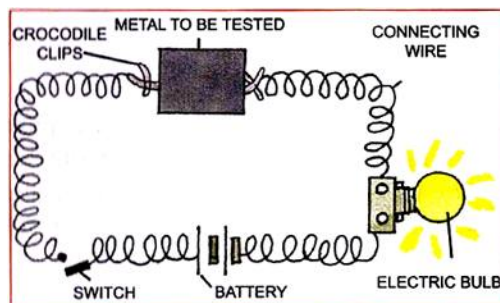
Metals : Metals are good conductors of heat and therefore used for making cooking utensils. Silver is the best conductor of heat followed by copper, gold, aluminium and tungsten.

Non-metals : Non- metals are generally poor conductors of heat. Diamond, which is a good conductor of heat, is an exception.

2.5.10 Electrical Conductivity

Metals : Metals are good conductors of electricity and are, therefore, used for making electrical wires and cables.

Non-metals : Non- metals are generally poor conductors of electricity. Graphite, which is a good conductor of electricity is an exception.



Metals are good conductors of electricity

2.5.11 Sonorous

Metals : When metal pipes strike each other, they produce a ringing sound. The property by virtue of which metal objects produce a ringing sound when struck with a hard object is called **sonority**.

Objects like wind chimes and bells make use of this property of metals.

Non-metals: Non-metals produce a dull sound when struck with a hard object.

2.5.12 Colour

Metals : Most metals are white or silvery-grey. There are, however, a few exceptions. For example, gold is yellow and copper is reddish-brown.

Non-metals: Some non-metals are colourless while some are coloured. For example, chlorine is a greenish-yellow gas, bromine is a brown liquid, iodine is a violet solid and oxygen and nitrogen are colourless gases.

Table : Differences between Physical Properties of Metals and Non-metals

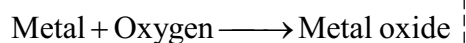
S.No.	Property	Metals	Non-metals
1	Physical state	They are solid at room temperature except mercury (Hg) which is a liquid.	They are either solids or gases except bromine which is a liquid.
2	Metallic lustre	They are lustrous (shiny).	They are non-lustrous or dull, except graphite and iodine.
3	Density	They usually have high density.	They usually have low density.
4	Malleability	They are malleable.	They are non-malleable and brittle.
5	Ductility	They are ductile.	They are non-ductile.
6	Conductivity	They are good conductors of heat and electricity.	They are bad or poor conductors of heat and electricity except graphite.
7	Melting and boiling points	They have high melting and boiling points, except Na and K.	They have low melting and boiling points except graphite, diamond, silicon, boron.
8	Hardness	They are hard except Na and K which are soft metals.	They are soft except diamond which is hard.
9	Sonority	They are sonorous.	They are non-sonorous.
10	Tensile strength	They have high tensile strength.	They have low tensile strength.

2.6 CHEMICAL PROPERTIES OF METALS AND NON METALS

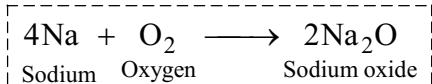
Some typical chemical properties of metals and non-metals are :

2.6.1 Reaction with Oxygen

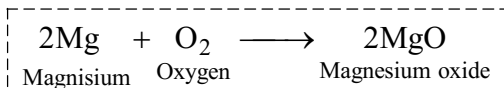
➤ **Metal** : Most metals combine with oxygen to form metal oxides.



- Sodium reacts vigorously with the oxygen present in air to form sodium oxide. As a result it catches fire if left in open. It is, therefore, kept immersed in kerosene.

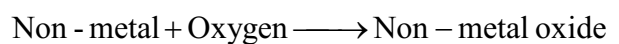


- Magnesium on heating burns in air (oxygen) with a dazzling white light to form magnesium oxide.

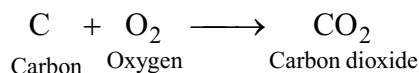


The metallic oxides formed are **basic** in nature and turn **red litmus solution blue**.

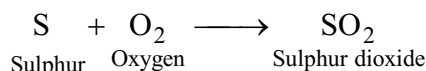
➤ **Non-metal** : Non-metals like carbon, sulphur, and phosphorus react with oxygen to form non-metallic oxides. These oxides are also called acidic oxides as they form acids when dissolved in water.



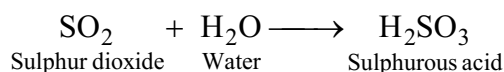
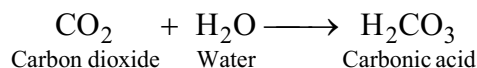
- Carbon burns in air (oxygen) to form carbon dioxide.



- Sulphur burns in air (oxygen) to form a pungent (i.e., having a strong smell), suffocating gas called sulphur dioxide.



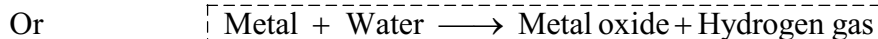
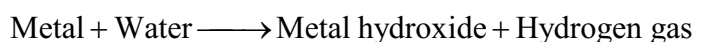
These oxides dissolve in water to form acids.



2.6.2 Reaction with Water

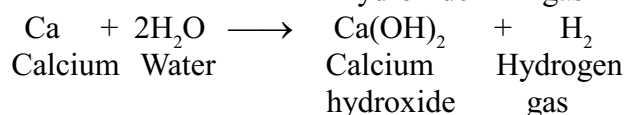
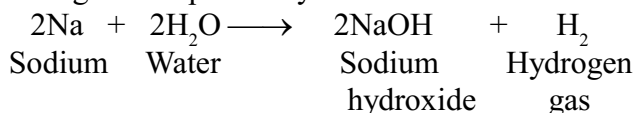
When a metal reacts with water, a metal oxide or metal hydroxide and hydrogen gas are formed. The intensity of reaction of a metal with water depends on its chemical reactivity. Some metals react even with cold water, some react with hot water, some react only with steam whereas some do not react at all with water.

- **Metal :** Most metals react with water to produce a metal hydroxide or metal oxide and hydrogen gas.



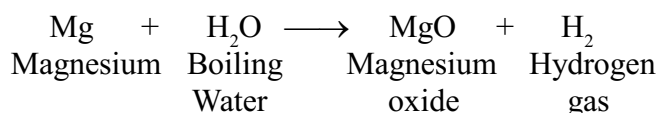
2.6.3 Reaction with Cold Water

Very reactive metals such as sodium, potassium and calcium rapidly displace hydrogen from cold water at room temperature forming their respective hydroxides.



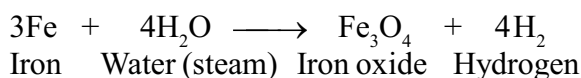
2.6.4 Reaction with Boiling Water

Less reactive metals like magnesium and zinc displace hydrogen gas only from boiling water forming oxides of the metals.



2.6.5 Reaction with Steam

Other less reactive metals like iron and nickel displace hydrogen gas from steam forming only oxides of metals.



Non-metals do not react with water or steam to release hydrogen gas.



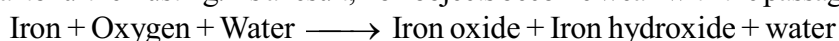
ACTIVITY - 4

Sodium Reacts with Water : Take a beaker half filled with water. Add a small piece of dry sodium into the water. Observe what happens. Sodium reacts vigorously with water and a gas is evolved. Dip a red litmus paper in the beaker and note the change in colour of the litmus. It turns blue. This is due to the formation of sodium hydroxide solution. The gas evolved is hydrogen.

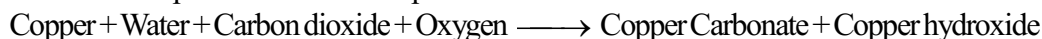
2.6.6 Corrosion

Iron and many other metals react with oxygen and moisture present in the atmosphere. This phenomenon is called corrosion. The process of slow eating away of a metal due to the attack of atmospheric gases and moisture on its surface is called **corrosion**.

- Iron reacts with oxygen and moisture present in the atmosphere to form a brown, flaky substance called rust. Rusting of iron is an undesirable reaction because the layer of rust formed falls off, exposing the metal to further rusting. As a result, iron objects become weak with the passage of time.



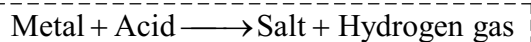
- Copper objects get coated with a green substance called basic copper carbonate with the passage of time. This green substance is formed due to the reaction of copper with carbon dioxide and moisture present in the atmosphere.



- Silver objects become blackened and lose their sheen with the passage of time. This happens due to the reaction of silver with hydrogen sulphide gas present in the atmosphere.

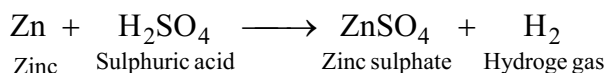
2.6.7 Reaction with Acids

Metals : When a metal reacts with an acid, a salt and hydrogen gas are produced.

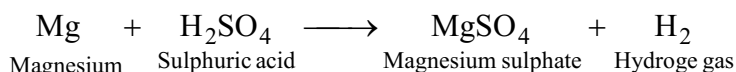


Salts are compounds formed when a metal replaces hydrogen in an acid. Different acids and metals react to form different salts.

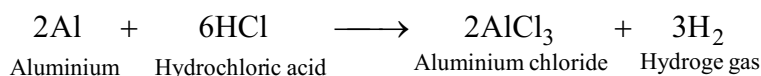
- Zinc reacts with sulphuric acid to form zinc sulphate and hydrogen gas.



- Magnesium reacts with sulphuric acid to form magnesium sulphate and hydrogen gas.



- Aluminium reacts with hydrochloric acid to form aluminium chloride and hydrogen gas.



With some metals, the reaction is very fast and vigorous, while with others it may be slow. Some metals do not react with acids at all.

Non-metals : Generally, non-metals do not react with acids.



ACTIVITY - 5

Aim : To show that hydrogen is produced when magnesium reacts with dilute sulphuric acid.

Materials needed : Magnesium ribbon, dilute sulphuric acid, test tube, dropper, and a matchstick.

Method :

1. Take a piece of magnesium ribbon in the test tube.
2. Using a dropper, carefully add a few drops of dilute sulphuric acid from the sides of the test tube.
3. Bring a burning matchstick near the mouth of the test tube.

Observation : Bringing a burning matchstick near the mouth of the test tube produces a 'pop' sound.

Conclusion : The gas produced in the reaction is hydrogen.

Note : Adult supervision required.

2.6.8 Reaction with Bases

Metals : Most metals do not react with bases. Only a few, like aluminium, zinc, and lead react with solutions of strong bases like sodium hydroxide to produce a compound of that metal and hydrogen gas.

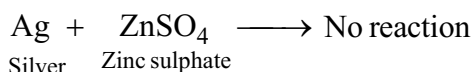
Non-metals : The reactions of non-metals with bases are complex.

2.6.9 Displacement Reactions

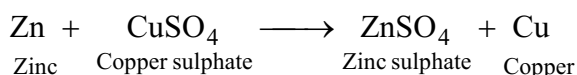
In a displacement reaction, a metal reacts with a salt solution and 'displaces' (or replaces) the metal present in it. Displacement reactions are explained on the basis of the activity series of metals. The **activity series of metals** is a list of common metals arranged in the decreasing order of reactivity.

This means that a metal which is placed higher in the activity series is more reactive than those placed below it. The activity series of metals is shown in Figure. You can predict whether or not a displacement reaction will take place by looking at the activity series. A metal will only react with a salt solution if it is placed higher in the activity series than the metal in the salt. For example, iron, which is placed higher in the activity series than copper, reacts with copper sulphate solution. Copper, however, does not react with iron sulphate as it is less reactive than iron. Some more examples are discussed below .

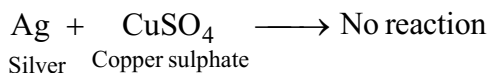
- Silver does not react with zinc sulphate.



- Zinc reacts with copper sulphate to form zinc sulphate and copper .

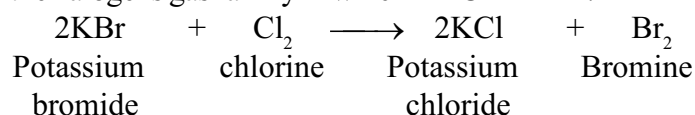


- Silver does not react with copper sulphate



From the above reactions, we can conclude that the order of reactivity of zinc, copper, and silver is : $\text{Zn} > \text{Cu} > \text{Ag}$ (i.e. zinc is the most reactive of the three and silver, the least reactive).

Like metals, a more reactive non-metal displaces a less reactive non-metal from its salt solution. This is observed in the halogens gas family in which $\text{F} > \text{Cl} > \text{Br} > \text{I}$.



Potassium (K)
Sodium (Na)
Calcium (Ca)
Magnesium (Mg)
Aluminium (Al)
Zinc (Zn)
Iron (Fe)
Tin (Sn)
Lead (Pb)
Hydrogen (H)
Copper (Cu)
Mercury (Hg)
Silver (Ag)
Gold (Au)
Platinum (Pt)

↑ Most reactive
↓ Least reactive

Activity series of metals



ACTIVITY - 6

Aim: To prove that iron is more reactive than copper Materials needed: Iron filings, copper turnings, copper sulphate solution, iron sulphate solution, test tubes, and a dropper

Method:

1. Take some iron filings in a test tube and add some copper sulphate solution with the help of a dropper (test tube A).
2. Take some copper turnings in a test tube and add some iron sulphate solution with the help of a dropper (test tube B).

Observation: In test tube A, iron filings turn brown due to the deposition of copper and the solution turns pale green due to the formation of iron sulphate solution. No reaction is observed in test tube B.

Conclusion: Iron is more reactive than copper as it displaces copper from copper sulphate solution.

Differences between Chemical Properties of Metals and Non-metals

S.N.	Property	Metals	Non-metals
1	Reaction with oxygen	They form basic oxides which turn red litmus blue.	They form acidic oxides which turn blue litmus red. Some nonmetals also form neutral oxides.
2	Reaction with water	They react with water to form metal oxide or metal hydroxide	They do not react with water and produce hydrogel) gas.
3	Reaction with dilute acids	They react with dilute acids to form corresponding salt and hydrogen gas.	They do not react with acids.
4	Displacement reaction	A more reactive metal displaces a less reactive metal from its salt solution.	A more reactive non-metal displaces a less reactive non-metal from its salt solution.

Alloy

An **alloy** is a mixture of two or more metals or a metal and a non-metal. Examples of alloys are stainless steel (a mixture of iron, nickel, and chromium) and bronze (a mixture of Copper and Tin). Alloys have more desirable properties than their constituents and are more corrosion resistant.

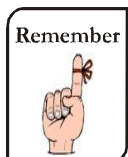
Uses of Common metals

1. Copper and aluminium metals are used to make wires to conduct electric current.
2. Iron, copper and aluminium are used to make household utensils and factory equipments.
3. Iron is used as a catalyst in the preparation of ammonia gas by Haber's process. It is also used in the construction of ships, buildings, automobiles and other machinery.
4. Zinc is used for galvanising iron to protect it from rusting.
5. Chromium and nickel metals are used for electroplating and in the manufacturing of stainless steel.
6. The aluminium foils are used in packaging of medicines, cigarettes and food materials. It is used for making alloys and high voltage transmission wires.
7. Mercury is used for making thermometres.
8. Sodium, titanium and zirconium are used in projects related with atomic energy and space science..
9. Zirconium is also used for making bullet proof alloy steel.
10. Silver and gold are used to make jewelleryes and ornaments.
11. Copper and zinc are constituents of enzymes which act as biological catalysts.
12. Iron is the constituent of haemoglobin and magnesium is a constituent of chlorophyll.
13. Tin is used for tinning, cooking utensils, for making alloys and electrical fuse wire.
14. Magnesium is used in fireworks and for making alloys.
15. Gold and silver amalgam are used in dentistry for filling tooth cavities.
16. Lead is used for making water pipes, bullets and X-ray shields.

Uses of common Non metals

1. Phosphorus is used in manufacturing phosphoric acid and superphosphate fertiliser, matchstick, rat poison, alloy, fireworks, smoke screens.
2. Sulphur is used for making sulphuric acid which in turn is used for making plastics, synthetic fibres, dyes, drugs, detergents, explosives, fertilizers, vulcanization of rubber, germicide and in beauty parlours.

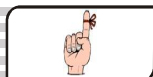
3. Powdered graphite is used as a dry lubricant. Graphite is used for making graphite electrodes in dry cells and electric arcs. It is also used for making the core of pencils called pencil leads.
4. Sand is used in making glass and cement.
5. Nitrogen is used for manufacturing ammonia, nitric acid, explosive, etc.
6. Silicon is used for making silicon steel alloy and a polymer called silicone.
7. Hydrogen is used as a fuel and for making ammonia, hydrochloric acid and vegetable ghee.
8. Chlorine is used for bleaching and sterilising water.
9. Iodine is used for making iodine salt and tincture iodine.
10. Oxygen is essential for respiration and combustion.



- **Did you know exposure to high doses of mercury can lead to blindness and paralysis? In the 1950s, hundreds of people in a small town called Minamata, Japan, were disabled and many others died due to nervous disorder and brain damage. It was later found that the fish they ate from Minamata bay were poisoned with mercury, and it was this exposure to mercury that was responsible for the ‘Minamata syndrome’.**
- **This iron pillar near the Qutub Minar in New Delhi is considered a metallurgical wonder by archaeologists and metallurgists all over the world as it has withstood corrosion for the last 1600 years, despite harsh weather conditions.**

KEY WORDS

- **Atom** : Atom is the smallest particle of matter which cannot be divided further by any physical mean. Atom are the basic units from which molecules and ions are formed.
- **Element** : a pure substance that consists of only one kind of atoms.
- **Metals** : elements which are hard, solid, malleable, ductile, possess lustre and are good conductors of heat and electricity.
- **Non-metals** : elements which are non-lustrous, brittle and are poor conductors of heat and electricity.
- **Metalloids** : elements which share the properties of metal and non-metals
- **Native state** : free state.
- **Malleability** : the ability of a metal to be beaten into sheets.
- **Ductility** : the property by which a metal can be drawn into wires.
- **Brittle** : substance which can be easily broken.
- **Displacement Reaction** : a reaction in which a more reactive metal displaces a less reactive metal from its salt solution.
- **Lustre** : the property of a metal by virtue of which its surface has a shine.
- **Sonorous** : the property of a metal which produces sound when struck with a hammer.
- **Conductivity** : the property due to which a substance conducts heat and electricity.
- **Acidic oxides** : the oxides of non-metals which dissolve in water to form acids.
- **Basic oxides** : the oxides of metals which dissolve in water to form bases.



POINTS TO REMEMBER

- An element consists of only one kind of atoms.
- Elements are classified into metals, non-metals and metalloids.
- Metals occur both in free and combined state in nature.
- Properties of Metals: Metals are:
 - (i) **hard** to touch.
 - (ii) **lustrous** i.e., freshly cut surfaces of metals have characteristic shining .
 - (iii) **malleable**; the property of metals by which they can be beaten into thin sheets is called malleability.
 - (iv) **ductile**; the property of metal by which they can .be drawn into wires are called ductility.
 - (v) **sonorous** i.e., produce ringing sound when struck on a hard surface.
 - (vi) good conductors of heat and electricity.
- Metals like **sodium** and **potassium** are **soft** and can be cut with a knife.
- Mercury is the only metal which is found in the liquid state at room temperature.
- Chemical Properties of Metals and Non-metals
 - (i) **Reaction with Oxygen:** Both metals and non-metals when burnt in oxygen, form their oxides. Oxides of metals are basic in nature while that of non-metals are generally acidic in nature e.g.,

(a)	2Mg	+	O_2	\longrightarrow	2MgO	
	Magnesium		Oxygen		Magnesium oxide	(basic)

(b)	S	+	O_2	\longrightarrow	SO_2	
	Sulphur		Oxygen		Sulphur dioxide	(acidic)
 - (ii) **Reaction with Water:** Some metals react with water to produce metal hydroxide and hydrogen gas. Generally, non-metals do not react with water.

2Na	+	$2\text{H}_2\text{O}$	\longrightarrow	2NaOH	+	H_2
Sodium		Water		Sodium hydroxide		Hydrogen
 - (iii) **Reaction with Acids:** Metals react with dil. acids and produce metal salt and hydrogen gas. Generally non-metals do not react with dil. acids.
 - (iv) **Reaction with Bases:** Metals react with bases to produce hydrogen gas.
 - (v) **Displacement Reaction:** More reactive metals displace less reactive metals from their metal compounds in aqueous solutions .
- **Uses of Metals and Non-metals**
 - (i) Metals are used in making machinery, automobiles, aeroplanes, trains, satellites, industrial gadgets, cooking utensils, water boilers etc.
 - (ii) Non-metals are also used in day-to-day life e.g.,
 - oxygen is essential for life.
 - nitrogen, phosphorus and potassium are used as fertilizers.
 - chlorine is used as water purifier.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q.1 Which of the following can be beaten into thin sheets?

- (A) Zinc (B) Phosphorus (C) Sulphur (D) Oxygen

Ans. (A) Zinc

Q.2 Which of the following statements is correct?

- (A) All metals are ductile. (B) All non-metals are ductile.
(C) Generally, metals are ductile. (D) Some non-metals are ductile.

Ans. (C) Generally, metals are ductile.

Q.3 Fill in the blanks.

- (A) Phosphorus is a very non-metal.
(B) Metals are conductors of heat and
(C) Iron is reactive than copper.
(D) Metals react with acids to produce gas.

Ans. (A) reactive (B) good, electricity (C) more (D) hydrogen

Q.4 Mark 'T' if the statement is true and 'F' if it is false.

- (A) Generally, non-metals react with acids.
(B) Sodium is a very reactive metal.
(C) Copper displaces zinc from zinc sulphate solution.
(D) Coal can be drawn into wires.

Ans. (A) F (B) T (C) F (D) F

Q.5 Some properties are listed in the following table. Distinguish between metals and non-metals on the basis of these properties.

Properties	Metals	Non-metals
1. Appearance		
2. Hardness		
3. Malleability		
4. Ductility		
5. Heat conduction		
6. Conduction of Electricity		

Ans. Metals:

1. have metallic lustre, 2. hard, 3. malleable, 4. ductile, 5. good conductors, 6. good conductors

Non-metals:

1. non-metals are dull, 2. soft, 3. non-malleable, 4. non-ductile, 5. bad conductors, 6. bad conductors/insulator

Q.6 Give reasons for the following.

- (A) Aluminium foils are used to wrap food items.
(B) Immersion rods for heating liquids are made up of metallic substances.
(C) Copper cannot displace zinc from its salt solution.
(D) Sodium and potassium are stored in kerosene.

- Ans.** (A) Aluminium is highly malleable metal and it is very easy to make aluminium foil in compare to other metals.
- (B) Immersion rods are made up of metallic substance because metals are good conductors of heat and electriciy.
- (C) Copper cannot, displace zinc from its solution because zinc is more reactive than copper (i.e., copper is less reactive than zinc).
- (D) Sodium and potassium metals are very reactive because they react with oxygen and water easily. A lot of heat is produced in the reaction so sodium and potassium always stored and kerosene.

Q.7 Can you store lemon pickle in an aluminium utensil? Explain.

Ans. No. This is because acids react with aluminium.

Q.8 Match the substance given in Column A with their uses given in Column B.

Column-A	Column-B
(i) Gold	(a) Thermometers
(ii) Iron	(b) Electric wire
(iii) Aluminium	(c) Wrapping food
(iv) Carbon	(d) Jewellery
(v) Copper	(e) Machinery
(vi) Mercury	(f) Fuel

Ans. (i)-(d), (ii)-(e), (iii)-(c), (iv)-(f), (v)-(b), (vi)-(a)

Q.9 What happens when

(A) Dilute sulphuric acid is poured on a copper plate?

(B) Iron nails are placed in copper sulphate solution?

Write word equations of the reactions involved.

- Ans.** (A) Copper sulphate is formed and hydrogen gas is released.
Copper + dil. sulphuric acid \longrightarrow Copper sulphate + Hydrogen (gas)
- (B) Brown coating is deposited on the iron nails. This is because of the displacement of copper from copper sulphate solution by iron.
Iron + Copper sulphate (solution) \longrightarrow Iron sulphate (solution) + Copper

Q.10 Saloni took a piece of burning charcoal and collected the gas evolved in a test tube.

(A) How will she find the nature of the gas?

(B) Write down word equations of all the reactions taking place in this process.

- Ans.** (A) She will bring a wet litmus paper in contact with the gas. If the gas turns wet blue litmus paper into red, the gas will be acidic.
- (B) (i) Carbon + Oxygen \longrightarrow Carbon dioxide
(ii) Carbon dioxide + Water \longrightarrow Carbonic acid (from wet litmus)

Q.11 One day Reeta went to a jewellery's shop with her mother. Her mother gave on old gold jewellery to the goldsmith to polish. Next day when they brought the jewellery back, they found that there was a slight loss in its weight. Can you suggest a reason for the loss in weight?

Ans. The jeweller's dip the jewellery in the solution of acid, which reacts with the outer covering of metals. Thus there is a net loss of weight in the metal of the ornament.

CONCEPT APPLICATION LEVEL - II

SECTION-A

Q.1 Complete the following equation:



Ans. $\text{Zn} + 2\text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2$

Q.2 Explain the term 'metallurgy'.

Ans. Metallurgy is the science of extracting metals from their ores and purifying them for various uses.

Q.3 State general steps involved in metallurgy of a metal.

Ans. The general steps of metallurgy are :

- (a) Concentration of ore. (b) Reduction of the metal compound.
(c) Refining of metal.

Q.4 Arrange the following metals in the order of their decreasing chemical activity: magnesium, potassium, iron, gold.

Ans. Potassium, magnesium, iron, gold

Q.5 Why is aluminium used in making aeroplanes?

Ans. Aluminium is used in making aeroplanes, as it is light and has high resistance to corrosion when exposed to air which aircrafts demand the most.

Q.6 What is the significant of an atom? What do you mean by element?

Ans. A pure substance that consists of only one kind of atoms is called an **element**. The smallest unit of an element is **atom**. Elements cannot be broken down into smaller unit and the building blocks of a variety of substances.

Q.7 Write short note on classification of elements.

Ans. ➤ **Metals**

The elements which are hard, lustrous, malleable, ductile, sonorous, and good conductors of heat and electricity are called **metals**.

Examples: iron, copper, gold, silver, aluminium etc.

➤ **Non-metals**

The elements which are brittle, non-lustrous, non-malleable, non-ductile, and poor conductors of heat and electricity are called **non-metals**.

Examples: nitrogen, sulphur, phosphorus, carbon, oxygen.

➤ **Metalloids**

The elements which possess the characteristics of both metals and non-metals are called **metalloids**.

Examples: boron, silicon, arsenic, germanium.

Q.8 What do you mean by malleability?

Ans. The property of metals by which they can be beaten into thin sheets is called malleability. This is the property of metals.

Q.9 What do you mean by conductivity?

Ans. The metals allow the electricity to pass through them. This property of metals is called conductivity.

Q.10 What do you mean by sonority? Why are metals called sonorous?

Ans. The property of metal to produce ringing sound is called sonority. Since metals produce ringing sounds, they are called sonorous?

Q.11 What do you mean by ductility? Which substances show this property?

Ans. The property which allows a substance to be drawn into wires is called ductility. Metals show ductility. For example, copper, aluminium and iron can be drawn into wires when hot.

Q.12 How can you distinguish metals from non-metals?

Ans. Metals can be distinguished from non-metal on the basis of their physical and chemical properties.

Q.13 Have you ever seen a blacksmith beating an iron piece? Do you find a change in the shape of these pieces on beating? Would you expect a similar change in wood log on beating?

Ans. Yes, we have seen blacksmith beating the iron pieces. We have seen the changes in the shape on beating. It increases in size it does not break.

Q.14 Gaurav knows that wires can be made from copper and aluminium. He tries to make wire from sulphur and carbon. Will he succeed? Give reason also.

Ans. No, he will not succeed because sulphur and carbon are non-metals. Non-metals are not ductile, that is, they cannot be drawn into wires.

Q.15 If you put one end of a rod of a metal in hot water, you feel hot at the other end. What does it mean? What is this property of metals called?

Ans. The above observation means that heat is transmitted from one end to the other. This property of metals is called conductivity.

Q.16 (i) Give two important uses of silver.

(ii) Give two uses of gold.

(iii) Give two uses of platinum.

Ans.

- (i)** It is used for making coins.
Silver salts (silver bromide and silver iodide) are used for making photographic films.
- (ii)** Gold is used for making ornaments.
Gold foils are used in the preparation of Ayurvedic medicines.
- (iii)** It is used as a catalyst in the manufacture of sulphuric and nitric acid.
Platinum catalytic converts use platinum as catalytic agent.

Q.17 Compare the properties of metals and non-metals with respect to malleability, ductility and conductivity.

Ans.	Metals		Non-metals
1.	Malleable – gives sheets on hammering.	1.	Brittle – no sheets can be obtained.
2.	Ductile – can be transformed into wires.	2.	Not ductile – no wires can be obtained.
3.	Good conductors of heat and electricity.	3.	Bad conductors of heat and electricity.

Q.18 (a) A copper spoon had fallen into a container containing dil. HCl. What would happen to it is three days time?

(b) Give reasons for the following:

(i) Metals are used for making bells.

(ii) We can't use pure gold to make jewellery.

(c) A metal ribbon burns in air with bright white light and forms a white powder.

(i) Which metal is this?

(ii) Give the equation of the reaction taking place.

(iii) The metallic oxide formed would be acidic or basic in nature.

Ans. (a) Nothing will happen as copper does not react with hydrochloric acid.

(b) (i) Metals have the property of sonorosity so they are used for making bells.

(ii) Pure gold cannot be used for making jewellery because it is very soft.

(c) (i) Mangesium **(ii)** $2\text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO}$

(iii) Basic in nature

Q.19 Give some differences with examples between metals and non-metals with reference to their physical properties. Give one exception in each case.

Ans. 1. Metallic Lustre : Metals have a shining surface i.e., called metallic lustre, while the non-metals have dull appearance, for example: Metals like silver, gold have shining appearance. Non-metal like sulphur has dull appearance.

Exception : Diamond a form of carbon is a non-metal but has the most shining look. Iodine is also a non-metal which gives shining crystals.

2. Malleability : Metals are malleable. They can be beaten into sheets. But non-metals cannot be beaten into sheets. They break into pieces when hammered. They are not malleable. Metals like gold, aluminium, copper etc. form sheets when hammered.

Exception: Mercury is a metal. It breaks into pieces when hammered.

3. Ductility : Metals are ductile, and can be drawn into wires. Non-metals cannot be drawn into wires.

Exception : Mercury is metal but not ductile in nature.

4. Conductivity: Metals are good conductors of heat and electricity while non-metals are bad conductors of heat and electricity.

Exception : Graphite is a non-metal but is a good conductor of heat and electricity.

5. Hardness : Metals like sodium or potassium are quite soft and can be easily cut with a knife. Diamond (a form of non-metal carbon) is the hardest substance.

Q.20 Which property of metals make them useful as ringing bells?

Ans. Sonority.

Q.21 How will you show that metals form basic oxides?

Ans. The metallic oxides formed are **basic** in nature and turn **red litmus solution blue**.

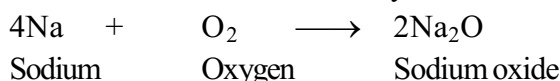
Q.22 White phosphorous has to be kept in water. Why?

Ans. Phosphorous is to be kept in water to prevent in contact with air because it is highly reactive.

Q.23 Discuss some chemical properties of metals.

Ans. 1. Reaction with Air :

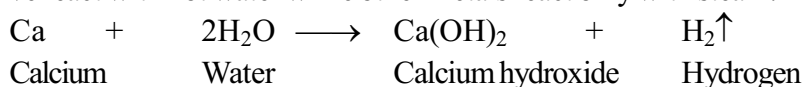
(i) Metals are converted into their oxides by the action of oxygen present in air.



(ii) Some metals are not affected by dry air. Zinc and aluminium are oxidized by moist air only to form their oxides.



2. Reaction with Water: Different metals react with water at different temperatures to evolved out hydrogen. Some metals reacts with water at room temperature and some metals which are less active react with hot water while other metals react only with steam.



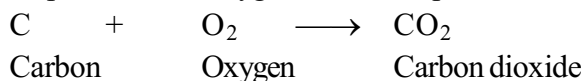
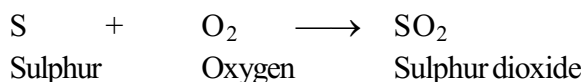
3. Reaction with Acids: Metals react with acids and produce hydrogen gas that burns with a 'pop' sound.

4. Reaction with Bases: Metals react with Sodium hydroxide to produce hydrogen gas.

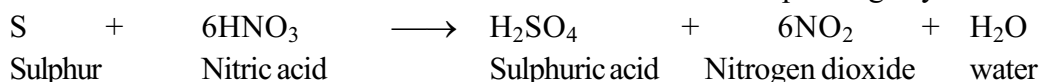
5. Displacement Reactions: More reactive meals displace less reactive metals from their compound in aqueous solutions.

Q.24 Write some chemical properties of non-metals.

Ans. (i) Reaction with Air : Non-metals react with air to form non-metallic oxides or acidic oxides. These oxides turn blue litmus into red.



(ii) **Reaction with Acids :** Some non-metals react with acids to form corresponding oxy-acids.



(iii) **Reaction with Water :** Generally non-metals do not react with water.

(iv) **Reaction with Bases :** Reactions of non-metals with bases are complex.

Q.25 State some chemical properties on the basis of which metals can be distinguished from non-metals.

Metals	Non-metals
1. Metals form basic oxides with oxygen which turn red litmus into blue. $2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO}$	1. Non-metals form acidic oxides with oxygen which turn blue litmus into red. $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$
2. Metals react with dilute acids to form salt and hydrogen gas. $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$	2. Non-metals do not react and if react then they form corresponding acids. $\text{S} + 6\text{HNO}_3 \rightarrow \text{H}_2\text{SO}_4 + 6\text{NO}_2 + 2\text{H}_2\text{O}$
3. Metals are electropositive in nature.	3. Non-metals are electronegative in nature.
4. Metals form unstable hydrides.	4. Non-metals form stable hydrides.
5. Metals form hydroxides in water.	5. Non-metals do not react with water.

Q.26 Give two uses of sulphur in chemical industry.

- Ans.** (i) It is used in the manufacture of sulphuric acid.
(ii) It is used in the manufacture of carbon disulphide, which is used as an industrial solvent.

Q.27 Purity of gold is 15 carat. What is the percentage of gold in the ornaments?

Ans. 24 carat purity of gold = 100

$$\therefore 1 \text{ carat purity of gold} = \frac{100}{24}$$

$$15 \text{ carat purity of gold} = \frac{100}{24} \times 15 = 62.5\%$$

Q.28 What would you observe when a strip of zinc is dipped in the solution of copper sulphate?

Ans. It will be observed that blue colour of the copper sulphate solution starts fading and zinc strip gets a shiny brown coating of copper.

Q.29 Can copper displace iron from iron sulphate solution? Give reasons.

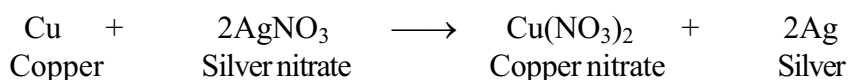
Ans. No, because copper is less reactive than iron. It is only more reactive metal that displaces a less reactive metal from its compound in aqueous solution.

Q.30 Why do some metals replace the other metals from their solutions?

Ans. Because of the difference in the reactivity, some metals replace the less reactive metals. More reactive metal replaces the less reactive metal from its solution.

Q.31 Name a metal that replaces silver from silver nitrate solution. Give its equation and reason also.

Ans. Copper replaces silver from silver nitrate solution. Silver gets deposited over copper. This reaction is used in silver electroplating over copper articles. This happens because copper is more reactive than silver.



Q.32 Why should foodstuffs with acid components be not stored in metallic containers?

Ans. Metals react with acids. So foodstuffs with acid components may produce poisonous materials on reaction with metals. Hence, foodstuffs are not stored in metallic containers.

Q.33 Why does an aluminium vessel loose its shine so soon after use?

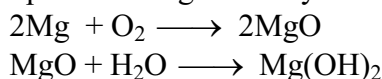
Ans. Aluminium is a reactive metal. As it comes in contact with air, it forms a dull layer of aluminium oxide on its surface hence loses its shine.

Q.34 Silver does not combine easily with oxygen but silver jewellery tarnishes after sometime. Why?

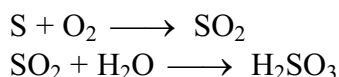
Ans. Silver does not combine with oxygen easily but jewellery exposed to atmosphere tarnishes black after sometime because it reacts with gases like hydrogen sulphide in air to form silver sulphide which is black.

Q.35 Taking the examples of magnesium and sulphur explain how metals and non-metals produce oxides with different characteristics.

Ans. (i) Magnesium is metal : When it burns with oxygen it produces basic magnesium oxide - MgO. When it added to water, it produces magnesium hydroxide, which turns the red litmus solution into blue.



(ii) Sulphur is a non-metal : When combines with oxygen, it forms acidic oxide, SO₂. It gets changed into sulphurous acid - H₂SO₃ when react with water. This turns the blue litmus solution into red. Red litmus solution remains unaffected.



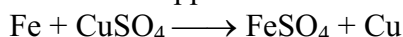
Q.36 (a) Identify the most reactive and least reactive metal amongst the followings:

Al, K, Cu, Au

(b) An iron knife kept dipped in blue copper sulphate solution changes to light green. Why? Write the equation also.

Ans. (a) Most reactive metal is K and least reactive metal is Au.

(b) An iron knife kept dipped in blue copper sulphate solution changes to light green because iron replaces copper from copper sulphate and forms iron sulphate. This happens because iron is more reactive than copper.



Q.37 What happens when

(a) Hydrochloric acid is poured on aluminium foils?

(b) Sodium is placed in water?

(c) Sulphur dioxide is dissolved in water?

(Write the chemical equation of the reaction involved)

Ans. (a)

$$\begin{array}{ccccccc} 2\text{Al} & + & 6\text{HCl} & \longrightarrow & 2\text{AlCl}_3 & + & 3\text{H}_2 \\ \text{Aluminium} & & \text{Hydrochloric} & & \text{Aluminium} & & \text{Hydrogen} \\ & & \text{acid} & & \text{chloride} & & \end{array}$$

(b)

$$\begin{array}{ccccccc} 2\text{Na} & + & 2\text{H}_2\text{O} & \longrightarrow & 2\text{NaOH} & + & \text{H}_2 \\ \text{Sodium} & & \text{Water} & & \text{Sodium} & & \text{Hydrogen} \\ & & & & \text{hydroxide} & & \end{array}$$

(c)

$$\begin{array}{ccccccc} \text{SO}_2 & + & \text{H}_2\text{O} & \longrightarrow & \text{H}_2\text{SO}_3 \\ \text{Sulphur} & & \text{Water} & & \text{Sulphurous} \\ \text{dioxide} & & & & \text{acid} \end{array}$$

Q.38 A set of metals in order of their increasing chemical reactivity is given below:

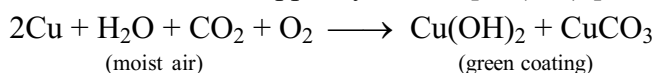
silver, copper, lead, iron, zinc, magnesium and sodium

- (a) Which of the above metals is stored in kerosene?
 (b) Which metals will react with cold water?
 (c) Which gas will be liberated when metals react with cold water?
 (d) Which of the metals will react with oxygen and heated?
 (e) Which of the metals become black in the presence of hydrogen sulphide?

Ans. (a) Sodium (b) Sodium (c) Hydrogen (d) Zinc, magnesium
 (e) Silver

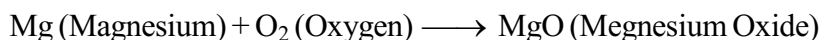
Q.39 What happens when a copper vessel is exposed in moist air?

Ans. When a copper vessel is exposed in moist air for a long time, it acquires a dull green coating. The green substance is the mixture of copper hydroxide [Cu(OH)₂] and copper carbonate (CuCO₃)



Q.40 What happens when a magnesium ribbon is heated in presence of air?

Ans. When a magnesium ribbon is heated in presence of air on a burner flame, after some time it starts burning with a white flame and white powder is formed which is called magnesium oxide.



Q.41 What are the conditions necessary for rusting of iron?

Ans. Iron reacts with oxygen and moisture present in the atmosphere to form a brown, flaky substance called rust. Rusting of iron is an undesirable reaction because the layer of rust formed falls off, exposing the metal to further rusting. As a result, iron objects become weak with the passage of time.



Q.42 What happens when samples of metals and non-metals are mixed with acids?

Ans. We observe that non-metals do not react with acids but metals react with acids and produce hydrogen gas that burns with a pop sound. Copper does not react with dilute hydrochloric acid but reacts with sulphuric acid.

Q.43 Explain the reaction of metals and non-metals with acids with the help of an activity.

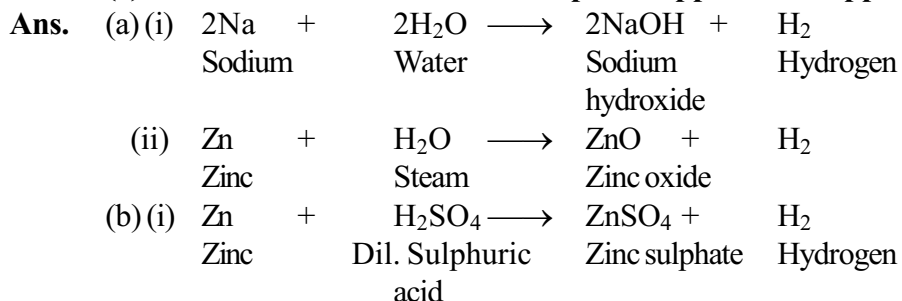
Ans. Take samples of metals and non-metals in separate test tubes and label them A, B, C, D, E and F. With the help of a dropper add 5 ml of dilute hydrochloric acid to each test tube only by one. Observe the reaction carefully. If no reaction occurs in the cold solution, warm the test tube gently. Bring a burning match stick near the mouth of each test tube. Repeat the same activity using dilute Sulphuric acid in place of dilute hydrochloric acid. Record your observation in a table:

Table : Reaction of Metals and Non-metals with Acids

Test tube label	Metal/ Non-metal	Reaction with Dilute Hydrochloric Acid		Reaction with Dilute Sulphuric Acid	
		Room	Warm Temperature	Room	Warm Temperature
A	Magnesium (ribbon)	Reacts to give hydrogen	Rapid reaction	Reacts to give hydrogen	Rapid reaction
B	Aluminium (foil)	Reacts to give hydrogen	Rapid reaction	Reacts to give hydrogen	Rapid reaction
C	Iron (filings)	Reacts to give hydrogen	Rapid reaction	Reacts to give hydrogen	Rapid reaction
D	Copper (peeled flexible wire)	No reaction	at all	No reaction	Reacts to give hydrogen
E	Charcoal (Powder)	No reaction	at all	No reaction	at all
F	Sulphur (Powder)	Does not react	at all	No reaction	React

Q.44 From among the set of metals – sodium, zinc, iron, copper, silver select the following giving equations for each reaction:

- (a) Two metals which will liberate hydrogen from water.
 (b) One metal which is used to prepare hydrogen gas in the laboratory.
 (c) One metal which will displace copper from copper sulphate solution.
 (d) One metal which will not displace copper from copper sulphate solution.



Q.45 What are coinage metals?

Ans. Copper, silver and gold are coinage metals. Nowadays coins are made from suitable combination of these metals.

Q.46 Why is tincture iodine applied on wounds?

Ans. Tincture iodine is a solution of iodine in alcohol. It has antiseptic properties and, is therefore, applied on wounds to protect from germs.

Q.47 Explain the use of chlorine in water purification plants.

Ans. Chlorine has the ability to kill germs. Hence it is used in water purification plants.

Q.48 Give two reasons for aluminium being preferred to copper for manufacturing cooking utensils.

- Ans.** (i) Aluminium is unaffected by food acids.
(ii) It is very light metal.

Q.49 List different uses of metals that you come across in everyday life.

Ans. Uses of Metals :

- (i) Iron alloyed with other metals is used in trains, automobiles, aeroplanes, satellites, and industrial gadgets.
- (ii) Iron whenever in conjunction with cement is used to construct big buildings.
- (iii) Aluminium and its alloys are used in making household items and aeroplanes.
- (iv) Metals like copper, iron and aluminium are used in making cooking utensils and water boilers.
- (v) Copper and aluminium are used in electric wires.
- (vi) Gold and silver are used in making electrical contacts in computers and solar cells and jewellery.
- (vii) Aluminium foils are used as packing material.
- (viii) In combined form metals are used as salt, cement and glass.

Q.50 Why is aluminium nowadays replacing copper for use in electrical cables?

Ans. Aluminium is cheaper and is making a good substitute for copper.

Q.51 How is sulphur useful in agriculture? How is sulphur useful in medicine?

Ans. Sulphur powder is an excellent insecticide and fungicide. It is used in spraying fruit trees.
– Sulphur is the main constituent of skin ointments.
– Metallic sulphides of sulphur are used in preparation of Ayurvedic medicines.
