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METALS AND NON METALS

Metals are used to make parts for gadgets like Smart watches, TV, fridge and computers. Paints have powdered graphite in them which is a non-metal. Carbon atoms arrangement in paint's graphite helps in offering authentic protection.

Topic Notes

- *Physical Properties of Metals and Non-metals*
- *Chemical Properties of Metals and Non-metals*
- *Reaction between Metals and Non-metals*
- *Occurrence and Extraction of Metals*
- *Corrosion of Metals*

TOPIC 1

PHYSICAL PROPERTIES OF METALS AND NON-METALS

On the basis of their properties, all the elements can be divided into two main groups: metals and non-metals. Apart from metals and non-metals, there are some elements which show characteristics of both metals and non-metals and known as metalloids, for example, Si, Ge, As, Sb and Te.

Metals are opaque, lustrous elements that are good conductors of heat and electricity. **Examples:** Copper, Iron, Silver, Aluminium, etc.

Non-metals are the elements that have properties which are different from those of metals. **Examples:** Carbon, Nitrogen, Oxygen, Sulphur etc.

Physical Properties of Metals

(1) **State:** Metals are generally solids at room temperature except mercury which is a liquid.

(2) **Lustre:** In pure state metals have a shining surface. Al and Mg are white whereas Au is yellow and Cu is reddish brown in colour.

(3) **Hardness:** Metals are generally hard but hardness varies from metal to metal.

(4) **Malleability:** Some metals can be beaten into thin sheets and this property is called malleability. Gold and silver are the most malleable metals.

(5) **Ductility:** Some metals can be drawn into very thin wires and this property is called ductility. Gold is the most ductile metal.

(6) **Thermal and electrical conductivity:** Metals are generally good conductors of heat and electricity. Silver is the best conductor of heat followed by copper and aluminium. Silver and copper are the best conductors of electricity.

(7) **Melting and Boiling points:** Metals generally have high melting and boiling points. The boiling and melting points of aluminium are 933 K and 2792 K respectively.

(8) **Sonorous:** Metals that produce a sound on striking a hard surface are said to be sonorous.

Example 1. Case Based:

A student took an aluminium or copper wire and clamped this wire on a stand, as shown in Fig. 1.

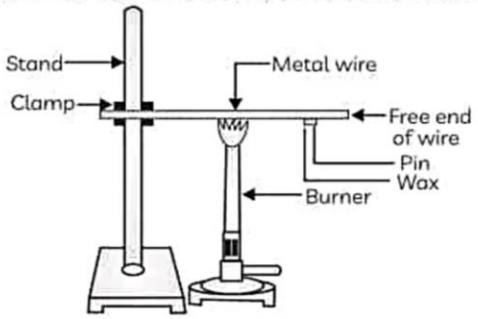


Fig. 1

He then fixed a pin to the free end of the wire using wax and heated the wire with a spirit lamp, candle or a burner near the place where it is clamped.

Another student set up an electric circuit as shown in Fig. 2 below to test the electrical conductivity of metals. He placed the metal to be tested in the circuit between terminals A and B as shown.

[NCERT Activity 3.5, 3.6]

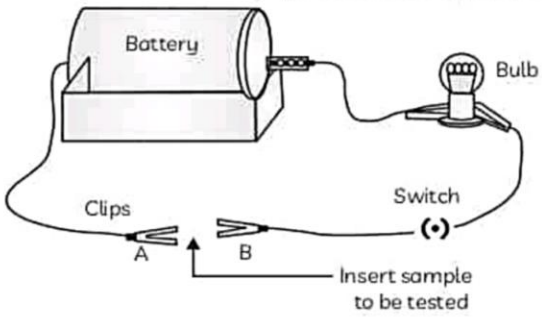


Fig. 2

(A) The activity performed by the first student (Fig.1) shows that:

(a) Metals are good conductors of heat and have low melting points.

(b) Metals are poor conductors of heat and have high melting points.

(c) Metals are good conductors of heat and have high melting points.

(d) Metals are poor conductors of heat and have low melting points.

(B) The metals which are poor conductors of heat are:

(a) Lead and zinc

(b) Mercury and zinc

(c) Lead and tin

(d) Lead and mercury

(C) What conclusion can be drawn from the activity performed by the second student (Fig.2)?

(D) Name the two best conductors of electricity.

(E) Assertion (A): Metal such as aluminium is used for making cooking utensils.

Reason (R): Aluminium is a highly ductile metal.

(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Ans. **(A)** *(c) Metals are good conductors of heat and have high melting points.*

Explanation: Metals have a high melting point and are generally good conductors of heat. Most metals are also good conductors of electricity.

(B) *(d) Lead and mercury*

Explanation: The metals lead and mercury are comparatively poor conductors of heat. Whereas the best conductors of heat are silver and copper.

(C) The conclusion that can be drawn from the activity performed by the second student (Fig.2) is that the bulb glows when a metal is inserted between A and B showing that most of the metals conduct electricity.

(D) Silver and copper are the best conductors of electricity.

(E) *(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).*

Explanation: Metal such as aluminium is used for making cooking utensils as it is a good conductor of heat and has high melting point. The property of metals used for making electrical wires are ductility and good electrical conductivity.

Physical Properties of Non-Metals

(1) State: Non-metals are either solids or gases except bromine which is a liquid.

(2) Lustre: Non-metals do not have any lustre.

(3) Hardness: Non-Metals are generally soft.

Exceptions: Diamond is an allotrope of carbon and is the hardest natural substance

(4) Malleability: Non-metals are not malleable. Actually they are brittle.

(5) Ductility: Non-metals are not ductile also.

(6) Thermal and electrical Graphite, which is an allotrope of Carbon conducts electricity. Therefore, this is an execption. do not conduct heat and electricity.

(7) Melting and boiling points: Non-metals have low melting and boiling points.

Example 2. You are given a hammer, a battery, a bulb, wires and a switch.

(A) How could you use them to distinguish between samples of metals and non-metals?

(B) Assess the usefulness of these tests in distinguishing between metals and non-metals. [NCERT]

Ans. **(A)** Metals and non-metals have different physical properties. If we take the given samples and strike them with a hammer, metals will be converted into sheet, whereas non-metals will not. This is because metals are malleable.

Also, metals are sonorous and produce sound when hit with a hammer, whereas non-metals are not sonorous.

The battery, wires, bulb and switch can be arranged in the form of a circuit for testing the electrical conductivity of samples (refer to Fig. 2).

When sample of metals are inserted between A and B, the bulb glows which shows that metals are good conductors of electricity, whereas the bulb does not glow when samples of non-metals are inserted which shows that non-metals are poor conductors of electricity.

(B) These tests are useful in distinguishing between metals and non-metals based on the differences in properties of metals and non-metals as metals are malleable, sonorous and good conductors of electricity whereas non-metals do not possess any of these properties.

Exceptions in Physical Properties

	Physical Property	Exception
(1)	Physical State	Mercury is a metal that is a liquid at room temperature. Bromine is a non-metal that is liquid at room temperature.
(2)	Melting Point and Boiling point	Sodium, potassium, cesium and gallium are metals that have low melting points. Diamond is a non-metal which has a high melting point.
(3)	Density	Alkali metals (lithium, sodium, potassium) are so soft that they can be cut with a knife.
(4)	Electrical Conductivity	Mercury, a metal, offers a very high resistance to the passage of current.
(5)	Lustre	Iodine is a non-metal which is lustrous.

TOPIC 2

CHEMICAL PROPERTIES OF METALS AND NON-METALS

Metals are electropositive in nature as they lose electrons and form positive ions.

$$K \longrightarrow K^+ + e^-$$
$$Ca \longrightarrow Ca^{2+} + 2e^-$$

Non-metals are electronegative in nature as they accept electrons and form negative ions.

$$Cl + e^- \longrightarrow Cl^-$$
$$S + 2e^- \longrightarrow S^{2-}$$

Most non-metals produce acidic oxides

Examples: SO_2, CO_2

Most metals produce basic oxides. Examples: Na_2O, CaO

Chemical Properties of Metals

Reaction with Oxygen

Metals combine with oxygen to form basic or amphoteric oxides.

Metal + Oxygen $\longrightarrow$ Metal Oxide

Examples: $2Cu + O_2 \longrightarrow 2CuO$ (Copper oxide)

$4Al + 3O_2 \longrightarrow 2Al_2O_3$

Although metal oxides are basic in nature but some metals show both acidic and basic nature.

Amphoteric oxides: The metal oxides which show both acidic and basic nature are known as amphoteric oxides.

For example, aluminium oxide and zinc oxide are amphoteric oxides.

The reaction of aluminium oxide with acids and bases is given below:

$$Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$$
$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

Alkalies: The oxides of most metals are insoluble in water but some of these dissolve in water to form alkalies.

Examples: Sodium oxide and potassium oxide

$$Na_2O_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)}$$
$$K_2O_{(s)} + H_2O_{(l)} \longrightarrow 2KOH_{(aq)}$$

Reaction of different metals with oxygen: Different metals show different reactivities towards oxygen.

(1) The reaction of alkali metals such as potassium and sodium with oxygen is so vigorous that they are kept immersed in kerosene oil to prevent accidental fires in case they are kept in open.

(2) The surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide at ordinary temperature,, which prevents the metal from further oxidation and is therefore a protective layer.

(3) Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of a burner.

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

(5) Silver and gold do not react with oxygen even at high temperatures.

Anodising: Anodising is a process of forming a thick oxide layer of aluminium. Aluminium forms a thin oxide layer when exposed to air which makes it resistant to further corrosion. During anodising, a clean aluminium article is made the anode and is electrolysed with dil. H_2SO_4. The oxygen gas evolved at the anode reacts with aluminium to form a thicker protective oxide layer.

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

(a) Calcium **(b) Carbon**
(c) Silicon **(d) Iron** **[NCERT]**

Ans. *(a) Calcium*

Explanation: As the compound has a high melting point, it is an ionic compound. Since metal oxides are ionic in nature, therefore, the element could be calcium or iron.

However, it is also given that the compound is also soluble in water and as calcium oxide is soluble in water, whereas iron oxide is not soluble, the given element is calcium.

$$2Ca_{(s)} + O_{2(g)} \longrightarrow 2CaO_{(s)}$$
$$CaO_{(s)} + H_2O_{(l)} \longrightarrow 2Ca(OH)_{2(aq)} + Heat$$

Reaction with Water

Metals react with water and produce a metal hydroxide or oxide and hydrogen gas is evolved.

Metal + Water $\longrightarrow$ Metal oxide + H_2

Metal oxides that are soluble in water dissolve in it to further form metal hydroxide.

Metal oxide + Water $\longrightarrow$ Metal hydroxide

(1) Metals like K and Na react violently with cold water.

$$2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)} + Heat$$
$$2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)} + Heat$$

(2) The reaction of calcium with water is less violent.

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

Calcium starts floating because the bubbles of

hydrogen gas formed stick to the surface of the metal.

(3) Mg does not react with cold water but reacts with hot water to form $Mg(OH)_2$. It also starts floating because the bubbles of hydrogen gas formed stick to the surface of the metal.

(4) Metals like Al, Zn and Fe react with steam to form a metal oxide.

$$2Al_{(s)} + 3H_2O_{(g)} \longrightarrow Al_2O_{3(s)} + 3H_{2(g)}$$
$$3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$$

(5) Metals like Pb, Cu, Ag and Au do not react with water at all.

Example 4. Case Based:

Collect the samples of following metals: aluminium, copper, iron, lead, magnesium, zinc and sodium. Put small pieces of the samples separately in beakers half-filled with cold water. Put the metals that did not react with cold water in beakers half-filled with hot water. For the metals that did not react with hot water, arrange the apparatus as shown in Fig. 3 and observe their reaction with steam. **[NCERT Activity 3.10]**

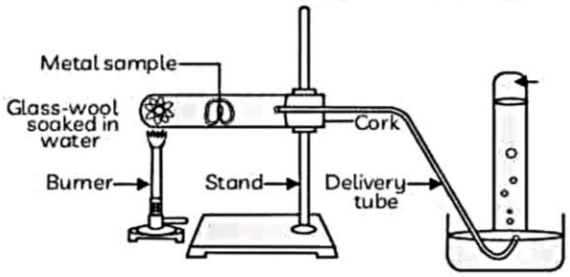


Fig. 3 Action of steam on a metal

(A) Select the metals which react with cold water:

(I) Al (II) Mg
(III) Na (IV) K
(a) Both (I) and (II)
(b) Both (I) and (III)
(c) Both (III) and (IV)
(d) (I), (II) and (IV)

(B) A metal X when treated with cold water gives the metal hydroxide Y and starts floating.

The metal X and compound Y could be:

	Metal X	Compound Y
(I)	Mg	$Mg(OH)_2$
(II)	Ca	$Ca(OH)_2$
(III)	Na	NaOH
(IV)	K	KOH

Select the correct option:

(a) Only (I) (b) Only (II)
(c) Both (I) and (III) (d) Both (II) and (IV)

(C) Name the metals which do not react either with cold or hot water.

(D) Arrange the metals aluminium, copper, iron, lead, magnesium, zinc and sodium in decreasing order of their reactivity with water.

(E) Assertion (A): Sodium catches fire when it reacts with hot water.

Reason (R): The reaction between sodium and cold water is highly exothermic.

(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Ans. (A) *(c) Both (III) and (IV)*

Explanation: Metals like K and Na react violently with cold water.

$$2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)} + Heat$$
$$2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)} + Heat$$

Mg does not react with cold water but reacts with hot water to form $Mg(OH)_2$.

Al reacts with steam to form a metal oxide.

$$2Al_{(s)} + 3H_2O_{(g)} \longrightarrow Al_2O_{3(s)} + 3H_{2(g)}$$

(B) *(b) Only (II)*

Explanation: Out of the metals Mg, Ca, Na and K, both Na and K react so violently with water that the hydrogen gas evolved immediately catches fire.

The reaction of Ca with cold water is less violent and calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of the metal.

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

Mg does not react with cold water but reacts with hot water to form $Mg(OH)_2$ and hydrogen.

(C) The metals Al, Zn and Fe do not react either with cold or hot water but they react with steam to form the metal oxide and hydrogen gas.

$$2Al_{(s)} + 3H_2O_{(g)} \longrightarrow Al_2O_{3(s)} + 3H_{2(g)}$$
$$3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$$

(D) The decreasing order of reactivity of metals with water is:

Na > Mg > Al > Zn > Fe > Pb > Cu

(E) *(d) (A) is false, but (R) is true.*

Explanation: Sodium reacts violently even with cold water and the reaction is such a highly exothermic reaction that the hydrogen gas evolved immediately catches fire.

Example 5. **Give reasons why copper is used to make hot water tanks and not steel (an alloy of iron).** [NCERT]

Ans. Steel is an alloy of iron and iron reacts with steam to form Fe_3O_4.

$$3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$$

However, copper is less reactive and does not react either with cold water, hot water or steam. Therefore, copper is used to make hot water tanks being less reactive than iron.

Reaction with Acids

(1) When a metal reacts with dil HCl and dil H_2SO_4, a salt is formed and H_2 gas is evolved.

Metal + Dil. Acid $\longrightarrow$ Salt + Hydrogen

$$Zn_{(s)} + ZnSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_2$$

(2) H_2 gas is not evolved when a metal reacts with HNO_3 (nitric acid) as HNO_3 is a strong oxidizing agent and oxidizes the H_2 produced to water and is itself reduced to any of the oxides of nitrogen.

Exceptions: Magnesium and Manganese.

(3) The reactivity of all metals towards acids is not the same and can be found out from the rate at which bubbles of hydrogen gas are formed and the amount of heat generated. Amongst Al, Mg, Fe and Zn, the reactivities towards acids is: Mg > Al > Zn > Fe

(4) **Aqua regia:** It is a freshly prepared mixture of conc. HCl and conc. HNO_3 in the ratio of 3:1. It is a highly corrosive, fuming liquid which can even dissolve gold and platinum, even though neither of these acids can do so alone.

Important

➥ *Metals such as copper, mercury, silver and gold, which are placed below hydrogen in the reactivity series of metals, do not react with dilute acids.*

Example 6. **A man went door-to-door posing as a goldsmith. He promised to bring back the glitter of old and dull gold ornaments. An unsuspecting lady gave a set of gold bangles to him which he dipped in a particular solution. The bangles sparkled like new but their weight was reduced drastically. The lady was upset but after a futile argument the man beat a hasty retreat. Can you play the detective to find out the nature of the solution he had used?**[NCERT]

Ans. The man used aqua regia which is a mixture of conc. HCl and conc. HNO_3 acids in the ratio 3:1 and has the property of dissolving gold. When the unsuspecting lady gave a set of gold bangles to the man, he dipped them in aqua regia solution due to which some gold dissolved in the solution bringing back the sparkle but at the same time the weight of gold bangles was reduced as it went into the solution.

Example 7. **Name two metals which will displace hydrogen from dilute acids, and two metals which will not.** [NCERT]

Ans. Two metals which will displace hydrogen from dilute acids are magnesium and aluminium, and two metals which will not displace hydrogen are copper and silver.

Reaction of Metals with Solutions of Other Metal Salts

(1) Reactive metals displace less reactive metals from their compounds in solution or molten form. Displacement reactions give better evidence about the reactivity of metals. If metal A displaces metal B from its solution, it is more reactive than B.

Metal A + Salt solution of B $\longrightarrow$ Salt solution of A + Metal B

(2) If we put an iron nail in a solution of copper sulphate, we observe that the blue colour of copper sulphate solution in the test tube fades gradually and red-brown copper metal is formed.

The reaction taking place is:

$$CuSO_{4(aq)} + Fe_{(s)} \longrightarrow FeSO_{4(aq)} + Cu_{(s)}$$

However, no reaction takes place if a strip of copper metal is placed in iron sulphate solution because copper is less reactive than iron and hence cannot displace iron from iron sulphate solution.

Important

➥ *Some examples of reaction of metals with solutions of other metal salts.*

S. No.	Example of Reaction of Metal with solution of Metal Salt	Chemical Equation
(1)	Reaction of zinc with copper sulphate solution	$CuSO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$
(2)	Reaction of copper with silver nitrate solution	$2AgNO_{3(aq)} + Cu_{(s)} \longrightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$

➥ *If zinc oxide, magnesium oxide and copper oxide were heated, turn by turn, with zinc, magnesium and copper metals, we can note down the displacement reactions taking place as shown:*

Metal Oxide	Zinc	Magnesium	Copper
(1) Zinc Oxide	-	Displace-ment	-
(2) Magnesium Oxide	-	-	-
(3) Copper oxide	Displacement	Displace-ment	-

Activity Series (The Relative Reactivities of Metals): The metals have been arranged in order of their

decreasing reactivity by using displacement reactions since all metals are not equally reactive. The activity series is shown below:

K	Potassium	Most reactive
Na	Sodium	↓
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	
Fe	Iron	
Pb	Lead	
(H)	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

Example 8. **Samples of four metals A, B, C and D were taken and added to the following solution one by one. The results obtained have been tabulated as follows:**

Metal	Iron(II) Sulphate	Copper(II) Sulphate	Zinc Sulphate	Silver nitrate
A	No reaction	Displace-ment		
B	Displace-ment		No reaction	
C	No reaction	No reaction	No reaction	Displace-ment
D	No reaction	No reaction	No reaction	No reaction

Use the table above to answer the following questions about metals A, B, C and D.

(A) Which is the most reactive metal?

(B) What would you observe if B is added to a solution of Copper(II) sulphate?

(C) Arrange the metals A, B, C and D in the order of decreasing reactivity. **[NCERT]**

Ans. **(A)** We observe that A undergoes displacement reaction with Copper(II) sulphate. Therefore, A > Cu.

Metal B displaces iron from iron(II) sulphate. Therefore, B > Fe.

Metal C displaces silver from silver nitrate. Therefore, C > Ag.

Metal D does not undergo reaction with any of the given salt solutions. Therefore D is the least reactive metal.

As reactivity of Fe, Cu, Zn and Ag can be written as : Zn > Fe > Cu > Ag, and B displaces Fe, therefore B is the most reactive metal.

(B) If B is added to a solution of $CuSO_4$, it will displace copper from the solution as B is more reactive than copper.

(C) Metals A, B, C and D arranged in decreasing order of reactivity: B > A > C > D

Chemical Properties of Non-Metals

Reaction with Oxygen

Non-metals combine with oxygen to form acidic or neutral oxides which are covalent compounds.

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

$$CO_{2(g)} + H_2O_{(l)} \longrightarrow H_2CO_{3(aq)}$$

Examples of neutral oxides are carbon monoxide (CO), nitrous oxide (N_2O).

Non-metals do not displace hydrogen from dilute acids as it cannot supply electrons to H^+ ions.

Reaction with Hydrogen

A few active metals like Na, K and Ca can force the hydrogen atom to accept electrons to form salts called hydrides.

$$2Na_{(s)} + H_{2(g)} \longrightarrow 2NaH_{(s)}$$

$$Ca_{(s)} + H_{2(g)} \longrightarrow CaH_{2(s)}$$

Non-metals combine with hydrogen to form covalent hydrides.

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

Example 9. **Pratyush took sulphur powder on a spatula and heated it. He collected the gas evolved by inverting a test tube over it, as shown in Fig. 4 below.**

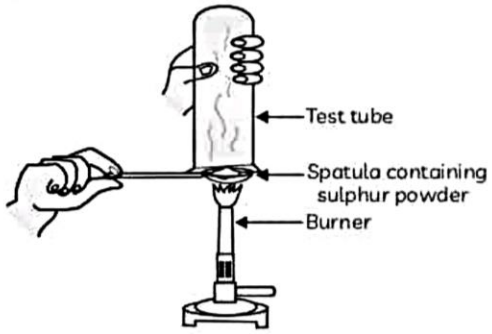


Fig. 4 Collection of gas

(A) What will be the action of gas on:

(i) dry litmus paper?

(ii) moist litmus paper?

(B) Write a balanced chemical equation for the reaction taking place. **[NCERT]**

Ans. **(A)** The gas evolved when Pratyush heated sulphur powder in a spatula is sulphur dioxide, SO_2.

(i) There will be no change by the action of this gas (SO_2) on dry litmus paper.

(ii) When this gas acts on moist blue litmus paper, it changes the colour of litmus from blue to red as sulphur dioxide is acidic in nature, since oxides of non-metals are acidic in nature, but in presence of water.

(B) Balanced chemical equation for the reaction taking place is:

$$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$$
$$SO_{2(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(aq)}$$

TOPIC 3

REACTION BETWEEN METALS AND NON-METALS

Electronic Configuration of Noble Elements

Noble gases have a completely filled valence shell and hence are chemically inert. The usual number of valence electrons in the atom of noble gases is 8 except helium in which it is 2.

Cause of Chemical Reactivity

The reactivity of an element can be explained as the tendency of an atom to attain a completely filled valence shell.

The atoms combine with one another to achieve the inert gas electron configuration and become more stable. Atoms therefore form chemical bonds to achieve stability by acquiring the inert gas electron configuration. An atom can achieve the inert gas electron configuration in the following ways:

(1) By losing one or more electrons to another atom.

(2) By gaining one or more electrons from another atom.

(3) By sharing one or more electrons with another atom.

Ions: An ion is an electrically charged atom or group of atoms. An ion is formed by the loss of electrons (sodium ion, Na^+, magnesium ion, Mg^{2+}) or gain of electrons (chloride ion, Cl^-, oxide ion, O^{2-}) by an atom. There are two types of ions:- cations and anions.

Cation: A positively charged ion is known as cation. Sodium ion, $Na^+$and magnesium ion, Mg^{2+} are cations because they are positively charged ions since the number of protons in the nucleus is more than the number of electrons due to which there is a net positive charge on the atom. A cation has less electrons than protons.

Anion: A negatively charged ion is known as anion. Chloride ion, Cl^- and oxide ion, O^{2-} are formed by the addition of electrons due to which there is a net negative charge on the atom. An anion has more electrons than protons.

Ionic Compounds

When metals react with non-metals, they form compounds by the transfer of electrons from a metal to a non-metal. Such compounds are known as ionic or electrovalent compounds.

Ionic Bond

The chemical bond formed by the transfer of electrons from one atom to another is known as an ionic bond. An ionic bond is formed when a metal reacts with a non-metal and transfer of electrons takes place from metal atoms to non-metal atoms.

The metal atom develops a positive charge after donating electrons and thus becomes a cation.

The non-metal atom, on the other hand, becomes a negatively charged ion, anion, after gaining or accepting electrons.

Formation of Sodium Chloride (NaCl)

Sodium donates one electron to a chlorine atom and forms a sodium ion, Na^+.

Formation of Sodium ion, Na^+: The atomic number of sodium is 11. Its electronic configuration is: 2, 8, 1

Since it does not have an octet, it is not very stable. In order to become stable, the sodium atom donates its 1 outermost electron to some other atom.

$$Na - e^- \longrightarrow Na^+$$

Sodium atom			Sodium ion	
K	L	M	K	L
2	8	1	2	8

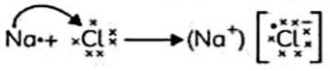
Formation of Chloride ion, Cl^-: Chlorine atom takes one electron from the sodium atom and forms a negatively charged ion, Cl^-.

$$Cl + e^- \longrightarrow Cl^-$$

Sodium chloride is an ionic compound and contains ionic bonds.Both these ions, being oppositely charged, attract each other and are held by strong electrostatic forces of attraction to form an ionic compound. Ionic compounds do not exist as molecules but as aggregates of oppositely charged ions.

$$Na \longrightarrow Na^+ + e^-$$
$$2,8,1 \qquad 2,8$$
(Sodium cation)

$$Cl + e^- \longrightarrow Cl^-$$
$$2,8,7 \qquad 2,8,8$$
(Chloride anion)



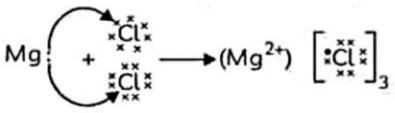
Formation of Magnesium Chloride ($MgCl_2$): Magnesium donates two electrons to two chlorine atoms and forms a magnesium ion, Mg^{2+}. Similarly, 2 chlorine atoms take one electron each from the magnesium atom and forms 2 negatively charged ions, Cl^-.

$$\underset{2,8,1}{Mg} \longrightarrow \underset{2,8}{Mg^{2+}} + 2e^-$$

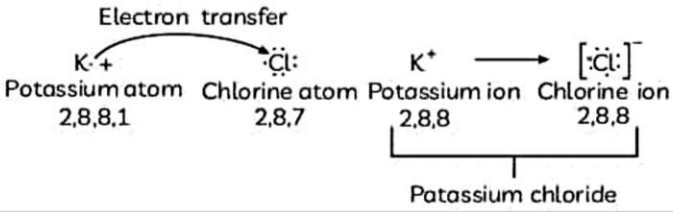
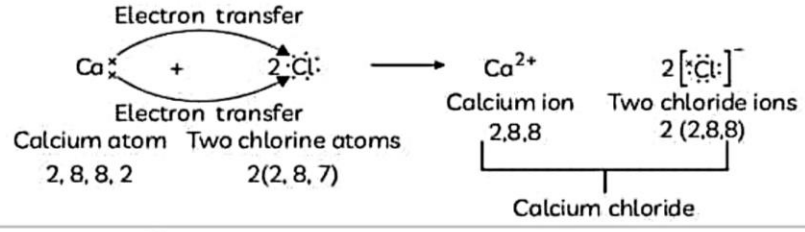
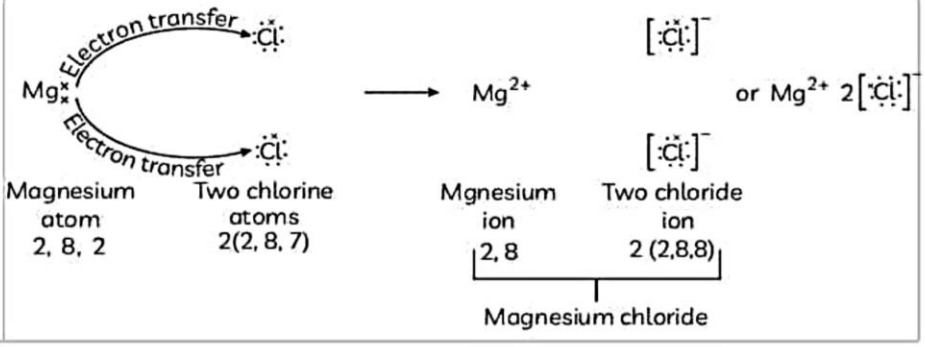
(Magnesium cation)

$$\underset{2,8,7}{Cl} + e^- \longrightarrow \underset{2,8,8}{Cl^-}$$

(Chloride anion)



Formation of Some Common Ionic Compounds

Ionic Compound	Formation of Ionic Bond
Potassium chloride (KCl)	
Calcium chloride ($CaCl_2$)	
Magnesium chloride ($MgCl_2$)	

Properties of Ionic Compounds

The general properties of ionic compounds are summarised below:

S.No.	Property name	Property Shown by Ionic Compounds
(1)	Physical nature	Ionic compounds are generally crystalline solids and hard due to the strong force of attraction between the positive and negative ions. They are generally brittle.
(2)	Melting and boiling points	They have high melting and boiling points as a large amount of energy is required to break the strong inter-ionic attraction.
(3)	Solubility	These are generally soluble in water but insoluble in organic solvents like ether, kerosene, petrol etc.
(4)	Conduction of electricity	These conduct electricity in the molten state as the electrostatic forces of attraction between the oppositely charged ions are overcome due to the heat. Moreover, they also conduct electricity when dissolved in water as its solution in water contains ions. However, these do not conduct electricity in the solid state due to their rigid structure.

TOPIC 4

OCCURRENCE AND EXTRACTION OF METALS

A major source of metals is the earth's crust. Soluble salts of certain metals such as sodium chloride, magnesium chloride, etc., are also found in seawater.

Minerals: The inorganic elements or compounds which occur naturally in the earth's crust are known as minerals, for example, zinc blende, cinnabar, etc.

Ores: Those minerals from which a metal can be profitably extracted are called ores.

Gangue: The impurities like sand and rocky materials which are present in the ore are called gangue.

Occurrence of Metals

(A) The metals at the bottom of the activity series (Au, Ag, Pt etc) are the least reactive and are often found in free state.

(B) The metals in the middle of the activity series (Zn, Fe, Pb, etc) are moderately reactive and are found in the earth's crust mainly as oxides, sulphides or carbonates.

(C) Metals at the top of the activity series (K, Na, Ca, Mg, Al) are very reactive and are never found as free elements.

Important

➥ *The ores of many metals are oxides because oxygen is a very reactive element and is very abundant on the earth.*

Extraction of Metals

The extraction of metals and the refining of them for use is known as metallurgy. The process of metallurgical operations consists of mainly three steps:

(1) Enrichment of ores
(2) Reduction
(3) Refining.

Steps involved in the extraction of pure metals from ores

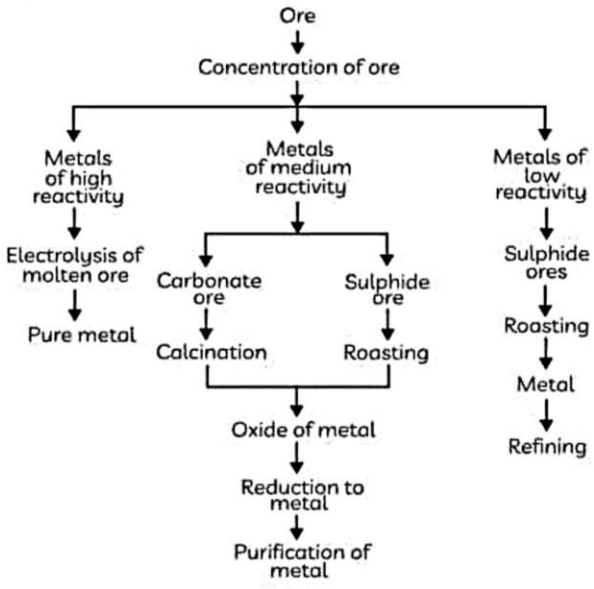


Fig. 5

Enrichment of Ores

The removal of impurities like sand, soil etc from the ore prior to the extraction of the metals is called enrichment of ores. The processes used for removing the gangue from the ore are based on the differences between the physical or chemical properties of the ore and the gangue.

Reduction of Ore to Metal

Reduction: The process of obtaining metals from their oxides is known as reduction. Metal sulphides and carbonates are first converted into metal oxides as it is easier to reduce metal oxides as compared to metal sulphides and carbonates.

(1) Extracting Metals Low in the Activity Series: Metals which are low in the activity series are very unreactive. Their oxides can be reduced to metals by heating alone.

Examples:

- **Extraction of Mercury:** Cinnabar (HgS) is an ore of Mercury, which is first converted to mercuric oxide by heating and then it is reduced to mercury on further heating:

$$2HgS_{(s)} + 3O_{2(g)} \xrightarrow{Heat} 2HgO_{(s)} + 2SO_{2(g)}$$

$$2HgO_{(s)} \xrightarrow{Heat} 2HgO_{(l)} + O_{2(g)}$$

- **Extraction of copper:** Copper which is found as Cu_2S is obtained from its ore by heating in air:

$$2Cu_2S + 3O_{2(g)} \xrightarrow{Heat} 2Cu_{2(s)} + 2SO_{2(g)}$$

$$2Cu_2S + Cu_2S_{(g)} \xrightarrow{Heat} 6Cu_{(s)} + SO_{2(g)}$$

(2) Extracting Metals in the Middle of the Activity Series

Metals in the middle of the activity series such as iron, zinc, lead, copper etc are moderately reactive and are usually present as sulphides or carbonates in nature.

- **Roasting:** The process of converting sulphide ores into oxides by strongly heating in presence of excess of air is known as roasting.

$$2ZnS_{(s)} + 3O_{2(g)} \longrightarrow 2ZnO_{(s)} + 2SO_{2(g)}$$

- **Calcination:** The process of converting carbonate ores into oxides by strongly heating in absence of excess of air is known as calcination.

$$ZnCO_{3(s)} \longrightarrow ZnO_{(s)} + CO_{2(g)}$$

The metal oxides are then reduced to the corresponding metals by using suitable reducing agents such as carbon or by using displacement reactions with a more reactive metal.

Methods of Reduction

Metal Type	Method of Reduction
Unreactive metals which are low in the activity series, like mercury	Oxides of these metals are reduced by heating alone. Cinnabar (HgS) is heated in air and converted to mercuric oxide (HgO): $2HgS_{(s)} + 3O_{2(g)} \longrightarrow 2HgO_{(s)} + 2SO_{2(g)}$ Mercuric oxide is then reduced to mercury on further heating: $2HgO_{(s)} \longrightarrow 2Hg_{(l)} + O_{2(g)}$
Moderately reactive metals which are in the middle of the activity series, such as iron, zinc, lead, copper etc	Oxides of these metals are reduced by heating with carbon. $ZnO_{(s)} + C_{(s)} \longrightarrow Zn_{(s)} + CO_{(g)}$
Very reactive metals which are high up in the activity series, such as sodium, magnesium, calcium etc	Sometimes, displacement reactions can also be used. The highly reactive metals such as sodium, calcium, aluminium, etc, are used as reducing agents. $3MnO_{2(s)} + 4Al_{(s)} \longrightarrow 3Mn_{(l)} + 2Al2O_{3(s)} + Heat$
	The oxides of these metals are reduced by electrolytic reduction, i.e., by the electrolysis of their fused chlorides. The metals are deposited at the cathode and chlorine is liberated at the anode. At cathode: $Na+^{+} \longrightarrow e^{-} + Na$ At anode: $2Cl^{-} \longrightarrow Cl_2 + 2e^{-}$

Thermite Reactions: The reactions of metal oxides with aluminium are highly exothermic and the amount of heat evolved is so large that the metals are produced in the molten state. The reaction of iron oxide (Fe_2O_3) with aluminium is used to join railway tracks or cracked machine parts.

$$Fe_2O_{3(s)} + 2Al_{(s)} \longrightarrow 2Fe_{(l)} + Al_2O_{3(s)}$$

(3) Extracting Metals Towards the Top of the Activity Series

The highly reactive metals are extracted by the electrolysis of their molten chlorides or oxides. These oxides are very stable and cannot be reduced by the most common reducing agent carbon as these metals have more affnity for oxygen than carbon.

Extraction of Sodium Metal: Sodium metal is extracted by the electrolysis of molten sodium chloride. When electric current is passed through molten sodium chloride, it decomposes to form sodium metal and chlorine gas:

$$2NaCl \longrightarrow 2Na + Cl_2$$

The reactions taking place at the two electrodes are given below:

At the Cathode: $2Na^{+} + 2e^{-} \longrightarrow 2Na$

At the Anode: $2Cl^{-} - 2e^{-} \longrightarrow Cl_2$

Example 10. Which chemical process is used for obtaining a metal from its oxide? [NCERT]

Ans. The chemical process used for obtaining a metal from its oxide is reduction. Metal oxides can be reduced to metal either by heating alone (less reactive metals) or by heating with carbon (moderately reactive metals).

Example: Reduction of HgO (oxide of less reactive metal) by heating alone:

$$2HgO_{(s)} \longrightarrow 2Hg_{(l)} + O_{2(g)}$$

Reduction of ZnO (oxide of moderately reactive metal) by heating with carbon:

$$ZnO_{(s)} + C_{(s)} \longrightarrow Zn_{(s)} + CO_{(g)}$$

Refining of Metals

The process of purification of impure metals is known as refining of metals and the method used for refining an impure metal depends upon:

(1) Nature of the element

(2) Nature of impurities present in it.

Electrolytic refining of copper: The metals such as copper, zinc, nickel, silver, gold, etc., are refined electrolytically.

The impure metal is made as anode and a thin strip of pure metal is made as cathode.

A solution of the metal salt is used as an electrolyte.

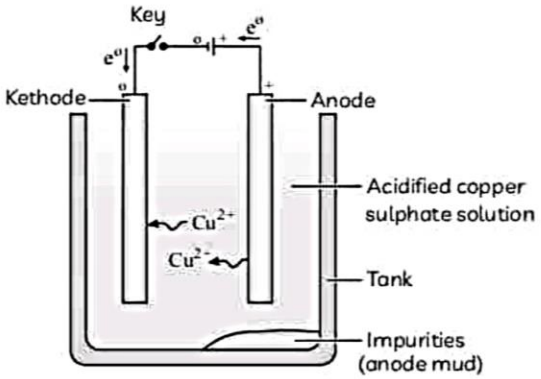


Fig. 6 Electrolytic refining of copper

On passing current through the electrolyte, the pure metal from the anode dissolves into the electrolyte. An equivalent amount of pure metal from the electrolyte is deposited on the cathode.

The solid impurities go into the solution and the insoluble impurities settle down at the bottom of the anode and are known as anode mud.

At anode: $Cu \longrightarrow Cu^{2+} + 2e^{-}$

At cathode: $Cu^{2+} + 2e^{-} \longrightarrow Cu$

Anode: A thin block of the impure metal is connected to the positive terminal of the battery.

Cathode: A thin strip of the pure metal is connected to the negative terminal of the battery.

Electrolyte: A water soluble salt of the metal to be refined is taken as the electrolyte.

TOPIC 5

CORROSION OF METALS

The phenomenon of a surface of a metal being attacked by air, water or any other substance around it is known as corrosion and the metal being attacked is said to corrode.

Examples of corrosion:

(1) When iron is exposed to moist air for a long time, its surface acquires a coating of a brown, flaky substance called rust, which is mainly hydrated iron oxide ($Fe_2O_3.xH_2O$).

(2) The surface of copper acquires a green coating of basic copper carbonate in moist air.

(3) The surface of aluminium gets coated with a thin layer of aluminium oxide which prevents the metal underneath from further damage.

(4) Silver articles become black after sometime when exposed to air as silver reacts with sulphur present in the air to form a coating of silver sulphide.

(5) Noble metals such as gold and silver do not corrode readily.

Both air and water are necessary for corrosion to take place.

Example 11. You must have seen tarnished copper vessels being cleaned with lemon or tamarind juice. Explain why these sour substances are effective in cleaning the vessels. **[NCERT]**

Ans. Copper vessels become tarnished when the copper metal gets corroded and forms a layer of basic copper carbonate by reacting with carbon dioxide present in air.

Sour substances such as lemon juice or tamarind juice are acidic in nature as they contain citric acid and tartaric acid respectively. Being acidic, they neutralize the basic copper carbonate and dissolves the layer of copper carbonate formed.

Prevention of Corrosion

Rusting of iron can be prevented by painting, oiling and greasing, galvanizing (by coating iron objects with zinc), chrome plating etc.

Galvanization

Galvanisation is the method of protecting steel and iron from rusting by coating them with a thin layer of zinc. The galvanized article remains protected from corrosion even if the zinc layer is broken.

Important

➥ *If the zinc coating is broken, the galvanised object remains protected against rusting because zinc is more reactive than iron and hence can be easily oxidised .Thus when zinc layer breaks down, the zinc continues to react and gets oxidized.*

Alloying

Alloying is a method for improving the properties of a metal thereby getting desired properties.

Example: Pure iron is very soft and stretches easily when hot. It is therefore never used in its pure state, but instead mixed with a small amount of carbon (0.05 %) due to which it becomes hard and strong.

Alloys: An alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal. It is prepared by first melting the main metal and then dissolving the other elements in it in a definite proportion.

Amalgam: An alloy whose one of the metals is mercury is known as an amalgam.

Properties of alloys:

(1) The electrical conductivity of an alloy is less than that of pure metals.

(2) Sometimes an alloy has lower melting point than any of its constituents.

Some common alloys:

Alloy	Constituents	Properties	Uses
Steel	Iron, Carbon	Hard, tough and strong	Construction of ships, bridges, vehicles etc
Stainless steel	Iron, Nickel, Chromium	Hard and does not rust	Surgical instruments, cutlery, utensils etc
Brass	Copper and Zinc	Malleable, strong, resists corrosion and can be easily cast.	Utensils, screws, nuts and bolts

Bronze	Copper and Tin	Very strong and highly resistant to corrosion	Statues, coins, medals, ship's propellers, etc
Duralumin	Aluminium, Copper and traces of Magnesium and Manganese	Light and strong. Resistant to corrosion	Aircrafts, pressure cooker
Magnalium	Aluminium and Magnesium	Very light and hard	Balance beams and light instruments
22 carat gold	22 parts pure gold with 2 parts of copper or silver	24 carat gold is very soft and hence unsuitable for making jewellery	Making ornaments
Solder	Lead, tin	Low melting point	Welding electrical wires

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Which of the following properties is generally not shown by metals?

(a) Electrical conduction

(b) Sonorous in nature

(c) Dullness

(d) Ductility **[NCERT Exemplar]**

Ans. *(c) Dullness*

Explanation: Metals generally do not show dullness. Metals such as gold and silver are usually shiny rather than dull.

Related Theory

- *Conduction: Metals are good conductors of heat and electricity as they have free electrons. Silver and copper are the best conductors of heat, whereas lead and mercury are poor conductors of heat.*
- *Sonorous: Metals that produces a sound on striking a hard surface.*
- *Metallic lustre: Metal, in its pure state, has a shining surface. This property is known as metallic lustre.*
- *Ductility: The ability of metals to be drawn into thin wires. Gold is the most ductile metal.*

2. The solution of one of the following compounds will not conduct electricity. This compound is:

(a) NaCl **(b) CCl_4**

(c) $MgCl_2$ **(d) $CaCl_2$**

3. Which one of the following metals does not react with cold as well as hot water?

(a) Na **(b) Ca**

(c) Mg **(d) Fe**

[NCERT Exemplar]

4. An aluminium strip is kept immersed in freshly prepared ferrous sulphate solution taken in a test tube, the change observed is that:

(a) Green solution slowly turns colourless

(b) Lower end of test tube becomes slightly warm

(c) A colourless gas with the smell of burning sulphur is observed

(d) Light green solution changes to blue

5. Which of the following oxide(s) of iron would be obtained on prolonged reaction of iron with steam?

(a) FeO (b) Fe_2O_3

(c) Fe_3O_4 (d) Fe_2O_3 and Fe_3O_4

Ans. *(c) Fe_3O_4*

6. What happens when calcium is treated with water?

(I) It does not react with water.

(II) It reacts violently with water.

(III) It reacts less violently with water.

(IV) Bubbles of hydrogen gas formed stick to the surface of calcium.

(a) (I) and (IV) (b) (II) and (III)

(c) (I) and (II) (d) (III) and (IV)

[CBSE 2015]

Ans. *(d) (III) and (IV)*

Explanation: When calcium is treated with water, it reacts vigorously with water and to produce a cloudy white precipitate of calcium hydroxide and hydrogen gas is released as bubbles.

$$\underset{\text{Calcium}}{Ca_{(s)}} + \underset{\text{Water}}{2H_2O_{(g)}} \longrightarrow \underset{\substack{\text{Calcium}\\\text{Hydroxide}\\\text{(white ppt)}}}{Ca(OH)_{2(s)}} + H_{2(g)}\uparrow$$

Related Theory

➥ *Sometimes hydrogen bubbles get stuck to the surface of calcium metal, making it light and thus calcium starts floating. Reaction of calcium with water is exothermic but the heat produced in this reaction is not sufficient so that hydrogen can catch fire.*

7. Which of the following are not ionic compounds?

(I) KCl (II) HCl

(III) CCl_4 (IV) NaCl

(a) (I) and (II) (b) (II) and (III)

(c) (III) and (IV) (d) (I) and (III)

[NCERT Exemplar]

8. Generally non-metals are not lustrous. Which of the following non-metals is lustrous?

(a) Sulphur (b) Oxygen

(c) Nitrogen (d) Iodine

[NCERT Exemplar]

Ans. *(d) Iodine*

Explanation: Iodine is a non-metal with lustrous appearance and exists in solid state.

Related Theory

➥ *Graphite is another non-metal that is shiny and lustrous.*

9. 2 ml each of conc. HCl, HNO_3, and a mixture of conc. HCl and conc. HNO_3 in the ratio of 3:1 were taken in test tubes labelled as A, B and C. A small piece of metal was put in each test tube. No change occurred in test tubes A and B but the metal got dissolved in test tube C. The metal could be:

(a) Al (b) Au

(c) Cu (d) Pt

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

(a) Mg (b) Na

(c) P (d) Ca [CBSE 2010]

Ans. *(b) Na*

Explanation: Na (sodium) possesses all the above properties. It is too soft and can be cut with a knife. It is also very reactive and reacts with oxygen or moisture present in air and produces sodium hydroxide, which is a highly exothermic reaction producing a lot of heat. It also reacts with water and burns due to the vigorous formation of hydrogen gas. That is why sodium is stored in kerosene oil to prevent any reaction.

11. Which among the following statements is incorrect for magnesium metal?

(a) It burns in oxygen with a dazzling white flame.

(b) It reacts with cold water to form magnesium oxide and evolves hydrogen gas.

(c) It reacts with hot water to form magnesium hydroxide and evolves hydrogen gas.

(d) It reacts with steam to form magnesium hydroxide and evolves hydrogen gas.

[NCERT Exemplar]

12. The electronic configurations of three elements X, Y and Z are X — 2, 8; Y — 2, 8, 7 and Z — 2, 8, 2. Which of the following is correct?

(a) X is a metal

(b) Y is a metal

(c) Z is a non-metal

(d) Y is a non-metal and Z is a metal

13. In the given reaction,

$Al_2O_3 + NaOH \longrightarrow X + H_2O$.

What is element X?

(a) $NaAlO_2$ (b) Na_3Al
(c) Na_2O_3 (d) $NaAl_2O_3$ [Diksha]

14. Sandhya took three beakers A, B and C containing zinc sulphate, silver sulphate and iron(II) sulphate solutions respectively. Copper pieces were added to each beaker. The solution will appear blue in the case of:
(a) Beaker A (b) Beaker B
(c) Beaker C (d) Beakers B and C
[Diksha]

Ans. *(b) Beaker B*

Explanation: The solution will appear blue in Beaker B. Let us see how.

When pieces of copper metal are kept immersed in silver sulphate solution for some time, the solution gradually becomes blue and a shiny greyish-white deposit of silver metal is formed on copper strip.

In this reaction, copper metal is displacing silver from silver sulphate solution, forming copper sulphate and silver metal. The solution becomes blue due to the formation of copper sulphate. The reason behind this displacement reaction is that copper is more reactive than silver.

$$\underset{\text{Silver sulphate (Colourless solution)}}{Ag_2SO_4} + \underset{\text{Copper (Red brown)}}{Cu} \longrightarrow \underset{\text{Copper sulphate (Blue solution)}}{CuSO_4} + \underset{\text{Silver (Greyish white)}}{2Ag}$$

On the other hand, copper metal is less reactive than iron and zinc, and hence cannot displace them from their respective salt solutions.

15. Arrange the following metal in the decreasing chemical activity series.
(I) Potassium (II) Magnesium
(III) Gold (IV) Iron
Correct options are:
(a) (I), (II), (III) and (IV)
(b) (I), (III), (IV) and (II)
(c) (I), (II), (IV) and (III)
(d) (I), (IV), (II) and (III)

16. Which metal can be displaced by copper from its salt solution?
(I) Silver (II) Zinc
(III) Iron (IV) Mercury
Correct options are:
(a) (I) and (II) (b) (I) and (III)
(c) (II) and (III) (d) (I) and (IV)

Ans. *(d) (I) and (IV)*

Silver and mercury are less reactive than copper and as copper will displace those metals from its salt solution which are less reactive than it, correct option is (d).

17. Metals are refined by using different methods. Which of the following metals are refined by electrolytic refining?
(I) Au (II) Cu
(III) Na (IV) K
(a) (I) and (II) (b) (IV) and (III)
(c) (II) and (III) (d) (II) and (IV)
[NCERT Exemplar]

Ans. *(a) (I) and (II)*

Explanation: Gold (Ag) and copper (Cu) obtained after extraction are in impure form. So, metals Au (gold) and Cu (copper) are refined by electrolytic refining. Other than gold and copper, electrolytic refining is used for metals such as Zn and Ag. Sodium (Na) and potassium (K) are extracted by electrolytic reduction. Metals obtained after electrolytic reduction are in pure form.

Related Theory

➥ *Alkali metals are very reactive, so they cannot be refined with the help of electrolytic refining process.*

18. Galvanisation is a method of protecting iron from rusting by coating it with a thin layer of:
(a) Gallium (b) Aluminium
(c) Zinc (d) Silver
[CBSE 2013, NCERT Exemplar]

Ans. *(c) Zinc*

Explanation: Zinc (Zn) metal is used to protect iron surface from rusting.

Related Theory

➥ *Galvanization is basically coating iron or steel with a layer of zinc to prevent it from rusting. Water pipes are also galvanized to prevent corrosion.*

19. Stainless steel is a very useful material in our life. In stainless steel, iron is mixed with:
(a) Ni and Cr (b) Cu and Cr
(c) Ni and Cu (d) Cu and Au
[NCERT Exemplar]

Ans. *(a) Ni and Cr*

Explanation: Stainless steel is an alloy of iron (74%), nickel (8%) and chromium (18%).

Related Theory

➥ *Alloying elements enhance the structure and properties such as durability, strength and toughness of the metal. It makes them corrosion-resistant.*

20. If copper is kept in open air, it slowly loses its shining brown surface and gains a green coating. It is due to the formation of:

(a) $CuSO_4$ (b) $CuCO_3$

(c) $Cu(NO_3)_2$ (d) CuO

[NCERT Exemplar]

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

(I) Na (II) Ca

(III) Fe (IV) Cu

(a) (I) and (IV) (b) (III) and (IV)

(c) (I) and (III) (d) (I) and (II)

[CBSE 2010, NCERT Exemplar]

22. An electrolytic cell consists of:

(I) Positively charged cathode

(II) Negatively charged anode

(III) Positively charged anode

(IV) Negatively charged cathode

(a) (I) and (II) (b) (III) and (IV)

(c) (I) and (III) (d) (II) and (IV)

[NCERT Exemplar]

Ans. *(b) (III) and (IV)*

Explanation: There is a positively charged anode and a negatively charged cathode in an electrolytic cell. Positively charged ions (cations) are deposited at the negatively charged cathode. Negatively charged ions (anions) are deposited at the positively charged anode.

23. During electrolytic refining of zinc, it gets:

(a) Deposited on cathode

(b) Deposited on anode

(c) Deposited on cathode as well as anode

(d) Remains in the solution

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

(a) Brass (b) Bronze

(c) Amalgam (d) Steel

[CBSE 2020, NCERT Exemplar]

Ans. *(d) Steel*

Explanation: Steel contains non-metal as one of its constituents. Steel is an alloy made by combining iron and other elements, mainly carbon. Carbon gives strength to iron. It is used to make buildings, ships, automobiles, machines, and appliances.

Related Thery

(1) Brass - Copper and zinc

(2) Bronze - Copper and tin

(3) Amalgam - Mercury with other metal

(4) Steel - Iron with carbon

25. Which among the following alloys contains mercury as one of its constituents?

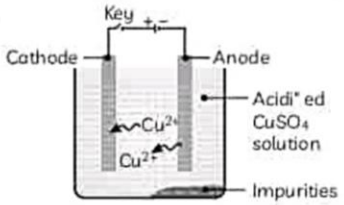
(a) Stainless steel (b) Alnico

(c) Solder (d) Zinc amalgam

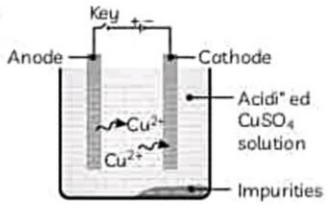
[NCERT Exemplar]

26. Which one of the following figures correctly describes the process of electrolytic refining?

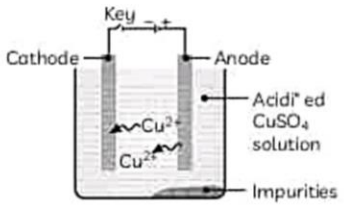
(a)



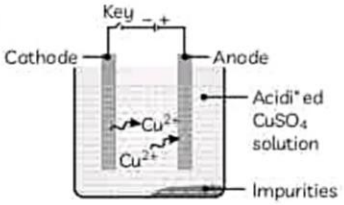
(b)



(c)

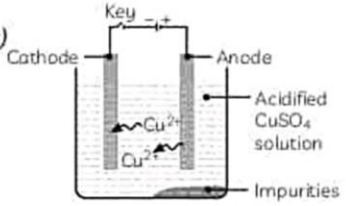


(d)



[CBSE 2018, 15, NCERT Exemplar]

Ans. *(c)*



Explanation: In electrolytic refining process, impure metal forms the anode, which is positive electrode, whereas pure metal forms the cathode which is negative electrode.

Figure (c) shows the process of electrolytic refining of copper metal. Copper from impure anode dissolves into the solution. Copper ions (Cu^{2+}) from the solution are deposited on the cathode and impurities settle down below the anode as anode mud.

27. **Select the incorrect statement(s):**

(I) Solder is an alloy of lead and copper

(II) Solder is an alloy of lead and tin

(III) Melting point of solder is low

(IV) Melting point of solder is high

(a) Only (I)

(b) Both (I) and (III)

(c) Both (II) and (IV)

(d) Both (I) and (IV)

28. **All ionic compounds:**

(a) Have high melting point but low boiling point

(b) Are generally soluble in kerosene

(c) Are generally brittle

(d) Conduct electricity in solid state

29. **The cations and anions present in aluminium oxide are:**

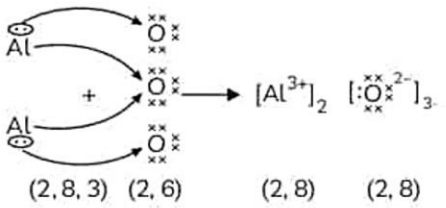
	Cation	Anion
(a)	Al^{+}	O^{-}
(b)	Al^{3+}	O^{2-}
(c)	Al^{3+}	O^{-}
(d)	Al^{2+}	O^{2-}
(e)	Al_3^{+}	O_2^{-}

Ans. *(b) Cation: Al^{37}; Anion: O^{2-}*

Explanation: Aluminium oxide or Al_2O_3 is formed by the transfer of electrons from aluminium atoms to oxygen atoms.

Aluminium (Atomic number=13) has 3 valence electrons whereas oxygen (atomic number=8) has 2 valence electrons.

So, each aluminium atom donates its 3 valence electrons to the oxygen atoms and forms cations [Al^{3+}], whereas each oxygen atom gains two electrons and forms anions [O^{2-}].



30. **The metals which have very low melting points are:**

(a) Gallium and caesium

(b) Gallium and sodium

(c) Caesium and potassium

(d) Sodium and potassium

Assertion-Reason Questions

For the following questions, two statements are given – one labeled Assertion (A) and other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

(a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

31. **Assertion (A) : Alkali metals like sodium and potassium can be cut with a knife.**

Reason (R) : They have high densities.

Ans. *(c) (A) is true but (R) is false.*

Explanation: Alkali metals like sodium and potassium are so soft that they can be cut with a knife as they have low densities.

32. **Assertion (A) : Magnesium is less reactive than sodium.**

Reason (R) : Sodium reacts more vigorously with oxygen than magnesium.

33. **Assertion (A) : In the following reaction between calcium and water, calcium starts floating.**

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

Reason (R) : Calcium hydroxide is lighter than water.

Ans. *(c) (A) is true but (R) is false.*

Explanation: In the reaction between calcium and water, calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of calcium metal.

34. **Assertion (A) : Hydrogen gas is evolved when a metal reacts with nitric acid.**
Reason (R) : Nitric acid is a strong oxidizing agent.

35. **Assertion (A) : The compound $MgCl_2$ will not conduct electricity in solid-state.**
Reason (R) : Movement of ions in ionic compounds is not possible in solid-state.

Ans. *(b) Both (A) and (R) are true but (R) is not correct explanation of the (A).*

Explanation: The compound $MgCl_2$ is an ionic compound as it is formed by transfer of electrons between magnesium and chlorine. It will not conduct electricity in solid state as movement of ions in ionic compounds is not possible in solid state.

36. **Assertion (A) : The metals and alloys are good conductors of electricity.**
Reason (R) : Bronze is an alloy of copper and tin and it is not a good conductor of electricity.

[CBSE 2020]

Ans. *(d) (A) is false but (R) is true.*

Explanation : All the metals and alloys are not always good conductors of electricity like bronze is not a good conductor of electricity. Its constituents are copper and tin. Copper is good conductor where as tin is not a good conductor of electricity. Alloy nichrome is a good conductor of electricity.

Related Theory

- *Metals are good conductors of electricity because they.*
- *have large number of free electrons.*
- *Possess small resistivity in the range of 10–8 W m to 10–6 W m. Whereas alloys have more resistivity.*

Very Short Answer Type Questions

37. **A metal combines with a non-metal to form a compound Y. Will it dissolve in an organic solvent or not?**

Ans. Metals combine with non-metals to form ionic compounds by transfer of electrons. Ionic compounds do not dissolve in organic solvents but are soluble in water.

38. **An element E combines with O_2 to form an oxide E_2O, which is a good conductor of electricity. Write the formula of the compound formed when it combines with chlorine?**

39. **Why do ionic compounds conduct electricity in molten state?**

Ans. Ionic compounds conduct electricity in molten state because the ions move freely in molten state since electrostatic force of attraction between oppositely charged ions is overcome due to heat.

40. **Why should the metal sulphides and carbonates be converted to metal oxides in the process of extraction of metal from them?** **[NCERT Exemplar]**

Ans. Usually metal sulphides and carbonates are converted to metal oxides in the process of extraction of metal. This is because extraction of a metal from its oxide is easier as compared to its extraction from its sulphides and carbonates. Metal oxides can easily reduce to metal with the help of a common reducing agent like coke.

41. **From amongst the metal, sodium, calcium, aluminium, copper and magnesium, name the metal :**
(A) Which reacts with water only on boiling.
(B) Another one which does not react even with steam. **[CBSE 2013]**

Ans. (A) The metal which reacts with water only on boiling is magnesium as it does not react with cold water.
(B) The metal which does not react even with steam is copper.

42. **An element 'A' form two oxides AO and AO_2. The oxide AO is neutral whereas the oxide AO_2 is acidic in nature. Would you call element 'A' a metal or a non-metal?**
[CBSE 2011]

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

43. *The exact date that humans first began to mine gold is unknown, but some of the oldest known gold artifacts were found in the Varna Necropolis in Bulgaria. The graves of the necropolis were built between 4700 and 4200 BC, indicating that gold mining could be at least 7000 years old.In the area of the Kolar Gold Fields in Bangarpet Taluk, Kolar District of Karnataka state, India, gold was first mined prior to the 2nd and 3rd century AD by digging small pits. (Golden objects found in Harappa and Mohenjo-daro have been traced to Kolar through the analysis of impurities — the impurities include 11% silver concentration, found only in KGF ore.* **[CBSE 2012, 11, 10]**

In nature, aluminium is found in combinedstate whereas silver/gold are found in freestate. Give reason.

Ans. Silver and gold are least reactive metals and are often found in their native or free state. Aluminium is a very reactive metal and is never found in free state, but in combined state.

44. *Dhanteras, also known as Dhanatrayodashi, is the first day that marks the festival of Diwali in India.Dhanteras is the worship of lord Dhanvantari.Hindus consider this an extremely auspicious day for making new purchases, especially of gold or silver articles and new utensils. It is believed that new "Dhan" (wealth) or some item made of precious metal is a sign of good luck. In modern times, Dhanteras has come to be known as the most auspicious occasion for buying gold, silver, and other metals, especially kitchenware. Palak, along with her mother, purchased some kitchenware articles made of stainless steel on this occasion.*

How does alloying of iron change its properties?

Ans. Pure iron is very soft and stretches easily when hot but if iron ismixed with a small amount of carbon (about 0.05 %), it becomes hardand strong. When iron is mixed with nickel and chromium, we getstainless steel, which is hard and does not rust. Thus, if iron is mixedwith some other substance, its properties change.

45. *Have you ever imagined what would happen if all the electrical wires used in our homes, offices and other places were without any covering? Well, people handling them would die of electrical chock and there would be short circuiting leading to electrical fires all around us!*

Electrical wires have a coating of an insulating material. The material, generally used is:

(a) Sulphur **(b) Graphite**
(c) PVC **(d) All can be used**

[NCERT Exemplar]

Ans. *(c) PVC*

Explanation: An insulating substance is required to coat the electrical wire such as PVC. PVC is a polymer and a bad conductor of electricity. It is the most common insulating material used to insulate electrical conductors from electric charge, thus preventing direct human contact with electricity.

Graphite is a good conductor of electricity. Hence, it cannot be used as insulating material.

Sulphur, although a bad conductor of electricity, is brittle in nature. So, it cannot be used as an insulating material.

46. *Analyse the following reactivity series given below and answer the questions that follow:*

Most reactive

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

Least reactive

(A) Which of the two metals is more reactive: copper or silver?

(B) What will happen if a strip of zinc is immersed in a solution of copper sulphate?

(C) If copper is kept open in air, it slowly loses its shining brown surface and gains a green coating. It is due to the formation of:

(a) Acidic $CuSO_4$ (b) Basic $CuCO_3$

(c) Acidic $Cu(NO_3)_2$ (d) Basic CuO

(D) Which one of the following four metals would be displaced from the solution of its salts by other three metals?

(a) Mg (b) Ag

(c) Zn (d) Cu

Ans. (B) When a strip of zinc metal is put in copper sulphate solution, then the blue colour of copper sulphate solution fades gradually and red brown coating of copper is deposited on zinc strip.

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Copper sulphate}}{CuSO_4} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + \underset{\text{Copper}}{Cu}$$

This is an example of displacement reaction.

Explanation: Zinc is more reactive than copper so it will displace copper from its salt solution so displacement reaction takes place.

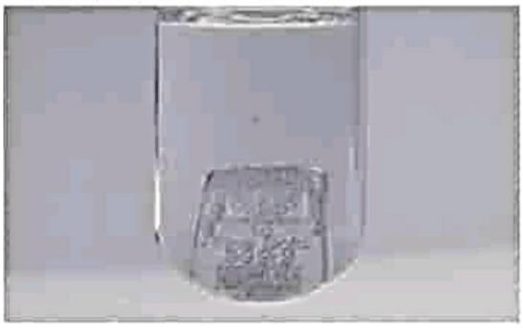
(D) *(b) Ag*

Explanation: Least reactive metal can be displaced from its solution by other three metals. Silver is least reactive out of given four metals.

Related Theory

➥ *Basic copper carbonate is undesired layer formed on the surface of the copper and the process is known as corrosion.*

47. *Aqua regia is a yellow-orange (sometimes red) fuming liquid, so named by alchemists because it can dissolve the noble metals gold and platinum, though not all metals.*



The composition of aqua-regia is:

(a) Dil. HCl : Conc. HNO_3
3 : 1

(b) Conc. HCl : Dil. HNO_3
3 : 1

(c) Conc. HCl : Conc. HNO_3
3 : 1

(d) Dil. HCl : Dil. HNO_3
3 : 1 **[CBSE 2020]**

Ans. *(c) Conc. HCl : Conc. HNO_3*
3 : 1

Explanation: Aqua-regia is a mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1. Aqua-regia, being a strong acid, dissolves gold.

48. *Atoms that gain electrons and therefore have a net negative charge are known as anions. Conversely, atoms that lose electrons and therefore have a net positive charge are called cations. Cations tend to be metals, while anions tend to be non-metals. Ions may also be single atoms or multiple, complex groups of atoms. When we talk about ions, it's true that opposites attract.*

The opposite negative and positive charges of the ions hold together in ionic bonds, forming

ionic compounds, which are just what they sound like: compounds made of ions. The loss or gain from one atom matches the loss or gain of the other, so one atom essentially 'donates' an electron to the other atom it pairs up with. Two positive or two negative ions will not join together because they have the same charge. But one positive and one negative will happily join together to make an ionic compound.

(A) Explain the formation of MgO. (Atomic No. of O = 8, Mg = 12).

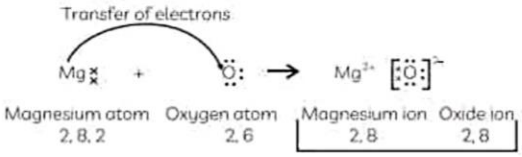
(B) Will the aqueous solution of MgO conduct electricity? If yes, give reasons for your answer?

(C) Name a solvent in which ionic compounds are soluble and a solvent in which they are insoluble.

(D) Why do ionic compounds have high melting and boiling points?

Ans. (A) Electronic configuration of Mg: 2, 8, 2 and that of O: 2, 6.

Magnesium atom loses its two valence electrons to form Mg^{2+} ion and oxygen atom gains two electrons to form O^{2-} ion thereby achieving their nearest inert gas configuration.



(C) Ionic compounds are soluble in water and insoluble in kerosene.

49. *When Rohan was suffering from fever, the doctor had asked his parents to check his temperature every 2 hours and also to keep a record. He was a thermometer that has a certain metal in liquid state inside it.*

Generally, metals are solid in nature. Which one of the following metals is found in liquid state at room temperature?

(a) Na (b) Fe

(c) Cr (d) Hg [CBSE 2012]

Ans. *(d) Hg*

Explanation: At room temperature, mercury (Hg) is the only metal found in liquid state.

Related Theory

All other metals are solid at room temperature. Hg also has the lowest melting point.

50. *Collect the samples of following metals aluminium, copper, iron, lead, magnesium, zinc and sodium. Hold each of the samples above with a pair of tongs and try burning over a flame . It would be better if students wear eye protection and perform this activity with assistance from the teacher. Repeat with the other metal samples.* **[NCERT Activity 3.9]**

(A) Select the incorrect statement(s).

(I) All metals burn easily.

(II) Not all metals bum easily.

(III) Magnesium bums easily.

(IV) Copper and aluminium take time to burn.

(a) Only (I)

(b) Only (II)

(c) Both (I) and (III)

(d) Both (II) and (IV)

(B) The student performing this activity noted the following observations on the colour of flame observed when the metal is burnt.

	Metal	Colour of Flame
(a)	Aluminium	Blue
(b)	Copper	Yellow
(c)	Sodium	White
(d)	Magnesium	White

Select the correct observation.

(C) The correct arrangement of metals Al, Mg, Na and Zn in the decreasing order of their reactivity towards oxygen is:

(a) Na > Al > Mg > Zn

(b) Na > Mg > Al > Zn

(c) Na > Al > Zn > Mg

(d) Mg > Na > Al > Zn

(D) Which of the following metal oxides are soluble in water?

(I) CuO (II) Na_2O

(III) FeO (IV) K_2O

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (IV)

(d) Both (I) and (IV)

(E) Metals such as sodium and potassium are kept immersed in:
(a) Kerosene oil
(b) Water
(c) Carbon disulphide
(d) Alcohol

Ans. (B) *(d) Metal: Magnesium; Colour of Flame: White*

Explanation: The colour of flame observed when the given metals are heated is given below:

Aluminium: Silvery white

Copper: Blue

Sodium: Yellow

Magnesium: White

(C) *(b) Na > Mg > Al > Zn*

Explanation: Almost all metals combine with oxygen to form metal oxide. However, the reactivities of different metals towards oxygen are different. The most reactive of the given metals is Na followed by Mg, Al and Zn.

(D) *(c) Both (II) and (IV)*

Explanation: Most metal oxides are insoluble in water but some of these dissolve in water to form alkalis. Sodium oxide and potassium oxide dissolve in water to produce alkalis as follows –

$$Na_2O_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)}$$
$$K_2O_{(s)} + H_2O_{(l)} \longrightarrow 2KOH_{(aq)}$$

51. *Pritha's mother had lots of silver jewellery which she had kept in a jewellery box. One day, when she took them out to show them to her friends, she was surprised to see that most of them had a black coating over them.*

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

(a) Ag_3N **(b) Ag_3O**
(c) Ag_2S **(d) Ag_2S and Ag_3N**

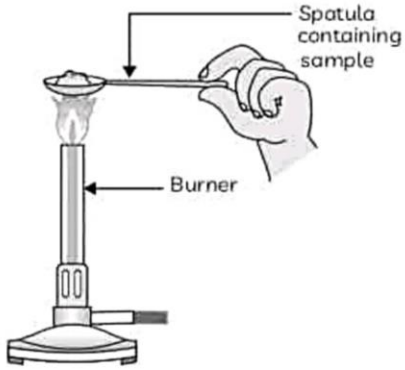
[CBSE 2017, NCERT Exemplar]

Ans. *(c) Ag_2S*

Explanation: Silver metal reacts with atmospheric sulphur compounds like H_2S gas and form black coating of Ag_2S over surface. This reaction is as below:

$$\underset{\text{Silver}}{Ag} + \underset{\text{Hydrogen sulphide}}{H_2S} \longrightarrow \underset{\text{Silver sulphide (black)}}{Ag_2S} + H_2$$

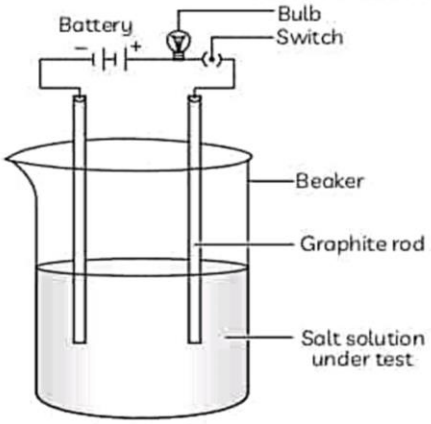
52. *Take samples of sodium chloride, potassium iodide, barium chloride or any other salt from the science laboratory. Take a small amount of a sample on a metal spatula and heat directly on the flame as shown in fig. Also try to dissolve the samples in water, petrol and kerosene.*



Heating a sail sample on a spatula

Make a circuit as shown in Fig. and insert the electrodes into a solution of one salt.

[NCERT Activity 3.13]



(A) The physical state and properties of the salt samples used in the activity is:
(I) All are crystalline solids
(II) All are brittle
(III) Not all are hard
(IV) Not all are brittle
Which of the statements above are correct?

(a) Both (I) and (III)
(b) Both (I) and (II)
(c) Both (II) and (III)
(d) Both (III) and (IV)

(B) Select the correct observation when the salt sample is taken on a metal spatula and heated directly on the flame:
(a) The salts melt immediately
(b) The salts give out characteristics flame upon heating
(c) The salts do not melt easily
(d) The salts undergo sublimation

(C) The solution of which of the following compounds will not conduct electricity?
(a) CCl_4 (b) NaCl
(c) $CaCl_2$ (d) KBr

(D) A student noted the following observations with four compounds A, B, C and D.

Compound	Melting Point (K)	Boiling Point (K)
A	1074	1686
B	250	350
C	290	391
D	2850	3120

Which of the compounds A, B, C and D are ionic compounds?
(a) A and B (b) B and C
(c) C and D (d) A and D

(E) Select the correct statement regarding electrical conductivity of ionic compounds:
(a) The salt samples in the activity conduct electricity in their solid state.
(b) The salt samples in the activity conduct electricity in a solution of water.
(c) The salt samples do not conduct electricity in molten state.
(d) The salt samples do not conduct electricity in solution or in molten state.

Ans. (A) *(b) Both (I) and (II)*
Explanation: All the salts are ionic compounds and are crystalline solids and hard due to the strong force of attraction between the positive and negative ions. They are also brittle.

(B) *(c) The salts do not melt easily*
Explanation: The given salts are ionic compounds which have very high melting and boiling points as a large amount of energy is required to break the strong inter-ionic attraction.

53. *Displacement reactions are very important reactions of chemistry. They have many applications in various fields some of which are listed below:*
(1) It is used in thermite welding.
(2) It is used in making the alloy steel.
(3) It is used in extraction of various metals.
(4) It is used in treating acid indigestion.
Thermite reaction is a single displacement reaction between iron oxide and aluminum which is also a highly exothermic reaction. The extreme heat released from this reaction is sufficient to melt the iron product.

(A) The correct chemical equation describing the thermite process is:
(a) $Fe_2O_{3(s)} + 2Al_{(s)} + Heat \longrightarrow 2Fe_{(s)} + Al_2O_{3(l)}$
(b) $Fe_2O_{3(s)} + 2Al_{(s)} \longrightarrow 2Fe_{(l)} + Al_2O_{3(s)} + Heat$
(c) $3FeO_{(s)} + 2Al_{(s)} + Heat \longrightarrow 3Fe_{(l)} + Al_2O_{3(s)}$
(d) $3FeO_{(s)} + 2Al_{(s)} \longrightarrow 3Fe_{(l)} + Al_2O_{3(s)} + Heat$

(B) What happens when zinc metal is added to a test tube containing $Al_2(SO_4)_3$ solution?
(a) Zinc displaces aluminium from its salt solution
(b) No reaction takes place
(c) The solution becomes blue in colour
(d) The solution becomes colourless and aluminium metal is deposited.

(C) A student made the following observations after studying the following displacement reactions between a metal and a salt solution of a different metal:
(i) $Mg + ZnSO_4 \longrightarrow MgSO_4 + Zn$
(ii) $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
(iii) $Ca + MgSO_4 \longrightarrow CaSO_4 + Mg$

Selsect the incorrect observation(s):

(I) Calcium will displace copper from copper sulphate solution.

(II) Magnesium will be displaced by both calcium and zinc

(II) The least reactive metal out of Mg, Ca, Cu and Zn is Zinc.

(IV) The most reactive metal out of Mg, Ca, Cu and Zn is calcium.

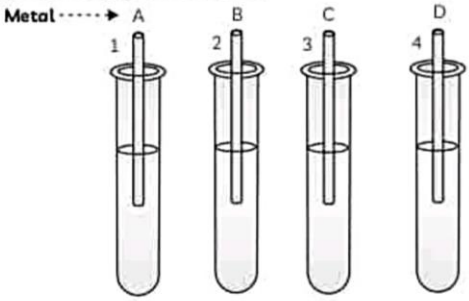
(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (III)

(d) Both (I) and (IV)

(D) An activity was performed by a student to find the reactivity of four metals- A, B, C and D by taking salt solutions of four metals in four test tubes numbered 1 to 4 and adding the samples of each metal one by one to each of the test tubes.



The observations recorded by the student are as given below:

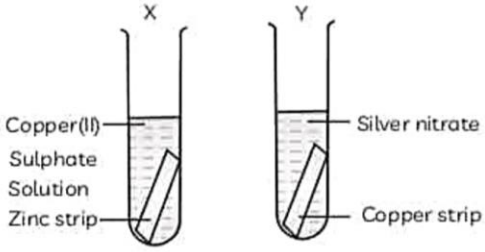
Test tube	Salt\Metal	Metal A	Metal B	Metal C	Metal D
(1)	Aluminium chloride	No Reaction	No Reaction	No Reaction	Reaction takes place
(2)	Iron (II) sulphate	Reaction takes place	No Reaction	No Reaction	Reaction takes place
(3)	Lead (II) nitrate	Reaction takes place	Reaction takes place	No Reaction	Reaction takes place
(4)	Magnesium sulphate	No Reaction	No Reaction	No Reaction	No Reaction

The correct arrangement of the given metals A, B, C and D in decreasing order of their reactivities is:

(a) C < B < A < D (b) B < C < A < D

(c) C < B < D < A (d) D < A < B < C

(E) A student performed an experiment to study the displacement reaction of metals. He took two test tubes X and Y containing copper sulphate and silver nitrate solutions respectively.



He dipped a strip of zinc in test tube X and copper strip in test tube Y and recorded his observations as shown below. Select the correct observation:

Option	Test tube X	Test tube Y
(a)	Reaction takes place	No reaction
(b)	No reaction	Reaction takes place
(c)	No reaction	No reaction
(d)	Reaction takes place	Reaction takes place

Ans. (A) *(b)* $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(l) + Al_2O_3(s)$ *+ Heat*

Explanation: Thermite reaction is the reaction between iron (III) oxide or Fe_2O_3 and aluminium. It is a highly exothermic process (shown by "+ Heat" in the product side) and iron is produced in the molten state. It is used to join is used to join railway tracks or cracked machine parts.

(B) *(b) No reaction takes place*

Explanation: No reaction takes place as zinc is less reactive than aluminium and

cannot displace aluminium from its salt solution, namely, $Al_2(SO_4)_3$ solution.

(E) *(d) Test Tube X : Reaction takes place; Test Tube Y: Reaction takes place.*

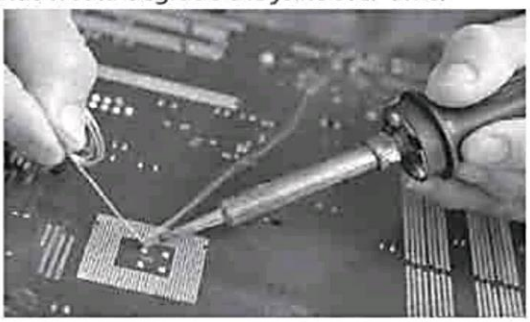
Explanation: Zinc is more reactive than copper and will displace copper from copper (II) sulphate solution in test tube X.

$$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$$

Also, copper is more reactive than silver and will displace silver from silver nitrate solution in test tube Y.

$$Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$$

54. *A fusible metal alloy is used to create a permanent bond between metal workpieces. The alloy is melted in order to adhere to and connect the pieces after cooling, which requires that the alloy have a lower melting point than the pieces being joined. The alloy should also be resistant to oxidative and corrosive effects that would degrade the joint over time.*



Name an alloy that is used for welding electrical wires together and also give its composition.

Ans. Solder is an alloy that is used for welding electrical wires together. It is an alloy of lead and tin (Pb and Sn) and has a low melting point.

55. *Sam went to the grocery store with his mother one day.*

He observed that pickles, curds and other sour things are always stored in glass or plastic containers and never in any container made of a metal or alloy. He later found out that this is related to the chemical properties of metals as metals react with acids.

(A) Metals react with dilute acids to give:

(a) Salt and water

(b) Salt and hydrogen gas

(c) Salt and carbon dioxide gas

(d) Salt, water and carbon dioxide gas

(B) Which of the following metal will react with dilute hydrochloric acid?

(I) Cu **(II) Zn**

(III) Al **(IV) Ag**

(a) Only (I)

(b) Only (II)

(c) Both (I) and (IV)

(d) Both (II) and (III)

(C) Which of the following oxides will not react with dilute sulphuric acid?

(a) CO_2 **(b) CuO**

(c) MgO **(d) Na_2O**

(D) Some students reacted an insoluble metal oxide with a dilute acid to form a soluble salt with a characteristic blue colour.

The insoluble metal oxide and the soluble salt could be:

	Insoluble Metal Oxide	Soluble Metal Salt
(a)	CuO	$CuCl_2$
(b)	CuO	$CuSO_4$
(c)	MgO	$MgSO_4$
(d)	MnO_2	$Zn(NO_3)_2$

(E) The correct arrangement of metals Mg, Zn, Fe and Al in decreasing order of their reactivity with dilute acids is:

(a) Al > Mg > Zn > Fe

(b) Al > Mg > Fe > Zn

(c) Mg > Al > Zn > Fe

(d) Mg > Al > Fe > Zn

Ans. (A) *(b) Salt and hydrogen gas*

Explanation: Most metals react with dilute acid to give the metal salt and hydrogen gas.

Example:

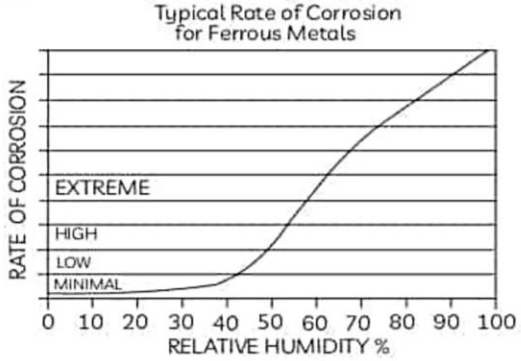
$$Zn_{(s)} + H_2SO_4\ (aq) \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$$

(E) *(c) Mg > Al > Zn > Fe*

Explanation: Out of the metals Mg, Zn, Fe and Al, Mg will react most vigorously with dilute acid, followed by Al, Zn and Fe.

56. *While walking along the roadside with his grandfather, Aman observed that many iron pipes had developed cracks on their surfaces.*

Being inquisitive in nature and also having learned about the phenomenon of corrosion, Aman searched the internet for more information about corrosion and its prevention and found out that the most important factor in atmospheric corrosion, overriding pollution or lack of it, is moisture, either in the form of rain, dew, condensation, or high relative humidity (RH). In the absence of moisture, most contaminants would have little or no corrosive effect.



(A) Identify the correct statement:

(a) Rusting of iron is caused only by water.

(b) Rusting of iron is caused only by air.

(c) Rusting of iron is caused only by impurities.

(d) Rusting of iron is caused by both air and water.

(B) Two students noted down the following observations after studying the graph showing the effect of relative humidity on the rate of corrosion in iron.

Option	Student A	Student B
(a)	Rate of corrosion is low for relative humidity < 20 %	Rate of corrosion is minimal for relative humidity < 50 %
(b)	Rate of corrosion is low for relative humidity between 20 % and 30 %	Rate of corrosion is low for relative humidity < 40 %
(c)	Rate of corrosion is high for relative humidity between 50 % - 60%	Rate of corrosion is extreme for relative humidity > 60 %
(d)	Rate of corrosion is extreme for relative humidity > 80 %	Rate of corrosion is high for relative humidity < 20 %

Select the correct option.

(C) Chemically rust is:

(a) Hydrated Iron (II) oxide

(b) Hydrated Iron (III) oxide

(c) Iron (III) sulphate

(d) Iron (III) oxide

(D) Which of the following statement(s) is/ are incorrect about corrosion?

(I) The black coating on silver articles is due to formation of basic silver oxide when silver reacts with oxygen present in air.

(II) The green coating on copper articles is due to formation of copper carbonate.

(III) The brown flaky substance formed on iron articles is due to the formation of rust.

(IV) The black coating on silver articles is due to formation of silver sulphide when silver reacts with hydrogen sulphide present in air.

(a) Only (I)

(b) Only (II)

(c) Both (I) and (III)

(d) Both (II) and (IV)

(E) Rusting of iron can be prevented by:

(a) Galvanisation only

(b) Alloying only

(c) Both (a) and (b)

(d) Neither (a) nor (b)

Ans. (B) *(c) Student A: Rate of corrosion is high for nelative humidity between 50% - 60%; Student B: Rate of corrosion... >60%.*

Explanation: From the graph, we observe that the rate of corrosion depends upon the relative humidity and it increases with increase in the relative humidity. Rate of corrosion is minimal for relative humidity < 40 %, is low for relative humidity between 40 % to 50 %, is high for relative humidity between 50% - 60 % and is extreme for relative humidity > 60 %.

(D) *(a) Only (I)*

SHORT ANSWER Type–I Questions (SA-I)

[2 marks]

57. A shining metal 'M', on burning gives a dazzling white flame and changes to a white powder 'N'.

(A) Identify 'M' and 'N'.

(B) Represent the above reaction in the form of a balanced chemical equation.

(C) Does 'M' undergo oxidation or reduction in this reaction? Justify. [CBSE 2020]

58. Compare in tabular form the reactivities of the following metals with cold and hot water:

(A) Sodium (B) Calcium (C) Magnesium [CBSE 2020]

Ans. Reactivities of the metals:

Sodium	Calcium	Magnesium
Sodium reacts with cold water and forms sodium hydroxide and hydrogen gas $2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)} + Heat$	Calcium reacts with cold water and forms calcium hydroxide and hydrogen gas. $Ca_{(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + H_{2(g)}$	Magnesium reacts with hot water and forms magnesium hydroxide and hydrogen gas $Mg + 2H_2O_{(l)} \longrightarrow Mg(OH)_{2(aq)} + H_2(g)$
Reaction with water is highly exothermic, hydrogen gas produced during the reaction catches fire and causes explosion.	The heat produced during reaction is not suffiicient to burn hydrogen gas. The bubbles of gas formed stick to the piece of calcium metal and it starts floating in water.	When Mg reacts with steam it forms magnesium oxide and hydrogen. $Mg_{(s)} + H_2O_{(g)} \longrightarrow MgO_{(s)} + H_{2(g)}$ Piece of Magnesium starts floating in water due to bubbles of Hydrogen gas which stick to its surface.
Sodium is a very reactive metal.	Calcium is less reactive than sodium Na > Ca > Mg.	Magnesium is less reactive than calcium.

59. Give the characteristic tests for the following gases:

(A) CO_2 (B) SO_2 (C) H_2

Ans. Characteristic tests for the following gases:

(A) CO_2 gas: When CO_2 gas is passed through lime water, it forms insoluble calcium carbonate which turns the solution milky. This is called as lime water test.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

The solution becomes clear in excess of CO_2 because of formation of soluble calcium bicarbonate.

$$CO_2 + H_2O + CaCO_3 \longrightarrow Ca(HCO_3)_2$$

(B) SO_2 gas: Due to acidic nature, sulphur dioxide gas turns moist litmus paper from blue to red. It also changes the orange colour of acidified potassium dichromate solution to green.

$$K_2Cr_2O_{7(aq)} + 3SO_{2(g)} + H_2SO_{4(aq)} \longrightarrow Cr_2(SO_4)_{3(aq)} + K_2SO_{4(aq)} + H_2O_{(l)}$$

(C) H_2 gas: In the presence of atmospheric oxygen, hydrogen gas burns with a pop sound.

60. Name one metal and one non-metal that exist in liquid state at room temperature. Also name two metals having melting point less than 310 K (37°C). [NCERT Exemplar]

61. When a metal X is treated with cold water, it gives a basic salt Y with molecular formula XOH (molecular mass = 40) and liberates a gas Z which easily catches fire. Identify X, Y and Z and also write the reaction involved.

62. An alkali metal A gives a compound B (molecular mass = 40) on reacting with water. The compound B gives a soluble compound C on treatment with aluminium oxide. Identify A, B and C and give the reactions involved. [CBSE 2012]

Ans. A is Na, B is NaOH and C is $NaAlO_2$

Reactions involved are:

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

Let the atomic weight of alkali metal A be a. When it reacts with water, it forms compound B having molecular mass 40.

Therefore, $a + 16 + 1 = 40 \Rightarrow a = 40 - 17 = 23$

We know that the atomic weight of Na (sodium) is 23.

Therefore, the alkali metal (A) is Na. Sodium reacts with water to form sodium hydroxide. So, compound B is sodium hydroxide (NaOH).

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

Sodium hydroxide reacts with aluminium oxide (Al_2O_3) to give sodium aluminate ($NaAlO_2$). Thus, C is sodium aluminate ($NaAlO_2$).

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

63. Answer the following:

(A) Write the electron-dot structures for sodium, oxygen and magnesium.

(B) Show the formation of Na_2O and MgO by the transfer of electrons.

(C) What are the ions present in these compounds?

64. A metal M does not liberate hydrogen from acids but reacts with oxygen to give a black coloured product. Identify M and the black coloured product and also explain the reaction of M with oxygen. [NCERT Exemplar]

Ans. The metal M is Cu and the black coloured product is copper oxide (CuO).

Because of less reactivity, copper metal does not release hydrogen gas with acid.

$$Cu_{(s)} + HCl \longrightarrow \text{No reaction}$$

Copper reacts with oxygen to form copper oxide. The reaction of metal M with oxygen is as follows:

$$2Cu + O_2 \longrightarrow 2CuO$$

Hence, metal M is copper.

65. Answer the following questions:

(A) Predict which of the following elements will form cation and which will form anions?

(a) Na (b) Al

(c) Cl (d) O

(B) Also name two elements that are inert in nature.

66. An element forms an oxide A_2O_3 which is acidic in nature. Identify A as a metal or non-metal. [NCERT Exemplar]

Ans. Metals usually form basic oxides like BaO, MgO, Na_2O etc. Unlike metals, non-metals tend to form acidic oxides. Since an oxide of element is acidic in nature, therefore, A will be a non-metal.

The formula for oxide is A_2O_3, which means the charge on the element must be +3 or the element should have 3 valence electrons. This implies that the element is boron and the formula for oxide would be B_2O_3.

67. A metal M forms an oxide having the formula M_2O_3. It is dissolved both in dilute sulphuric and dilute sodium hydroxide solution. Identify the metal and write equations for the reaction involved. What criteria would you use to assess it?

68. What are the constituents of solder alloy? Which property of solder makes it suitable for welding electrical wires? [NCERT Exemplar]

69. Metal X is found in nature as its sulphide XS. It is used in the galvanisation of iron of articles. Identify the metal X. How will you convert this sulphide ore into the metal? Explain with equations. [NCERT Exemplar]

Ans. Metal X is Zinc

The sulphide ore is first heated strongly in supply of oxygen and changed into its oxide. This process is called roasting.

$$2ZnS + 3O2 \xrightarrow{\text{Heat}} 2ZnO + 2SO2$$

Zinc oxide is then reduced to zinc metal by heating it with carbon. This process is called reduction.

$$2ZnO + C \longrightarrow 2Zn + CO2$$

70. How do properties of iron change when

(A) a small quantity of carbon is mixed in it?

(B) nickel and chromium are mixed in it? [CBSE 2012]

Ans. (A) Pure iron is very soft and stretches easily when heated. It is mixed with about 0.05 % of carbon to increase its strength and hardness.

(B) Iron is mixed with nickel and chromium to increase its hardness and make it rust proof.

SHORT ANSWER Type–II Questions (SA-II)

[3 marks]

71. **A non-metal X exists in two different forms Y and Z. Y is the hardest natural substance, whereas Z is a good conductor of electricity. Identify X, Y and Z.** [NCERT Exemplar]

72. **What are ionic compounds? Why do ionic compounds not conduct electricity in the solid state?** [CBSE 2019]

Ans. Ionic compounds are the compounds formed by the combination of oppositely charged ions formed by transfer of electrons from one atom to another.

Ionic compounds do not conduct electricity in solid state as they have a rigid structure as ions are not free to move due to strong electrostatic forces of attraction between them.

Related Theory

- *The chemical bond formed by the transfer of electrons from one atom to another is known as an ionic bond.*
- *An ionic bond is formed when a metal reacts with a non-metal and transfer of electrons takes place from metal atoms to non-metal atoms.*
- *The metal atom develops a positive charge after donating electrons and thus becomes a cation.*
- *The non-metal atom becomes a negatively charged ion, anion, after gaining or accepting electrons.*
- *Examples of ionic compounds are NaCl, MgO, etc.*
- *These conduct electricity in the molten state as the electrostatic forces of attraction between the oppositely charged ions are overcome due to the heat.*

73. **No chemical reaction takes place when granules of a solid A are mixed with the powder of another solid B. However when the mixture is heated, a reaction takes place between its components. One of the products, C, is a metal and settles down in its molten state, while the other product, D, floats over it. It was observed that the reaction is highly exothermic.**

(A) Based on the given information, make an assumption about A and B and write a chemical equation for the chemical reaction indicating the conditions of the reaction, physical state of reactions and products and thermal status of reaction.

(B) Mention any two types of reaction under which the above chemical reaction can be classified. [Diksha]

74. **Of the three metals X, Y and Z, X reacts with cold water, Y with hot water and Z with steam only. Identify X, Y and Z and also arrange them in increasing order of reactivity.**

75. **Explain the following:**

(A) Carbon cannot reduce the oxides of Na or Mg.

(B) Iron articles are galvanised. [CBSE 2013, NCERT Exemplar]

(C) Metals like Na, K, Ca and Mg are never found in their free state in nature.

Ans. (A) Sodium and magnesium have a tendency to react with oxygen rather than carbon because these are highly reactive metals. They have a greater affiinity for oxygen than for carbon. Hence, their oxides are stable. The reduction of these metallic oxides with carbon requires very high temperature and at that temperature, metals react with carbon to form their corresponding carbides. Hence, carbon cannot reduce the oxides of Na or Mg.

(B) Galvanisation is a process of formation of thin layer over metal surface. It prevents further contact of metal surface with atmosphere and reduces the corrosion level. So, iron articles are galvanized with a thin layer of zinc over them. Since zinc is more reactive than iron, it undergoes oxidation more readily than iron. As a result, iron articles remain protected.

(C) Metals such as Na, K, Ca and Mg are highly reactive metals and hence they are not found in their free state in nature. Na, K, Ca and Mg are alkali and alkaline Earth metals. They are the most reactive metals

and readily react with atmospheric oxygen and other gases. Therefore, they are found in nature in the form of their compounds.

76. Give reasons for the following:

The reaction of iron (III) oxide [Fe_2O_3] with heated aluminum is used to join cracked machine parts. [CBSE 2019]

Ans. The reaction of iron oxide (Fe_2O_3) with aluminium is used to join railway tracks or cracked machine parts as it is a highly exothermic reaction and the heat evolved is so large that metals are produced in their molten state.

$$Fe_2O_{3(s)} + 2Al_{(s)} \longrightarrow 2Fe_{(l)} + Al_2O_{3(s)}$$

77. Define an alloy. How is an alloy prepared? List two advantages of making alloys. Write the composition of stainless steel. Why is steel preferred over iron? List two reasons. [CBSE 2020]

LONG ANSWER Type Questions (LA)

[5 marks]

78. (A) Complete and balance the following chemical equations:

(i) $Al_2O_3 + HCl \longrightarrow$

(ii) $K_2O + H_2O \longrightarrow$

(iii) $Fe + H_2O \longrightarrow$

(B) An element 'X' displaces iron from the aqueous solution of iron sulphate. List your observations if the element 'X' is treated with the aqueous solutions of copper sulphate, zinc sulphate and silver nitrate. Based on the observations arrange X, Zn, Cu and Ag in increasing order of their reactivities. [CBSE 2020]

79. Name the following:

(A) Metal that can be cut by knife

(B) Lustrous non-metal

(C) Metal that exists in liquid state at room temperature

(D) Most malleable and ductile metal

(E) Metal that is best conductor of electricity

(F) Non-metal that can exist in different forms [CBSE 2020]

Ans. (A) Metal which can be cut by knife—Sodium

(B) Lustrous non—metal—Iodine

(C) Metal that exists in liquid state at room temperature—mercury

(D) Most malleable and ductile metal—Gold

(E) Metal that is best conductor of electricity—Silver

(F) Non-metal that can exist in different forms—Carbon

80. (A) What are amphoteric oxides? Choose the amphoteric oxides from amongst the following oxides: Na_2O, ZnO, Al_2O_3, CO_2, H_2O.

(B) Why is it that non-metals do not displace hydrogen from dilute acids? [Diksha]

Ans. (A) Those metal oxides which show basic as well as acidic behaviour are known as amphoteric oxides. Amphoteric oxides react with both acids as well as bases to form salts and water. Al_2O_3, ZnO are amphoteric oxides among the given oxides.

(B) Non-metals do not displace hydrogen from dilute acids because in order to displace hydrogen ions (H^+) of an acid and convert them into hydrogen gas, electrons should be supplied to the hydrogen ions (H^+) of the acid.

A non-metal is itself an acceptor of electrons. Hence it cannot give electrons to the hydrogen ions of the acid to reduce them to hydrogen gas. As a result, non-metals are not able to displace hydrogen ions from acids to form hydrogen gas.

81. (A) When calcium metal is added to water, the gas evolved does not catch fire but the same gas evolved on adding potassium metal to water catches fire. Explain.

(B) Name a metal for each case:

(i) It displaces hydrogen gas from nitric acid.

(ii) It does not react with any physical state of water.

(iii) It does not react with cold as well as hot water but reacts with steam. [Diksha]

82. State five uses each of metals and non-metals.

Ans. Uses of metals:

(1) Lead metal is used in making car batteries.
(2) Zinc is used for galvanizing iron to protect it from rusting.
(3) Iron, copper and aluminium are used to make utensils.
(4) Copper and aluminium metals are used to make electrical wires.
(5) Aluminium is used to make aluminium foil for packaging materials.

Uses of non-metals:

(1) Hydrogen is used in the hydrogenation of vegetable oils.
(2) Carbon is used to make electrodes of electrolytic cells and dry cells.
(3) Nitrogen is used in the manufacture of ammonia, nitric acid and fertilizers.
(4) Sulphur is used for producing sulphuric acid.
(5) Liquid hydrogen is used as rocket fuel.

83. List in tabular form three chemical properties on the basis of which we can differentiate between a metal and a non-metal.

[CBSE 2019]

Ans. Chemical properties used to differentiate between metal and non-metals:

	Metals	Non-Metals
(1)	Metals are electro-positive in nature as they lose electrons and form positive ions. $K \longrightarrow K^+ + e^-$	Non-Metals are electronegative in nature as they accept electrons and form negative ions. $S + 2e^- \longrightarrow S^{2-}$
(2)	Metals combine with oxygen to form basic or amphoteric oxides. $2Cu + O_2 \longrightarrow 2CuO$	Non-metals combine with oxygen to form acidic or neutral oxides which are covalent compounds. $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$
(3)	Metal reacts with dil acids such as dil HCl and dil H_2SO_4 to form salt and H_2 gas. $Mg_{(s)} + 2HCl \longrightarrow MgCl_{2(aq)} + H_{2(g)}$	Non-metals do not displace hydrogen from dilute acids as it cannot supply electrons to H^+ ions.
(4)	Metals react with water and produce a metal hydroxide or oxide and H_2. $2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)} + Heat$	Non-metals do not react with water.
(5)	Metals react with chlorine to form metal chlorides, which are electrovalent compounds. $Ca^{2+} + 2Cl^- \longrightarrow CaCl_2$	Non-metals form covalent chlorides which is generally a volatile liquid or a gas. $P_{4(s)} + 6Cl_{2(g)} \longrightarrow 4PCl_{3(g)}$
(6)	A few active metals like Na, K and Ca can force the hydrogen atom to accept electrons to form salts called hydrides. $2Na_{(s)} + H_{2(g)} \longrightarrow 2NaH_{(s)}$	Non-metals combine with hydrogen to form covalent hydrides. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

(Any 3 of 6 points can be written to get full marks)

84. Give the steps involved in the extraction of metals of low and medium reactivity from their respective sulphide ores.

[CBSE 2019, 18, NCERT Exemplar]

Ans. Extraction of less reactive metals like mercury:

(1) Roasting: Heating of metal sulphide in the excess of air to form metal oxide.

$$\text{Ore} \xrightarrow{\text{Roasting}} \text{Metal oxide}$$

$$\underset{\text{Cinnabar ore}}{2HgS} + \underset{\text{Oxygen (from air)}}{3O_2} \xrightarrow{\text{Roasting}} \underset{\text{Mercury(II) oxide}}{2HgO_{(s)}} + 2SO_2$$

(2) Reduction: Metal oxide can be reduced to metal in the presence of a reducing agent at high temperature.

$$\text{Metal oxide} \xrightarrow[\text{Reduction}]{\text{Heat}} \text{Metal}$$

$$\underset{\text{Mercury(II) oxide}}{2HgO_{(s)}} \xrightarrow[\text{Reduction}]{\text{Heat}} \underset{\text{Mercury metal}}{2Hg_{(l)}} + O_{2(g)}$$

(3) Refining

Extraction of metals with medium reactivity like zinc:

(1) Roasting: Heating of metal sulphide in the excess of air to form metal oxide.

$$2ZnS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2ZnO_{(s)} + 2SO_{2(g)}$$

(2) Reduction: Metal oxide can be reduced to metal in the presence of a reducing agent like coke or aluminium at high temperature.

Smelting process:

$$\underset{\text{Zinc oxide}}{ZnO_{(s)}} + \underset{\text{Coke}}{C_{(s)}} \xrightarrow{\Delta} \underset{\text{Zinc}}{Zn_{(s)}} + \underset{\text{Carbon monooxide}}{CO_{(g)}}$$

Thermite reaction:

$$\underset{\text{Iron(III) oxide}}{Fe_2O_{3(s)}} + 2\underset{\text{Aluminium}}{Al_{(s)}} \xrightarrow{\Delta} \underset{\text{Iron (melt)}}{2Fe_{(l)}} + \underset{\text{Aluminium oxide}}{Al_2O_{3(s)}}$$

(3) Refining

85. An element A burns with a golden flame in air. It reacts with another element B (atomic number 17) to give a product C. An aqueous solution of product C on electrolysis gives a compound D and liberates hydrogen. Identify A, B, C and D. Also write down the equations for the reactions involved. **[NCERT Exemplar]**

Ans. A = Sodium (Na)

B = Chlorine (Cl_2)

C = Sodium chloride (NaCl)

D = Sodium hydroxide (NaOH)

Element A is sodium that burns with a golden flame.

Element B is chlorine. Its atomic number is 17.

Sodium and chlorine react to form sodium chloride (NaCl) which is an ionic compound.

$$2Na + Cl_2 \longrightarrow 2NaCl$$

Product C is sodium chloride.

Electrolysis of sodium chloride gives sodium hydroxide.

$$2NaCl_{(aq)} + 2H_2O_{(l)} \xrightarrow{\text{Electrolysis}} 2NaOH_{(aq)} + Cl_2 + H_{2(g)}$$

Compound D is sodium hydroxide.

86. Two ores A and B were taken. On heating, ore A gives CO_2, whereas, ore B gives SO_2. What steps will you take to convert them into metals? **[NCERT Exemplar]**

87. Name the ore of mercury. With the help of balanced chemical equations, explain the process of extraction of mercury from its ore. **[CBSE 2019]**

Ans. Cinnabar (HgS) is an ore of Mercury.

The ore is first converted to mercuric oxide by heating and then it is reduced to mercury on further heating.

Chemical equation for the reactions are given below:

$$2HgS_{(s)} + 3O_{2(g)} \xrightarrow{\text{Heat}} 2HgO_{(s)} + 2SO_{2(g)}$$

$$2HgO_{(s)} \xrightarrow{\text{Heat}} 2Hg_{(l)} + O_{2(g)}$$

Related Theory

- *It is easier to obtain a metal from its oxide, as compared to its sulphides and carbonates.*
- *Metals which are low in the activity series are very unreactive and their oxides can be reduced to metals by heating alone.*
- *The ores of the metals in the middle of the activity series, such as iron, zinc, lead, copper which are usually present as sulphides or carbonates, must be converted into metal oxides prior to reduction.*

88. How is the method of extraction of metals high up in the reactivity series different from that for metals in the middle? Why can the same process not be applied for them? Name the process used for the extraction of these metals. **[CBSE 2019]**

Ans. The metals high up in the reactivity series are very reactive, are strong reducing agents and therefore cannot be obtained from their compounds by chemical reduction.

Metals in the middle of the reactivity series are less reactive and can be obtained by first converting them into their oxide and then reducing by carbon.

The same method cannot be applied for highly reactive metals as they have more affnity for

oxygen than carbon.

Highly reactive metals are extracted by electrolytic reduction, *i.e.*, by the electrolysis of their fused chlorides.

The metals are deposited at the cathode and chlorine is liberated at the anode.

At cathode: $Na^+ + e^- \longrightarrow Na$

At anode $2Cl^- \longrightarrow Cl_2 + 2e^-$