3 METALS AND NON-METALS

BASIC CONCEPTS – A FLOW CHART

ELEMENTS

Metals

Metals lose electrons and form +ve ions

Physical Properties

- Are malleable, i.e., they can be hammered into thin sheets.
- Are ductile, lustrous and can be polished.
- Are good conductors of heat and electricity.
- Have high tensile strength.
- Have high density.
- Melting and boiling points are usually high.
- All are solid at room temperature except mercury (liquid).

Chemical Properties

- Reaction with oxygen
  Metal + Oxygen → Metal oxide (Basic)
- Reaction with water
  Metal + Water
  ↓
  Metal oxide + Hydrogen
  Metal oxide + Water
  ↓
  Metal hydroxide
- Reaction with acids
  Metal + Dilute acid
  ↓
  Metal salt + Hydrogen
- Reaction with solutions of other metal salts
  Metal A + Salt solution of B
  ↓
  Salt solution of A + Metal B

Extraction and Purification

Concentration of Ores

- Metals of high reactivity → Electrolysis of molten ores → Pure metal
- Metals of medium reactivity → Carbonate ores → Calcination; Sulphide ores → Roasting → Oxide of metal → Reduction to metal → Purification of metal
- Metals of low reactivity → Sulphide ores → Roasting → Metal → Refining

Metalloids

Show both characteristics, metallic as well as non-metallic.
Examples:
Si, Ge, As, Sb and Te

Non-metals

Non-metals gain electrons and form –ve ions

Physical Properties

- Are solids or gases except bromine (liquid)
- Are brittle, i.e., they break down when hammered or stretched
- Are non-malleable
- Are non-ductile
- Except graphite, all are bad conductors of heat and electricity
- Have very low tensile strength
- Have low melting and boiling points

Chemical Properties

- Reaction with oxygen
  Non-metal + oxygen → Non-metallic oxide (Acidic)
  $C(s) + O_2(g) \rightarrow CO_2(g)$
  $CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$ (Carbonic acid)
- Reaction with acids
  Non-metals do not displace H_2

Ionic Compounds

Properties

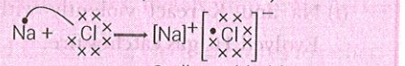
- Solid and crystalline in nature.
- Made up of positive and negative ions.
- Soluble in water and insoluble in solvents such as kerosene, petrol.
- Good conductors of electricity in aqueous solutions and molten state but do not conduct in the solid state.
- Melting and boiling points are high.

Formation

Compounds are formed by a give-and-take relation between the elements as shown below:

$Na \rightarrow Na^+ + e^-$
2,8,1 → 2,8
(Sodium cation)

$Cl + e^- \rightarrow Cl^-$
2,8,7 → 2,8,8
(Chloride anion)



Sodium chloride

Corrosion

Gradual destruction of metal by air, water or any other substance around it.

Methods of Prevention

- Painting
- Oiling and greasing
- Plastic coating
- Chromium plating
- Galvanising (zinc plating)
- Alloying

Activity Series: Relative reactivities of metals

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

MORE POINTS TO REMEMBER

❒ Comparison of Chemical Properties:

Metals	Non-metals
1. Metals lose electrons and form +ve ions. $Na \longrightarrow Na^+ + e^-$ Metals are electropositive elements.	**Non-metals gain electrons** and form –ve ions. $Cl + e^- \longrightarrow Cl^-$ Non-metals are electronegative elements.
2. Metals combine with oxygen and form basic oxides. $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$	**Non-metals combine with oxygen** and form acidic oxides or neutral oxides. $C(s) + O_2(g) \longrightarrow CO_2(g)$
3. Basic oxides + Water → Bases $Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$ Sodium hydroxide In litmus test, the bases formed turn red litmus paper blue.	**Acidic oxides + Water → Acids** $CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$ Carbonic acid In litmus test, the acids formed turn blue litmus paper red.
4. Oxidation (*i*) K and Na catch fire in oxygen. To prevent oxidation they are kept immersed in kerosene. (*ii*) The surfaces of metals like Mg, Al, Zn, Pb, etc., are covered with a thin layer of their oxides. So, no further oxidation takes place. (*iii*) Magnesium on heating burns forming magnesium oxide. (*iv*) Copper on heating becomes coated with black coloured copper oxide (CuO). (*v*) Silver and gold do not react with oxygen.	(*i*) CO_2 and SO_2 are acidic oxides (turn blue litmus paper red). (*ii*) Carbon monoxide (CO), water (H_2O) and nitrous oxide (N_2O) are neutral oxides (no action on litmus paper). (*iii*) A jet of hydrogen gas burns in air with a pale blue flame. Steam produced can be condensed to water. $2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$
5. Reaction with Water (*i*) Na and K react violently with **cold water.** Evolved H_2 gas catches fire. $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$ $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$ (*ii*) Magnesium reacts with **hot water**. $Mg(s) + 2H_2O(l) \xrightarrow{\text{(Hot)}} Mg(OH)_2(aq) + H_2(g)$ (*iii*) Al, Zn and Fe react with **steam.** $2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3(s) + 3H_2(g)$ $3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + 4H_2(g)$ $Zn(s) + H_2O(g) \longrightarrow ZnO(s) + H_2(g)$ (*iv*) Lead(Pb), Copper(Cu), Silver(Ag) and Gold (Au) **do not react** with water.	Non-metals do not react with water to evolve hydrogen gas.
6. Reactions with Acids (*i*) Metals react with dil. HCl and H_2SO_4 to liberate H_2 gas. Metal + dil. Acid ⟶ Salt + Hydrogen (*ii*) When metals react with dilute HNO_3, H_2 gas is not evolved but H_2O (water) is formed. Metal + dil. Nitric acid ⟶ Metal salt + Water + Oxides of nitrogen. (**Exceptions:** Mg and Mn evolve H_2 gas with dil. HNO_3)	Non-metals do not displace H_2 from acids because non-metals are electron acceptor, and they cannot supply electron to hydrogen.
7. Reaction with Hydrogen Hydrogen can share or lose electrons. But active metals like Na, K and Ca can force hydrogen atom to accept the electrons to form hydrides. $2Na(s) + H_2(g) \rightarrow 2NaH(s)$ $Ca(s) + H_2(g) \rightarrow CaH_2(s)$	Hydrides of non-metals are stable compounds and are formed by sharing electrons. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $H_2(g) + S(s) \rightarrow H_2S(g)$

❒ Alloy:

An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal. The electrical conductivity and melting point of an alloy is less than that of pure metals.

A.	**Alloys of Iron:**		
	1. Steel	Iron, Carbon	Hard, tough and strong. Used in construction of ships, bridges, vehicles, etc.
	2. Stainless steel	Iron, Nickel, Chromium	Hard, does not rust. Used in surgical instruments, cutlery, utensils, etc.
B.	**Alloys of Copper:**		
	1. Brass	Copper and Zinc	Malleable, strong, resistant to corrosion. Used in screws, nuts, bolts, utensils, etc.
	2. Bronze	Copper and Tin	Very strong, highly resistant to corrosion. Used for statues, coins, metals, ship propellers, etc.
C.	**Solder**	Lead and Tin	Used for welding electrical wires together.

NCERT Intext Questions

Q. 1. Give an example of a metal which

(*i*) is a liquid at room temperature;

(*ii*) can be easily cut with a knife;

(*iii*) is the best conductor of heat;

(*iv*) is a poor conductor of heat.

Ans. (*i*) Mercury (*ii*) Sodium

(*iii*) Silver (*iv*) Lead.

Q. 2. Explain the meanings of malleable and ductile.

Ans. Metals can be hammered into thin sheets. This property of metal is called malleability and the metals showing this property are called malleable. Gold, silver, copper, aluminium etc., are malleable metals.

Metals can be drawn into wires. The ability of metals to be drawn into thin wires is called ductility. Gold is the most ductile metal. It is interesting to know that a wire of about 2 km length can be drawn from one gram of gold.

Q. 3. Why is sodium kept immersed in kerosene oil?

Ans. Sodium is a very reactive metal. It reacts vigorously with the water and oxygen present in air and even catches fire. Hence, to protect sodium, it is kept immersed in kerosene oil.

Q. 4. Write equation for the reactions of

(*i*) iron with steam

(*ii*) calcium and potassium with water

Ans. (*i*) $3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + 4H_2(g)$

(*ii*) $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

$2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$

Q. 5. 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	Displacement	—	—
B	Displacement	—	No reaction	—
C	No reaction	No reaction	No reaction	Displacement
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.

(*i*) Which is the most reactive metal?

(*ii*) What would you observe, if B is added to a solution of copper(II) sulphate?

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

Ans. (*i*) B is most reactive.

(*ii*) B will displace copper from copper(II) sulphate.

(*iii*) B > A > C > D.

Q. 6. Which gas is produced, when dilute hydrochloric acid is added to a reactive metal? Write the chemical equation, when iron reacts with dilute H_2SO_4.

Ans. Hydrogen gas is produced, when a metal reacts with dilute hydrochloric acid.

$$\underset{\text{Metal}}{M(s)} + \underset{\substack{\text{Hydrochloric acid}\\(\text{Dilute})}}{2HCl(aq)} \longrightarrow \underset{\text{Metal chloride}}{MCl_2(s)} + \underset{\text{Hydrogen}}{H_2(g)}$$

Chemical equation for the reaction of iron with dilute H_2SO_4 is

$$\underset{\text{Iron}}{Fe(s)} + \underset{\substack{\text{Dilute Sulphuric}\\\text{acid}}}{H_2SO_4(aq)} \longrightarrow \underset{\text{Iron (II) sulphate}}{FeSO_4(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

Q. 7. What would you observe, when zinc is added to a solution of iron(II) sulphate? Write the chemical reaction that takes place.

Ans. When zinc is added to a solution of iron(II) sulphate, the greenish colour of iron(II) sulphate solution fades away gradually, due to the formation of colourless zinc sulphate solution. Iron metal is deposited on zinc.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\substack{\text{Iron(II) sulphate}\\(\text{Greenish solution})}}{FeSO_4(aq)} \longrightarrow \underset{\substack{\text{Zinc sulphate}\\(\text{Colourless solution})}}{ZnSO_4(aq)} + \underset{\text{Iron}}{Fe(s)}$$

Q. 8. (*i*) Write the electron dot structures of sodium, oxygen and magnesium.

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

(*iii*) What are the ions present in these compounds?

Ans. (*i*)

Metal	Symbol	Atomic Number	Electronic Configuration K, L, M, N	Number of Outermost Electrons	Electron dot structures
Sodium	Na	11	2, 8, 1	1	Na·
Oxygen	O	8	2, 6	6	:Ö:
Magnesium	Mg	12	2, 8, 2	2	Mg:

(*ii*) Formation of Na_2O :

The atomic number of sodium is 11 and it has only one valence electron.

Hence, electronic configuration of $_{11}Na$ is 2, 8, 1.

The atomic number of oxygen is 8 and it has 6 electrons in its valence shell.

Hence, electronic configuration of $_8O$ is 2, 6.

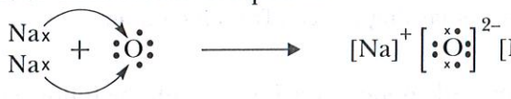
Sodium has a tendency to lose the valence electron and oxygen has a tendency to gain the electron lost by sodium. Since, sodium can lose only one electron of the valence shell and oxygen atom needs two electrons to complete its octet in the valence shell, two atoms of sodium combine with one atom of oxygen. By losing valence electron, sodium is changed into Na^+ and by gaining two electrons lost by two sodium atoms, oxygen atom is changed into an oxide anion, O^{2-}. In this process, both the atoms, sodium and oxygen, obtain the stable electronic configuration of the noble gas neon.

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

$$\underset{2,6}{O} + 2e^- \longrightarrow \underset{2,8}{O^{2-}}$$

$$2Na^+ + O^{2-} \longrightarrow 2Na^+O^{2-} \text{ or } Na_2O$$

The oppositely charged sodium ion, Na^+ and oxide ion, O^{2-} are now held together by electrostatic forces of attraction or by ionic or electrovalent bond. Na_2O is, therefore, an ionic or electrovalent compound.



or Na_2O

Formation of MgO:

The atomic number of magnesium = 12

Its electronic configuration is K L M

2, 8, 2

It has two electrons in its outermost shell. So, the magnesium atom donates its 2 valence electrons and forms a stable magnesium ion, Mg^{2+}, to attain the electronic arrangement of neon gas.

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

The atomic number of oxygen = 8

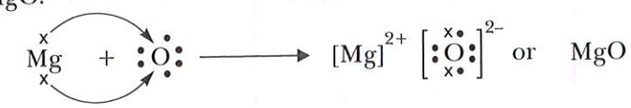
Electronic configuration = K L

2, 6

It has six electrons in its valence shell. Therefore, it requires two more electrons to attain the stable electronic arrangement of neon gas. Thus, oxygen accepts two electrons donated by magnesium atom and forms a stable oxide ion, O^{2-}.

$$\underset{2,6}{O} + 2e^- \longrightarrow \underset{2,8}{O^{2-}}$$

The oppositely charged magnesium ions, Mg^{2+} and oxide ions, O^{2-}, are held together by a strong force of electrostatic attraction to form magnesium oxide compound $Mg^{2+}O^{2-}$ or MgO.



MgO is an ionic compound.

(*iii*) The ions present in Na_2O are sodium ions ($2Na^+$) and oxide ion O^{2-}.

The ions present in MgO are magnesium ion (Mg^{2+}) and oxide ion O^{2-}.

Q. 9. Why do ionic compounds have high melting points?

Ans. The ionic compounds are made up of positive and negative ions. There is a strong force of attraction between the oppositely charged ions. Therefore, a lot of energy is required to break this force of attraction and melt this ionic compound. That is why ionic compounds have high melting points.

Q. 10. Define the terms: (*a*) Mineral (*b*) Ore (*c*) Gangue

Ans. **Mineral:** The inorganic element or compound, which occurs naturally in the earth's crust is called mineral. For example, copper pyrites ($CuFeS_2$), cuprite (Cu_2O), etc. are the minerals of copper.

Ore: The mineral from which a metal can be extracted profitably and conveniently is called an ore. For example, bauxite ($Al_2O_3.2H_2O$) and clay ($Al_2O_3.2SiO_2.2H_2O$) are the minerals of aluminium. But, extraction of aluminium is cheaper and easier from bauxite. Hence, bauxite is the ore of aluminium.

Thus, "every ore is a mineral but every mineral is not an ore."

Gangue or Matrix: The unwanted impurities of sand and rocky materials present in the ore are known as gangue or matrix. We get a concentrated ore by removing the gangue present in it.

Q. 11. Name two metals, which are found in nature in the free state.

Ans. Gold and silver are least reactive and hence these metals occur in nature in the free state.

Q. 12. Which chemical process is used for obtaining a metal from its oxide?

Ans. Reduction.

Q. 13. Metallic oxides of zinc, magnesium and copper were heated with the following metals:

Metal	Zinc	Magnesium	Copper
Zinc oxide			
Magnesium oxide			
Copper oxide			

In which case will you find, displacement reactions taking place?

Ans. As we know, a more reactive metal can displace a less reactive metal from its oxide. Here, magnesium is the most reactive, zinc is less reactive whereas copper is the least reactive metal. Thus, displacement reactions will take place in the following cases:

Metal	Zinc	Magnesium	Copper
Zinc oxide	—	Displacement	—
Magnesium oxide	—	—	—
Copper oxide	Displacement	Displacement	—

Q. 14. Which metals do not corrode easily?

Ans. Silver, gold, platinum and titanium.

Q. 15. What are alloys?

Ans. Alloys are homogeneous mixtures of two or more metals, or a metal and a non-metal. For example, brass is an alloy of two metals—copper and zinc, whereas steel is an alloy of a metal, iron and a small amount of a non-metal, carbon.

NCERT Exercises

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

(*a*) NaCl solution and copper metal **(*b*) $MgCl_2$ solution and aluminium metal**

(*c*) $FeSO_4$ solution and silver metal **(*d*) $AgNO_3$ solution and copper metal**

Ans. (*a*) No displacement reaction will occur between NaCl solution and copper metal, as copper metal is less reactive than sodium metal.

(*b*) Al is less reactive than Mg. So, no displacement reaction will take place.

(*c*) Ag is less reactive than Fe. So, no displacement reaction will take place.

(*d*) Cu (copper metal) is more reactive than silver (Ag), so the displacement reaction will take place between $AgNO_3$ solution and copper metal.

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

(*a*) Applying grease **(*c*) Applying a coating of zinc**

(*b*) Applying paint **(*d*) All of the above**

Ans. The suitable method for preventing an iron frying pan from rusting is (*c*) applying a coating of zinc.

Applying grease will spoil the food to be cooked in frying pan. Also, we cannot apply paint because it will gradually come out when the frying pan is heated on a gas stove while cooking.

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

(*a*) calcium **(*b*) carbon**

(*c*) silicon **(*d*) iron**

Ans. Pure calcium oxide or lime, is an amorphous white solid, having a high melting point (2273K).

When lime is added to water, a hissing sound is produced and a large amount of heat is generated.

$$CaO + H_2O \longrightarrow \underset{\text{Slaked lime}}{Ca(OH)_2} + \text{Heat}$$

Therefore, the correct answer is (*a*).

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

(*a*) zinc is costlier than tin. **(*b*) zinc has a higher melting point than tin.**

(*c*) zinc is more reactive than tin. **(*d*) zinc is less reactive than tin.**

Ans. (*c*) Zinc is more reactive than tin.

Q. 5. 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.

Ans. (*a*) (*i*) We use the hammer to break the sample. If the sample breaks, this means that it is brittle and hence it is a non-metal. On the other hand, if the sample flattens to form a sheet, this means that the sample is malleable and hence is metal.

(*ii*) We set up the electric circuit and place the sample in between clips A and B and put the switch 'on'. If the bulb glows, the sample is a good conductor of electricity and hence, it must be a metal. If, on the other hand, the bulb does not glow, the sample is a poor conductor of electricity and hence, it must be a non-metal.

(*b*) Because of malleability of iron and many other metals, we can cast them into sheets, which can be used for various purposes. For example, iron sheets are used for roofing and for making trunks, boxes etc.

Metals are good conductors of electricity. It is because of this property that metal wires made up of copper and aluminium are used for carrying electricity.

These tests of distinguishing metals and non-metals are widely applicable in industries and its validity has been scientifically proved.

Q. 6. What are amphoteric oxides? Give two examples of amphoteric oxides.

Ans. Some metal oxides show both acidic as well as basic character. Such oxides are called amphoteric oxides.

For example, (*i*) Aluminium oxide (Al_2O_3) (*ii*) Zinc oxide (ZnO).

Q. 7. Name two metals, which will displace hydrogen from dilute acids and two metals, which will not.

Ans. (*i*) Magnesium and zinc will displace hydrogen from dilute acids.

(*ii*) Copper and silver will not displace hydrogen from dilute acids.

Q. 8. What would you take as the anode, the cathode and the electrolyte in the electrolytic refining of metal M?

Ans. **Anode:** A thick block of impure metal M.

Cathode: A thin strip of the pure metal M.

Electrolyte: A water soluble salt of the metal M.

Q. 9. Pratyush took sulphur powder on a spatula and heated it. He collected the gas evolved by inverting a test tube over it.

(*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.

Ans. (*a*) When sulphur is heated in air, sulphur dioxide gas is formed.

(*i*) Sulphur dioxide has no action on dry litmus paper.

(*ii*) Sulphur dioxide turns moist blue litmus paper to red.

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

Q. 10. State two ways to prevent the rusting of iron.

Ans. (*i*) Galvanisation

(*ii*) Greasing

Q. 11. What type of oxides are formed, when non-metals combine with oxygen?

Ans. Non-metals react with oxygen to form acidic oxides or neutral oxides. Carbon forms an acidic oxide CO_2, sulphur forms an acidic oxide SO_2 and hydrogen forms a neutral oxide H_2O. Carbon monoxide (CO), nitrous oxide (N_2O) and nitric oxide (NO) are also the examples of neutral oxides.

Q. 12. Give reasons:

(*a*) Platinum, gold and silver are used to make jewellery.

(*b*) Sodium, potassium and lithium are stored under oil.

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

(*d*) Carbonate and sulphide ores are usually converted into oxides during the process of extraction.

Ans. (*a*) Platinum, gold and silver are used to make jewellery because of their bright shiny surface and high resistance to corrosion. Also, they have high malleability and ductility.

(*b*) Sodium, potassium and lithium are stored under oil to prevent their reaction with oxygen, moisture and carbon dioxide of air so as to protect them because they are very reactive metals.

(*c*) Aluminium metal forms a thin layer of aluminium oxide all over its surface, under the action of moist air. This layer prevents the metal underneath from further corrosion. It is cheap, easily available, malleable, ductile and a good conductor of heat. Therefore, it is used to make utensils for cooking.

(*d*) It is easier to obtain a metal from its oxides as compared to its sulphides and carbonates. So, prior to reduction, metal carbonate and sulphides must be converted into metal oxides. A carbonate ore is converted into oxide by **calcination**, whereas a sulphide ore is converted into oxide by **roasting**.

Q. 13. 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.

Ans. When copper vessels are exposed to moist air, they form a green coating of basic copper carbonate [$CuCO_3.Cu(OH)_2$].

$$2Cu + \underbrace{CO_2 + O_2 + H_2O}_{\text{(From moist air)}} \longrightarrow \underset{\substack{\text{Basic copper carbonate}\\\text{(Green)}}}{CuCO_3.Cu(OH)_2}$$

The sour substances such as lemon or tamarind juice contain acids. Lemon juice contains citric acid and tamarind contains tartaric acid. These acids dissolve the coating of copper oxide or basic copper carbonate, present on the surface of tarnished copper vessels and make them shining red brown again.

Q. 14. Differentiate between metals and non-metals on the basis of their chemical properties.

Ans.

Metals	Non-metals
1. Metals combine with oxygen and form basic oxides. $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ Basic oxides + Water → Bases $Na_2O(s) + H_2O(l) \longrightarrow \underset{\text{Sodium hydroxide}}{2NaOH(aq)}$ Litmus test (turn red litmus blue)	1. Non-metals combine with oxygen and form acidic oxides or neutral oxides. $C(s) + O_2(g) \rightarrow CO_2(g)$ Acidic oxides + Water → Acids $CO_2(g) + H_2O(l) \longrightarrow \underset{\text{Carbonic acid}}{H_2CO_3(aq)}$ Litmus test (turn blue litmus red)
2. Metals react with water to liberate hydrogen gas.	2. Non-metals do not react with water.
3. (*a*) Metals react with dil HCl and H_2SO_4 to liberate H_2 gas. Metal + dil. Acid → Salt + Hydrogen (*b*) Metal + dil. Nitric acid → Metal salt + Water + Oxides of nitrogen. (**Exception:** Mg and Mn evolve H_2 gas with dil. HNO_3)	3. Non-metals do not displace H_2 from acids because non-metals are electron acceptor, they cannot supply electron to hydrogen.

Q. 15. 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?

Ans. The goldsmith dipped the set of the gold bangles in aqua regia solution. Aqua regia is a freshly prepared mixture of 1 part of conc. HNO_3 and 3 parts of conc. HCl by volume. Aqua regia dissolved a considerable amount of gold from the dipped gold bangles and hence reduced their weight drastically. The dishonest goldsmith can recover the dissolved gold from aqua regia by a suitable treatment.

Q. 16. Give reasons, why copper is used to make hot water tanks but not steel (an alloy of iron).

Ans. Copper is a much better conductor of heat than steel. Also, copper does not react with water at all but steel (an alloy of iron) reacts with steam. So, copper is used to make hot water tanks but not steel (an alloy of iron).

VERY SHORT ANSWER QUESTIONS [1 mark]

Q. 1. Why are metals good conductors of electricity?

Ans. Metals are good conductors of electricity because they contain free electrons. These free electrons move easily through the metal and conduct electric current.

Q. 2. Which property of graphite is utilised in making electrodes?

Ans. Graphite is a good conductor of electricity. Due to this property, graphite is utilised in making electrodes.

Q. 3. Which of the following metals will melt at body temperature?
Gallium, Magnesium, Caesium, Aluminium

Ans. Gallium and caesium will melt at 37°C (body temperature).

Q. 4. Name two metals that do not react with water at all.

Ans. Lead and copper.

Q. 5. What happens when calcium is treated with water?

Ans. Calcium reacts less violently with water and bubbles of hydrogen gas stick to its surface.

Q. 6. Generally, non-metals are not lustrous. Name a non-metal which is lustrous.

Ans. Iodine

Q. 7. What is the nature of non-metal oxide?

Ans. Non-metal oxides are acidic or neutral in nature.

Q. 8. What is the nature of metal oxides?

Ans. Metal oxides are basic in nature.

Q. 9. Why does calcium float in water? *[CBSE Delhi 2011]*

Ans. When calcium reacts with water, hydrogen gas is produced which sticks to the surface of calcium, so it floats in water.

Q. 10. What is flux?

Ans. Flux is a substance which is added to the ore, during reduction, for removing the non-fusible impurities.

Q. 11. Why do copper objects develop a green coating in air?

Ans. Copper reacts with moist carbon dioxide in the air and gains a green coating of basic copper carbonate.

Q. 12. Why do silver articles become black on prolonged exposure to air?

Ans. Sulphur compounds such as hydrogen sulphide gas (H_2S) present in the air when combine with the silver articles, form a black coating of silver sulphide (Ag_2S).

Q. 13. Which oxide of iron could be obtained on prolonged reaction of iron with steam?

Ans. Fe_3O_4

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

Q. 14. Why are ionic compounds usually hard?

Ans. In all ionic compounds, their positive and negative ions are attached to each other by a strong ionic bond. So, they are rigid and hard solids.

Q. 15. Why does aluminium not react with water under ordinary conditions?

Ans. Aluminium does not react with water under ordinary conditions because of the presence of a thin layer of aluminium oxide on its surface.

Q. 16. In nature, metal A is found in a free state while metal B is found in the form of its compounds. Which of these two will be nearer to the top of the activity series of metals?

Ans. Metal B will be nearer to the top of the activity series of metals as it is so reactive that it is found in combined state.

Q. 17. Arrange the following metals in decreasing order of their reactivity:
Fe, Zn, Na, Cu, Ag

Ans. Na > Zn > Fe > Cu > Ag.

Q. 18. Why cannot aluminium be obtained by reduction of its oxide with carbon?

Ans. Aluminium has more affinity for oxygen than carbon.

Q. 19. Why does a little addition of carbon in iron make it more useful?

Ans. Pure iron is very soft and stretches easily when hot. When it is mixed with a small quantity of carbon (0.05%), it becomes hard and strong and hence becomes more useful.

Q. 20. Give an example of a sulphide ore which is reduced to metal by heating alone, *i.e.*, by roasting.

Ans. Cinnabar (HgS) on roasting is first changed to mercuric oxide which on further heating is reduced to mercury.

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

$$2HgO(s) \xrightarrow{\text{Heat}} 2Hg(l) + O_2(g)$$

Q. 21. Metals are refined by using different methods. Name two metals refined by electrolytic refining.

Ans. Copper and gold.

Q. 22. What is rust?

Ans. The coating of brown, flaky substance on the surface of iron when it is kept exposed in moist air is called rust.

Q. 23. What is corrosion?

Ans. When the surface of a metal is attacked by air, water and some other substances, it is said to be corroded. This phenomenon is known as corrosion.

Q. 24. What is aqua regia?

Ans. It is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3 : 1. It can dissolve gold. It is a highly corrosive liquid.

Q. 25. Which metals are mixed with iron to get stainless steel?

Ans. Nickel and chromium.

Q. 26. Why is stainless steel preferred for making household utensils?

Ans. Stainless steel is preferred as it is non-reactive and so the milk or food is not spoiled in it.

Q. 27. What is galvanisation?

Ans. Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc.

Q. 28. Name an alloy of
(*i*) aluminium used in the construction of aircraft.
(*ii*) lead used in joining metals for electrical work.

Ans. (*i*) Duralium (*ii*) Solder

SHORT ANSWER QUESTIONS–I [2 marks]

Q. 1. Explain why the surface of some metals acquires a dull appearance when exposed to air for a long time.

Ans. The surface of some metals acquires a dull appearance when exposed to air for a long time due to the formation of a thin layer of oxide, carbonate or sulphide on their surface by the slow action of the various gases present in air.

Q. 2. Give two examples each of the metals that are good conductors and poor conductors of heat respectively. *[NCERT Exemplar]*

Ans. (*a*) Good conductors: Ag and Cu

(*b*) Poor conductors: Pb and Hg

Q. 3. 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]*

Ans. **Metal:** Mercury (Hg); **Non-metal:** Bromine (Br)

Two metals with melting points less than 310K are Cesium (Cs) and Gallium (Ga).

Q. 4. The following reaction takes place when aluminium powder is heated with MnO_2.

$$3MnO_2(s) + 4Al(s) \longrightarrow 3Mn(l) + 2Al_2O_3(l) + Heat$$

(*a*) Is aluminium getting reduced?

(*b*) Is MnO_2 getting oxidised? *[NCERT Exemplar]*

Ans. (*a*) No, because oxygen is added to aluminium therefore, it is getting oxidised.

(*b*) No, since manganese has lost oxygen therefore, it is getting reduced.

Q. 5. A solution of $CuSO_4$ was kept in an iron pot. After few days the iron pot was found to have a number of holes in it. Explain the reason in terms of reactivity. Write the equation of the reaction involved. *[NCERT Exemplar]*

Ans. Iron is more reactive than copper. Hence, when a solution of $CuSO_4$ is kept in an iron pot, iron slowly displaces copper from the solution and blue colour of the solution keeps fading away. Because of iron going into solution as iron sulphate, a number of holes are seen in the iron pot. The reaction is

$$CuSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Cu(s)$$

Q. 6. Generally, when metals are treated with mineral acids, hydrogen gas is liberated but when metals (except Mn and Mg) are treated with HNO_3, hydrogen is not liberated, why? *[NCERT Exemplar]*

Ans. It is because HNO_3 is a strong oxidising agent. It oxidises the H_2 produced to H_2O and itself get reduced to any of the oxides of the nitrogen, like NO_2, NO, etc.

Q. 7. Metals replace hydrogen from dilute acids, whereas non-metals do not. Why?

Ans. Hydrogen from dilute acids can only be replaced if electrons are supplied to H^+ ions of the acid.

$$H_2SO_4(aq) \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

$$2H^+ + 2e^- \longrightarrow H_2(g)$$

$$HCl(aq) \longrightarrow H^+(aq) + Cl^-(aq)$$

$$H^+ + e^- \longrightarrow H$$

$$2H \longrightarrow H_2(g) \uparrow$$

Metals have a tendency to lose electrons and hence they supply electrons, *i.e.*, they are electron donors. That is why metals displace hydrogen from dilute acids.

On the other hand, non-metal is an electron acceptor. It cannot supply electrons to H^+ and hence, it does not displace hydrogen from dilute acids.

Q. 8. A metal *M* does not liberate hydrogen from acids but reacts with oxygen to give a black colour product. Identify *M* and black coloured product and also explain the reaction of *M* with oxygen. *[NCERT Exemplar]*

Ans. *M* is copper. It reacts with oxygen to form black coloured compound, CuO.

$$2Cu + O_2 \longrightarrow \underset{\text{(Black)}}{2CuO}$$

Q. 9. What happens when

(*i*) iron nail is placed in silver nitrate solution?

(*ii*) iron strip is dipped in zinc sulphate solution?

Ans. (*i*) Iron is more reactive than silver.

$$Fe(s) + 2AgNO_3(aq) \longrightarrow Fe(NO_3)_2(aq) + 2Ag(s)$$

(*ii*) Iron is below zinc in the reactivity series; therefore, iron cannot displace zinc from zinc sulphate solution. No reaction takes place.

Q. 10. Why do metals not evolve hydrogen gas with nitric acid?

Ans. When metal reacts with nitric acid (HNO_3), hydrogen gas is not evolved. This is because HNO_3 is a strong oxidising agent. It oxidises H_2 produced to water and is itself reduced to any of the oxides of nitrogen (N_2O, NO or NO_2). For example,

$$3Cu(s) + 8HNO_3(aq) \longrightarrow 3Cu(NO_3(aq) + 2NO(g) + 4H_2O(l)$$

Q. 11. (*i*) Name a metal for each case:

(*a*) It does not react with cold as well as hot water but reacts with steam.

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

(*ii*) When calcium metal is added to water the gas evolved does not catch fire but the same gas evolved on adding sodium metal to water catches fire. Why is it so?

Ans. (*i*) (*a*) Aluminium, (*b*) Copper

(*ii*) In both cases, the gas evolved is H_2. When calcium reacts with water the heat evolved is not sufficient for hydrogen to catch fire. On the other hand, sodium metal reacts with water violently and in this case a lot of heat is evolved which is sufficient for hydrogen to catch fire.

Q. 12. Which of the following reactions will not occur? Give reasons.

(*i*) $MgSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Mg(s)$

(*ii*) $MgSO_4(aq) + Cu(s) \longrightarrow CuSO_4(aq) + Mg(s)$

(*iii*) $CuSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Cu(s)$

Ans. Reaction (*i*) will not occur because Fe is less reactive than Mg. Reaction (*ii*) will not occur because Cu is less reactive than Mg.

Q. 13. List any two observations when a highly reactive metal is dropped in water. *[CCE 2016]*

Ans. (*i*) Large amount of heat is evolved.

(*ii*) Metal starts floating.

Q. 14. State the reason for the following behaviour of zinc metal:

On placing a piece of zinc metal in a solution of mercuric chloride, it acquires a shining silvery surface but when it is placed in a solution of magnesium sulphate no change is observed.

Ans. When a piece of zinc metal is placed in a solution of mercuric chloride ($HgCl_2$), a white layer of mercury is deposited on zinc metal to give it silvery shining look. This is because mercury is lower to zinc in reactivity series and hence, zinc can displace mercury from $HgCl_2$.

But when zinc is placed in a solution of magnesium sulphate, there is no change. This is because magnesium is above zinc in the reactivity series and hence, zinc cannot displace magnesium from its salt solution.

Q. 15. An ore gives carbon dioxide on treatment with a dilute acid. What steps will you take to convert such a concentrated ore into free metal?

Ans. A metal carbonate reacts with a dilute acid to form carbon dioxide. Therefore, this ore is a carbonate ore. Carbonate ore is converted into free metal in the following two steps:

(*i*) Calcination: The carbonate ore is strongly heated in the absence of air to get the metal oxide.

$$\text{Metal carbonate} \xrightarrow{\text{Calcination}} \text{Metal oxide} + \text{Carbon dioxide}$$

(*ii*) **Reduction:** The metal oxide is reduced with carbon to get free metal.

$$\underset{}{\text{Metal oxide}} + \underset{\text{(Coke)}}{\text{Carbon}} \xrightarrow{\text{Reduction}} \text{Metal} + \text{Carbon monoxide}$$

Q. 16. What happens when:

(*a*) $ZnCO_3$ is heated in the absence of oxygen?

(*b*) a mixture of Cu_2O and Cu_2S is heated? *[NCERT Exemplar]*

Ans. (*a*) It undergoes calcination. The chemical reaction can be given as:

$$ZnCO_3 \xrightarrow{\text{Heat}} ZnO + CO_2$$

(*b*) It undergoes auto reduction forming copper and sulphur dioxide.

$$2Cu_2O + Cu_2S \xrightarrow{\text{Heat}} 6Cu + SO_2$$

Q. 17. Give the reaction involved during extraction of zinc from its ore by:

(*a*) roasting of zinc ore

(*b*) calcination of zinc ore *[NCERT Exemplar]*

Ans. (*a*) $2ZnS(s) + 3O_2(g) \xrightarrow{\text{Heat}} 2ZnO(s) + 2SO_2(g)$

(*b*) $ZnCO_3(s) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$

Q. 18. What is a thermit reaction? State one use of this reaction.

Ans. The reaction between iron(III) oxide (Fe_2O_3) and aluminium gives out lots of heat. It is called the thermit reaction.

$$\underset{\text{Iron(III) oxide}}{Fe_2O_3(s)} + \underset{\text{Aluminium}}{2Al(s)} \longrightarrow \underset{\text{Iron}}{2Fe(l)} + \underset{\text{Aluminium oxide}}{Al_2O_3(s)} + \text{Heat}$$

This displacement reaction is used to join railway tracks or cracked machine parts.

The heat given out in the reaction melts the iron formed. The molten iron runs down between the tracks and welds them together.

Q. 19. Why should the metal sulphides and carbonates be converted to metal oxides in the process of extraction of metal from them? *[NCERT Exemplar]*

Ans. It is easier to obtain metal from its oxide, as compared from its sulphides and carbonates. So prior to reduction, sulphide ores are converted into oxides by roasting and carbonate ores by calcination.

Q. 20. What is 24-carat gold? How will you convert it into 18-carat gold?

Ans. 24-carat gold is pure gold. Pure gold is very soft and not suitable for making jewellery.

Therefore, to increase its hardness, it is alloyed either with copper or silver.

18-carat gold is prepared by alloying 18 parts pure gold with 6 parts of either copper or silver.

Q. 21. What would happen to iron railings on the road side if they are not painted? Why does it happen so?

Ans. If the iron railing on the road side is not painted, a brown rust would form on its surface because the moist air of the atmosphere reacts with iron to form brown flaky substance on its surface. The rust is hydrated iron (III) oxide, $Fe_2O_3.xH_2O$.

Q. 22. Explain why, the galvanised iron article is protected against rusting even if the zinc layer is broken.

Ans. The galvanised iron article is protected against rusting even if the zinc layer is broken because zinc is more easily oxidised than iron. So when zinc layer on the surface of galvanised iron article is broken, then zinc continues to corrode but iron article does not corrode or rust.

Q. 23. Why is aluminium oxide considered an amphoteric oxide?

Ans. Aluminium oxide (Al_2O_3) shows basic as well as acidic behaviour because it reacts with both acids and bases. Thus, it is considered an amphoteric oxide. The two types of reactions given by Al_2O_3 are as follows:

(*i*) $\underset{\text{Aluminium oxide}}{Al_2O_3(s)} + \underset{\text{Hydrochloric acid (Acid)}}{6HCl(aq)} \longrightarrow \underset{\text{Aluminium chloride (Salt)}}{2AlCl_3(aq)} + 3H_2O(l)$

In this reaction, Al_2O_3 behaves as a basic oxide because it reacts with an acid to form salt and water.

(*ii*) $Al_2O_3(s) + \underset{\text{Sodium hydroxide (Base)}}{2NaOH(aq)} \longrightarrow \underset{\text{Sodium aluminate (Salt)}}{2NaAlO_2(aq)} + H_2O(l)$

In this reaction, Al_2O_3 behaves as an acidic oxide because it reacts with a base to form salt and water.

Q. 24. Why are food cans tin-plated instead of zinc plated though zinc is cheaper than tin?

Ans. Tin is less reactive than zinc. It is less likely to dissolve in the liquid stored in the food cans. Tin reacts only with powerful acids whereas zinc can easily react even with tomatoes, so it is not safe to store food in zinc-plated cans.

SHORT ANSWER QUESTIONS–II [3 marks]

Q. 1. Name two metals which react violently with cold water. Write any observation you would make when such a metal is dropped into water. How would you identify the gas evolved, if any, during the reactions?

Ans. Metals which react violently with cold water are potassium (K) and sodium (Na).

$$2K + 2H_2O \longrightarrow 2KOH + H_2 + \text{Heat energy}$$

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2 + \text{Heat energy}$$

The hydrogen gas produced during the reactions of these two metals with water immediately catches fire. Thus, these reactions are violent and exothermic.

The gas evolved during these reactions burns with a popping sound which confirms that the gas is hydrogen (H_2).

Q. 2. Explain the following statements:

(*i*) Most metal oxides are insoluble in water but some of these dissolve in water. What are these oxides and their solutions in water called?

(*ii*) At ordinary temperature, the surface of metals such as magnesium, aluminium and zinc, etc. is covered with a thin layer. What is the composition of this layer? State its importance.

(*iii*) Some alkali metals can be cut with a knife. *[CCE 2016]*

Ans. (*i*) These oxides are called basic oxides and their solutions in water are called alkalis.

(*ii*) This layer formed is protective oxide layer which prevents the metal from further oxidation.

(*iii*) Some alkali metals can be cut with a knife because they are very soft and have low densities.

Q. 3. 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. *[NCERT Exemplar]*

Ans. Sodium (Na) and potassium (K) react with cold water to form basic salt NaOH and KOH respectively. The molecular mass of NaOH is 40. So, X is Na and Y is NaOH. The gas liberated during the reaction is hydrogen (H_2). So Z is H_2.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2 + \text{Heat energy}$$

Q. 4. 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 order of increasing reactivity. *[NCERT Exemplar]*

Ans. X is an alkali metal, Na or K.

Y is an alkaline earth metal, Mg or Ca.

Z is Fe.

Increasing reactivity series: Na > Mg > Fe.

Q. 5. An element A burns with 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 – Na; B – Cl_2; C – NaCl; D – NaOH

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

$$2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Q. 6. Iqbal treated a lustrous, divalent element M with sodium hydroxide. He observed the formation of bubbles in reaction mixture. He made the same observations when this element was treated with hydrochloric acid. Suggest how can he identify the produced gas. Write chemical equations for both the reactions. *[NCERT Exemplar]*

Ans. The element is a metal.

$$M + 2NaOH \longrightarrow Na_2MO_2 + H_2$$

$$M + 2HCl \longrightarrow MCl_2 + H_2$$

The produced gas can be identified by bringing a burning matchstick near the reaction vessel. The gas burns with a pop sound. This confirms that the gas is H_2.

Q. 7. Compound X and aluminium are used to join railway tracks.

(*a*) Identify the compound X.

(*b*) Name the reaction.

(*c*) Write down its reaction. *[NCERT Exemplar]*

Ans. (*a*) The compound, X is Fe_2O_3.

(*b*) Thermite reaction

(*c*) $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(l) + Al_2O_3(s) + Heat$

Q. 8. Give reasons:

(*a*) Platinum, gold and silver are used to make jewellery.

(*b*) Sodium, potassium and lithium are stored under oil.

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

Ans. (*a*) Platinum, gold and silver are used to make jewellery because of their bright shiny surface and high resistance to corrosion. Also they have high malleability and ductility.

(*b*) Sodium, potassium and lithium are stored under oil to prevent their reaction with oxygen, moisture and carbon dioxide of air so as to protect them as they are highly reactive metals.

(*c*) Aluminium metal forms a thin layer of aluminium oxide all over its surface under the action of moist air. This layer prevents the metal underneath from further corrosion. It is cheap, easily available, malleable and ductile. Therefore, it is used to make utensils for cooking.

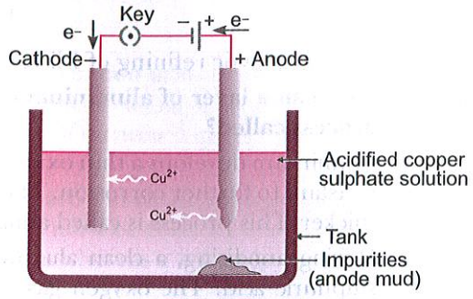
Q. 9. Give the differences between electrolytic reduction and reduction with carbon.

Ans.

Reduction with carbon	Electrolytic reduction
1. Carbon is used as a reducing agent.	1. Electrolysis process is used for reduction.
2. Oxides of moderately reactive metals (*e.g.*, Zn, Fe, Cu, Ni) are reduced by carbon.	2. Oxides (and chlorides) of highly reactive metals (*e.g.*, Al, Na, K, Mg, Ca) are reduced by this process.
3. In this process, the metal oxide is mixed with carbon (coke) and heated in a furnace. $ZnO + C \longrightarrow Zn + CO$ (Zinc oxide, Carbon, Zinc, Carbon monoxide)	3. In this process, molten metal oxide is electrolysed in an electrolytic cell where the cathode acts as a powerful reducing agent by supplying electrons to reduce metal ions into metal. $Al^{3+} + 3e^- \xrightarrow{\text{Electrolytic reduction}} Al$ (Aluminium ion (from molten Al_2O_3), Electron (from cathode), Aluminium metal)

Q. 10. What is meant by refining of metals? Describe the electrolytic refining of copper with a neat labelled diagram.

Ans. In electrolytic refining process, 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 made as an electrolyte. On passing the 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 soluble impurities go into the solution, whereas, 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: $Cu^{2+} + 2e^- \longrightarrow Cu$

Q. 11. An ore on heating in air produces sulphur dioxide. Which process would you suggest for its concentration? Describe briefly any two steps involved in the conversion of this concentrated ore into related metal.

Ans. The ore on heating produces sulphur dioxide gas so it is a sulphide ore. The method used for its concentration is "froth floatation process". After concentration of the ore following two steps would be followed to convert it into metal.

(*i*) **Roasting:** The sulphide ore is converted into its oxide by heating it in the presence of air.

$$MS + O_2 \longrightarrow MO + SO_2\uparrow$$

(*ii*) **Reduction of metal oxide to metal:** The oxide formed by roasting is then reduced to metal by using a suitable reducing agent like carbon (coke).

$$MO + \underset{(Coke)}{C} \xrightarrow{\text{Reduction}} M + CO$$

Q. 12. During extraction of metals, electrolytic refining is used to obtain pure metals.

(*i*) Which material will be used as anode and cathode for refining of silver metal by this process?

(*ii*) Suggest a suitable electrolyte also.

(*iii*) In this electrolytic cell, where do we get pure silver after passing electric current? *[NCERT Exemplar]*

Ans. (*i*) Anode: Impure silver

Cathode: Pure silver

(*ii*) Electrolyte: Silver salt, such as $AgNO_3$, AgCl, etc.

(*iii*) We get pure silver at cathode.

Q. 13. A metal that exists as a liquid at room temperature is obtained by heating its sulphide in the presence of air. Identify the metal and its ore and give the reaction involved. [*NCERT Exemplar*]

Ans. Metals low in activity series can be obtained by reducing their sulphides or oxides by heating. Mercury is the only metal that exists as liquid at room temperature. It can be obtained by heating cinnabar (HgS), the sulphide ore of mercury.

The reactions are as follows:

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

$$2HgO(s) \xrightarrow{\text{Heat}} 2Hg(l) + O_2(g)$$

Q. 14. How is copper obtained from sulphide ore? Give equation of the reactions. [*CBSE Delhi 2017*]

Ans. (*i*) Sulphide ore of copper *i.e.*, Cu_2S is concentrated by froth floatation process.

(*ii*) Ore is then roasted.

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

(*iii*) Self reduction

$$Cu_2S + 2Cu_2O \xrightarrow{\text{Heat}} \underset{\text{Blister copper}}{6Cu} + SO_2$$

(*iv*) Electrolytic refining of Blister copper is done to obtain pure copper.

Q. 15. How can a layer of aluminium oxide on an aluminium object be made thicker? What is this process called?

Ans. Aluminium develops a thin oxide layer when exposed to air. This aluminium oxide coat makes it resistant to further corrosion. The resistance can be improved further by making the oxide layer thicker. This process is called **anodising**.

During anodising, a clean aluminium article is made the anode and is electrolysed with dilute sulphuric acid. The oxygen gas evolved at the anode reacts with aluminium to make a thicker protective oxide layer. This oxide layer can be dyed easily to give aluminium articles an attractive finish.

Q. 16. (*i*) A metal M is found in nature as MCO_3. It is used in galvanising iron articles. Name the metal.

(*ii*) How can the metal be obtained from its carbonate ore?

Ans. (*i*) The metal is zinc (Zn).

(*ii*) The carbonate ore is first heated strongly in limited supply of oxygen and changed into its oxide. This process is called calcination.

$$ZnCO_3(s) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$$

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

$$ZnO(s) + C(s) \xrightarrow{\text{Heat}} Zn(s) + CO(g)$$

Q. 17. Which two metals do not corrode easily? Give an example in each case to support that

(*i*) corrosion of some metals is an advantage.

(*ii*) corrosion of some metals is a serious problem.

Ans. Gold and platinum.

(*i*) A thin impervious layer of aluminium oxide forms a protective layer which protects the aluminium metals underneath from further damage.

(*ii*) Corrosion of iron is a serious problem. Every year enormous amount of money is spent to replace damaged iron and steel structures.

Q. 18. In the formation of the compound XY, atoms of X lost one electron each while atoms of Y gained one electron each. What is the nature of bond in XY? Predict the two properties of XY.

Ans. The atoms of X lose electrons whereas the atoms of Y gain electrons. Thus, there is transfer of electrons from atoms of X to atoms of Y. The bond formed by the transfer of electrons is called ionic bond. Therefore, the nature of bond in the compound XY is ionic.

Properties of ionic compound XY:

(*i*) The compound will be soluble in water.

(*ii*) The compound will conduct electricity when dissolved in water or in molten state.

Q. 19. Explain how the properties of an alloy are different from those of constituent metals. [*CCE 2016*]

Ans. (*i*) Alloys are stronger and harder than the constituent metals.

(*ii*) Alloys are more resistant to corrosion.

(*iii*) Alloys have lower melting point than the constituent metals.

(*iv*) Alloys have lower electrical conductivity than pure metals.

Q. 20. State reason for the following:

(*i*) Lemon is used for restoring the shine of tarnished copper vessels.

(*ii*) A metal sulphide is converted into its oxide to extract the metal from the sulphide ore.

(*iii*) Copper wires are used in electrical connections. [*CCE 2016*]

Ans. (*i*) When copper vessels are exposed to moist air, they form a green coating of basic copper carbonate [$CuCO_3.Cu(OH)_2$].

$$2Cu + \underbrace{CO_2 + O_2 + H_2O}_{\text{(From moist air)}} \longrightarrow \underset{\substack{\text{Basic copper carbonate}\\\text{(Green)}}}{CuCO_3.Cu(OH)_2}$$

The sour substances such as lemon or tamarind juice contain acids. Lemon juice contains citric acid and tamarind contains tartaric acid. These acids dissolve the coating of copper oxide or basic copper carbonate present on the surface of tarnished copper vessels and make them shining red-brown again.

(*ii*) It is easier to obtain a metal from its oxides as compared to its sulphides and carbonates. So, prior to reduction, metal carbonate and sulphides must be converted into metal oxides. A carbonate ore is converted into oxide by **calcination** whereas a sulphide ore is converted into oxide by **roasting**.

(*iii*) Copper wires are good conductor of electricity, so, they are used in electrical connections.

LONG ANSWER QUESTIONS [5 marks]

Q. 1. What are ionic or electrovalent compounds? Give an example of ionic compound. Explain with reason four properties of these compounds. [*CCE 2016*]

Ans. Ionic compounds are those compounds which are formed by the transfer of electrons from a metal to a non-metal. For example, NaCl.

Properties:

(*i*) **Physical nature:** Ionic compounds are hard and solid due to strong force of attraction between oppositely charged ions.

(*ii*) **Melting point and boiling point:** As more amount of energy is required to break strong bonds. So, they have high melting point and boiling point.

(*iii*) **Solubility:** These are soluble in water (polar solvent) but insoluble in organic solvent.

(*iv*) **Conduction of electricity:** They conduct electricity in solution or molten state as ions move towards opposite electrodes.

Q. 2. 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*]

Ans. Since ore *A* gives CO_2 and ore *B* gives SO_2. Therefore, ores are MCO_3 and MS.

As *A* is a carbonate ore, it is first subjected to calcination followed by reduction.

$$MCO_3 \xrightarrow{\text{Calcination}} MO + CO_2$$

$$MO + C \xrightarrow{\text{Reduction}} M + CO$$

As *B* is a sulphide ore, it is first subjected to roasting followed by reduction.

$$2MS + 3O_2 \xrightarrow{\text{Roasting}} 2MO + 2SO_2$$

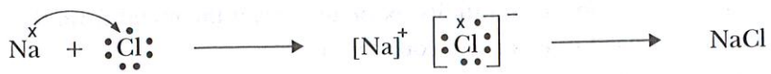
$$MO + C \xrightarrow{\text{Reduction}} M + CO$$

Q. 3. Write the names and symbols of two most reactive metals. Explain by drawing electronic structure how any one of them reacts with a halogen. Explain any two physical properties of the compound formed. *[CCE 2016]*

Ans. Most reactive metals are Na (sodium) and K (potassium)

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

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



Physical properties:

(*i*) Physical nature: Hard and solid due to strong attractive forces between oppositely charged ions.

(*ii*) High melting point and boiling point because more amount of energy is required to break strong force of attraction.

Q. 4. (*i*) Hydrogen is not a metal but it has been assigned a place in the reactivity series of metals. Explain.

(*ii*) How would you show that silver is chemically less reactive than copper?

Ans. (*i*) Though hydrogen is not a metal but even then it has been assigned a place in the activity series. The reason is that like metals, hydrogen also has a tendency to lose electron and forms a positive ion H^+.

The metals which lose electrons less readily than hydrogen are placed below it and the metals which lose electrons more readily than hydrogen are placed above it in the reactivity series of metals.

(*ii*) By displacement reaction silver can be shown to be chemically less reactive than copper or copper is more reactive than silver. If a piece of silver is immersed in a solution of copper sulphate, no reaction will take place because silver is less reactive than copper and will not displace copper from the copper sulphate solution.

$$CuSO_4(aq) + Ag(s) \longrightarrow \text{No reaction}$$

On the other hand, if a copper plate is placed in a solution of silver nitrate, copper will slowly displace silver from the solution and blue solution of copper nitrate is formed.

$$\underset{\text{Colourless}}{2AgNO_3(aq)} + Cu(s) \longrightarrow \underset{\text{Blue}}{Cu(NO_3)_2(aq)} + 2Ag(s)$$

This shows that copper is more reactive than silver.

Q. 5. (*i*) What is an ionic bond?

(*ii*) How is an ionic bond formed?

(*iii*) Write the formation of magnesium chloride.

Ans. (*i*) The chemical bond formed by the transfer of electrons from one atom to another is known as an ionic bond.

(*ii*) An ionic bond is formed when one of the atoms can donate electrons to achieve the inert gas electronic configuration and other atom needs electrons to achieve the inert gas electronic configuration.

When a metal (usually 1, 2 or 3 electrons in outermost shell) reacts with a non-metal (usually 5, 6 or 7 electrons in outermost shell), transfer of electrons takes place from metal atoms to the non-metal atoms and an ionic bond is formed. There is a strong force of electrostatic attraction between metallic cation and non-metallic anion which is responsible for the formation of ionic bond.

(*iii*) **Formation of magnesium chloride ($MgCl_2$):** The atomic number of magnesium is 12. It has two electrons in its valence shell as shown below:

$$_{12}Mg — 2, 8, 2$$

Magnesium, therefore, has a tendency to lose the 2 valence electrons and in the process attains the electronic configuration of neon.

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

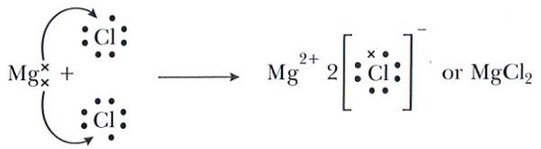
Chlorine (atomic number 17) has 7 electrons in the valence shell. It has a tendency to gain one electron to complete its octet.

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

Thus, when magnesium and chlorine are brought together, the magnesium atom transfers its two valence electrons to two chlorine atoms. In the process, both the atoms acquire the stable electronic configuration of nearest inert gases. The positively charged magnesium ion Mg^{2+} and negatively charged chloride ions (Cl^-) are now held together by the electrostatic force of attraction and form ionic bond.

$$Mg^{2+} + 2Cl^- \longrightarrow Mg^{2+}2Cl^- \text{ or } MgCl_2$$

This process can also be shown as below:



Q. 6. (*i*) Distinguish between ionic and covalent compounds under the following properties:

(*a*) Strength of forces between constituent elements

(*b*) Solubility of compounds in water

(*c*) Electrical conduction in substances

(*ii*) Explain how the following metals are obtained from their compounds by the reduction process:

(*a*) Metal M which is in the middle of the reactivity series

(*b*) Metal N which is high up in the reactivity series

Give one example of each type.

Ans. (*i*) (*a*) Ionic compounds have strong force of attraction between the oppositely charged ions (*e.g.*, Na^+ and Cl^-), so they are solids. Covalent compounds have weak force of attraction between their molecules, so they are usually liquids or gases.

(*b*) Ionic compounds are soluble in water but covalent compounds are insoluble in water.

(*c*) Ionic compounds conduct electricity when dissolved in water or when melted because they contain ions (charged particles). But, covalent compounds like glucose do not conduct electricity because they do not contain ions.

(*ii*) (*a*) The metal M which is in the middle of the reactivity series (such as iron, zinc, lead, copper, etc.) is moderately reactive. So, for obtaining such metals from their compounds, their sulphides and carbonates (in which they are present in nature) are first converted into their oxides by the process of roasting and calcination respectively.

For example,

$$\underset{\substack{\text{Zinc sulphide}\\\text{(Sulphide ore)}}}{2ZnS(s)} + 3O_2(g) \xrightarrow{\text{Heat}} 2ZnO(s) + 2SO_2(g)$$

$$\underset{\text{Zinc carbonate (Carbonate ore)}}{ZnCO_3(s)} \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$$

The metal oxides (MO) are then reduced to the corresponding metals by using suitable reducing agents such as carbon. For example, zinc metal from its oxide is obtained as follow:

$$\underset{\text{Zinc oxide}}{ZnO(s)} + C(s) \longrightarrow \underset{\text{Zinc}}{Zn(s)} + CO(g)$$

(*b*) The metal N which is high up in the reactivity series (such as sodium, magnesium, calcium, aluminium, etc.), is very reactive and cannot be obtained from its compound by heating with carbon.

Therefore, such metals are obtained by electrolytic reduction of their molten salt. For example, sodium is obtained by the electrolysis of molten sodium chloride (NaCl).

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

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

Q. 7. (*i*) Distinguish between 'roasting' and 'calcination'. Which of these two is used for sulphide ores and why?

(*ii*) Write a chemical equation to illustrate the use of aluminium for joining cracked railway lines.

(*iii*) Name the anode, the cathode and the electrolyte used in the electrolytic refining of impure copper.

Ans. (*i*) **Roasting:** It is the process in which sulphide ores of the metals are converted into oxides by heating them in the presence of excess air. For example, zinc sulphide is converted into zinc oxide by roasting.

$$2ZnS(s) + 3O_2(g) \xrightarrow[\text{Roasting}]{\text{Heat}} 2ZnO(s) + 2SO_2(g)$$

Calcination: It is the process in which carbonate ores of the metals are decomposed into oxides by heating them in the absence or limited air. For example, zinc carbonate is decomposed into zinc oxide and carbon dioxide by calcination.

$$ZnCO_3(s) \xrightarrow[\text{Calcination}]{\text{Heat}} ZnO(s) + CO_2(g)$$

Out of roasting and calcination, only roasting is used for sulphide ores. This is because it is easier to obtain metal from its oxide as compared to its sulphide.

(*ii*) $\underset{\text{Iron(III)oxide}}{Fe_2O_3(s)} + \underset{\text{Aluminium powder}}{2Al(s)} \xrightarrow{\text{Heat}} \underset{\text{Iron metal}}{2Fe(l)} + \underset{\text{Aluminium oxide}}{Al_2O_3(s)} + \text{Heat}$

(*iii*) Anode — Impure copper

Cathode — Strip of pure copper

Electrolyte — Acidified copper sulphate solution.

Q. 8. Write about different chemical processes used for obtaining a metal from its oxides, for metals low in the reactivity series, metals in the middle of reactivity series and metals towards the top of the reactivity series.

Ans. (*i*) For obtaining the metals that are low in the reactivity series, oxides of such metals can be reduced to metals by simply heating them in the air.

For example, HgS or cinnabar is the ore of mercury metal which on heating changes to HgO. This metal oxide (HgO) gets reduced to mercury metal (Hg) on further heating.

$$2HgS + 3O_2 \xrightarrow[\text{(Roasting)}]{\text{Heat}} 2HgO + 2SO_2\uparrow$$
$$\text{(air)}$$

$$2HgO \xrightarrow{\text{Heat}} \underset{\text{Mercury metal}}{2Hg} + O_2\uparrow$$

(*ii*) For obtaining metals that are in the middle of reactivity series, oxides of such metals can be reduced with coke (carbon) which acts as a reducing agent.

For example, iron(III) oxide can be reduced to iron, as follows:

$$2Fe_2O_3 + \underset{\text{(Coke)}}{3C} \xrightarrow{\text{Heat}} \underset{\text{Metal}}{4Fe} + 3CO_2\uparrow$$

(*iii*) For obtaining metals that are high up in the reactivity series, their oxides are reduced to metals by electrolysis.

For example,

$$\underset{\text{(Bauxite ore)}}{2Al_2O_3} \xrightarrow{\text{Current}} 4Al^{3+} + 6(O)^{2-}$$

At cathode: $4Al^{3+} + 12e^- \longrightarrow \underset{\text{(Metal)}}{4Al}$

At anode: $6(O)^{2-} \longrightarrow 3O_2 + 12e^-$

Q. 9. (*i*) How do you classify elements into metals and non-metals on the basis of their electronic configuration? Choose metal and non-metal out of the following:

$$^{23}_{11}A, \quad ^{19}_{9}B, \quad ^{24}_{12}C, \quad ^{31}_{15}D, \quad ^{35}_{17}E$$

(*ii*) What type of bond will be formed if

(*a*) 'A' combines with 'B'? **(*b*) 'A' combines with 'E'?**

(*c*) 'C' combines with 'E'? **(*d*) 'D' combines with 'E'?**

Ans. (*i*) Elements which contain 1 to 3 electrons in their outermost shell are metals.

Elements containing 4 to 7 electrons in their valence shell are non-metals.

Electronic configurations:

$^{23}_{11}A(Z = 11) = 2, 8, 1$ $^{19}_{9}B(Z = 9) = 2, 7$

$^{24}_{12}C(Z = 12) = 2, 8, 2$ $^{31}_{15}D(Z = 15) = 2, 8, 5$

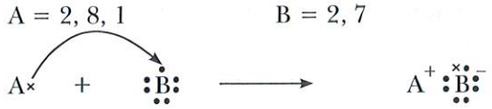
$^{35}_{17}E(Z = 17) = 2, 8, 7$

Hence A and C are metals whereas, B, D and E are non-metals.

(*ii*) **Type of bonds**

(*a*) 'A' is metal and 'B' is non-metal, so the bond formed will be ionic.

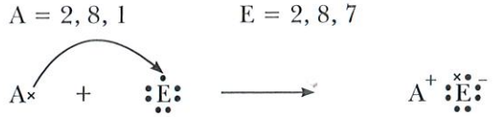
A = 2, 8, 1 B = 2, 7



Ionic bond

(*b*) 'A' is metal and 'E' is non-metal, so the bond formed is ionic.

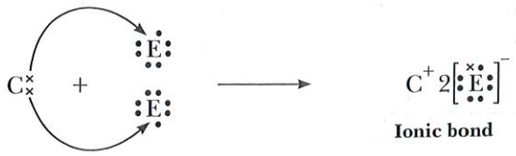
A = 2, 8, 1 E = 2, 8, 7



Ionic bond

(*c*) 'C' is metal and 'E' is non-metal, so the bond formed is ionic.

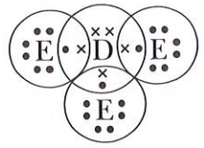
C = 2, 8, 2 E = 2, 8, 7



Ionic bond

(*d*) 'D' is a non-metal and E is also a non-metal, so the bond formed will be covalent.

D = 2, 8, 5 E = 2, 8, 7



DE_3 Covalent bond

Q. 10. Give reasons:

(*i*) Reactivity of Al decreases if it is dipped in HNO_3.

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

(*iii*) NaCl is not a conductor of electricity in solid state whereas it does conduct electricity in aqueous solution as well as in molten state.

(*iv*) Iron articles are galvanised.

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

[NCERT Exemplar]

Ans. (*i*) Due to the formation of a layer of oxide, *i.e.*, Al_2O_3 it becomes less reactive.

(*ii*) Na or Mg are more reactive metals as compared to carbon. So, their oxides are more stable.

(*iii*) In solid NaCl, the movement of ions is not possible due to its rigid structure but in aqueous solution or molten state, the ions can move freely. These free ions are responsible for conduction of electricity.

(*iv*) Iron articles are galvanised to protect them from corrosion.

(*v*) Na, K, Ca and Mg are highly reactive metals and thus never found in their free state in nature.

HOTS (Higher Order Thinking Skills)

Q. 1. There are 3 unknown metals—A, B and C. C displaces B from its oxide while with oxide of A, there is no reaction. Give the reactivity order of A, B and C.

Ans. C displaces B from its oxide, therefore, C is more reactive than B.

There is no reaction when C is treated with oxide of A or C does not displace A from its oxide. So, A is more reactive than C. Thus, the reactivity order is B < C < A.

Q. 2. A copper coin is kept immersed in a solution of silver nitrate for some time. What will happen to the coin and the colour of solution?

Ans. Copper is placed above the silver in the reactivity series which indicates that copper is more reactive than silver. When a copper coin or strip is kept immersed in a solution of silver nitrate ($AgNO_3$), silver from its solution will deposit on copper coin.

$$\underset{\text{Colourless}}{2AgNO_3(aq)} + Cu(s) \longrightarrow 2Ag(s) + \underset{\text{Blue}}{Cu(NO_3)_2(aq)}$$

Copper slowly displaces silver from the $AgNO_3$ solution and the colour of solution changes from colourless to blue due to formation of copper nitrate [$Cu(NO_3)_2$]. The copper coin will disappear and silver will precipitate out.

Q. 3. An element A reacts with water to form a compound B which is used in white-washing. The compound B on heating forms an oxide C which on treatment with water gives back B. Identify A, B and C and give the reactions involved. *[NCERT Exemplar]*

Ans. A is calcium, it reacts with water to form calcium hydroxide which is used in white washing. So, B is $Ca(OH)_2$.

$$Ca(s) + 2H_2O(l) \longrightarrow \underset{(B)}{Ca(OH)_2(aq)} + H_2(g)$$

On heating compound *B*, *i.e.*, calcium hydroxide, it forms calcium oxide, *i.e.*, C.

$$Ca(OH)_2 \xrightarrow{\text{Heat}} \underset{(C)}{CaO} + H_2O$$

Q. 4. 'M' is an element which is out of Cu, Fe, Al, Na. It shows the following properties:

(*i*) One of its ore is rich in M_2O_3.

(*ii*) M_2O_3 is not affected by water.

(*iii*) It corrodes easily.

(*iv*) It forms two chlorides MCl_2 and MCl_3. Identify 'M'.

Ans. As the metal 'M' forms oxide M_2O_3 it is trivalent. Out of the metals listed, only Fe and Al are trivalent.

M_2O_3 is not affected by water, so 'M' can be out of Fe or Al.

Fe and Al both corrode easily.

Out of Al and Fe, only Fe can form divalent chloride, so the element 'M' is Fe.

Q. 5. Carbon can reduce copper oxide to copper but not CaO to Ca. Why?

Ans. C is a strong reducing agent and can reduce CuO as follows:

$$CuO + C \longrightarrow Cu + CO\uparrow$$

Ca is much more reactive than Cu and has greater affinity for oxygen than C has. So, carbon cannot reduce CaO to Ca.

Q. 6. A metal A, which is used in thermit process, when heated with oxygen gives an oxide B, which is amphoteric in nature. Identify A and B. Write down the reactions of oxide B with HCl and NaOH. *[NCERT Exemplar]*

Ans. A is aluminium (Al). It reacts with oxygen to form aluminium oxide, Al_2O_3.

$$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$$

So, B is Al_2O_3.

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

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

Q. 7. A non-metal A which is the largest constituent of air, when heated with H_2 in 1: 3 ratio in the presence of catalyst (Fe) gives a gas B. On heating with O_2 it gives an oxide C. If this oxide is passed into water in the presence of air it gives an acid D which acts as a strong oxidising agent.

(*a*) Identify A, B, C and D.

(*b*) To which group of periodic table does this non-metal belong? *[NCERT Exemplar]*

Ans. (*a*) 'A' is N_2, nitrogen gas.

When N_2 is heated with H_2 in 1 : 3 ratio in the presence of catalyst (Fe), ammonia gas is produced.

So, 'B' is NH_3.

$$N_2 + 3H_2 \xrightarrow[Fe]{\text{Heat}} 2NH_3$$

When N_2 reacts with O_2, it forms an oxide, NO.

$$N_2 + O_2 \xrightarrow{\text{Heat}} 2NO$$

So, 'C' is NO.

When this oxide of nitrogen is passed into water in the presence of air, it forms HNO_3 *i.e.*, nitric acid which is a strong oxidising agent.

So, 'D' is HNO_3.

(*b*) It belongs to group 15 of the periodic table.

Q. 8. A non-metal A is an important constituent of our food and forms two oxides B and C. Oxide B is toxic whereas C causes global warming.

(*a*) Identify A, B and C

(*b*) To which group of Periodic Table does A belong? *[NCERT Exemplar]*

Ans. (*a*) 'A' is carbon. Its two oxides are carbon monoxide, CO and carbon dioxide, CO_2. CO is toxic so 'B' is carbon monoxide and carbon dioxide causes global warming, so 'C' is carbon dioxide *i.e.*, CO_2.

(*b*) 'A' belongs to group-14 of the Periodic Table.

Proficiency Exercise

Very Short Answer Questions [1 mark]

1. Why does calcium float on water?
2. List two properties of gold and silver which make them most suitable for making ornaments according to our need.
3. An element forms an oxide A_2O_3 which is acidic in nature. Identify A as a metal or non-metal. *[NCERT Exemplar]*
4. By which method metals of high reactivity are purified?
5. 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]*
6. Name the process by which sulphide ores are concentrated.
7. What is anode mud?

Short Answer Questions–I [2 marks]

8. Give reason for the following:
   (*a*) Sodium metal is kept immersed in kerosene.
   (*b*) Blue colour of copper sulphate solution disappear when some aluminium powder is added in it.
9. 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 them is a metal and a non-metal?
10. What are the constituents of solder alloy? Which property of solder makes it suitable for welding electrical wires? *[NCERT Exemplar]*
11. The reaction of a metal 'X' with Fe_2O_3 is highly exothermic and is used to join broken railway tracks. Identify metal 'X'. Write the balanced chemical equation of its reaction with Fe_2O_3. State the special name given to this reaction.
12. What will you observe when:
    (*a*) Some zinc pieces are put into copper sulphate solution?
    (*b*) Some silver pieces are put into green coloured ferrous sulphate solution?

Short Answer Questions–II [3 marks]

13. Give the formulae of the stable binary compounds that would be formed by the combination of following pairs of elements
    (*a*) Mg and N_2
    (*b*) Li and O_2
    (*c*) Al and Cl_2
    (*d*) K and O_2 *[NCERT Exemplar]*
14. Write the chemical equations for the reactions taking place when:
    (*a*) Magnesium ribbon is burnt in presence of air.
    (*b*) Sodium metal catches fire in contact with water.
    (*c*) Steam is passed over hot aluminium.
15. (*a*) Compare the properties of a typical metal and a non-metal on the basis of the following:
    (*i*) Nature of the oxide formed by them (*ii*) Conductivity
    (*b*) Name a non-metal which is lustrous and a metal which is liquid at the room temperature.
16. A compound '*X*' conducts electricity and is soluble in water. What kind of compound is *X*, ionic or covalent? Assign other two properties of compound *X* other than given in the question.
17. An alkali metal A gives a compound B (molecular mass = 40) on reacting with water. The B gives a soluble compound C on treatment with aluminium oxide. Identify A, B and C and give the reaction involved. *[NCERT Exemplar]*

Long Answer Questions [5 marks]

18. (*a*) With the help of a labelled diagram, explain the process of electrolytic refining of copper.
    (*b*) Name the substance formed on the surface of copper when it reacts slowly with moist CO_2 in the air.
19. The electronic configuration of a magnesium atom is 2, 8, 2 and that of a chlorine atom is 2, 8, 7. State the type of bond formed between the two and the formula of the compound formed. Show its formation with the help of electron-dot structure. Also list its two properties.
20. (*a*) Metals react with water to form their oxides or hydroxides. State the special name given to the metallic oxides which dissolve in water.
    (*b*) Explain the reactions of different metals with hot water, cold water and steam. Give one example with a proper balanced chemical equation. Name two metals which do not react with any form of water.
21. (*i*) Given below are the steps for extraction of copper from its ore. Write the reaction involved.
    (*a*) Roasting of copper (I) sulphide
    (*b*) Reducing of copper (I) oxide with copper (I) sulphide
    (*c*) Electrolytic refining
    (*ii*) Draw a neat and well-labelled diagram for electrolytic refining of copper. *[NCERT Exemplar]*
22. Give the steps involved in the extraction of metals of low and medium reactivity from their respective sulphide ores. *[NCERT Exemplar]*