

# Metals and Non-metals

## Quick Revision

### 1. Metals

Elements that are electropositive in nature are called metals, e.g. copper.

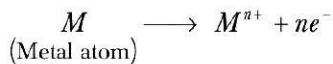
### 2. Physical Properties of Metals

- (i) **Malleability** It is the property of metals due to which they can be beaten into thin sheets. Most of the metals are malleable.
- (ii) **Ductility** It is the property due to which a metals can be drawn into wires. Metals are generally ductile. Gold is the most ductile metal.
- (iii) **Hardness** Most of the metals are hard. But some alkali metals like sodium and potassium are so soft that they can be cut easily with knife.
- (iv) **Metallic Lustre** Metals in their pure state have bright shining surfaces. This property is called metallic lustre.
- (v) **Electrical Conductivity** Most of the metals are good conductors of electricity.
- (vi) **Thermal Conductivity** Generally metals are good conductors of heat, except lead and mercury, which are poor conductors of heat. The best conductors of heat are copper and silver among all metals.
- (vii) **Melting and Boiling Points** Metals generally have high melting and boiling point, except mercury, gallium and alkali metals. Tungsten has the highest melting point among metals while mercury has the lowest.
- (viii) **Sonority** When metals are struck with a hard substance, they produce sound. This property is called **sonority** and the metals are said to be

sonorous. Bells are made up of metals due to this property.

### 3. Chemical Properties of Metals

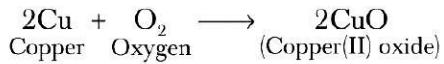
Most of the chemical properties of metals are due to their electropositive nature. It means metal atom loses electrons to form cations.



#### • Reactions of Metals with Oxygen in Air (Formation of oxides)

- (i) Almost all the Metals react with Oxygen (or air) to form Metal Oxides

Metal + Oxygen  $\longrightarrow$  Metal Oxide  
e.g. When copper is heated in air, it combines with oxygen to form copper (II) oxide, a black oxide.

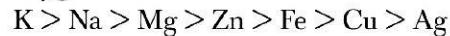


#### (ii) Order of Reactivity with Oxygen

Different metals react with oxygen at different rates. e.g. sodium (Na) and potassium (K) catch fire, when placed in the open.

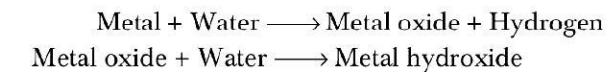
Hence, these are most reactive metals.

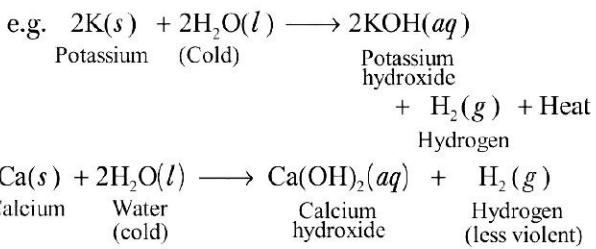
The order of reactivity of metals with oxygen is



#### • Reactions of Metals with Water

Metals react with water and produce a metal oxide and hydrogen gas.

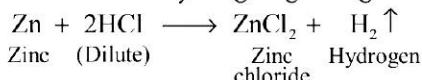




#### • Reactions of Metals with Dilute Acids

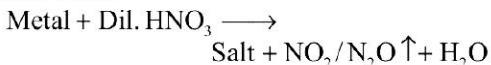
##### (i) Reaction of Metals with Dilute HCl and Dilute $\text{H}_2\text{SO}_4$

Except a few less reactive metals (Cu, Hg, Ag, Au, Pt, etc) all metals react with dilute sulphuric acid and hydrochloric acid to produce salt and hydrogen gas. e.g.

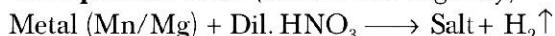


##### (ii) Reaction of Metals with Dil. $\text{HNO}_3$

Except magnesium and manganese, metals do not give  $\text{H}_2$  gas on reaction with dilute nitric acid. This is due to the oxidising nature of nitric acid.



##### Exceptional Case (for Mn and Mg only)



#### Aqua-regia

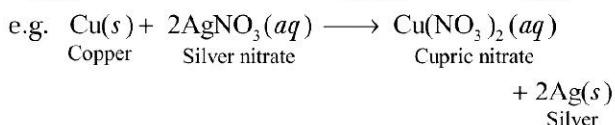
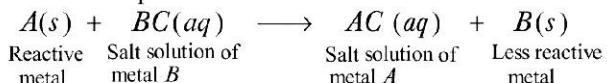
It is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in ratio of 3 : 1.

It can dissolve gold, even though neither of these acids can do so alone. *Aqua-regia* is highly corrosive, fuming fluid.

#### • Reaction of Metals with Solution of Other Metal Salts

A **reactive metal** can displace a comparatively **less reactive** metal from their compounds in aqueous solution or in molten state.

General equation is



#### 4. Reactivity Series or Electrochemical Series of Metals

The series obtained by placing the metals in order of their decreasing reactivity is called electrochemical series or reactivity series. In other words, the series obtained by placing the metals in increasing order of their standard reduction potential is called electrochemical series or reactivity series.

The series is as follows:

K (most reactive) > Ba > Sr > Ca > Na > Mg > Al > Zn > Fe > Cd > Ni > Sn > H > Cu > Hg > Ag > Pt > Au (least reactive)

#### 5. Non-metals

Elements that are **electronegative** in nature are called non-metals. It means non-metals gain electrons to form negative ions, e.g. iodine.

#### 6. Physical Properties of Non-metals

(i) **Brittleness** Non-metals are neither malleable nor ductile but they are brittle in nature.

(ii) **Physical State** Most of the non-metals are soft (if solid). Only diamond, a form of carbon is the hardest known substance. Other non-metals are gases except bromine which is a liquid.

(iii) **Metallic Lustre** The non-metals do not have lustre, i.e. shining surface. However, diamond, graphite (forms of carbon) and iodine have lustre, even they are non-metals.

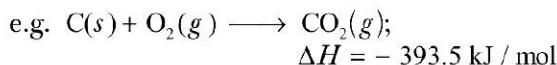
##### (iv) Electrical and Thermal Conductivity

Non-metals are generally poor conductors of heat and electricity.

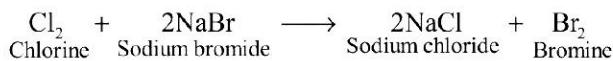
(v) **Melting and Boiling Points** Generally, non-metals have low melting and boiling points. But non-metals that are solids have comparatively higher boiling points (e.g. B, Si, C, etc.).

#### 7. Chemical Properties of Non-metals

(i) **Reaction with Oxygen** Non-metals react with oxygen to form oxides. These oxides are generally acidic. Only some of the non-metallic oxides are neutral. Acidic oxides are  $\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{P}_2\text{O}_5$ , etc.



- (ii) **Reaction with Water** Non-metals do not react with water or steam to evolve hydrogen gas. This is because non-metals cannot give electrons to hydrogen in water therefore, hydrogen gas cannot be released.]
- (iii) **Reaction with Acids** Non-metals do not react with acids to release hydrogen gas. Reason is being non-metal is an electron acceptor, it cannot supply electrons to the  $\text{H}^+$  ions of acids to reduce than to hydrogen gas.
- (iv) **Displacement Reaction** Non-metals also show displacement reaction like metals. e.g.

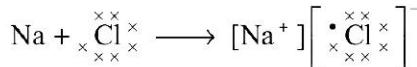
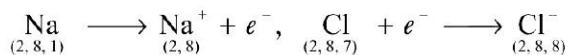


- (v) **Formation of Covalent Compounds** Non-metals form covalent compounds with other non-metals like hydrides, chlorides, etc.
- e.g.  $\text{H}_2(g) + \text{S}(s) \longrightarrow \text{H}_2\text{S}(g)$



## 8. Ionic Compounds

- The compounds formed by the transfer of electrons from a metal to a non-metal are called ionic compounds. e.g.



- The strong electrostatic forces of attraction which helps to bind  $\text{Na}^+$  and  $\text{Cl}^-$  ions together is called **ionic bond** or **electrovalent bond**.

## 9. Properties of Ionic Compounds

- (i) **Physical Nature** Ionic compounds are solids due to the presence of strong forces of attraction between the positive and negative ions. These compounds are generally brittle.
- (ii) **Melting and Boiling Points** Ionic compounds have high melting and boiling points because a large amount of energy is required to break the strong inter-ionic attraction.
- (iii) **Solubility** Ionic compounds are generally soluble in water and insoluble in solvents like petrol, kerosene.
- (iv) **Conduction of Electricity** Ionic compounds conduct electricity in the molten state only because the electrostatic forces of attraction between the oppositely charged ions are overcome due to heat and thus, the ions move freely and conduct electricity.  
 They do not conduct electricity in the solid state due to the absence of free ions.

# Objective Questions

## Multiple Choice Questions

- 01.** Which of the following statement is correct about metals?
- Metals form positive ions by losing electrons
  - Metals form negative ions by losing electrons
  - Metals form positive ions by gaining electrons
  - Metals form negative ions by gaining electrons

- 02.** Which of the following is a characteristic of metals?

- They have one to three valence electrons
- They have 4 to 8 valence electrons
- They are brittle
- They are capable to form anions easily

- 03.** Gold is used for making jewellery. What are the properties of gold make it a suitable metal for making jewellery?

- Ductility
- Malleability
- Lustrous
- All of these



**16.** Which of the following pairs will give displacement reactions?

- (a) Zinc sulphate solution and aluminium metal
- (b) Ferrous sulphate solution and silver metal
- (c) Magnesium chloride solution and aluminium metal
- (d) Silver nitrate solution and copper metal.

**17.** Which of the following metal will not give  $H_2(g)$  with  $H_2O$ ?

- (a)  $Na(s) + 2H_2O \longrightarrow$
- (b)  $Mg(s) + H_2O \longrightarrow$
- (c)  $Zn(s) + H_2O \longrightarrow$
- (d)  $Cu + H_2O \longrightarrow$

**18.** Few particles of Zn are dropped in the  $CuSO_4$  solution, the correct observation is .....

- (a) blue colour of  $CuSO_4$  solution fades
- (b) solution changes to red colour
- (c) solution becomes black
- (d) solution becomes silvery white

**19.** An aluminium strip is kept immersed in freshly prepared ferrous sulphate ( $FeSO_4$ ) solution taken in test tube, the change obtained is that

- (a) light green solution changes to blue
- (b) green solution slowly turns brown
- (c) lower end of test tube become slightly warm
- (d) colourless gas with the smell of burning sulphur is observed

**20.** Copper sulphate solution can be safely kept in a container made of silver and lead.

- (a) True
- (b) False
- (c) Can't say
- (d) Partially true/false

**21.** Non-metals are electropositive in nature.

- (a) True
- (b) False
- (c) Can't say
- (d) Partially true/false

**22.** Which of the following is not a property of non-metals?

- (a) They are neither malleable nor ductile
- (b) They are brittle

- (c) They are sonorous
- (d) They are poor conductor of heat and electricity (except graphite)

**23.** Generally, non-metals are not conductors of electricity. Which of the following is a good conductor of electricity?

- (a) Diamond
- (b) Graphite
- (c) Sulphur
- (d) Fullerene

**24.** Which of the following non-metal is liquid at room temperature?

- (a) Mercury
- (b) Carbon
- (c) Phosphorus
- (d) Bromine

**25.** Generally, non-metals are not lustrous. Which of the following non-metals is lustrous?

- (a) Sulphur
- (b) Oxygen
- (c) Nitrogen
- (d) Iodine

**26.** Match the elements given in Column I with their state/property given in Column II and select the correct answer using the options given below:

Column I (Elements)	Column II (State/Property)
A. Iodine	1. Liquid metal
B. Mercury	2. Liquid non-metal
C. Bromine	3. Lustrous
D. Diamond	4. Hardest substance

#### Codes

A	B	C	D
(a) 1	3	4	2
(b) 3	1	2	4
(c) 2	4	3	1
(d) 4	1	3	2

**27.** Non-metals oxides react with water to form .....

- (a) salts
- (b) bases
- (c) acids
- (d) hydrogen

**28.** The combination of carbon monoxide and hydrogen is known as

- (a) carbon gas
- (b) coal gas
- (c) carbonic gas
- (d) water gas

- 29.** When sulphur reacts with conc. nitric acid, then which gas is evolved?
- (a)  $\text{CO}_2$                                   (b)  $\text{NO}_2$   
 (c)  $\text{O}_2$                                       (d)  $\text{H}_2$
- 30.** Chlorine can displace Br and I from solutions of their respective salts.
- (a) True                                        (b) False  
 (c) Can't say                                (d) Partially true/false
- 31.** An element can react with oxygen to give a compound with high melting point. This compound is also water soluble. The element is likely to be
- (a) Calcium                                    (b) Carbon  
 (c) Silicon                                    (d) Iron
- 32.** A metal  $M$  of moderate reactivity is present as sulphide  $X$  on heating in air,  $X$  converts in its oxide  $Y$  and a gas evolves. On heating  $Y$  and  $X$  together, the metal  $M$  is produced.  $X$  and  $Y$  respectively are
- (a)  $X$ -cuprous sulphide,  $Y$ -cuprous oxide  
 (b)  $X$ -cuprous sulphide,  $Y$ -cupric oxide  
 (c)  $X$ -sodium sulphide,  $Y$ -sodium oxide  
 (d)  $X$ -calcium sulphide,  $Y$ -calcium oxide
- 33.** The following observations are given for four metal
- I. Metal H does not react with dilute HCl.
  - II. Metal K reacts with warm water.
  - III. Metal L does not react with water but displs metal H from its aqueous salt solution.
  - IV. Metal M reacts with cold water.
- Choose the correct decreasing order of reactivity of these metals among the following.
- (a)  $M > L > H > K$                             (b)  $K > M > H > L$   
 (c)  $M > K > L > H$                             (d)  $L > H > K > M$
- 34.** ..... gas is evolved when Mn react with very dilute  $\text{HNO}_3$ .
- (a)  $\text{NO}_2$                                         (b)  $\text{H}_2$   
 (c)  $\text{N}_2\text{O}$                                         (d)  $\text{NO}$

- 35.** Aqueous solution of  $\text{CsO}_2$  is
- (a) Basic                                        (b) Neutral  
 (c) Acidic                                      (d) Amphoteric
- 36.** Match the oxides given in Column I with their nature given in Column II and select the correct option given below:

Column I (Oxides)	Column II (Nature of oxides)
A. $\text{SO}_2$	1. Basic oxide
B. $\text{H}_2\text{O}$	2. Acidic oxide
C. $\text{Al}_2\text{O}_3$	3. Neutral oxide
D. $\text{CaO}$	4. Amphoteric oxide

**Codes**

A	B	C	D
(a) 2	3	4	1
(b) 1	4	2	3
(c) 2	3	4	1
(d) 3	2	4	1

- 37.** Which of the following electronic configuration shows that the given element is a metalloid?
- (a) 2, 8, 4                                      (b) 2, 8, 18, 8  
 (c) 2, 4    (d) 2, 6
- 38.** Which elements among the following can be considered as a metal and non-metal both?
- (a) Nitrogen                                      (b) Sulphur  
 (c) Silicon                                        (d) Mercury
- 39.** Which of the following are not ionic compounds? *(NCERT Exemplar)*
- |                     |                   |
|---------------------|-------------------|
| I. $\text{KCl}$     | II. $\text{HCl}$  |
| III. $\text{CCl}_4$ | IV. $\text{NaCl}$ |
- (a) I and II                                      (b) II and III  
 (c) III and IV                                    (d) I and III
- 40.** Which one of the following properties is not generally exhibited by ionic compounds? *(NCERT Exemplar)*
- (a) Solubility in water  
 (b) Electrical conductivity in solid state  
 (c) High melting and boiling points  
 (d) Electrical conductivity in molten state

- 41.** Metal and non-metal combine by gaining or losing electrons.  
 (a) True                                  (b) False  
 (c) Can't say                            (d) Partially true/false
- 42.** Which of the following statements is incorrect about ionic compounds?  
 (a) Ionic compounds are brittle  
 (b) Ionic compounds have high melting and boiling points  
 (c) Ionic compounds are insoluble in water  
 (d) A solution of ionic compound can conduct electricity
- 43.** Reaction between *X* and *Y*, forms compound *Z*. *X* loses electron and *Y* gains electron. Which of the following properties is not shown by *Z*? *(NCERT Exemplar)*  
 (a) Has high melting point  
 (b) Has low melting point  
 (c) Conducts electricity in molten state  
 (d) Occurs as solid
- 44.** Which of the following metals exist in their native state in nature?  
*(NCERT Exemplar)*
- |               |                |
|---------------|----------------|
| I. Cu         | II. Au         |
| III. Zn       | IV. Ag         |
| (a) I and II  | (b) II and III |
| (c) II and IV | (d) III and IV |
- 45.** The second most abundant metal in the earth's crust is  
 (a) silicon                                (b) calcium  
 (c) iron                                    (d) carbon

### Assertion-Reasoning MCQs

**Direction** (Q.Nos. 46-54) For question numbers 1 to 8, two statements are given—one labeled

**Assertion (A)** and the other labeled **Reason (R)**. Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below.

- (a) Both A and R are true and R is 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.

- 46. Assertion** Electrical wires are made by sodium.  
**Reason** Sodium is a bad conductor of electricity.
- 47. Assertion** When zinc is added to a solution of iron (II) sulphate, no change is observed.  
**Reason** Zinc is more reactive than iron.
- 48. Assertion** Food cans are coated with tin and not with zinc.  
**Reason** Zinc is more reactive than tin.
- 49. Assertion** Carbon reacts with oxygen to form carbon dioxide which is acidic oxide.  
**Reason** Non-metals form acidic oxides.
- 50. Assertion** Ionic compounds have high melting and boiling points.  
**Reason** Ionic compounds are compounds consisting of ions.
- 51. Assertion** At higher temperatures, metal wires have a greater chance of short circuiting.  
**Reason** Both resistivity and resistance of a material vary with temperature. *(CBSE 2020)*
- 52. Assertion** Platinum, gold and silver are used to make jewellery.  
**Reason** Platinum, gold and silver are least reactive metals.
- 53. Assertion** Electrical wires are be made up of copper.  
**Reason** Copper is a bad conductor of electricity.
- 54. Assertion** The electrical conductivity of an alloy is less than that of pure metals.  
**Reason** An alloy is prepared by mixing the metals in molten form.

### Case Based MCQs

**55.** Read the following and answer any four questions from (i) to (v).

On the basis of reactivity of different metals with oxygen, water and acids as well as displacement reactions, the metal have been arranged in the decreasing order of their reactivities. This arrangement is known as activity series or reactivity series of metals.

From the position of the aluminium (Al) metal in the activity series, it seems to be quite reactive. However, it is not so reactive.

Actually, when the metal is kept in air or oxygen for sometime, it is converted into its oxide called aluminium oxide ( $\text{Al}_2\text{O}_3$ ). This gets deposited as the surface of the metal as a thin coating. It is rather passive which means that it is not reactive. Therefore, the metal is used for packing food articles which do not get spoiled under the foil.

(i) Which is the correct order of reactivity series?

- (a)  $\text{Mg} < \text{Ca} < \text{Na} < \text{K}$
- (b)  $\text{K} < \text{Na} < \text{Ca} < \text{Mg}$
- (c)  $\text{K} < \text{Mg} < \text{Na} < \text{Ca}$
- (d)  $\text{Mg} < \text{Ca} < \text{Na} < \text{K}$

(ii) Choose the correct match from the following:

A. Sodium	1. Quick lime
B. Aluminium	2. Keep in kerosene
C. Calcium	3. Wrapping food

#### Codes

A	B	C	A	B	C
(a) 1	2	3	(b) 2	3	1
(c) 3	1	2	(d) 2	1	3

(iii) What is the reaction of quick lime into slaked lime?

- (a)  $\text{CaO} + \text{CO}_2 \xrightarrow{\Delta} \text{CaCO}_3$
- (b)  $\text{Ca(OH)}_2 \xrightarrow{\Delta} \text{CaO} + \text{H}_2\text{O}$
- (c)  $\text{CaO} + \text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + \Delta$
- (d)  $\text{C} + \text{O}_2 \xrightarrow{\Delta} \text{CO}_2$

(iv) Why we wear ornaments of gold and silver?

- (a) They are expensive, to look rich
- (b) They are most reactive
- (c) They are least reactive
- (d) None of the above

(v) The gas evolved from slaked lime, is ..... in nature.

- |            |                  |
|------------|------------------|
| (a) acidic | (b) amphoteric   |
| (c) basic  | (d) All of these |

**56.** Read the following and answer questions from (i) to (v).

An element is a pure substance made up of same kind of atoms. At present, nearly 118 elements are known but all of them do not occur free in nature, some of them have been synthesised by artificial methods. Based on their properties, they are mainly classified as metal and non-metals.

The easiest way to start grouping substances is by comparing their physical properties. Metals, in their pure state, have a shining surface. This property is called metallic luster. metals are generally hard. The hardness varies from metal to metal. Some metals are used for making cooking vessels.

(i) Metals generally are

- (a) reducing agents
- (b) oxidising agent
- (c) both oxidising and reducing agents
- (d) None of the above

(ii) The most abundant metal in the earth's crust is

- |               |             |
|---------------|-------------|
| (a) iron      | (b) copper  |
| (c) aluminium | (d) mercury |

(iii) The metal that reacts with cold water is

- |             |              |
|-------------|--------------|
| (a) mercury | (b) sodium   |
| (c) zinc    | (d) tungsten |

(iv) Metal present in chlorophyll is

- |               |            |
|---------------|------------|
| (a) iron      | (b) copper |
| (c) magnesium | (d) cobalt |

(v) Which of the following metal(s) catch fire on reaction with water?

- |               |                      |
|---------------|----------------------|
| (a) Sodium    | (b) Potassium        |
| (c) Magnesium | (d) Both (a) and (b) |

- 57.** Read the following and answer questions from (i) to (v).

The arrangement of metals in a vertical column in the decreasing order of their reactivities is called the reactivity series or activity series of metals. The most reactive metal is at the top position of reactivity series and the least reactive metal is at bottom of the reactivity series.

An element placed above in the activity series will replace the element placed below it from its aqueous solution.

Reactivity of metals towards other elements decreases as you go down the series. The stability of their compounds also decreases.

Any metal above hydrogen reacts with acids, replaces hydrogen from acids.

The more active a metal, the more strongly it holds on to oxygen in an oxide and therefore, the more strongly the oxide resists decomposition into its elements upon heating.

- (i) Copper displaces which of the following metals from its salt solution?
  - (a) Zinc
  - (b) Iron
  - (c) Silver
  - (d) Nickel
  
- (ii) Which of the following oxides can be decomposed with difficulty?
  - (a) CuO
  - (b) ZnO
  - (c) AgO
  - (d) CrO
  
- (iii) Which of the following statement is correct?
  - (a) Elements near the top of the series are never found free in nature
  - (b) Elements near the bottom of the series are often found free in nature
  - (c) Elements near the top of the series are found free in nature
  - (d) Both (a) and (b)
  
- (iv) Which of the following metals can react with steam but not with hot water.
  - (a) Iron
  - (b) Calcium
  - (c) Sodium
  - (d) Potassium

- (v) The method which is used to extract metal present at the top of the series will be
  - (a) electrolytic refining
  - (b) calcination
  - (c) electrolytic reduction
  - (d) Roasting

- 58.** Read the following and answer questions from (i) to (v).

Metals are electropositive elements. They can easily lose electrons to form ions:

Metals show, distinguished physical as well as chemical properties.

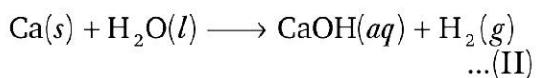
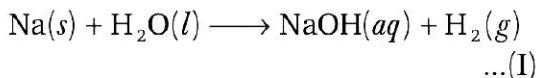
Generally most of the metals are ductile and malleable with exception such as mercury. These properties make them valuable for commercial as well as domestic uses. Reaction of a metal with water is one of important chemical property.

Metals like sodium and potassium reacts with cold water while magnesium reacts with hot water. Metals like aluminium, zinc do not react with hot/cold water but they easily react with steam.

When a metal react with hot/cold water the products are metal hydroxide and hydrogen, and when it react with steam, the product are metal oxide and hydrogen. Some metals like sodium, potassium react violently with water.

- (i) When zinc reacts with steam it produces
  - (a)  $Zn(OH)_2$
  - (b)  $ZnO$
  - (c)  $O_2$
  - (d)  $ZnO_2$
  
- (ii) Most ductile metal among the following is
  - (a) Au
  - (b) Ag
  - (c) Cu
  - (d) Al
  
- (iii) During the reaction of calcium with water, pieces of metal start floating due to the formation of
  - (a)  $Ca(OH)_2$
  - (b)  $CO_2$
  - (c)  $H_2$
  - (d) None of these

(iv) Consider the reactions:



- (a) Reaction I is endothermic reaction
- (b) Reaction II is endothermic reaction
- (c) Reaction II is more exothermic than reaction I
- (d) Reaction I is more exothermic than reaction II

(v) Metals can be converted into thin sheet by hammering. This property is known as

- (a) ductility
- (b) sonorous
- (c) malleability
- (d) Both (a) and (c)

**59.** Read the following and answer questions from (i) to (v).

### Metallic Character

The ability of an atom to donate electrons and form positive ion (cation) is known as electropositivity or metallic character.

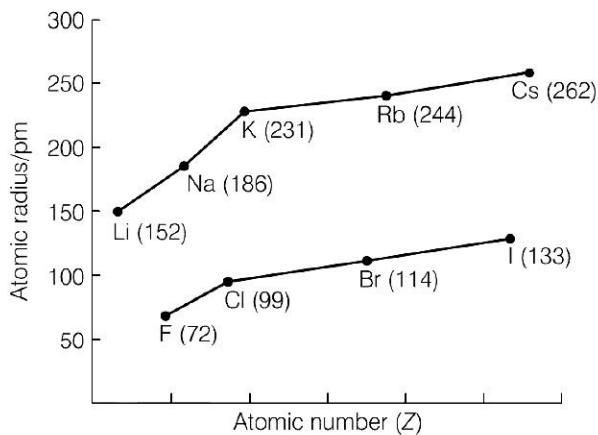
Down the group, metallic character increases due to increase in atomic size and across the period, from left to right electropositivity decreases due to decrease in atomic size.

### Non-metallic Character

The ability of an atom to accept electrons to form a negative ion (anion) is called non-metallic character or electronegativity.

The elements having high electro-negativity have a higher tendency to gain electrons and form anion.

Down the group, electronegativity decreases due to increase in atomic size and across the period, from left to right electronegativity increases due to decrease in atomic size.



(CBSE Sample Paper 2021)

- (i) Which of the following correctly represents the decreasing order of metallic character of alkali metals plotted in the graph?
  - (a) Cs > Rb > Li > Na > K
  - (b) K > Rb > Li > Na > Cs
  - (c) Cs > Rb > K > Na > Li
  - (d) Cs > K > Rb > Na > Li
- (ii) Hydrogen is placed along with alkali metals in the modern periodic table though it shows non-metallic character
  - (a) as hydrogen has one electron and readily loses electron to form negative ion
  - (b) as hydrogen can easily lose one electron like alkali metals to form positive ion
  - (c) as hydrogen can gain one electron easily like halogens to form negative ion
  - (d) as hydrogen shows the properties of non-metals
- (iii) Which of the following has highest electronegativity?
  - (a) F
  - (b) Cl
  - (c) Br
  - (d) I

- (iv) Identify the reason for the gradual change in electronegativity in halogens down the group.
- Electronegativity increases down the group due to decrease in atomic size
  - Electronegativity decreases down the group due to decrease in tendency to lose electrons
  - Electronegativity decreases down the group due to increase in atomic radius/tendency to gain electron decreases
  - Electronegativity increases down the group due to increase in forces of attractions between nucleus and valence electrons
- (v) Which of the following reason correctly justifies that “fluorine (72 pm) has smaller atomic radius than lithium (152 pm)”?
- F and Li are in the same group. Atomic size increases down the group
  - F and Li are in the same period. Atomic size increases across the period due to increase in number of shells
  - F and Li are in the same group. Atomic size decreases down the group
  - F and Li are in the same period and across the period atomic size/radius decreases from left to right.

## ANSWERS

### Multiple Choice Questions

- |         |         |         |         |         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (a)  | 2. (a)  | 3. (d)  | 4. (d)  | 5. (d)  | 6. (c)  | 7. (d)  | 8. (c)  | 9. (d)  | 10. (a) |
| 11. (c) | 12. (b) | 13. (b) | 14. (a) | 15. (d) | 16. (d) | 17. (d) | 18. (a) | 19. (b) | 20. (d) |
| 21. (b) | 22. (c) | 23. (b) | 24. (d) | 25. (d) | 26. (b) | 27. (c) | 28. (d) | 29. (b) | 30. (a) |
| 31. (a) | 32. (a) | 33. (c) | 34. (b) | 35. (a) | 36. (c) | 37. (a) | 38. (c) | 39. (b) | 40. (b) |
| 41. (b) | 42. (c) | 43. (b) | 44. (c) | 45. (c) |         |         |         |         |         |

### Assertion-Reasoning MCQs

- |         |         |         |         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 46. (b) | 47. (d) | 48. (a) | 49. (a) | 50. (b) | 51. (a) | 52. (a) | 53. (c) | 54. (b) |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|

### Case Based MCQs

- |   |   |
|---|---|
| 55. (i)-(a), (ii)-(b), (iii)-(c), (iv)-(c), (v)-(a) | 56. (i)-(a), (ii)-(c), (iii)-(b), (iv)-(c), (v)-(d) |
| 57. (i)-(c), (ii)-(b), (iii)-(d), (iv)-(a), (v)-(c) | 58. (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d), (v)-(c) |
| 59. (i)-(c), (ii)-(b), (iii)-(a), (iv)-(c), (v)-(d) |   |

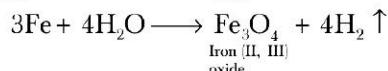
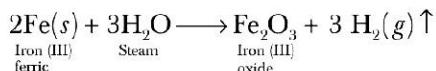
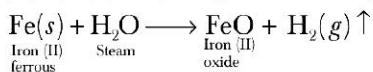
## EXPLANATIONS

- Those elements which form positive ions by losing electrons are called metals. So, option (a) is correct.
- Metal can easily give up their electrons and form electropositive ions. They have one to three valence electrons in their valence shell. They are not brittle and do not form anions.
- Gold has all given properties which make it suitable for making jewellery. Gold is ductile, malleable and lustrous. It can be drawn into thin sheets, wires and has shiny appearance.
- Good thermal conductivity, malleability, light weight and high melting point are the

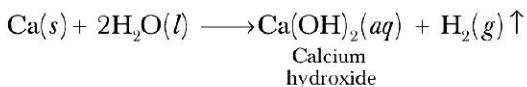
properties of aluminium due to which it is used for making cooking utensils.

- Tungsten has the highest melting point among the metals because it is one of the hardest metal present on earth surface.
- The metal with the lowest melting point is mercury. Hence, it is liquid at room temperature.
- Metals when react with the oxygen, give basic-oxides/amphoteric oxide.  $ZnO$  is an amphoteric oxide.  
Option (b) and (c) indicates that,  $ZnO$  reacts with the acid ( $H_2SO_4$ ) as well as with the base ( $NaOH$ ).  
Hence, (b) and (c) together gives the nature of oxide.

**8. Reactions of iron metal with water**



**9. Calcium reacts less violently with water and the bubbles of hydrogen gas produced stick to the surface of calcium. Due to which it floats over water surface.**

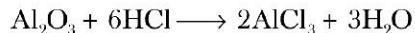


Much less heat is produced in this reaction due to which hydrogen gas formed does not catch fire.

**10. Nitric acid ( $\text{HNO}_3$ ) on reacting with metals (except Mn and Mg) does not give hydrogen gas.**

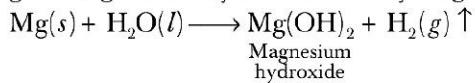
Because it is a strong oxidising agent so, as soon as hydrogen gas is formed in the reaction between metal and dil.  $\text{HNO}_3$ , the nitric acid oxidises this hydrogen to water.

**11. When aluminium oxide reacts with acid, HCl then aluminium chloride and water get formed.**



**12. Magnesium metal does not react with cold water.**

Mg reacts with hot water and steam both, to give magnesium hydroxide and hydrogen.

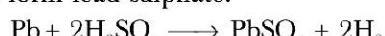


**13. A mixture of conc. HCl and conc.  $\text{HNO}_3$  in the ratio of 3 : 1 is known as *aqua-regia*. Gold (Au) dissolve only in *aqua-regia*.**

**14. According to the reactivity series of metal,  $\text{Fe} < \text{Zn} < \text{Mg} < \text{K}$ .**

Potassium is highly reactive and iron is least reactive among them.

**15. Lead reacts with concentrated sulphuric acid and form lead sulphate.**

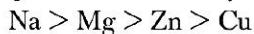


But lead does not react with ferrous sulphate as Pb is less reactive than Fe.

**16. As copper is more reactive than silver, so, it will displace silver from silver nitrate solution.**

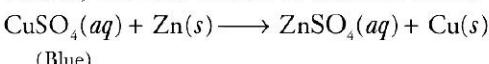
**17. Metals placed below the hydrogen in reactivity series, will not give  $\text{H}_2(g)$  with water ( $\text{H}_2\text{O}$ ).**

Decreasing order of reactivity of metals is



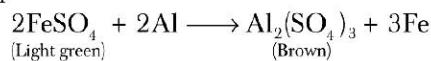
**18. Since, zinc (Zn) is more reactive than copper (Cu), it will displace the  $\text{Cu}^{2+}$  ions from the  $\text{CuSO}_4$  solution.**

Hence, the blue colour of solution fades.



**19. When an aluminium strip is kept immersed in freshly prepared ferrous sulphate ( $\text{FeSO}_4$ ), the change in colour is observed.**

The green solution slowly turns into brown. Because Al is more reactive than Fe, it displaces iron from its sulphate solution and form aluminium sulphate which is responsible for brown colour.



**20. Copper sulphate solution can be safely kept in silver container but not in lead container because lead is more reactive than copper, hence it can displace copper from copper sulphate solution.**

**21. Non-metals are electronegative elements because they can form negative ions by gaining electrons. Metals are electropositive.**

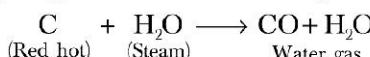
**22. Almost all the non-metals produce no metallic sound on hitting. Thus, they are not sonorous.**

**23. Carbon is a non-metal and it has two allotropes diamond and graphite, out of them graphite has free electrons in its crystal due to which it conducts electricity.**

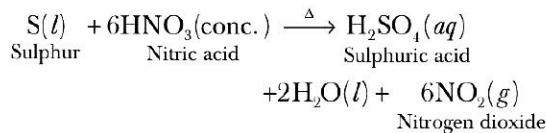
**24. Most of the non-metals are gases and a few are solids and bromine is the only non-metal which is liquid at room temperature.**

**25. Iodine is a non-metal having lustrous appearance. It has a shining surface like metals.**

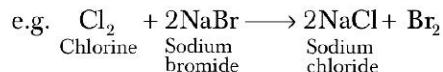
- 26.** Iodine is a lustrous non-metal and mercury is a liquid metal.  
 Bromine is a non-metal which is liquid at room temperature.  
 Diamond is the hardest substance.
- 27.** The non-metals oxides react with water to form sulphuric acid and hence, these oxides are acidic in nature.
- 28.** The gaseous mixture of carbon monoxide and hydrogen is known as water gas.



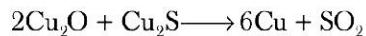
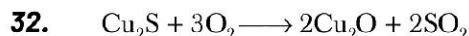
- 29.** The sulphur reacts with conc. nitric acid, to form sulphuric acid along with water and evolution of nitrogen dioxide gas.



- 30.** Just like metals, non metals are also differ in their reactivities. The order of reactivity of given halogens is  $\text{Cl} > \text{Br} > \text{I}$ . Therefore, chlorine can displace Br and I from their solution of salts.



- 31.** Calcium (Ca) combines with oxygen to form calcium oxide ( $\text{CaO}$ ) which has a high melting point and dissolved in water to form  $\text{Ca}(\text{OH})_2$ .



$X$  = Cuprous sulphide

$Y$  = Cuprous oxide

- 33.** Metals below hydrogen in a reactivity series does not react with dilute HCl. Medium reactive metals reacts with warm water and highly reactive metals react with cold water.

As per the given information H, K, L and M can be identified as Cu, Mg, Pb and K / Na respectively.

So, their reactivity order will be

$M > K > L > H$ , i.e.  $K > Mg > Pb > Cu$ .



Hydrogen gas is evolved when Mn reacts with very dilute  $\text{HNO}_3$ .

- 35.**  $2\text{CsO}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{CsOH} + \text{H}_2\text{O}_2 + \text{O}_2$   
 $\text{CsO}_2$  is the oxide of alkali metal. It is a basic oxide. Due to formation of  $\text{CsOH}$  its aqueous solution is basic.
- 36.** (A)  $\text{SO}_2$  is acidic oxide because is in non-metal and non-metals form acidic oxide.  
 (B)  $\text{H}_2\text{O}$  is a neutral oxide.  
 (C)  $\text{Al}_2\text{O}_3$  is an amphoteric oxide which behaves as acid as well as base.  
 (D)  $\text{CaO}$  is basic oxide because metals form basic oxide and Ca is a metal.
- 37.** Generally, metalloids are present in  $p$ -block, i.e. on the right side of the periodic table.  
 The element with electronic configuration 2, 8, 4 is silicon. It is a metalloid. It can react with both acids as well as bases.  
 (i)  $\text{Si} + 4\text{HCl} \xrightarrow{\text{(Acid)}} \text{SiCl}_4 + 2\text{H}_2(g)$   
 (ii)  $2\text{Si} + 2\text{NaOH}(aq) + 4\text{H}_2\text{O} \xrightarrow{\text{(Base)}} 2 \text{Na}_2\text{SiO}_3 + 5\text{H}_2(g)$
- 38.** Silicon is a metalloid, as it can react with an acid and base both.
- 39.** Ionic compounds are the result of electron transfer.  $\text{HCl}$  is a polar covalent compound while  $\text{CCl}_4$  is a non-polar covalent compound because both are formed by sharing of electrons.  
 $\text{KCl}$  and  $\text{NaCl}$  are formed by the transfer of electrons and are ionic compounds.
- 40.** Ionic compounds can conduct electricity in molten or aqueous state only. In solid state, these are non-conductor of electricity because of the absence of free ions.  
 In the solid ionic compounds, the ions are held together in fixed position by strong electrostatic force and cannot move freely. So, electrical conductivity in solid state is not generally exhibited by ionic compounds.
- 41.** Metals and non-metals combine by the transfer of electrons from metals to non-metals to form ionic bonds. Therefore, the given statements is false.
- 42.** Ionic compounds are generally soluble in water (polar solvent) and insoluble in solvents such as kerosene, petrol, etc., (non-polar solvents).

- 43.** During reaction between  $X$  and  $Y$ , the compound  $Z$  is formed, which is an ionic compound. Ionic compounds have high melting point, conduct electricity in molten state and usually occur as solids.
- 44.** Gold and silver (Au and Ag) are less reactive metals, so they are usually found in free state (native state) in nature.
- 45.** The second most abundant metal in the earth's crust is iron. It is about 5% in composition.
- 46.** Both A and R are true but R is not the correct explanation of A.
- 47.** A is false but R is true. Zinc being more reactive than iron displaces iron from iron (II) sulphate solution. Thus, the green colour of the solution fades and iron metal gets deposited.
- $$\text{Zn(s)} + \text{FeSO}_4\text{(aq)} \longrightarrow \text{ZnSO}_4\text{(Colourless)} + \text{Fe(s)}$$
- (Green) (Colourless)
- 48.** Both A and R are true and R is the correct explanation of A. Food cans are coated with tin not with zinc because zinc is more reactive than tin, it can react with organic acids present in food.
- 49.** Both A and R are true and R is the correct explanation of A. Carbon being a non-metal form acidic oxides, i.e. their aqueous solution turns blue litmus solution red.
- 50.** Both A and R are true but R is not the correct explanation of A because ionic compounds have high melting and boiling points due to presence of strong electrostatic forces of attraction which are held between oppositely charged ions.
- 51.** Both A and R are true and R is the correct explanation of A. At high temperature, chances of short circuiting increase due to increase in resistance and resistivity of material.
- 52.** Both A and R are true and R is the correct explanation of A. Platinum, gold and silver are highly malleable lustrous and least reactive, i.e. noble metals, so they are not corroded by air and water easily.
- 53.** A is true but R is false. Electrical wires are made up of copper as copper is very good conductor of electricity.

- 54.** A and R are both true but R is not the correct explanation of A. The electrical conductivity of an alloy is less than that of pure metals due to existence of impurities than pure metal.
- 55.** (i) The correct order of reactivity order is  $\text{Mg} < \text{Ca} < \text{Na} < \text{K}$ . Because according to reactivity series, K is placed at the top which indicates that it is the most reactive metal, then Na comes, and after that Ca and Mg comes down the series.
- (ii) (A) Sodium is kept in kerosene due to its high reactivity.
- (B) Aluminium is used in wrapping food because it is not so reactive and protect food from light, moisture, etc.
- (C) Quick lime is an oxide of calcium. Its molecular formula is  $\text{CaO}$ .
- (iii)  $\text{CaO(s)} + \text{H}_2\text{O(aq)} \longrightarrow \text{Ca(OH)}_2\text{(s)} + \text{Heat}$
- In this reaction, quick lime,  $\text{CaO}$  is treated with water to form slaked lime,  $\text{Ca(OH)}_2$  with evolution of heat.
- (iv) We wear gold and silver ornaments because they are least reactive and do not corrode easily.
- (v) The gas evolved from slaked lime is carbon dioxide,  $\text{CO}_2$  that is acidic in nature.
- 56.** (i) Metals act as a reducing agent because they have tendency to donate electrons and get oxidised.
- (ii) Aluminium is the most abundant metal in earth's crust and iron is the second most abundant metal.
- (iii) Metals like sodium and potassium react violently with cold water because they are highly reactive metals.
- (iv) Magnesium metal is present in chlorophyll.
- (v) Sodium and potassium reacts vigorously with water. The reaction is so violent that they catch fire as it is exothermic reaction.
- 57.** (i) Silver can be easily displaced by copper from its salt solution because according to reactivity order, Cu is more reactive than Ag.
- (ii) As zinc is more reactive metal among the Cu, Ag and Cr, it will strongly hold on to oxygen in an oxide and hence, more strongly the oxide resists decomposition.

- (iii) Both (a) and (b) are correct. Elements like Na, K etc., which are at top of the series never found free in nature they are high reactive while elements like gold, platinum, etc., are found free in nature because they are least reactive and placed at bottom of the series.
- (iv) Iron reacts with steam and do not reacts with cold or hot water. It reacts with steam to form metal oxide and hydrogen.
- (v) Due to high affinity with oxygen, electrolytic reduction is employed for metals, like Na, Mg, Ca, etc.
- 58.** (i) When zinc reacts with steam, it gives zinc oxide,  $ZnO$  and hydrogen gas,  $H_2$ .
- (ii) Gold and platinum are the most ductile metals and here, among the given metals, Au is the most ductile metal. Hence, it is used in jewellery.
- (iii) During the reaction of calcium with water, pieces of calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of the water.
- (iv) Both given reactions are exothermic but reaction (I) is more exothermic because when sodium reacts with water, it reacts violently and catches fire while in reaction (II), heat is evolved in less amount. The solution gets warm only in reaction (II).
- (v) Malleability is the characteristic of metal in which metal can be converted into thin sheet by hammering.
- 59.** (i)  $Cs > Rb > K > Na > Li$  represents the decreasing order of metallic character of alkali metals. Down the group metallic character increases due to increase in atomic size.
- (ii) As hydrogen can easily lose one electron like alkali metals to from positive ion. That's why hydrogen is placed along with alkali metals in the modern periodic table though it shows non-metallic character.
- (iii) Fluorine has the highest electronegativity. As fluorine is the smallest and first element of its group. So, down the group electronegativity decreases due to increase in atomic size.
- (iv) In halogens, the electronegativity decreases down the group due to increase in atomic radius and decrease in tendency to gain electron.
- (v) Fluorine (72 pm) has smallest atomic radius than lithium (152 pm) because atomic radius/size decreases from left to right in a period. As F and Li are in the same period.