ALAKH sir ke FARREY

Metals and Non-Metal

PHYSICAL PROPERTIES :-

METALS :-

(1) Lustrous : have shining surface (in pure state), Metallic Lustre.
(2) Generally Hard.
(3) Malleability : property of substance that it can be beaten into thin sheets.
[Gold and Silver Most Malleable]
(4) Ductility : Ability of metals to be drawn into thin wire (1g of Gold metal → 2km length of wire)
(5) Good Conductor of electricity (Best conductor are silver, copper, Gold)
(6) Good Conductor of Heat : (Best conductor are silver, copper).
(7) Have High Melting point.
(8) Sonorous : Metals that produce a sound on striking a hard surface.
(9) Physical state : All metals except mercury exist as solids at room temperature.

Non-Metals :-

(1) Non-Lustrous
(2) Generally soft
(3) Non-malleable
(4) Non-ductile
(5) Poor conductor of electricity
(6) Poor conductor of Heat.
(7) Low melting point.
(8) Non-sonorous
(9) solid → Carbon sulphur
liquid → Bromine
Gases → Nitrogen, Cl_2
Oxygen, F_2

Important point (Exception)

METALS :-

(1) Alkali Metals - Li, Na, K are so soft that they can be cut with a knife. (also Rb and Cs)
(2) Gallium (Ga) and cesium (Cs) very soft and have very low Melting point. They melt if you keep them on your palm
(3) Mercury is poor conductor of Heat. (exist at liquid)
(4) lead (Pb) is a poor conductor of electricity.

NON-METALS

(1) Iodine and Graphite are lustrous.
(2) Diamond (form of carbon) is Hardest Natural substance. it has high Melting and Boiling point.
(3) Graphite (form of carbon) is Lustrous, conducts electricity.

(1) copper and Aluminium are used for making cooking vessels. They are good conductor of heat & they do not melt (have high Melting point).

(2) Carbon is a non-metal that can exist in different forms. Each form is called an allotrope.
Eg - Graphite, Diamond, Coal

CHEMICAL PROPERTIES :-

$4K + O_2 \longrightarrow 2K_2O$ (s)

$4Na + O_2 \longrightarrow 2Na_2O$ (s)

- K and Na react so vigorously with oxygen that they catch fire (Burns in air) even if kept in the open.
- They are kept inside kerosene oil to (i) Protect them from burning in air. (ii) Prevents accidental fires.

Metal + Oxygen ⟶ Metal Oxide (Generally Basic in nature)

✡ $2Mg + O_2 \xrightarrow{Heat} MgO$ (Ribbon) (White powder)

- Mg ribbon burns with dazzling white light.

✡ $4Al + 3O_2 \xrightarrow{Heat} 2Al_2O_3$

- Aluminium burns with a brilliant white flame.

✡ $2Cu + O_2 \xrightarrow{Heat} 2CuO$ (Black layer)

- Cu does' not burn. (takes long time).

Gold and silver do not react with oxygen even at high temperature.

Flame Test

Trick-

YELLOW SUN GREEN COP LIQOUR BLACK BIKE CAR ORANGE

Element	Ion	Flame test colour
Lithium	Li^+	Crimson
Sodium	Na^+	Yellow
Potassium	K^+	Lilac
Calcium	Ca^{2+}	Orange-red
Copper	Cu^{2+}	Green

Aqua Regia
Freshly prepared mixture (Conc) HCl + (Conc) HNO_3 3:1
- Dissolves Gold
- Highly corrosive & fuming liquid

Amphoteric oxide

Metal oxides are generally basic in nature. Turns moist red litmus blue.
Eg - MgO, CuO, Na_2O, K_2O, Fe_2O_3

But some metal oxides show both acidic and basic nature, called Amphoteric oxide.
Eg - oxides of Al and Zn

Base + Acid ⟶ salt + water
$Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$

Acid + Base ⟶ salt + water
$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$

Metal + water ⟶ Metal hydroxide / oxide + H_2

$2K + 2H_2O \longrightarrow 2KOH + H_2\uparrow$
$2Na + 2H_2O \longrightarrow 2NaOH + H_2\uparrow$
$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2\uparrow$
$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2\uparrow$
$2Al + 3H_2O \longrightarrow Al_2O_3 + 3H_2\uparrow$
$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$

- Na reacts Violently with Cold water. Reaction is highly exothermic. H_2(g) evolved catches fire.
- less violent react do not catch fire.
- Ca and Mg floats in water as Bubbles of H_2(g) sticks to surface of metal.

Reaction with acids :-

Metal + Dil Acid ⟶ salt + $H_2\uparrow$

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$
$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$
$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$
$Cu + H_2SO_4 \not\longrightarrow$ No reaction

More reactive metals = more heat evolved & more is rate of formation of H_2 gas

Special Case of Nitric Acid :-

Metal + Dil Acid ⟶ salt + H_2

H_2(g) not evolved when a metal reacts with dil HNO_3 (nitric acid). HNO_3 is strong oxidising agent. it oxidises the H_2(g) produced to

$H_2 \xrightarrow[[O]]{HNO_3} H_2O$

and itself gets reduced to (NO, NO_2, N_2O) only Magnesium (Mg) and Manganese (Mn) reacts with very dil HNO_3 to give H_2(g)

Displacement Reaction :-

$A + BC \longrightarrow AC + B$

A is more reactive than B

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

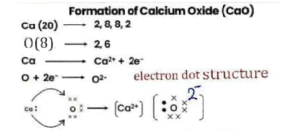
$Zn(s) + CuSO_4(aq) \longrightarrow ZnSO_4(aq) + Cu(s)$ (Blue) (colourless) (Brown)

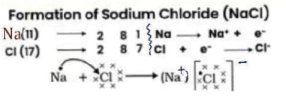
$Cu(s) + FeSO_4(aq) \longrightarrow$ No reaction

This reaction can be used to identify more reactive metal.

Metals and Non-Metals React → Ionic compound / Electrovalent compounds

Element	Atomic No.	Electronic Configuration
Sodium (Na)	11	2,8,1
Magnesium (Mg)	12	2,8,2
Calcium (Ca)	20	2,8,8,2
Chlorine (Cl)	17	2,8,7
Oxygen (O)	8	2,6





* Na^+ and Cl^- ions (oppositely charged) attract each other.
* Na^+ and Cl^- are hold together by strong electrostatic forces of attraction.
* sodium chloride (NaCl) do not exist as molecule but as combination of oppositely charged ions → ionic compound / Electrovalent compound.

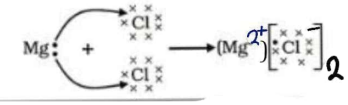
Formation of Magnesium chloride ($MgCl_2$)

$Mg(12) \longrightarrow 2, 8, 2$

$Cl(17) \longrightarrow 2, 8, 7$

$Mg \longrightarrow Mg^{+2} + 2e^-$

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



Ionic / Electrovalent Compounds Properties

(1) Hard, solid compounds because of strong force of attraction between +ve and -ve ions. Brittle in nature, Breaks into pieces if pressure is applied.

(2) Have High Melting and Boiling point Because large amount of energy is required to break strong interionic attraction.

(3) Generally soluble in water but insoluble in solvents like kerosene, petrol, alcohol etc.

(4) In solid state do not conduct electricity as ions cannot move because of strong electrostatic force of attraction.

(5) In Molten state, Heat Energy weakens the strong electrostatic forces of attraction and ions can move freely, hence in molten state, conduct electricity.

(6) In aqueous solution, conducts electricity as solution of ionic compound in water contains ions.

ions move to opposite electrodes.
(water weakens the strong electrostatic forces of attraction between ions).

Extraction of Metals

(1) Minerals :– elements or compounds which occur naturally in earth's crust.

(2) Ores :– Those minerals which contain a very high % of a particular metal and metal can be profitably extracted from it, are called ores.

Top in Activity Series

5 — K, Na, Ca, Mg, Al — very reactive, so never found in free state as free metal

3 — Zn, Fe, Pb, H — Middle of Activity Series — moderately reactive found in earth's crust in form of oxides, sulphides and carbonates.

5 — Cu, Hg, Ag, Au, Pt — least reactive, hence found in free state as free metals as well as sulphides form. — low in Activity series

Extracting Metal → Middle of Activity Series

Present as oxides, sulphides or carbonates in nature.

Sulphides / carbonates converted to oxide as its easy to extract metal from oxide

Roasting :– Heating sulphide ores strongly in presence of excess air.

$2ZnS + 3O_2 \xrightarrow{Heat} 2ZnO + 2SO_2$

Calcination :– Heating carbonate ores strongly in limited air. or in absence of air.

$ZnCO_3 \xrightarrow{Heat} ZnO + CO_2$

Now, metal oxide is reduced (removal of oxygen) with help of Reducing agent carbon (coke).

$ZnO + C \longrightarrow Zn + CO$

Extracting Metals → Top of Activity series

carbon cannot reduce their oxides, these metals are very reactive and have More affinity (likeness) for oxygen than carbon.

- Such Metals are obtained by Electrolytic Reduction (Reduction with help of electric current).
- Na, Ca, Mg → electrolysis of molten chlorides

At cathode: $2Na^+ + 2e^- \longrightarrow 2Na$

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

$2NaCl_{(molten)} \xrightarrow{\text{electric current}} 2Na_{(s)} + Cl_{2(g)}$

Refining of Metals

- Metal obtained after carbon reduction or electrolytic reduction is not very pure.
- The most common method for refining metal is Electrolytic refining.

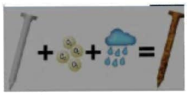
At Anode : Pure copper dissolves in solution.

At Cathode : Equivalent amount of pure copper from solution deposits at cathode.

Corrosion :– When a metals is attacked by substance around it such as moisture (water vapour + oxygen), acid etc. it is said to be corrode and this process is called corrosion.

Examples :–

(1) Rusting of iron



$2Fe + \frac{3}{2}O_2 \cdot xH_2O \longrightarrow 2Fe_2O_3 \cdot xH_2O$

(2) Tarnishing of copper

Copper $\xrightarrow[H_2O]{O_2}$ Copper Hydroxide + Copper carbonate (green)

(3) Tarnishing of silver

Silver $\xrightarrow[O_2]{H_2S}$ Silver sulphide (Black)

Note :– Corrosion is an example of oxidation.

$2Cu(s) + H_2O(g) + CO_2(g) \longrightarrow CuCO_3(s) + Cu(OH)$

Prevention of corrosion :–

- Painting
- Oiling
- Greasing
- Galvanishing
- Anodising

Galvanisation :–

- Steel and iron are coated with thin layer of zinc.
- It is done through electrolysis.
- it does not change property of metal.

Anodising :–

process of forming a thick oxide layer of Al. This layer prevents corrosion of Al metal. The oxide layer also give Al articles attractive finish

Alloy :– A homogenous mixture of two or more metals, or a metal and non metal.

step-1 Melting primary metal.
step-2 Dissolving other elements is fixed proportions.
step-3 Cooling to room temperature.

The properties of An Alloy is different from the metals from which it obtained.

(1) Pure iron is very soft and streches easily when hot pure iron + carbon (0.05%) → Hard and strong iron carbon Alloy.

(2) stainless steel → Alloy of Fe + C

(3) Amalgam → Alloy in which one metal is mercury.

(4) Brass (BCoZ) → Alloy of Zn + Cu

(5) Bronze (CoaT) → Alloy of copper & Tin (Cu + Sn)

(6) solder (SoTeLa) → Alloy of lead & Tin (Pb + Sn)

Thermit Reaction / Welding

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

The above reaction is so highly exothermic that heat given out procluces metal in molten state. This molten metal is used to Join railway tracks or cracked machine parts. This reaction is known as thermit reaction.

CURRENT YEAR QUESTIONS

QUESTION-1 (a) Name the following. **(CBSE 2019, 2022, 2024)**

(i) Metal that can be cut by a knife.
(ii) Lustrous non-metal.
(iii) Metal that exists in liquid state at room temperature.
(iv) Most malleable and ductile metal.
(v) Metal that is the best conductor of electricity.
(vi) Non-metal that can exist in different forms.
(b) How are alloys better than metals? Give the composition of solder and amalgam.

QUESTION-2) Three metal samples of magnesium, aluminium, and iron were taken and rubbed with sandpaper. These samples were then put separately in test tube containing dilute hydrochloric acid. Thermometers were also suspended in each test tubes so that their bulbs dipped in the acid. The rate of formation of bubbles was observed. The above activity was repeated with dilute nitric acid and the observations were recorded. Answer the following questions.

(a) When the activity was done with dilute hydrochloric acid, then in which one of the test tubes was the rate of formation of bubbles the fastest and the thermometer showed the highest temperature.

(b)(i) Why does hydrogen gas not evolve when a metal reacts with dilute nitric acid? Name the ultimate products formed in the reaction.

OR

(ii) Name the type of reaction on the basis of which reactivity of metals is decided. you have two metals X and Y. How would you decide which is more reactive than the other? **(2020, 2021, 2024) [CBQ]**

QUESTION-3) (a) Name the process of reduction used for a metal that gives a vigorous reaction with air and water both. (2019, 2022, 2023) [CBQ]

(b) Carbon cannot be used as a reducing agent to obtain aluminium from its oxide? Why?
(c) Differentiate between roasting and calcination giving a chemical equation for each.

QUESTION-4) (a) Where is iron placed in the reactivity series of metals? Write the form/forms in which its ores are found in nature.
(b) Differentiate between roasting and calcination.
(c) Explain any two methods that are employed to prevent rusting/corrosion of metals.

OR

(c) Why is aluminium used to join railway tracks or the cracked machine parts of iron? Write a balanced chemical equation for the reaction which occurs. **(CBSE 2017, 2019, 2023) [CBQ]**

QUESTION-5) Write balanced chemical equations to explain what happens, when

Mercuric oxide is heated.
A mixture of cuprous oxide and cuprous sulphide is heated.
ferric oxide is reduced with aluminium.
Zinc carbonate undergoes calcination. **[CBSE 2020, 2021, 2022]**

QUESTION-6) An ore on treatment with dilute hydrochloric acid produces brisk effervescence. Name the type of ore with one example. What steps will be required to obtain metal from the enriched ore? Also, write the chemical equation for the reactions involved in the process. **[CBSE 2018, 2019, 2020, 2023]**

QUESTION-7) A metal 'A' reacts violently with cold water and the gas evolved catches fire. Another metal 'B' when dipped in water starts floating. The metal 'C' does not react either with cold or hot water, but reacts with steam. The metal 'D' does not react with water at all, identify the metals 'A', 'B', 'C' and 'D'.

[CBSE 2017, 2019, 2023]

QUESTION-8) ✡✡ **(CBSE 2015, 2018, 2024) [CBQ]**

Answer the following questions.

(i) In the electrolytic refining of copper, what materials are used for the cathode and anode?

(ii) Name the solution used in this process and write its chemical formula.

(iii) How does copper get refined when an electric current is passed through the electrolytic cell?

QUESTION-9) ✡

Ananya's family owns a small ornamental metal workshop where different metals like copper, zinc, and aluminium are used to create decorative items. One day, while cleaning an old iron ornament, she noticed that some parts had changed colour due to exposure to moisture. This made her curious about how metals interact with different solutions.

To satisfy her curiosity, she conducted a small experiment at home. She prepared four glasses of pale green ferrous sulphate solution and added small pieces of copper, zinc and aluminium in to three of them, leaving one untouched for comparison. After some time, she noticed interesting changes in the solutions and the metal pieces?

Answer the following questions.

(a) In which glass will the colour of the ferrous sulphate solution remain unchanged? Explain why.

(b) In which case will the solution fade in colour?

QUESTION-10)

(a) What happens when copper is heated in air? (Give the equation of the reaction involved)

(b) Why are some metal oxides categorized as amphoteric? Give one example.

(c) Complete the following equations.

(i) $Na_2O(s) + H_2O(l)$

(ii) $Al_2O_3(s) + 2NaOH(aq)$ **[CBQ]**

QUESTION-11) ✡✡

(1) Draw e⁻ dot structure of CaO

(2) Explain why CaO does not conduct electricity in solid state. How will it conduct electricity then?

QUESTION-12) ✡✡

(1) What are allotropes?

(2) What is Aqua regia?