METALS AND NON-METALS

PHYSICAL PROPERTIES :-

METALS	NON-METALS
(1) Lustrous : have shining surface (in pure state). Metallic lustre	(1) Non-Lustrous.
(2) Generally Hard	(2) Generally soft.
(3) Malleability : property of substance that it can be beaten into thin sheets. [Gold and silver most malleable]	(3) Non-malleable.
(4) Ductility : Ability of metals to be drawn into thin wires. 1g of Gold metal → 2km length of wire.	(4) Non-ductile
(5) Good conductor of Heat. Best are silver, copper.	(5) poor conductor of Heat.
(6) Good conductor of electricity. Best are silver, copper, Gold.	(6) poor conductor of electricity.
(7) Have High Melting point.	(7) Low melting point.
(8) sonorous : Metals produce a sound on striking a hard surface.	(8) Non-sonorous.
(9) Physical state : All metals except mercury exist as solids at room temperature.	(9) solid → Carbon, sulphur liquid → Bromine Gases → Nitrogen, Cl_2, oxygen, F_2

Trick

- MALL SHEET - Ek mall ke under bahut sari paper ki sheet padi hue hai.
- DUCK WIRE - Ek duck ko wire se bandh diye hai.

EC EXCEPTIONS

METALS

(i) Alkali metals :- Li, Na, K are so soft that they can be cut with a knife. (also Ga and Cs)

Trick *Nak Ce Gaki me chaku chalaya.*

(2) Gallium (Ga) and Cesium (Cs) very soft and have very low melting point. They melt if you keep them on your palm.

Trick *Chess khelti Gal ko hath me Rakha, Pighal gayi.*

(3) Mercury is poor conductor of Heat (exist as liquid)

Trick *Mercury planet pe doop nahi aati.*

(4) Lead (Pb) is a poor conductor of electricity.

Trick *Pub me light chali gayi.*

NON-METALS

(1) Iodine and Graphite are lustrous.

Trick *Pencil me Iodex lagaya chamakne lagi.*

(2) Dimond (form of carbon) is Hardest Natural substance. it has high melting and Boiling point.

Trick *Majboot Heere ko hathode se toda tave pe garm kiya, beasar rha.*

(3) Graphite (form of carbon) is ~~Hardest~~ lustrous, conducts electricity.

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

(2) Carbon is a non-metal that can exit in different forms. Each form is called an Allotrope. Example - Graphite, Diamond, Coal.

CHEMICAL PROPERTIES :-

Metal + Oxygen ⟶ Metal Oxide
(Generally basic in nature)
Turns moist red litmus blue

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

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

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

✡✡ $2Mg + O_2 \longrightarrow 2MgO$
(Ribbon) (White powder)
✓ Mg ribbon burns with dazzling white light.

$4Al + 3O_2 \longrightarrow 2Al_2O_3$
✓ Aluminium burns with a brilliant white flame.

✡✡ $2Cu + O_2 \longrightarrow 2CuO$
(Red) Black layer
✓ Cu does not burn (takes long time)

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

FLAME TEST :-

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

Yellow sun ⟶ yellow sodium
Green cop ⟶ copper
Liqour ⟶ Lithium crimson
Black bike ⟶ kaLi
Car orange ⟶ calcium orange.

Trick

Bhari dhupmein. Ek admi car chalate huye Arha hai. car ke upar orange rakhe huye hai. Ek police wala kaale rang ke bike se aya. Aur use liqour offer kiya.

Amphoteric oxide :-

Metal Oxides are generally basic in nature. Turns moist red litmus blue.

Example - MgO, CuO, Na_2O, K_2O, Fe_2O_3

✡ But some metal oxides show both acidic and basic nature called Amphoteric oxide.

Example - oxides of Al and Zn

Trick ~~Z~~anebey Ali
(Zn) (Al)

Base + Acid → salt + water

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

Acid + Base → salt + water

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

Reaction with water :-

Metal + water ⟶ Metal hydroxide/oxide + H_2

Trick

Potassium	Kudi	K	cold water	Hydrides
Sodium	Naal	Na	cold water	Hydrides
Calcium	Car	Ca	cold water	Hydrides
Magnesium	Mango	Mg	Hot water	Hydrides
Aluminium	Alto	Al	steam	oxides
Zinc	~~Z~~isko	Zn	steam	oxides
Iron	Fir	Fe	steam	oxides
Lead	Lekar	Pb	Do not react with water	
Hydrogen	Hum	H	Do not react with water	
Copper	chale	Cu	Do not react with water	
Mercury	Mathura	Hg	Do not react with water	
Silver	sath	Ag	Do not react with water	
Gold	Ghumne	Au	Do not react with water	

✡ Ca and Mg floats in water

✡ Na reacts violently with cold water. Reaction is highly exothermic. $H_2(g)$ evolved catches fire.

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

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

✡ Ca reacts less violently with cold water. $H_2(g)$ does not catches fire.
Ca starts floating in water as bubbles of $H_2(g)$ sticks to surface of Ca.

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

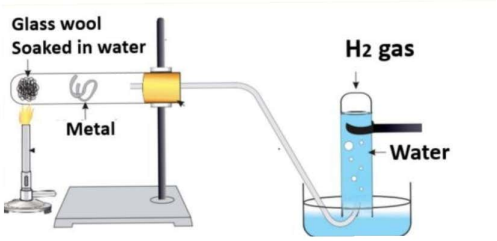
✡ Mg reacts with hot water. it also floats due to the $H_2(g)$ bubble sticking to its surface.

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

✡ Al, Zn, Fe reacts with steam to form oxides.

$$2Al + 3H_2O \longrightarrow Al_2O_{3(s)} + 3H_2$$

$$3Fe + 4H_2O \longrightarrow Fe_3O_{4(s)} + 4H_2$$



Reaction with Acids :-

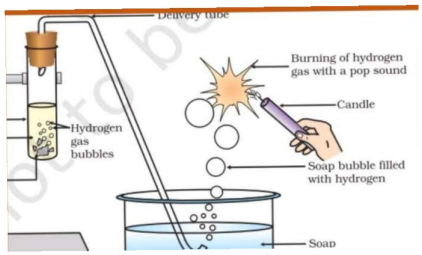
$$Metal + Dil.HCl \longrightarrow salt + H_2$$

$$Mg_{(s)} + 2dil.\ HCl \longrightarrow MgCl_2 + H_2$$

$$2Al + 6\ dil\ HCl \longrightarrow 2AlCl_3 + 3H_2$$

$$Zn + 2dil.\ HCl \longrightarrow ZnCl_2 + H_2$$

$$Cu + 2dil.\ HCl \not\longrightarrow CuCl_2 + H_2$$



- Bubbles of $H_2(g)$ are formed. $H_2(g)$ Burns with a pop sound and Extinguishes a burning candle.
- Rate of formation of bubble.
  - Mg > Al > Zn > Fe
  - Heat is evolved (exothermic Reaction order is same.

Special case of Nitric Acid

$$Metal + Dil\ Acid \longrightarrow salt + H_2$$ → oxidised to water

✓ $H_2(g)$ 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)

- $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
  (Blue) (aq) (Red)
- $Fe + CuSO_4 \longrightarrow FeSO_4(aq) + Cu$
  (Green) (Red)
- $Cu + ZnSO_4 \not\longrightarrow CuSO_4 + Zn$

Metal and Non-Metal React → ionic compound Electrovalent compound

Element	Atomic No.	Electronic configuration	
Sodium (Na)	11	2, 8, 1	Metal (lose e^-)
Magnesium (Mg)	12	2, 8, 2	
Calcium (Ca)	20	2, 8, 8, 2	
Chlorine (Cl)	17	2, 8, 7	Non-mel (gains e^-)
Oxygen (O)	8	2, 6	

Complete octet last shell = $8e^-$

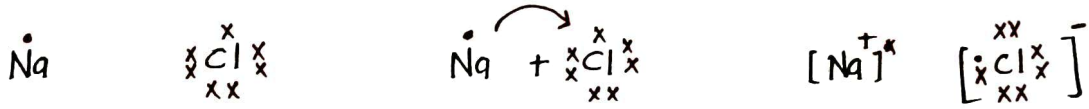
Formation of sodium chloride (Na^+Cl^-)

Na (11) = 2, 8, 1
Cl (17) = 2, 8, 7

$Na \longrightarrow Na^+ + e^-$ (cation)

$Cl + e^- \longrightarrow Cl^-$ (Anion)

e^- dot structure



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

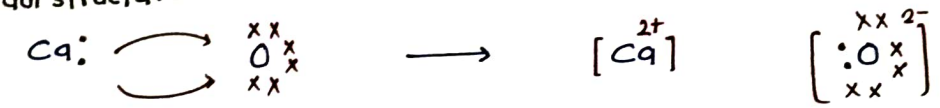
formation of calcium oxide

Ca(20) = 2,8,8,2
O(8) = 2,6

$Ca \longrightarrow Ca^{+2}$ cation

$O + 2e^- \longrightarrow O^{2-}$ Anion

✓ e^- dot structure



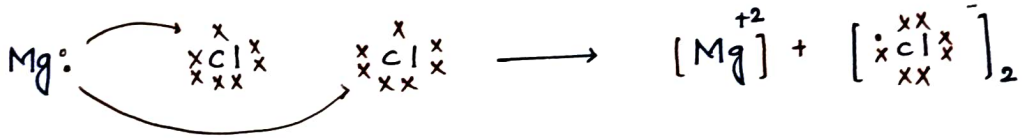
formation of Magnesium chloride ($MgCl_2$)

Mg(12) = 2,8,2
Cl (17) = 2,8,7

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

$2Cl + 2e^- \longrightarrow 2Cl^-$

✓ e^- dot structure



ionic / Electrovalent Compounds properties :-

(1) Hard, solid compounds because of strong force of attraction between +ve and -ve ions.

(2) Brittle in nature, Breaks into pieces if pressure is applied.

(3) Have High Melting and Boiling points because large amount of energy is required to break strong inter-ionic attraction.

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

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

(6) In molten state, Heat Energy weakens the strong electrostate forces of attraction and ions can move freely, hence in molten state conducts electricity.

(7) 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 :-

Minerals :- Elements or compound which occur naturally in earth's crust.

Ores :- Those minerals which contain a very high % of a particular metal and metal can be profitably extracted form it, are called ores.

Gangue :- impurities like soil, sand, etc present in metal ore.

Free Comb ko silver cup me Mercury liquid me dubaya.

Top in Activity series

(5) K, Na, Ca, Mg, Al — Very Reactive, so never found in free state as free metal.

Middle of Activity series

(3) Zn, Fe, Pb — moderately reactive. found in Earth's crust in form of oxides, sulphides and carbonates.

H

Low in Activity series

(5) Cu, Hg, Ag, Au, Pt — least reactive, hence found in free state as free metals

Trick

C O S → sulphides
↓ oxide
carbonates

C O S
C R

Extracting Metal → Middle of Activity series

1) Present as oxide, sulphides or carbonate in nature.
2) sulphides / carbonates converted to oxide as it's easy to attract metal from oxide.

- **Roasting :-** Heating sulphides ores strongly in presence of excess air.

$$2ZnS + 3O_2 \xrightarrow{Heat} \underset{(oxide)}{2ZnO} + 2SO_2$$

- **Calcination :-** Heating carbonate ores strongly in limited 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 low in Activity series

- Their sulphides are converted to oxides.
- The oxides on heating converts to metal, no reducing agent used.

✡ Cinnabar(HgS) ore → oxide Roasting

$$2HgS + 3O_2 \xrightarrow{Heat} 2HgO + 2SO_2$$

$$2HgO\,(s) \xrightarrow{Heat} 2Hg + O_2$$

✡ Cu_2S

$$2Cu_2S + 3O_2 \xrightarrow{Heat} 2Cu_2O + 2SO_2$$

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

K, Na, Ca, Mg, Al	Electrolysis
Zn, Fe, Pb, Cu	Reduction using carbon
Ag, Au	Found in native state

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: Al form oxides

$$\underset{\text{(molten)}}{Na^+Cl^-} \longrightarrow \underset{\text{(cation)}}{Na^+} + \underset{\text{(Anion)}}{Cl^-}$$

At cathode (−ve)

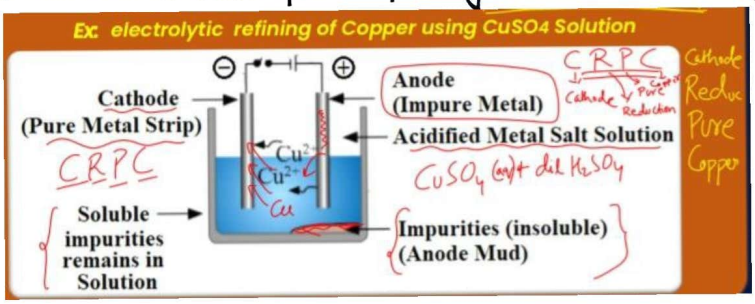
$$Na^+ + e^- \longrightarrow Na$$

At anode (+ve)

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

Refining of Metals

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



At Anode :- Pure copper enters solution.

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

Galvanisation :-

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

Anodising (Al_2O_3)

- process of forming a thick oxide layer of Al.
- This layer prevents corrosion of metal.
- The oxide layer also give 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 in fixed proportions.
step-3: cooling to room temperature.

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

(1) Pure iron is very soft and stretches easily when hot

Pure iron + carbon (0.05%) ⟶ Hand and strong iron carbon Alloy

(2) stainless steel – iron + Nickel + chromium
Hard and do not rust.

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

(4) Brass (Bcoz) - Alloy of Zn + Cu.

(5) Bronze (CoaT) - Alloy of copper and Tin (Cu + Sn)

(6) Solder (SoTeLa) - Alloy of Lead and Tin (Pb + Sn)

Trick

steal ke rod par
crow ne nicker
Pehan kar baitha hai

iron crow Nicker
↓ ↓ ↓
iron chromium Nick

Trick

✡ Brass (Bcoz) ⇒ Poor conductor of electricity
↓ ↓
Cu Zn

✡ Bronze (CoaT) ⇒ poor conductor of electricity
↓ ↓
Cu Tin

✡ Solder
↓
has low melting point.

Thermit Reaction / Welding :-

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe + Heat$$
(molten)

The above reaction is so highly exothermic, that heat given out produces metal in molten state. This molten metal is used to join railway tracks or cracked machine parts. This reaction is know as thermit reaction.

Corrosion :- • When a metal is attacked by substances around it such as moisture (water vapour & oxygen), acid etc it is said to be corrode and this process is called corrosion.

(i) Rusting of iron.

iron + O_2 + H_2O = Hydrated (Reddish Brown) (ironoxide)

(ii) Tarnishing of copper.

Copper $\xrightarrow[H_2O \\ CO_2]{O_2}$ copper Hydroxide + copper carbonate (green)

(iii) Tarnishing of silver.

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

Note :- Corrosion is an example of oxidation.

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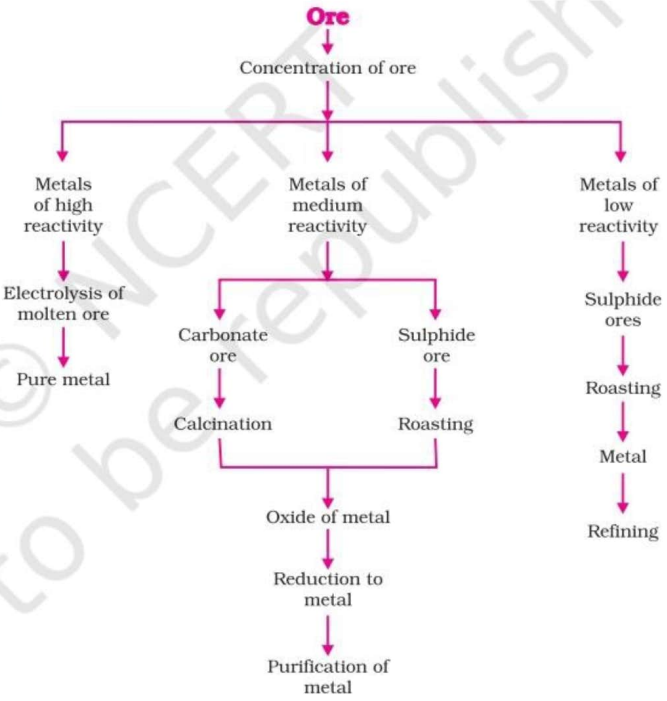

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