Science

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Ch-3

Metals and Non-Metals

→ Questions:

1.) $Na + HCl \longrightarrow NaCl_{(aq)} + H_{2(g)}$

It produces sodium chloride and hydrogen gas.

2.) X — Carbon, X - Diamond and Z - Graphite.

3.) Since, the reactivity of Gold and Platinum is least therefore it found in pure state in Earth's Crust.

4.) ZnO and Al_2O_3.

5.) Correct observation are Zinc and Iron. Since Copper is lower reactive than Hydrogen therefore it doesn't react apart magnesium is more reactive than Hydrogen therefore it reacts with acid to produce Hydrogen gas.

$Fe + HCl \longrightarrow FeCl_{2(aq)} + H_{2(g)}$

$Zn + HCl \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

6.) i.) Q > P > R > S

ii.) $Q + CuSO_4 \longrightarrow QSO_4 + Cu_{(aq)}$

Chapter-9

Metals and Non-Metals

→ Types of Elements (तत्व) :-

Metals (धातु)	Non-Metals (अधातु)	Metalloids (उपधातु)	Noble Gases (उत्कृष्ट गैस)

* Common Metals :- Lithium (Li), Sodium (Na), Potassium (K), Magnesium (Mg), Calcium (Ca), Aluminium (Al), Copper (Cu), Zinc (Zn), Silver (Ag), Gold (Au) etc.

* Common Non-Metals :- Carbon (C), Phosphorus (P), Sulphur (S), Selenium (Se), Iodine (I) — Solid at room temp. (25°C)

Hydrogen (H), Nitrogen (N), Oxygen (O), Fluorine (F), Chlorine (Cl), ~~Bromine (Br)~~ — Gaseous at room temp. (25°C)

Bromine (Br) — Liquid at room temp. (25°C)

* Common Metalloids :- Boron (B), Silicon (Si), Germanium (Ge), Antimony (Sb), Arsenic (As), Tellurium (Te).

* Common noble gases :- Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe) and Radon (Rn).

→ Physical Properties of Metals & Non-Metals

↓ {Behaviour} ↓ {उपयोग}

	Metals	Non-Metals
Hardness	Generally, hard except- Lithium, Sodium and Potassium, Mercury	Generally, soft except: Diamond. Form of ~~Diamond~~ Carbon. Naturally hard substance.
Lusture (The ability of metals to reflect the light rays)	~~Gen~~ lusturous ↓ Pure (native / free state.	Generally, non-lusterous, except - Graphite & Iodine
Malleability (Ability of metals to convert into thin sheets) - दबाव से	Generally, malleable except - Mercury and Zinc at room temp.	Non-malleable and brittle.
Ductility (Ability of metals to convert into thin wires) ↓ खींचाव से	Generally, ductile Except- Mercury	Generally, non-ductile except: Carbon fibre
Sonority (Ability of metals to produce Sound)	Sonorous	Non-Sonorous
Electrical Conductivity (∵ Free electrons)	Good electrical conductors	Generally, poor electrical conductors except: Graphite and Carbon form.

Heat Conductivity → due to atomic vibrations	Generally good conductors of heat. Except: lead, mercury and Bismuth	Generally poor Conductors of heat Except- Diamond ↓ forms of C
Melting Point (point where solid turns into liquid)	High melting point Except: Gallium (29.7°C) & Caesium (28.4°C) — melt on human palm (37°C)	Generally, low melting point. Except: Diamond form of Carbon

{Activity 3.5 shows that metals are good conductor of heat and have high melting point}

Note: Melting point & freezing point are same of any substance.

{Activity 3.6 shows that Metals are good Conductor of Electricity}

→ Insulator

{PVC is made up of rubber. prevent Electric Shock.}

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Fun Fact:-

- Gold — Most malleable Metal
- Platinum - Most ductile metal (Gold according to NCERT)
- Diamond - Best conductor of heat.
- Silver — Best Conductor of heat in all metals.
- Silver - Best Conductor of Electricity ⚡.

Silver > Copper > Gold > Aluminium

→ How Reactivity series was Built

Chemical properties of Metals

-O- Concept

Note:- More Reactive Metal :- easily loses electrons

-O- Concept

Note:- Metal 'A' reacts at a lower temp, than another metal (B). It means (A) is more reactive than 'B'.

-O- Concept:-

Note:- Metal 'A' reacts faster than B and releases more amount of heat & light energy as compared to Metal 'B'

It means that 'A' is more reactive than 'B'.

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* Reaction of metals with oxygen :-

Metal + oxygen → Metal oxide

Room temp. ⇒ $2Mg(s) + O_2(g) \rightarrow \underbrace{2MgO(s)}$ white layer

Strong Heating ⇒ $2Mg(s) + O_2(g) \rightarrow \underbrace{2MgO(s)}_{\text{white powder}} + Heat + light$

Room temp. or on low heating

Metal	Product formed	Colour of product	Colour of Flame
Potassium	K_2O	Yellow	lilac/Purple
Sodium	Na_2O	White	orange/Golden
Calcium	CaO	"	↑
Magnesium	MgO	"	
Aluminium	Al_2O_3	"	No flame (No light + energy)
Zinc	ZnO	"	
Iron	Fe_3O_4	Black	
Lead	PbO	Yellow	
Copper	CuO	Black	
Silver	←	No reaction →	
Gold	"	"	
Platinum	"	"	

Make Protective layer

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Conclusion:

Potassium and sodium — most reactive

Siver, Gold and Platinum — least reactive

Calcium, Aluminium, magnesium — All reactive but which is most

Zinc & Iron are more reactive than Lead & Cu but less than above metals but which is more reactive between lead and copper

→ Points to Notes:

All metals oxide / hydroxide are not basic

Basic

Amphoteric

Acid as well as Base

Amphoteric metals:

Aluminium

Zinc

etc.

Tin (Sn)

Pb (lead)

Neutralisation reaction
(D.D. reaction)

e.g.- $Al_2O_3(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2O(l)$

Al_2O_3 ↓ Basic; HCl ↓ Acid

Neutralisation reaction (D.D. reaction)

$Al_2O_3(s) + 2NaOH(aq) \rightarrow 2NaAlO_2(aq) + H_2O(l)$

Al_2O_3 ↓ Acidic; $NaOH$ ↓ Base

* Reaction of Metals with Water :-

$Na + H_2O \longrightarrow Na_2O + H_2$

Metal + Water → Metal oxide + Hydrogen + Heat

Why ?

↓

Reactivity of Sodium is greater than H_2

↓

Metal - non metal displacement reaction

↓

Mostly exothermic & Redox

IMPORTANT:- Oxides like Na_2O, K_2O, CaO, MgO are soluble in water of form metal hydroxide.

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* Reaction of metal with cold water

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ + heat

Rate of Reaction is more of K (potassium)

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

Density K, Na < H_2O

$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ + heat

- evolved H_2 doesn't catch fire
- Density of Ca > H_2O
- The tiny bubbles of H_2 gas formed stick to the surface of the calcium and hence it starts floating on the water

No other Metals React with Cold water.

* Reaction of Metals with Hot water

K > Na > Ca

~~Magn~~ $Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ + Heat

↓

Same as Calcium in cold water

No other metal react with Hot water

* Reaction of Metals with Steam:- K > Na > Ca > Mg

$2Al(s) + 3H_2O(g) \rightarrow Al_2O_3(s) + 3H_2(g) + Heat$

$Zn(s) + H_2O(g) \rightarrow ZnO(s) + H_2(g) + Heat$

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

evolved H_2 gas doesn't catch fire

Conclusion:- K > Na > Ca > Mg

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* Reaction of - Metals with Dilute Acids :-

Concept :- Metal + dil. Acid → Salt + H_2
(when reactivity metal > H_2 gas)

⇒ More reactive metal = More speed of reaction
= More H_2 gas.

When, Magnesium, Aluminium, Zinc, iron and lead reacts with dil. HCl the rate of formation of Hydrogen bubbles ever-

Mg > Al > Zn > Fe > Pb
↓
Amount of Heat evolved decreases

Metal (Mg & Mn) + dil. HNO_3 (Nitric Acid) →
Salt + H_2

But
(Oxidising agent)
Other Metals + dil. HNO_3 → Salt + Water
↳ oxidises H_2 to ↑
itself reduces to

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* Aqua Regia :-

↓

latin word — Royal water

Mixture of Concentrated HNO_3 and HCl in the ratio of 1:3.

↓

Dissolve gold & platinum.

Highly unreactive metals

* Reaction of Metals with Solutions of Other Metals :-

Metal A + Salt Solution of Metal B → Salt Solution of Metal A + Metal B

Reactivity of A > B

* When Strip of lead metal is in the blue-green Sol. of Copper Chloride.

$$Pb(s) + CuCl_2(aq) \longrightarrow PbCl_2(aq) + Cu(s)$$

Hence, reactivity of Pb > Cu

$NO / NO_2 / N_2O$

↑

$Cu(NO_3)_2 + Ag$
$Cu(NO_3)_2 + Au$
} No reaction

* Reaction of copper with silver nitrate Solution.

$$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

Hence, Reactivity of Cu > Ag.

↓

Metal, Metal displacement reaction

Conclusion: Cu is more reactive than Ag & Au as well.

* Silver (Ag) - Free state as well as Combined State
Gold (Au) - only Free State

Make Compounds

Hence, Ag > Au

↓

Reactivity

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Reactivity Series .....

K - Potassium
Na - Sodium
Ca - Calcium
Mg - Magnesium

} Reaction with Hot & Cold water

Al - Aluminium
Zn - Zinc
Fe - Iron
Pb - Lead

} Reaction with Dillute acid

H - Hydrogen → Behaves as Metals as well

Cu - Copper
Hg - Mercury
Ag - Silver
Au - Gold
Pt - Platinum

} Reaction with solution of other metal and occurence of silver & gold in the earth crust.

Allotropes
↓
Same Element
↓
Exist in different forms
↓
Same Physical State

* Reaction of Non-metals with oxygen & water.

{I} Non-Metal + Oxygen ⟶ Non Metal oxide

$C(s) + O_2(g) \longrightarrow CO_2(g)$

$S(s) + O_2(g) \longrightarrow SO_2(g)$

{II} Generally, non-metals don't react with water because they can't displace hydrogen from water.

Also a non metal

{III} Non-metal oxide + water ⟶ Acid

$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$ → {Carbonic Acid}

$2NO_2(g) + H_2O(l) \longrightarrow HNO_2(aq) + HNO_3(aq)$ (oxidises to)

↓

Nitric Acid

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$SO_3(g) + H_2O(l) \longrightarrow H_2SO_4(aq)$ → Sulphuric acid.

* Note:- Non-metallic oxides are acidic in nature :- CO_2, SO_2, SO_3 etc.

Non metallic oxides can be neutral in nature as well: CO, H_2O, N_2O etc

→ Ionic Compounds and its Properties

Cation (generally metals except NH_4^+) (loses electrons)

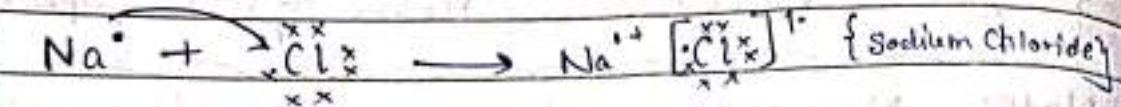
Anion (Non-metallic) (Gain electrons)

Element	(Z) (Atomic No.)	Electronic Configuration K	L	M
Na	11	2	8	1
Cl	17	2	8	7

$Na^{\cdot}$ and $\cdot\underset{\cdot\cdot}{\overset{\times\times}{Cl}}\overset{\times}{\underset{\times}{}}$

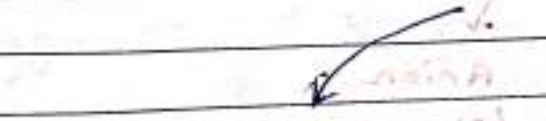
↓ To stable

$Na^{\cdot} \rightarrow Na^{+} + e^-$ and $\underset{\cdot\cdot}{\overset{\cdot\cdot}{Cl}} + e^- \rightarrow [\underset{\times\times}{\overset{\times\times}{Cl}}]^-$

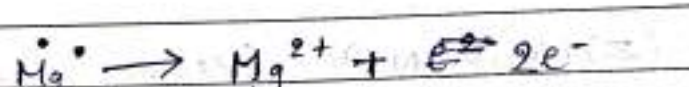


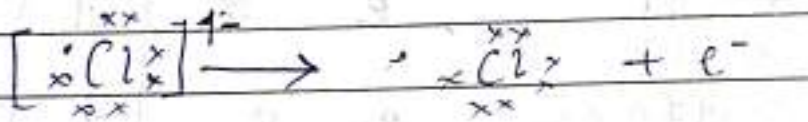
* Magnesium Chloride :-

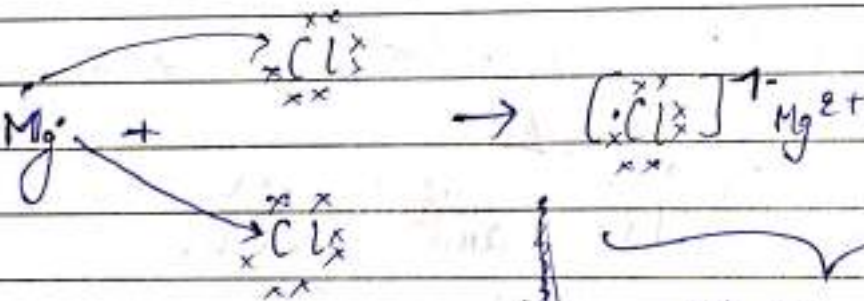
Element	(Z) (Atomic No.)	Electronic Configuration K L M
Mg	12	2 8 2
Cl	17	2 8 7



To stable it







$MgCl_2$ {Magnesium chloride}

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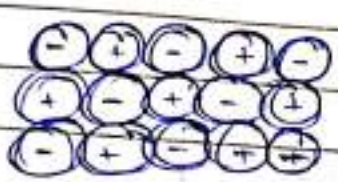
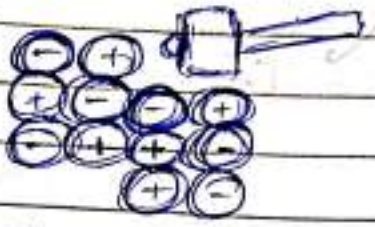
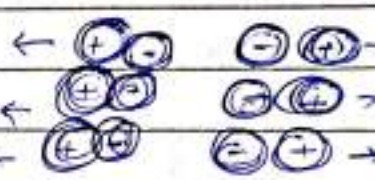
* Properties of Ionic Compounds :-

Physical Nature :- Generally brittle solids and breaks into pieces when pressure is applied.





Charge in Orientation



Same charges repel each other

Melting & Boiling Points :- High melting and boiling points to break down these strong electrovalent bonds.

Solubility :- Generally, soluble in water and insoluble in solvent like kerosene, petrol and more → except → $BaSO_4$, $CaCO_3$, PbI etc. insoluble in water

Electrical Conductivity :- Conducts electricity in molten & aqueous form and doesn't conduct electricity in solid form as the ions are immobile in the solid state.

$Na(s) \xrightarrow{800^\circ C} NaCl(l)$ {Molten / fused form} {ions move freely}

$Na(s) \xrightarrow{\text{dissolve in } H_2O} NaCl(aq)$ {aqueous form}

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→ **Metallurgy** :- Branch of Science that deals with extraction of metals economically & Conveniently.

- Metals → Free State / Pure / Elemental form → Au and Pt
  → Combined State → Compound form → oxides, Sulphides, Carbonates etc.

- Major Source of metal (combined & free state) – Earth's Crust

Minor Source of Metals or Soluble Salts in Seawater

- K, Na, Ca, Mg, Al } Metals of high reactivity → Always in Combined state
- Zn, Fe, Pb } metals of medium reactivity
- Cu, Hg, Ag } Metals of low reactivity → Combined as well as Free State
- Au, Pt } Metals of least reactivity → Always in Free State

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→ **Minerals and Ores :-** Metals occur naturally in the form of elements or compounds in the earth's crust or seawater and are called minerals.

↓ :
Free state

↓
Combined state

Earthly and rocky impurities in it is called gangue ~~and~~ or matrix.

* Metals are extracted from some minerals only because:

- process of extraction of metal from that mineral is not economicall.

- there are certain impurities that are hard to remove

Inconvenient

-O- The minerals from which metals can be extracted economically and conveniently are called ores.

All ores can be minerals but all minerals can't be ore.

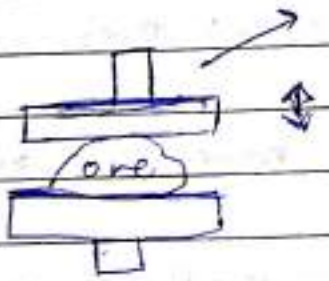
Note: ores of the most of the metals are in the form of oxides because oxygen is a very highly reactive element and is abundantly found in the earth's crust.

→ Ores of Some common metals

Metal	Name of ore	Formula
Sodium (Na)	Rock salt	NaCl
Aluminium (Al)	Bauxite	i $Al_2O_3.2H_2O$
Zinc (Zn)	i) Zinc blende	i ZnS
	ii) Calamine	ii $ZnCO_3$
Iron (Fe)	i) Haematite	i Fe_2O_3
	ii) Magnetite	ii Fe_3O_4
	iii) Iron Pyrite	iii FeS_2
	iv) Siderite	iv $FeCO_3$
Copper (Cu)	i) Copper glance	i Cu_2S
	ii) Cuprite	ii Cu_2O
	iii) Copper pyrite	iii $CuFeS_2$
Mercury (Hg)	Cinnabar	i HgS
Lead (Pb)	Galena	i PbS

* Crushing and Grinding of Ore :-

Crushing of ore

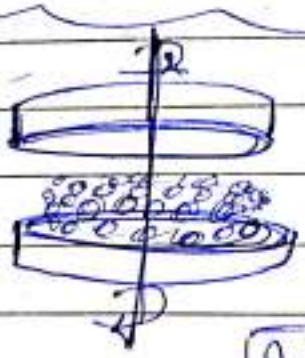


Impact force

↓

ore, is crushed into smaller pieces

Grinding of ore



→ Grinder

Ore is turned into powdered form.

Attrition force

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* Enrichment of Ore :-

↓

Importance

↓

Before extracting the metal, it is important to remove gangue or matrix

Principle of separation of gangue from ore:- the difference between the physical or chemical properties of the gangue and the ore.

* Extraction of Metal from Concentrated ore

→ Extraction of low reactivity metals

– Extraction of medium reactivity metals

– Extraction of high reactivity metals

Note:- ~~low~~ least reactive metal like Gold and Platinum are found in free state.

Note:- It is easy to extract metal from its oxide. Sulphide or Carbonates are firstly converted into oxides.

→ Extraction of metal of low reactivity :-

• Roasting :- Strongly heating the sulphide ore in excess of air below melting point.

↓

And the metal oxide obtained automatically reduces to convert into metals

↙ In case of low reactivity

↙ Removal of oxygen

↓ No Reducing agent required

low reactivity metals:- Mercury (Hg), Silver (Ag) and Copper (Cu)

* Case of copper :

Roasting — $2Cu_2S(s) + 3O_2(g) \xrightarrow{\Delta} 2Cu_2O(s) + 2SO_2(g)$

↓

Auto reduction — $2Cu_2O(s) + 2Cu_2S(s) \xrightarrow{\Delta} 6Cu(s) + SO_2(g)$

↓

Refining of metal

* Case of Mercury

Roasting — $2HgS(s) + 3O_2(g) \xrightarrow{\Delta} 2HgO(s) + 2SO_2(g)$

Auto reduction → $HgS(s) + 2HgO(s) \xrightarrow{\Delta} 3Hg(l) + SO_2(g)$

↓

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

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→ Extraction of metal ores of medium reactivity :-

Zn, Fe, Pb are some metals of ↗ medium reactivity ↘ found in sulphides, oxides or carbonates.

* Roasting V/S Calcination

Roasting	Calcination
i) Used for sulphide ore.	i) Used for carbonate ore.
ii) Sulphide ore is strongly heated in excess air below its melting point.	ii) Carbonate ore is strongly heated in the absence of air below its melting point.
iii) Metal sulphide + oxygen $\xrightarrow{\Delta}$ Metal oxide + Sulphur dioxide	iii) Metal carbonate $\xrightarrow{\Delta}$ Metal oxide + CO_2 gas
iv) ↓ gas evolved.	↓ gas evolved.

* Case of Zinc

Ore - ZnS (zinc blende) - Sulphide ore

Roasting - $2ZnS(s) + 3O_2(g) \xrightarrow{\Delta} 2ZnO(s) + 2SO_2(g)$

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* Another case of zinc :-

Ore - Calamine ($ZnCO_3$) → (Carbonate ore)

Calcination - $ZnCO_3(s) \xrightarrow{\Delta} ZnO(s) + CO_2(g)$

↓

Next step is :- Reduction of metal oxide to metal.

↓

Reducing agents such as carbon, aluminium are used

* Reduction of metal oxide by carbon (coke) — Smelting

Cheap ← lack of fixed shape ← Porous (holes) & amorphous form of carbon

Convinent

Process takes place in Smelter.

Reduction of oxygen — oxidising agent } Reduction

$ZnO(s) + C(s) \xrightarrow{\Delta} Zn(l) + CO(\uparrow)$

(Coke)

Addition of oxygen - reducing agent } oxidation

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~~Fe2~~ $Fe_2O_3(s) + 3C(s) \xrightarrow{\Delta} 2Fe(l) + 3CO(g)$

* Reduction of Metal oxide by aluminium - Aluminothermy

{Pyrolusite}

~~3 MNO~~ $3MnO_2(s) + 4Al(s) \xrightarrow{\Delta} 3Mn(l) + 2Al_2O_3(s) + heat.$

↓

Reactivity of Al > Mn

- Metal - Metal displacement reaction
- All are redox reaction
- Generally, exothermic

{Why Carbon is not used in Case Mn}

↓

Al > Mn therefore it easily forms Aluminium oxide. But with carbon it is not ~~possible~~ done satisfactorily.

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* Application of Aluminothermy :-

$Fe_2O_3(s) + 2Al(s) \xrightarrow{\text{Ignited by Mg ribbon}} 2Fe(l) + Al_2O_3(s) + \text{Heat}$

(Reddish brown powder) → Fe: molten

Heat → because of this

The reaction is therefore used for welding the broken parts of iron machinery, railway tracks etc.

The reaction is known as thermite reaction.

displacement, exothermic and redox reaction

→ Extraction of Metal from high reactivity metal ore :-

K, Na, Ca, Mg and Aluminium are

↓

Extracted from Chlorides or oxides.

Metal - Na → NaCl (Ore)

AL → Al_2O_3

the oxides / chlorides of highly reactive metals are quite stable, cannot be reduced by any reducing agent. They have more affinity for oxygen or chlorine.

↓

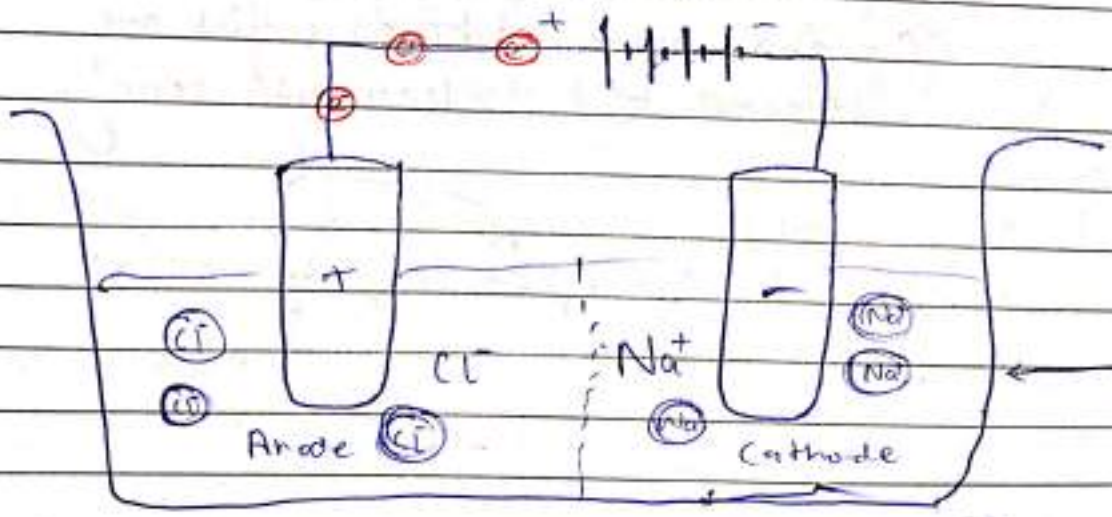
A special reduction process

↓

Electrolytic Reduction

↓

Type of electrolysis. The oxides / chlorides of metals in fused / molten state are electrically reduced by using this method.



Molten/fused state of NaCl

↓

$NaCl(s) \xrightarrow{880^\circ C} NaCl(l)$

Na^+ Cl^-

Cathode: reduction (gain of electrons)

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

Anode: oxidation (loss of electrons)

$Cl^{1-} \longrightarrow Cl + e^-$

$2Cl^{1-} \longrightarrow Cl_2 + 2e^-$

↓

Pure metal is obtained from this

→ Refining / Purification of metals

↓

Metals obtained after extraction still contains some impurities which are removed by: Electrolytic refining

Cu, Zn, Au, Ag, Ni etc.

↓

Nickel

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* Process:

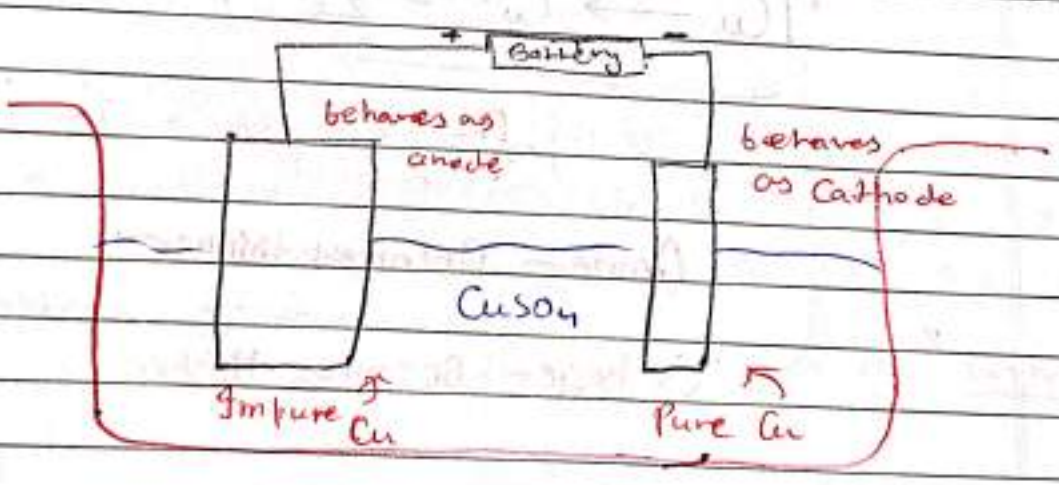
i) the set up consists of an electrolytic tank that contains copper sulphate solution,

Electrolyte
↓
that breaks into ions

Metal salt is taken as electrolyte whose refining is done.

Here, $CuSO_4$!

ii) A thick block of impure copper metal is connected to the positive terminal that behaves as anode.

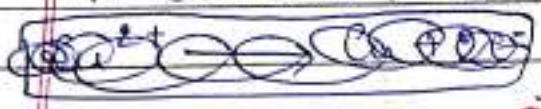


iii) A thin strip of pure copper metal is connected to the negative terminal it behaves as cathode

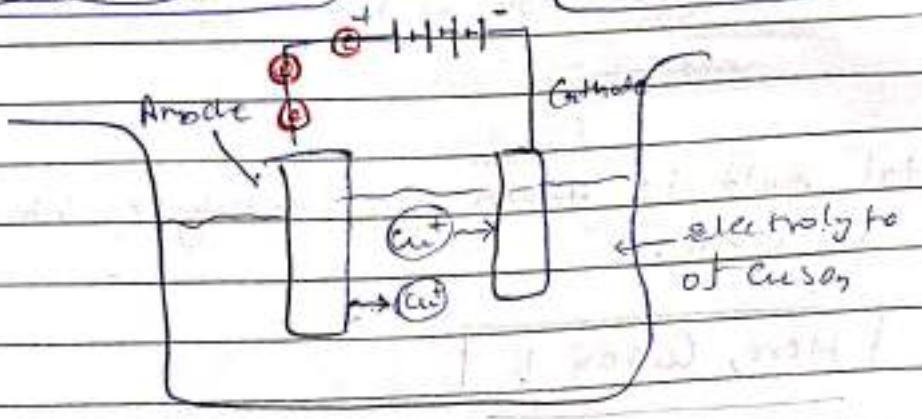
* Refining :

$CuSO_4(aq) \longrightarrow Cu^{2+} + SO_4^{2-}$

At Cathode :- Reduction (gain of electrons)



$Cu^{2+} + 2e^- \rightarrow Cu$



At anode - oxidation - loss of electrons

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

⇩

Anode - Becomes thinner

Cathode - Becomes thicker

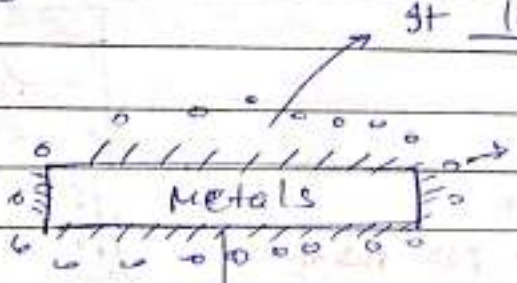
What happens to the impurities then

Soluble impurities
↓
Fe
↓ loses electrons
Fe^{2+} and moves into the solution

Insoluble impurities
↓
Ag & Au
↓
won't dissolve in electrolyte & will deposit below anode as anode mud.

→ Corrosion, its types and ways to prevent it.
↓

It is a surface degradation process of metals in which they convert to a more stable form, i.e. oxides, sulphides, carbonates and more, due to the attack of atmospheric gases.



Metals
↓
love to lose electrons

↓
It can be oxides, sulphides, carbonates etc.

↓
love to accept electrons

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* Corrosion & its Types

1. Rusting of Iron: Iron reacts with moist air to form hydrated ferric oxide

↓

Reddish brown

↓

$4Fe(s) + 3O_2(g) + x H_2O(g) \rightarrow 2Fe_2O_3 . XH_2O(s)$

Rust → Flaky (non-sticky)

→ Hydrated ferric oxide

→ lets Analyse

→ Rusting will happen

In Case of Boil water No rusting performed because

Oxygen (x) Water (✓) dissolved oxygen in water

(✓)

In case of Normal water → Rusting will be perform

Oxygen (x) Water (✓) Oxygen dissolved in water (✓)

No Rusting Happen

* Air (O_2) (✓)
* Water (water vapour (✗)

In case of moist Air

* Air (O_2) (✓)
* Water / water vapour (✓)

↓

Rusting will be happen

Q- Tarnishing of Copper : Copper reacts with moist Carbon dioxide gas in the air to form copper Carbonate.

↓

Green Colour.

$2Cu(s) + CO_2(g) + O_2(g) + H_2O(g) \rightarrow CuCO_3.Cu(OH)_2(s)$

Copper carbonate hydroxide

Also called Patina

Stick — Non-brittle.

- Tarnishing of Silver: Silver reacts with hydrogen sulphide gas present in the air to form silver sulphide.

Black in colour

$4Ag(s) + 2H_2S(g) + O_2(g) \rightarrow 2Ag_2S(s) + 2H_2O(g)$

Patina
(Protective layer)

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* Pros of Corrosion - Patina

Patina seems to be helpful for some of the metals like copper (Cu), which on oxidation forms an impervious protective layer that protects further corrosion (here tarnishing) of metal.

↘ Protective layer

*

* Cons of Corrosion :- Rusting

Rust is a flaky layer that is brittle and peels off, it then exposes the fresh iron layer to moisture and oxygen. This continuous cycle makes iron objects weak and can collapse buildings and bridges, break oil pipe lines and more.

* Ways to Prevent Corrosion - Rusting

i) Barrier Protection :- In this a layer is introduced between iron and factors that cause rusting, i.e. oxygen and water vapour.

Some of the ways are :- Painting and applying oil or grease

ii) Sacrificial Protection :- In this layer of more reactive metal is placed on a less reactive. the more reactive prevents Oxygen and

Water to come in contact with iron and gets corroded in place of iron.

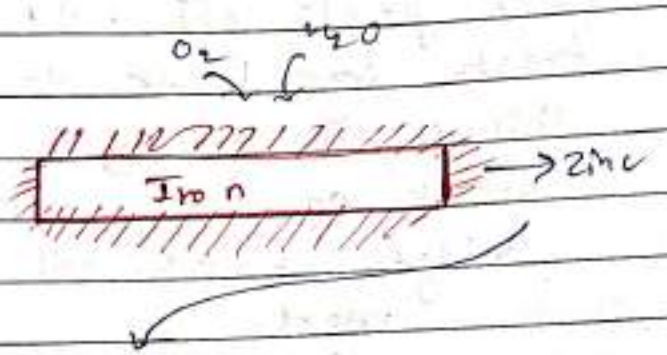
↓

Galvanisation

↓

Requires a lot of maintenance.

If the layer of zinc breaks on iron, will iron rust or zinc?



Zinc will corrode again at place of Fe b/c Zn is more reactive than Fe.

(ii.) **Alloying** :- In alloying two or more than two metals or metals along with small amount non-metals are mixed. It is a permanent solution to prevent corrosion.

Alloy:- Homogenous (uniform composition) or Heterogeneous (non-uniform composition) mixture of metals or metals with non-metals.

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* Objective of Alloying

i) To increase hardness.
ii) To increase tensile strength. — Converted into Iron → Steel
iii) To reduce melting point. — Solder
iv) To increase resistance to corrosion. — Iron to stainless steel
v) To decrease electrical Conductivity. — Mixture of metals or non-metals increase resistance.

∴ Pure Iron — Tensile Strength is low
(Tensile Strength: Max. force (tensile force) bear up by a substance before fracture.)

∴ Mixed with Carbon

More to know:- Stainless Steel ← Iron + Chromium + Nickel

- Not prone to rusting
- Used to create utensils

- Resistance to corrosion.
- Prevents from getting stains

- Provides hardness.

* Pure gold - 24 Carat gold — Soft - break easily.

Ornamental gold - 22 Carat gold - 22 parts by weight of gold is alloyed with 2 parts by weight of either Copper or Silver.

Provides strength ←

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Au and Pt are use to make jewellery because they are least reactive therefore doesn't corrode easily and lose their lusture.

* Common Alloys:-

i.) Brass - Copper (80%) & Zinc (20%) - Utensils, Screw etc.

ii.) Bronze - Copper (90%) and Tin (10%) - coins, bells etc.

iii.) German silver - Copper (60%) Zinc (20%) and Nickel (20%) - Electroplating

iv.) Solder - lead (50%) and Tin (50%) - For joining electrical wires together.

v.) Alnico - Al + Ni + Co (cobalt)

Note:- the alloys of mercury with any other metal is called amalgam

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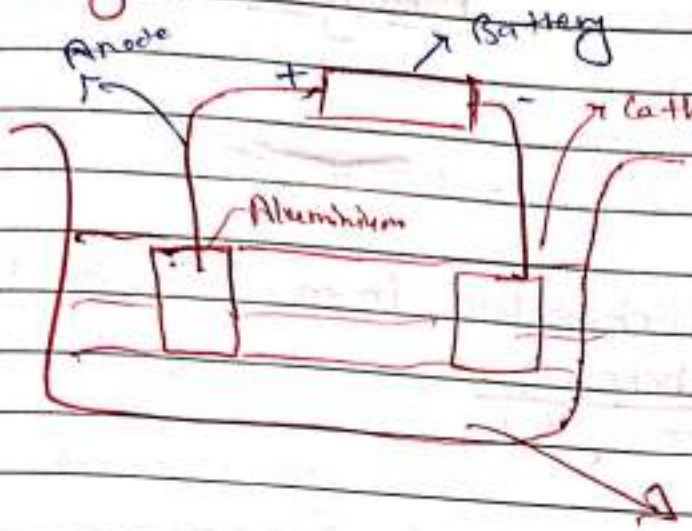
Anodising :-



$2H^+, SO_4^{2-}$

$H_2SO_4 \rightarrow H_2O \rightleftharpoons H^+ + OH^-$

Cathode - reduction - gain of electrons

$2H^+ + 2e^- \rightarrow H_2$

Anode - oxidation - loss of electrons

$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

O_2 → Reacts with AL and makes Al_2O_3 more thicker.

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Ch-3 :- Metals & Non-Metals

List of Reactions :-

1.) $2Cu + O_2 \rightarrow 2CuO$
{Copper} {Copper(II) oxide}

2.) $4Al + 3O_2 \rightarrow 2Al_2O_3$
{Aluminium} {Aluminium oxide}

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

4.) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$
{Sodium Aluminate}

5.) $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$

6.) $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

7.) $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g) + Heat$

8.) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Heat$

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

10.) $2Al + 3H_2O(g) \rightarrow Al_2O_3(s) + 3H_2(g)$

11.) $3Fe + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

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12) Metal A + Salt Solution of B → Salt solution of A + Metal B

→ Low Activity Metals -

13) $2HgS(s) + 3O_2(g) \xrightarrow{Heat} 2HgO(s) + 2SO_2(g)$

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

14) $2Cu_2S + 3O_2(g) \xrightarrow{\Delta} 2Cu_2O(s) + SO_2(g)$

$2Cu_2O + Cu_2S \xrightarrow{\Delta} 6Cu(s) + SO_2(g)$

→ Medium Activity Metals -

15) Roasting -

$2ZnS(s) + 3O_2(g) \xrightarrow{\Delta} 2ZnO(s) + SO_2(g)$

Calcination -

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

16) $ZnO(s) + C(s) \longrightarrow Zn(s) + CO(g)$

17) $3MnO_2(s) + 4Al(s) \longrightarrow 3Mn(l) + 2Al_2O_3(s) + Heat$

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

→ High Activity Metals—

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19.7 At cathode :- $Na^+ + e^- \rightarrow Na$

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