CLASS-XI

BRUSH UP for NEET/JEE 2020

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

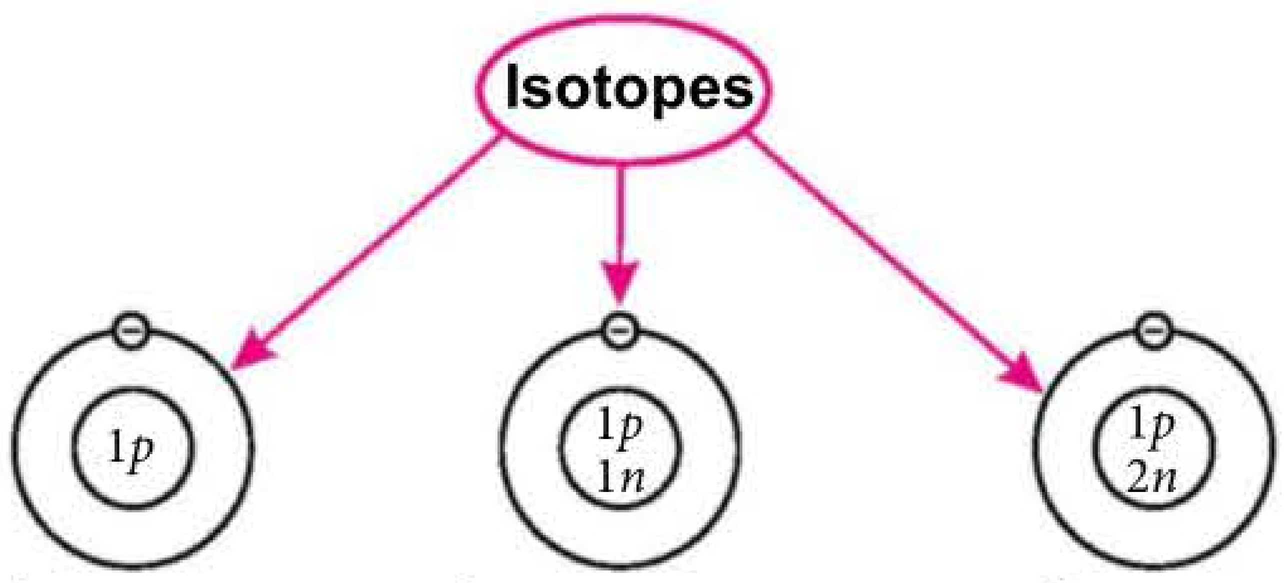
Unit 5 Hydrogen | *s*-Block Elements

Hydrogen

- Hydrogen is the most abundant element in the universe.
- Hydrogen has the simplest atomic structure of all the elements, and consists of a nucleus containing one proton and one orbital electron. The electronic structure may be written as $1s^1$.

General Characteristics	
Name, Symbol, Atomic number	hydrogen, H, 1
Chemical nature	non-metals
Group, Period, Block	1, 1, *s*
Appearance	colourless
Atomic mass	1.00794
Electronic configuration	$1s^1$
Electrons per shell	1

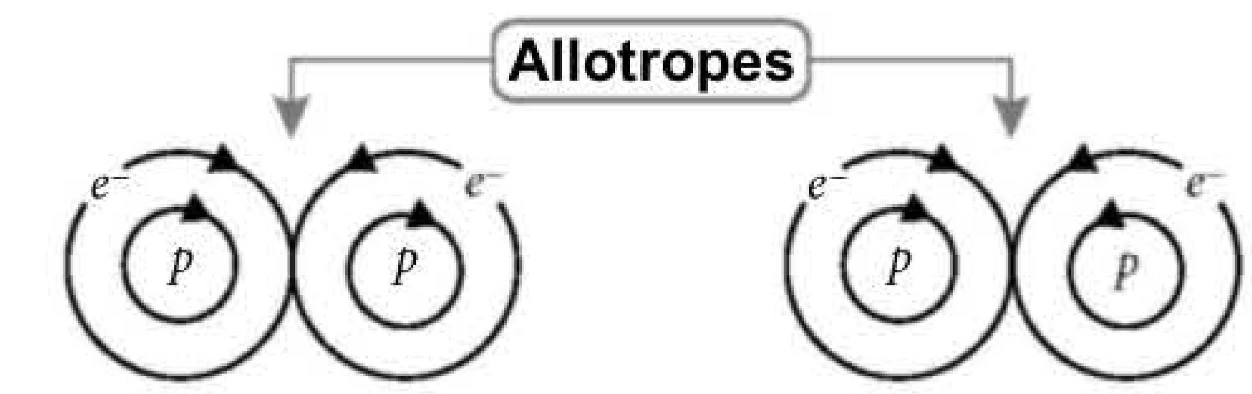
Isotopes



^1_1H Protium (Hydrogen) ^2_1H Deuterium (Heavy hydrogen) ^3_1H Tritium (Radioactive hydrogen)

- **Bond Energy and Reactivity**
  Bond energy : $H_2 < D_2 < T_2$
  Reactivity : $H_2 > D_2 > T_2$
- The difference in the properties of isotopes which arises due to difference in their atomic masses is called isotopic effect.

Allotropes

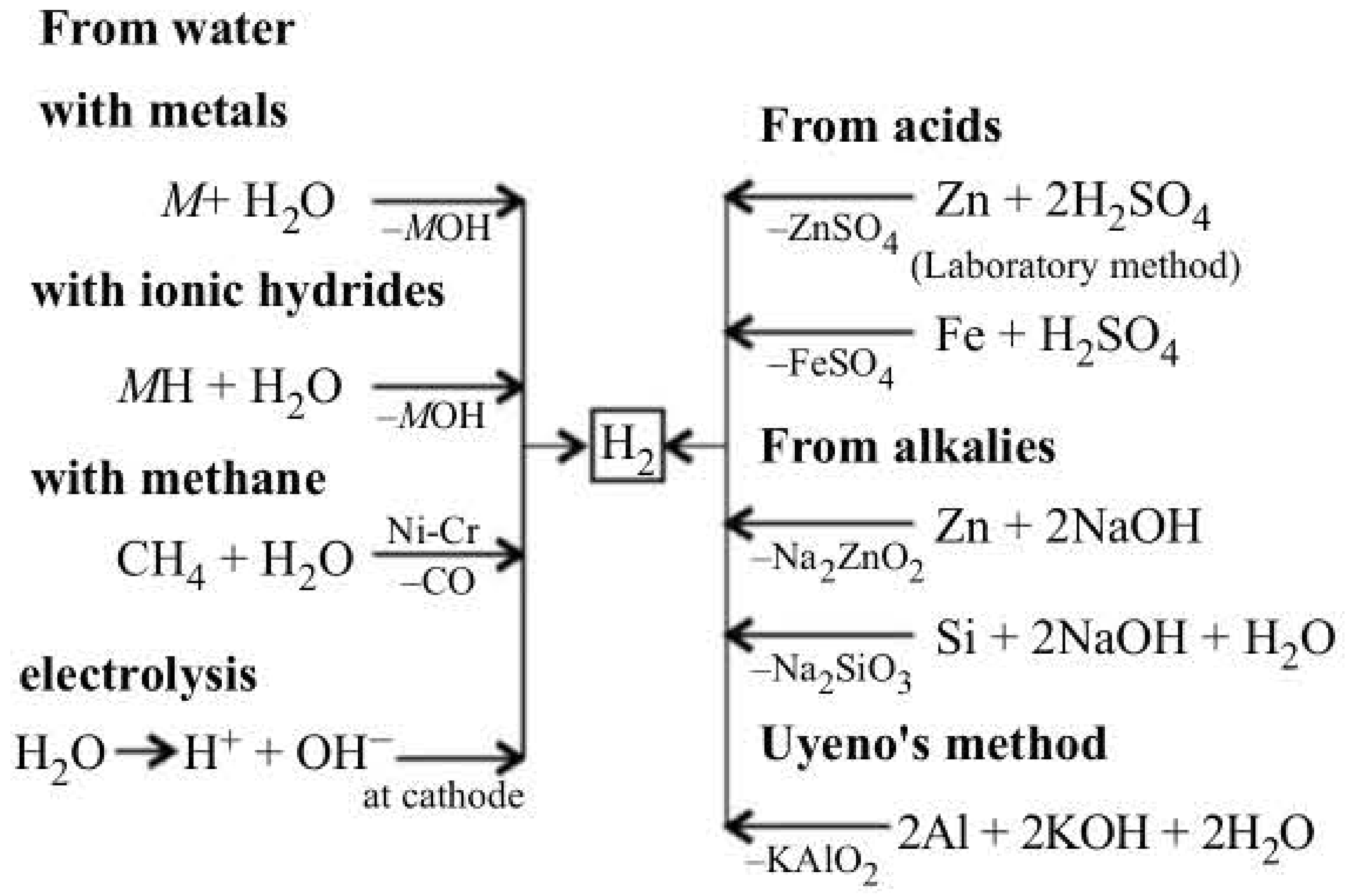


Ortho-hydrogen (Parallel nuclear spin *i.e.*, spins of both protons in hydrogen molecule are in the same direction.)

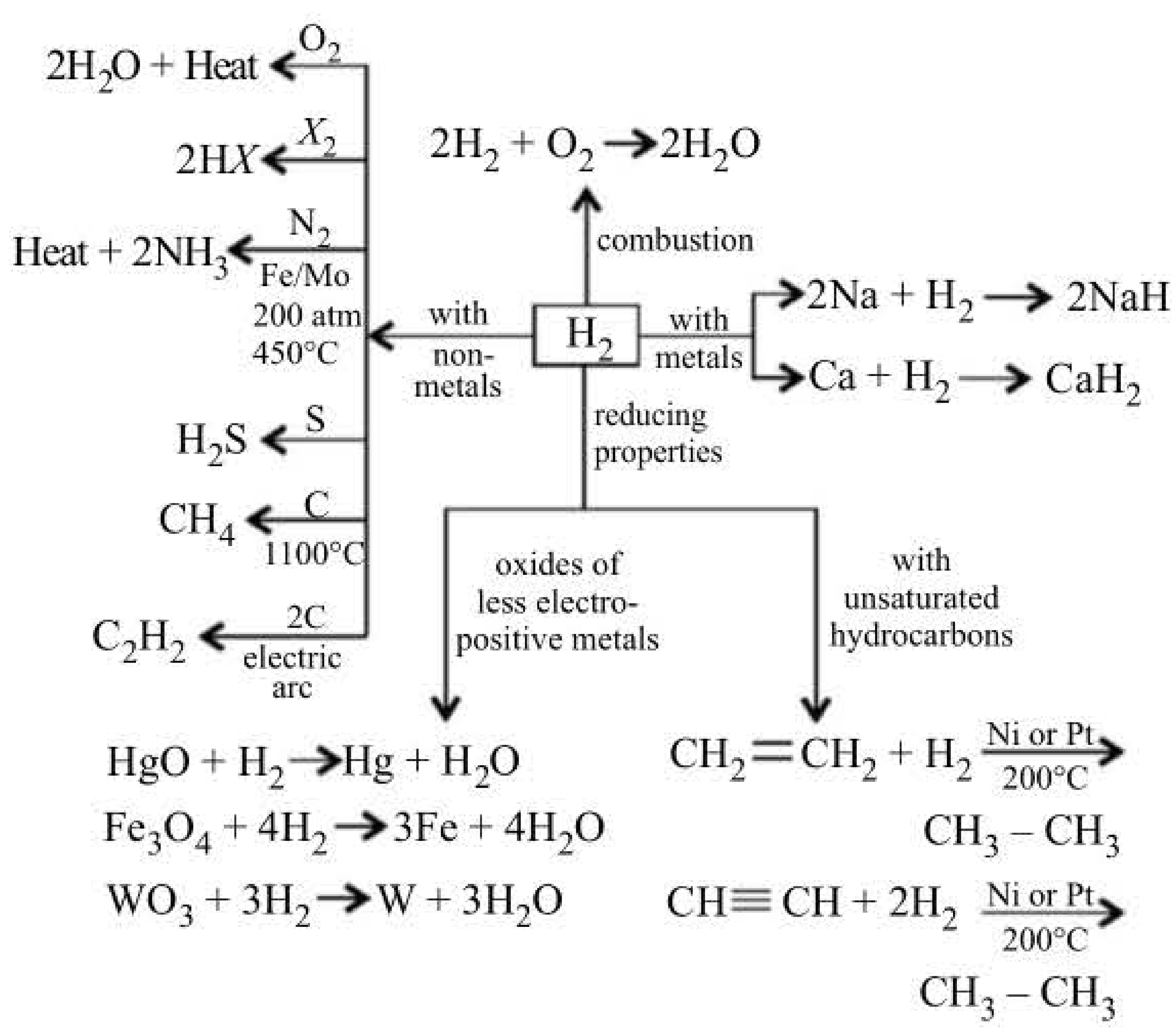
Para-hydrogen (Anti-parallel nuclear spin *i.e.*, spins of both protons in hydrogen molecule are in the opposite directions.)

- At room temperature, ordinary hydrogen contains 75% *ortho*-hydrogen and 25% *para*-hydrogen. As the temperature decreases, the percentage of *ortho* hydrogen in the mixture decreases. Pure *para* hydrogen can be prepared by cooling nearly to absolute zero but pure *ortho* hydrogen cannot be prepared.
- **Stability :** *Ortho* hydrogen > *Para* hydrogen.
- Differences in physical properties of both is because of differences in internal energy of both.
- Internal energy of *ortho* H_2 > *para* H_2.

Preparation of Hydrogen



Chemical Properties of Hydrogen



Hydrides

- Dihydrogen, under certain reaction conditions, combines with almost all elements except noble gases to form binary compounds called hydrides. If '*E*' is the symbol of an element, then hydride can be expressed as EH_x (*e.g.*, MgH_2) or E_mH_n (*e.g.*, B_2H_6).

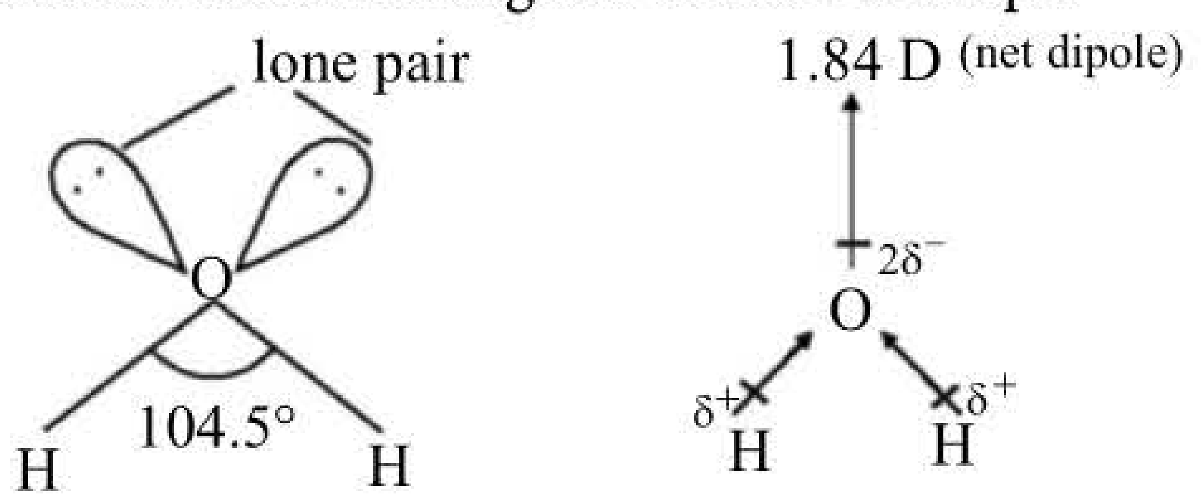
Classification of Hydrides

Ionic hydrides	These are formed by transfer of electrons from most of the *s*-block elements (electropositive metals) to hydrogen atom. *e.g.*, $2Li_{(s)} + H_{2(g)} \xrightarrow{973\text{ K}} 2LiH_{(s)}$ $2Na_{(s)} + H_{2(g)} \xrightarrow{973\text{ K}} 2NaH_{(s)}$
Molecular or covalent hydrides	Compounds of hydrogen with *p*-block elements and some *s*-block elements (Be & Mg). In some cases partly covalent and partly ionic character is found, *e.g.*, HF. $N_2 + 3H_2 \xrightarrow{\text{catalyst, 750 K}} 2NH_3$ $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$
Metallic or interstitial hydrides	Compounds of hydrogen with *d*-block and *f*-block metals. These are non-stoichiometric and show electric conduction.

- Elements of groups 7, 8, 9 do not form hydrides. This region of periodic table is referred to as hydride gap.

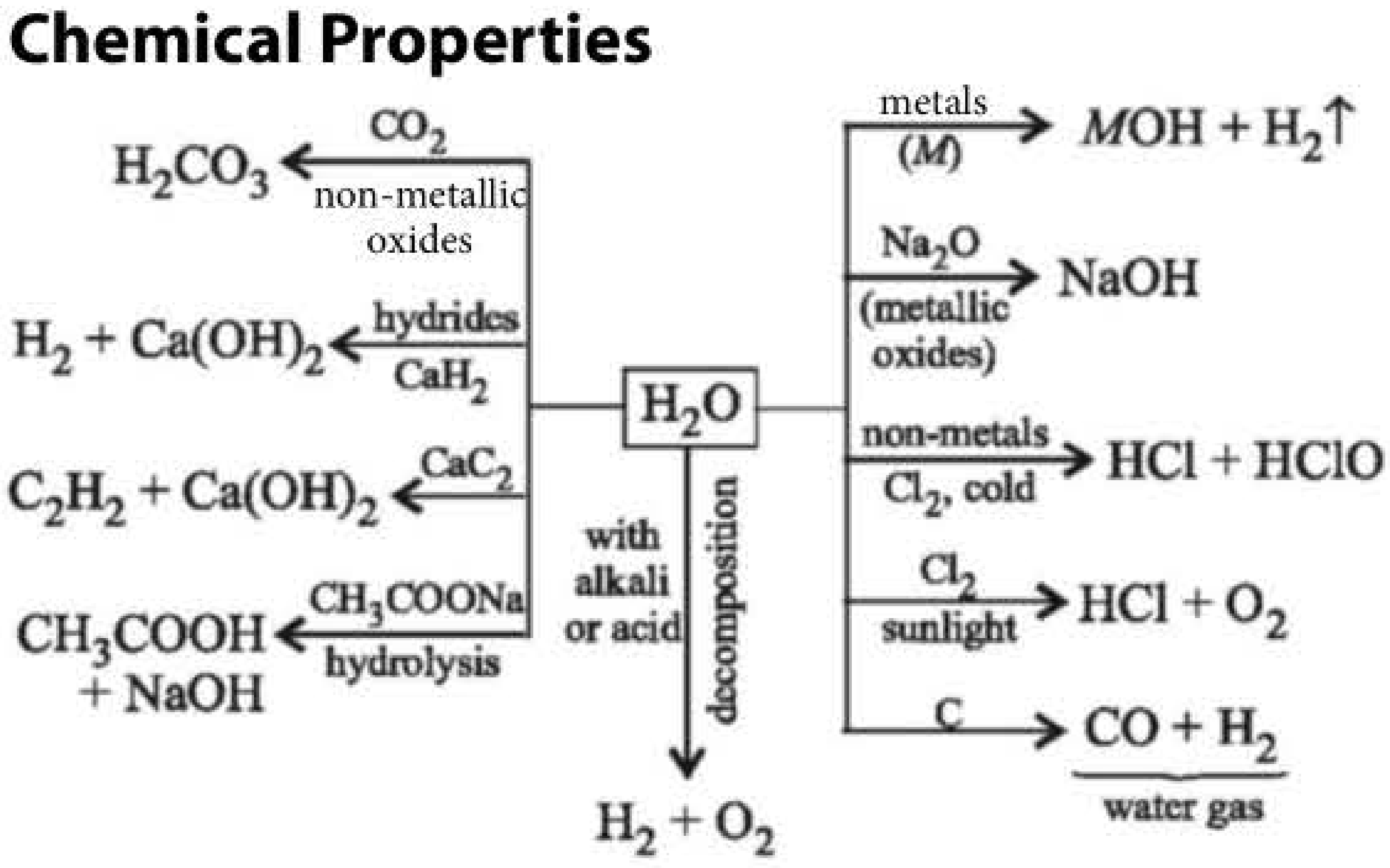
Water

- Water is a covalent molecule in which oxygen undergoes sp^3 hybridisation and contains two lone pairs.
- Due to the presence of two lone pairs of electrons on the oxygen atom, the H—O—H bond angle is 104.5°. Molecule is angular or bent in shape.



- In solid state (ice) water molecules are arranged in highly ordered three dimensional open cage like structure through hydrogen bonding.
- This arrangement leads to a packing with large open spaces and results in lower density of ice than that of liquid water.

Chemical Properties



Hard and Soft Water

- **Soft water :** Water which forms lather with soap easily is called soft water.
- **Hard water :** Water which does not form lather with soap easily and hence is unfit for washing is called hard water.

Types of Hard Water

Permanent hardness : It is due to the presence of soluble chlorides and sulphates of Ca and Mg. It can be removed by treating it with Na_2CO_3.

$CaSO_4 + Na_2CO_3 \rightleftharpoons CaCO_3\downarrow + Na_2SO_4$

$MgCl_2 + Na_2CO_3 \rightleftharpoons MgCO_3\downarrow + 2NaCl$

Removal of permanent hardness is affected by ion exchangers like zeolite, permutit and synthetic resins, etc.

Temporary hardness : It is due to the presence of bicarbonates of Ca and Mg. It can be removed by

(a) Boiling :

$$\underset{\text{Soluble bicarbonates}}{M(HCO_3)_2} \overset{\Delta}{\rightleftharpoons} \underset{\text{Insoluble carbonates}}{MCO_3\downarrow} + H_2O + CO_2\uparrow$$

Here, M = Mg or Ca

(b) Clark's process :

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$

Heavy Water (D_2O)

- Discovered by Urey.
- It is obtained from ordinary water by prolonged electrolysis.
- Heavy water is colourless, odourless and tasteless mobile liquid. Nearly all the physical constants are higher than the corresponding values of ordinary water.

Chemical Properties of Heavy Water

- Heavy water is chemically similar to ordinary water, However D_2O reacts slowly than H_2O.
- $SO_3 + D_2O \rightarrow \underset{\text{Deuterosulphuric acid}}{D_2SO_4}$
- $\underset{\text{Aluminium carbide}}{Al_4C_3} + 12D_2O \rightarrow \underset{\text{Deutero methane}}{3CD_4} + 4Al(OD)_3$
- $\underset{\text{Calcium carbide}}{CaC_2} + 2D_2O \rightarrow \underset{\text{Deutero ethyne}}{DC{\equiv}CD} + Ca(OD)_2$

Uses :

- As a neutron moderator in nuclear reactors.
- For the preparation of deuterium.
- As a tracer compound for studying reaction mechanisms.

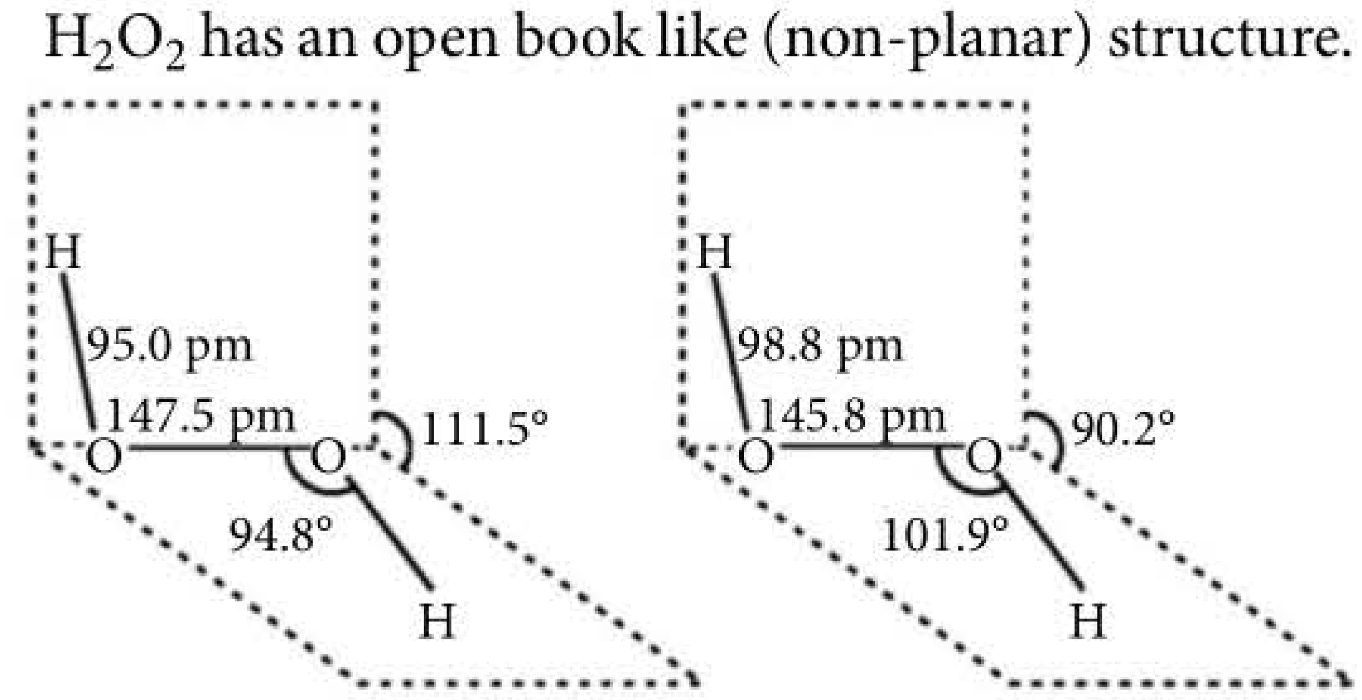
Peep Into Previous Years

1. The correct statements among (I) to (IV) are :
   I. Saline hydrides produce H_2 gas when react with H_2O.
   II. Reaction of $LiAlH_4$ with BF_3 leads to B_2H_6.
   III. PH_3 and CH_4 are electron - rich and electron-precise hydrides, respectively.
   IV. HF and CH_4 are called as molecular hydrides.
   (a) I, II, III and IV (b) III and IV only
   (c) I, III and IV only (d) I, II and III only
   (JEE Main 2019)

2. The method used to remove temporary hardness of water is
   (a) synthetic resins method
   (b) Calgon's method
   (c) Clark's method
   (d) ion-exchange method. *(NEET 2019)*

Hydrogen Peroxide or Oxygenated Water (H_2O_2)

- It is the hydride of oxygen.
- Its boiling point is higher than H_2O due to the presence of stronger intermolecular hydrogen bonding than in water.
- **Structure :**
  H_2O_2 has an open book like (non-planar) structure.



Gas phase   Solid phase

Preparation

From sodium peroxide

$Na_2O_2 + 2H_2O$ (Ice-cold) $\longrightarrow 2NaOH + H_2O_2$

Merck's process :

$Na_2O_2 + H_2SO_4$ (Dilute (20%) (cold)) $\longrightarrow Na_2SO_4 + H_2O_2$

From barium peroxide

$BaO_2\cdot 8H_2O + H_2SO_4$ (Ice-cold) $\longrightarrow BaSO_4 + H_2O_2 + 8H_2O$

$3BaO_2 + 2H_3PO_4 \longrightarrow Ba_3(PO_4)_2\downarrow + 3H_2O_2$

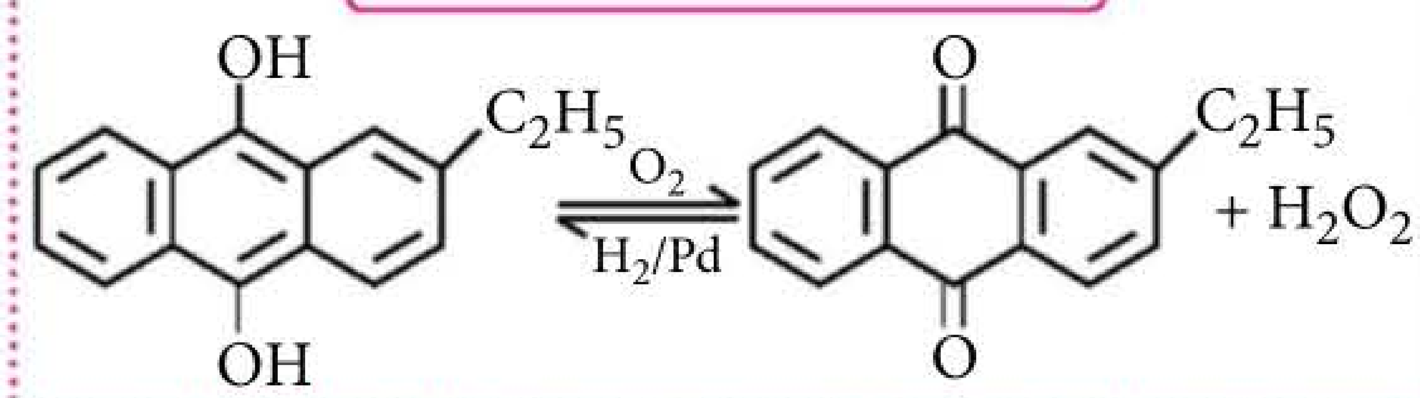
$BaO_2 + CO_2 + H_2O \longrightarrow BaCO_3\downarrow + H_2O_2$

From electrolysis of $(NH_4)_2SO_4$ and H_2SO_4

$(NH_4)_2SO_4 + H_2SO_4 \longrightarrow 2NH_4HSO_4 \xrightarrow{\text{Electrolysis}}$

$(NH_4)_2S_2O_8 \xrightarrow{2H_2O} 2NH_4HSO_4 + H_2O_2$

From 2-ethylanthraquinol



Chemical Properties

H_2O_2

Oxidising nature

- $\xrightarrow{C_6H_6} C_6H_5OH$
- $\xrightarrow{HCHO} HCOOH$
- $\xrightarrow[H_2SO_4]{K_2Cr_2O_7} K_2SO_4 + CrO_5$ (Blue)
- $\xrightarrow{Na_3AsO_3} Na_3AsO_4$
- $\xrightarrow{KI} I_2$
- $\xrightarrow[H_2SO_4]{FeSO_4} Fe_2(SO_4)_3$
- $\xrightarrow{PbS} PbSO_4$
- $\xrightarrow{CH_2=CH_2}$ CH_2OH–CH_2OH
- $\xrightarrow{\text{Bleaching nature}} H_2O + [O]$

Reducing nature

- $\xrightarrow{Ag_2O} 2Ag$
- $\xrightarrow{Cl_2} 2HCl$
- $\xrightarrow[H_2SO_4]{KMnO_4} MnSO_4$ (Colourless)
- $\xrightarrow[H_2SO_4]{K_2Cr_2O_7} Cr_2(SO_4)_3$ (Green)
- $\xrightarrow{O_3} H_2O$
- $\xrightarrow[KOH]{K_3[Fe(CN)_6]} K_4[Fe(CN)_6]$

Uses

- As an antiseptic.
- As an antichlor.
- As an oxidant for rocket fuel.
- Used to control pollution.
- Restores the colour of the old lead paintings.

Strength of Hydrogen Peroxide Solution

- **Volume strength of H_2O_2 :** Volume strength of H_2O_2 means the volume of O_2 released by decomposition of 1 volume H_2O_2. For example, H_2O_2 of x volume strength means 1 mL or 1 L of H_2O_2 on decomposition gives x mL or x L of oxygen respectively.

  $$\underset{2\times 34\text{ g}}{2H_2O_2} \longrightarrow 2H_2O + \underset{22.4\text{ L at STP}}{O_2}$$

  i.e., 22.4 L of oxygen is released from 68 g H_2O_2, then x L of oxygen will be released from

  $$= \frac{68}{22.4}\times x = \frac{17x}{5.6}\text{ g of }H_2O_2$$

  $$\text{Strength} = \frac{17x}{5.6}\text{ g/L}$$

- $$\text{Normality} = \frac{\text{Strength}}{\text{Equivalent weight}} = \frac{17x}{5.6}\times\frac{1}{17} = \frac{x}{5.6}$$

  ∴ Normality of H_2O_2 solution

  $$= \frac{\text{Volume strength of }H_2O_2}{5.6}$$

- $$\text{Molarity} = \frac{\text{Normality}}{2} = \frac{x}{11.2}\ \text{(Valency factor = 2)}$$

  ∴ Molarity of H_2O_2 solution

  $$= \frac{\text{Volume strength of }H_2O_2}{11.2}$$

PEEP INTO PREVIOUS YEARS

3. The chemical nature of hydrogen peroxide is
   (a) oxidising and reducing agent in both acidic and basic medium
   (b) oxidising agent in acidic medium, but not in basic medium
   (c) oxidising and reducing agent in acidic medium, but not in basic medium
   (d) reducing agent in basic medium, but not in acidic medium. *(JEE Main 2019)*

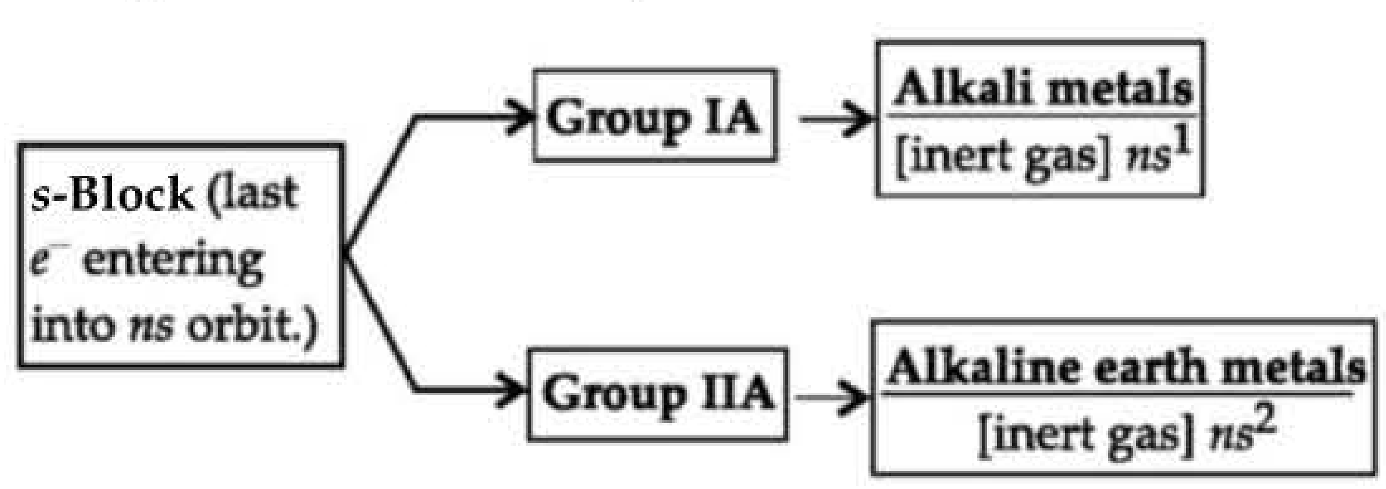
4. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively
   (a) $(H_2O + O_2)$ and H_2O
   (b) $(H_2O + O_2)$ and $(H_2O + OH^-)$
   (c) H_2O and $(H_2O + O_2)$
   (d) H_2O and $(H_2O + OH^-)$ *(JEE Main 2018)*

POINTS FOR EXTRA SCORING

- **Nascent hydrogen :** Hydrogen at the moment of formation is know as nascent hydrogen. It can reduce compounds that do not readily react with normal hydrogen.
  e.g., $Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H$
  (Nascent hydrogen)
- **Adsorbed or occluded hydrogen :** Some metals (*e.g.*, Pd, Pt, Au, Fe, Ni) can adsorb under certain conditions relatively large volumes of hydrogen. For example, one volume of palladium adsorbs 935 volumes of hydrogen while cooling from red heat. The gas thus adsorbed by metals is given off when the metal is heated especially under reduced pressure. The phenomenon was termed as occlusion or adsorption by Graham.
- **Active hydrogen** : When ordinary hydrogen at room temperature is subjected to the action of silent electric discharge at an electrical pressure more than 30,000 volts, it changes into an active variety of hydrogen. This is called active hydrogen.
- **Atomic hydrogen :** When hydrogen is passed through an electric arc established between two tungsten filaments, hydrogen is dissociated into atoms. This form of hydrogen is known as atomic hydrogen. The life period of atomic hydrogen is 0.3 seconds. It readily returns to ordinary form.
- Hydrogen forms polymeric hydrides like $(BeH_2)_n$, $(AlH_3)_n$, $(InH_3)_n$, $(GaH_3)_n$, $(SiH_4)_n$ etc. with elements having electronegativity in the range of 1.40 to 2.0 and also forms complex hydrides like $NaBH_4$, $LiBH_4$, $LiAlH_4$ where, H^- acts as a ligand.

s-Block Elements

The *s*-block elements are those in which the last electron enters the outermost *s*-orbital. Two groups (1 and 2) belongs to the *s*-block of periodic table.



GROUP 1 ELEMENTS : ALKALI METALS

Property	Li	Na	K	Rb	Cs	Fr
At. no. (*Z*)	3	11	19	37	55	87
Electronic configuration	[He] $2s^1$	[Ne] $3s^1$	[Ar] $4s^1$	[Kr] $5s^1$	[Xe] $6s^1$	[Rn] $7s^1$

Physical Properties

Group 1 Elements (ns^1)

Physical state : Alkali metals are silvery white, soft and light metals. They have only one valence electron, so the metallic bond is not so strong which makes them soft metals.

Hydration of ions : Degree of hydration of alkali metal ions decreases in the order : $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$.

Oxidation state : All the alkali metals exhibit an oxidation state of +1.

Conductivity : Increases down the group due to the presence of loosely held valence electron which is free to move throughout the metal structure.

Density : Increase from Li to Cs. However, potassium is lighter than sodium (anomaly) due to an unusual increase in atomic size of potassium.

Electropositive or metallic character : Alkali metals are strongly electropositive because of their low ionisation energies.

Melting and boiling points : Due to weak intermetallic bonding, alkali metals have very low m.pt. and b.pt.

Flame colouration : All the alkali metals impart a characteristic colouration to the flame.

Li	Na	K	Rb	Cs
Crimson red	Golden yellow	Pale violet	Violet	Violet

Gradation in Properties

Property	Trend (Li → Cs)	Elements	Trend (Cs → Li)	Property
Atomic radii Atomic volume Density Reducing power Electropositivity Large anion stabilisation	Increases (↓)	Li Na K Rb Cs	Increases (↑)	M.pt. and b.pt. Hardness Ionisation enthalpy Heat of atomization Hydration enthalpy Electronegativity

Diagonal relationship between lithium and magnesium

- Lithium shows diagonal relationship with magnesium since they have the same charge/size ratio *i.e.* polarising power.
- Li and Mg show close resemblance in the following :

Nitrides	Li and Mg both form nitrides. Other alkali metals do not. $6Li + N_2 \xrightarrow{\Delta} 2Li_3N$, $3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$
Carbonates	Like $MgCO_3$, Li_2CO_3 is decomposed by heat (the other alkali carbonates are thermally stable). $MgCO_3 \xrightarrow{\Delta} MgO + CO_2$, $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
Nitrates	$LiNO_3$ decomposes to give Li_2O like $Mg(NO_3)_2$, but other alkali metal nitrates give nitrite. $Mg(NO_3)_2 \xrightarrow{\Delta} MgO + 2NO_2 + 1/2O_2$; $2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + 1/2O_2$
Oxides	Both give their normal oxides (Li_2O, MgO) when they burn in oxygen.
Hydration	Both Li^+ and Mg^{2+} are heavily hydrated.

Anomalous Behaviour of Li

All alkali metals	Li
Do not react directly with N_2 or C.	Forms Li_3N or Li_2C_2
Form amide (MNH_2) with ammonia.	Forms Li_2NH
Nitrates are thermally stable.	$LiNO_3$ is Not Stable
Carbonates are thermally stable.	$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
Form double salts (alums) from their sulphates.	Forms Li_2SO_4

Chemical Properties

Chemical properties

Reaction with oxygen

$4M + O_2 \longrightarrow 2M_2O$

(where, M = Li, Na, K, Rb, Cs)

When heated with excess of air.

$4Li + O_2 \longrightarrow 2Li_2O$ (Lithium oxide)

$2Na + O_2 \xrightarrow{575\ K} Na_2O_2$ (Sodium peroxide)

Reaction with water

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

Solution in liquid ammonia

$M + (x + y)NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$

Ammoniated cation responsible for conductivity; Ammoniated electron responsible for blue colour and paramagnetism

Reaction with hydrogen

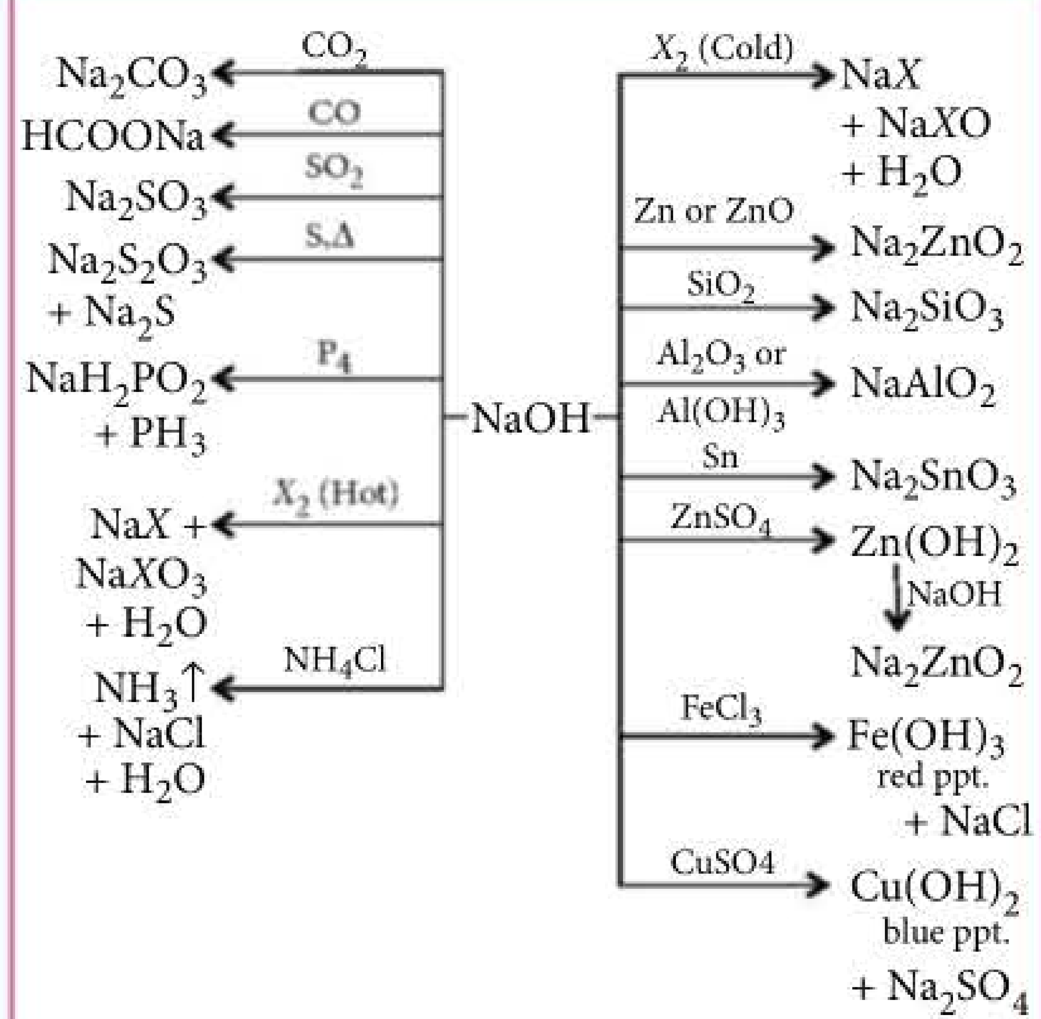
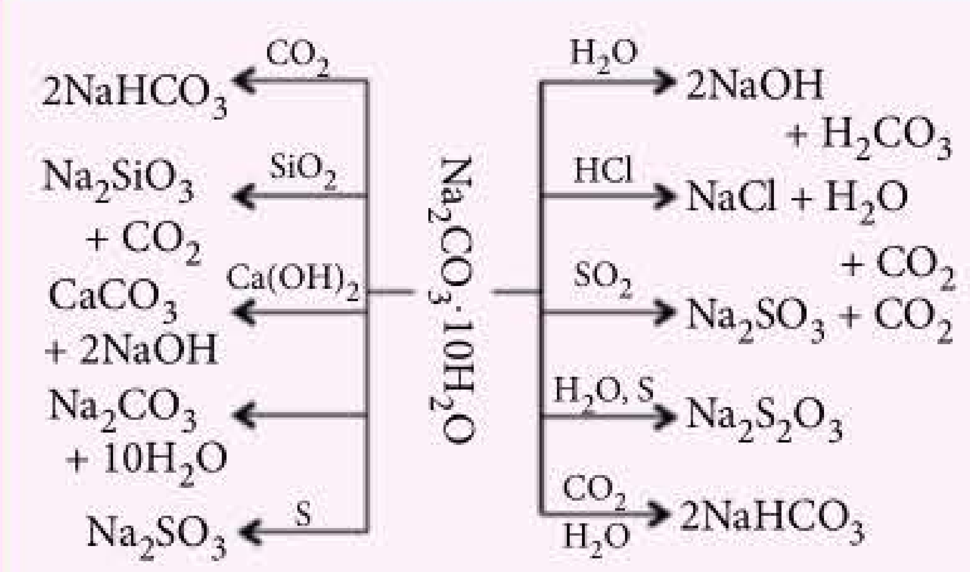
$2M + H_2 \xrightarrow{\Delta} 2MH$ (M = Li, Na, K, Rb or Cs)

Reaction with halogens

$2M + X_2 \longrightarrow 2MX$

(where, M = Li, Na, K, Rb or Cs and X = F, Cl, Br or I)

Some Important Compounds of Sodium

Compound	Preparation	Properties	
		Physical	Chemical
Sodium hydroxide or caustic soda (NaOH)	Electrolytic process in mercury cathode cell $2NaCl_{(aq)} + 2H_2O_{(l)} \longrightarrow \underbrace{H_{2(g)}}_{\text{At cathode}} + \underbrace{Cl_{2(g)} + 2NaOH_{(aq)}}_{\text{At anode}}$	NaOH is deliquescent, white crystalline solid. NaOH dissolves readily in water to yield highly alkaline solution which is corrosive, soapy in touch and bitter in taste.	
Sodium carbonate or washing soda ($Na_2CO_3 \cdot 10H_2O$)	Sodium carbonate is manufactured by Solvay process. Brine solution is saturated with ammonia and then made to react with CO_2. Sodium bicarbonate being sparingly soluble, crystallises out. This is finally calcined to form sodium carbonate. $NH_3 + NaCl + H_2O + CO_2 \longrightarrow NaHCO_3\downarrow + NH_4Cl$ $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$	$Na_2CO_3 . 10H_2O$ is a white crystalline solid which effloresces in air to given the powdery monohydrate $Na_2CO_3 \cdot H_2O$, which on heating gives anhydrous amorphous sodium carbonate called soda ash.	

Sodium hydrogen carbonate or baking soda ($NaHCO_3$)	Obtained as an intermediate product in Solvay process. $NaCl + NH_3 + CO_2 + H_2O \longrightarrow NaHCO_3 + NH_4Cl$ It can also be prepared by passing CO_2 through solution of sodium carbonate. $Na_2CO_3 + CO_2 + H_2O \longrightarrow 2NaHCO_3$	It is a white crystalline powder and less soluble than sodium carbonate. It is weakly alkaline which gives yellow colour with methyl orange but no colour with phenolphthalein.	$NaHCO_3$ on heating decomposes to produce bubbles of CO_2 which make the cakes and pastries fluffy. $2NaHCO_3 \xrightarrow[100°C]{\Delta} Na_2CO_3 + H_2O + CO_2$ It is amphiprotic *i.e.*, it can act as H^+ donor as well as H^+ acceptor. $HCO_3^- + H^+ \rightleftharpoons H_2CO_3$; $HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$

Peep Into Previous Years

5. In KO_2, the nature of oxygen species and the oxidation state of oxygen atom are, respectively
(a) superoxide and −1/2 (b) oxide and −2
(c) peroxide and −1/2 (d) superoxide and −1.
(JEE Main 2018)

6. Both lithium and magnesium display several similar properties due to the diagonal relationship, however, the one which is incorrect, is
(a) both form nitrides
(b) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(c) both form basic carbonates
(d) both form soluble bicarbonates.
(JEE Main 2016)

Group 2 Elements : Alkaline Earth Metals

Property	Be	Mg	Ca	Sr	Ba	Ra
At. no. (Z)	4	12	20	38	56	88
Electronic configuration	[He] $2s^2$	[Ne] $3s^2$	[Ar] $4s^2$	[Kr] $5s^2$	[Xe] $6s^2$	[Rn] $7s^2$

Physical Properties

Group 2 Elements (ns^2)

Atomic and ionic radii : Smaller than corresponding alkali metals and increases down the group.

Oxidation number and valency : All form divalent cations and exhibit +2 oxidation state.

Physical state : All are silvery white when freshly cut, light, malleable and soft but harder than alkali metals.

Conductance : Good conductors of heat and electricity.

Ionisation enthalpy : Higher than corresponding alkali metals and decreases down the group.

Melting and boiling points : Higher than alkali metals and do not show any regular trend because of different crystal structures adopted by different metals.

Electropositive or metallic character : Less electropositive or metallic than alkali metals.

Density : Denser, heavier and harder than alkali metals and density decreases from Be to Ca and then increases.

Electronegativity : Higher than corresponding alkali metals and decreases down the group.

Gradation in Properties

Increases (down the group)		Increases (up the group)
Atomic radii Electropositivity Reducing power Stability of carbonates, hydroxides and sulphates Solubility and basic strength of oxides and hydroxides	Be Mg Ca Sr Ba	Ionization enthalpy Electronegativity Hydration enthalpy Solubility of carbonates and bicarbonates Solubility of halides

Anomalous Behaviour of Be

All alkaline earth metals	Be
Form ionic non-volatile nitrides.	Be_3N_2 is covalent and volatile.
Form ionic carbonates.	$BeCO_3$ is unstable.
Form basic oxides.	BeO is amphoteric.

DIAGONAL RELATIONSHIP BETWEEN Be AND Al

- The similarity between Be and Al arises due to their same electronegativity, polarising power and the charge / radius ratio of their ions.
- Be^{2+} and Al^{3+} favour covalent bonding due to same charge to radius ratio.
- Both become passive on treating with conc. HNO_3.
- Both Be_2C and Al_4C_3 on hydrolysis give methane.
  $Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$
  $Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$
- $Be(OH)_2$ dissolves in excess of alkali to give a beryllate ion $[Be(OH)_4]^{2-}$, $Al(OH)_3$ gives aluminate ion $[Al(OH)_4]^-$.
- Both Be and Al form complexes like $[BeF_4]^{2-}$ and $[AlF_6]^{3-}$.
- Both BeO and Al_2O_3 or $Be(OH)_2$ and $Al(OH)_3$ are amphoteric in nature.

Chemical Properties

Chemical properties

Reaction with hydrogen (formation of hydrides)

All the alkaline earth metals except Be combine with hydrogen directly on heating to form metal hydrides of formula, MH_2.

$M + H_2 \xrightarrow{\Delta} MH_2$

Reaction with halogens

They react with halogens at elevated temperature to form the halides of the type MX_2.

Reaction with ammonia

Like alkali metals, the alkaline earth metals dissolve in liquid ammonia to give deep blue-black solution from which ammoniates $[M(NH_3)_6]^{2+}$ can be recovered.

Reaction with carbon

When BeO is heated with carbon at 2175 – 2275 K a brick red coloured carbide is formed.

$2BeO + 3C \xrightarrow{2175-2275\text{ K}} Be_2C + 2CO$

$Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$

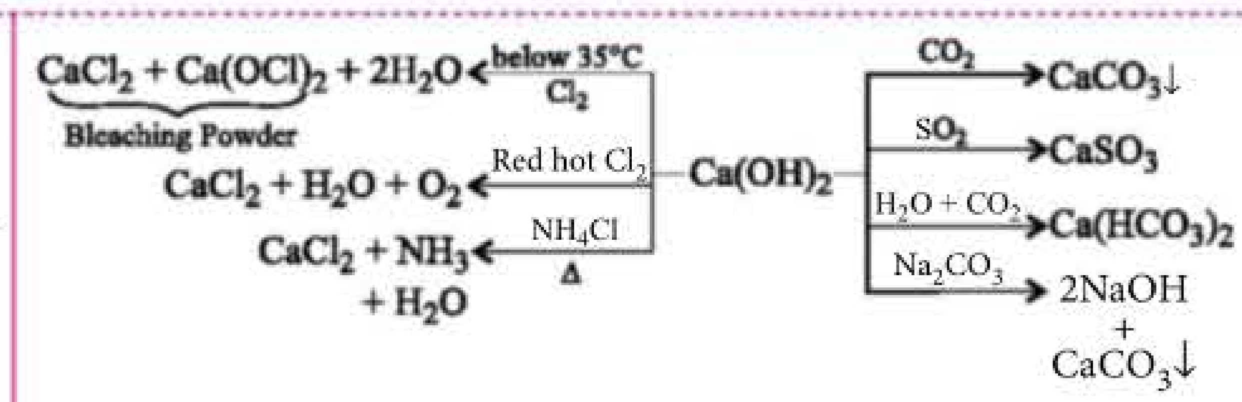
Action of acids

They readily react with acids liberating hydrogen.

$M + 2HCl \longrightarrow MCl_2 + H_2$ (M = Be, Mg, Ca, Sr, Ba)

Some Important Compounds of Calcium

Compound	Preparation	Properties	
		Physical	Chemical
Calcium oxide or quick lime (CaO)	$\underset{\text{Limestone}}{CaCO_3} \underset{}{\overset{1070-1270\text{ K}}{\rightleftharpoons}} CaO + CO_2$	CaO is white amorphous solid having m.pt. 2870 K.	$Ca(OH)_2 \xleftarrow{H_2O} CaO \xrightarrow{SiO_2} CaSiO_3$ $CaCO_3 \xleftarrow{CO_2} CaO \xrightarrow{P_4O_{10}} Ca_3(PO_4)_2$ **Uses :** It is used as a basic lining in furnaces.

Calcium hydroxide or slaked lime $Ca(OH)_2$	$CaO + H_2O \rightarrow Ca(OH)_2$ $CaCl_2 + 2NaOH \rightarrow Ca(OH)_2 + 2NaCl$	It is a white amorphous powder which is sparingly soluble in water. The aqueous solution is known as lime water and a suspension of slaked lime in water is known as milk of lime.	 **Uses :** It is used for white washing and for softening of water.
Calcium carbonate $(CaCO_3)$	$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$	$CaCO_3$ is a white fluffy powder, insoluble in water.	$CaCO_3 \xrightarrow{1200\text{ K}} CaO + CO_2$ $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$ **Uses :** It is used as precipitated chalk in tooth-pastes, cosmetic powder etc.
Plaster of Paris or hemihydrate calcium sulphate $(CaSO_4\cdot\frac{1}{2}H_2O)$	$\underset{\text{Gypsum}}{2(CaSO_4\cdot 2H_2O)} \xrightarrow{393\text{ K}} \underset{\text{Plaster of Paris}}{2(CaSO_4)\cdot H_2O} + 3H_2O$ If heated above 393 K, anhydrous $CaSO_4$ is formed called dead burnt plaster.	It is a white powder. It has a remarkable property of setting with water. On mixing with an adequate quantity of water it forms a plastic mass that gets into a hard solid in 5-15 minutes.	$2(CaSO_4)\cdot H_2O \xrightarrow[H_2O]{\text{Setting}} \underset{\text{Orthorhombic}}{CaSO_4\cdot 2H_2O} \xrightarrow{\text{Hardening}} \underset{\text{Monoclinic}}{CaSO_4\cdot 2H_2O}$ $2(CaSO_4)\cdot H_2O \xrightarrow[200°C]{\Delta} \underset{\text{Dead burnt plaster}}{CaSO_{4(anhy.)}}$ **Uses :** It is used for setting broken or dislocated bones, in making casts for statues, toys etc.

PEEP INTO PREVIOUS YEARS

7. The alkaline earth metal nitrate that does not crystallise with water molecules is
(a) $Ba(NO_3)_2$ (b) $Ca(NO_3)_2$
(c) $Sr(NO_3)_2$ (d) $Mg(NO_3)_2$
(JEE Main 2019)

8. The covalent alkaline earth metal halide (X = Cl, Br, I) is
(a) CaX_2 (b) BeX_2 (c) MgX_2 (d) SrX_2
(JEE Main 2019)

9. Among CaH_2, BeH_2, BaH_2, the order of ionic character is
(a) $BeH_2 < CaH_2 < BaH_2$
(b) $CaH_2 < BeH_2 < BaH_2$
(c) $BeH_2 < BaH_2 < CaH_2$
(d) $BaH_2 < BeH_2 < CaH_2$ *(NEET 2018)*

POINTS FOR EXTRA SCORING

- The order of hydration of ions : $Cs^+ < Ba^{2+} < Rb^+ < Sr^{2+} < K^+ < Ca^{2+} < Na^+ < Mg^{2+} < Li^+ < Be^{2+}$
- Thermal stability of hydrides :
Group - IA : $LiH > NaH > KH > RbH > CsH$
Group - IIA : $BeH_2 > MgH_2 > CaH_2 > SrH_2 > BaH_2$
- Order of basic character of hydroxides :
Group - IA : $CsOH > RbOH > KOH > NaOH > LiOH$
Group - IIA : $Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2 > Be(OH)_2$
- Thermal stability of metal carbonates :
Group - IA : $Rb_2CO_3 > K_2CO_3 > Na_2CO_3 > Li_2CO_3$