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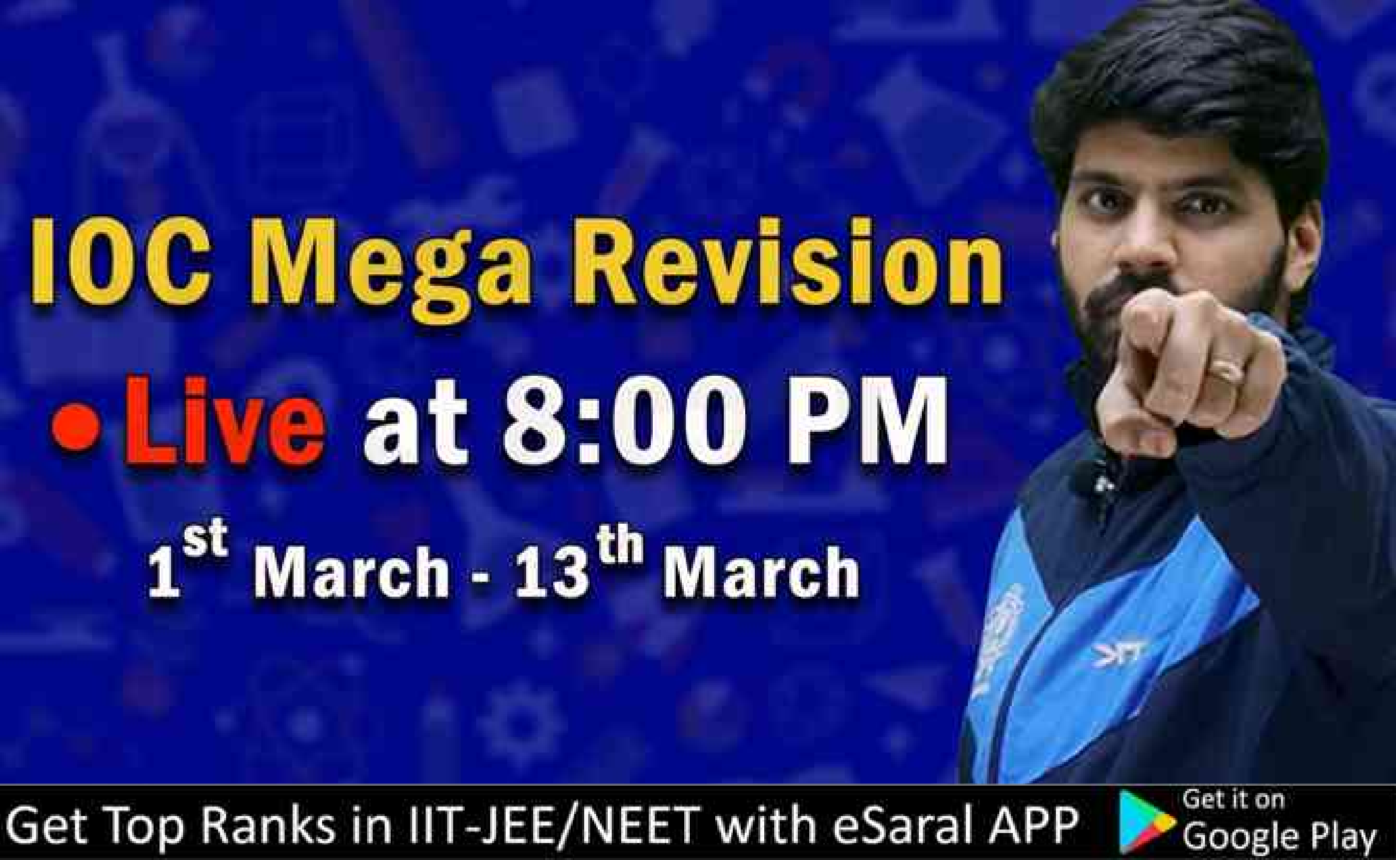
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I Love Chemistry


Samjho, dekho & yaad karo

Complete Chemistry Mega Revision Timetable

1 March	3,4 March	5 March	6 March
Coordination Compounds	Chemical Bonding	p–block (Class 12)	p–block (class 11) + Periodic Table
8 March	**10 March**	**12 March**	**13 March**
Metallurgy	s-block + Hydrogen	d & f-block	Surprise Gift

Complete Chemistry Mega Revision PYQs & Quiz Timetable

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2 March	4 March	5 March	7 March
Coordination Compounds	Chemical Bonding	p–block (Class 12)	p–block (class 11) and Periodic Table
PYQs	PYQs	PYQs	PYQs
Quiz	**Quiz**	**Quiz**	**Quiz**

11 March	12 March	13 March
Metallurgy	s-block + Hydrogen	d & f-block
PYQs	PYQs	PYQs
Quiz	**Quiz**	**Quiz**

Hydrogen

Sun → H_2

1p 1e^-

Hydrogen is the most abundant element in the universe. Hydrogen isn't common in a pure form on Earth, but is mostly found as part of water.

Isotopes of Hydrogen

Hydrogen has three isotopes protium(P), deuterium(D) and tritium(T).

Learn

D_2O Heavy water

Hydrogen

Properties	protium(P)	Deuterium(D)	Tritium(T)
e-, p+, n^0	1,1,0	1,1,1	1,1,2
abundance	99.98%	0.02%	trace
Common name	Simple hydrogen	Heavy hydrogen	Radioactive hydrogen

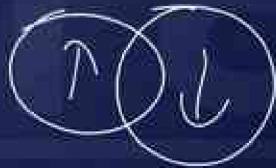
Isomers of molecular hydrogen

ortho-hydrogen

1. one with its two proton nuclear spins aligned parallel.
2. Presence in nature = 75%

para-hydrogen

1. The other with its two proton spins aligned antiparallel.
2. Presence in nature = 25%



Different forms of Hydrogen

Hydrogen

- Atomic Hydrogen
- Nascent hydrogen
- Dihydrogen H_2

नया नया

Dihydrogen, H_2

Occurrence

Dihydrogen is the most abundant molecule in the universe (70% of the total mass of the universe) and is the principal molecule in the solar atmosphere.

An, AEn

Preparation of Dihydrogen

Metal + Acid → $H_2\uparrow$

Laboratory Preparation of Dihydrogen

(i) It is usually prepared by the reaction of granulated zinc with dilute hydrochloric acid.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2\uparrow$$

$$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2\uparrow$$

Sodium Zincate

Commercial Production of Dihydrogen

(i) Electrolysis of acidified water using platinum electrodes gives hydrogen.

$$2H_2O(\ell) \xrightarrow[\text{traces of acid}]{\text{Electrolysis}} 2H_2(g) + O_2(g)$$

Cathode

Conductivity

H^+

NaCl
↓
Electrolysis

(ii) It is obtained as a byproduct in the manufacture of sodium hydroxide and chlorine by the electrolysis of brine solution.

(1) H_2O
(2) Brine
(3) Coke or Hydrocarbon

(iv) Reaction of steam on hydrocarbons or coke at high temperatures in the presence of catalyst

$$C_nH_{2n-2} + nH_2O \xrightarrow[Ni]{1270\ K} nCO + (2n-1)\,H_2 \uparrow$$

Properties of Dihydrogen

Physical Properties

Dihydrogen is a colourless, odourless, tasteless, combustible gas. It is lighter than air and insoluble in water.

Chemical Properties

The chemical behaviour of dihydrogen is determined, to a large extent, by bond dissociation enthalpy.

The H-H bond dissociation enthalpy is the highest for a single bond between two atoms of any element.

$H_2 \rightarrow$ dark

Haber

Reaction with Nonmetals

With halogens

$$H_2(g) + X_2(g) \longrightarrow 2HX(g)$$

(X = F(In dark), Cl, Br, I(with catalyst))

Reaction with Dioxygen

$$2H_2(g) + O_2(g) \xrightarrow{\text{Catalyst or heating}} 2H_2O(\ell) \quad \Delta H = -285.9 \text{ kJ mol}^{-1}$$

$$3H_2(g) + N_2(g) \xrightarrow[\text{Fe}]{673 \text{ K} / 200 \text{ atm}} 2NH_3(g)$$

$$\Delta = 92.6 \text{ kJ mol}^{-1}$$

Reaction with metals

$$H_2(g) + 2M(g) \longrightarrow 2MH(s)$$

where M is an alkali metal

Note : These are formed by many d-block and f-block elements. However, the metals of group 7, 8 and 9 do not form hydride.

Reaction with metal ions and metal oxides

RA

$$H_2(g) + Pd^{2+}(aq) \longrightarrow Pd(s) + 2H^+(aq)$$

RA

$$yH_2(g) + M_xO_y(s) \longrightarrow xM(s) + yH_2O(\ell)$$

Hydrides

NaH → Ionic

(i) Ionic or saline or saltlike hydrides

(ii) Covalent or molecular hydrides H_2O

(iii) Metallic or non-stoichiometric hydrides

Water → जल ही जीवन है

Hardness of Water

Rain water is almost pure (may contain some dissolved gases from the atmosphere). Being a good solvent, when it flows on the surface of the earth, it dissolves many salts.

Presence of calcium and magnesium salts in the form of bicarbonate, chloride and sulphate in water makes water 'hard'.

Hard water does not give lather with soap.

Mg^{+2}, Ca^{+2}

The hardness of water is of two types

(i) Temporary hardness Bicarbonate

(ii) Permanent hardness SO_4^{2-}, Cl^-

Temporary hardness is due to the presence of magnesium and calcium **bicarbonates.**

(i) Boiling

Hardness X Mg^{2+}, Ca^{2+} X

During boiling, the soluble $Mg(HCO_3)_2$ is converted into insoluble $Mg(OH)_2$ and $Ca(HCO_3)_2$ is changed to insoluble $CaCO_3$.

These precipitates can be removed by filtration. Filtrate thus obtained will be soft water.

$$Mg(HCO_3)_2 \xrightarrow{\text{Heating}} Mg(OH)_2 \downarrow + 2CO_2$$

$$Ca(HCO_3)_2 \xrightarrow{\text{Heating}} CaCO_3 \downarrow + H_2O + CO_2$$

(ii) Clark's method

In this method calculated amount of lime is added to hard water. It precipitates out calcium carbonate and magnesium hydroxide which can be filtered off.

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

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

Permanent Hardness

(i) Treatment with washing soda (sodium carbonate)

Washing soda reacts with soluble calcium and magnesium chlorides and sulphates in hard water to form insoluble carbonates.

$$MCl_2 + Na_2CO_3 \longrightarrow MCO_3 \downarrow + 2NaCl$$

$$MSO_4 + Na_2CO_3 \longrightarrow MCO_3 \downarrow + Na_2SO_4$$

(ii) Calgon's method

Sodium hexametaphosphate ($Na_6P_6O_{18}$), commercially called 'calgon', when added to hard water, the following reactions take place.

$$Na_6P_6O_{18} \longrightarrow 2Na^+ + Na_4P_6O_{18}^{2-}$$

$$2M^{2+} + Na_2[Na_4(PO_3)_6] \longrightarrow Na_2[M_2(PO_3)_6] + 2Na^+$$

(M = Mg,Ca)

The complex anion keeps the Mg^{2+} and Ca^{2+} ions in solution.

(iii) Ion-exchange method (By Zeolite)

This method is also called zeolite / permutit process.

$[Na_2Al_2Si_2O_8 . xH_2O]$

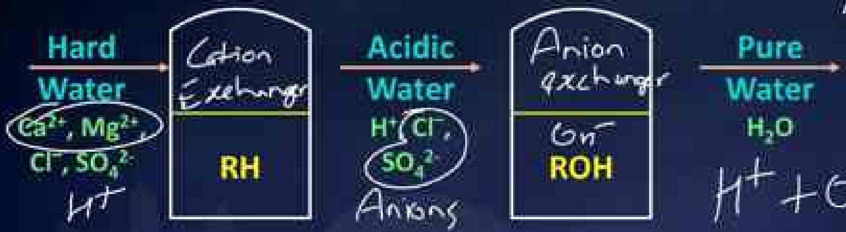
$[Na_2O.Al_2O_3.2SiO_2.xH_2O]$

$$2NaZ(s) + M^{2+}(aq) \longrightarrow MZ_2(s) + 2Na^{+}(aq)$$

ppt → filter

(iv) Ion exchange method (By synthetic resins)

Ion exchange resins are the most popular water softener these days. These resins are synthetic substance. This process is more efficient than Zeolite process. → costly



$$Ca^{2+} + 2RH \longrightarrow R_2Ca + 2H^+$$

$$Mg^{2+} + 2RH \longrightarrow R_2Mg + 2H^+$$

$$RNH_2 + H{-}OH \longrightarrow R\overset{+}{N}H_3\,\overset{-}{O}H$$

$$R\overset{+}{N}H_3\,\overset{-}{O}H + Cl^- \longrightarrow R\overset{+}{N}H_3\,Cl^-_{(s)} + OH^-$$

Regenration of resin

(i) Cation exchange resin We use dil acid.

$$2HCl + R_2Ca \longrightarrow 2RH + CaCl_2$$

(ii) Anion exchange resin. We use dil NaOH solution

$$NaOH + RCl \longrightarrow NaCl + ROH$$

Hydrogen Peroxide (H_2O_2)

Most Imp Compound

Hydrogen peroxide is an important chemical used in pollution control treatment of domestic and industrial effluents.

Preparation

(i) $Na_2O_2 + 2H\text{-}OH$ (ice cold water) $\longrightarrow 2NaOH + H_2O_2$

(ii) Acidifying barium peroxide and removing excess water by evaporation under reduced pressure gives hydrogen peroxide.

$$BaO_2.8H_2O(s) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + H_2O_2(aq) + 8H_2O(\ell)$$

Instead of H_2SO_4, H_3PO_4 is added now-a-days because H_2SO_4 catalyses the decomposition of H_2O_2 whereas H_3PO_4 favours to restore it.

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

Method 3

$2HSO_4^-$ -

$$2H_2SO_4 \rightleftharpoons 2H^+ + 2HSO_4^-$$

$$2HSO_4^- \xrightarrow{\text{Electrolysis}} H_2S_2O_8 + 2e^- \text{ [At anode]}$$

[At cathode]

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

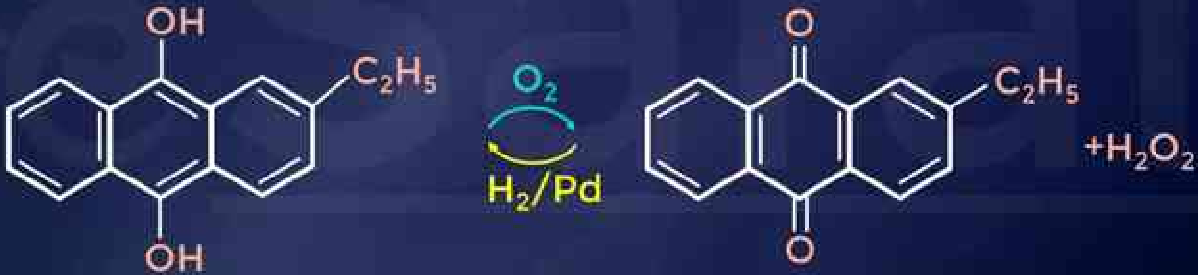
$$H_2S_2O_8 + 2H_2O \longrightarrow 2H_2SO_4 + H_2O_2$$

Hydrolysis

(iii) Industrially it is prepared by the autooxidation of 2-alklylanthraquinols.

VV Imp

Series
10 minute
↓
30-40 number



2-ethylanthraquinol

2-ethylanthraquinone

Physical Properties

In the pure state H_2O_2 is an almost colourless (very pale blue) liquid.

H_2O_2 is miscible with water in all proportions and forms a hydrate $H_2O_2.H_2O$ (mp 273K).

A 30% solution of H_2O_2 is marketed as '100 volume' hydrogen peroxide.

90% 10%

10% 90%

30% H_2O_2

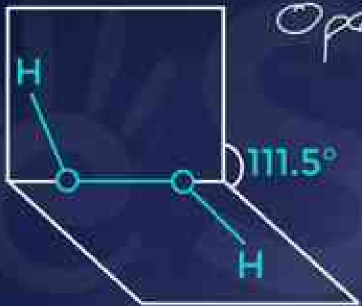
70% H_2O

Structure

VVV Imp

Hydrogen peroxide has a non-planar structure.

Open-book like



Gas phase

Solid phase

(a) H_2O_2 structure in gas phase, dihedral angle is 111.5°.

(b) H_2O_2 structure in solid phase at 110K, dihedral angle is 90.2°.

Storage

vvv Imp

H_2O_2 decomposes slowly on exposure to light.

$$2H_2O_2(\ell) \longrightarrow 2H_2O(\ell) + O_2(g)$$

metal X
glass X

In the presence of metal surfaces or traces of alkali (present in glass containers), the above reaction is catalysed.

It is stored in wax-lined glass or plastic vessels in dark.

Acetanilide or Glycerol or Urea can be added as a stabiliser. It is kept away from dust because dust can induce explosive decomposition of the compound.

(i) Hydrogen peroxide is a mild antiseptic used on the skin to prevent infection of minor cuts, scrapes, and burns.

(ii) It may also be used as a mouth rinse to help remove mucus or to relieve minor mouth irritation (e.g., due to canker/cold sores, gingivitis).

(iii) As a rocket propellant Ques

$$NH_2.NH_2 + 2H_2O_2 \longrightarrow N_2 + 4H_2O$$

[highly exothermic and large increase in volume]

Chemical Properties

It acts as an oxidising as well as reducing agent in both acidic and basic medium.

Oxidising Agent (H_2O_2)

(A) Acidic Medium

$$2e^- + 2H^+ + H_2O_2 \rightarrow 2H_2O$$

(B) Basic Medium

$$2e^- + 2H^+ + H_2O_2 \rightarrow 2OH^-$$

Reducing Agent (H_2O_2)

(A) Acidic Medium

$$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$$

(B) Basic Medium

$$2OH^- + H_2O_2 \rightarrow O_2 + 2H_2O + 2e^-$$

$H_2O_2 \xrightarrow{KMnO_4 / H^+} O_2 + Mn^{+2}$

$H_2O_2 \xrightarrow{KMnO_4 / OH^-} O_2 + Mn^{4+}$

$H_2O_2 \xrightarrow{Fe^{2+} / OH^-} Fe^{+3}$

$H_2O_2 \xrightarrow{Fe^{2+} / H^+} Fe^{+3}$

$H_2O_2 \xrightarrow{HOCl / H^+} O_2 + HCl$

$H_2O_2 \xrightarrow{I_2 / OH^-} O_2 + I^-$

$H_2O_2 \xrightarrow{Mn^{+2} / OH^-} Mn^{4+}$

Learn

Heavy Water, D_2O

It can be prepared by electrolysis of water or as a by-product in some fertilizer industries.

(a) Heavy water is a colourless, odourless and tasteless liquid.

(b) Nearly all the physical constants are higher than the corresponding values of ordinary water.

It is used for the preparation of other deuterium compounds, for example

$$CaC_2 + 2D_2O \longrightarrow C_2D_2 + Ca(OD)_2$$

$$SO_3 + D_2O \longrightarrow D_2SO_4$$

$$Al_4C_3 + 12D_2O \longrightarrow 3CD_4 + 4Al(OD)_3$$

Uses

It is extensively used as a moderator & coolant in nuclear reactors and in exchange reactions for the study of reaction mechanisms.

D_2O

मेहनत
Result

Group 1 Elements : Alkali Metals

Atomic And Ionic Radii

Gr ↓ A&IR ↑ n ↑

Li < Na < K < Rb < Cs
Increases down the group, because value of n (principal quantum number) increases.

Ionization Enthalpy

size ↓ IE ↑

Li > Na > K > Rb > Cs

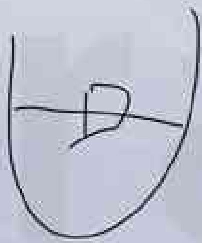
As size increases ionization enthalpy decreases.

Hydration Enthalpy

The hydration enthalpies of alkali metal ions decrease with increase in ionic sizes.

$Li^{+} > Na^{+} > K^{+} > Rb^{+} > Cs^{+}$

$HE \propto \frac{1}{Size} \propto \phi$ (CB)



Chemical Properties

The alkali metals are highly reactive due to their large size and low ionization enthalpy. The reactivity of these metals increases down the group.

(i) Reactivity Towards Air

The alkali metals tarnish in dry air due to the formation of their oxides which in turn react with moisture to form hydroxides. They burn vigorously in oxygen forming oxides.

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

$2Na + O_2 \longrightarrow Na_2O_2$ (peroxide)

$M + O_2 \longrightarrow MO_2$ (superoxide)

(M = K, Rb, Cs)

$$2M + 2H_2O \longrightarrow 2M^+ + 2OH^- + H_2 \uparrow$$

(M = an alkali metal)

$$2M + H_2 \longrightarrow 2M^+H^-$$

All the alkali metal hydrides are ionic solids with high melting points.

The alkali metals react vigorously with halogens to form ionic halides, M^+X^-.

However, lithium halides are somewhat covalent. It is because of the high polarisation capability of lithium ion.

(v) Reducing Nature

Li > Cs > Rb > K > Na > Li

Li → small size

The alkali metals are strong reducing agents, lithium being the most and sodium the least powerful.

The alkali metals dissolve in liquid ammonia giving deep blue solutions which are conducting in nature.

VV Imp

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

The blue colour of the solution is due to the ammoniated electron which absorbs energy in the visible region of light and thus imparts blue colour to the solution.

$$M^{+}_{(am)} + e^{-} + NH_3 \longrightarrow MNH_{2(am)} + \frac{1}{2}H_2(g)$$

The solutions are paramagnetic and on standing slowly liberate hydrogen resulting in the formation of NH_2^{-}.

Anomalous Properties of Lithium

The anomalous behaviour of lithium is due to:

(i) Exceptionally small size of its atom and ion.

(ii) High polarising power (i.e.,charge/radius ratio).

Points of Difference Between Lithium And Other Alkali Metals

(i) Lithium is much harder. Its m.p. and b.p. are higher than the other alkali metals.

(ii) On combustion in air it forms mainly monoxide, Li_2O and the nitride, Li_3N unlike other alkali metals.

(iii) LiCl is deliquescent and crystallises as a hydrate, $LiCl.2H_2O$ whereas other alkali metal chlorides do not form hydrates.

(iv) Lithium nitrate when heated gives lithium oxide, Li_2O, whereas other alkali metal nitrates decompose to give the corresponding nitrite.

$$4LiNO_3 \longrightarrow 2Li_2O + 4NO_2 + O_2$$

$$2NaNO_3 \longrightarrow 2NaNO_2 + O_2$$

Sodium Carbonate (Washing Soda), $Na_2CO_3.10H_2O$

Preparation

Solvay Process.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$2NH_3 + H_2O + CO_2 \longrightarrow NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3$$

$$2NaHCO_3 \longrightarrow Na_2CO_3\,(\text{crystals}) + CO_2 + H_2O$$

Properties

Paani → Cement crystallize

Sodium carbonate is a white crystalline solid which exists as a decahydrate, $Na_2CO_3 \cdot 10H_2O$. It is readily soluble in water.

↓ Δ

Choora Choora

Uses

(i) It is used in water softening, laundering and cleaning.

(ii) It is used in paper, paints and textile industries.

Sodium Chloride, NaCl

→ Namak
Gandhi Baapu

Crude sodium chloride, generally obtained by crystallisation of brine solution, contains sodium sulphate, calcium sulphate, calcium chloride and magnesium chloride as impurities.

NaCl
NaCl → NaCl
Impurities

To obtain pure sodium chloride, the crude salt is dissolved in minimum amount of water and filtered to remove insoluble impurities. The solution is then saturated with hydrogen chloride gas.

Crystals of pure sodium chloride separate out. Calcium and magnesium chloride, being more soluble than sodium chloride, remain in solution.

Uses

(i) It is used as a common salt or table salt for domestic purpose.

(ii) It is used for the preparation of Na_2O_2, $NaOH$ and Na_2CO_3.

(iii) For melting ice and snow on road.

Sodium Hydroxide (Caustic Soda), NaOH

1. Sodium hydroxide is generally prepared commercially by the electrolysis of sodium chloride in Castner-Kellner cell.

2. A brine solution is electrolysed using a mercury cathode and a carbon anode.

3. Sodium metal discharged at the cathode combines with mercury to form sodium amalgam. Chlorine gas is evolved at the anode.

Cathode

$$Na^+ + e^- \xrightarrow{Hg} Na(Hg)$$

Anode

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

The amalgam is treated with water to give sodium hydroxide and hydrogen gas.

$$Na(Hg) + H_2O \longrightarrow NaOH + Hg + \frac{1}{2} H_2$$

Sodium hydroxide is a white, translucent solid. It melts at 591 K. It is readily soluble in water to give a strong alkaline solution.

Uses

NaOH

(i) The manufacture of soap, paper, artificial silk and a number of chemicals.

(ii) In petroleum refining.

Learn

(iii) In the purification of bauxite.

(iv) In the textile industries for mercerising cotton fabrics.

Sodium Hydrogen Carbonate (Baking Soda), $NaHCO_3$

Cake → fluffy

Sodium hydrogen carbonate is made by saturating a solution of sodium carbonate with carbon dioxide. The white crystalline powder of sodium hydrogen carbonate, being less soluble, gets separated out.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

Uses

1. Sodium hydrogen carbonate is a mild antiseptic for skin infections.

2. It is used in fire extinguishers.

Group 2 Elements : Alkaline Earth Metals

Atomic And Ionic Radii

G↓ n↑ size↑

The atomic and ionic radii of the alkaline earth metals are smaller than those of the corresponding alkali metals in the same periods.

Be < Mg <Ca <Sr <Ba

Ionization Enthalpy

Be > Mg > Ca > Sr > Ba

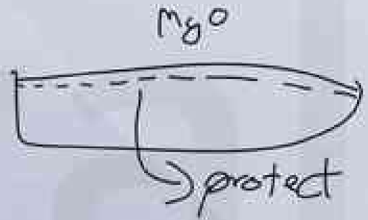
Down the group IE decreases due to increase in size

Chemical Properties

$AEM_r < AM_r$

The alkaline earth metals are less reactive than the alkali metals. The reactivity of these elements increases on going down the group.

MgO



Reactivity Towards Air

Beryllium and magnesium are kinetically inert to oxygen and water because of the formation of an oxide film on their surface. However, powdered beryllium burns brilliantly on ignition in air to give BeO and Be_3N_2.

Magnesium is more electropositive and burns with dazzling brilliance in air to give MgO and Mg_3N_2. Calcium, strontium and barium are readily attacked by air to form the oxide and nitride.

Reactivity Towards Water

AEM have lesser tendency to react with water as compared to AM. They form hydroxides and liberate H_2 on reaction with H_2O

$$M + 2H_2O \xrightarrow{\Delta} M(OH)_2 + H_2 \uparrow$$

Be is inert towards water.
Magnesium reacts as

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

Learn

Or

$$Mg + H_2O(g) \longrightarrow MgO + H_2 \uparrow$$

Reactivity Towards The Halogens

All the alkaline earth metals combine with halogen at elevated temperatures forming their halides.

$$M + X_2 \longrightarrow MX_2 \ (X = F, Cl, Br, I)$$

Reactivity Towards Hydrogen

$Be + H_2 \xrightarrow{\Delta} X$

Directly

LAH

All the elements except beryllium combine with hydrogen upon heating to form their hydrides, MH_2. BeH_2, however, can be prepared by the reaction of $BeCl_2$ with $LiAlH_4$.

$$2BeCl_2 + LiAlH_4 \longrightarrow 2BeH_2 + LiCl + AlCl_3$$

Reactivity Towards Acids

Metal + Acid → H_2↑

AEM react with acids & liberate H_2

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

Reducing Nature

Like alkali metals, the alkaline earth metals are strong reducing agents. However their reducing power is less than those of their corresponding alkali metals.

Be< Mg <Ca< Sr< Ba< Ra

Solutions In Liquid Ammonia

Like alkali metals, the alkaline earth metals dissolve in liquid ammonia to give deep blue black solutions forming ammoniated ions.

$$M + (x + y)\, NH_3 \longrightarrow [M(NH_3)_x]^{2+} + 2[e(NH_3)_y]^-$$

From these solutions, the ammoniates, $[M(NH_3)_6]^{2+}$ can be recovered.

Oxides And Hydroxides

BeO → covalent

AEMO → rock-salt → Ionic

The alkaline earth metals burn in oxygen to form the monoxide, MO which, except for BeO, have rock-salt structure. The BeO is essentially covalent in nature.

The enthalpies of formation of these oxides are quite high and consequently they are very stable to heat.

BeO is amphoteric while oxides of other elements are ionic in nature. All these oxides except BeO are basic in nature and react with water to form sparingly soluble hydroxides.

$$MO + H_2O \longrightarrow M(OH)_2$$

The alkaline earth metal hydroxides are, however, less basic and less stable than alkali metal hydroxides. Beryllium hydroxide is amphoteric in nature as it reacts with acid and alkali both.

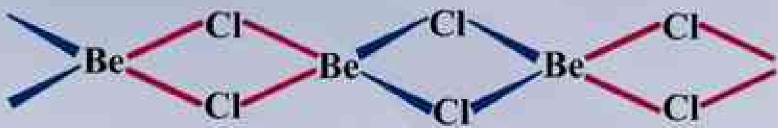
Halides

Except for beryllium halides, all other halides of alkaline earth metals are ionic in nature.

Beryllium halides are essentially covalent and soluble in organic solvents.

Beryllium chloride has a chain structure in the solid state.

$3c-4e^-$



Bridge Bonding

Salts of Oxoacids

The alkaline earth metals also form salts of Oxoacids.

For example $MgSO_4$

Carbonates

Carbonates of alkaline earth metals are insoluble in water and can be precipitated by addition of a sodium or ammonium carbonate solution to a solution of a soluble salt of these metals.

Beryllium carbonate is unstable and can be kept only in the atmosphere of CO_2.

The thermal stability increases with increasing cationic size.

Sulphates

The sulphates of the alkaline earth metals are all white solids and stable to heat.

$BeSO_4$ and $MgSO_4$ are readily soluble in water; the solubility decreases from $CaSO_4$ to $BaSO_4$.

$Mg(NO_3)\cdot 6H_2O$

Nitrates

The nitrates are made by dissolution of the carbonates in dilute nitric acid. Magnesium nitrate crystallises with six molecules of water, whereas barium nitrate crystallises as the anhydrous salt.

Anomalous Behaviour of Beryllium

It shows diagonal relationship to Aluminium.

(i) Beryllium has exceptionally small atomic and ionic sizes and thus does not compare well with other members of the group. Because of high ionisation enthalpy and small size it forms compounds which are largely covalent and get easily hydrolysed.

(ii) The oxide and hydroxide of beryllium, unlike the hydroxides of other elements in the group, are amphoteric in nature.

Some Important Compounds Of Calcium

Calcium Oxide or Quick Lime, CaO

It is prepared on a commercial scale by heating limestone ($CaCO_3$) at 1070-1270 K.

furnace

$$CaCO_3 \underset{}{\overset{heat}{\rightleftharpoons}} CaO + CO_2$$

It has a melting point of 2870 K. On exposure to atmosphere, it absorbs moisture and carbon dioxide.

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$CaO + CO_2 \longrightarrow CaCO_3$$

Calcium Hydroxide (Slaked lime), $Ca(OH)_2$

Calcium hydroxide is prepared by adding water to quick lime, CaO.

When carbon dioxide is passed through lime water it turns milky due to the formation of calcium carbonate.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

On passing excess of carbon dioxide, the precipitate dissolves to form calcium hydrogen carbonate.

$$CaCO_3 + CO_2 + H_2O \longrightarrow Ca\,(HCO_3)_2$$

Calcium Carbonate, $CaCO_3$ → Marble

Calcium carbonate occurs in nature in several forms like limestone, chalk, marble etc. It can be prepared by passing carbon dioxide through slaked lime or by the addition of sodium carbonate to calcium chloride.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

$$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$$

When heated to 1200 K, it decomposes to evolve carbon dioxide.

$$CaCO_3 \xrightarrow{1200K} CaO + CO_2$$

Uses

It is used as a building material in the form of marble and in the manufacture of quick lime.

Calcium carbonate along with magnesium carbonate is used as a flux in the extraction of metals such as iron.

Calcium Sulphate (Plaster of Paris), $CaSO_4 \cdot \frac{1}{2} H_2O$

$2CaSO_4 \cdot H_2O$

It is a hemihydrate of calcium sulphate. It is obtained when gypsum, $CaSO_4 \cdot 2H_2O$, is heated to 393 K. Learn

$$2(CaSO_4 \cdot 2H_2O) \longrightarrow 2(CaSO_4 \cdot \frac{1}{2} H_2O) + 3H_2O$$

Above 393 K, no water of crystallisation is left and anhydrous calcium sulphate, $CaSO_4$ is formed. This is known as 'dead burnt plaster'.

Uses

The largest use of Plaster of Paris is in the building industry as well as plasters. It is used for immoblising the affected part of organ where there is a bone fracture or sprain. It is also employed in dentistry, in ornamental work and for making casts of statues and busts.

Cement

Cement is an important building material. It was first introduced in England in 1824 by Joseph Aspdin. It is also called 'Portland cement' because it resembles the natural limestone found in the Isle of Portland, England.

Cement is a product obtained by combining a material rich in lime, CaO with other material such as clay which contains silica, SiO_2 along with the oxides of aluminium, iron and magnesium.

The raw materials for the manufacture of cement are limestone and clay. When clay and lime are strongly heated together they fuse and react to form 'cement clinker'. This clinker is mixed with 2-3% by weight of gypsum ($CaSO_4 \cdot 2H_2O$) to form cement.