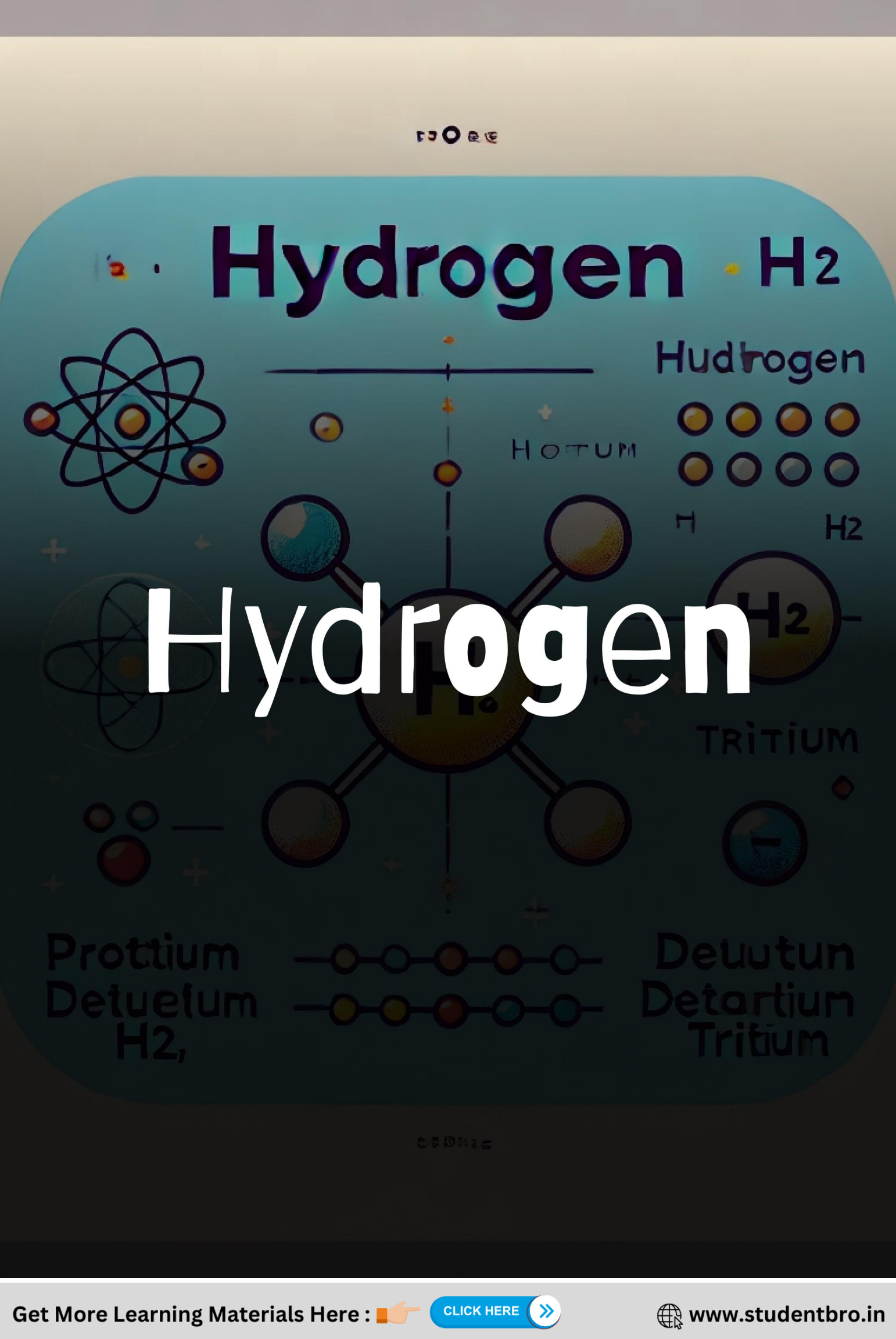


HYDROGEN

Pyrites means sulphite ores. Apatite means Phosphate ores.

$Ca_3(PO_4)_2 \cdot CaCl_2 \longrightarrow$ chlous apatite

Solubility of $Ca(HCO_3)_2 > CaCO_3 > CaHSO_4 > CaSO_4$

$x\ Ca_3(PO_4)_2 \cdot y\ CaF \longrightarrow (x+y) = 4$

NaF - Anti-bacterial. Dry fish can be stored for years.

All those salts whose OH^- and CO_3^{-2} are insoluble, then on reaction with $Na_2CO_3 \longrightarrow$ basic metal carbonate.

$(NaPO_3)_b \longrightarrow$ Calgoan $\longrightarrow$ Polymer. sulphur exists as S_8 and S_2 because

$H-F > H-Cl$ (Bond energy) $\qquad Cl_2 > F_2$ (Bond energy)

SiO_2 — Polymer $\qquad \ddot{F}—\ddot{F}$ (lp-lp repulsion)

$SO_2 \longrightarrow$ An solid and liquid state $\longrightarrow (sp^3)$

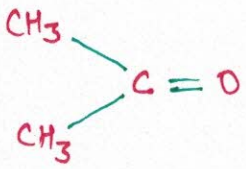
A Linear polymer

In vapour phase, SO_3 exists as monomer (sp^2).

The compounds which have (2p-3p) bonds unstable. when they go in solid phase, they exist as polymer.

(HPO_3) exists as a cyclic $\qquad (HPO_3)_3 \longrightarrow H_3P_3O_9 \longrightarrow POP = 3$

$(HPO_3)_6 \longrightarrow H_6P_6O_{18} \longrightarrow POP = 6$



Doesn't exist as monomer. It's polymer is used as water repellant finish for textiles.

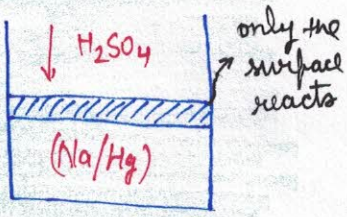
$PbCl_2$ is insoluble in cold H_2O but sol. in hot H_2O.

$2Na + H_2O \longrightarrow 2NaOH + H_2\uparrow$ (Highly exo.)

↳ Here H_2 catches fire.

Metal exp. are always redox.

No amalgan in water doesn't catch fire, heat is less.



Mg liberates H_2 in hot water. Less electro(+ve) metals require the passage of steam.

A. LANE'S PROCESS

– commercial process for manufacturing H_2. Red hot iron is used when steam is passed over it.

$$H_2SO_4 \rightarrow H_2SO_3 + (O), \qquad H_2SO_4 \longrightarrow SO_2 + (O) + H_2O$$

All elements are sol. in the conc. H_2SO_4 including those below H in reactivity series except. (Au/Pt).

In → H_2
In → H_2SO_4 ✓, Cl ✗, HNO_3 ✗

When a metal has two O.S, if H_2 is formed, then H_2 is a R.A; then the compound of Fe having a Low O.S will be formed.

$$Fe + \text{dil.}\ (H_2SO_4) \longrightarrow FeSO_4 + H_2\uparrow$$

In conc. H_2SO_4 higher O.S will be formed.

Water gas → $(H_2 + CO)$, $(H_2 + N_2)$ → Producer gas
Water gas → Better fuel (Higher Calorific value).

B. BOACH PROCESS

(From water gas)

$$H_2 + CO + \underset{\text{(steam)}}{H_2O} \xrightarrow[\text{(R.A)}]{FeS_4} 2H_2 + CO_2$$

We Also get a use of Lane's process here.

We use $Ca(OH)_2$ as it is a cheap base – counter current flow. H_2 gas is purified by treating with $Ca(OH)_2$.

In Castner Kellner's cell, H_2 gas is a by product.

"H_2" is obtained as a by product in the petroleum industry. so whenever there is a petroleum plant, we would find urea prodⁿ plant.

There are three isotops of H ⟶ (H, D, T). Total ways of forming compounds $= 3! = 6$

$H \overset{a}{—} H$ $\qquad$ $D \overset{b}{—} D$; b is a shouter.

Whenever an isotops is replaced by the higher isotops the frequency of vibration ↓, Bond dist ↓ mass ↑. BE ↑

$H \overset{a}{—} OH$; $H \overset{b}{—} OD$ $\qquad$ $CH_3—H$; $CH_3—D$ $\qquad$ $CH_3—H$; $CH_3—T$ (B.L)

Rate of reaction ∝ Bond distance

$H_2O > D_2O$ (Basicity) but $NaOH < NaOD$ (Basicity)

$(Kw)_{H_2O} = (10^{-14})$ $\qquad$ $(Kw)_{D_2O} = \frac{1}{2}(10^{-14}) = \frac{1}{3}(Kw)_{H_2O}$

H_2O is more polar than D_2O

$H^- > OH^-$ ⟶ Basic Nature

Metal hydrides > Metal Hydrides ⟶ Basicity

$NaH \longrightarrow Na^+ + H_2\uparrow$ (Anode)

$H_2O \longrightarrow H\uparrow + OH^-$ (cathode)

$2NaOH + CO_2 \rightarrow 2H-\overset{O}{\overset{\|}{C}}-O^-Na^+ \xrightarrow{\Delta} Na_2C_2OH + H_2\uparrow$

$BeCl_2 + 2NaOH \longrightarrow BeH_2 + 2NaCl$ (covalent)

E. **INTERSTICIAL HYDRIDES** – H_2 gas is trapped in the interstitial voids they are non-stoichiometric. Molten metals are passed by H_2 gas. H_2 gets trapped in voids.

(H_2O_2) is manufacture the best from BaO_2 (soft porous) along with the use of H_3PO_4 as $Ba_3(PO_4)_2$ is formed as a ppt ↓

Ionks of metal alloys such as $NaNi_5$, $Ti - TiH_2$ / $Mg - Mg_2$ used to store H_2.

$$2H_2SO_4 \xrightarrow{e^-} H_2\uparrow + H_2S_2O_8 \text{ (Marshall acid at anode)}$$

Only the peroxides on acidification give H_2O_2.

100 % pure H_2O_2 is unstable. Highly explosive.

BP = 130°C but decomposes much earlier. H_2O_2 is more acidic than H_2O. It can act as both OA and RA.

Strength of hypo. is estimated by iodometry.

HF can't be ox. by H_2O_2. ($F > H_2O_2 > Cl_2 > Br_2 > I_2$)

All O.A are EN in nature.

$$H_2S + H_2O_2 \longrightarrow 2H_2O + S\downarrow$$

(Light yellow)

With PbS

$$PbS + 4H_2O_2 \longrightarrow PbSO_4 + H_2O$$

(Black) (White)

$x\,Pb(OH)_2 \cdot y\,PbCO_3$ Basic lead carbonate $\longrightarrow$

A pigment in oil paints.

$\xrightarrow{H_2S} PbS\downarrow$ (Black)

When oil paintings turns black, then treated with H_2O_2.

$(Cr_2O_3) \longrightarrow$ green

$FeCrO_4 \mid Cr_2O_3 \mid Cr(OH)_3 \mid CrCl_3 \xrightarrow[(O.A.)]{O_2/H_2O_2} \xrightarrow{NaOH/Na_2O_3} Na_2CrO_4 \xrightarrow{KCl} (Na_2Cr_2O_7) \longrightarrow (K_2Cr_2O_7)$

With MnO

$$MnO + 2H_2O_2 \longrightarrow MnO_3 + 2H_2O$$

$$MnO_2 + 2NaOH \longrightarrow Na_2MnO_4 + H_2O$$

$$MnO + 2H_2O_2 + 2NaOH \longrightarrow Na_2MnO_4 \text{ (green)} + 3H_2O$$

When H_2O_2 is R.A $\longrightarrow O_2$

When H_2O_2 is O.A $\longrightarrow$ ~~O_2~~

When $[K_3Fe(LN)_6]$ is in basic medium ⟶ (O.A)

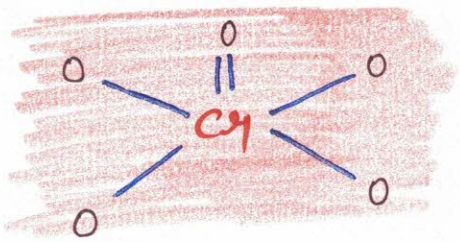
When $[K_4Fe(N)_6]$ is in acidic medium ⟶ (R.A)

As H_2O_2 is a R.A. in acidic medium

$$KMnO_4 + H_2SO_4 + H_2O_2 \longrightarrow K_2SO_4 + MnSO_4$$

$$K_2Cr_2O_7 + H_2SO_4 + H_2O_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + O_2\uparrow$$

(orange) (green)



CrO_5 (Blue) ⟶ It is soluble in diethyl Ether

$$K_2Cr_2O_7 + H_2SO_4 \text{ (concn)} + H_2O \longrightarrow K_2SO_4 + CrO_5 + H_2O$$

When H_2SO_4 (conc) is used, it is can never be a redox reaction.

$$K_2Cr_2O_7 + H_2O_2 \xrightarrow[H_2SO_4]{\text{Conc.}} K_2SO_4 + CrO_5$$

$$K_2Cr_2O_7 + H_2O_2 \xrightarrow[H_2SO_4]{\text{Dil.}} K_2SO_4 + Cr_2(SO_4)_3 + O_2$$

$$\underset{\text{(white)}}{Ti(SO_4)_2} + 2H_2O_2 + H_2O \longrightarrow 2H_2SO_4 + \underset{\text{(orange)}}{H_2TiO_4}$$

It can be used as a test for the presence of H_2O_2.

Test For H_2O_2

- Given the dichromate and permanganate test.
- Turns the starch iodide paper into blue.

$$2KI + H_2O_2 \longrightarrow 2KOH + I_2\uparrow$$

O_3 NO_2 F_2 Br_2 Cl_2 converts KI into blue.

- Gives orange colour with $Ti(SO_4)_2$.

Q. As a bleaching agent

$$H_2O_2 \longrightarrow H_2O + (O)$$

Coloured matter + (O) ⟶ Colourless matter . oxidised

(H_2O_2) + (Cl_2) ⟶ Bleaching agent

$CaCl_2$ ⟶ $CaCl_2 + (O)$

O_3 ⟶ $O_2 + (O)$

$NaCl$ ⟶ $NaCl + (O)$

ClO_2 ⟶ $ClO + (O)$

} ⟶ oxidation bleaching is ver

H_2O_2 ⟶ $H_2O + (O)$

Coloured matter + 2H ⟶ colourless products

It is reductive bleaching (Reverside). whenever the state of papers are kept together for years they get attached due to H-bond.

All disinfectants are O.A. H_2O_2 is used in rockets.

Strength (g/L) = $3.036x$

$x = 11.2$ M, $x = 5.6 \times N$

% strength = $\frac{3.036x}{10}$

Hardness of Water

(a) Temp – Due to HCO_3^{-1} of Mg^{+2} and Ca^{+2} can be removed by clarke's method and boiling.

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

Clarke's Method ➡ $Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + H_2O + CO \uparrow$

$3Ca(HCO_3)_2 + NaCO_3 \rightarrow (2NaOHCO_3 + 3CaCO_3)$

Parmanent hardness – (a) Na_2CO_2 used to remove it. It is due to the (Cl, SO_4^{-2}) of the Mg^{+2}, Ca^{+2}

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

(b) By permetite (Crytalline sodium aluminium silicate)

Zolite (Natural way) $Na_2Al_2(SO_4) \cdot xH_2O$

Only the cations get exchanged.

$Na_2N_2S_2O_3 \cdot xH_2 + CaCl_2 \longrightarrow CaCl_2S_2O_8 \cdot xH_2O + 2NaCl$

When the tubes containing these zeolites get used up the cations gets converted, thus it further can't nullify the impurities (Recharging process).

By Calgon $\longrightarrow Na_2[Na_4(PO_3)_6] + MgSO_4 \longrightarrow Na_2SO_4 + Mg[Na_4(PO_3)_6]$

Ion-Exchange process - cation are the giant organic acids such as $-SO_3H$, $-COOH$

Anions are giant molecules of alkanes, amines.

We get pure water.

H_2 is the most hundant element in the universe (70%). However due to its light nature, it is abundant only upto 0.15% in earth.

Harold C. Urey got nobel prize for separating the hydrogen isotope of Mass = 2.

only Tritium is radioactive (H_2 = 12.3 yrs)

H_2O_2 → Peuhydrol (antiseptic), sodium perporate, sodium percarb (Detergent)

↳ Hydroquenone, Tetraniacid, pharmeceuticals (cephalosprim)

N_2 is present as an impurity in H_2. H_2 releases 3 times more energy than petrol.

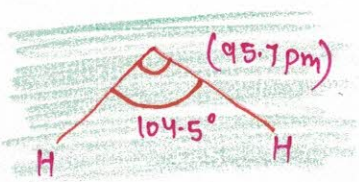
CO and H_2 are called as syn gas (synthetic gas) developed from the sewage saw dust, newspapers etc. the process of producing "syngas" from coal is called "coal gasification".

$CO + H_2O \longrightarrow CO_2(g) + H_2\uparrow$, This is called "Water gas shift reaction"

H-H bond enthalpy is high and relatively stable.

H_2 is used in the manufacture of bulk organic molecule such as methonol.

Water shows unsual prop. due to the presence of the H-bonds in its.



Ice is crystallized in the hexagonal form.

Ice formed on the surface of H_2O during the winter season provides thermal insulation.

Co-ordinated water — $[Cr(H_2O)_6]Cl_2$

Interstitial water — $BaCl_2 \cdot 2H_2O$

H-bonded water — $CuSO_4 \cdot 5H_2O$

In $CuSO_4 \cdot 5H_2O$, 4 molecules of H_2O are co-ordinate while only 1 mol. of H_2O is H-bonded.

Industrially H_2O is prepared by autooxidation of the 2-allylanthraquinones.