Hydrogen

→ Lightest gas & element.
→ Smallest size
→ Most abundant in universe.

Earth crust
Abundance → O > Si > AL > Fe

Q. Which IVA element is more abundant in earth?
(a) C (b) Si (c) ~~Ge~~ Ge (d) Sn

$_1H^1$ (Hydrogen/protium)

Z = 1
P = 1
e = 1
n = 0

$H \longrightarrow H^+$ (proton)
$1s^1 \quad 1s^0$
└ smallest cation in chemistry

Abhishek

→ H^+ never exist in free state and always exist in form of hydronium ion (H_3O^+).

$$H^+ + H_2O \longrightarrow H_3O^+$$

Isotopes of Hydrogen

	$_1H^1$ protium	$_1H^2$ Deuterium	$_1H^3$ Tritium → Radioactive
Z	1	1	1
P	1	1	1
e	1	1	1
n	0	1	2

→ protium is neutronless species.

→ I.E of protium = Deuterium = Tritium.

→ H_2 — H_2 → vanderwaals force of attraction ∝ mass
molecules molecules

→ H_2 D_2 T_2

mass ↑, V.F ↑, Bpt ↑es

→ Isotopic effect :- observed only in isotope of Hydrogen because maximum change in mass (double/triple).

$_1H^1$ $_1H^2$ $_1H^3$
M - (1) (2) (3)

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→ Effect by which maximum change in physical properties but no change in chemical property.

Bond dissociation energy → $D_2 > H_2$.

$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl \quad \text{– fast}$$

$$CD_4 + Cl_2 \longrightarrow CD_3Cl + DCl \quad \text{– slow}$$

→ All acids are covalent but ionic and conducting in water

e.g. HCl, HNO_3, H_2SO_4 - - -

covalent

↓ aq.

H^+Cl^- ionic.

→ Anhy. HCl is non conducting but aq. HCl is conducting.

Position of Hydrogen

→ placed in IA or VIIA group.

→ IA (Reason) → valance e^- → 1
→ Valency → 1
→ Valance e^- configuration is same → ns^1

→ VIIA (Reason)
→ Both are diatomic. H_2 / X_2
→ Both require 1 e^- to obtain stability (inert gas).

$H + e^- \longrightarrow H^-$ $1s^2$

$F + e^- \longrightarrow F^-$ $1s^2 2s^2 2p^6$

→ Valency → -1

$NaCl \rightarrow Na^+ Cl^-$

$NaH \rightarrow Na^+ H^-$

→ on fused or molten salt electrolysis, gas evolved at anode.

Fused NaCl → Na^+ (cathode) Cl^- (anode)

Fused NaH → Na^+ (cathode) H^- (anode)

→ I.E of H_2 close to Halogen.

H = 1312 KJ/mol

F = 1681 KJ/mol

Methods of Preparation of H_2

(I) Industrial Method

(a) Lane Process:-

$$3Fe + 4H_2O \xrightarrow{} Fe_3O_4 + 4H_2$$

(steam) — Fe_3O_4: magnetite

$$Fe_3O_4 \xrightarrow{CO + H_2} Fe$$

(water gas)

→ Iron regenerated by treating with water gas.

(b) Bosch process:-

→ carbon/coke heated with steam at 1000°C.

$$\underset{\text{R.A}}{C} + \underset{\text{steam}}{H_2O} \xrightarrow{1000^\circ C} CO + H_2$$

$CO + H_2$: water gas - syn gas or synthesis gas.

$$CO + H_2 + H_2O \longrightarrow CO_2 + 2H_2$$

CO_2 separated by passing in sod. arsenite soln.

but

$$CO + H_2 + H_2 \longrightarrow CH_3OH$$

$CO + H_2$: water gas; CH_3OH: methanol.

(c) Electrolysis of water containing small amount of acid or base

$$HOH \xrightarrow{\text{electrolysis}} H_2 + O_2$$

→ $HOH \longrightarrow H^+ + OH^-$

At cathode:- $H^+ + e^- \longrightarrow \frac{1}{2}H_2$

At anode: $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$

O_2: anode

Q. Electrolysis of acidified dilute H_2SO_4 (H_2O) gas evolved at anode?

(a) H_2 (cathode) ~~(b) O_2~~

→ Pure H_2 obtained by electrolysis of aq. Barium hydroxide solution using nickel electrode.

② Other method

ⓐ From metal hydride

$$\overset{\oplus}{Na}\overset{\ominus}{H} + HOH \longrightarrow H_2 + NaOH$$

$$\underset{\text{hydrolith}}{CaH_2} + 2HOH \longrightarrow \underset{\text{hydrolith}}{Ca(OH)_2} + 2H_2$$

ⓑ Electrolysis of Fused/molten salt of metal hydride.

$$\underset{\text{Fused/molten}}{NaH} \xrightarrow{\text{electrolysis}} Na^+ + H^-$$

$Na^+ \downarrow e^-$ → Na (cathode)

$H^- \downarrow -e^-$ → $\frac{1}{2}H_2$ (anode)

Q. Which compound on reaction with water evolve H_2 & alkaline solution forms:-

ⓐ Na_2O ↓ HOH → $NaOH$

ⓑ CaO ↓ HOH → $Ca(OH)_2$

ⓒ CaH_2 ↓ HOH → $Ca(OH)_2 + H_2$

ⓓ None

ⓒ Electrolysis of Fused/molten NaCl. — X (no H_2)

ⓓ Electrolysis of aq. NaCl (Nelson cell process)

aq. NaCl (brine) → $Na^+ + Cl^-$

$Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$ (anode)

HOH → $H^+ + OH^-$

$H^+ \downarrow$ → $\frac{1}{2}H_2$ (cathode)

$Na^+ + OH^-$ → NaOH.

→ Hydrogen gas obtained as biproduct during electrolysis of aq. NaCl.

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Q. H_2 gas obtained by electrolysis of :-

(a) Fused NaH (b) aq. NaCl (c) aq. NaBr (d) Brine (e) AU

same

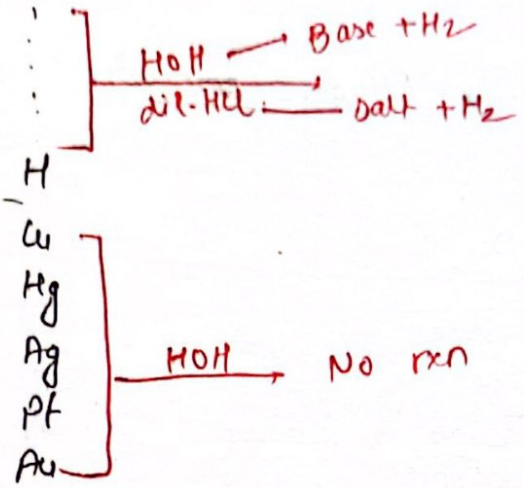
→ Metal above hydrogen in E.C.S liberate H_2 gas with water & dil HCl / dil. H_2SO_4.

H

HOH → Base + H_2

dil. HCl → Salt + H_2

Cu, Hg, Ag, Pt, Au → HOH → No rxn



E.C.S.

Li	Cd
K	Ni
Ca	Sn
Mn	Pb
Mg	H
Al	Cu
Zn	Hg
Cr	Ag
Fe	Pt
	Au.

Properties

(1) Physical:- colorless, odorless, tasteless, lightest gas & highly inflammable. (बनने), insoluble in water.

(2) Chemical:-

→ less reactive because of high Bond dissociation energy.

H—H → High B.D.E.

→ In single bond, Bond dissociation energy of H_2 is maximum except H-F.

Q. Bond dissociation energy ↓ing order:-

H_2 (H-H), O_2 (O=O), N_2 (N≡N.)

→ $N_2 > O_2 > H_2$

Q. Bond dissociation energy ↓ing order:-

O_2 (O=O), N_2 (N≡N.), F_2 (F-F), I_2 (I-I), H_2 (H-H)

↳ $N_2 > O_2 > H_2 > F_2 > I_2$

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① Rxn with Halogen

$$H_2 + X_2 \longrightarrow 2HX$$

Reactivity:- $F_2 > Cl_2 > Br_2 > I_2$

also in dark.

② N_2

$$N_2 + 3H_2 \xrightarrow[\text{catalyst}]{Fe} 2NH_3 \quad \text{(Haber's process)}$$

③ $2H_2 + O_2 \longrightarrow 2H_2O$

④ Reaction with metal

$$Na + \tfrac{1}{2} H_2 \xrightarrow{\Delta} NaH$$

$$Ca + H_2 \xrightarrow{\Delta} CaH_2$$

] Ionic.

⑤ Hydrogenation

$$CH_2 = CH_2 + H_2 \xrightarrow[Pd]{Ni, Pt,} CH_3 - CH_3$$

$$CH \equiv CH + 2H_2 \xrightarrow{\cdot\cdot} CH_3 - CH_3.$$

alkene
alkyne
unsaturated oil

$\xrightarrow[Ni/Pt/Pd]{H_2}$

Alkane
saturated solid form
↳ Banaspati ghee

Types of Hydride

① Ionic Hydride → salt like / saline.

- 's' block metal hydride are ionic. except BeH_2 & MgH_2. ↳ covalent.
- → contain H^- unit (Hydride).

$$M + H_2 \xrightarrow{\Delta} MH.$$

IA)

LiH — CsH → ionic

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

IIA

Ca — Ba → Ionic

BeH_2, MgH_2 } covalent & polymeric.

- Thermal stability of ionic hydride $\propto$ L.E $\propto \frac{\text{charge}}{\text{size}}$

T.S → LiH > NaH > KH > CsH

size ↓es, L.E ↑es T.S ↑es

property of ionic hydride

1. Crystalline solid
2. Non-conductive in solid state but conductive in fused/molten state.
3. On reaction with H_2O, H_2 gas evolved.

$$NaH + HOH \longrightarrow NaOH + H_2$$

$$CaH_2 + HOH \longrightarrow Ca(OH)_2 + 2H_2$$

4. Ionic hydride are used as drying agent because it removes moisture/H_2O from organic substance.

$$NaH + C_6H_6 \xrightarrow{\text{(moist)}} H_2 + NaOH.$$

5. High mpt & B.pt.
6. Non volatile nature.
7. Act as reducing agent.

$$LiH + AlCl_3 \longrightarrow LiAlH_4 + 3LiCl.$$

2. Covalent Hydride/Molecular hydride

→ Formed by p-block.

→ Types:-

A) e^- deficient :- IIIA.

BH_3, AlH_3, ... } Val. $e^- = 6$, e^- deficient, hypovalent

(B) e^- precise

IVA

CH_4, SiH_4, GeH_4, ..., PbH_4 } Val. $\bar{e} = 8$, octet complete.

C. e⁻ rich :- Lone pair donor.

NH_3,	H_2O	HF
PH_3	H_2S	HCl
AsH_3		HBr
⋮	⋮	

$$NH_3 + H^+ \longrightarrow NH_4^{\oplus}$$

Q. e⁻ deficient hydride :-

(a) BeH_2 (4 V.E) (b) MgH_2 (4 V.E) (c) BH_3 (6 VE) ~~(d)~~ Al

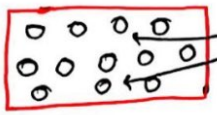
(3) Metallic Hydride | Interstial hydride | Non-stoichiometric hydride

→ d & f-block metals ले बनाउँछ।

→ These compounds are neither ionic nor covalent.

→ These are non-stiochiometric in nature.

e.g. $VH_{0.56}$, $TiH_{1.5}$



voids | Interstial space.

→ Small size non-metal (H) occupy in vacant space of d-blocks & f-block metals.

→ 7, 8 & 9 groups does not form hydrides. This is known as hydride gap.

→ In 6th group, only cromium form hydride.

Q. Which is interstial hydride?

(a) LiH (ionic) (b) CaH_2 (c) BH_3 (covalent e⁻ def) (d) CH_4 (covalent e⁻ pr.) (e) NH_3 (cov. e⁻ rich)

(f) H_2O (g) HF (coval. e⁻ rich) ~~(h)~~ $VH_{0.56}$

Types of Hydrogen

(1) Atomic Hydrogen :- When H_2 gas pass between electric arc.

$H_2 \xrightarrow{\text{electric arch}} 2H$ → endothermic.

↳ energy need $\Delta H = 105$ Kcal.

↓ within 0.3 sec combine

H_2 ← $2H$

↓ large heat liberate

↳ used in welding purpose.

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- Atomic H is used in welding purpose

② Nascent Hydrogen

- Hydrogen produced at site of chemical rxn.
- Newly Born Hydrogen.

$$Zn + dil.\ H_2SO_4 \longrightarrow ZnSO_4 + 2H_2$$ ← H_2 after some sec

acidic $KMnO_4$ (purple) $\xrightarrow[\text{gas}]{H_2}$ No decolorization

acidic $KMnO_4$ $\xrightarrow[H_2SO_4]{Zn}$ disappear of purple color

$ZnSO_4 + 2(H)$ ← nascent H.

- Reducing character:- atomic H > Nascent H > Molecular H.

③ Molecular Hydrogen

$$H-H \longrightarrow H-H(H_2)$$

- ortho & para-H differ in spin of proton (nuclear spin isomer)

ortho H_2

- spin of proton clockwise:



para H_2

- spin of proton anticlockwise.



- At room tempr.
  ortho – 75%.

para → 25%.

- As tempr ↑es, % ortho content ↑es.
- As tempr ↓es, % para content ↑es
- At 20K, 99.82% para form.
  - pure paraform possible but pure ortho form not possible.
    @PPP

Hydrogen peroxide (H_2O_2)

properties

① **Dibasic acid:-** Loses 2 proton.

$H_2SO_4 \longrightarrow 2H^+ + SO_4^{--}$

$\hookrightarrow H^+ + HSO_4^-$

$\downarrow$

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

$H_2O_2 \longrightarrow H^+ + HO_2^-$

$\downarrow$ $\qquad\qquad$ $\downarrow$

$2H^+ + O_2^{-2} \qquad H^+ + O_2^{-2}$

$H-O-O-H$

→ $H_2O_2 + 2NaOH \longrightarrow Na_2O_2 + 2H_2O$

② **Bleaching agent:-**

Colored $\xrightarrow{\text{Bleaching gent}}$ colorless

$H_2O_2 \longrightarrow H_2O + [O]$

$\hookrightarrow$ nascent oxygent.

→ H_2O_2 show bleaching property by oxidation & bleaching action is permonent.

$[O]$ + Colored $\longrightarrow$ colorless

③ **Oxidation** → ↑es in O.S

Reduction:- ↓es in O.S.

O. agent → oxidises other & itself get reduce.

R. agent → reduces other & itself get oxidise.

O → −2 to +2. $\qquad$ F = −1 always.

Minium O.S.	Intermediate O.S.	Maximum O.S
R. Agent	both	Oxidising agent
$H_2\overset{-2}{S}$	$\overset{+4}{S}O_2$	$\overset{+6}{S}O_3$

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- H_2O_2 act as oxidising agent & reducing agent due to intermediate O.S. in acidic & basic medium

④ Oxidising character of H_2O_2

$Fe^{+2} + H_2O_2 \longrightarrow Fe^{+3}$
R.A O.A.

$KI + H_2O_2 \longrightarrow I_2$
R.A O.A

$H_2S + H_2O_2 \longrightarrow$
R.A O.A

$PbS + H_2O_2 \longrightarrow PbSO_4 + H_2O$
R.A (black) O.A (white)

⑤ Reducing character of H_2O_2

$\overset{+7}{K}\overset{+7}{M}n\overset{-2}{O_4} + \overset{-1}{H_2}O_2 \longrightarrow \overset{+2}{M}n + \overset{0}{O_2}$
O.A R.A

$\overset{0}{Cl_2} + \overset{-1}{H_2}O_2 \longrightarrow 2\overset{-1}{H}Cl + \overset{0}{O_2}$
O.A R.A

$\overset{+4}{Pb}O_2 + H_2O_2 \longrightarrow \overset{+2}{Pb}O + H_2O + O_2$
O.A R.A

$\overset{+7}{K}\overset{+7}{I}O_4 + H_2O_2 \longrightarrow \overset{+5}{K}IO_3 + H_2O + O_2$
O.A R.A

$\overset{+1}{Ag_2}O + H_2O_2 \longrightarrow Ag + H_2O + O_2$
O.A R.A

$Fe^{+3} + H_2O_2 \longrightarrow$
O.A R.A

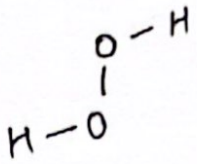
Uses :-

- used as antiseptic (germicide)
- used as bleaching agent.

Perhydrol solution

Structure

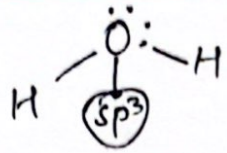
Half open book, non-planar structure. ($\mu \neq 0$) polar.

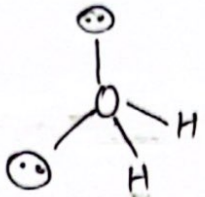


also of H_2O_2, O_2F_2, H_2S_2, $-S_2Cl_2$

└ half open book str.
isostructural.

Water (H_2O)





Geometry :- Tetrahedral
structure :- V shaped / angular / Bent.
Bond angle :- 105° / 104.5°

→ H_2O is liquid & other member gas.

→ Boiling point of water is maximum among chalcogen hydride due to association by H-bond.

$H_2O_{(l)} \longrightarrow H_2O_{(vapour)}$ → evaporation

during this process, H-bond break at temp^T 100°C.

→ Density of ice (volume वढ़ी) < H_2O.

open cage tetrahedral porous str.

but ~~D_2O~~ Density of D_2O ice > H_2O

ice of heavy water sink in H_2O.

Density of D_2O ice < D_2O

→ Chemical property of H_2O & D_2O same but rate of rxn changes.

Rate of D_2O is slow than H_2O. because bond energy of

O-D > O-H.

$SO_3 + H_2O \longrightarrow H_2SO_4$ → fast

$SO_3 + D_2O \longrightarrow D_2SO_4$ → slow

↳ Deutero sulphuric acid

→ $CaO + HOH \longrightarrow Ca(OH)_2$

$CaO + DOD \longrightarrow Ca(OD)_2$

→ $Na + HOH \longrightarrow NaOH + \frac{1}{2}H_2$

$Na + DOD \longrightarrow NaOD + \frac{1}{2}D_2$

→ $CaC_2 + HOH \longrightarrow C_2H_2 + Ca(OH)_2$

Q. Al_4C_3 on reaction with H_2O form:-

(a) C_3H_8 (b) C_3H_6 (c) C_3H_4 ~~(d)~~ (d) CH_4

* properties

$D_2O > H_2O$

mpt
bpt
Density
viscosity
surf tension

but volatility is more of H_2O than D_2O.

→ NaCl is more soluble in H_2O than D_2O because the dielectric constant of ~~NaCl~~ H_2O is more than D_2O.

Chemical properties

① Amphoteric Nature:- Loses H^+ & accept H^+ as well.

$NH_3 + \underset{\text{acid}}{HOH} \longrightarrow NH_4^+ + OH^-$

$HCl + \underset{\text{base}}{HOH} \longrightarrow Cl^- + H_3O^+$

→ self ionisation of H_2O (protolysis of H_2O)

$H_2O \longrightarrow H^+ + OH^-$

$H_2O + H^+ \longrightarrow H_3O^+$

$2H_2O \longrightarrow H_3O^+ + OH^-$

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(2) Water act as oxiding agent & reducing agent

$$\underset{R.A}{Na} + \underset{O.A}{HOH} \longrightarrow NaOH + \tfrac{1}{2} H_2$$

$$Ca + HOH \longrightarrow Ca(OH)_2 + H_2$$

- F_2 decomposes water and liberate O_2 / O_3.

$$\overset{0}{F_2} + \underset{R.A}{\overset{-2}{H_2O}} \longrightarrow 2H\overset{-1}{F} + \tfrac{1}{2}\overset{0}{O_2}$$

$$\underset{O.A.}{F_2} + 3H_2O \longrightarrow 6HF + O_3$$

(3) Hydrolysis :-

(A) oxide

$$CaO \xrightarrow{HOH} Ca(OH)_2$$

$$Na_2O \xrightarrow{HOH} NaOH$$

$$Al_2O_3 \xrightarrow{HOH} Al(OH)_3$$

→ $$CO_2 \xrightarrow{HOH} H_2CO_3$$

$$SO_3 \xrightarrow{"} H_2SO_4$$

$$SO_2 \xrightarrow{"} H_2SO_3$$

$$N_2O_5 \xrightarrow{"} HNO_3$$

N_2O_5 : anhydride of nitric acid.

$$HNO_3 \xrightarrow[-H_2O]{\Delta} N_2O_5$$

$$N_2O_3 \xrightarrow{HOH} HNO_2$$

$$NO_2 \xrightarrow{HOH} HNO_3 + HNO_2$$

$$P_4O_{10} \xrightarrow{HOH} H_3PO_4.$$

(B) Hydride.

$$NaH \xrightarrow{HOH} NaOH + H_2.$$

$$CaH_2 \xrightarrow{"} Ca(OH)_2 + 2H_2.$$

(C)

ⓒ Nitride

$Li_3N \xrightarrow{HOH} NH_3 + LiOH$

$Mg_3N_2 \xrightarrow{"} " + Mg(OH)_2$

$Ca_3N_2 \xrightarrow{"} Ca(OH)_2 + NH_3$

$Ca_3P_2 \xrightarrow{"} Ca(OH)_2 + PH_3$

ⓓ Halide

$BCl_3 + HOH \longrightarrow B(OH)_3 + HCl$
$\hookrightarrow H_3BO_3$

$PCl_3 + HOH \longrightarrow P(OH)_3 + 3HCl$
$\hookrightarrow H_3PO_3$

$SiCl_4 + HOH \longrightarrow Si(OH)_4 + 4HCl.$

Hardness of water

→ Due to Ca & Mg salt of HCO_3^- / SO_4^{-2} / Cl^- for Hardness.

[Hardwater ले साबुन संग फिज बनाउँदैन ।]

$C_{17}H_{35}COONa$
Sod. Sterate.

A) Temporary Hardness

- due to Ca & Mg salt of bicarbonate.

B. Permanent Hardness

- due to Ca & Mg salt of SO_4^{-2} / Cl^-.

$C_{17}H_{35}COONa$ (Sod. Sterate) $\xrightarrow{\text{Hard water}}$ Ca/Mg stearate को ppt.

→ $C_{17}H_{35}COONa + M^{+2} \longrightarrow (C_{17}H_{35}COO)_2M\downarrow + 2Na^+$
ppt.
M = Ca / Mg.

→ Hard water doesn't give lather with soap.

Temporary Hardness :-

removal ↗

① Boiling :-

$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + CO_2\uparrow + H_2O$
Calcite ppt.

→ $CaCO_3$ & $Mg(OH)_2$ settled down & now filter.

② Clark's method:-

Calculated amount of $Ca(OH)_2$

$$Ca(OH)_2 + Ca(HCO_3)_2 \longrightarrow \underset{\text{ppt}}{2CaCO_3\downarrow} + 2H_2O$$

Permanent hardness removal:

① Washing soda process:-

$$CaSO_4 + Na_2CO_3 \longrightarrow \underset{\text{calcite ppt.}}{CaCO_3}$$

② Calgon method

↳ sod. Hexa meta phosphate — cyclic str.

$$Na_2[Na_4(PO_3)_6] \Rightarrow Na_6P_6O_{18}$$

$$\sim Na_2[Na_4P_6O_{18}]$$

$$[Na_4P_6O_{18}]^{-2} + \underset{\text{↳ Ca/Mg.}}{M^{+2}} \longrightarrow [Na_2MP_6O_{18}]^{-2} + 2Na^+$$

Q. Which of the following is used for removal of permanent hardness?

(a) $Ca(OH)_2$ Clark. (b) Boiling (c) cyclic metaphosphate (d) None

③ Zeolite / permutit / ion-exchange method

↳ sod. aluminium ortho silicate

$$Na_2O.Al_2O_3.2SiO_2.xH_2O$$

$$\downarrow$$

$$Na_2Al_2Si_2O_8.xH_2O$$

$$\downarrow \text{in short}$$

$$Na\boxed{AlSiO_4}$$

↳ NaZ.

$$NaZ + M^{+2} \longrightarrow MZ_2 + 2Na^+$$

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→ Zeolite regenerated by treating with NaCl

$$MZ_2 + 2NaCl \longrightarrow 2NaZ + MCl_2$$

Q. Temporary hardness of water is due to presence of :-

(a) $MgSO_4$ (b) $Mg(HCO_3)_2$ (c) $CaCl_2$ (d) $CaCO_3$

Q. Water is hard, if it contains :-

(a) $NaHCO_3$ (b) $MgSO_4$ (c) KCl (d) NaCl

Q. Water is said to be permanently hard when it contains :-

(a) chlorides & sulphates of Mg & Ca (b) bicarbonates of Na & K

(c) carbonates of Na & K (d) phosphate of Na & K.

Q. The alum used for purifying water is :-

(a) Potash alum (b) Ferric alum

(c) ammonium alum (d) chrome alum

Q. Why do calcium ions makes water hard but sodium ions do not ?

(a) Calcium forms insoluble compounds with stearate ions present in soap.

(b) sodium forms insoluble compounds " " " " "

Q. Water softening by Clarke's process uses :-

(a) Calcium bicarbonate (b) sodium bicarbonate

(c) Potash alum (d) Calcium hydroxide (slaked lime).

Q. The reagent commonly used to determine hardness of water titrimetrically is :-

(a) oxalic acid (b) Disodium salt of EDTA

(c) Sodium citrate (d) Sodium thiosulphate

Q. The chemical formula of zeolite is :-

(a) $K_2Al_2Si_2O_8 . x H_2O$ (b) $CaAl_2Si_2O_8$

(c) $Na_2Al_2Si_2O_8 . x H_2O$ or NaZ (d) none

Q. When zeolite, which is hydrated sodium aluminium silicate, is treated with hard water the sodium ions are exchanged with :-

(a) H^+ ions (b) Ca^{+2} ions (c) OH^- ions (d) SO_4^{2-} ions

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Q- The exhauted permutit is generally regenerated by percolat through it a solution of :-

(a) Sodium chloride (b) Potassium chloride

(c) Calcium chloride (d) Magnesium chloride.

Q. Calgon used as a water softner is:-

(a) $Na_2[Na_4(PO_3)_6]$ (b) $Na_4[Na_2(PO_3)_6]$

(c) $Na_2[Na_4(PO_4)_5]$ (d) $Na_2[Na_4(PO_4)_6]$

Q. The reagent used for softening the temporary hardness of wa

(a) Na_2CO_3 (b) $Ca(OH)_2$ (c) Both a & b (d) NaOCl

Q. Permanent hardness of water can be removed by adding:-

(a) Na_2CO_3 (b) K (c) $Ca(OCl)Cl$ (d) Cl_2

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