Quality of Water

Quality of water is found with the help of sudden indicator or parameter term as water quality parameter which are further classifield into:-

(i) Physical Quality Parameter.
(ii) chemical Quality. Parameter.
(iii) Biological Quality "

Physical Quality Parameter

These are parameter which indicate physical quality of water and can be sense by any our senses.

(i) Source
(ii) Impact
(iii) Measurement
(iv) Limits.

1) Suspended Solids.

Source: Suspeded solid may come from organic or inorganic matter.

IS : silt, clay, sand, soil etc.

OS : plant; algae, plankton etc.

Carbon present ← organic

$$C_a H_b O_c S_d N_e P_f$$

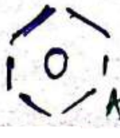
eg. CH_4 , $C_6 H_{12} O_6$ (Glucose) , $C_6 H_6 O$ (phenol)

$a=1$ $b=4$; $a=6$ $b=12$ $c=6$; $a=6$, $b=6$ $c=1$

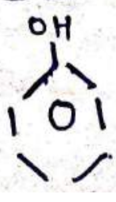
Organic Matter.

Microorganism can break

Biodegrable	Non-biodegrable
$-C-C-$	$-C \equiv C-$



Aramotic Campound.



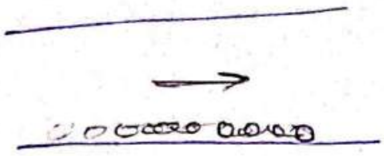
Cross linked polymer.

Impact:

i) Suspended solid is biological in nature may promote growth of disease causing M/o.

(ii) It makes the water aesthically displeasing. (psych. effect)

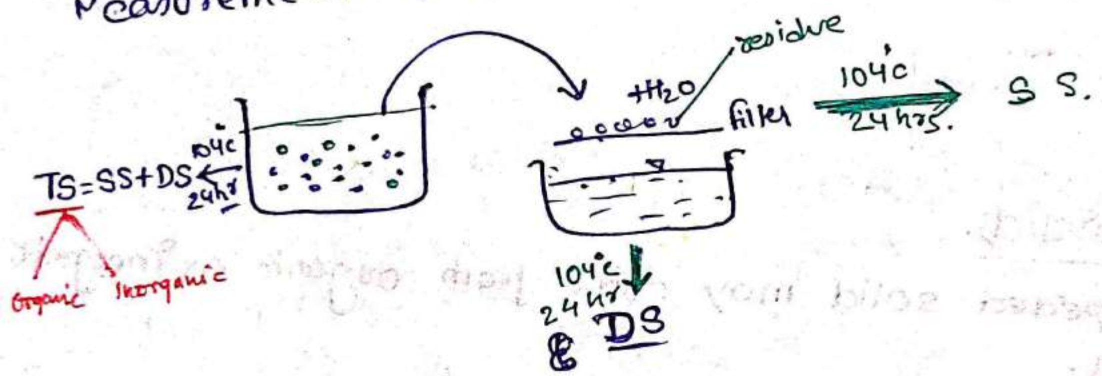
(iii) It leads to incrustation (deposition) in pipes hence reduces its discharge carrying capacity.

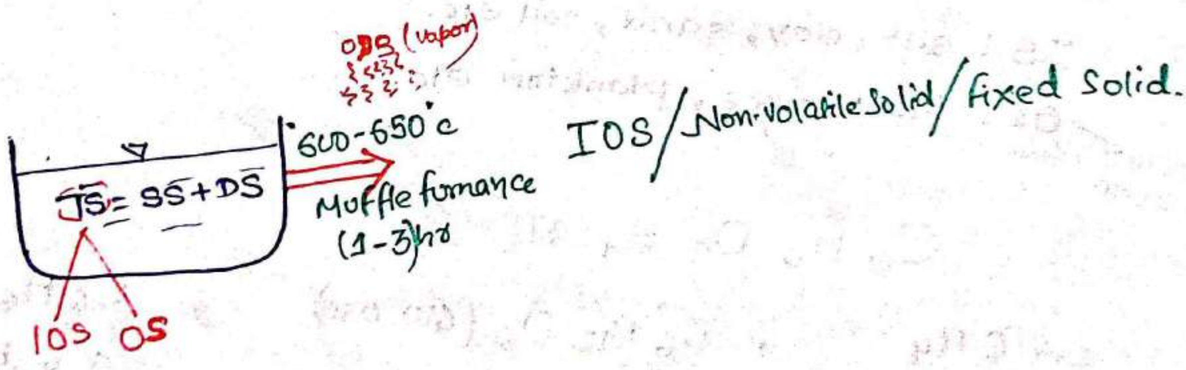


(iv) SS Interferce with treatment of water (either increase cost or reduce its efficiency).

Measurement

Measurement of solid is done by Graviometric Technique.





$OS = TS - IOS$

$$\boxed{\begin{array}{l} SS \xrightarrow[1-3\,hr]{600\ to\ 650^\circ C} IOSS \\ OSS = SS - IOSS \\ ODS = OS - OSS \end{array}}$$

$IODS = DS - ODS$

EPA: Environment protection Agency

Limits of total dissolve solid =

	Acceptable	Cause for rejection limit
	500 mg/lit	2000 mg/lit.

Q following observation were made on raw water sample. Chiradish

(i) A crucible was dried to a constant mass of 65gm.

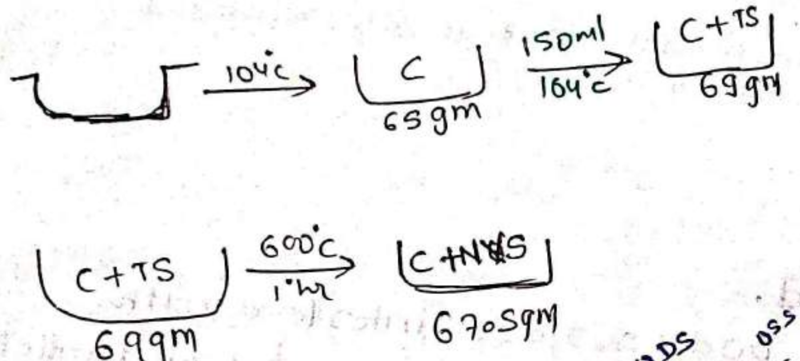
(ii) 150 ml of raw water sample was placed in crucible and was dried to a constant mass of 69gm at 104°c.

(iii) Crucible and residue was placed in Muffle furnance for 1hour at 600°c and reduced to constant mass of 67.59gm.

find concentration of TS and Volatile solid in mg / liter.

$$TS = \frac{(69-65)\times 1000}{\frac{150}{1000}} = 26666 \text{ mg/lit}$$

$$VS = \frac{(69-67.59)\times 1000}{\frac{150}{1000}} = 19000 \text{ mg/lit}$$



Q Find the concentration of TS, FDS, OSS in given sample of water.

ppm

- $MgCO_3$ - 20 - IO, DS
- $Mg(OH)_2$ - 30 - IOSS
- $C_6H_{12}O_6$ - 15 - ODS
- SiO_2 - 20 - IOSS
- NaCl - 35 - IODS
- Algae - 50 - OSS
- C_6H_6O - 5 → ODS
- Fe_2O_3 - 2 - IOSS
- $CaCO_3$ - 3 - IOSS
- Plankton - 5 - OSS
- $MgSO_4$ - 15 - IODS
- CO_2 - 40 - IODS

ppm = mg/lit only for water

Total solid = 240ppm = 240 mg/lit

FDS = $MgCO_3$ + NaCl + $MgSO_4$ + CO_2

= 20 + 35 + 15 + 40 = 110

OSS = 10

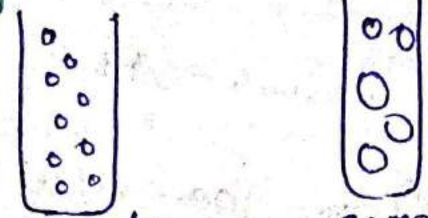
Limits of

(2) Turbidity

Turbidily is exteded to which light is either scattered or obstructed due to presence of suspended particle in water. but rather no relation between two.

SUU

Turbidity : I > II

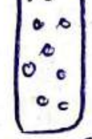


50mg/lit 50mg/lit

$\uparrow SSA \propto \frac{1}{d\downarrow}$

Specific surface area

III



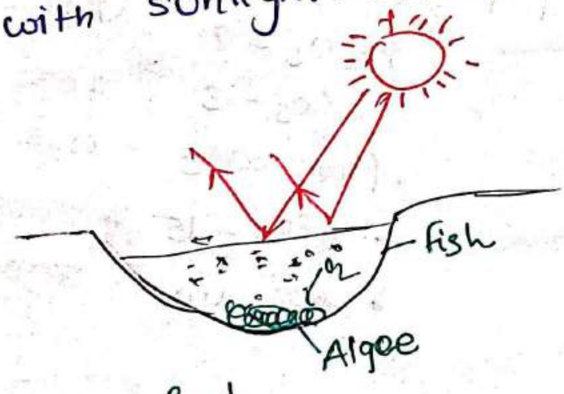
= turbidity will more that as compare to I. but not double.

100mg/lt

Impact

→ same as suspendedsolid.

→ Turbidily of water body surface interfere with penetration with sunlight. effects the survival of aquaticlife.

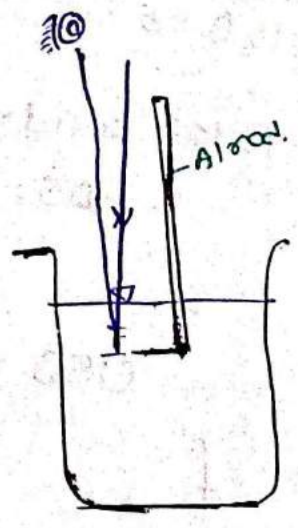


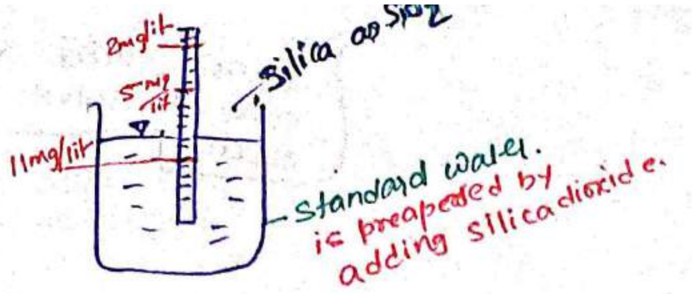
Pond.

Method Measurement

(i) Turbidily Rod Method. (F
— field method.

- depth Calculated. and calibrated with standard water.





mg/lit	d
2mg	10
5mg/lit	6
11mg/lit	2

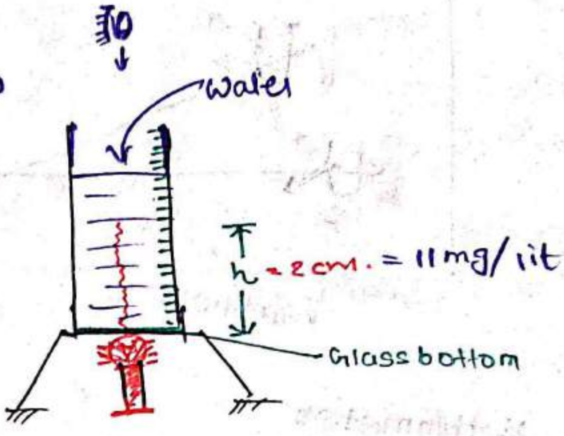
→ mg/lit, parts per million (ppm), STU (silica turbidity unit).

(ii) Jackson Turbidmeter Method. (lab test)

→ drawback → measure turbidity → 25 to 1000

→ Based on absorption principle.

→ mg/lit, ppm, $\boxed{\text{STU}}$, JTU



→ 1 JTU means 1mg of finely divided silica if mixed in 1 liter distilled water then turbidity produced is taken as 1 JTU.

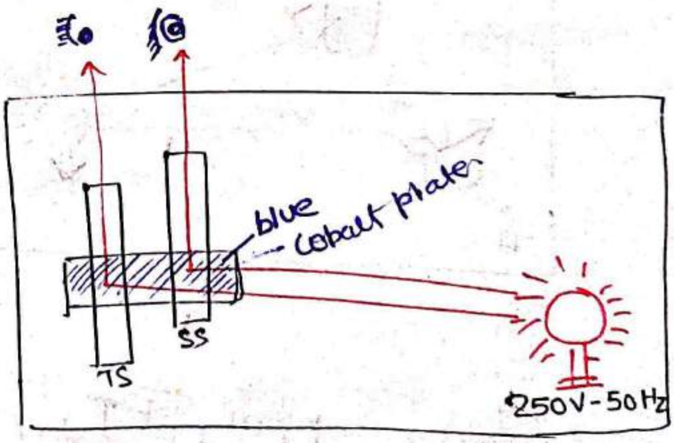
(iii) Baylis turbidmeter & Nephlometer. (0-1) ppm.

→ colour matching technique.

→ Used for domestic water supply.

$Ss = 1 mg/lit$

$TS = x =$



→ Nephlometer In this method, Formazine polymer is added if mixed in 1 liter of distilled water then turbidity produced called as 1 NTU or 1 FTU.

→ Baylis turbidity meter, ligh intensity is measured in the direction of incident ray only whereas in nephlometer light is measured at right angles to the incident ray.

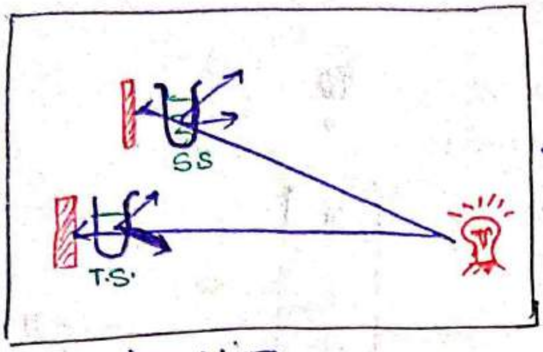
60

New version

Photometer
-(Semi conductor)

Ionic solid are dissolve solid.

Baylis

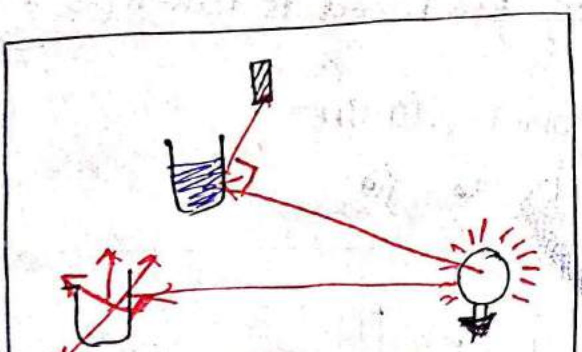


Absorption.

→ light pass through sample. and photometer kept just back of sample.

→

Nephlometer



→ It works on scattering principle.

→ In nepholometer we use 1mg formazine in 1 lit of distilled water.

→ light is measured at right angle.

mg/lit , ppm, $\boxed{\text{FTU}}$, NTU,

most appropriate unit:

	Acceptable	Cause for rejection
Limits:	1 NTU	5NTU

(iii) Colour

- Apparent: TS = SS + DS
- True: DS

<u>Soure</u>: Organic & Inorganic.

<u>Impact</u>: (i) Colour water can't be used for washing or drying purpose.

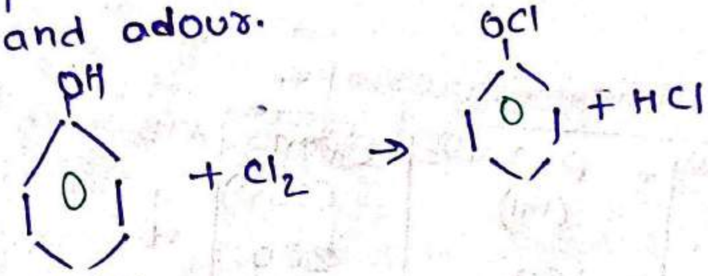
(ii) There are certain colour causing compound, which increase the demand of Iron, magnese. Chlorine in water.

$$Fe^{2+} / Mn^{2+} \rightarrow Fe^{3+} / Mn^{4+}$$

$Fe^{+2} + Cl_2 \rightarrow Fe(OH)_3 \downarrow$

$Mn^{+2} + Cl_2 \rightarrow MnO_2$

(iii) There are certain colour causing compound like phenol which reacts with chlorine to give taste and adour.



Yellow

(iv) There are certain colour causing compound which reacts with chlorine to form carcinogenic (cancer causing compound).

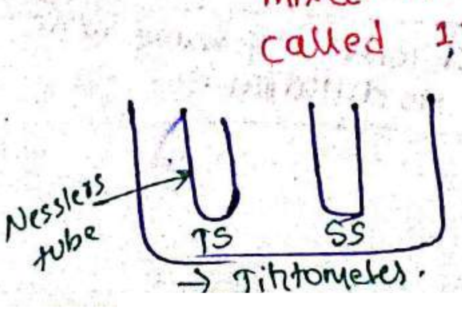
$$CC + Cl_2 \rightarrow \text{Carcinogenic}.$$

<u>Measurement</u>:

→ Colour is measured by using colour matching technique.

→ Colour is measured on platinum cobalt scale in terms of true colour unit (TCU).

1TCU = 1mg of platinum cobalt in form of <u>chloroplatinate</u> ion is mixed in 1 liter distilled water. then colour produced called 1TCU. (Hazzen unit)



	AL	CFR
limits	5	15 (TCM

(iv) Taste and Odour.

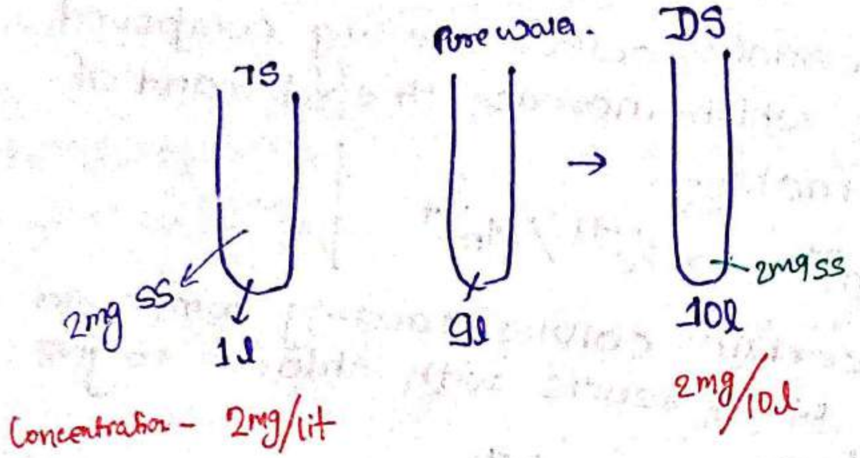
Source: Organic & Inorganic, solids & gases.

Impact:- Pschological effect,

Measurement: Dilution.

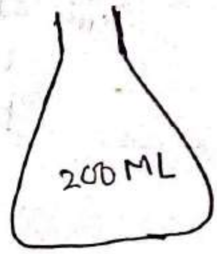
↓

Artificial increase (augmentation) in vol. of water.



$$10 \text{ times} = \frac{\text{F.V. of DS}}{\text{IV of TS}} = \frac{10}{1}$$

$$\% = \frac{1}{10} = 10\%$$



→ Measured using Osmoscope.

TS (A) (ml)	+ PW (B) (ml)	= DS (200)	A+B
50	150	200	4
40	160	200	5
⋮			
25	175	200	8

TON (threshold Odour No.) = Dillution ratio.

$$= \frac{\text{Final Volume of DS free from T\&O}}{\text{Initial Vol. of TS}}$$

$$\boxed{= \frac{A+B}{A}}$$

$A+B = 200\,ml$

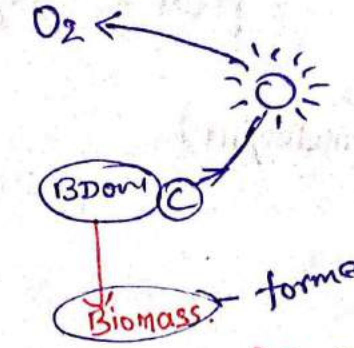
	AL.	CFR
Limit =	1 TON	3 TON

1 TON means same water no dillution.

(v) Temperature.

→ For water supply temp in rang (10-25)°c.

→ Higher temp increase decomposition rate.



formed after decomposition of organic particles

[CO_3^{2-}, NO_3^{-}, SO_4^{2-}, acids, alcohol, gases:- CO_2, CH_4, H_2S, N_2]

CHEMICAL WATER QUALITY PARAMETER

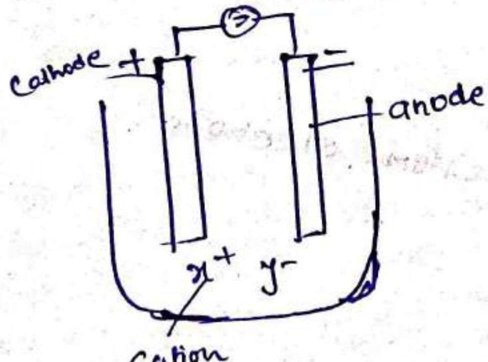
1.) Dissolve solid.

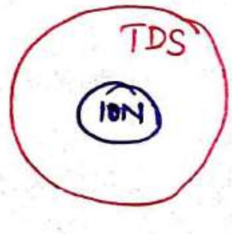
Soure: Organic & Inorganic

Impact: Same as of taste, colour, odour.

Measurement: Graviometric technique.

→ Dissolved solid can also be determined approximately by measuring electrical conductivity of water using ~~dipionic~~ Di-ionic tester.





$$\boxed{\left[\text{Electrical conductivity in } \frac{\mu\, mho}{cm} \text{ @ } 25°c\right] 0.65 = TDS\,(mg/lit)}$$

→ All ions are dissolved solids but all dissolve solids are not ion.

temp ↑ → electrical conductivity ↑

→ E

(iii) pH: artificial scale (0-14)

power potential · acidity · Basicity

$$pH = -\log_{10}[H^+] \qquad pOH = -\log_{10}[OH^-]$$

$[H^+]$, $[OH^-]$ = (moles/lit)

pH

0 – Acidic — corrosion

7 — Neutral

Basic — incrustation

14

$$\boxed{[H^+][OH^-] = 10^{-14}\ (\text{moles/lit})^2}$$

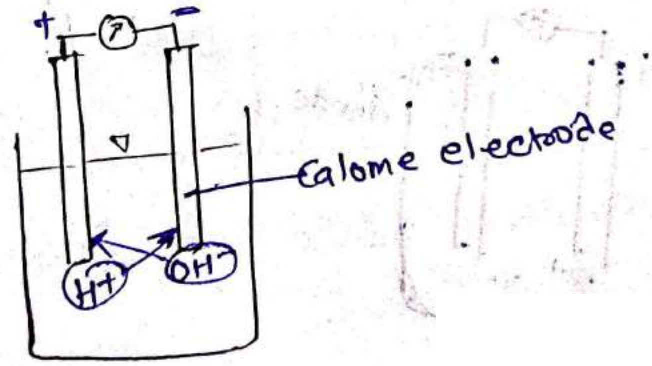
$$\log[H^+][OH^{-1}] = \log 10^{-14}$$

$$\log[H^+] + \log_{10}[OH^-] = -14$$

$$-\log[H^+] - \log_{10}[OH^-] = 14$$

$$\boxed{pH + pOH = 14}$$

→ PH of water can be found using potentiometer or pH meter.



Limit = (6.5 – 8.5)

	AL	CFR
PH	6.5-8.5	No relaxation

Q $pH_A = 4.5$

$[OH^-]_B = 2[OH^-]_A$

$pH_B = ?$

$pH_A = 4.5$

$pOH_A = 9.5$

$-\log_{10}[pOH^-] = 9.5$

$\log_{10}\left[\frac{1}{OH^-}\right] = 9.5$

$\frac{1}{OH^-} = 10^{9.5}$

$\boxed{[OH^-]_A = 10^{-9.5}}$

$(OH^-)_B = 2 \times 10^{-9.5}$

$(pOH)_B = \log_{10}\left[\frac{1}{2\times10^{-9.5}}\right]$

$(pOH)_B = 9.19$

$(pH)_B = 14 - 9.19$

$= 4.8$

$pH = \log\frac{1}{H^+}$

$= \log 1 - \log[H^+]$

$pH = -\log[H^+]$

H^+ = moles/lit.

$[H^+][OH^-]_B = 10^{-14}$

$(H^+)_B = \frac{10^{-14}}{2\times10^{-9.5}}$

$= 1.5\times10^{-6.5}$

$(H^+)_B = -\log(1.5\times10^{-6.5})$

$= 4.8$

Q $t = 0$, $p_H = 6$

$t = 24h$, $p_H = 8.5$

Find time mean pH value of effluent over 24 hr. period assuming

(i) Assume hydronium ion concentration varies linearly.

(ii) Assume hydronium ion concentration varies parabolic.

(iii) Assume pH varies linearly.

(i) $[H^+]_0 = 10^{-6}$ moles/lit $\quad [H^+]_{24} = 10^{-8.5}$ moles/lit

$[H^+]_{avg} = -\log_{10}\left[\frac{10^{-6}+10^{-8.5}}{2}\right] = 6.299$

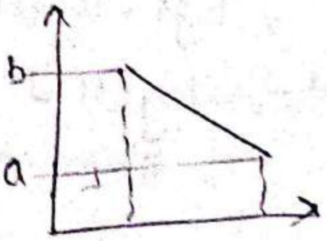
(II) $[H^+]_{avg} = [H^+]_0 - \frac{2}{3}\left[[H^+]_0 - [H^+_{24}]\right]$

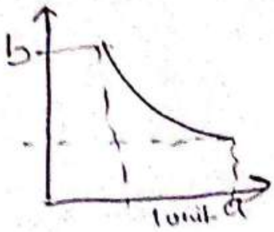
$= 10^{-6} - \frac{2}{3}[10^{-6} - 10^{-8.5}]$

$= 3.35\times10^{-7}$ moles/lit

$\boxed{pH = 6.474}$

(iii) P_H avg $= \frac{6+8.5}{2} = 7.25$





pH

→ It is an artificial scale in the range of 0-14 which is used to indicate acidily or basicily of water.

→ pH of water can be found with the help of colour indicator like phenolphlin, methyle organe, Bromoethymol blue, is used to find the pH apparatue is termed as AQUASCOPE.

→ pH can also be delermined by help of polentiomeler.

Acceptable limit – $\boxed{6.5 - 8.5}$

Basic Stoichiometry

① Molecular weight (MW) = Σ atomic weight of all atoms in the molecule.
Std unit - g

eg. ① $H_2SO_4 = (2+32+64) = 98g$

② $Al_2(SO_4)_3 \cdot 18H_2O = (27\times2)+(32\times3+16\times12)+18\times(2+16)$
$= 666g$

Hydrated aluminium sulphate

③ $CaCO_3 \rightarrow 40+12+16\times3 = 100g$

② No. of moles (n)

$$n = \frac{\text{given weight in (g)}}{\text{molecular weight (g)}}$$

eg. find no. of moles in 350g of $CaCO_3$

$$n = \frac{350}{100} = 3.5$$

eg. Find no. of moles in 196 mg of H_2SO_4

$$n = \frac{196\times10^{-3}g}{98} = 0.002 \text{ moles.}$$

$$\text{no. of milimoles} = \frac{196}{98} = 2 \text{ milimoles} = 2 \text{ mmoles.}$$

③ Equivalent Weigth (g)

$$\text{eq. wt (g)} = \frac{\text{Molecular weight (g)}}{\text{Valency}}$$

Valency := the no. of electrons which can be transfered

(i) $CaCO_3 = \frac{100}{2} = 50g$

$CaCO_3 \rightarrow Ca^{2+} \quad CO_3^{2-}$

$Ca^{2+} \xrightarrow{2e^-} CO_3^{2-}$

(ii) $NaCl = \frac{23+35.5}{1} = 58.5$

$NaCl \rightarrow Na^+ \quad Cl^-$

$Na^+ \xrightarrow{e^-} Cl^-$

(iii) $Mg^{2+} = \frac{24}{2} = 12\ g$

(iv) $SO_4^{2-} = \frac{96}{2} = 48g$

(v) $H_2SO_4 = \frac{2+32+64}{2} = \frac{98}{2} = 49$

(vi) $MgSO_4 = \frac{120}{2} = 60g$

1. H-1
2. He-4
3. Li-7
4. Be-9
5. Boron-11
6. Carbon-12
7. N-14
8. O-16
9. F-19
10. Neon.Ne 20
11. Na 23
12. Mg 24
13. Al 27
14. Si-28
15. Phosphorus-31
16. Sulphur-32
17. Cl - 35.5
18. Ar 40
19. Potassium(K) - 39
20. Ca - 40

K	L	M	N
2	8	8	--

(iv) Gram equivalent.

$$g\ eq./no.\ of\ eq. = \frac{Given\ wt(g)}{eq.wt\ (g)}$$

(i) find the g.eq. in 350g of $CaCO_3$

$$g.eq = \frac{350}{50} = 7\ g\ eq.$$

Gram equivalent principle.

"1gm eq. of any compound react with 1 g equivalent of any other compound & produce 1 g.eq. each of the respective products in a reaction".

$$\underset{3g\ eq}{A} + \underset{3g\ eq.}{B} + \underset{3g\ eq}{C} \rightarrow \underset{3g.eq}{D} + \underset{3g\ eq.}{E}$$

Proof

$$\underset{98g}{H_2SO_4} \rightarrow \underset{2g}{2H^+} + \underset{96g}{SO_4^{2-}}$$

let given weight of H_2SO_4 600 gm

$$600 = \quad \underset{12.24g}{600 \times \frac{2}{98}} \quad \underset{587.76g}{600 \times \frac{96}{98}}$$

g.eq. of 600g of H_2SO_4

$$= \frac{600}{(98/2)g} = \frac{12.24\,g}{1g} \quad \frac{587.76g}{48g}$$

12.24 g.eq.   12.24 g.eq.   12.24 g.eq

Given $\quad A + B + C = D + E$

A forms E

$$g.\text{equ. of } A = \frac{\text{given wt. of } A}{\text{equi. wt of } A} = g.\text{ev. of } E$$

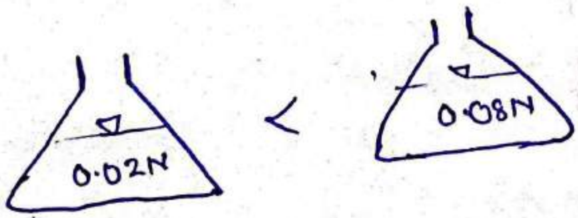
$$\boxed{\text{Wt. of } E = g.E \text{ of } E \times \text{Equivalent weight of } E}$$

(5) Normality(N)

→ strength of a solution.

$$\boxed{N = \frac{\text{no. of g.eq. of solute}}{\text{volume of solution (l)}}}$$

$\underbrace{\underbrace{H_2SO_4}_{\text{solute}} \text{ dissolve in } \underbrace{\text{water}}_{\text{solvent}}}_{\text{solution.}}$

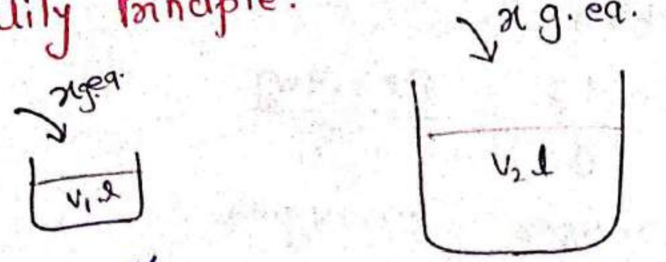


Prepare 1N solution of NaCl.

$$1N = \frac{1\text{ g.eq.}}{1l}$$

$$\Rightarrow 1g.eq. = \frac{wt(g)}{58.5} \qquad wt. \Rightarrow 58.5g$$

Normality Principle.



$N_1 \uparrow = \dfrac{x}{V_1 \downarrow}$ $\qquad$ $N_2 \downarrow = \dfrac{x}{V_2 \uparrow}$

$$\boxed{x = N_1V_1 = N_2V_2}$$

when no. of g.eq in the two case are equal.

⑥ Molarity (M)

→ also indicates strength of solution.

$$M = \frac{\text{no. of moles of solute}}{\text{vol. of solution (l)}}$$

Relation between N & M.

$$N = \frac{\text{no. of gram eq. of solute}}{V(l)}$$

$$N = \frac{\text{Given (wt).}}{\text{equivalent wt.} \times V(l)}$$

$$N = \frac{\text{Given (wt)}}{\frac{\text{Molecular weight}}{\text{Valency}} \times V(l)}$$

$$N = \frac{\text{Given (wt).}}{\text{molecular weight}} \times \frac{\text{Valency}}{V(l)}$$

$$\boxed{N = M \times \text{Valency}}$$

Alkalinity

→ it is capacity to neutralise acid.

→ Ability of water to neutralize the hydronium ion or concentration of all the ion in water which are capable of neutralising hydronium ion is known as alkalinity of water

Carbonate CO_3^{2-} (96-97)% }
Bicarbonate HCO_3^- } Major Alkalinity. (100%)
Hydroxide OH^-
Caustic alkalinity.

$B(OH)_4$
$H_3(SiO)_4$
HS^- } Minor Alkalinity. (0.1%)
NH_3^0
$H_2PO_4^-$
HPO_4^{2-}

Source:- Organic or inorganic (CO_3^{2-}) particles. and dissolve gases. (CO_2, H_2S)

$\underline{CO_2} + H_2O \rightarrow H_2CO_3$ (carbonic acid)

$H_2CO_3 \rightleftharpoons HCO_3$ (Bicarbonate ion)

$HCO_3^- \rightleftharpoons CO_3^{2-}$ Carbonate acid

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

* reversible reaction depend on pH and temp.
rate depend on concentration of ION.

$$aA + bB \underset{K_b}{\overset{K_f}{\rightleftharpoons}} cC + dD$$

a, b, c, d - moles.

$$K_f = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$$K_b = \frac{1}{K_f}$$

$$\boxed{K_f \cdot K_b = 1}$$

Algae → nutrient consume

$$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$$

remain in water.

weak to reverse back

→ forward direction.

→ If algae is found in water then water will be basic $pH = 8-10$

Impact :-

(i) Excess of alkalinity imparts bitter taste. in water.

(ii) Prime objection of alkalinity is that it leads to incrustation in pipe. which leads to reduce in discharge carrying capacity.

$$CO_3^{2-} + Ca^{2+} = CaCO_3 \downarrow$$ precipitate.

$$OH^- + Mg^{2+} = Mg(OH)_2 \downarrow$$

$$OH^- + Al^{3+} = Al(OH)_3 \downarrow$$

$$OH^- + Fe^{3+} = Fe(OH)_3 \downarrow$$

Measurement

→ Alkalinity of water is measured by titrating.

Molecular weight.

→ Weight of 1 mole = Σ atomic weight

eg. $CaCO_3 = 14 + 12 + 16 \times 3 = 100\ g$

$H_2SO_4 = 1 \times 2 + 32 + 16 \times 4 = 98\ g$

$HCO_3^- = 1 + 12 + 16 \times 3 = 61\ g$

$OH^- = 16 + 1 = 17\ g$

$SO_4^{2-} = 32 + 16 \times 4 = 96$

$$\text{No. of moles} = \frac{\text{Given weight}}{\text{Molecular weight.}}$$

Q No. of moles in 300kg of calcium carbonate.

$$\text{moles} = \frac{300 \times 10^3}{100} = 3000$$

Equivalent Weight

→ Weight of 1 gm equivalent.

$$\Rightarrow \boxed{\text{Equivalent weight} = \frac{\text{Molecular weight}}{\text{Valency}}}$$

eq. wt. of 1 gm equivalent weight $CaCO_3 = \frac{100}{2} = 50\,g$

$H_2SO_4 = \frac{98}{2} = 49\,g$

$HCO_3^- = \frac{61}{1} = 61\,gm$

$OH^- = \frac{17}{1} = 17\,g$

$Al(OH)_3 = \frac{27+(16+1)\times 3}{3} = \frac{78}{3} = 26$

Q wt. of 5gm equivalent of $CO_3^{2-} = 5 \times \frac{(12+16\times 3)}{2} = \frac{60\times 5}{2} = 150\,gm$

no. of gm. equivalent in 300mg of $CaCO_3$.

$$= \frac{300 \times 10^{-3}}{50} = 6 \times 10^{-3}.$$

$$\boxed{\text{No. of gm. equivalent} = \frac{\text{Given weight}}{\text{equivalent weight.}}}$$

$$\text{Normality} = \frac{\text{No. of gm. eq}}{lt} = N$$

$$\text{Morality} = \frac{\text{No of moles}}{lt} = M.$$

(1) water is 20N H_2SO_4.

(2) water is 10 M, H_2SO_4.

Q 2 lit of water has 196gm of H_2SO_4.

$$\text{concentration of } H_2SO_4 = \frac{196}{2} = 98 \text{ gm/lit}$$

in terms of molar (i)
$$\text{moles} = \frac{\text{given weight}}{\text{molecular weight}}$$

$$= \frac{196}{98} = 2$$

$$\text{moles/lit} = \frac{2}{2} = 1 \text{ moles /lit}$$

Gram equivalent (ii)
$$\frac{196}{49 \times 2} \frac{(\text{given weight})}{\text{Equivalent weight} \times L} = 2 \text{ gm-eq /liter}.$$

Molarity - (iii)
$$\text{molarity} = \frac{\text{no. of moles}}{\text{liter}} = \frac{196/98}{2} = \frac{2}{2}$$

$$= 1M\ H_2SO_4$$

$1M\ H_2SO_4$.

Normality (iv)

~~1N H_2SO_4~~.

$$\text{Normality} = \frac{\text{No. of gm-equivalent}}{\text{liter}.}$$

$$= \frac{\frac{196}{49}}{2} = \frac{4}{2} = 2N\ H_2SO_4.$$

Note:-

(1) 1 gm. eq of anything = 1 gm. equ. of any other thing.

$N_1V_1 = N_2V_2$

$(\text{total eq})_{\text{anything}} = (\text{total equ})_{\text{any other thing}}$.

(2) 1 gm-equ of anything reacts with 1 gm. equ of any other thing and leads to formation of one gm. eqq of any other thing.

$$2H^+ + CO_3^{2-} \longrightarrow H_2CO_3$$

2 mole   1 mole   1 mole - X

2 gm   60 gm   62 gm. X   conservation of mass.

$\frac{\text{given wt.}}{\text{Equivalent weight}}$ = gram equivalent = $\frac{2}{1} = 2$ gm-eq. $\frac{60}{30} = 2$ gm-eq $\frac{62}{31} = 2$ gm-eq.

1 gm-equi ≠ 1 gm equ.   1 gm equi.

Q If water contains 420 gm of CO_3^{2-}, 244 gm of HCO_3^- and 68 gm of OH^- report the alkalinity of this water as $CaCO_3$ (mg/lit)

$$\boxed{X_{in} \text{ terms of } Y = X \text{ mg/lit} \times \frac{\text{Equivalent wt. of } Y}{\text{Equivalent of } X}}$$

eg. OH^- in terms of $CaCO_3$ = OH mg/lit $\times \frac{50}{17}$

$\frac{\text{Given wt}}{\text{Equivalent weight}}$ = gm-eq. of $CO_3^{2-} = \frac{420}{30} = 14$ = gm. eq of $CaCO_3$

gm. eq. of $HCO_3^- = \frac{244}{61} = 4$ = gm equ of $CaCO_3$

gm eq. of $OH^- = \frac{68}{17} = 4$ = gm equ of $CaCO_3$.

$$[H][OH] = 10^{-14}$$

$$[H^+] = \frac{10^{-14}}{68/17} = 0.25 \times 10^{-14}$$

moles/lit $\quad [H] = \underline{2.5 \times 10^{-15}}$ moles/lit

$$= 2.5 \times 10^{-5} \times 1 \text{ gm/lit}$$

$$= 2.5 \times 10^{-5} \times \frac{1}{1} \text{ gm-equ/lit} = \text{gm equ of } CaCO_3$$

neglect

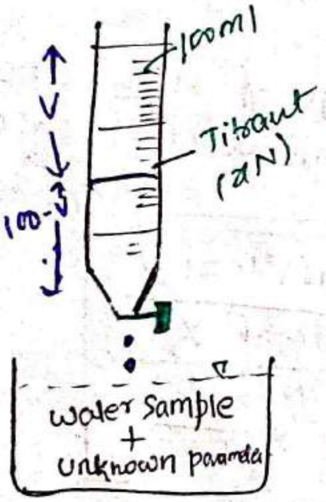
$$\text{Total alkalinity} = \left(14 + 4 + 4 - \cancel{2.5 \times 10^{-5}}\right) \frac{\text{gm-eq}}{\text{Lit}}$$

$$= 22 \times 50 \times 10^{3}$$

$$= \cancel{\text{mg/lit}}$$

$$= 11 \times 10^{5} \text{ mg/lit}$$

Measurement of Alkanity (titration)



$1\,l \rightarrow x$ ~~mg~~ gm-eq.

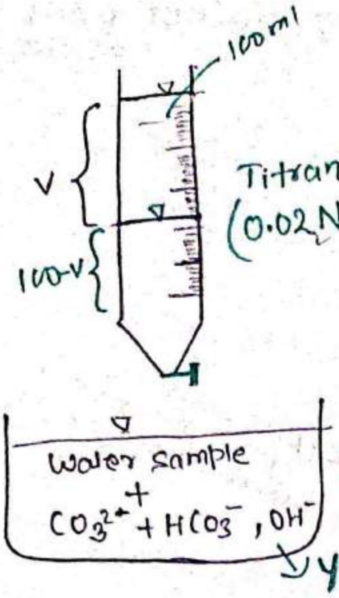
$1000\,ml \rightarrow x$ gm-eq.

$1ml \rightarrow \frac{x}{1000}$ gm.eq.

$100ml \rightarrow \frac{x}{10}$ gm.equ.

$100ml = 0.1x.$

$Vml = \frac{x}{1000} \times V$ gm.equ



Titrant
$(0.02N\ H_2SO_4)$
$= 0.02$ geq/lit.

$= \frac{0.02}{1000} \times 100 = 0.002$

+ Indicator

Normality = $\frac{\text{no. of gm eqv.}}{\text{Litre}}$

Gram equivalent = $\frac{\text{given wt.}}{\text{Equivalent wt.}}$

Eq. wt = $\frac{\text{molecular wt}}{\text{Valency}}$

$0.02 = \frac{\text{given wt.}}{49}$

given wt = 0.98 gm

$$V\,ml = \frac{x}{1000} \times V \text{ gm eq.}$$

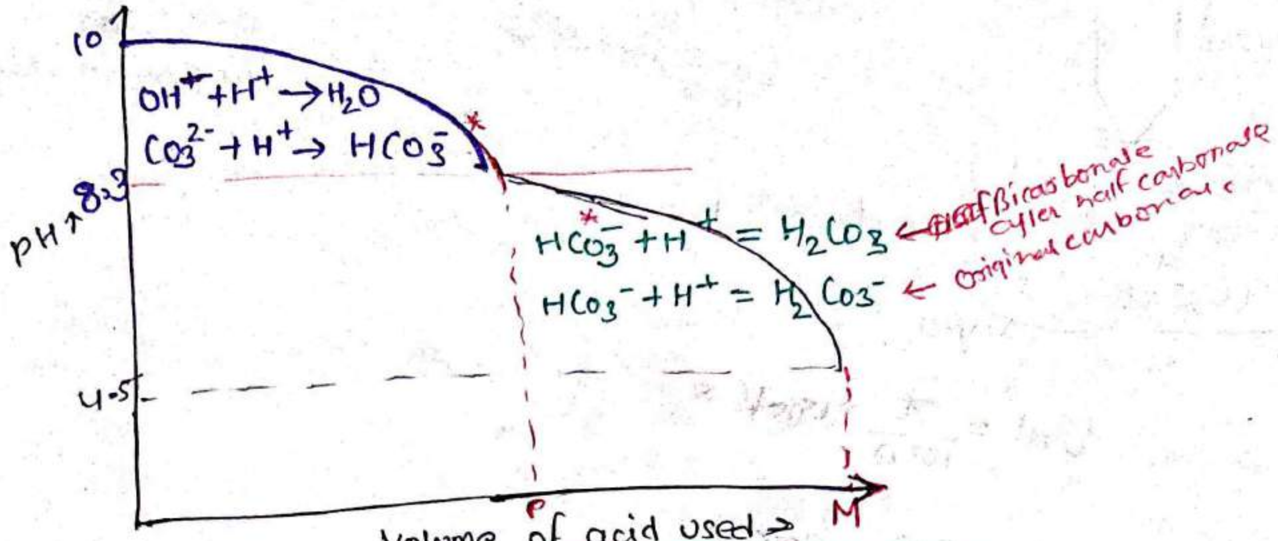
$$= \frac{0.02}{1000} V$$

$\boxed{\text{Equivalent alkalinity} = \text{Acid} = \text{eq } CaCO_3}$

$$= \frac{0.02\,V}{1000} \times 100 \times 50 \times 10^3 \left(\frac{mg}{y\,ml}\right)$$

$$= V\left(\frac{mg}{y\,ml}\right)$$

Fact :- $P_{H_0} \geq 10$, (HCO_3^-, OH^-) alkalinity do not exist together at same time.



$$\boxed{CO_3^{-2} + H^+ \longrightarrow HCO_3^- + H^+ \rightarrow H_2CO_3}$$

(i) Phenolapthlein (8.6-10.3) [colourless, Yellow]

→ when we add it before titration, water change its colour to pink.

→ Then we start titration and when our sample become (Yellow). colourless, it means.

→ water pH is 8.3,

→ Half carbonate is neutralise, (Half carbonate means whole CO_3^{2-} converted into HCO_3^-)

→ OH^- full neutralise.
(caustic Alkalinity)

$P_H < 8.3$

Original bicarbonate - $H_2CO_3 \rightleftharpoons HCO_3^-$

At $P_H = 8.3 - 4.5$

→ Half carbonate neutralise
→ HCO_3^-

$\Big\}$ acid. (M-P)

At $P_H = 4.5$ - $OH^- + HCO_3^- + CO_3^- \rightarrow M$

III when second stage start,

we add (Methyle orage) [2.8 - 4.4] (orange red)

→ we add it at 8.3 pH.

→ when we add it in water, ~~water~~ colour change from colourless to orange red.

→ ~~when~~ Then again we start titration and when water colour become colourless ~~mean~~ it means water pH is at 4.4.

P = Acid use in first stage.
M = Acid used in whole stage.

① If $P = 0$, $M \neq 0$ ⇒ ONLY HCO_3^- is present.

② If $P = M$ ⇒ ONLY CAUSTIC alkalinity present in water

③ If $P = \frac{M}{2}$ ⇒ { ① ONLY carbonate (CO_3^{2-})
② $[OH^-]$, $[HCO_3^-]$ ⇒ concentration of both same.
③ $[CO_3^{2-}]$, $[OH^-] = [HCO_3^-]$ }

④ If $P > \frac{M}{2}$ = OH^-, CO_3^{2-} alkalinity is predominent.
or, $[OH^-] > [HCO_3^{2-}]$ concentration

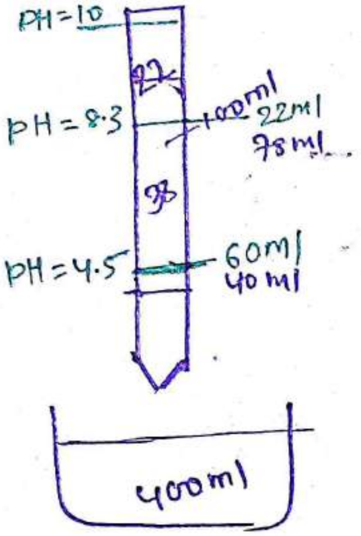
⑤ If $P < \frac{M}{2}$ = CO_3^{2-}, HCO_3^{2-} alkalinity is predominent
$[HCO_3^{2-}] > [OH^-]$.

⇒ In raw water we get 5th observation.

	Acceptable.	Cause for rejection.
Limits	200 mg/lit as $CaCO_3$	600 mg/lit as $CaCO_3$

6) Q. 400ml sample of wate has initial pH = 10, 60ml of 0.02N H_2SO_4 is used to bring the wate at 4.5 and 22ml of 0.02N H_2SO_4 is used to bring to 8.3.

(1) Total Alkanity, $CaCO_3$ mg/lit. = V used.
(2) concentration of all alkalinity as $CaCO_3$ (mg/lit)
(3) Methyle orange and Phenolaphleine alkaline.



(1) → If 400ml water samle 60ml acid is used to ~~bring~~ neutralise total alkanity.

$$\Rightarrow (OH^- + CO_3^{2-} + HCO_3^-) \text{ as } CaCO_3 = \frac{60}{400}\frac{mg}{ml}$$

$$= \frac{60 \times 1000}{400}$$
$$= 150 \text{ mg/lit.}$$

(2) 22ml used to bring pH 8.3. means to neutralize (OH^- and $\frac{1}{2} CO_3^{2-}$) alkanity.

$$(OH^- + \tfrac{1}{2} CO_3^{2-}) \text{ alk as } CaCO_3 = 22 \text{ mg}/400 \text{ ml.}$$
$$= \frac{22}{400} \times 1000$$
$$= 55 \text{ mg/lit}$$

Phenolapthaline alkalinity = 55 mg/lit

Methyle orange alkalinity = 150 − 55 = mg/lit.

$pH = 10 \Rightarrow H^+ = 10^{-10}$ moles/lit $= 10^{-10} \times 1$ gm/lit

$[H^+] = \frac{10^{-10} \times 1}{V_1}$ gm.eq/lit as $CaCO_3$.

H^+ alkalinity as $CaCO_3 = 10^{-10} \times 50 \times 10^{-3} = 5 \times 10^{-6}$ mg/lit

---

$pOH = 14 - 4 = 4$

$\Rightarrow [OH]^- = 10^{-4}$ moles/lit

$= 10^{-4} \frac{\times 17}{17}$ gm-eq.

OH^- alkalinity as $CaCO_3 = 10^{-4} \times 50 \times 10^3$

$= 5$ mg/lit — (i)

CO_3^{2-} alkalinity $= 55 - 5$

$= 50$ mg/lit.

$HCO_3^{2-} = 150 - 5 - 100$

$= 45$ mg/lit.

Total Alkalinity $= \overset{CO_3^{2-} + HCO_3^- + OH^-}{100 + 45 + 5} - 5 \times 10^{-6}$

$= 149.9999995$ mg/lit

Hardness

→ It is ability of water to destroy surfactant property of the soap or may also be referred as concentration of multivalent cation in water.

eg. → Ca^{2+}, Mg^{2+} } – Major multivalent cation.

→ Al^{3+}, $Fe^{2+,3+}$, Mn^{2+}, Pb^{2}, Sn^{2} } – Minor multivalent cation.

Hardness

Carbonate

Hardness due to carbonate (CO_3^-) and (HCO_3^-) of multivalent cation is termed as carbonate hardness.

→ temporary hardness – because it remove easily by boiling or adding lime.

eg. $Ca(HCO_3)_2$ – CH

$MgCO_3$ – CH

$CaCO_3 \downarrow$ → X ppt

Na_2CO_3 – X

$MgCl_2$ (NCH)

$CaSO_4$ (NCH)

$Ag(NO_3)$ X Silver is univalent ion.

Non-Carbonate Hardness.

Hardness due to (Cl^-), (SO_4^-), (NO_3^{2-}), of multivalent cation is termed as Non carbonate.

→ Permanent. hardness.

→ Removed by Ion exchange method, zeolite process etc.

eg.

temporary hardness. – It can be remove by boiling or adding lime.

eg. $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 \downarrow$

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

$MgCO_3 + Ca(OH)_2 \rightarrow Mg(OH)_2 \downarrow + CaCO_3 \downarrow$

$Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow Mg(OH)_2 + Ca(HCO_3)_2$

Clark degree (°clark) or English degree of hardness.
= 14.254 mg/lit of hardness as $CaCO_3$

1 french degree (°fn) or (°f) of hardness
= 10 mg/lit of hardness as $CaCO_3$.

Q A water sample has 120 mg/lit of calcium, 96 mg/lit of Mg^{2+}, 27 mg/lit of Al^{3+} in it. find total hardness.

$\frac{27}{3} = 9$

$$TH = 120 \times \frac{50}{20} + 96 \times \frac{50}{12} + 27 \cdot \frac{50}{9}$$

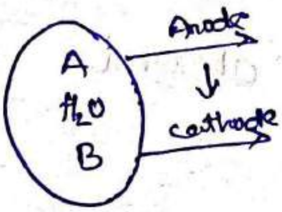
$$= 850 \text{ mg/lit}$$

$$\boxed{TH = \underset{mg/lt}{Ca^{2+}} \left(\frac{\text{equivalent weight of } CaCO_3}{\text{Equivalent of Ca}}\right) + \underset{mg/lit}{Mg^{2+}} \left(\frac{\text{equivalent weight of } CaCO_3}{\text{Equivalent wt of Mg}}\right)}$$

Source :- Organic or Inorganic particle.

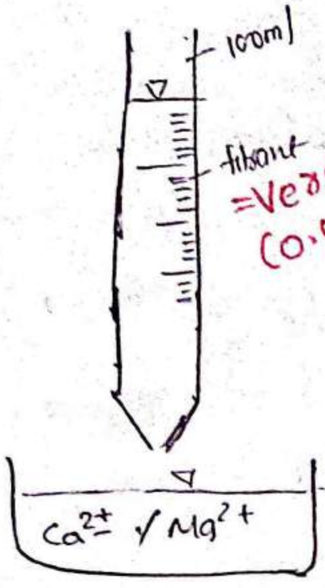
Impact:

(i) It increases the consumption of soap.
(ii) It leads to incrustation.
(iii) It imparts bad taste. in water.
(iv) If $MgSO_4$ > 50ppm, it causes laxative effect. (lose motion, digestion problem)
(v) It leads to corrosion in pipe. (reduce Discharge carrying capacity).



(O_2, H^+) (O_2, H^+)
Catalyst

Measurement : titration.



Indicators:- EBT (Eri-chrome black-T)
Black/Blue colour

① $EBT + Ca^{+}/Mg^{2+} \longrightarrow EBT-Ca/Mg$
Black/blue → Wine red.

(ii) EBTA + EBT-Ca/Mg → EDTA-Ca/Mg (colourless) + EBT (Blue colour)
Wine red

EDTA = Ethylene diamine tetracetic acid.
($C_{10}H_{16}N_2O_8$)

Limits	Acceptable	Rejection
	200mg/lit as $CaCO_3$	600mg/lit as $CaCO_3$

* For domestic water supply hardness must be in range of 75-115mg/lit

Hardness and Alkanity:-

$\boxed{Ca^{2+}, Mg^{2+}}$; $\boxed{Na^{+}, CO_3^{2-}, HCO_3^{-}}$ — Alkanity.

CO_3^{2-}, HCO_3^{-}
Carbonate hardness

① If Na Alkalinity [Na_2CO_3, $NaHCO_3$] is absent

$\boxed{\text{Alkalinity} = CH}$ —(i)

TH = CH + NCH
TH = Alkanity + NCH

$\boxed{TH > \text{Alkanity}}$ —(ii)

$\boxed{NCH = TH - CH}$

* Na alkanity ~~only~~ obseve only when NCH is present.

$$Ca^+, Mg^+ \begin{cases} Cl^- \\ SO_4^- \\ NO_3^- \end{cases} + Na^+ \begin{cases} CO_3^{-2} \\ HCO_3^- \end{cases} \rightarrow Ca^+/Mg^+ \begin{cases} CO_3^{2-} \\ HCO_3^- \end{cases} +$$

NCH

Na Alkanity

Alkanity = CH

(2) If Na alkanity is present.

$\Rightarrow NCH = 0$

$TH = CH + NCH$

$TH = CH$ —(i)

Alkanity > CH

Alkanity > TH —(ii)

from (i), (ii)

$$\boxed{(TH, \text{Alkanity})_{min} = CH}$$

Q find TH, CH, NCH and Alkanity of given water sample.

$Ca^{2+} = 40 mg/lit$ – har

$Mg = 48 mg/lit$ – har

$Na^+ = 46 mg/lit$ –

$Al^{3+} = 18 mg/lit$ – har

$HCO_3^- = 244 mg/lit$

$SO_4^{2-} = 96 mg/lit.$

$PH = 7 \Rightarrow [OH^-] = 10^{-7} mole/lit.$
$= 17 \times 10^{-7} mg/lit$
$= 17 \times 10^{-7} \times 10^3 g/lit$

$$TH = 40 \times \frac{50}{20} + 48 \times \frac{50}{24/2} + 18 \times \frac{50}{27/3}$$

Mg=12

$= 400 mg/lit$

$T.A = HCO_3^- \times \frac{50}{61} = 244 \times \frac{50}{61} = 200 mg/lit$

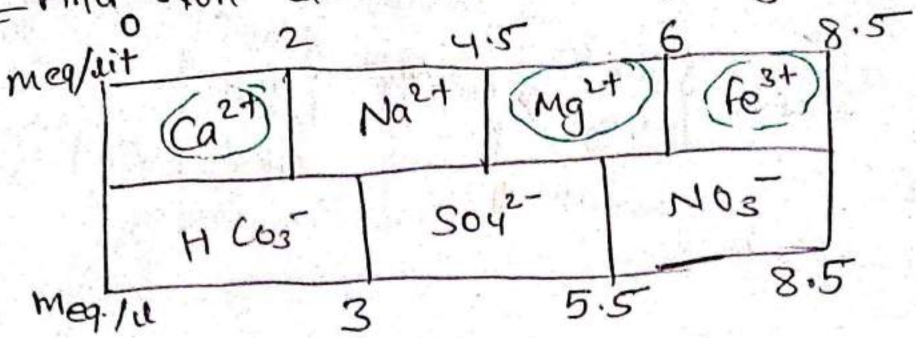
$TH > TA.$

$TA. = CH. = 200 mg/lit$

$NCH = 400 - 200 = 200 mg/lit.$

$TA = 244 \times \frac{50}{61} + 10^{-4} \times \frac{17 \times 50}{17}$
$- 10^{-7} \times \frac{1}{1} \times 10^3$
$= 200 mg/lit.$

Q Find Non-Carbonate hainen for given sample of water.



$TH = (2 + 1.5 + 2.5) \times 50 = 300$ mg/lit

Alkanit = $3 \times 50 = 150$

CH = (TH, Alkanit) Min

CH = 150 mg/lit as $CaCO_3$

NCH = 150 mg/lit $CaCO_3$.

(5) Chloride content

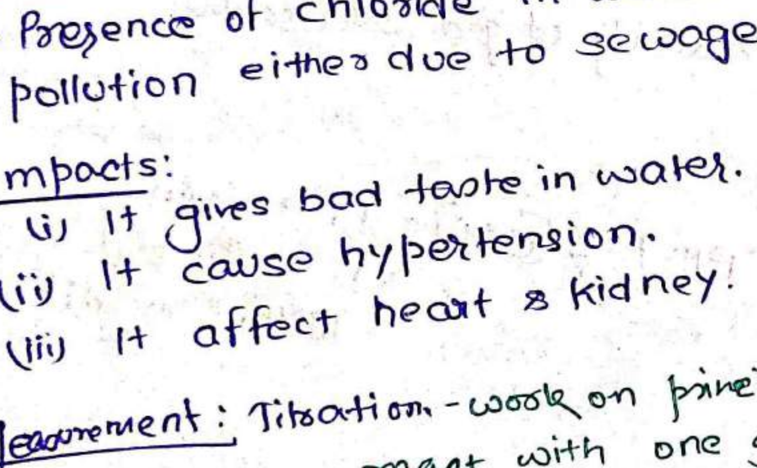
Limits → Acceptable → 250 mg/lit
C.F.R → 1000 mg/lit

→ Presence of chloride in water in excess indicates its pollution either due to sewage or due to industrial waste.

Impacts:
(i) It gives bad taste in water.
(ii) It cause hypertension.
(iii) It affect heart & kidney.

Measurement: Titration - work on principle of 1 gm eq of any thing react with one gram eq of any other thing.

→ Mohr's method



$AgNO_3 + Cl^- \rightarrow AgCl \downarrow$ (white) ppt

$AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 (\downarrow)$ (Redish/Brown) ppt ↓

Flouride Content

→ Flouride upto 1mg/lit is required to prevent dental cavity and for growth of permanent teeth. (It combines with tooth enamel & makes it hard & strong)

→ Beyond 1.5 ppm it cause declourisation of molting of teeth & result in disease called as fluorosis.

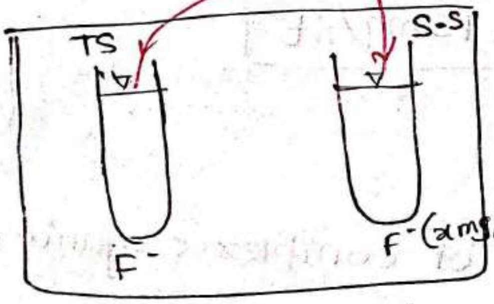
→ Beyond 5ppm it causes chemical deformation of bones and result in BONE FLUOROSIS and other skelton abhormalities.

Limit →	Acceptable	C.F.R
	1 mg/lit	1.5 Mg/lit

√ Measurement:-

Flouride is measured by colour mating technige.

ZIRCONIUN ION + ALAZARINE



* Flouride is dissolve solid.

	Ground water	Surface water
SS.	↓ (Filtration)	↑ (Turbulence)
DS.	↑ (O_2 ✗, ↓)	↓ (O_2 ✓, ↑)

→ In presence of oxygen dissolve solid oxidise,

$$Fe^{2+} \xrightarrow[H_2O]{O_2} \underset{ss}{Fe(OH)_3} \downarrow$$

$$Mn^{2+} \xrightarrow[H_2O]{O_2} MnO_2 \downarrow$$

(vii) Nitrogen Content

→ Minor consistuent of water

→ Presence of nitrogen in water indicates its pollution due to organic matter.

→ It is found in following different forms:-

① Free Nitrogen (Ammonia).

→ It indicates recent pollution due to organic water.

→ Measurement: By Boiling ammonia gas liberated.

→ By boiling of water decomposition of organic matter takes place.

→ To separate ammonia and water by distillation.

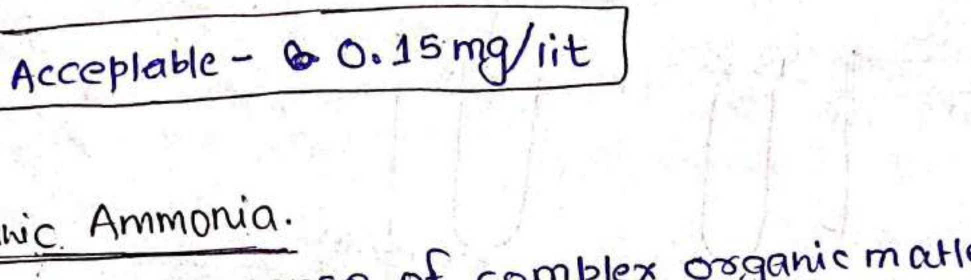
$\boxed{\text{Limit :- Acceptable - 0.15 mg/lit}}$

② Organic Ammonia.

→ It signifies presence of complex organic matter in water

Measurement: Boiling.

→ It is determined by boiling the already boiled sample of water with addition of strong alkaline reagent like Potassium permagnate and noting the amount of gas liberated.



$\boxed{\text{FA + OA = KJELDHA'S AMMONIA}}$

Limit → Acceptable limit → 0.3 mg/lit.

③ Nitrite (NO_2^-)

→ Presence of nitrite in water is highly dangerous as it indicate the partial decomposition of organic matter.

→ $\boxed{\text{Limit} \rightarrow 0\,mg/lit.}$

→ Measurement:- Colour matching technique. and colour is induced by adding of Sulphonic acid and Napthamine.

Nitrite — Oxidation State

① NO_2^-

$x + (-2) \times 2 = -1$

$x = 4 - 1 = 3$

② Nitrate

NO_3^-

$x + (-2) \times 3 = -1$

$x = 5$

④ Nitrate (NO_3^-)

→ Presence of nitrate is not harmful. as it signify the complete decomposition of organic matter.

→ $\boxed{\text{Limit} - 45\,mg/lit}$

→ But if it is present more than 45mg/lit it affect infant & cause MATHEMOGLOBINEMIA and Blue Baby disease.

displacement reaction, oxygen displaced

$$NO_3^- \xrightarrow[\text{acid}]{\text{infant}} NO_2^- \longrightarrow \underset{(HbO_2)}{\text{Hemoglobin}} \rightarrow HbNO_2$$

Measurement:-

Colour matching technique.

→ colour induced by- Phenol Di-Sulphonic Acid + Potassium hydroxide

✱- Different types of gases in water.

hydrogen sulphide H_2S :- Rotten egg / Pungent smell.

CO_2 : It adds taste and odour in water and causes corrosion. catalyst.

NH_3 :- Ammonia. (←)

Methane CH_4 : It is an explosive gas . High calorific value.

due to presence of organic matter O_2

(90) Oxygen

→ Max^m oxygen that may be dissolve in water at any given temperature is termed as saturation dissolve oxygen.

$$D = DO_{sat} - DO.$$

→ DO_{sat} @ $20^\circ c$ = 9.2 mg/lit

DO_{sat} @ $100^\circ c = 0$

→ Any deficiency of O_2 in water indicates the presence of organic matter.

→ DO in water is measured by Winker's test.

① If DO is absent

$$\text{Water sample} + \overset{2+}{Mn}SO_4 + (NaOH + KI) \rightarrow \underset{\text{(white)}}{\overset{2+}{Mn}(OH)_2 \downarrow}$$

② If DO is present.

$$\underset{(O_2)}{\text{Water sample}} + \overset{2+}{Mn}SO_4 + (NaOH + KI) \rightarrow \underset{\text{(Red/Brown)}}{\overset{4+}{Mn}O_2 \downarrow}$$

$$MnO_2 + \underset{\text{(added)}}{H_2SO_4} + I^- \xrightarrow{O_2} I_2 + I^- \rightarrow \underset{\text{(yellow colour)}}{I_3^-}$$

↓ Starch (Indicator)

BLUE COLOURED COMLEX SOLTION

Titrate with 0.01N $Na_2S_2O_3$ →

V(ml) of 0.01N $Na_2S_2O_3$ required to decolourised the sample.

$$\frac{0.01}{10^3} \times V = I_3^- = I_2 = O_2 =$$

Modified Winkler test

when other oxidising agent present eg. NO_3 - then add NaN_3 (Sodium azide)

→ NaN_3 is a strong reducing agent reduces the oxidation of other source.

BIOLOGICAL WATER QUALITY PARAMETER

→ Organic matter in water may be either be biodegrable or non-biodegrable

→ Biodegradable organic matter is that which can be decomposed by action of micro-organism either in presence of oxygen or absence of oxygen.

→ If the decomposition takes place in the presence of oxygen then it is termed as aerobic decomposition.

→ Aerobic decomposition is carried by aerobic micro-organism

→ End product of aerobic decomposition is comparatively stable which includes carbonate, nitrate & sulphate.

→ If this decomposition takes place in the absence of O_2 then it is termed as anerobic decomposition which carried out by anerobic microorganism.

→ End product of anerobic decomposition is comparitively unstable and it include acids, alcohol and gases.

→ Anerobic microorganism utilises molecular bond oxygen which is both time and energy consumptive process. Hence rate of anerobic decomposition is 3 times slower than rate of aerobic decomposition.

Note:- There are certain type of micro-organism which can act both in presence or absence of oxygen these are termed as Faculatitive microorganisms.

Organic Matter

BD | NBD

$-C-C-$ | $-C\equiv C-$ } Aliphatic

  } Arimatic ← More energy required to decompose arimatic

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$CO_3^{-2} = -\overset{O^-}{C}=O$

NO_3^- $O=N=O$, O^-

SO_4^{-2} $O-S-O^-$, O, O

O_2 — Microorganism

BOM

Bioman ← CO_3^{-2}, NO_3, SO_4^{2-}, DO
Acids, alcohol, gases, MBO.

$$NH_3 \xrightarrow[O_2]{\text{Nitrosomonus bacteria}} NO_2^- \xrightarrow[O_2]{\text{Nitrobecter}} NO_3^-$$

← Nitorfication → Oxidation

$$NO_3^- \xrightarrow{\text{Parracous De-Nitriticanis}} N_2\uparrow$$

← Denitrification →

→ The most important type of micro-organism present in water which are capable of carrying disease is termed as pathogens.

→ Testing & counting of pathogen is difficult and test involved are comparatively costly & time taken. hence instead of testing the water for pathogen it is being tested for coliform which themselves are harmless. which themselves are harmless micro-organism. but their presence or absence indicates the presence or absence of pathogens in water moreover they are easier and economical to be tested.

→ Coliforms like E-coli & B-coli are present in ~~the~~ the intenstine of all warm blooded animals.

Pathogens
- Virus – Hepatitis/ Poliomyelitis / Jaundice. (disease)
- Bacteria – typhoid/ ~~[illegible]~~ /chloreo/ Dysentry
- Fungi – Valley fever.
- Portoza – Ameobic Dysentry
- Helmethix – Hel-menthtitis

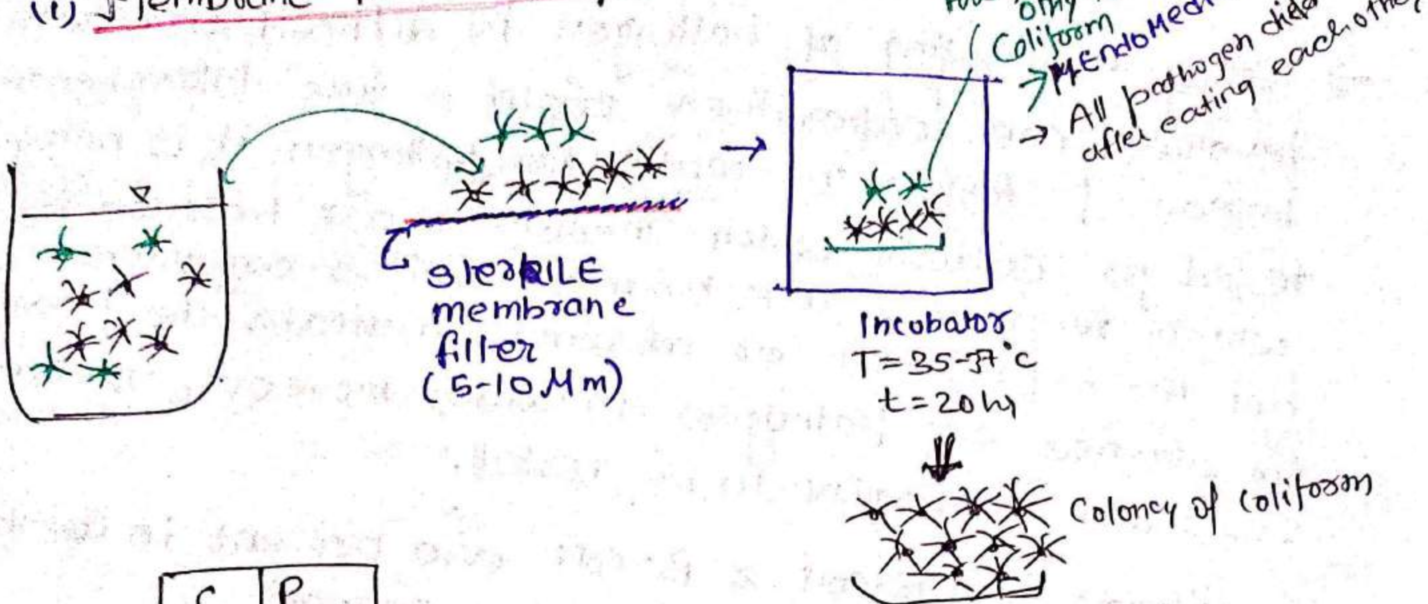
Coliforms
- Ecoli
- B-coli

Harmless

Testing of Coliforms:

Testing of coliform can be done by any one of following method:

(i) Membrane filter Technique.



C	P
100	15
80	10

(ii) Most Probable Number test (MPN Test)

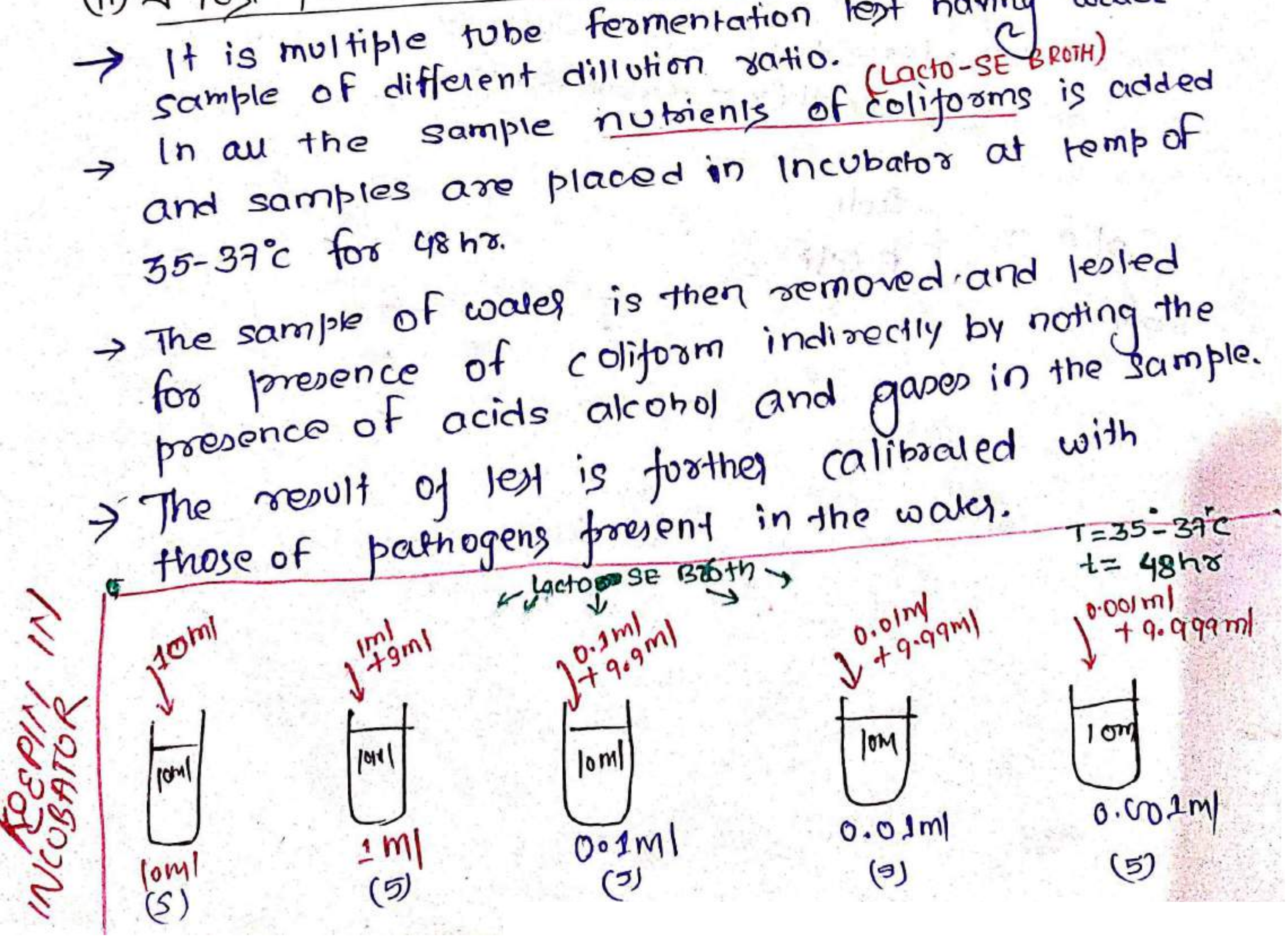
(i) Presumptive test
(ii) Confirmatory test
(iii) Completed test

→ It is multiple tube fermentation test having water sample of different dillution ratio.

→ In all the sample nutrients of coliforms (LACTO-SE BROTH) is added and samples are placed in Incubator at temp of 35-37°C for 48 hr.

→ The sample of water is then removed and tested for presence of coliform indirectly by noting the presence of acids alcohol and gases in the sample.

→ The result of test is further calibrated with those of pathogens present in the water.



(5) 10ml	(5) 1ml	(5) 0.1ml	MPN/100
5	5	5	20
5	4	3	30
3	4	2	5
4	3	2	16
0	2	2	28

$\propto$ density of pathogen which is mostly likely to present.

Aage aur होगा

Sample size	Ex_1	Ex_2	Ex_3	Ex_4	Ex_5
10ml	5	5	5	4	0
0.1ml	5	5	3	3	2
0.1ml	5	5	4	2	2
0.01ml	5	4	2	0	0
0.001ml	5	3	0	0	0
				16×1	28×1
MPN/100ml	20×100 (Dilution times)	30×100	5×10	16	28
	2000	3000	50		

MPN value can also be found using thomas Equation.

$$\frac{MPN}{100ML} = \frac{\text{No. of Positive tube} \times 100}{\sqrt{(\text{ml of sample in negative tube}) \times (\text{ml of sample in all tube})}}$$

Used when table is not available.

Q.

Sample Size (ml)	No. of positive tube of 5	No. of negative tube
10	4	1
1	2	3
0.1	1	4
0.01	0	5

MPN TABLE is as follows.

Combination of (+ve) 10ml, 1ml, 0.1ml	MPN/100ml
5-4-3	280
4-3-1	33
4-2-1	26
2-1-0	7

① MPN/100ml = 26

② No. of +ve tube = 4+2+1 = 7

Ml of sample in negative tube = $1\times10 + 3\times1 + 4\times0.1 + 5\times0.01$

$= 13.45$

wt of sample in all tube = $5\times(10 + 0.1 + 0.01 + 1)$

$= 55.55$

$$MPN/100 = \frac{7\times100}{\sqrt{13.45\times55.55}}$$

$= 25.60$

Caliform Index Test

in real terms it is not method of testing of coliforms only used to represent the coliform in water in terms of parameter coliform Index which can further be calibrated with those of pathogen present in water. Coliform Index is defined as reciprocal of smallest quantity of sample which show the presence of coliform in it

Note:- MPN test & coliform Index test are absolete.

V (ml)		CI - path	c
	—	10	A
0.1			B
10.0	—	0.01	C
1	—	1	
10	—	0.1	D