☆ Concentration Terms ☆

Solution → A solution is a homogenous mixture (uniform composition) of two or more components.

Homogenous Mixture → Uniform composition throughout the mixture

eg. H_2O + Salt
H_2O + Sugar
H_2O + Alcohol

components of Solution – The substance that make up a ~~s~~ homogenous mixture of Solution is called components of solution.

→ There are two types of components
1. solvent
2. Solute

→ ① **Solvent** – The Component of solution that dissolves the other components is called solvent.

→ ② **Solute** – The component of solution which dissolve in solution is called solute.

no. of Components	Components	name
2	1 Solute + 1 solvent	Binary solution
3	2 solute + ~~1~~ 1 solvent	Ternary solution
4	3 solute + 1 solvent	Quadnary Solution

Case 1 -

$Sugar_{(s)}$ +	$H_2O_{(l)}$	$Sugar_{(s)}$ +	$H_2O_{(l)}$
50g	100g	100g	50g
solute	Solvent	Solute	Solvent.

→ Here the two phase that are mixed, are different, hence the phase of the final solution decides the solvent.

Case 2:-

$Alcohol_{(l)} + H_2O_{(l)}$
100 g 50 g
Solvent Solute

$Alcohol_{(l)} + H_2O_{(l)}$
50 g 100 g
Solute Solvent

→ For the two components in the same phase, Hence the component in 'larger amount is the solvent.'

Concentration Terms :-

(1) $\%\left(\frac{w}{W}\right)$ or % mass → Percentage mass of solute wrt mass of solution

(1) $$\boxed{\%\left(\frac{w}{W}\right) = \frac{\text{wt of solute}}{\text{wt of solution}} \times 100}$$

wt of solution = wt of solute + wt of solvent

eg. (1) 10% $\left(\frac{w}{W}\right)$ of NaCl solⁿ → 100g of solⁿ contains 10g NaCl

(2) 15% $\left(\frac{w}{W}\right)$ of NaOH solⁿ → 100g of solⁿ contains 15g NaOH

↳ mass of solⁿ = 100 g
mass of solute (NaOH) = 15 g
mass of solvent = 100 − 15
= 85 g

→ This is Temp independent term.

Q1. 10g NaOH is present in 100g solvent H_2O find $\%\frac{w}{W}$

mass of solⁿ = 100 + 10 = 110 g

$$\%\frac{w}{W} = \frac{10}{110} \times 100 = \frac{100}{11} = \boxed{9.09\%}$$

② $\% \frac{w}{v}$

② $\boxed{\% \frac{w}{v} = \frac{\text{wt of solute (g)}}{\text{Vol of Sol}^n \text{(ml)}} \times 100}$

Eg. $10\% \frac{w}{v}$ NaOH(aq) Sol^n

10g NaOH in 100ml Sol^n

Eg 2. $x\% \frac{w}{v}$ solute solution

100ml Sol^n contains x g solute.

→ It is Temp Dependent.

Rel btw $\% \frac{w}{v}$ & $\% \frac{w}{w}$

$$\% \frac{w}{v} = \frac{\text{wt of solute (g)}}{\text{Vol of Sol}^n \text{(ml)}} \times 100 \longrightarrow ①$$

$$\% \frac{w}{w} = \frac{\text{wt of solute (g)}}{\text{wt of sol}^n \text{(g)}} \times 100 \longrightarrow ②$$

① ÷ ②

$$\frac{\% \frac{w}{v}}{\% \frac{w}{w}} = \frac{\text{wt of sol}^n \text{(g)}}{\text{Vol of sol}^n \text{(ml)}}$$

③ $\boxed{\% \frac{w}{v} = \% \frac{w}{w} \times \text{Density}_{sol^n} \text{ (in g/ml)}}$

Q2. The concentration of solution is $8\% \frac{w}{w}$ and $10\% \frac{w}{v}$ calculate density of the solution.

M-I

$$\text{Density} = \frac{\% \frac{w}{v}}{\% \frac{w}{w}}$$

$$= \frac{10}{8} \text{ g/ml}$$

$$\boxed{= 1.25 \text{ g/ml}}$$

M-II

let density = d

$10\% \frac{w}{v} \Rightarrow$ 10 g solute in 100ml Sol^n

$$d = \frac{m}{100}$$

$$m = 100\,d$$

$$\% \frac{w}{w} = 8 = \frac{10}{100d} \times 100$$

$$d = \frac{10}{8}$$

$$\boxed{d = 1.25 \text{ g/ml}}$$

Q3. density = 1.05 g/ml , $\% \frac{w}{v}$ find if $\% \frac{w}{w} = 10$

M I

$\% \frac{w}{w} = 10\% \Rightarrow$ 10 g solute in 100 g Sol^n

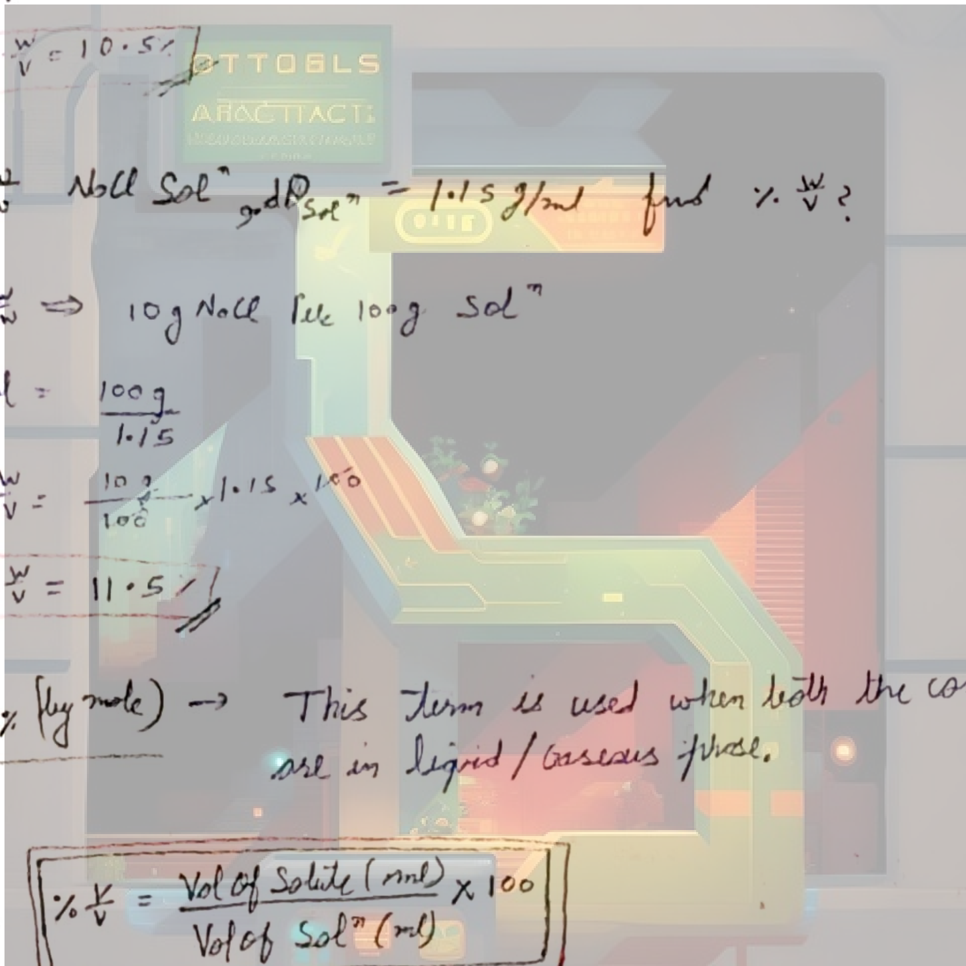
$$\text{Volume} = \frac{100}{1.05}$$

$$\% \frac{w}{v} = \frac{10}{100} \times 1.05 \times 100 = \boxed{10.5\%}$$

M II $\quad \% \frac{w}{v} = \% \frac{w}{w} \times \text{Density}$

$$\% \frac{w}{v} = 10 \times 1.05$$

$$\boxed{\% \frac{w}{v} = 10.5\%}$$



Q4. $10\% \frac{w}{w}$ NaCl Sol^n and ρ_{Sol^n} = 1.15 g/ml find $\% \frac{w}{v}$?

$10\% \frac{w}{w} \Rightarrow$ 10 g NaCl per 100 g Sol^n

$$\text{Vol} = \frac{100\,g}{1.15}$$

$$\% \frac{w}{v} = \frac{10\,g}{100} \times 1.15 \times 100$$

$$\boxed{\% \frac{w}{v} = 11.5\%}$$

(3) $\% \frac{V}{V}$ or % (by mole) → This term is used when both the components are in liquid / Gaseous phase.

(4) $$\boxed{\% \frac{V}{V} = \frac{\text{Vol of Solute (ml)}}{\text{Vol of } Sol^n \text{ (ml)}} \times 100}$$

eg. $10\% \frac{V}{V}$ Ethanol aq. Sol^n

→ 100 ml Sol^n contains 10 ml C_2H_5OH (Ethanol)

→ Temp Dependent term

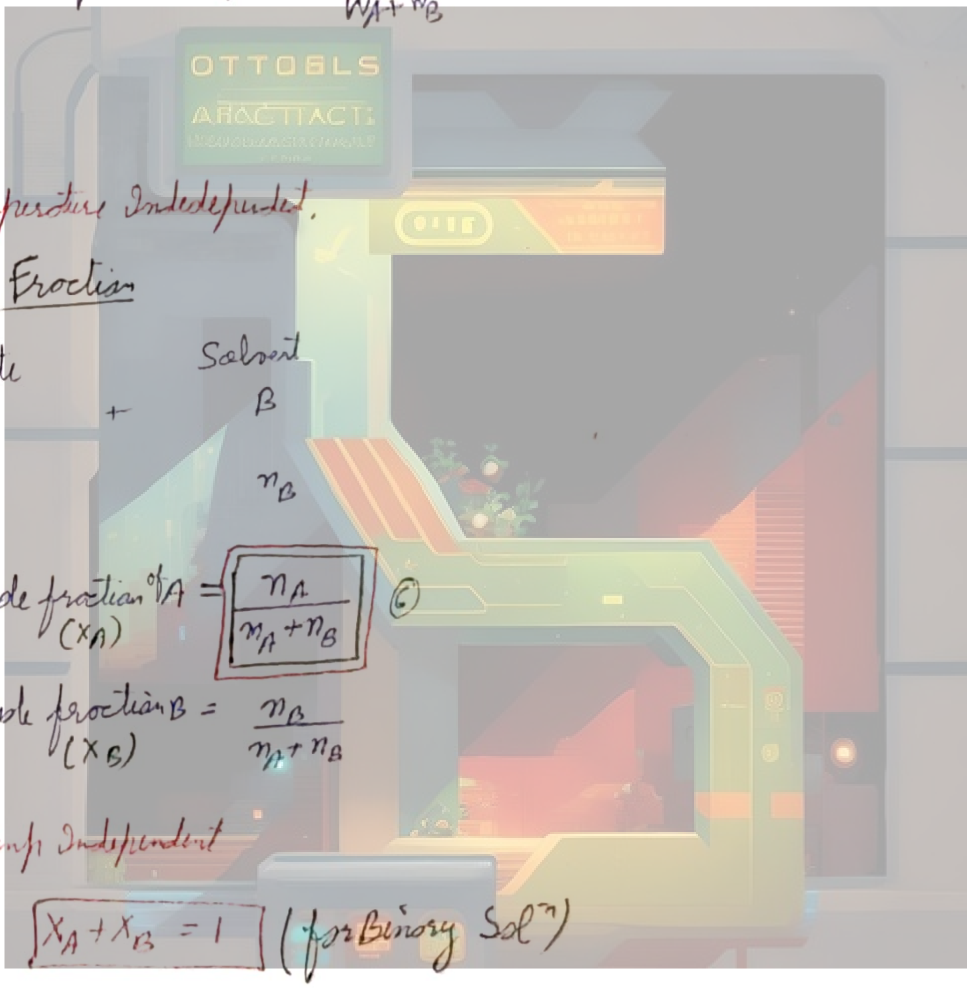
(4) Mass fraction

A → W_A → Solute

B → W_B → Solvent

$$\text{mass fraction of } A = \frac{\text{mass } A}{\text{Total}} = \boxed{\frac{W_A}{W_A + W_B}} \quad (5)$$

$$\text{mass fraction of } B = \frac{W_B}{W_A + W_B}$$



→ Temperature Independent.

(5) Mole Fraction

Solute A → n_A + Solvent B → n_B

$$\text{mole fraction of } A \; (X_A) = \boxed{\frac{n_A}{n_A + n_B}} \quad (6)$$

$$\text{mole fraction } B \; (X_B) = \frac{n_B}{n_A + n_B}$$

→ Temp Independent

$\boxed{X_A + X_B = 1}$ (for Binary Sol^n)

$\Sigma x_i = 1$ (always)

Q 5. Given $CO_2 = 44g$, $H_2 = 6g$, $N_2 = 56g$ find mole fraction each.

CO_2 → 1 mol, H_2 → 3 mol, N_2 → 2 mol

~~N~~ ~~Tot~~ $n = 1+3+2 = 6$ mol

mole fraction CO_2 = $\boxed{X_{CO_2} = \frac{1}{6}}$

$\boxed{X_{H_2} = \frac{1}{2}}$

$\boxed{X_{N_2} = \frac{1}{3}}$

(6) Molarity (M):

→ Molarity is defined as no. of moles of solute present in per liter of solution.

(7) $$\boxed{M = \frac{\text{no. of moles of solute}}{\text{Vol of sol}^n\ (l)}}$$

$$M = \frac{\text{no. of milli moles of solute}}{\text{Vol of sol}^n\ (ml)}$$

→ mole $= M \times V_{(l)}$

→ m.mole $= M \times V_{(ml)}$

→ Temperature Dependent

→ Unit:- mol/l

eg1. 3M NaOH ⇒ 3 Molar NaOH
⇒ 3 moles of NaOH is present in 1 l of Sol^n

eg2. 5M H_2SO_4 aq. soln
⇒ 1 lit Sol^n contain 5 mole of H_2SO_4

Note: Molar Solution $\Rightarrow M = 1 \Rightarrow$ Molarity $= 1$

Semi Molar Solⁿ $\rightarrow M = 1/2$

Deci Molar Solⁿ $\rightarrow M = \frac{1}{10}$

Centi Molar Solⁿ $\Rightarrow M = \frac{1}{100}$

Q6. $n_{NaCl} = 1.5$

$V_{sol^n} = 1500$ ml

~~Morlarity~~ Molarity $= ?$

$M = \frac{n}{V} = \frac{1.5}{1.5} = 1$

$\boxed{M = 1}$ mol/L

Q7. 8g of MgO is dissolved in water to form 500ml Solⁿ. find M.

~~M~~

moles of MgO $= \frac{8}{40} = \frac{1}{5}$

$M = \frac{1}{5} \times \frac{2}{1}$

$M = 2/5$

$\boxed{M = 0.4}$ M

Q8. 200ml, 0.2 M Glucose(aq) Solⁿ

i) find moles of Glucose

ii) no. of C-atom

i) $0.2 = \frac{n}{0.2}$

$\boxed{n = 0.04 \text{ moles}}$ i)

ii) no. of C $= 0.24 \times 6.022 \times 10^{23}$

$\boxed{= 1.44528 \times 10^{23}}$ ii)

Q9. 5.85g NaCl & 11.1 g $CaCl_2$ to form 600 ml Sol^n in water.

i) Find Molarity

ii) find $CaCl_2$ molarity.

$n_{NaCl} = \frac{5.85}{58.5} = 0.1$ mol

$n_{CaCl_2} = 0.1$ mol

$n = 0.2$ mol

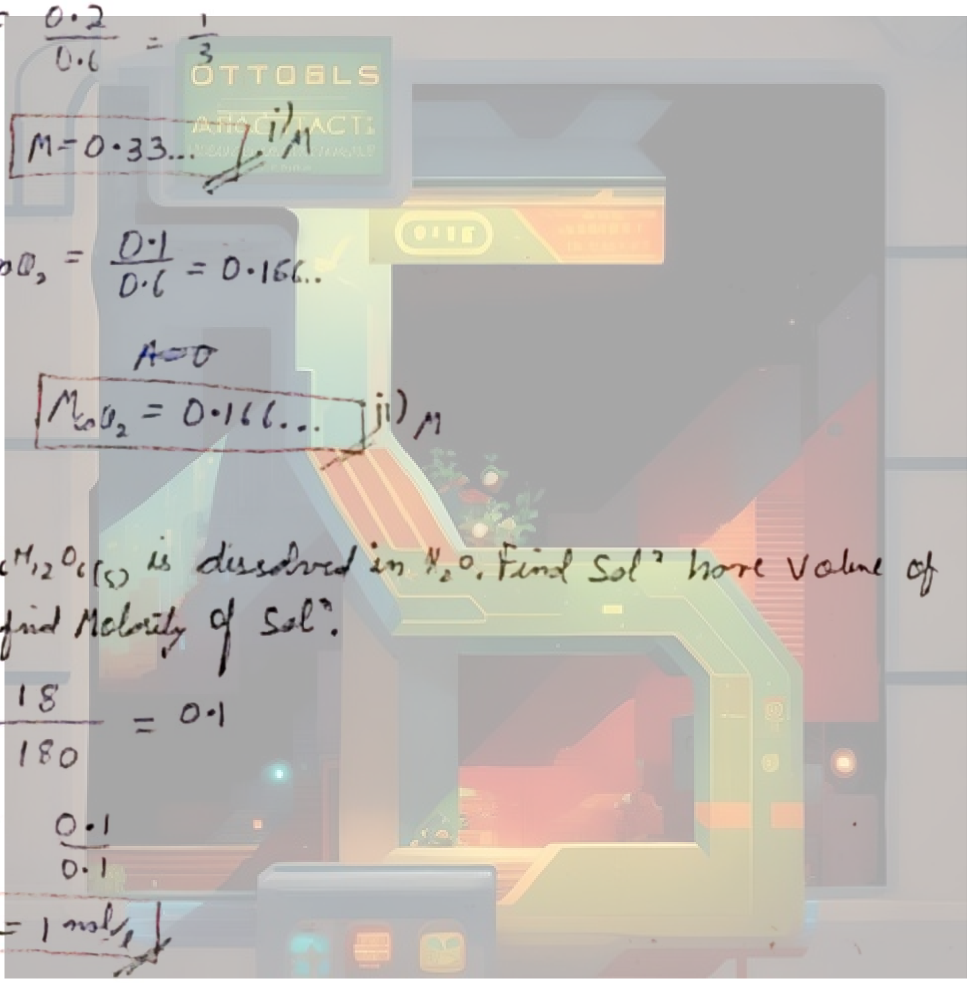
i) $M = \frac{0.2}{0.6} = \frac{1}{3}$

$\boxed{M = 0.33...}$ i) M

ii) $M_{CaCl_2} = \frac{0.1}{0.6} = 0.166...$

A=0

$\boxed{M_{CaCl_2} = 0.166...}$ ii) M



Q10. ~~10~~ 18g $C_6H_{12}O_{6(s)}$ is dissolved in H_2O. Find Sol^n have volume of 100ml find Molarity of Sol^n.

$n = \frac{18}{180} = 0.1$

$M = \frac{0.1}{0.1}$

$\boxed{M = 1 \text{ mol}/l}$

Q11. 58.5g NaCl dissolved in 741.5g H_2O to yield sol of density 1g/ml find molarity of sol

Molarity $= \frac{1 \text{ mol}}{0.8}$ → Yield mass of sol^n & Density given

$= \frac{10}{8}$

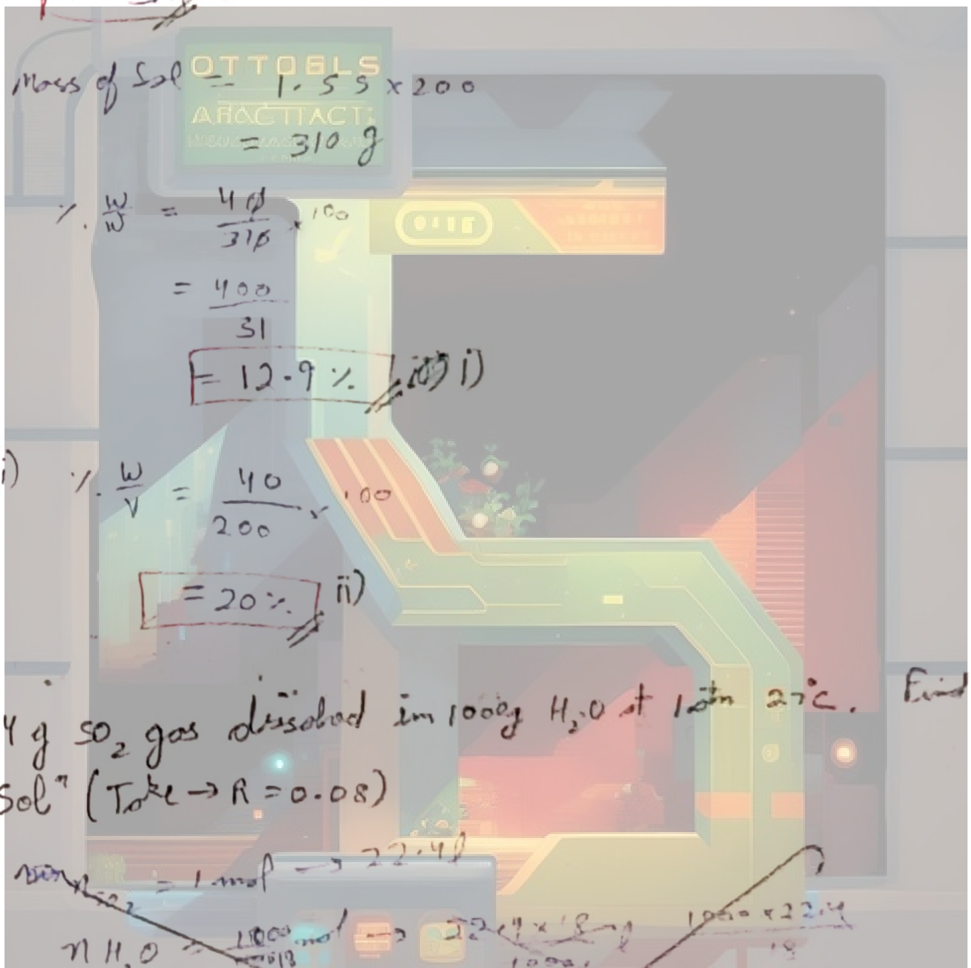
$\boxed{= 1.25M}$

Q12. 40g $MgO_{(s)}$ is dissolved in H_2O to form 200ml sol^n given
$d_{sol^n} = 1.55$ g/ml
i) % $\frac{w}{w}$ ii) % $\frac{w}{v}$ iii) M

i) Moles $MgO = \frac{40}{40} = 1$ mol

$M = \frac{1}{0.2} = \frac{10}{2}$

$\boxed{M = 5M}$ iii)



i) Mass of Sol $= 1.55 \times 200$
$= 310$ g

% $\frac{w}{w} = \frac{40}{310} \times 100$
$= \frac{400}{31}$
$\boxed{= 12.9\%}$ i)

iii) % $\frac{w}{v} = \frac{40}{200} \times 100$
$\boxed{= 20\%}$ ii)

Q13. 64 g SO_2 gas dissolved in 1000g H_2O at 1 atm 27°C. Find molarity of sol^n (Take → R = 0.08)

$n_{SO_2} = 1$ mol → 22.4 l
$n_{H_2O} = \frac{1000}{18}$ mol → $\frac{22.4 \times 1000}{18}$ l $\frac{1000 \times 22.4}{18}$

Vol Sol^n $= \frac{22400 + 403.2}{1000}$ Vol Sol^n $= \frac{403.2 + 22400}{18}$
$= \frac{22803.2}{1000}$ l $= \frac{22803.2}{18}$

$M = \frac{1000}{22803.2}$ $M = \frac{18}{22803.2}$

Ans 13.

$n_{SO_2} \rightarrow 1 \text{ mol} \rightarrow \cancel{22.4 l}\ 24 l$

$\cancel{n_{H_2O} \rightarrow}$ $Vol_{H_2O} = 1 l$

$$M = \frac{\cancel{0}\ 1}{1 + \cancel{22.4}\ 24 l}$$

$$\cancel{= \frac{1}{23.4}}$$

$$\cancel{= \frac{10}{234}}$$

$$= \frac{1}{1+24}$$

$$= \frac{1}{25}$$

$$= \frac{100}{25} \times \frac{1}{100}$$

$$= \frac{4}{100}$$

$$\boxed{= 0.04 \text{ M}}$$

<u>Note</u>.- Molarity of ions is expressed in Square bracket

$M_{Na^+} = 0.2$

eg. $[Na^+] = 0.2 M$

$[Cl^-] = 0.1 M$

Q14. 11.1 g $CaCl_2$ is dissolved to form 400 ml Sol^n. find $[Ca^{2+}]$ & $[Cl^-]$

moles of $CaCl_2 = \frac{11.1}{111} = 0.1$ mol

$n\ Ca^{2+} = 0.1$ mol

$n_{Cl^-} = 0.2$ mol

$$[Ca^{2+}] = \frac{0.1}{0.4} = \boxed{0.25 M}$$

$$[Cl^-] = \frac{0.2}{0.4} = \boxed{0.5 M}$$

Q15. 100 ml, 0.1 Molar $AlCl_3$ Solⁿ. find Cl^- ion moles.

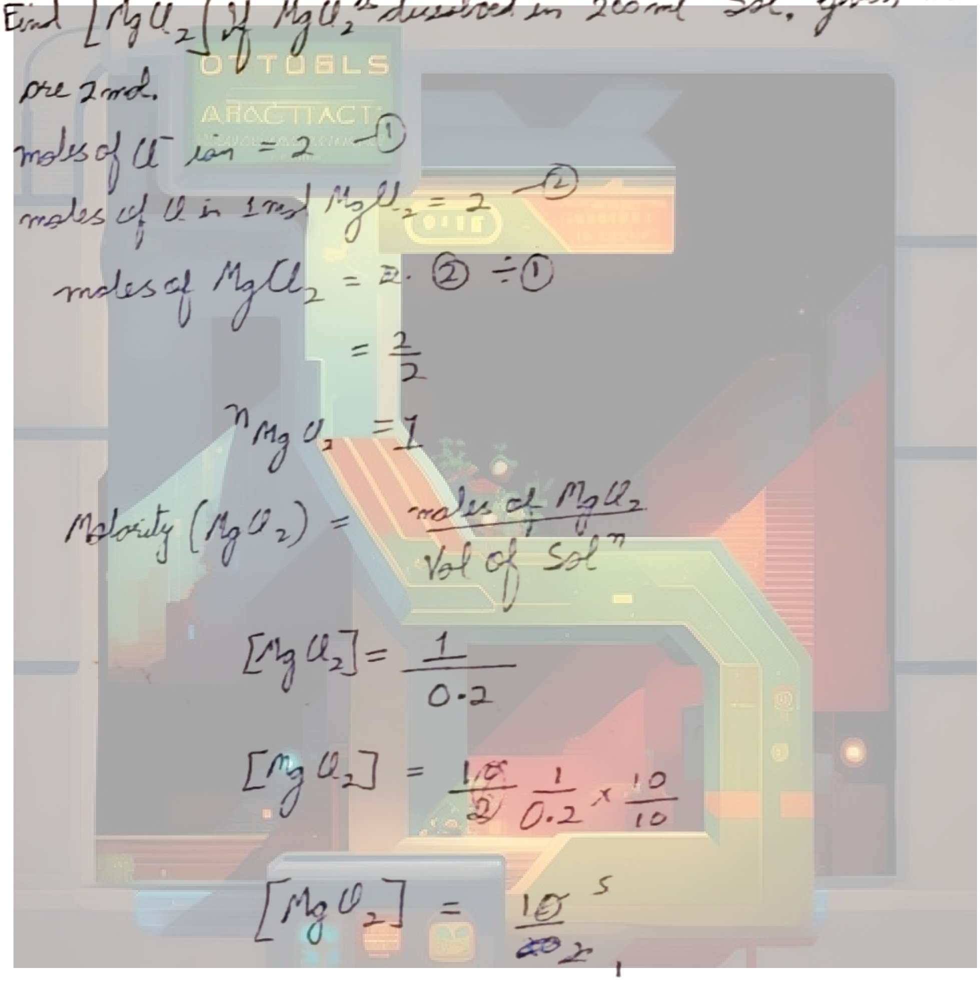
$$0.1 = \frac{n_{AlCl_3}}{0.1}$$

$$0.01 = n_{AlCl_3}$$

$$n_{Cl^-} = 0.01 \times 3$$

$$\boxed{= 0.03 \text{ mol}}$$

Q16. Find $[MgCl_2]$ if $MgCl_2$ is dissolved in 200 ml Solⁿ, given moles of Cl^- ion are 2 mol.



moles of Cl^- ion $= 2$ — ①

moles of Cl in 1 mol $MgCl_2 = 2$ — ②

moles of $MgCl_2$ = ② ÷ ①

$$= \frac{2}{2}$$

$$n_{MgCl_2} = 1$$

$$\text{Molarity } (MgCl_2) = \frac{\text{moles of } MgCl_2}{\text{Vol of Sol}^n}$$

$$[MgCl_2] = \frac{1}{0.2}$$

$$[MgCl_2] = \frac{1}{0.2} \times \frac{10}{10}$$

$$[MgCl_2] = \frac{10}{2}$$

$$\boxed{[MgCl_2] = 5M}$$

Relation b/w $\% \frac{w}{v}$ & M

$\% \frac{W}{V} = x \qquad M = ?$

$\downarrow$

$100\,ml\ sol^n = x\,g$ solute

mass of solute $= x\,g$

moles of solute $= \dfrac{x}{M\cdot M_{(solute)}}$

Vol of $Sol^n = 100\,ml$

$= 0.1\,l$

$M = \dfrac{\text{moles of Solute}}{Vol^n\,(l)}$

$M = \dfrac{\cancel{\% \frac{w}{v} \times 10}\ \% \frac{w}{v}}{M\cdot M_{(solute)}} \times \dfrac{1}{0.1}$

(8) $\boxed{M = \dfrac{\% \frac{W}{V} \times 10}{(M\cdot M)_{solute}}}$

Relation b/w $\% \frac{w}{w}$ & M

$\% \frac{W}{W} = x\ ,\ d_{sol^n} = d\ g/ml\ ,\ M = ?$

M1

$M = \dfrac{\% \frac{W}{V} \times 10}{(M\,M)_{solute}}$

$M = \dfrac{\% \frac{W}{W} \times d \times 10}{(M\cdot M)_{solute}}$

(9) $\boxed{M = \dfrac{\% \frac{W}{W} \times 10\,d}{(M\cdot M)_{solute}}}$

IM II

100 g Sol^n contains x g solute.

moles of Solute $= \dfrac{x}{(M.M)_{solute}}$

Vol^n of Sol $= \dfrac{mass}{density}$

$= \dfrac{100}{d}$ ml

$= \dfrac{100}{d \times 1000}$ l

$= \dfrac{1}{10d}$ l

Molarity $= \dfrac{\text{moles of solute (g)}}{\text{Vol}^n \text{ of Sol}^n \text{(l)}}$

$= \dfrac{x}{(M.M)_{solute}} \times \dfrac{1}{\frac{1}{10d}}$

$= \dfrac{x \times 10d}{(M.M)_{solute}}$

$$\boxed{M = \dfrac{\% \frac{w}{w} \times 10d}{(M.M)_{solute}}}$$

Q17. ~~4g~~ 10% $\frac{w}{w}$ glucose of sol^n, $d_{sol^n} = 1.2$ g/ml. Find molarity & mole fraction of the solute.

$M = \dfrac{10 \times 1.2 \times 10}{180}$

$M = \dfrac{120}{180}$

$M = \dfrac{2}{3}$

$$\boxed{M = 0.66}$$

mole fraction $= \dfrac{\text{mole of solute}}{\text{mole of sol}^n}$

~~mole of~~

mole of Solute $= \dfrac{10x}{180}$

mole of Solution $= \dfrac{100x}{M.M}$

(7) Molality :- (m)

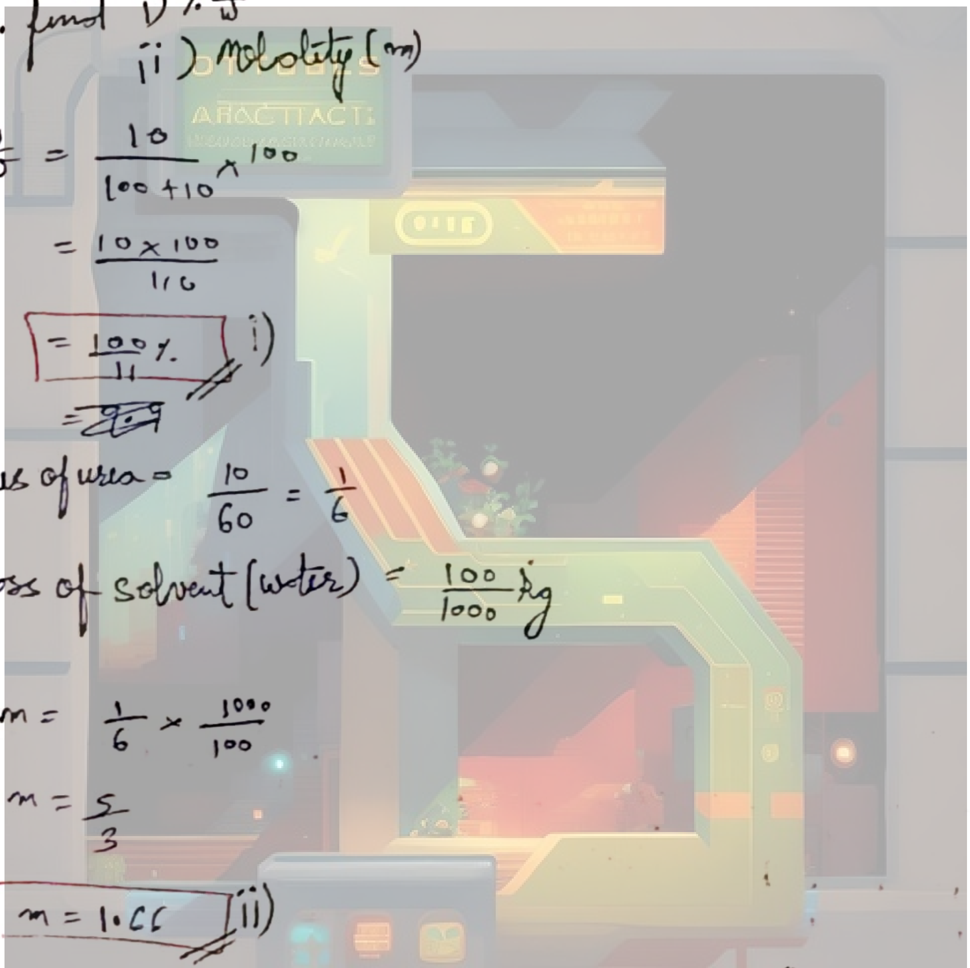
→ It is defined as the moles of solute per kg of solvent.

(10) $$\boxed{m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}}$$

→ It is temperature independent.

Q18. 10 g urea (NH_2CONH_2) is dissolved in 100 g water to form a solⁿ. find i) % $\frac{w}{w}$

ii) Molality (m)



i) $\% \frac{w}{w} = \frac{10}{100+10} \times 100$

$= \frac{10 \times 100}{110}$

$\boxed{= \frac{100}{11} \%}$ i)

$= \cancel{9.09}$

ii) moles of urea $= \frac{10}{60} = \frac{1}{6}$

mass of solvent (water) $= \frac{100}{1000}$ kg

$m = \frac{1}{6} \times \frac{1000}{100}$

$m = \frac{5}{3}$

$\boxed{m = 1.66}$ ii)

Q19. find the molality of 10% $\frac{w}{w}$ aqueous glucose solⁿ.

10 g glucose in 100 g solⁿ

mass of glucose = 10 g

moles of glucose $= \frac{10}{180} = \frac{1}{18}$ mol

mass of water / solvent $= \frac{90}{1000}$ kg

$m = \frac{1}{18} \times \frac{1000}{90} \Rightarrow \boxed{m = \frac{50}{81}}$

Q.20. If an aqueous ~~a~~ Sol^n of NaOH is 20%. Mass calculate its molality.

mass of NaOH = 20 g

moles = $\frac{1}{2}$ mol

mass of solvent = $\frac{80}{1000}$ kg

$$m = \frac{1}{2} \times \frac{100\cancel{0}}{8\cancel{0}}$$

$$m = \frac{100}{16}$$

$$\boxed{m = \frac{25}{4} \text{ molal}}$$

Q 21. Density of 4 m HF sol^n is 0.8 g/ml find $conc^n$ in diff ways.

i) $\% \frac{w}{w}$ ii) M iii) X_{solute} (mole ~~mass~~ fraction)

i) ~~mass of HF =~~

moles of HF = 4 mol

mass of water = 1000 g

~~$\% \frac{w}{w}$~~ mass of HF = 4 × 20

= 80

$$\% \frac{w}{w} = \frac{80}{108\cancel{0}} \times 10\cancel{0}$$

$$\boxed{\% \frac{w}{w} = \frac{800}{108} \%} \text{ i)}$$

ii) vol of water = $\frac{1080}{0.8}$ = $\frac{10800}{8}$ ml

$$M = \frac{4 \times 8}{108\cancel{00}} \times 10\cancel{00}$$

$$\boxed{M = \frac{80}{27} M} \text{ ii)}$$

~~iii) mass of HF = 80~~

~~mass of H_2O = 1000 g~~

iii) moles of HF = 4

moles of H_2O = $\frac{1000}{18}$

moles of Sol^n = $\frac{1000}{18} + 4$

= $\frac{1072}{18}$ mol

$$\boxed{X_{solute} = \frac{4 \times 18}{1072}} \text{ iii)}$$

Conversion of various concentration terms :-

(1) relation btw molality & molarity

given :- Molarity = M

Density$_{sol^n}$ = d g/ml

Molecular Wt of solute ⇒ (M.w)solute

moles of solute = M

vol of sol^n = 1 l = 1000 ml

mass of sol^n = 1000 d g

mass of solute = M (M.w)

~~$\frac{d}{kg}$~~

$\cancel{m = \frac{M}{d}}$

mass of solvent = 1000 d − M (M.w)solute

(11) $$\boxed{m = \frac{1000\,M}{1000d - M(M.w)_{solute}}}$$

Q22. What volume (ml) of 0.2 M KOH is required to react with 0.98 g H_3PO_4

$$3KOH + H_3PO_4 \longrightarrow K_3PO_4 + 3H_2O$$

H_3PO_4 ↓ 0.98 g ↓ 1/100 mol

$$Vol = \frac{1}{100} \times \frac{1}{0.2} \times 3$$

$$Vol = \frac{3}{20}\ l$$

$$\boxed{Vol = 150\ ml}$$

Q23. How many grams of NaOH must be dissolved in H_2O to form 400 ml ~~sol~~ of 2M Sol^n?

$Vol = 400\ ml = 0.4\ l$

$M = 2M$

~~n~~ $n_{NaOH} = 2 \times 0.4$

$n_{NaOH} = 0.8$

mass of $NaOH = 0.8 \times 40$

$\boxed{= 32\ g}$

(2) <u>Relation btw mole fraction & Molarity</u>

given:- mole fraction of solute $= X_{solute}$

mol wt of solute $\Rightarrow (M \cdot w)_{solute}$

mol. wt of solvent $= (M \cdot w)_{solvent}$

$d_{sol^n} = d\ g/ml$

moles of solute $= x$ mol

moles of solvent $= (1-x)$ mol

mass of $sol^n = (M \cdot w)_{solute} \times x + (M \cdot w)_{solvent} \times (1-x)$

Vol of $sol^n = \dfrac{(M \cdot w)_{solute} \times x + (M \cdot w)_{solvent}(1-x)}{1000\ d}\ l$

(12) $$\boxed{M = \frac{1000 \times x \times d}{(x \times M \cdot w_{solute}) + ((1-x)(M \cdot w_{solvent}))}}$$

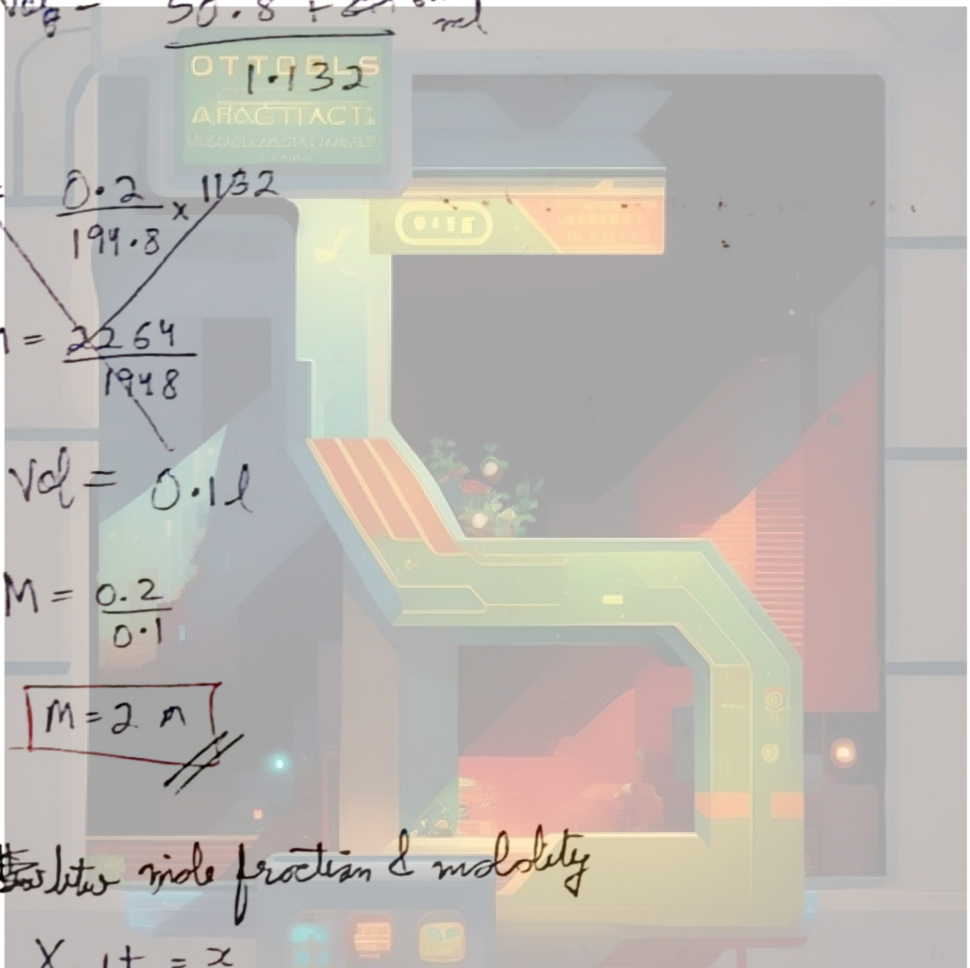
Q.21. A solⁿ contains I_2 in benzene. The mole fraction of I_2 is 0.2. find molarity of solⁿ, if density of solⁿ is 1.132 g/ml

moles of I_2 = 0.2

moles of Benzene = 0.8

$$\text{Vol of sol}^n = \frac{(0.2)(254) + (0.8)\cancel{(\ )}(78)}{1.132}$$

$$\text{Vol}_g = \frac{50.8 + \cancel{\ } 62.4}{1.132} \text{ ml}$$



$$M = \frac{0.2}{194.8} \times 1132$$

$$M = \frac{226.4}{194.8}$$

$$\text{Vol} = 0.1\,l$$

$$M = \frac{0.2}{0.1}$$

$$\boxed{M = 2\ M}$$

③ Relation ~~b/w~~ between mole fraction & molality

given:- $X_{solute} = x$

moles of solute = x

~~mass of solute~~

moles of solvent = $(1-x)$

mass = $(1-x)\,(M.w)_{solvent}$ g

(12) $$\boxed{m = \frac{X_{solute} \times 1000}{(1-x)\,(M.w)_{solvent}}}$$

Q25. mole fraction of solute in its 1 m aqueous solution.

1 molal

$$1 = \frac{1000x}{(1-x)(18)}$$

$$18 - 18x = 1000x$$

$$18 = 1018x$$

$$\boxed{x = \frac{18}{1018}}$$

Q26. Calculate molarity of 6.25 molal NaOH aqueous solⁿ ($d_{sol^n} = 1.2\ g/ml$).

~~M = 6.25~~

moles of NaOH = 6.25

mass of solvent = 1000 g

~~Vol of solvent~~

mass of solute = 6.25 (40)

= 250 g

mass of solⁿ = 1250 g

vol of solⁿ = $\frac{1250}{1.2}$ ml

$$M = \frac{6.25}{1250} \times 1.2 \times 1000$$

$$M = \frac{625 \times 1.2}{125}$$

$$M = 1.2 \times 5$$

$$\boxed{M = 6M}$$

Q 27. mole fraction of urea (NH_2CONH_2) in aqueous solⁿ is 0.02. calculate M & m. ($d_{sol^n} = 0.99\ g/ml$)

moles of urea = 0.02 mol

moles of H_2O = 0.98 mol

mass of H_2O = 0.98×18 g

$= \frac{0.98 \times 18}{1000}$ kg

~~vol of~~ Vol of $H_2O = \frac{0.98 \times 18}{0.99} \times \frac{1}{1000}$ l

$m = \frac{0.02}{0.98 \times 18} \times 1000$

$m = \frac{1000}{98 \times 9}$

$\boxed{m = \frac{1000}{882}}$

$M = \frac{0.02 \times 0.99 \times 1000}{0.98 \times 18}$

$\boxed{M = \frac{990}{882}}$

Q 28. 40g NaOH dissolved in H_2O & formed 200ml Solⁿ having density 1.5g/ml. calculate.

i) % $\frac{w}{w}$ ii) % $\frac{w}{v}$ iii) M iv) m v) X_{solute}

~~moles~~ $n_{NaOH} = 1$ mol

mass $H_2O = 260$ g

~~mass~~ $n_{H_2O} = \frac{260}{18}$

$\% \frac{w}{V} = \frac{40}{200} \times 100$

$\boxed{\% \frac{w}{V} = 20\%}$ ii)

$\cancel{\% \frac{w}{w} = \frac{40}{260} \times 100}$

$\cancel{\% \frac{w}{w} = \frac{200}{13}}$

$\% \frac{w}{w} = \frac{40}{300} \times 100$

$\boxed{\% \frac{w}{w} = \frac{40}{3} \%}$ i)

$M = \frac{1}{0.2}$

$\boxed{M = 5m}$ iii)

$m = \frac{1}{0.26}$

$\boxed{m = \frac{100}{26}}$ iv)

moles of $H_2O = \frac{260}{18}$

Total moles $= \frac{260}{18} + 1$

$= \frac{278}{18}$

$\boxed{X_{solute} = \frac{18}{278}}$ V)

Q29. Molarity of ~~gaseous~~ aqueous sol^n of MgO of density 1.2 g/ml is 3 M. find mole fraction of MgO. (Mg = 24)

moles of MgO = 3 mol → 72 g

Vol of sol^n = 1 l = 1000 ml

~~moles of sol^n = $\frac{1}{22.4}$~~

mass of sol^n = 1200 g

~~moles = 1200~~

moles $H_2O = \frac{\cancel{1128}\ 1080}{\cancel{48}\ 18}$

~~$X_{solute} = \frac{3}{\frac{1128}{564}} \times 188$~~

$X_{solute} = \frac{3}{\frac{1080}{18} + 3}$

$\boxed{X_{solute} = \frac{1}{21}}$

Parts Per Million (PPM)

→ This concentration term is used for very dilute solⁿ

** For very dilute solⁿ, mass of solvent ≃ mass of solⁿ.

(14) $$\boxed{PPM = \frac{\text{mass of solute}}{\text{mass of solvent / mass of sol}^n} \times 10^6}$$

Parts Per Billion (PPB)

→ Used for very very dilute solⁿ.

(15) $$\boxed{PPB = \frac{\text{mass of solute}}{\text{mass of sol}^n\text{ / mass of solvent}} \times 10^9}$$

Dilution of Solⁿ

→ addition of solvent is called dilution

→ when a solⁿ is diluted, the moles of solute do not change.

→ Molarity of Diluted Solⁿ is less than initial solⁿ

(16) $$\boxed{M_f = \frac{M_i V_i}{V_{added} + V_i}}$$

(Q.??) → when vol is increased n times / n folds.

(17) $$\boxed{M_f = M_i \times n}$$

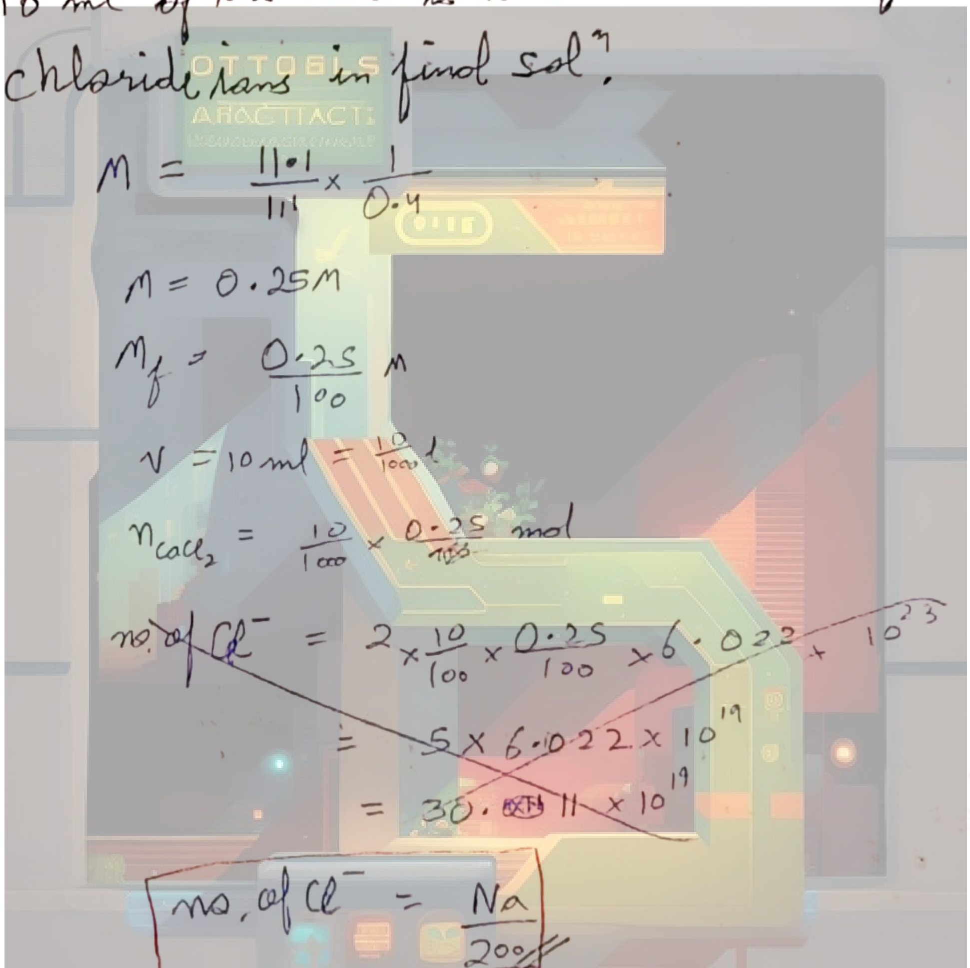
→ If some part of a solⁿ is taken out, its molarity remains same as the stock solⁿ

Q30. A sol^n of NaOH is 1M, If sol^n is diluted 100 times. find molarity.

$$M_f = \frac{M_i}{100}$$

$$\boxed{M_f = \frac{1}{100} M}$$

Q31. 11.1g of $CaCl_2$ is dissolved to form a sol^n of 400ml. 10 ml of this sol^n is diluted 100 times. find no. of chloride ions in final sol^n.



$$M = \frac{11.1}{111} \times \frac{1}{0.4}$$

$$M = 0.25M$$

$$M_f = \frac{0.25}{100} M$$

$$V = 10\,ml = \frac{10}{1000} l$$

$$n_{CaCl_2} = \frac{10}{1000} \times \frac{0.25}{100} mol$$

$$\text{no. of } Cl^- = \cancel{2 \times \frac{10}{100} \times \frac{0.25}{100} \times 6.022 \times 10^{23}}$$

$$\cancel{= 5 \times 6.022 \times 10^{19}}$$

$$\cancel{= 30.11 \times 10^{19}}$$

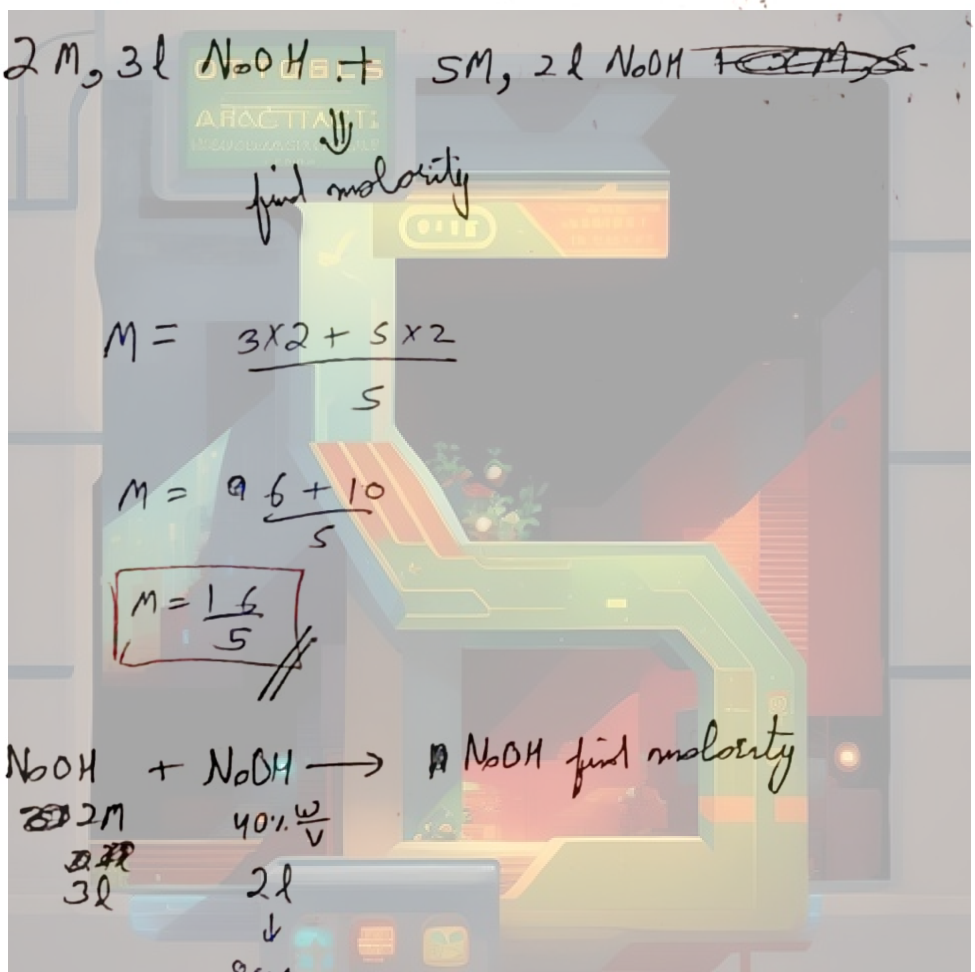
$$\boxed{\text{no. of } Cl^- = \frac{N_a}{200}}$$

Mixing of Solⁿ

Case I Non-reacting Solⁿ

$$M = \frac{\text{Total moles}}{\text{Total Vol}}$$

(18) $$\boxed{M = \frac{M_1V_1 + M_2V_2 + M_3V_3}{V_1 + V_2 + V_3 ..}}$$



Q32. 2 M, 3 l NaOH + 5M, 2 l NaOH

find molarity

$$M = \frac{3\times2 + 5\times2}{5}$$

$$M = \frac{6+10}{5}$$

$$\boxed{M = \frac{16}{5}}$$

Q33. NaOH + NaOH ⟶ NaOH find molarity

2M, 3 l 40% w/v, 2 l → 800g → 20 mol

$$\cancel{M = \frac{6+20}{4}}$$

$$\cancel{M = \frac{13}{2}}$$

$$M = \frac{20+6}{5}$$

$$\boxed{M = \frac{26}{5}}$$

Q34. $2M, NaOH\ 3l + 2M, KOH\ 3l$

$[OH^-]$, $[Na^+]$ $[K^+]$

$\cancel{M = \frac{6+6}{6}}$

$\cancel{\boxed{M = 2M}}$

$\cancel{[OH^-] =}$

$[OH^-] = \frac{6+6}{6}$

$\boxed{[OH^-] = 2M}$

$[Na^+] = \frac{3 \times 2}{6}$

$\boxed{[Na^+] = 1M}$

$\boxed{[K^+] = 1M}$

Q35. $2l, 10^{-3}M\ H_2SO_4 + 1l, 10^{-3}M, HCl$

find. $[H^+]$, $[SO_4^{2-}]$, $[Cl^-]$

$[H^+] = \frac{10^{-3} + 4 \times 10^{-3}}{3}$

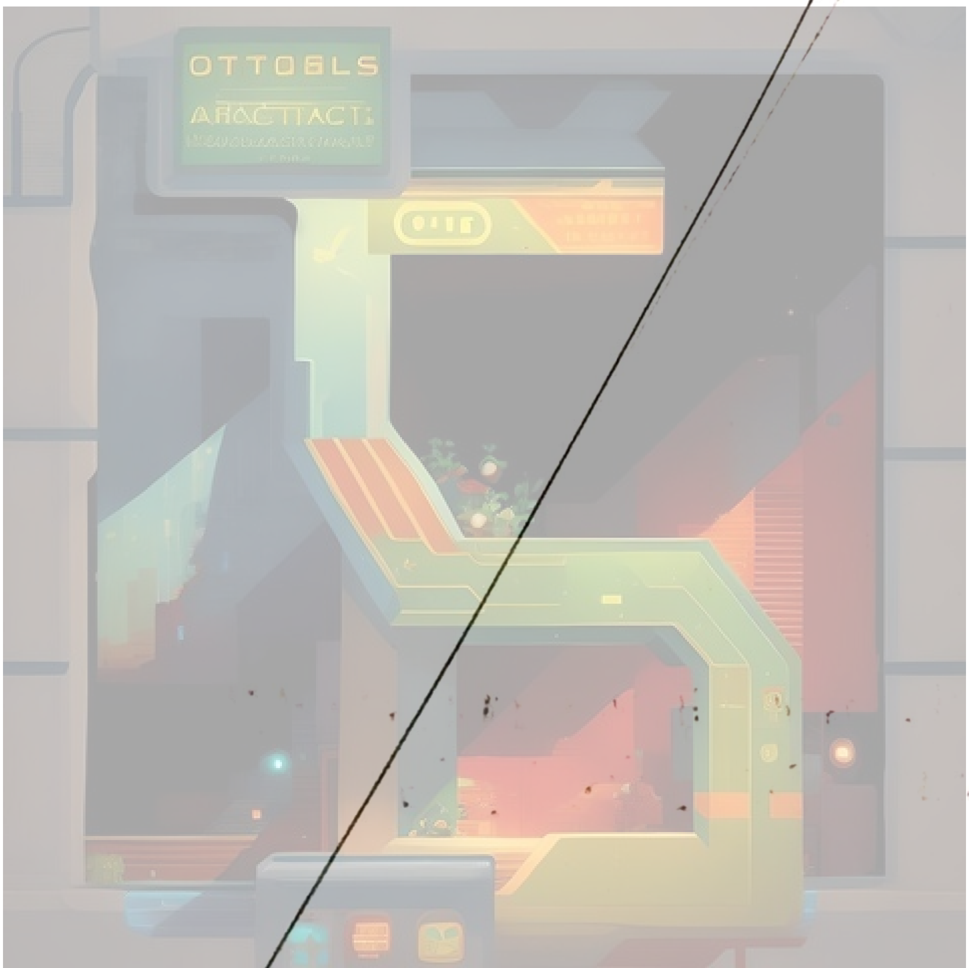
$= \frac{5}{3000}$

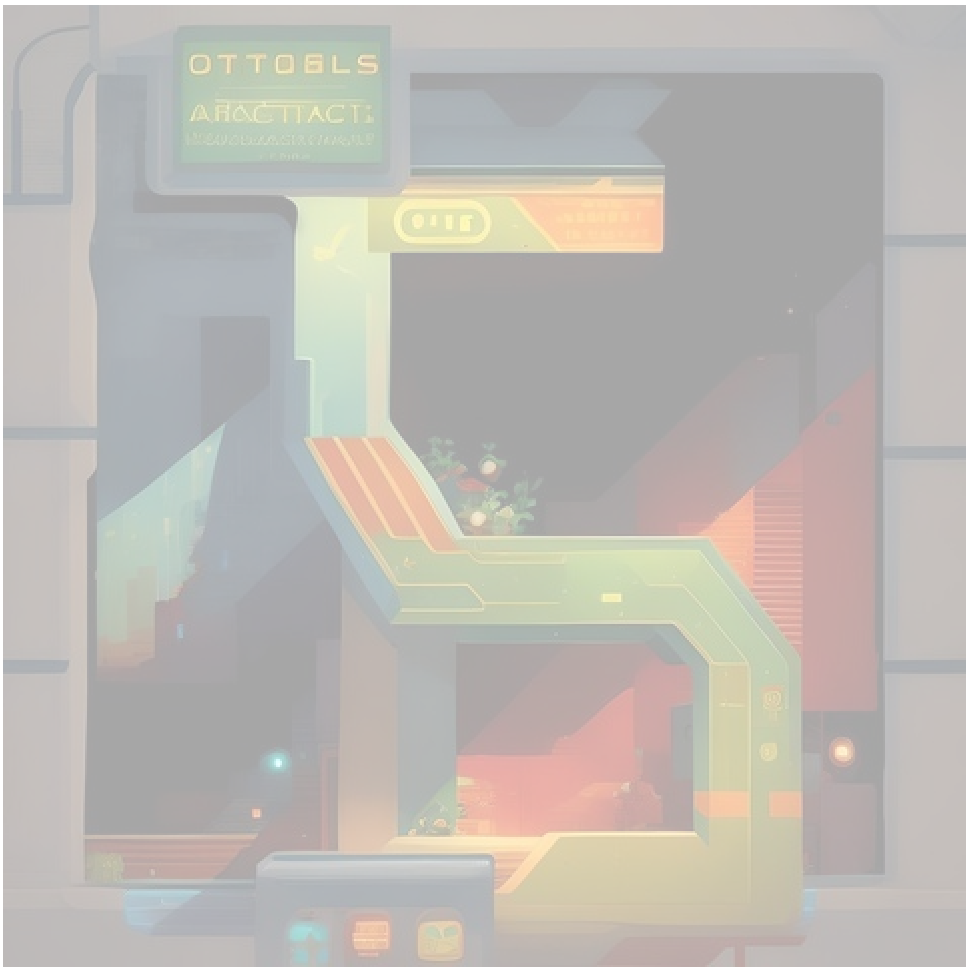
$\boxed{[H^+] = \frac{5}{3} \times 10^{-3}}$

$[SO_4^{2-}] = \frac{2 \times 10^{-3}}{3}$

$\boxed{[SO_4^{2-}] = \frac{2}{3} \times 10^{-3}}$

$\boxed{[Cl^-] = \frac{10^{-3}}{3}}$

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~~Q 100 ml~~

Q 36 100 ml of 1 M H_2SO_4 + 98% $\frac{w}{w}$ H_2SO_4 100 ml (d soln = 0.1 g/ml)

$n_{H_2SO_4} = 1M \times \frac{100}{1000} l$

$= 0.1$ mol

mass = 9.8 g

~~mass H_2SO_4 = 10 g~~

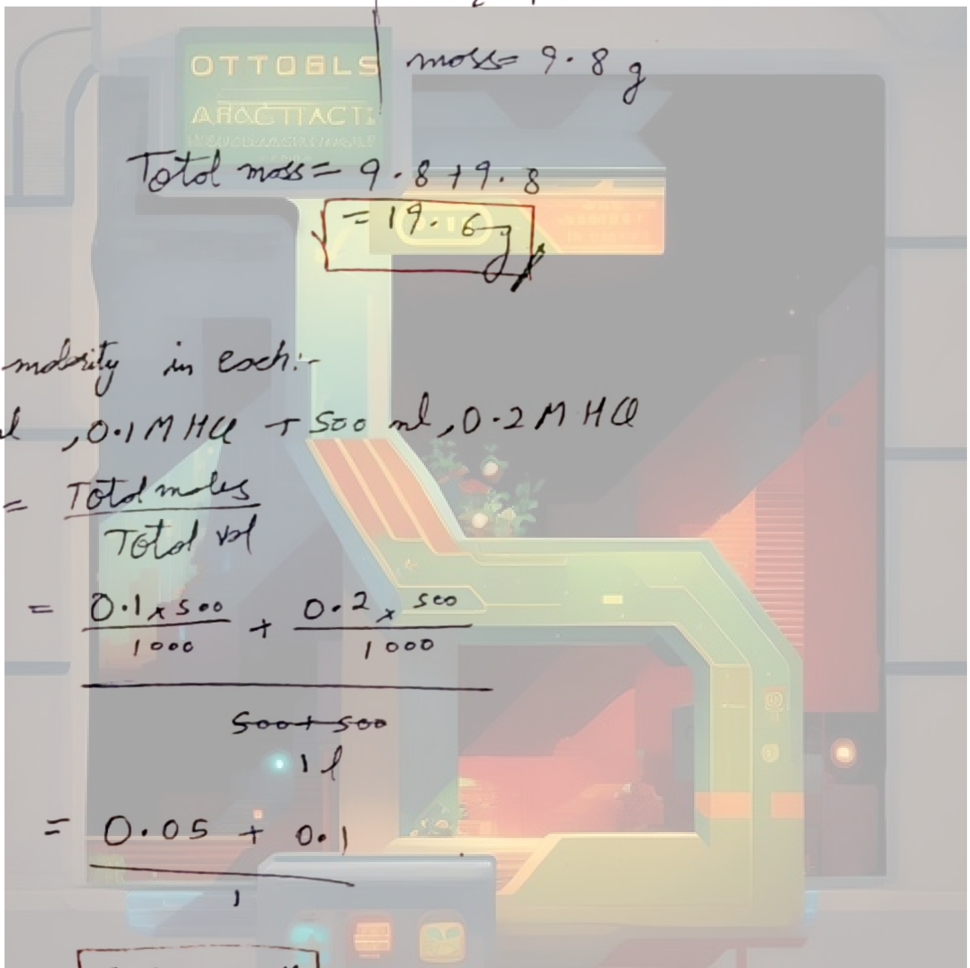
~~$9.8 \times 10 = w$~~

$M_{H_2SO_4} = \frac{98 \times 0.1 \times 10}{98}$

$= 1 M$

$n_{H_2SO_4} = 0.1$ mol

mass = 9.8 g



Total mass = 9.8 + 9.8

$\boxed{= 19.6 g}$

Q.37 find final molarity in each:-

① 500 ml, 0.1 M HCl + 500 ml, 0.2 M HCl

$M = \frac{\text{Total moles}}{\text{Total vol}}$

$= \frac{\frac{0.1 \times 500}{1000} + \frac{0.2 \times 500}{1000}}{\cancel{500 + 500} \; 1 l}$

$= \frac{0.05 + 0.1}{1}$

$\boxed{= 0.15 M}$

② 50 ml, 0.1 M HCl + 150 ml, 0.3 M HCl + 300 ml H_2O

$M = \frac{\text{moles}}{\text{vol}}$

$M = \frac{0.1 \times \frac{50 + 150 \times 0.3}{1000}}{0.5}$

$M = \frac{5 + 45}{500}$

$M = \frac{50}{500}$

$\boxed{M = 0.1}$

③ 4.9g H_2SO_4 + 250 ml H_2O + 250ml 0.1 M H_2SO_4

$$M = \frac{\frac{1}{20} + \frac{0.1}{4}}{250+250} \times 1000$$

$$M = \frac{\frac{1}{20} + \frac{0.5}{20}}{500} \times 1000$$

$$M = \frac{1.5}{20 \times 500} \times 1000$$

$$M = \frac{1.5}{10000} \times 1000$$

$$\cancel{M = 1.5 \times 10^{-4}\ M}$$

$$\boxed{M = 0.15\ M}$$

Case II Reacting Solution.

① No PPT formed –

→ write the equation & balance

→ Find the moles or milimoles of reactants

→ find the LR & decide the amount of product accordingly

Q 38 0.1 M, 200 ml H_2SO_4 is mixed with 0.2 M, 200ml NaOH find!

a) Nature of Resultant Solⁿ

b) $[Na^+]$ $[SO_4^{2-}]$

$$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$$

H_2SO_4	$2NaOH$	$2H_2O$	Na_2SO_4
0.02	0.04	0.04	0.02

NO LR

$\boxed{\text{(a) Neutral}}$ a)

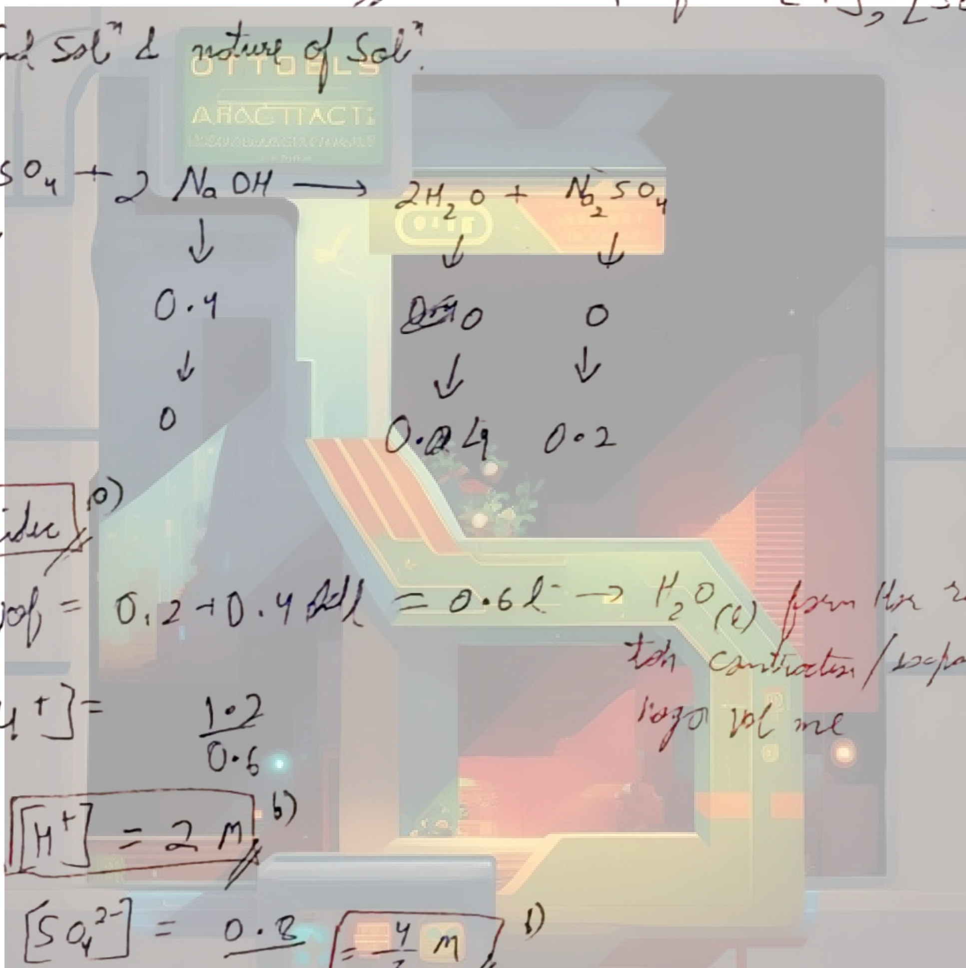
$[Na^+] = \dfrac{0.04}{0.4}$

$\boxed{[Na^+] = 0.1\ M}$ b)

$[SO_4^{2-}] = \dfrac{0.02}{0.4}$

$\boxed{[SO_4^{2-}] = 0.05\ M}$ b)

Q 39 2M, 200 ml NaOH + 2M, 400 ml H_2SO_4 find $[H^+]$, $[SO_4^{2-}]$ $[Na^+]$ in final solⁿ & nature of Solⁿ.



$$\begin{array}{cccc} H_2SO_4 & + \ 2\,NaOH & \longrightarrow \ 2H_2O & + \ Na_2SO_4 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0.8 & 0.4 & 0 & 0 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0.6 & 0 & 0.4 & 0.2 \end{array}$$

A) $\boxed{\text{Acidic}}$ b)

b) $V_f = 0.2 + 0.4$ ~~dl~~ $= 0.6\,l$ → $H_2O_{(l)}$ form then soln ki koi contraction / expansion nhi hogi vol me

$[H^+] = \dfrac{1.2}{0.6}$

$\boxed{[H^+] = 2\ M}$ b)

$[SO_4^{2-}] = \dfrac{0.8}{0.6} = \boxed{\dfrac{4}{3}\ M}$ b)

$[Na^+] = \dfrac{0.4}{0.6} = \dfrac{4}{6} = \boxed{\dfrac{2}{3}\ M}$ b)

② PPT is formed :-

→ PPT is that substance which does not dissociates into its ions upon dissolution

eg. $AgCl$, $AgBr$, AgI, $CaCO_3$, $BaSO_4$, etc.

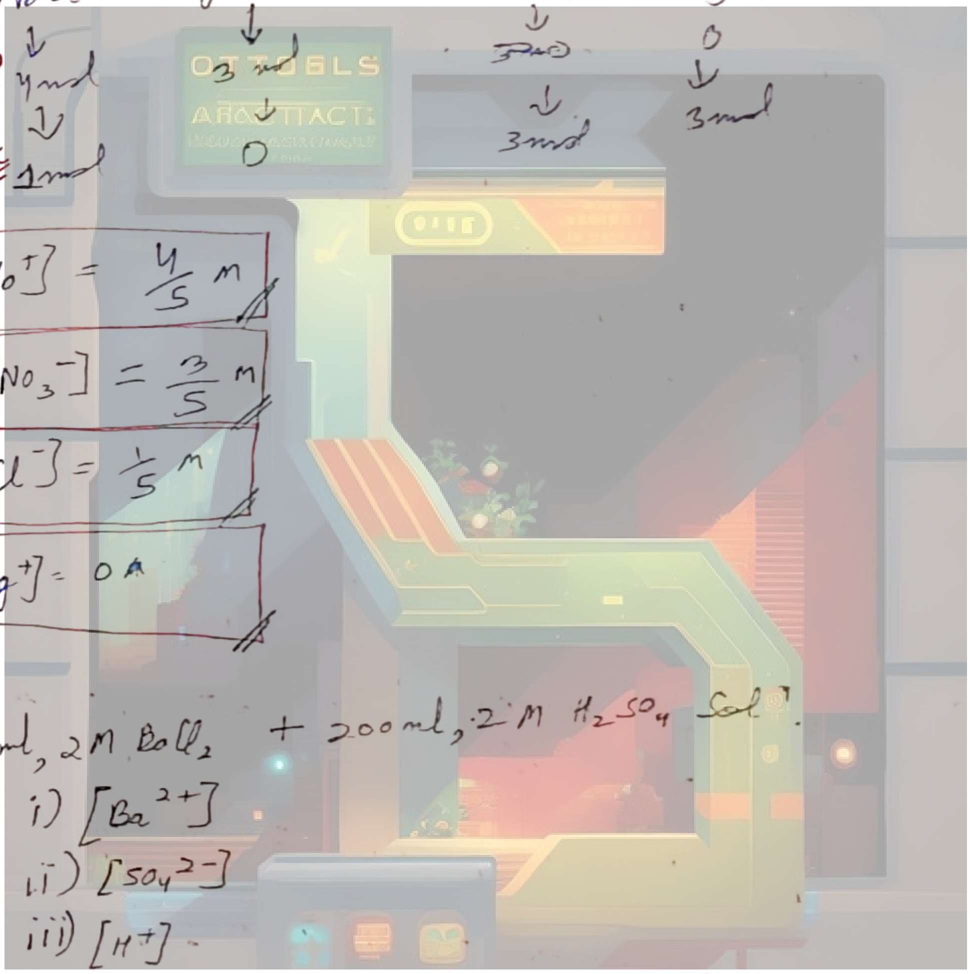
Q 40 2l, 2M NaCl + 3l, 1 M $AgNO_3$

find $[Na^+]$ $[Cl^-]$ $[Ag^+]$ $[NO_3^-]$

$NaCl + AgNO_3 \longrightarrow AgCl_{(s)}\downarrow + NaNO_3$ (PPT)

t=0: 4 mol, 3 mol, 0, 0

t=t: 1 mol, 0, 3 mol, 3 mol



$\boxed{[Na^+] = \frac{4}{5}\ M}$

$\boxed{[NO_3^-] = \frac{3}{5}\ M}$

$\boxed{[Cl^-] = \frac{1}{5}\ M}$

$\boxed{[Ag^+] = 0\ M}$

Q41. 100 ml, 2M $BaCl_2$ + 200 ml, 2 M H_2SO_4 Sol^n.

find i) $[Ba^{2+}]$

ii) $[SO_4^{2-}]$

iii) $[H^+]$

$BaCl_2 + H_2SO_4 \longrightarrow 2HCl + BaSO_4$

0.2, 0.4, 0, 0

0, 0.2, 0.4, 0.2

i) $[H^+] = \frac{0.8}{0.3} = \boxed{\frac{8}{3}\ M}$

ii) $[SO_4^{2-}] = \frac{0.2}{0.3} = \boxed{\frac{2}{3}\ M}$

iii) $[Ba^{2+}] = \boxed{= 0}$ PPT

Molarity & Molality of Pure liquid.

Solute = Pure liquid

Solvent = Pure liquid

Sol^n = Pure liquid

density of pure liquid = d g/ml

1 lit Pure sol^n

mass of sol^n = $(1000 \times d)$ g

mass of pure liquid (solute) = $1000 \times d$

moles of solute = $\dfrac{1000 \times d}{(M.W)_{\text{Pure liquid}}}$

(19) $\boxed{M = \dfrac{mol}{Vol(l)} = \dfrac{1000 \times d_{\text{Pure liquid}}}{M.W_{\text{pure liquid}}}}$

eg. H_2O

$M = \dfrac{1000}{18} \times 1$

$M = 55.55$

$\boxed{m = \dfrac{1000}{(M.W)_{\text{Pure liquid}}}}$

$m = \dfrac{1000}{18} = 55.55$

Note:- It is not true that for a pure liquid $M \underset{\text{(Always)}}{=} m$ as it depends upon density of liquid.

→ But for H_2O liquid, $M = m$ always cause its density is 1 g/ml

Note:- For a very dilute aqueous solution, Molarity of sol^n is approx equal to molality.

Volume Strength (V) of H_2O_2 solⁿ :-

→ It is defined as the volume in l of oxygen gas evolved at STP by decomposition of 1 L H_2O_2 ~~solⁿ~~ aqueous solⁿ.

Solute = H_2O_2

Solvent = H_2O

$$H_2O_2\,(aq) \longrightarrow H_2O + \tfrac{1}{2}O_2\,(g)$$

1 l ↓ $\qquad$ V l O_2 at STP ↓

$$n_{H_2O_2} = \frac{2V}{22.7} \qquad n_{O_2} = \frac{V}{22.7}\ \text{mol}$$

$$M_{H_2O_2} = \frac{2V}{22.7} \times \frac{1}{1\,l}$$

$$\boxed{M = \frac{V}{11.35}\ \text{molar}}$$ → volume strength.

$$M = \frac{V}{11.2}\ (\text{at NTP})$$

eg. 1 V H_2O_2 solⁿ

→ 1 l H_2O_2 will decompose to get 1 l O_2 gas at STP.

eg. 10 V H_2O_2 solⁿ

→ 1 l H_2O_2 will decompose to 10 l O_2 gas ~~at~~ at STP.

Q42. A Bottle of H_2O_2 is labeled at 45.4 V find molarity.

$$M = \frac{45.4}{11.35}$$

$$\boxed{M = 4\ \text{molar}}$$

Q43. A sol^n of H_2O_2 labelled at 11.35 V. calculate its concentration. % w/v.

$M = 1$ molar

$$M = \frac{\% \frac{w}{v} \times 10}{M.M_{solute}}$$

$$\frac{1 \times 34}{10} = \% \frac{w}{v}$$

$$\boxed{\% \frac{w}{v} = 3.4 \%}$$

Q44. 100 ml each of 1M H_2O_2 & 22.7V H_2O_2 sol^n are mixed. find the strength of final sol^n in g/litre.

$$M = \frac{0.1 + 0.2}{0.200} \text{ molar}$$

$$M = \frac{0.3}{0.2} \text{ molar}$$

$M = 1.5$ molar

$\cancel{M = \frac{V}{11.35}}$

$\cancel{V = 1.5 \times 11.35}$

$\cancel{V = 17.025 \text{ g/l}}$

moles $H_2O_2 = 0.3$ mol

vol $= 0.2$ mol

mass $= 0.3 \times 34$

$= 10.2$

$$\frac{g}{l} = \frac{10.2}{0.2} \boxed{= 51 \text{ g/l}}$$

Q45. In a particular H_2O_2 sol^n, $X_{H_2O_2} = 0.2$. If $d_{sol^n} = 1$ g/ml find

i) molarity of H_2O_2 ii) volume strength.

$n_{H_2O_2} = 0.2$

$n_{H_2O} = 0.8$

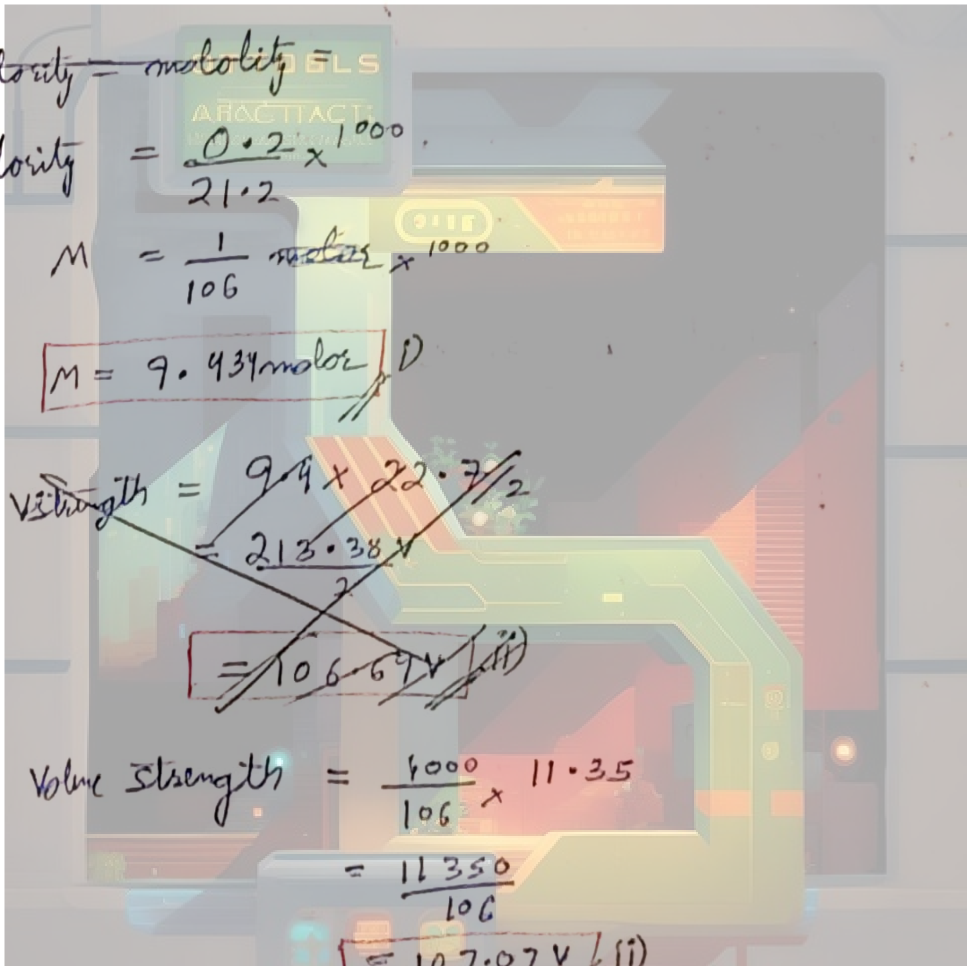
~~n~~ mass Total $= 34(0.2) + 18(0.8)$

$= 6.8 + 14.4$

$= 21.2g$

~~Vol $= \frac{21.2}{1}$~~

~~Vol = ?~~



~~Molarity = molality =~~

Molarity $= \frac{0.2}{21.2} \times 1000$

$M = \frac{1}{106}$ ~~molar~~ $\times 1000$

$\boxed{M = 9.434 \text{ molar}}$ (i)

~~V strength $= 9.4 \times 22.7/2$~~

~~$= \frac{213.38V}{2}$~~

~~$\boxed{= 106.69V}$ (ii)~~

Volume strength $= \frac{1000}{106} \times 11.35$

$= \frac{11350}{106}$

$\boxed{= 107.07V}$ (ii)

Q46. 45.4 V H_2O_2 sol^n 500 ml is dissociated, DOD = 0.2.

find i) New vol strength of H_2O_2 sol^n

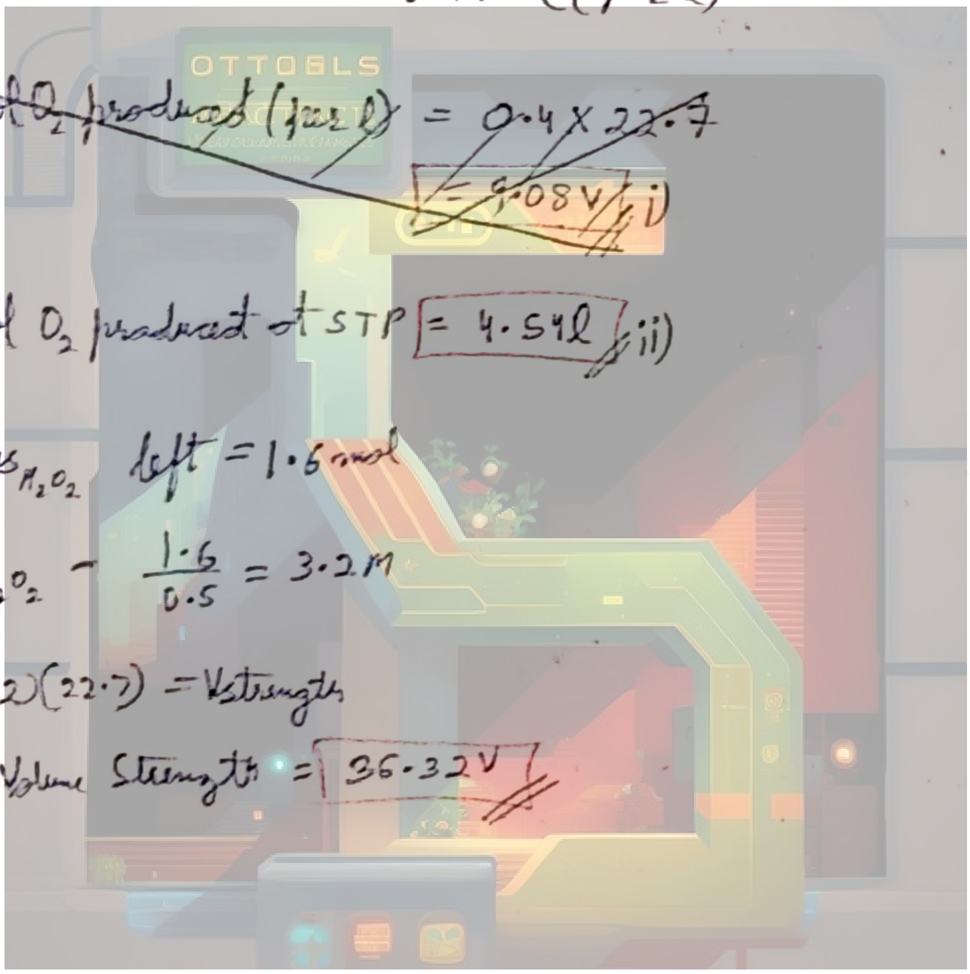
ii) Vol^n of O_2 at STP produced.

given:- During Dissociation, vol of sol^n not change.

moles of H_2O_2 = 2 mol

moles of O_2 produced = 0.2 mol (500 ml)

= 0.4 mol (per l)



~~Vol O_2 produced (per l) = 0.4 × 22.7~~

~~$\boxed{= 9.08 V}$ i)~~

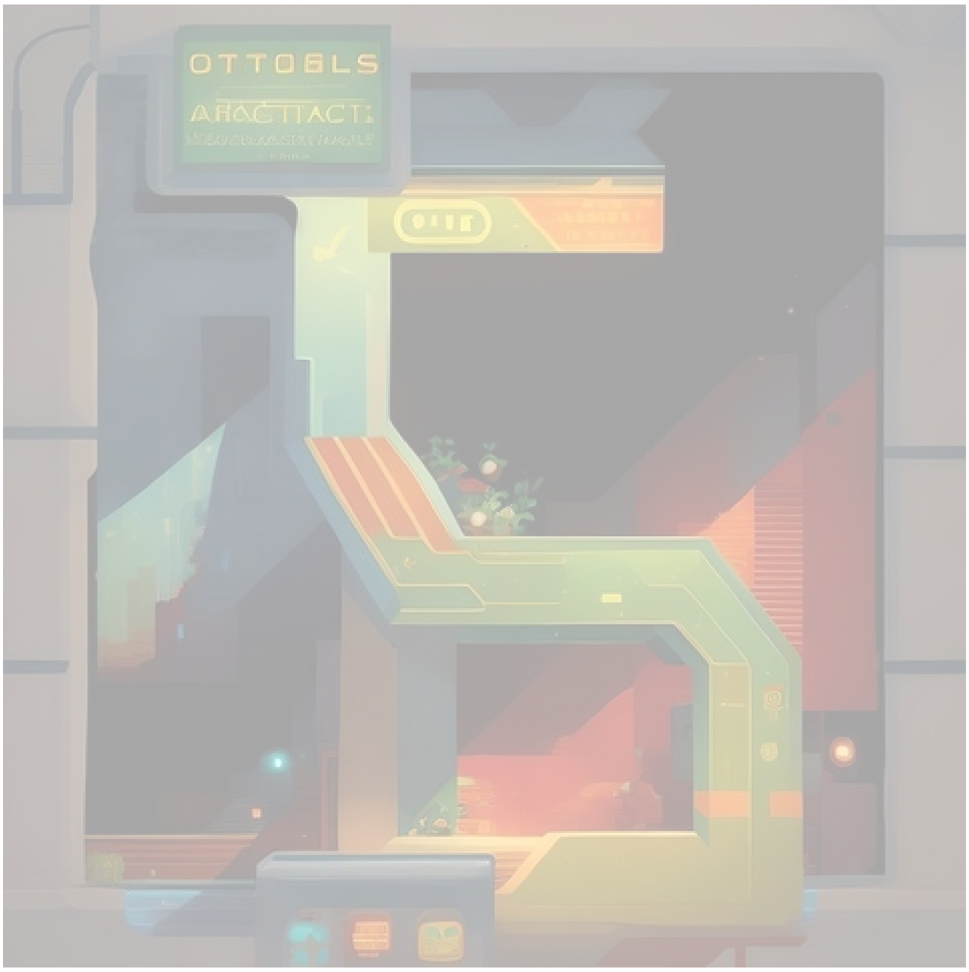
Vol O_2 produced at STP $\boxed{= 4.54 l}$ ii)

$moles_{H_2O_2}$ left = 1.6 mol

$M_{H_2O_2} = \frac{1.6}{0.5} = 3.2 M$

(3.2)(22.7) = V strength

Volume Strength = $\boxed{36.32 V}$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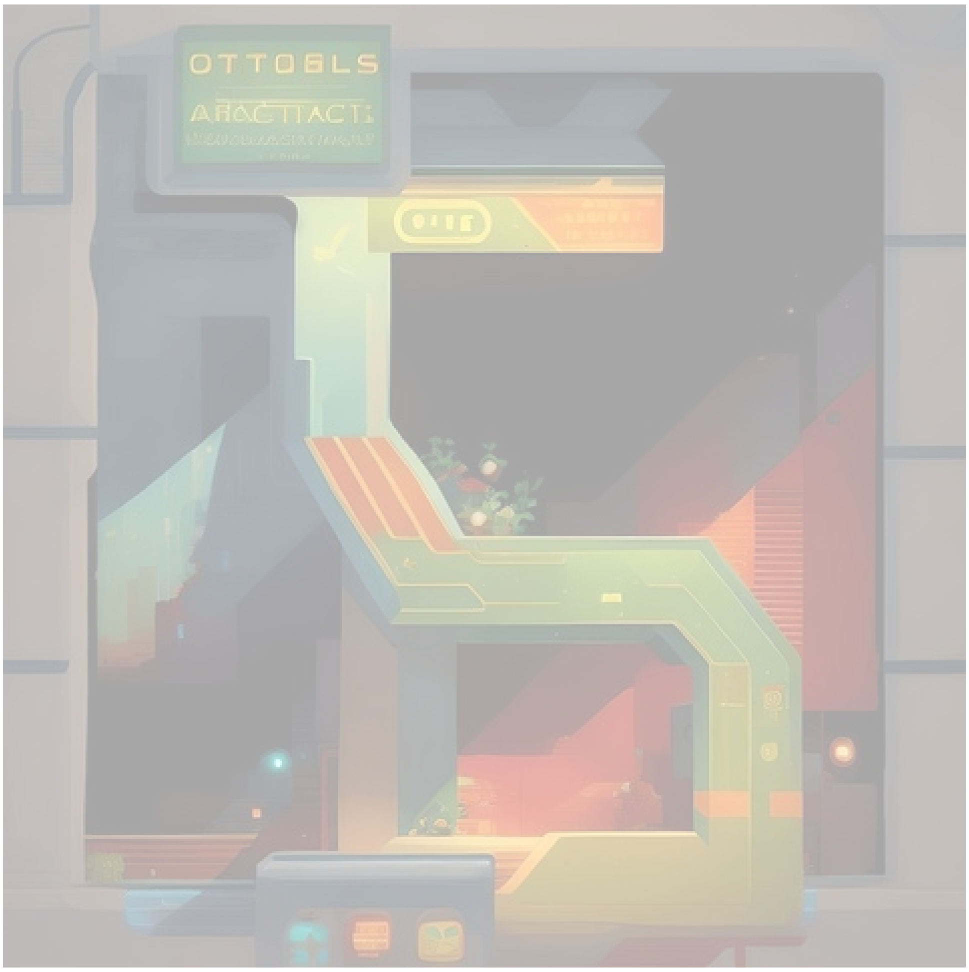
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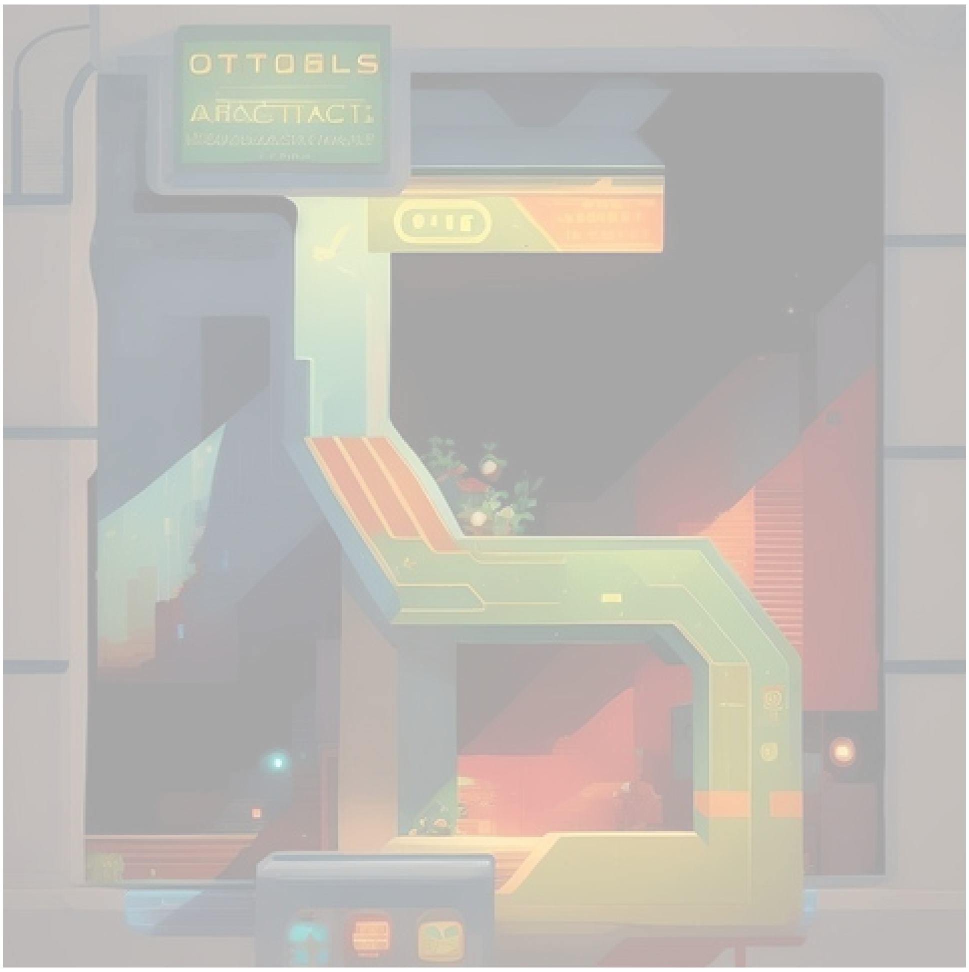
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