CONCENTRATIONS UNITS

(i) Molarity (M): No of moles per Litre of solution

(ii) Normality (N): No of Equivalents in 1L of solution

(iii) Molality (m):No of moles in 1kg of Solvent

(iv) Mass Percent: w/w

% Mass of solute in total mass of solution

(v) Mole fraction (x)

Problem: A solution of sulphuric acid is 20% w/w and has a density of 1.14g/cm^3. Calculate its (i) Molarity (ii) Molality (iii) Normality (iv) Mole fraction.

(i) Molarity

Consider 1000 cm^3 of the solution of H_2SO_4.

Mass of the 1000 cm^3 = 1140g

Mass of pure H_2SO_4 = 20% = 228g

$\therefore$ Molarity of $H_2SO_4 = \frac{228}{98}$ = **2.327M**

Molality:

Consider 100g of the Acid solution.

Mass of H_2SO_4 = 20g; Mass of water = 80

No of moles of acid = $\frac{20}{98}$ = 0.2040 mole

Molality = $\frac{0.2040 \times 1000}{80}$ = 2.551m

(iii) Normality: Since H_2SO_4 is dibasic

Normality = 2.327 x 2 = 4.654N

(iv) Mole fraction:

$$\chi_{H_2SO_4} = \frac{n_{H_2SO_4}}{n_{H_2SO_4} + n_{H_2O}} = \frac{0.204}{0.204 + 4.444}$$

(iv) Mole fraction:

$$\chi_{H_2SO_4} = \frac{n_{H_2SO_4}}{n_{H_2SO_4} + n_{H_2O}} = \frac{0.204}{0.204 + 4.444}$$

$$= 0.044$$

LOOK AT:

A solution of HCl has a density of 1.19g/cm^3 and it is 37% pure. Calculate its (i) mole fraction (ii) molarity (iii) Normality (ii) the volume of the acid required to prepare 600cm^3 of a solution that is 0.12N.

LECTURE FOUR

- **TITRIMETRIC CALCULATIONS**
- **Standard Solution: A solution of known concentration**
- **Concentrations measured in Molarity**
- **A Molar contains the Mol. Mass of the substance in 1 L of solution: Units: Moles/L**
- **Solution A: Unknown concentration**
- **Solution B: Known concentration**

TITRATION

By titrating A against B, the conc of A can be known

EXAMPLE

25 cm^3 0.1M sodium hydroxide requires 15.0 cm^3 of sulphuric acid for complete neutralisation. Calculate the molarity of the acid.

SOLUTION

STEP 1: **Write the chemical for the reaction**

$$H_2SO_4 + 2NaOH \rightarrow NaCl + H_2O$$

STEP 2: **Determine the mole ratio**

Here mole Ratio = 2:1 or 1:2

STEP THREE: **Determine the No of moles of reacting species**

No of moles of acid $= \dfrac{\text{Vol. of acid used} \times \text{Molarity of acid}}{1000}$

$$= \frac{15 \times M_a}{1000}$$

$$\text{No of moles of Base} = \frac{\text{Vol. of base used} \times \text{Molarity}}{1000}$$

$$= \frac{25 \times 0.1}{1000}$$

STEP 4: **Calculate the concentration of the unknown**

$$\frac{\text{No of moles of acid}}{\text{No of moles of Base}} = \frac{1}{2} = \frac{15 \times M_a}{25 \times 0.1}$$

$$M_a = \frac{25 \times 0.1}{30} = \mathbf{0.0833M}$$

EXERCISES

1. **A solution of nitric acid contains 0.67g in 100 cm^3. 31.00 cm^3 of this solution neutralised 25 cm^3 of sodium carbonate solution. Calculate the molarity and hence the concentration in g/L of the carbonate solution.**
2. **7.0 g of anhydrous K_2CO_3 containing a neutral salt as impurity was made up to 1L of aq soln. 24 ml of this solution was neutralised by 23 cm^3 of 0.1 M HCl. What is the % of impurity in the sample of K_2CO_3 by weight**
3. **25 cm^3 of a solution of Na_2CO_3 required 17.5 cm^3 of 0.05 M H_2SO_4 for neutralisation. Calculate the molarity of the Na_2CO_3 solution and its concentration in g/L.**

DILUTIONS

Stock solutions.

Derive $M_1 V_1 = M_2 V_2$ from 1st principles.

Problem

1. What volume of 5M HNO_3 would you require to make 250 cm^3 of a 0.3M solution.

2. What volume of water must you add to 20 ml of a 0.5M stock solution to obtain a 0.1M solution?

Ans 80 cm^3

This is different from the problem in the Lecture notes.

If you dilute 34 mL of 1.32M $KMnO_4$ to 0.28 M $KMnO_4$, what is the volume of the final solution?

How many millitres of 2.00 M acetic acid are required to make 45 mL of a 0.18 M $HC_2H_3O_2$ solution?

Just a Joke

A dying man gathered his lawyer, Doctor and Clergyman at his bed side and handed each of them an envelope containing $25,000 in cash. He made them each promise that after his death and during his repose, they would place the three envelopes in his coffin. He told them that he wanted to have enough money to enjoy the next life.

A week later he died.

At the wake, the Lawyer, Doctor and the Clergyman, each concealed an envelope in the coffin and bid their old friend farewell. Several months later, the three met by chance. The clergyman feeling guilty, blurted out a confession saying that there was only $10,000 in the envelope he placed in the coffin. He felt, rather than waste all the money, he would send it to mission in Africa. He asked for their forgiveness.

The Doctor, moved by the gentle Clergyman's sincerity, confessed that he too had kept some the money for some worthy medical charity. There was only $8,000.00 in the envelope. The Lawyer expressed disappointment in his colleagues. I am the only one who keep to the promise made to our old friend. I want you two to know that the envelope I placed in the coffin contained the full amount. Indeed, my envelope contained my personal cheque for entire $25,000.