5th lecture analytical Chemistry
1/2/2021

Percentage Strength Calculations

Methods for the Expression of Concentration of Solutions

Normality

- **Normality (N),** also known as the equivalent concentration of a solution**,** is equal to the *number of equivalents of solute that are contained in a* liter of solution.
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$

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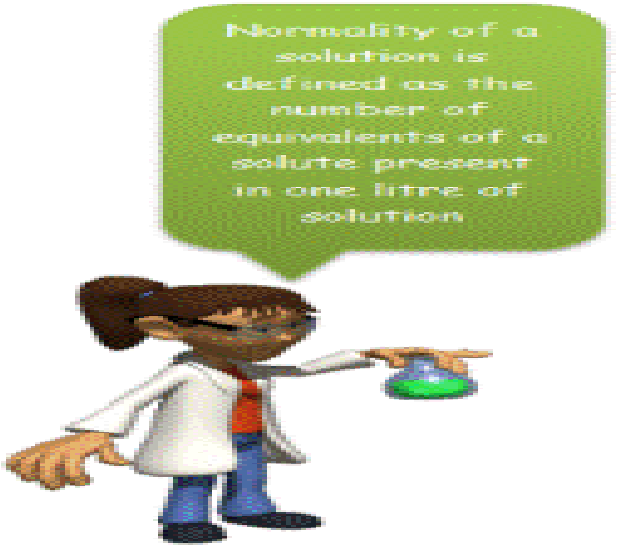
$$\text{Normality} = \frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$$



- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute}{\text{equivalent weight}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}}$
- what is (n) factor?

Methods used in Analytical Chemistry

- The methods used to determine the identity and the quantity of the analytes in the field of analytical chemistry can be broadly divided into

➢Classical Methods

➢volumetric analysis

➢for example Titration

- In volumetric analysis, chemists use equivalent weight as basis for volumetric analysis calculations
- Volumetric analysis involves Neutralization reaction, Oxidation reaction, Precipitation reaction and Complex formation reaction
- Normality is the corresponding units of concentration in which these units are defined depends upon the type of reaction that serves as the basis for analysis
- Normality units are defined depends on the chemical behavior of a substance in a specific chemical reaction

- What is the neutralization reaction? It is a quantitative chemical reaction between acid and base (called acid- base reactions)

- $NaOH + HCl \longrightarrow NaCl + H_2O$

- What is the Acid-Base?
- According to Bronsted-Lowry concept: Acid is any substance that is capable of donating a proton (H^+)
- Base is any substance that is capable of accepting a proton (H^+)
- $AH + B \rightarrow A + BH$

- acid + base ⟶ salt + water
- HCl + NaOH ⟶ NaCl + H -O-H
- The gram equivalent weight (eqw) in neutralization reactions is that weight of a substance participating in neutralization and either contribute or react with 1 mole of H^+
- HCl + NaOH ⟶ NaCl + H -O-H
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
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Normality is the only concentration unit that is reaction dependent

- $NaOH(aq) \rightarrow Na^{+}(aq) + OH^{-}(aq)$
- Calculate the normality of NaOH solution prepared by using 5.8g in 3L
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute\ g}{\text{equivalent weight g/eq}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}} = \frac{40\ g/mol}{1\ eq/mol} = 40$ g/eq
- $Number\ of\ equivalents\ of\ solute = \frac{5.8g}{40\ \text{g/eq}} = 0.145$eq
- Normality = $\frac{0.145\ eq}{3L} = 0.048$ eq/L

- Calculate the normality of $Ba(OH)_2$ solution prepared by using 0.46g in 500ml
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute\ g}{\text{equivalent weight g/eq}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}} = \frac{171.34\ g/mol}{2\ eq/mol} = 85.67$ g/eq
- $Number\ of\ equivalents\ of\ solute = \frac{0.46g}{85.67\ \text{g/eq}} = 0.082$eq
- Normality = $\frac{0.082\ eq}{500\text{ml}} = 0.00016$ eq/L

- Prepare a diluted solution of KOH with 0.15N in 250ml using a solution of KOH prepared by using 4.2g in 500ml
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute\ g}{\text{equivalent weight g/eq}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}} = \frac{56.1\ g/mol}{1\ eq/mol} = 56.1$ g/eq
- $Number\ of\ equivalents\ of\ solute = \frac{4.2g}{56.1\ \text{g/eq}} = 0.075$eq
- Normality = $\frac{0.68}{0.50L} = 0.149$eq/L
- N1V1 =N2V2 == 0.149 X V1 = 0.15 X 250ml = 250ml is the V1

- Prepare 2 diluted solutions of $Ca(OH)_2$ with (0.030N in 250ml) and (0.22N in 1000ml) prepared by using 3g in 500ml
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute\ g}{\text{equivalent weight g/eq}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}} = \frac{74.1\ g/mol}{2\ eq/mol} = 37.1$ g/eq
- $Number\ of\ equivalents\ of\ solute = \frac{3g}{37.1\ \text{g/eq}} = 0.081$eq
- Normality = $\frac{0.081\ eq}{0.50\text{ml}} = 0.16$ eq/L
- N1V1=N2V2 = 0.16N X V1 = 0.03N X 250ml = 46.9 ml V1

How to prepare a diluted HNO_3solution of 0.65N in 500 ml using the concentrated HNO_3 solution (specific gravity 1.70, 40 w/w%)?

- $HNO_4 + OH^- \rightarrow NO_3^- + H_2O$
- N = Specific gravity X w/w% /100X 1000/M.wt
- N = 1.70 g/ml X 40%X 1000/eqw
- $Equivalent\ weight = \frac{M.wt}{(n)\ factor} = \frac{63\ g/mol}{1\ eq/mol}$ = 63 g/eq
- N = 1.70 g/ml X (40/100 = 0.40)X 1000/63=10.8
- Dilution?
- N1V1 = N2 V2
- 10.8 X V1= 0.65 X 500ml = 30.1ml V1 need to prepare a diluted 0.65N in 500ml

How to prepare a diluted H_2SO_4 solution of 0.25M in 500 ml using the concentrated H_2SO_4 solution (specific gravity 1.69, 88 w/w%)?

- $H_2SO_4 + 2OH^- \rightarrow SO_4^{2-} + 2H_2O$
- N = Specific gravity X w/w% /100X 1000/M.wt
- N = 1.69 g/ml X 88%X 1000/eqw
- $Equivalent\ weight = \frac{M.wt}{(n)\ factor} = \frac{98\ g/mol}{2\ eq/mol} = 49$ g/eq
- N = 1.69 g/ml X (88/100 = 0.88)X 1000/49=30.4
- Dilution?
- N1V1 = N2 V2
- 30.4 X V1= 0.25 X 500ml = 4ml V1 need to prepare diluted 0.25 in 500ml

- Calculate the normality of Na_2SO_4 solution prepared by using 0.38g in 250ml
- Normality = $\frac{Number\ of\ equivalents\ of\ solute}{\text{Volume of solution in liters}}$
- $Number\ of\ equivalents\ of\ solute = \frac{wt\ of\ solute}{\text{equivalent weight}}$
- $Equivalent\ weight = \frac{M.wt}{\text{(n) factor}} = \frac{142.01\ g/mol}{2\ eq/mol} = 71$ g/eq
- $Number\ of\ equivalents\ of\ solute = \frac{0.38g}{71g/eq} = 0.0053$eq
- Normality = $\frac{0.0053eq}{250ml} = 0.0000212$ eq/ml

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Thank you