Equivalent weights

(1) Equivalent weight in neutralization reactions.

The equivalent weight of acid is that weight of it which contains one-gram atom of replaceable hydrogen.

Ex: equivalent weight of H_2SO_4 =M.Wt H_2SO_4/2

equivalent weight of H_3PO_4 =M.Wt H_3PO_4/3

$$\text{eq.wt acid} = \frac{\text{M.Wt acid}}{\text{No. of active } H^+}$$

The equivalent weight of Base is that weight of it which contains one replaceable hydroxyl group.

Ex: equivalent weight of NaOH =M.Wt NaOH/1

$$\text{eq.wt base} = \frac{\text{M.Wt base}}{\text{No. of active } OH^-}$$

(2) Equivalent weight in Oxidation -reduction reactions.

The equivalent weight of an oxidant or a reductant is the number of electrons which 1moL of the substance gains or losses in the reaction.

$$\text{eq.wt} = \frac{\text{Formula weight (gm/mole)}}{\text{No. of lost or gained electrons}}$$

Ex:

$$5C_2O_4^{=} + 2MnO_4^- + 16H^+ \rightarrow 10\ CO_2 + 2Mn^{2+} + 8H_2O$$

$$\text{eq.wt } MnO_4^- = \frac{\text{F.wt } MnO_4^-}{5} \qquad \text{eq.wt } C_2O_4^{=} = \frac{\text{F.wt } C_2O_4^{=}}{2}$$

(3) Equivalent weight of complex formation and precipitation reactions.

Here the equivalent weight is the weight of the substance which contains or reacts with 1g. atm of a univalent cation M^+.

Ex: When silver nitrate reacts with sodium chloride, to form silver chloride, the equivalent weight of $AgNO_3$ is:

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3 \qquad \text{eq.wt } (AgNO_3) = \frac{\text{F.wt } AgNO_3}{1}$$

Experiment (5)

Calibration of Hydrochloric Acid

A- Preparation hydrochloric acid solution (0.1N):-

Taking a given volume of hydrochloric acid center by graduated cylinder (Graduated cylinder) and empties the bottle volumetric capacity (500 ML) and wash cylinder with distilled water and empties water washing in the bottle volumetric so as to make sure that all the acid been the center transfer to the bottle and then completes the volumetric size with distilled water to the mark in the volumetric bottle. calculate calibration hydrochloric acid status by the following equation.

1-Calculate the normality of the concentrated HCl :

$$N1 = \frac{Sp. * Wt.\% * 1000}{Eq. Wt.} \quad \text{----------(1)}$$

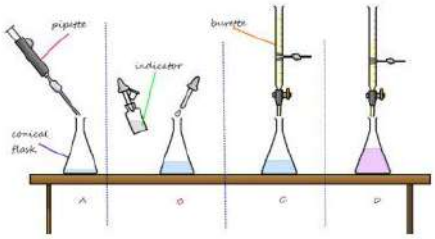
Where :-

N1 = hydrochloric acid calibratio n Centre

Sp. = Specific weight of acid (acid density)

Wt. % = The percentage of the weight of hydrochloric acid Center

$$N = \frac{1.19 * (37/100) * 1000}{36.5} = 12.0630$$



2- To prepare (500mL) of 0.1N HCl

Preparation titrated hydrochloric acid ($N_2 = 0.1$) and size ($V_2 = 500$ ML) Use the following formula to calculate the size of the acid Centre (V_1), which we take to prepare the acid diluted:

$$N_1 * V_1 = N_2 * V_2 \quad \text{----------(2)}$$

conc. HCl dil. HCl

$$V_1 = \frac{N_2 * V_2}{N_1} \quad \text{--------} \quad (3)$$

$$12.0630 \times V_1 = 500 \times 0.1$$
$$V_1 = 4.1449 \text{ mL}$$

B: Preparation of (0.1N) sodium carbonate (Na_2CO_3):

The sodium carbonate solution is from standard solutions and is prepared by weighing a known amount of carbonate and dissolving in a known volume of distilled water. Where a bowl is weighed and it must be clean and dry in a delicate and accurate balance up to (0.1N) then a quantity of sodium carbonate is placed (that can be calculated) and weighed with a sensitive scale, then this amount is dissolved with a small amount of distilled water and then emptied into a volumetric flask and washed in a vessel several times With distilled water, wash water is added each time to the solution in the volumetric bottle, to ensure that all the carbonate material has transferred to the volumetric bottle, and then the volume is completed to the marker.

To calculate the weight of **sodium carbonate** needed to prepare a titration solution (0.1), the following equation is used:

$$N = \frac{\text{Weight}}{\text{equivalent weight}} * \frac{1000}{\text{Volume(mL)}}$$

$$Wt = \frac{N * V * Eq.Wt}{1000}$$

Where:
WT = weight of sodium carbonate dissolved in a volume of water
N = Standard of Sodium Carbonate to be prepared = 0.1
V = volume of the solution to be prepared (in ml)
Eq.Wt = equivalent weight to sodium carbonate

Equipment:-

1) burette of 50 ml.

2) 10 ml pipette.

3) 500ML Beaker.

4) 500 ML volumetric vial, 250 ML volumetric flask and conical flask.

5) funnel.

6) Spatule.

7) cylinder.

Procedure: -

A- Standardization of HCl solution with standard solution of Na_2CO_3

1-Clean the burette and rinse with HCl solution.

2-Fill the burette with HCl.

3-Pipet 10 ml of standard solution (Na_2CO_3) into a 250mL conical flask. Add 3 drops of **Methyl orange indicator**.

4-Titrate by adding HCl drop wise until the solution just beings to change from yellow to red.

5-Reapeat the titration a few times until you get approximate results. Take the average of the results and subtract 0.05mL. (This result represents the volume of extra drop which change the color of indicator.

6-Calculate the normality of HCl :

$$N_{acid} \times V_{acid} = N_{base} \times V_{base}$$

7-Make label on your bottle containing your name, date of preparation and concentration of acid after standardization.

8- The equation of reaction

$$Na_2CO_3 + HCl \xrightarrow{M.O} H_2CO_3 + 2NaCl$$

B- Analysis of sodium carbonate Na_2CO_3

1-Clean the burette and rinse with standardized HCl solution and then fill it with the acid.

2-Pipet 10 ml unknown solution (Na_2CO_3) into a 250mL conical flask. Add 2 drops of **phenolphthalein indicator** the solution will be pink.

3-Titrate by adding HCl drop wise until the solution just beings to change its color from pink to **colorless** this data will be (V_1).

4- Add 1-2 drops of **Methyl orange indicator** to the above solution which became yellow then complete the titration until the color of the solution became pale **orange (onion)**, this data will be (V_2).

5-Reapeat the titration a twice time until you gets approximate results. Take the average of the results and subtract 0.05mL. (This result represents the volume of extra drop which change the color of indicator.

6- Make a table as bellow: -

Sq		First titration	Second titration	Third titration	Average of titrations
1	Titration with ph.ph	V1	V1	V1	V1 (av.)
2	Titration with M.O	V2	V2	V2	V2 (av.)

$$\mathbf{V1(av.)} = \frac{V1+V1+V1}{3}$$

V1(av.) =1/2 $CO_3^=$
V2(av.) = 1/2 $CO_3^=$
V1+V2 = $V_{tot.}$ of Na_2CO_3

$$\mathbf{N_{acid} \times V_{(tot.)\ acid\ (from\ burette)} = N_{base} \times V_{base}}$$

7- The equation of reaction :

$$Na_2CO_3 + HCl \xrightarrow{ph.ph} NaHCO_3 + NaCl$$
Pink → colorless

$$NaHCO_3 + HCl \xrightarrow{M.O} H_2CO_3 + NaCl$$
Yellow → pale orange