

Acidimetry and Alkalimetry

Demand of Alkalimetry

DATE
PAGE NO.

1

Equivalent weight :-

The Equivalent weight of an atom of an element is defined as the number of parts by weight of that element which can combine or displace directly or indirectly 1.008 parts by weight of hydrogen or 8 parts by weight of oxygen or 35.5 parts by weight of chlorine.

$$\text{Equivalent weight (E)} = \frac{\text{Atomic weight (A)}}{\text{Valency (V)}}$$

Equivalent weight of acid and base:

$$\text{Equivalent weight of acid} = \frac{\text{molecular weight}}{\text{basicity}}$$

$$\text{Equivalent weight of base} = \frac{\text{molecular weight}}{\text{acidity}}$$

- # The no. of replaceable H^+ ion are called acid basicity.
- # The no. of replaceable OH^- ion are called acidity.



HCl ionized to give one H^+ so, it is mono basic acid (basicity 1)

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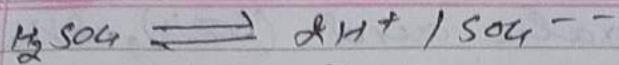


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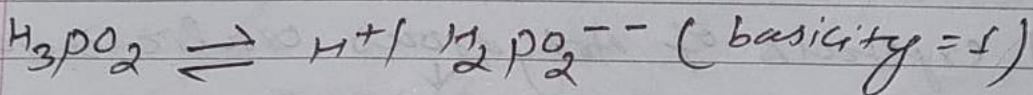
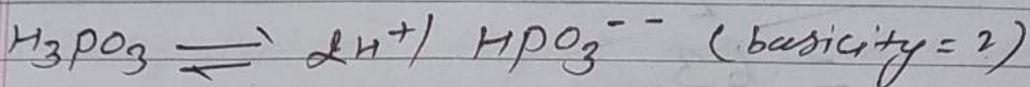
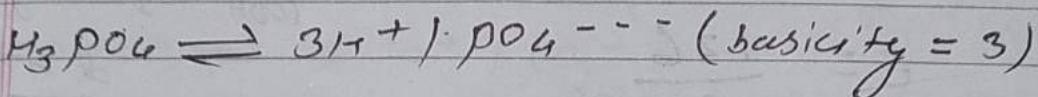
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2 Demand

DATE / /
PAGE No. / /



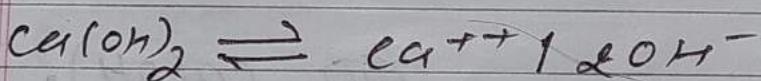
H_2SO_4 ionized to give two H^+ ion. so, it is dibasic acid. (basicity = 2)



e.g:-



NaOH ionized to give one OH^- ion. so, it is mono acidic base (acidity = 1)



$\text{Ca}(\text{OH})_2$ ionized to give two OH^- ion. so, it is di-acidic base (acidity = 2)

Example of Equivalent weight :-

e.g (1)

HCl

$$E = \frac{\text{mol. weight}}{\text{basicity}}$$



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$$\frac{36.5}{1} = 36.5$$

(ii) H_2SO_4

$$E = \frac{\text{mol. wt}}{\text{basicity}}$$

$$= \frac{98}{2} = 49.$$

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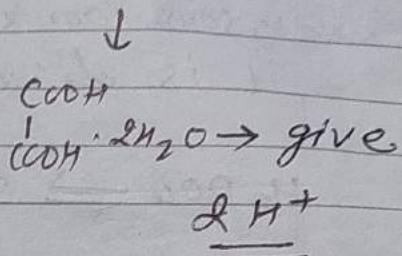
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DATE / /
PAGE No.

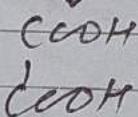
(i) crystals of oxalic acid $(COOH)_2 \cdot 2H_2O$.

$$E = \frac{\text{mol. wt}}{\text{basicity}}$$

$$E = \frac{126}{2} \\ = 63$$



(ii) crystals of dehydrated oxalic acid



$$E = \frac{\text{mol. wt}}{\text{basicity}} = \frac{90}{2} = 45.$$

Base:

(i) NaOH

$$E = \frac{\text{mol. wt}}{\text{basicity}} \\ = \frac{40}{1} \\ = 1.$$

(ii) $Ca(OH)_2$

$$E = \frac{\text{mol. wt}}{\text{acidity}} \\ = \frac{74}{2} \\ = 37$$

(iii) CaO (diacidic)

$$E = \frac{56}{2}$$



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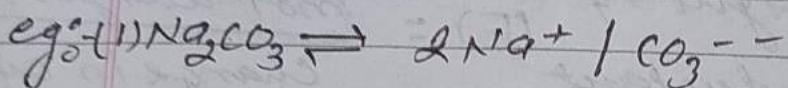
Demand

4

Equivalent weight of simple salt =

DATE / /
PAGE No.

Eq.wt. of simple salt = $\frac{\text{molar wt. of salt}}{\text{total positive or negative charge.}}$



Na_2CO_3 ionized to give two positive and two negative charge. So, Equivalent weight

$$E = \frac{\text{molar wt.}}{2}$$

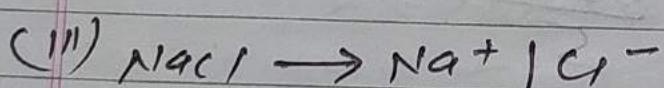
$$= \frac{106}{2}$$

$$= 53$$



$$E = \frac{100}{2}$$

$$= 50.$$

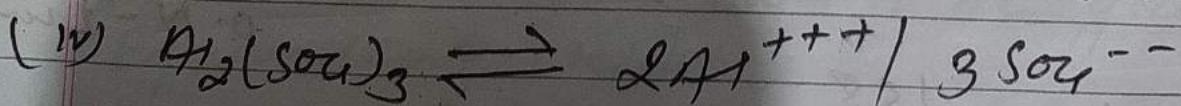


$$E = \frac{58.5}{1}$$

$$= 58.5$$

+ve \rightarrow ⑥

-ve \rightarrow ⑥



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$$\frac{27}{6} = 57.$$

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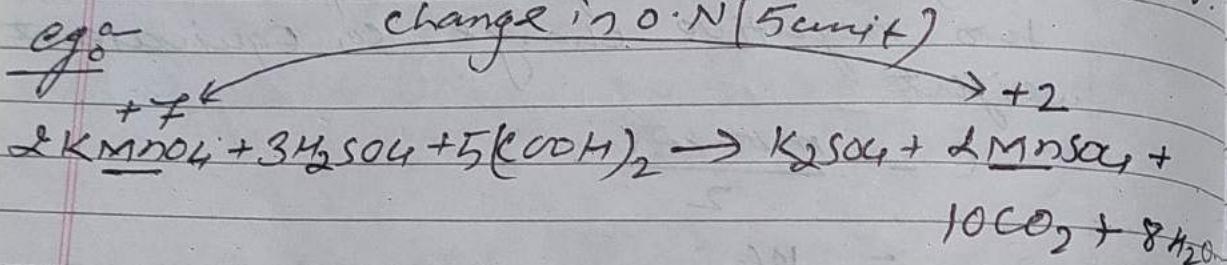
Demand

5

DATE _____
PAGE No. _____

Equivalent weight of oxidizing and reducing agent. (oxidant and reductant)

Equivalent weight of oxidant or reductant (E) = $\frac{\text{mol. weight}}{\text{change in oxidation number}}$



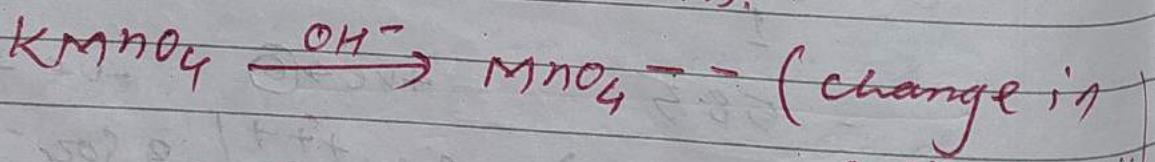
$$E \text{ of } \text{KMnO}_4 = \frac{\text{mol. wt.}}{\text{charge in O.N}}$$

$$= \frac{39(\text{K}) + 55(\text{Mn}) + 16(\text{O}) \times 4}{5}$$

$$= \frac{158}{5}$$

$$= 31.6$$

KMnO₄ in basic medium.



$$E = \frac{158}{1} = 158$$

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eg:-



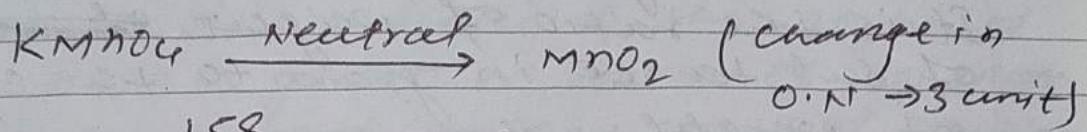
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6 F

DATE _____
PAGE No. _____

KMnO₄ in neutral medium:



$$E = \frac{158}{3} = 52.6.$$

Equivalent weight of reducing agent.

Mohr's salt, oxalic acid, FeSO₄, H₂O₂ etc are reducing agent.

eg:- Mohr's salt: FeSO₄(NH₄)₂SO₄.6H₂O.

mol. weight = 392

oxidation no. change = 1

$$E = \frac{\text{mol. wt}}{\text{change in O.N}}$$

$$= \frac{392}{1}$$

$$= 392.$$

Gram Equivalent weight:-

If Equivalent weight is expressed in gram, then it is said to be gram Equivalent weight.

eg:- 1-gram eq. of hydrogen = 1.008 g.

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Signature

Demand

DATE / /
PAGE No.

7

Number of gram Equivalent :-

It is the ratio of weight of ~~one~~ substance in gram to one equivalent weight.

$$\text{No. of gram Equivalent} = \frac{\text{weight of substance in gram}}{\text{Equivalent weight}}$$

for example:-

$$20 \text{ gm of NaOH contains } \frac{20}{40} = 0.5 \text{ gram}$$

Equivalent of
NaOH.

② Concentration or Strength of solution:

It measures quantity of solute present in given volume of solution.

③ gram per litre (g/l):-

gram per litre of a solution is defined as the weight of solute in gram present in one litre of solution.

$$\text{Gram/litre} = \frac{\text{weight of solute in gram}}{\text{Vol. of solution in litre}}$$

$$= \frac{\text{weight of solute in gram}}{\text{Vol. of solution in ml}} \times 1000$$

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(b) percentage solution :-

% solution is defined as the weight of solute in gram or volume of solute in ml present in either 100ml of solution or 100 gm of solution.

$$\% \text{ solution} \left(\frac{w}{W} \right) = \frac{\text{wt. of solute in gram}}{\text{vol. of soln in gram}} \times 100\%$$

$$\% \text{ solution} \left(\frac{v}{V} \right) = \frac{\text{weight of solute in ml}}{\text{vol. of soln in ml}} \times 100\%$$

$$\% \text{ solution} \left(\frac{w}{V} \right) = \frac{\text{weight of solute in gram}}{\text{vol. of solution in ml}}$$

(c) Normality :-

Normality of a solution is defined as the number of gram - equivalent of solute present in one litre of a solution.

It is denoted by N. It can be change with temp, as it depends upon the volume of solution.

$$\text{Normality} = \frac{\text{no. of gram equivalent of solute}}{\text{vol. of soln. in litre}}$$

$$(\text{No. of gram Eq.} = \frac{\text{wt of solute}}{\text{Eq. weight}})$$

$$\text{Normality} = \frac{\text{wt. of solute}}{\text{Eq. wt} \times \text{vol. of soln in litre}} \quad \text{in g/l}$$



Demand
ON BOARD

9

DATE _____
PAGE No. _____

$$\text{Normality} = \frac{\text{gram/litre}}{\text{Eq. weight}}$$

$$\boxed{\text{Normality} \times \text{Eq. weight} = \text{gram/litre}}$$

Normal solution: (1N)

The solution in which one gram-equivalence of solute present in one litre of solution.

e.g.: - 1N solution of HCl means 36.5 gm (1-gram equivalent) of it present in one litre of solution.

Semi-normal solution: (1/2N or 0.5N)

The solution in which half-gram equivalence of solute present in one litre of solution.

e.g.: - 0.5N NaOH solution means 20 gm (half gram equivalence) of it present in one litre of solution.

Deci-normal solution ($\frac{1}{10}$ N or 0.1N)

The solution in which one tenth gram equivalent of solute present in one litre of soln. e.g.: - $\frac{1}{10}$ N NaOH solution contain 4 gm in one litre of NaOH soln.

Signature



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Demand # Molarity (M) :-

10

DATE / /
PAGE No.

Molarity of a solution is defined as the number of gram moles of solute present in one litre of a solution. It is denoted by M. It decrease with temp., as it depends upon volume of solution.

$$\text{molarity} = \frac{\text{number of gram moles of solute}}{\text{vol. of solution in litre}}$$

$$(\text{no. of moles} = \frac{\text{weight of solute}}{\text{molecular weight}})$$

$$\text{molarity} = \frac{\text{weight of solute in gram}}{\text{molecular weight} \times \text{vol. of soln in litre}}$$

$$\text{molarity} = \text{gram/litre} \times \frac{1}{\text{molecular wt.}}$$

$$\text{gram/litre} = \text{molarity} \times \text{molecular wt.}$$

Molar solution: If one litre of solution contains one gram mole of a solute

e.g. - 1M H_2SO_4 means 98 gm H_2SO_4 present in one litre of solution.

Decimolar:- e.g. - $\frac{M}{10}$ H_2SO_4 means 9.8 gm of H_2SO_4 present in 1 litre of solution.

Signature



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Demand

DATE / /
PAGE NO. / /

Molarity (m) :-

11
molarity of a solution is defined as the number of gram moles of solute present in 1000 g (1 kg) of solvent.

$$\text{Molarity (m)} = \frac{\text{no. of gram moles of solute}}{\text{weight of solvent in kg}}$$
$$= \frac{\text{no. of grams of moles of solute}}{\text{wt. of solvent in gram}} \times 1000$$

Mole Fraction:

mole fraction of a solution is defined as the ratio of number of moles of either solute or solvent to the total number of moles of solute and solvent present in solution.

It depends on weight.

$$\text{mole fraction of solute} = \frac{n}{n+N}$$

$$\text{mole fraction of solvent} = \frac{N}{n+N}$$

where,

n = no. of moles of solute.

N = no. of moles of solvent

$n+N$ = no. of moles of solute and solvent.

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The sum of mole fraction is always unity.

$$\frac{n}{n+N} + \frac{N}{n+N} = \frac{n+N}{n+N} = 1$$

formality (F) :-

Formality of a solution is defined as the solution in which number of gram formula weight of solute present in one litre of a solution.

$$\text{Formality (F)} = \frac{\text{no. of gram formula weight}}{\text{Vol. of soln in litre}}$$

Formality is used for expressing concentration of ionic solid which doesn't exist in molecule.

Relation between Normality and Molarity:-

Normality :-

$$\text{gram/litre} = \text{Normality} \times \text{Eq. wt.} \quad \text{--- (i)}$$

$$\text{gram/litre} = \text{Molarity} \times \text{mol. wt.} \quad \text{--- (ii)}$$

from eqn (i) and (ii)

$$\text{Normality} \times \text{Eq. wt} = \text{molarity} \times \text{mol. wt.}$$

Demand

13.

DATE _____
PAGE No. _____

But,

$$\text{Equivalent wt} = \frac{\text{mol. wt}}{\text{basicity or acidity}}$$

$$\text{mol. weight} = \text{Equivalent weight} \times \text{basicity or acidity.}$$

(iv)

from eqn (ii) and (iv)

$$\text{Normality} \times \text{eq/wt} = \text{molarity} \times \text{eq.wt} \times \text{basicity or acidity.}$$

$$\boxed{\text{Normality} = \text{molarity} \times \text{acidity or basicity}}$$

For simple salt:-

$$\boxed{\text{Normality} = \text{molarity} \times \text{no. of } +ve \text{ or } -ve \text{ charge.}}$$

For oxidizing and reducing salt:-

$$\boxed{\text{Normality} = \text{molarity} \times \text{change in oxidation number.}}$$

Signature



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Demand
special formula's

21 14

DATE _____
PAGE No. _____

(i) $\% = \text{gram/litre} / 10$

(ii) $\text{gram/litre} = N \times \text{Eq. wt.}$

$$\% \times 10 = N \times \text{Eq. wt}$$

$$N = \frac{\% \times 10}{\text{Eq. wt.}}$$

(iii) Molarity

$$M = \frac{\% \times 10}{\text{mol. wt.}}$$

(iv) Relation with density :-

$$N = \frac{\% \times 10 \times \text{specific gravity (density)}}{\text{Eq. wt.}}$$

$$M = \frac{\% \times 10 \times \text{specific gravity}}{\text{molecular weight}}$$

(v) $W = \frac{V \times N}{1000}$

(vi) $W = \frac{V \times \text{Mol. wt.} \times M}{1000}$

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□ principle of volumetric analysis :-

(i) Equal volume of one solution neutralized with equal volume of another solution when their concentration is same.

e.g:-

$$1 \text{ ml of } 1N \text{ HCl} = 1 \text{ ml of } 1N \text{ NaOH}$$

$$10 \text{ ml of } 1N \text{ KMnO}_4 = 10 \text{ ml of } 1N \text{ oxalic acid}$$

$$1000 \text{ ml of } 1N \text{ NaOH} = 1000 \text{ ml of } 1N \text{ } \text{H}_2\text{SO}_4$$

(ii) Equivalent volume and normality for same solution are reciprocal to each other.

e.g:-

$$100 \text{ ml of } 1N \text{ HCl} = 10 \text{ ml of } 10N \text{ HCl}$$

$$= 1000 \text{ ml of } 0.1N \text{ HCl}$$

$$= 3 \text{ ml of } 100N \text{ HCl}$$

So, amt of $b N \text{ } \text{H}_2\text{SO}_4 = (a \times b) \text{ ml of } 1N \text{ solution}$.

3) when acid neutralized by base then it follows the following relation.

$$V_1 N_1 = V_2 N_2$$

where,

V_1 = vol. of acid

N_1 = normality of acid

V_2 = vol. of base

N_2 = normality of base

This eqn is called law of chemical equivalence or normality equation.

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Demand

IC 41

DATE		
PAGE No.		

Derivation of Normality Equations:-

From law of chemical equivalence,
No. of gram equivalence of acid = No. of gram equivalence of base - ①

gram/litre = Normality × Equivalent weight

$$N \times \text{Eq. wt} = \frac{\text{wt in gram}}{\text{vol. of soln in litre}}$$

$$N \times \text{vol. of soln in litre} = \frac{\text{wt in gram}}{\text{Eq. wt}}$$

(since, no. of gram equivalence = $\frac{\text{wt in gram}}{\text{eq. wt}}$)

$N \times \text{vol. of soln in litre} = \text{no. of gram equivalence}$. (1)

from ① and ②

$\text{vol. of soln in litre} \times \text{normality of acid} = \text{vol. of soln in litre} \times \text{normality of base}$.

$$N_A \times V_A = N_B \times V_B$$

$$S_1 V_1 = S_2 V_2$$

$S_1 = N_A$ = normality of acid

$S_2 = N_B$ = normality of base

$V_A = V_1$ = vol. of acid

$V_B = V_2$ = vol. of base

Signature



REDMI NOTE 8
AI QUAD CAMERA

Demand

17

DATE

PAGE No.

Normality factor (f) :-

Normality factor is defined as the ratio of weight taken and weight to be taken. It is denoted by f .

$$\text{Normality factor } (f) = \frac{\text{weight taken}}{\text{weight to be taken}}$$

The actual normality of prepared solution is the product of normality factor and given normality.

$$\text{Actual normality} = \text{given normality} \times f$$

e.g.-

To prepare $\frac{N}{10}$ oxalic acid solution in 250 ml we have to take 1.325 g. But if we take 1.320 g. Then strength may be varied.

$$F = \frac{\text{wt. taken}}{\text{wt to be taken}}$$

$$f = \frac{1.320}{1.325}$$

$$= 0.996$$

$$W = \frac{V \cdot N}{1000}$$

$$\text{Actual Strength} = f \times \text{Normality}$$

$$= 0.996 \times 0.1 N$$

$$= 0.0996 N$$

Signature



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Demand # CHEMICAL ANALYSIS

18

DATE / /
PAGE No.

(1) Qualitative analysis:-

It involve the detection or identification of the constituents of chemical compound as radical.

(2) Quantitative analysis:-

It involve the accurate estimation of particular constituents present in given compound.

Quantitative analysis:-

(1) Gravimetric analysis:- In gravimetric analysis, the amount of constituents present in solution is determined by precipitating the species from the soln. and taking the weight of precipitate.

Volumetric analysis:-

"The process of determination of concentration of unknown solution by finding the exact volume of it required to neutralized with known volume of another solution having known concentration in the presence of suitable indicator is called volumetric analysis and process from which this analysis is done is called titration or titrimetric method."



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The process of determination of concentration of unknown solution by gradual addition of one solution to another solution by determining the end point is called titration.

Acid-base titration

Acidimetry:-

The process of determination of the strength of acid by finding the exact volume of it, by neutralizing it with known volume of standard alkali solution in the presence of suitable indicator is known as acidimetry.

Alkalimetry:-

The process of determining the strength of alkali by finding exact volume of it, by neutralizing it with known volume of standard acid solution in the presence of suitable indicator is known as alkalimetry.

Redox titration (oxidation-reduction titration):-

The titration in which oxidation and reduction occur is called redox titration. In such a titration, one species loses electron and another gains the electron. Therefore, there is change in colour of the chemical

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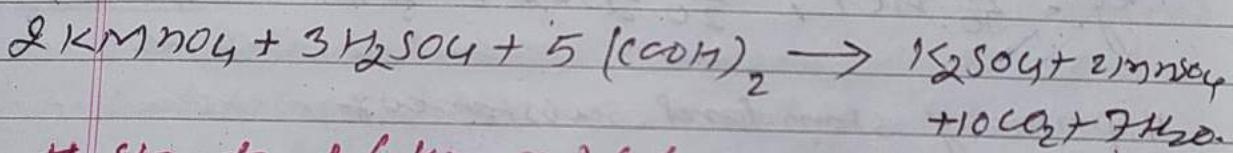
20

DATE

PAGE No.

species at the end point. In redox reaction chemical species itself indicates the end point are called self indicators.

e.g:- The titration between acidified KMnO_4 solution and oxalic acid solution is redox titration in which KMnO_4 acts as self indicator. At end point colour of KMnO_4 get persist.



Standard (Known) solution:-

The solution having known concentration is called standard solution.

(i) primary standard solution:- The solution prepared by dissolving suitable weight of the primary standard substance in solvent and making definite volume is called primary standard solution.

e.g:- $\frac{N}{10}$ oxalic acid solution.

$\frac{N}{5}$ mohr's salt.

$\frac{N}{20}$ Na_2CO_3 solution.

Demand

21

DATE: / /
PAGE No.:

(ii) secondary standard solution:-

The solution

which act as a standard solution only when its concentration known with the help of another standard solution is called secondary standard solution.

This process of knowing the concentration of unknown solution with the help of primary standard solution is called standardization.

e.g.: $\frac{N}{10}$ HCl, $\frac{N}{20}$ NaOH, $\frac{N}{5}$ KMnO₄, etc.

primary standard substance:-

The chemical substance whose exact amount can be taken in order to prepare the primary standard solution is called primary standard substance.

The requisites of primary standard substance is:

i) It should be pure found in pure and dry state.

ii) It should not be hygroscopic and deliquescent.

iii) It should have high equivalent weight.

iv) Concentration of solutes should not be altered after a storage of long period.

Signature



REDMI NOTE 8

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22

Demand

DATE / /
PAGE No.

Secondary standard substance:-

The chemical substances which have not above all characteristics are called secondary standard substance.

Different terms involve in Titration:-

Titrant:- The solution which is taken in burette is called titrant or the soln whose concentration is known is called titrant.

Titrand:- The solution which is to be titrated or the solution which contains the substance to be estimated is called titrand or titrate.

End point:- End point is that point at which completion of the reaction is shown by the indicator by changing its colour. It is also called neutralization point.

Equivalent point:- Equivalent point is the theoretical end point at which the number of gram equivalent of one substance is equal to number of gram equivalent of another substance.

Titration error:- The difference between end point and Equivalent point is called titration error.



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Indicators:-

Indicators are the chemical substances that indicate the completion of the chemical reaction by changing their own colour at the end point.

Types of indicators:-

(i) Internal indicators:- The indicators which is used in the reaction mixture is known as internal indicators.

e.g.: methyl orange, phenolphthalein, etc.

Some

 sol
mer
mer
phen
litm

P

(ii) Self-indicators:- When one of the reactants can itself act as indicator, then it is known as self indicator. e.g.: KMnO_4 .

(iii) External indicators:- These are not added in reaction mixture but are used externally. For e.g.: $\text{K}_3[\text{Fe}(\text{CN})_6]$ act as external indicator in the titration of FeSO_4 with K_2CrO_4 .

Characteristics of good indicators:-

- (i) It should have narrow working pH range.
- (ii) The colour change should be sharp and stable.
- (iii) Small drops of indicator should have capacity to signal end point.

Signature



REDMI NOTE 8

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Demand

242

DATE _____
PAGE No. _____

Some common indicators and pH ranges-

Indicators	Colour in acidic medium	Colour in basic medium	pH range
methyl orange	Red	Yellow	3.1 - 4.4
methyl red	Red	Yellow	4.2 - 6.3
phenolphthalein	Colourless	Pink	8.2 - 10.
Litmus paper	Red	Blue	5.5 - 8.

pH-curve and selection of indicators in acid base titration:-

In acid base titration, if alkali is taken in burette and acid is taken in conical flask, then the pH of the resulting solution is gradually increased while adding alkali in acid. If the pH of the resulting solution is plotted against the volume of alkali added, then the plots obtained are called pH-curve or titration curves. The nature of pH curve or sharpness in the pH curves help to select the suitable indicator.



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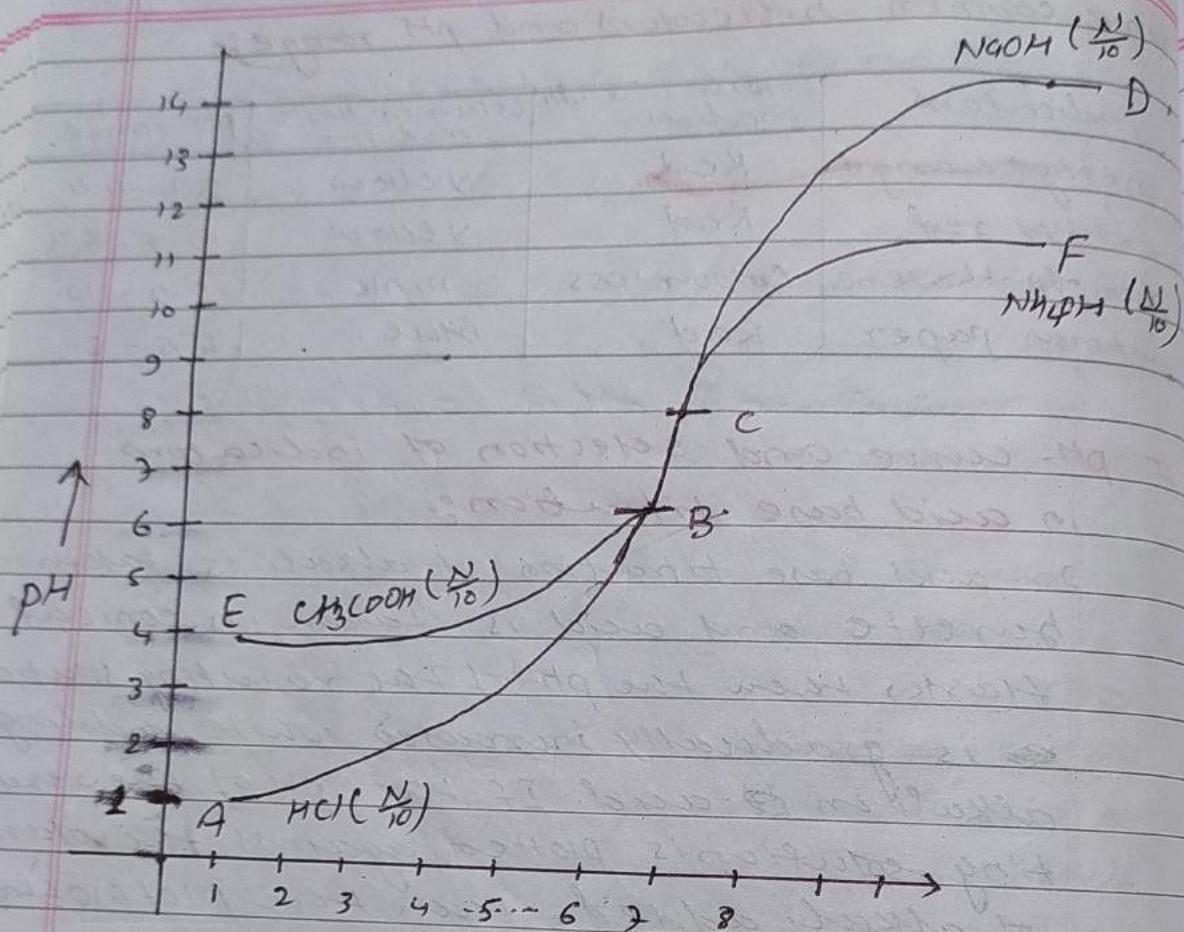
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AI QUAD CAMERA

Demand

25 + 5

DATE / /
PAGE No. 10



Vol. of alkali added →

fig:- Titration curves or pH-curves.

(i) Titration between strong acid and strong base:-
when strong acid is titrated against strong
base , the nature of pH curve like ABCD
is obtain . There is sudden pH change
from 3 to 11. therefore indicators like
phenolphthalein having pH range ^{Signature} 8.2 - 10
methyl orange (3.1 - 4.4), litmus (5-8)



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can be used as suitable indicator.

(ii) Titration between weak acid and strong base:-

when weak acid is titrated against strong base the curve like EBCD is obtain. there is sudden change in pH from ~~8.2-10.~~ 6 to 11. therefore phenolphthalein (8.2-10) is only suitable indicator.

(iii) Titration between ~~weak~~^{strong} acid and weak base:-
when strong acid is titrated against weak base, then curve like ABCF is obtain. there is sudden change in pH from ~~3 to 8~~ from 3 to 8. therefore methyl orange (3.1 - 4.4) is suitable.

(iv) Titration between weak acid and weak base:

when weak acid is titrated against weak base the curve like EBCF is obtain.

~~there is sudden change in pH from~~

There is no sharpness in the curve and none of the indicator can be chosen. So, titration between weak acid and weak base is not carried out.

Demand **27**

molarity of mixture (for same solute)

DATE / /
PAGE No.

$$M_1V_1 + M_2V_2 + M_3V_3 = M_m V_m \quad \text{--- (1)}$$

normality of mixture:

$$V_1N_1 + V_2N_2 = V_m N_m \quad (\text{acid + acid mix})$$

$$V_1N_1 - V_2N_2 = V_m N_m \quad (\text{acid + base mix})$$

(acid - base)

$N_m = +ve$ (acidic)

$N_m = -ve$ (basic)

$N_m = 0$ (neutral)

ppm

$$\text{ppm} = \frac{\text{mass of solute in g}}{\text{mass of solution in g}} \times 10^6$$

ppb

$$\text{ppb} = \frac{\text{mass of solute (gm)}}{\text{mass of solvent (gm)}} \times 10^9$$

millimole (mmol)

$$\frac{1 \text{ mole}}{1000 \text{ mmol}} = 1 \text{ mmole}$$

Signature



REDMI NOTE 8

AI QUAD CAMERA