Analytical Chemistry Course For second year pharmacy Students

by:

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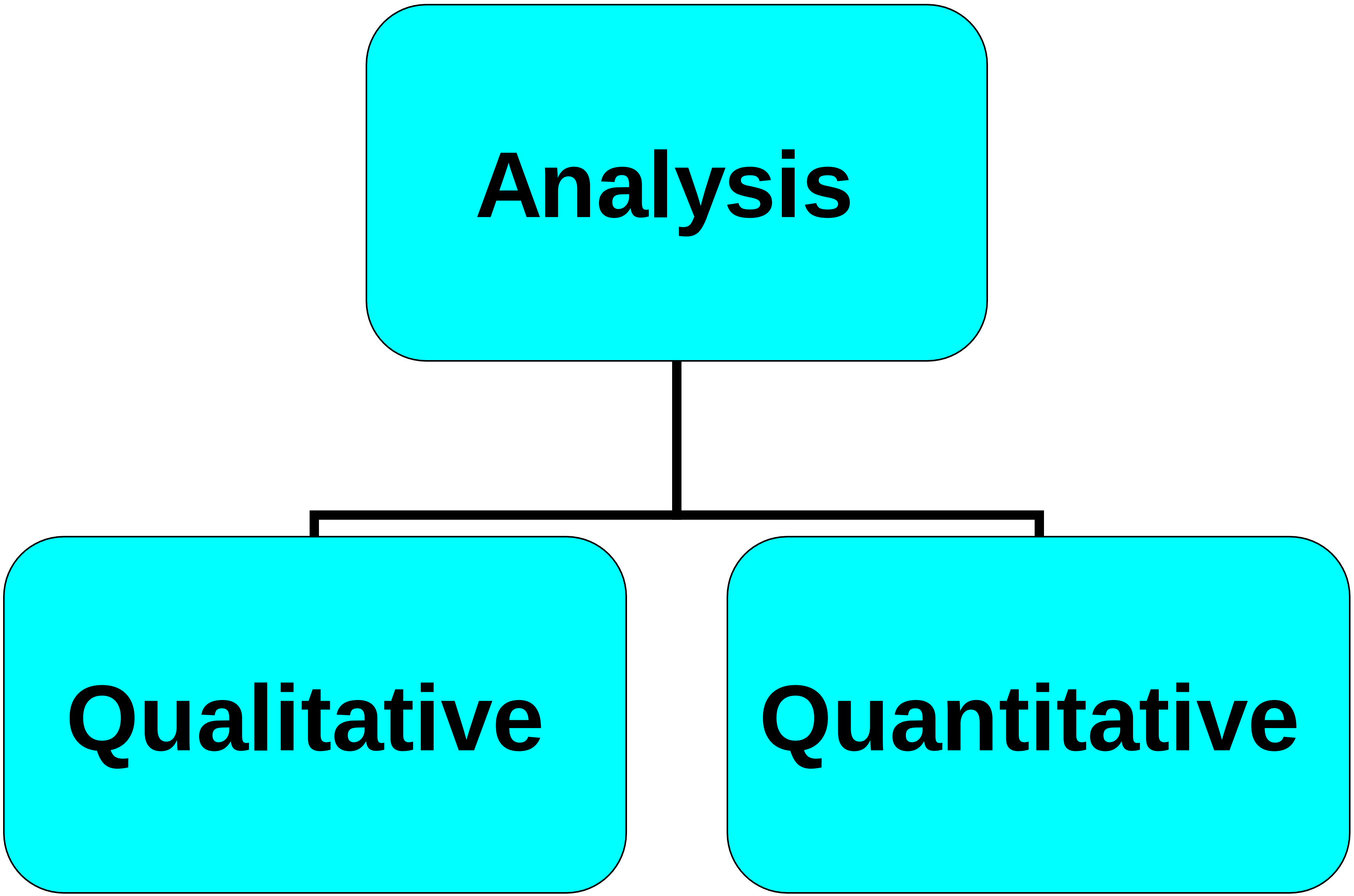
Analytical Chemistry

- The branch of chemistry that deals with the separation, identification and determination of components in a sample.


Analysis
Qualitative
Quantitative

Quantitative Analysis

❖ **Methods of analysis:-**

1-Traditional methods of analysis

- A- titrimetric(volumetric) analysis
- B- gravimetric analysis

2-Instrumental analysis

Ways to express concentration

Concentration may be

Molar

Normal

%

Molal

Formal

Molecular Weight

atom	H	C	O	Na	Cl	S
Atomic weight	1	12	16	23	35.5	32

Molecule	M.W
HCl	36.5
H_2SO_4	98
NaOH	40
Na_2CO_3	106
NaCl	58.5

Mole (gram-molecular weight)

- Molecular weight of the substance expressed in grams.

e.g. 1 mole of NaOH = 40 g

0.5 mole of NaOH = 20 g

2 moles of NaOH = 80 g

$$\textbf{No. of moles} = \frac{\textbf{Weight "gm"}}{\textbf{M.W}}$$

Equivalent Weight

Weight of the substance that will be chemically equivalent to one gram-atom of protons.

$$E.W = M.W / n$$

n

Acid

No. of replaceable H^+

Alkali

No. of OH groups

mole of HCl = 36.5 g

35.5 g Cl

1 g H

36.5 ≡ one gram-atom of protons

E.W of HCl = M.W/n = 36.5/1 = 36.5

mole of H_2SO_4 = 98 g → 96 g SO_4 ; 2 g H

98 ≡ 2 gram-atom of protons

49 ≡ 1 gram-atom of protons

E.W of H_2SO_4 = M.W/n = 98/2 = 49

$$H_2SO_4 + NaOH \longrightarrow NaHSO_4 + H_2O \quad n=1$$

$$E.W = 98/1 = 98$$

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O \quad n=2$$

$$E.W = 98/2 = 49$$

Acid	n
HCl	1
H_2SO_4	2
H_3PO_4	3

Alkali	n
NaOH	1
$Ca(OH)_2$	2
$Al(OH)_3$	3

Salt	n
NaCl	1*1
$MgSO_4$	1*2
$Fe_3(PO_4)_2$	3*2

Concentration may be

- Molar
- Normal
- %
- Molal
- Formal

Molar concentration

Solution which contains one gram-molecular weight of the substance in one liter of solution.

Molecule	M.W
HCl	36.5
H_2SO_4	98
NaOH	40
Na_2CO_3	106
NaCl	58.5

Molar concentration

$$\text{Molar concentration} = \frac{\text{No. of moles}}{\text{Volume “L”}}$$

$$\text{No. of moles} = \frac{\text{Weight “gm”}}{\text{M.W}}$$

$$M = \frac{\text{Weight “gm”}}{\text{M.W * volume “L”}}$$

Weight “gm” = M * M.W * volume “L”

Normal concentration

Solution which contains one gram-equivalent weight of the substance in one liter of solution.

Molecule	M.W /EW
HCl	36.5/ 36.5
H_2SO_4	98 / 49
NaOH	40 / 40
Na_2CO_3	106 / 53
NaCl	58.5 / 58.5

Normal concentration

$$\text{Normal concentration} = \frac{\text{No. of gm equivalents}}{\text{Volume “L”}}$$

$$\text{No. of gm equivalents} = \frac{\text{Weight “gm”}}{\text{E.W}}$$

$$N = \frac{\text{Weight “gm”}}{\text{E.W} * \text{volume “L”}}$$

Weight “gm” = N * E.W * volume “L”

Molarity & Normality

$$\text{Normal concentration} = \frac{\text{No. of gm equivalents}}{\text{Volume “L”}}$$

$$N = \frac{\text{Weight “gm”}}{E.W * \text{volume “L”}}$$

$$N = \frac{\text{Weight “gm”} * n}{MW * \text{volume “L”}}$$

N = M * n

Percentage %

=

gm in 100 ml

% concentration

$$\% \text{ conc.} = \frac{\text{weight (g)}}{\text{Volume (mL)}} \times 100$$

g % or % W / V

GLasswares

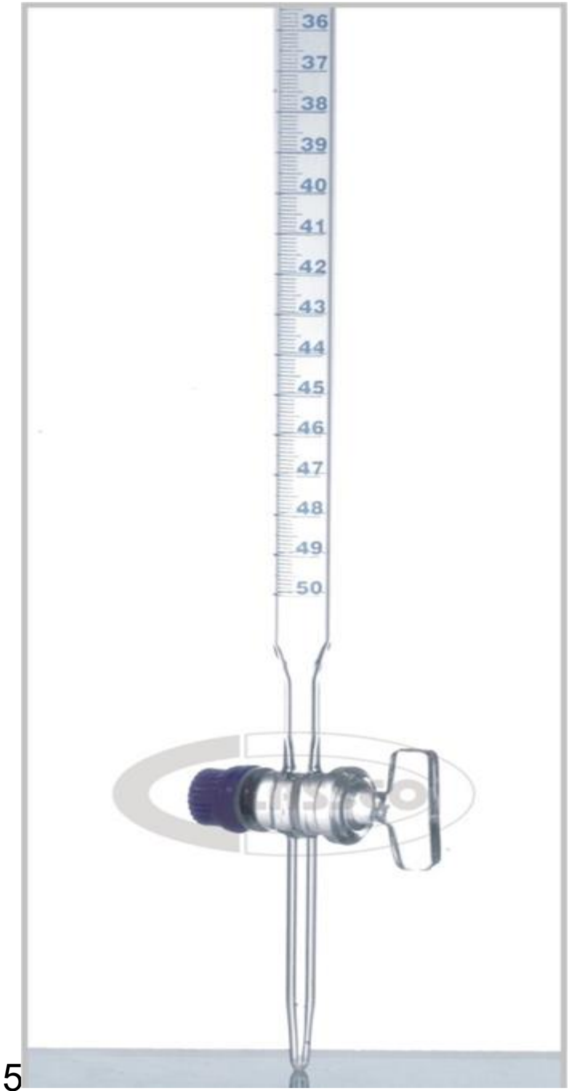
❖ Glasswares

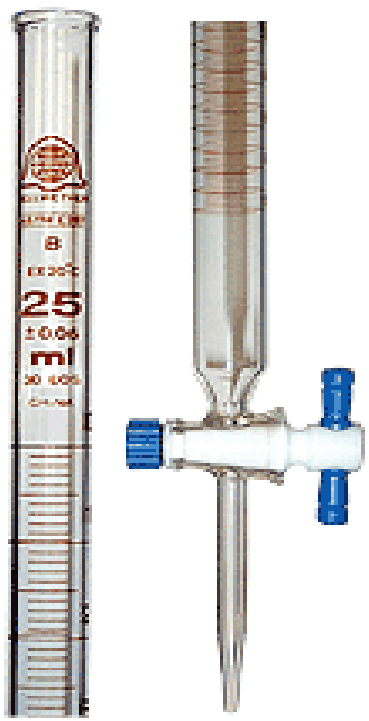
- **Volumetric glasswares**
- **Other glasswares**

Volumetric glasswares

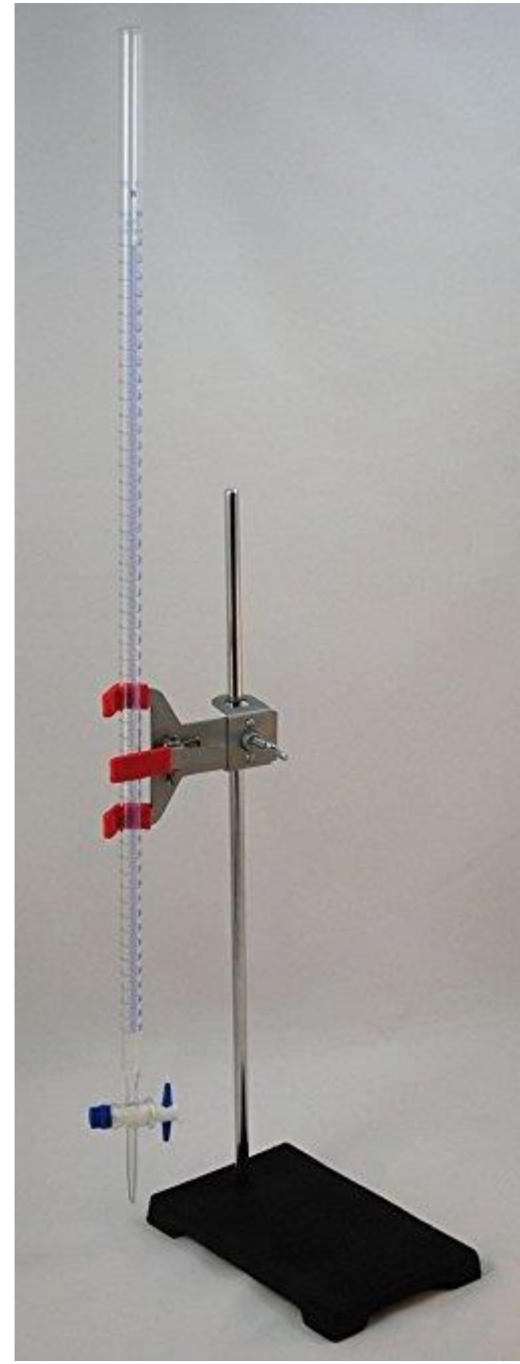
- 1-Burette
- 2-Pipette
- 3-Volumetric flask

1-Burette




25
ml


Ex
20°C
25
MC
ml
A
0
1
2



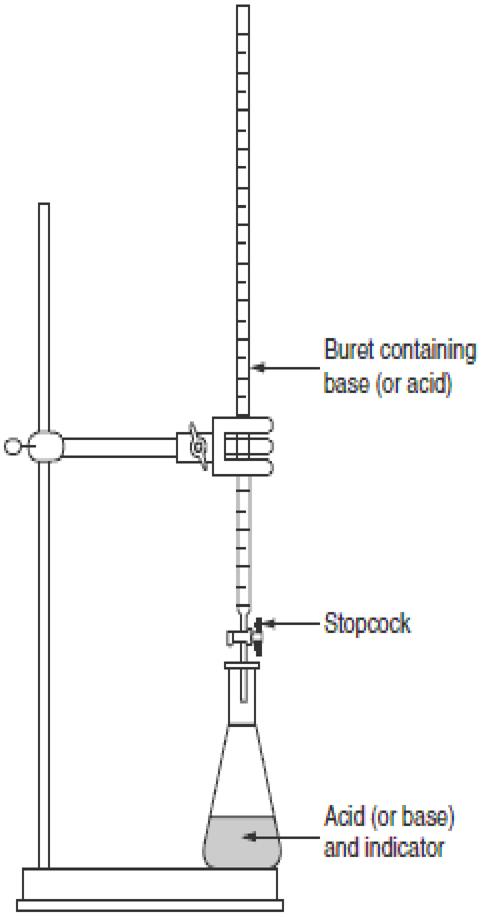
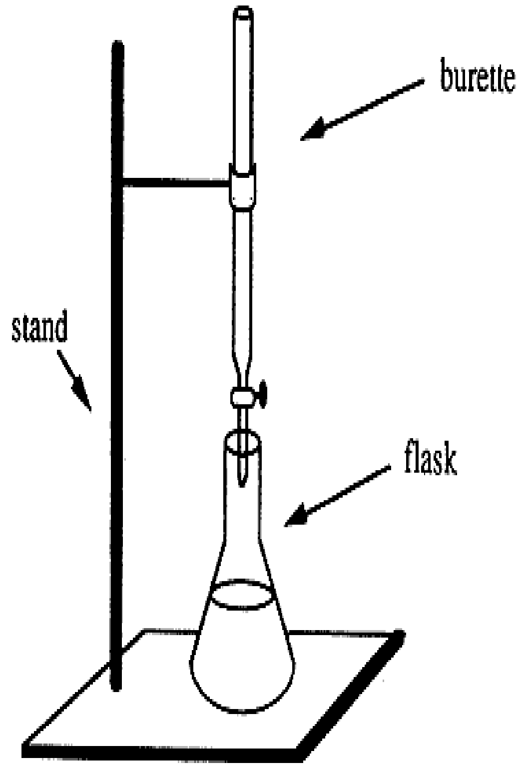
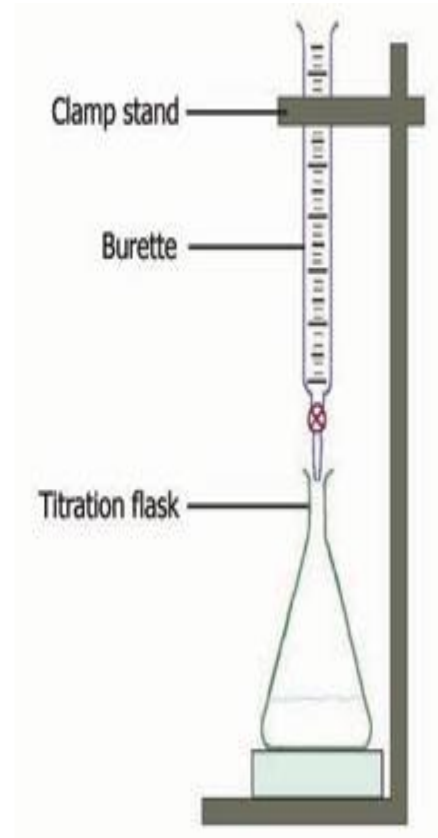
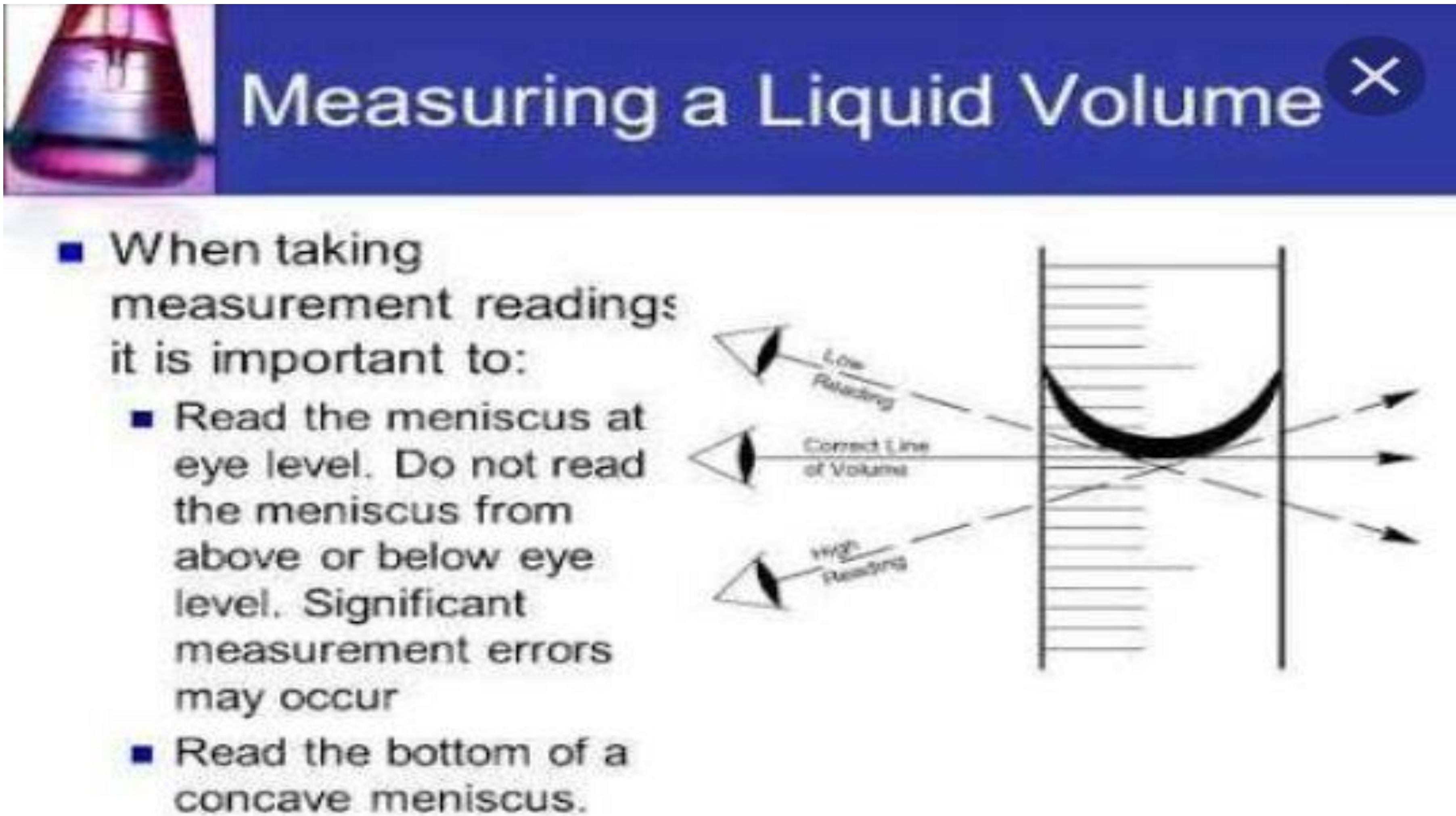


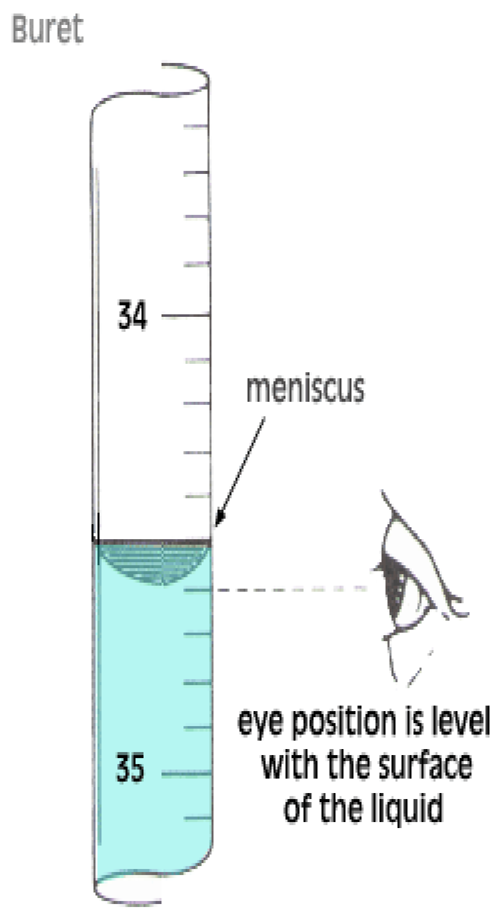
Figure 19.3 General acid–base titration set-up



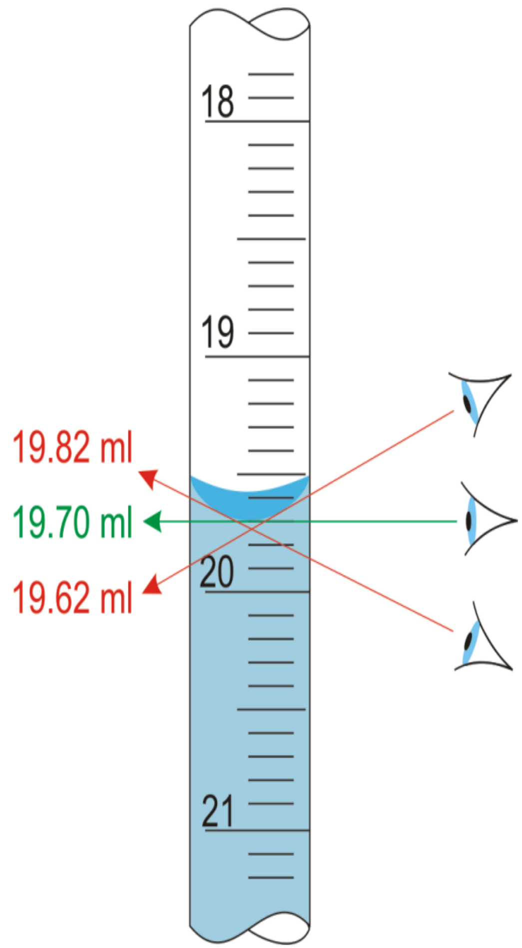


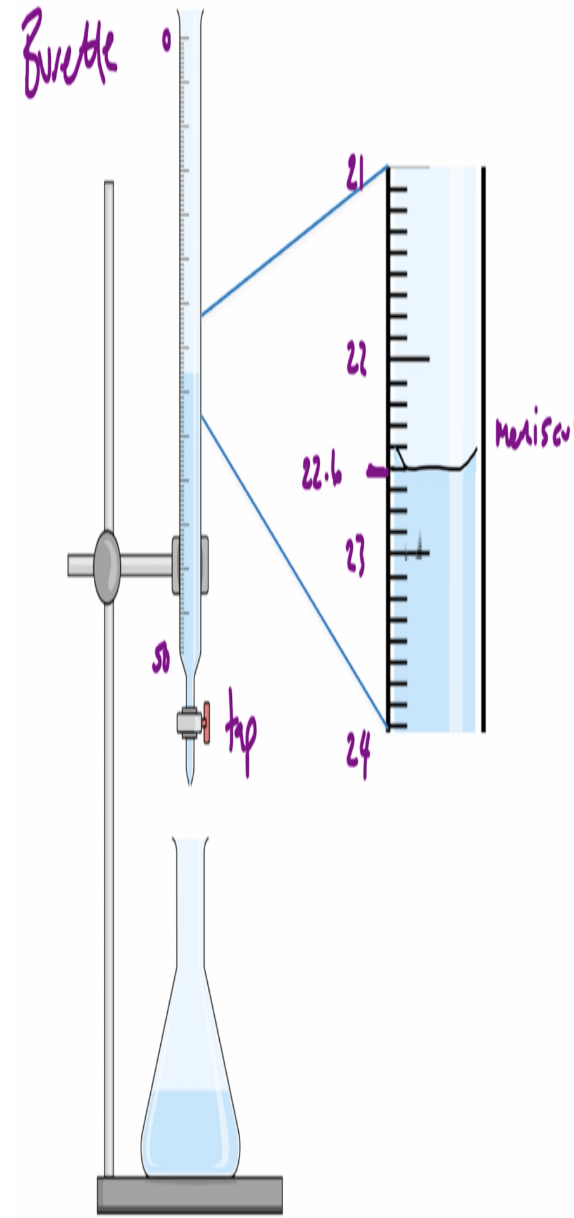
How to read burette?





(The unit of measurement is milliliter)





Pipette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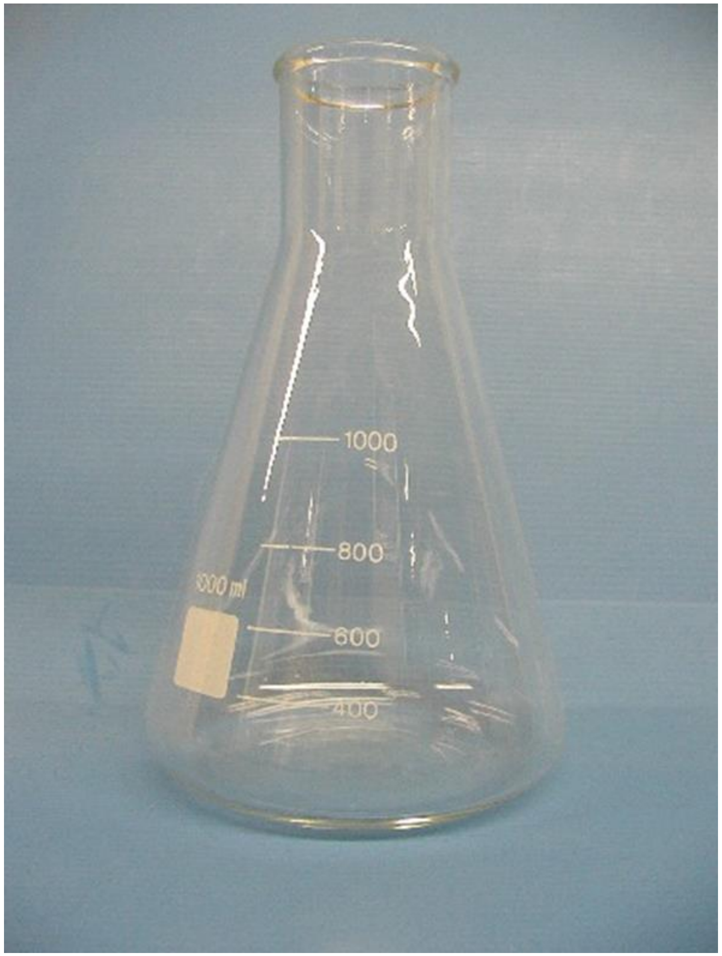
BioPette

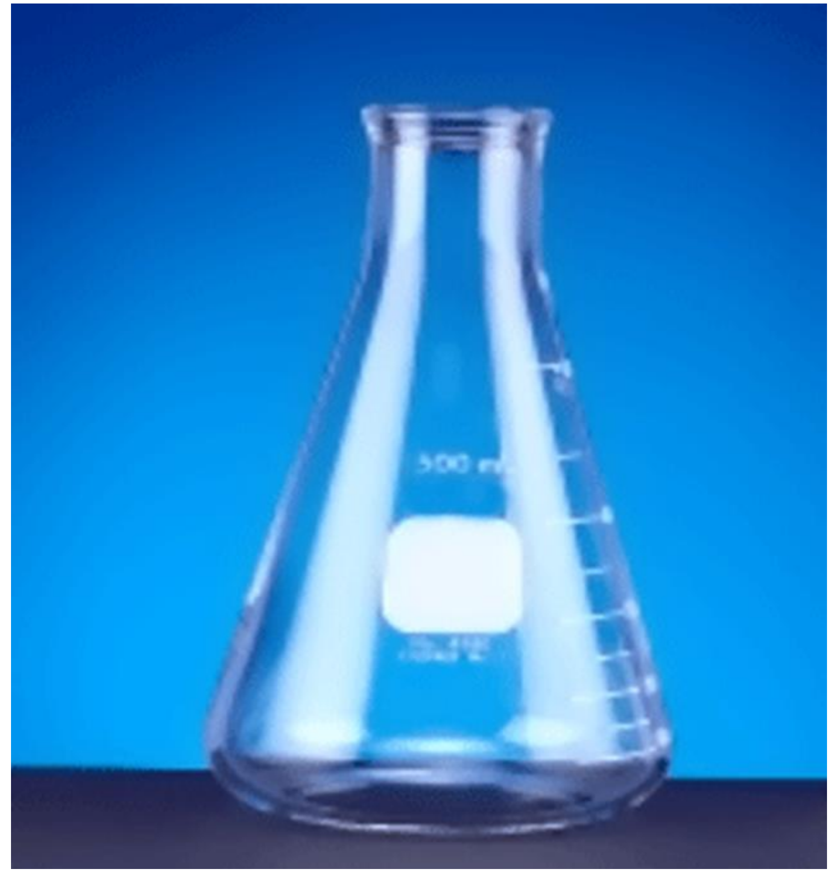
Volumetric flask

Other glasswares

- Conical Flasks
- Measure (cylinder)
- beaker

Conical flask

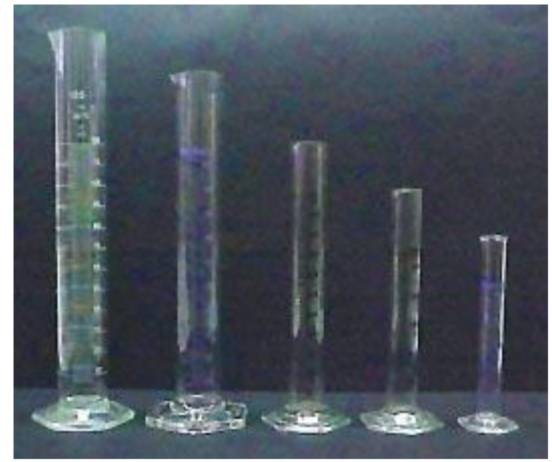




measure


1000:10ml
1000ml
900
800
700
600
500
400
300
200
100


Ex 20°C
50 ml
50
40
30
20
10
5




100
90
80
70
60
50
40
30
20
10

beaker

Quantitative Analysis

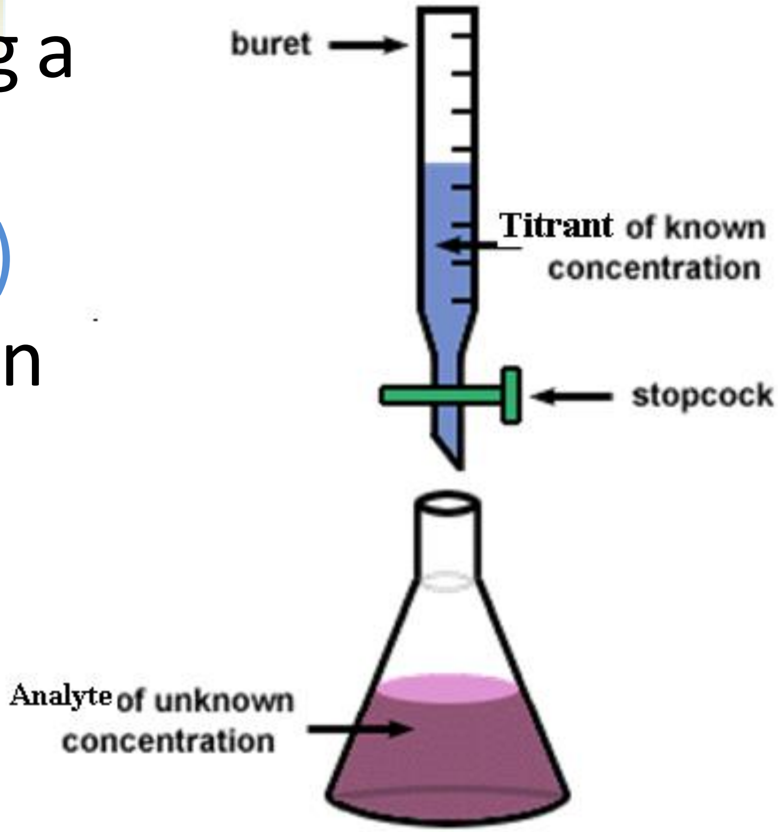
Volumetric / Titrimetric

Instrumental

Volumetric Analysis

Titration

It's the process of bringing a measured volume of standard solution (Titrant) into a quantitative reaction with the substance to be determined (analyte).



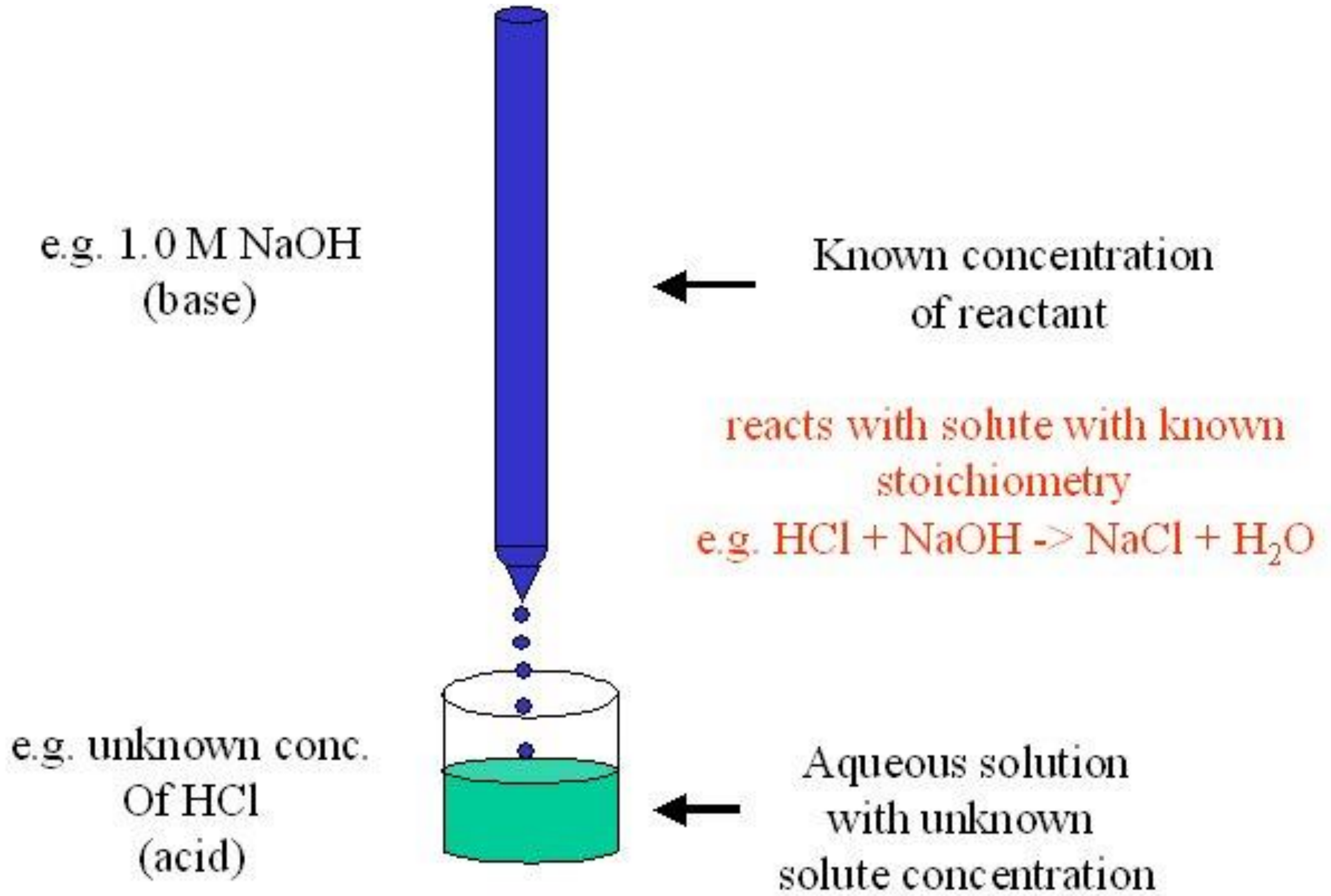
Standard Solution

Solution of accurately known concentration.

Types of titration

1. Acid-base (neutralization) titration.
2. Precipitation titration.
3. Complex formation titration.
4. Redox titration

$NaOH + HCl \longrightarrow NaCl + H_2O$



At E.P.

no of moles of titrant = no of moles of analyte

no of moles of NaOH = no of moles of HCl

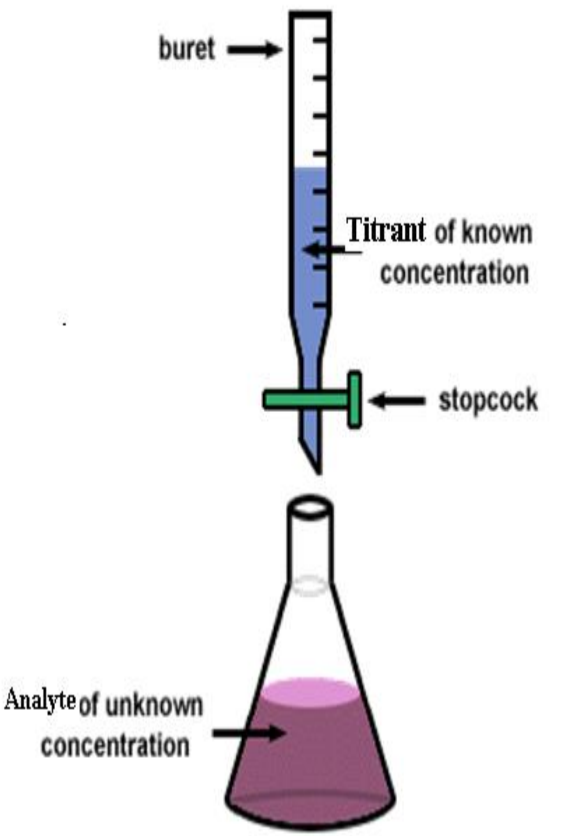
$$M \times V\ (NaOH) = M' \times V'\ (HCl)$$

$$M = \frac{\text{No of moles}}{V\ (L)}$$

$$N.V = N'.V'$$

Titre"Equivalence"

No. of milliliters of titrant equivalen to 1 gm of the sample



$$\text{Titre} = \frac{\text{E.W(sample)} \times \text{N. (titrant)}}{1000}$$

$$\% \text{ conc.} = \frac{\text{weight (g)}}{\text{Volume (mL)}} \times 100$$

$$\% \text{ conc.} = \frac{\text{E.P} \times \text{equivalence}}{\text{Volume taken (mL)}} \times 100$$

E.P is the volume of titrant equivalent to the sample

How can we recognize that a chemical reaction is completed?

Indicator

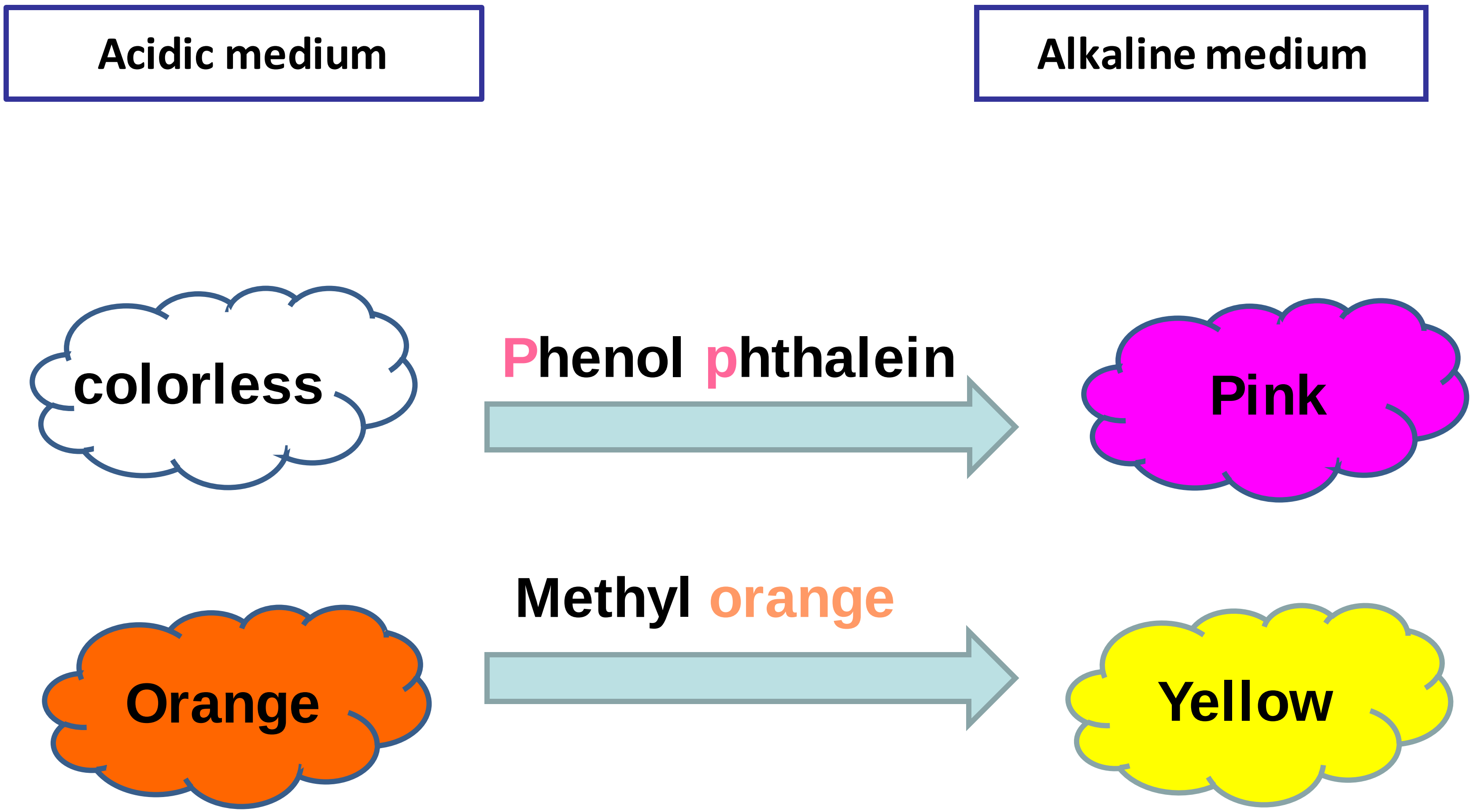
Substance (usually a dye) that change its color at the end point

In acid-base titration:

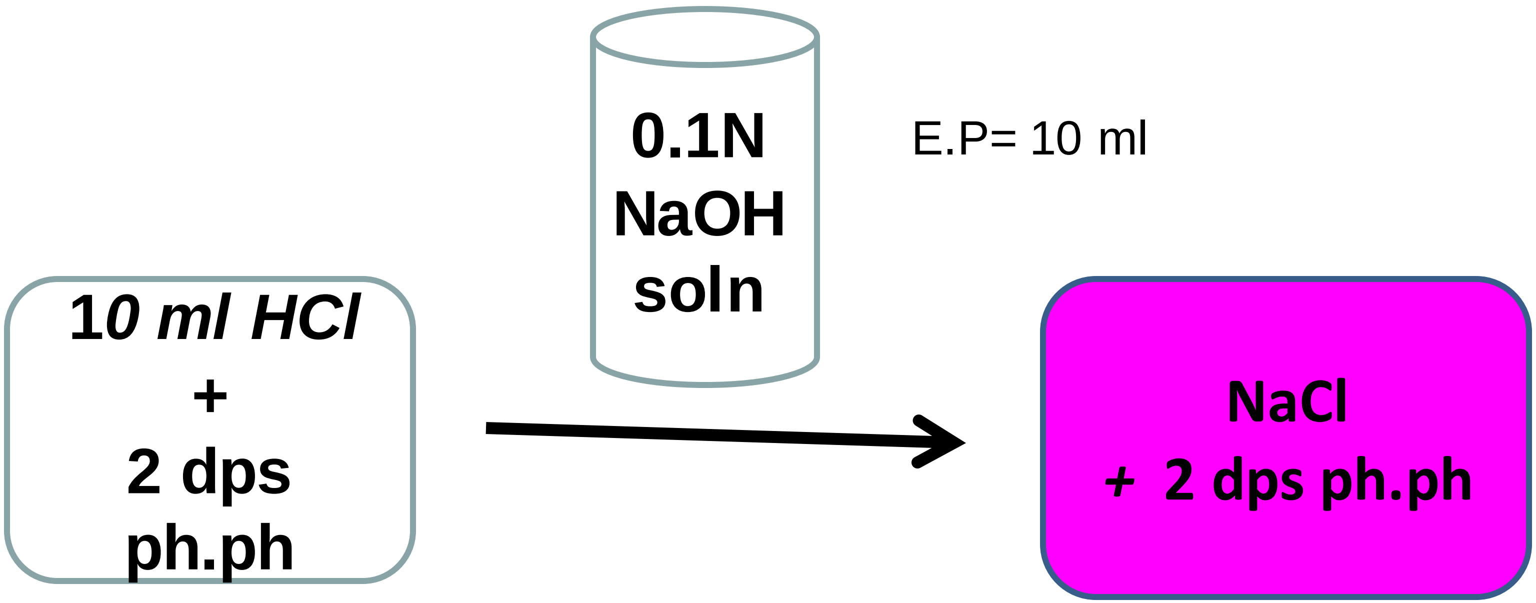
Substance which has two colors: one in acidic medium and other in alkaline medium.

(pH indicator or acid-base indicator)

Examples


Acidic medium
Alkaline medium
colorless
Phenol phthalein
Pink
Orange
Methyl orange
Yellow

We continue to add titrant till there is abrupt change in the color of the indicator which means that all of the analyte is consumed by the titrant “End point or Equivalence point : E.P”.



$$C * V_{acid} = C' * V'_{base}$$

Standard Solution

Primary

Prepared by direct weighing of known amount of primary standard substance and dissolving in solvent to reach certain volume.

Secondary

Solution of non-primary stanadard substance , can't be prepared by direct weighing, so it needs standardization

Primary Standard Substance

Definition

A substance of sufficient purity from which a primary standard solution can be prepared by direct weighing and dissolving in solution

Primary Standard Substance

Requirements

- Absolute or known purity.
- Stable at oven temperature for drying.
- Stable when become in contact with air “ NaOH absorbs moisture and produce Na_2CO_3”.
- Undergoes a quantitative reaction.
- High equivalent weight to reduce weighing errors.
- Available at reasonable cost.

Examples

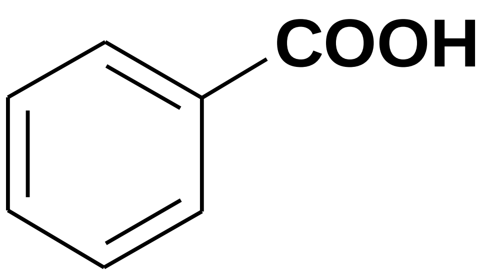
Acidic Primary St.Substance

CooH
|
CooH · 2 (H_2O)

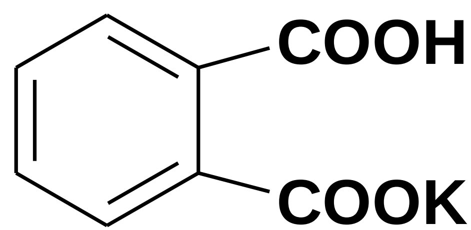
Oxalic acid

NH_2—SO_3H

Sulfamic acid



Benzoic acid



Potassium hydrogen phthalate

Examples

Alkaine Primary St.Substance

Na_2CO_3

$KHCO_3$

$Na_2B_4O_7 \cdot 10H_2O$

Borax

COONa
|
COONa

Sodium oxalate

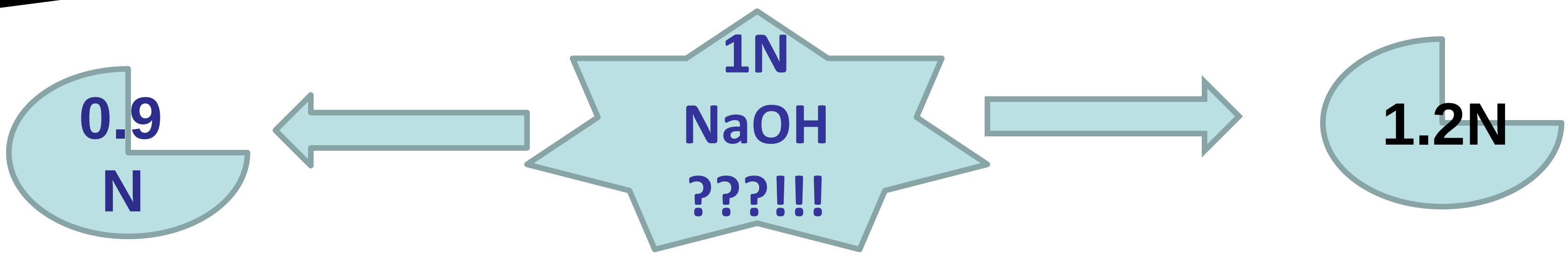
Secondary standard solution

- **Solution of non-primary standard substance.**
- **Can't be prepared by direct weighing.**
- **Must be standardized by:**

1. **Titration against primary st. solution.**
2. **Titration against standardized secondary st. solution.**
3. **Gravimetric analysis.**

1N SOD. HYDROXIDE

Preparation: **Weigh 40 gm to be dissolved in 1L D.W .**



Exact N ??

Desired N

Exact N ??

Needs Standardization

1N SOD. HYDROXIDE

Standardization

Oxalic acid
Primary standard solution

HCl solution
Standardized by
Na_2CO3 solution

Exact Normality

Determination of EXACT normality:

N . V acid = N' . V' base

→ **Exact Normality**

Calculation of Correction Factor:

F = Determined Normality / Desired Normality

Thank you