Quantitative analysis

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Ms.c Applied Chemistry

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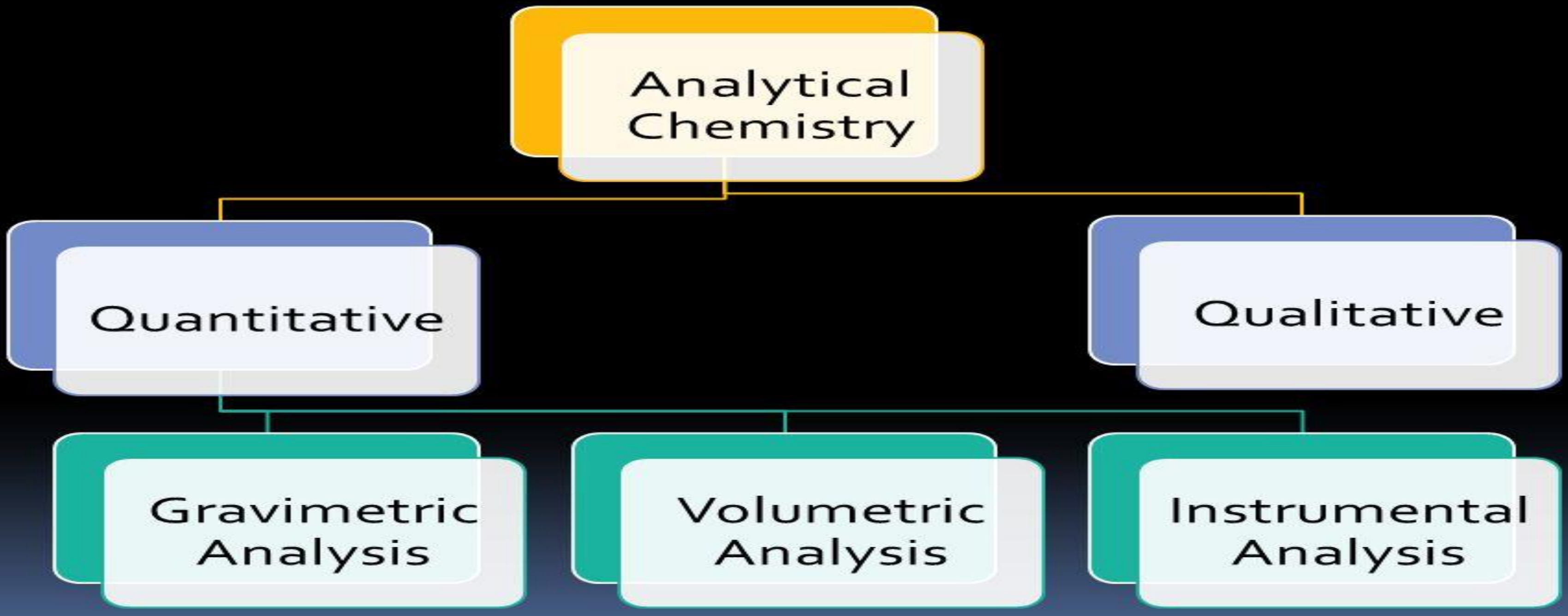
Quantitative analysis:

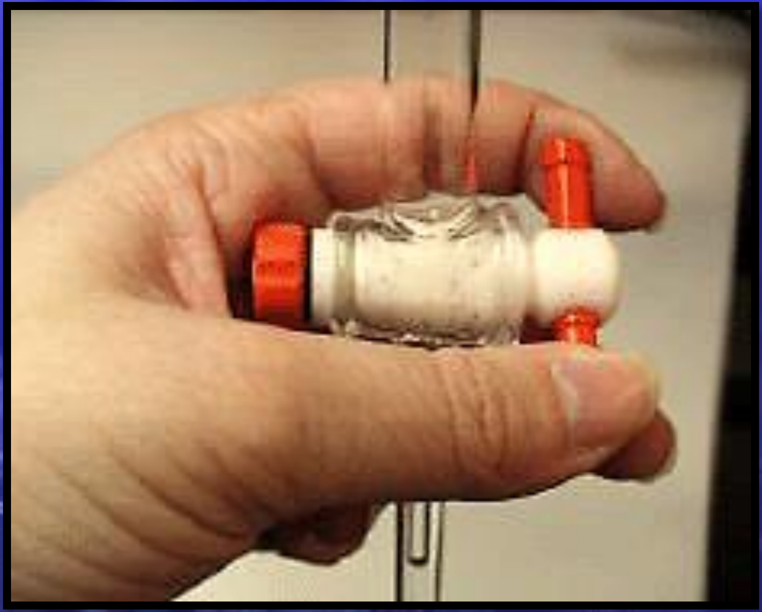
- The quantitative amounts of the chemical elements or of certain compounds in the analyzed substance. Along with specificity and sensitivity, the most important characteristic of every method of quantitative analysis is accuracy.

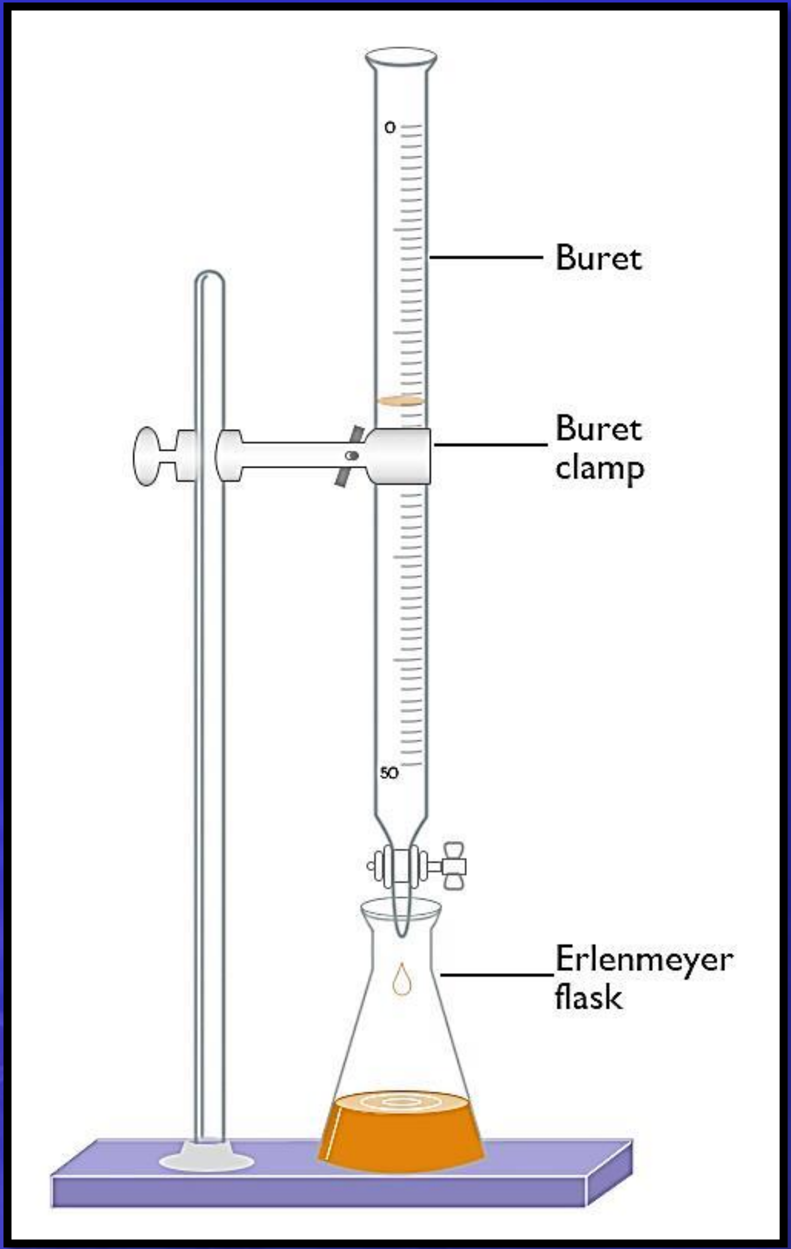


Volumetric analysis:

- analytical methods and techniques in which the amount of a substance in a sample is determined by measuring the volume of a liquid or gas; especially any method using titration
  The reaction of the known substance with the substance to be analyzed, occurring in aqueous solution, is generally conducted by a titration procedure.

The titration procedure





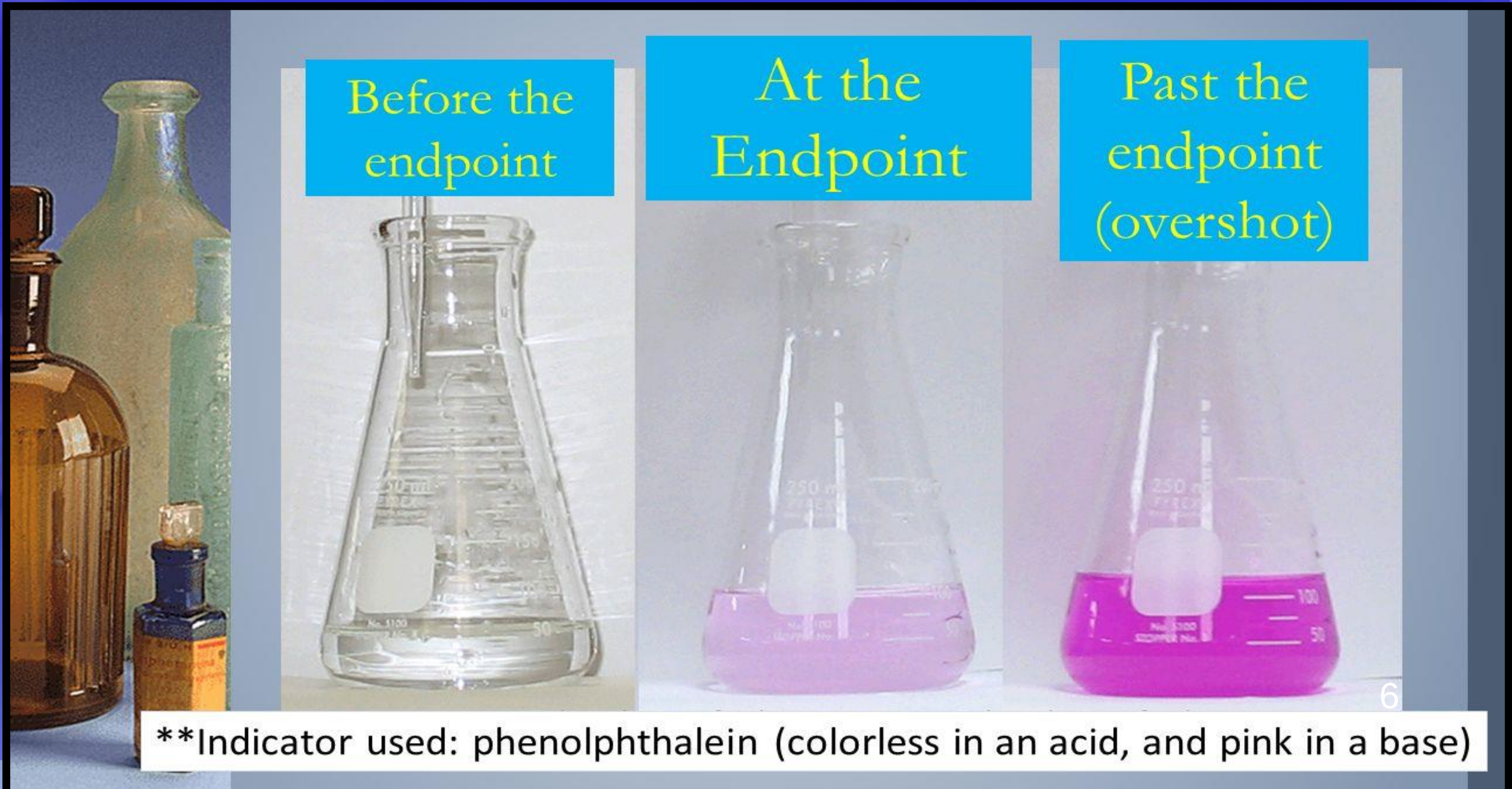
Type of Titrations:

Classified into four types based on type of reaction involved;

1) Acid-base titrations: in which an acidic or basic titrant reacts with an analyte that is a base or an acid.
2) Complex metric titrations: Complexometric titrations are based on the formation of a complex between the analyte and the titrant. The chelating agent EDTA is commonly used to titrate metal ions in solution.
3) Redox titrations: where the titrant is an oxidizing or reducing agent
4) Precipitation titrations: in which the analyte and titrant react to form a precipitate...

- ***Equivalence point***: It is a point at which the moles of the titrant and analyte are equal. Some time we are using end point which is almost same as equivalence point

- The ***end point*** of a titration indicates once the equivalence point has been reached. Is where you see a color change in an indicator added to the titration solution?

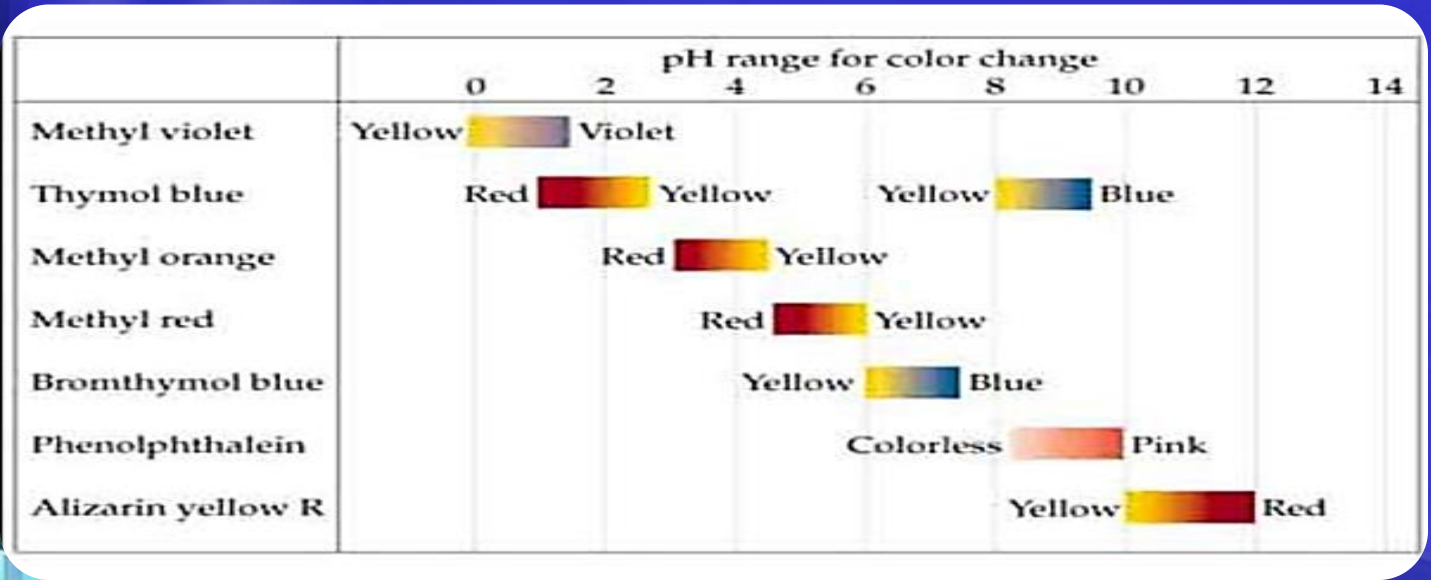


- ***Elements of Titration***

❖ ***Standard solution***: a solution having a very well-known concentration of a solute, can measurement number of moles of substance is present in a measured volume of solution.

- ***A primary standard*** : A reagent is a chemical that is used to cause a chemical reaction with another substance.
- ***A secondary standard:*** is a chemical that has been standardized against a primary standard for use in a specific analysis.

❖ ***PH indicator:*** plays an important role in acid-base titration. They show a color change at equivalence point. They can be used in Redox titration. PH indicators give an approximation of the equivalence point



A good primary standard meets the following criteria:

- high level of purity
- low reactivity (high stability)
- high equivalent weight (to reduce error from mass measurements)
- not likely to absorb moisture from the air (hygroscopic) to reduce changes in mass in humid versus dry environments
- non-toxic
- inexpensive and readily available

Expressing concentration of solution

- **Molarity**: is the number of moles of solute dissolved in one liter of solution. The units, therefore are moles per liter, specifically it's moles of solute per liter of solution.

✓ $\text{molarity} = \dfrac{\text{moles of solute}}{\text{liter of solution}}$

✓ $\text{Molarity} = \dfrac{\text{Weight (g)}}{\text{Molecular Weight (g/mol)}} \text{ X } \dfrac{1000}{\text{Volume (ml)}}$

✓ Molecular Weight = Sum. Of atomic weight

- Example : Prepare 0.1 M of NaCl in 250 ml of D.Water from Solid?

Wt= M x M.wt. x V(ml) / 1000

= 0.1 x 55.5 x 250 / 1000 = 1.38 g

- ***Normality*** : is the number of equivalents of solute dissolved in one liter of solution. The units, therefore are equivalents per liter, specifically it's equivalents of solute per liter of solution.
- $\text{Normality} = \dfrac{\text{No.of equivalents of solute}}{\text{liter of solution}}$
- $\text{No. of equivalents} = \dfrac{\text{Weight (g)}}{\text{Equivalent Weight (g/eq)}}$
- $\text{Normality} = \dfrac{\text{Weight(g)}}{\text{Equivalent weight (g/eq)}} * \dfrac{1000}{\text{Volume(ml)}}$
- $\text{Eq. Wt} = \dfrac{\text{M.Wt}}{\text{n}}$

- n = No. of (H) atoms for acids for HCl n=1
- n = No of OH groups for bases for NaOH n=1
- n = No of Cation atoms (M+) for salts for Na_2CO_3 n= 2
- n = No. of gained or lost electrons for oxidants and reductant for $KMnO_4$ n= 7

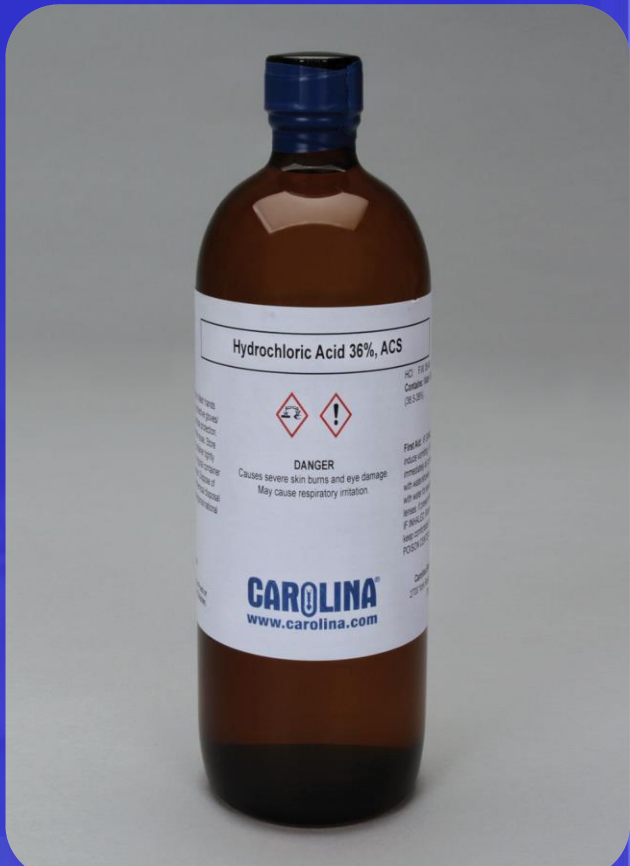
DILUTIONS

- [Concentration of the stock] x [Volume of the stock] = [Concentration of the final solution] x Volume of the final solution]
- **$N_1 V_1 = N_2 V_2$**
- **$M_1 V_1 = M_2 V_2$**
- Q /What is the volume of 0.2 mol / L of NaOH that it required to dilute it to 0.05 mol /L in 100 ml?
- $N_1 V_1 = N_2 V_2$
- $0.2 \times V_1 = 0.05 \times 100$
- $V_1 = 25$ ml complete to 100 ml
-

Normality of Concentrated Reagents

- $$\text{Normality} = \frac{\text{Specific Gravity (g/l) x Percentage (\%) x 1000}}{\text{Equivalent Weight (g/ eq)}}$$

- $$\text{Molarity} = \frac{\text{Specific Gravity (g/l) x Percentage (\%) x 1000}}{\text{Molecular Weight (g/ mol)}}$$



- Calculation of the volume of 11.961N HCl that

$$N_{HCl} = \frac{\text{Specific gravity} * \%\,(w/w) * 1000}{\text{Eq.mass of HCl}}$$

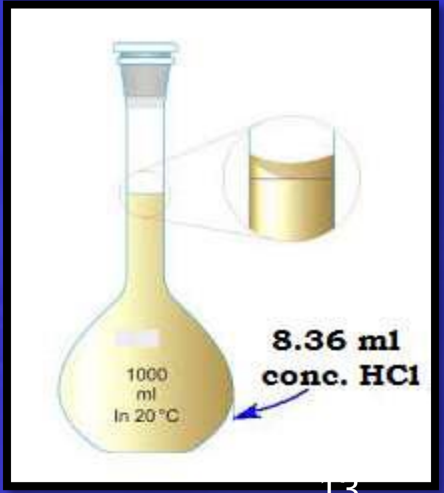
$$N_{HCl} = 11.961\ N$$

Calculation of the volume of 11.961N HCl that should be taken to prepare 1L of 0.1N HCl soln.

$$N_1 * V_{1\ \text{concentrated}} = N_2 * V_{2\ \text{diluted}}$$

$$11.961 * V_1 = 0.1 * 1000$$

V_1 = 8.36 ml of concentrated HCl should be taken and diluted to the mark with distilled water in a 1000 ml volumetric flask.



Preparation and Standardization 0.1 N of HCl by borax as primary standrad solution

- Borax ($Na_2B_4O_7 .10H_2O$) can be used as a **primary standard** since it does not decompose under normal storage, it is readily obtained in a very pure form (99.999% purity), it reacts with a known stoichiometry and can be weighed and used directly.

- ***Materials:***
- Borax solution (standard).
- HCl solution of unknown normality.
- M.O as indicator

Procedure:

1. Transfer 10 ml of the borax solution with a pipette to a conical flask then adds one or two drops of M.O. to this solution.
2. Add the acid (HCl) from the burette gradually with continuous stirring of the solution in the conical flask, and near the end point, the acid is added drop by drop. Continue the addition of the acid till the color of the solution passes from yellow to orange.
3. Repeat the experiment three times and tabulate your results then take the mean of the three readings.

Results

Standard hydrochloric acid Vs. borax

Indictor :

Nb.	Volume of standard borax 0.1 N(ml)	Burette readings		Volume of hydrochloric acid HCl (ml)
		V =Initial ml	V=Final ml	
1.	5 ml			
2.	5 ml			

Determination of the strength and normality of sodium hydroxide solution by a standard solution of hydrochloric acid

- ***Theory:***
- HCl reacts with sodium hydroxide according to the following equation:
- $HCl + NaOH = NaCl + H_2O$
- The eq.wt. of both the HCl and NaOH is equal to their molecular weights and so both the acid and alkaline are strong, any indicator may be used.
- ***Materials:***
- HCl solution (standard).
- NaOH solution of unknown normality.
- M.O as indeactor

Procedure:

- ***Standardization of the resulting NaOH solution:***

1. Transfer with a pipette 10 ml of NaOH solution to a conical flask then adds one or two drops of M.O., add the standard HCl solution from the burette till the end point. (the color changes from yellow to reddish orange)
2. Repeat the experiment three times and tabulate your results.
3. Repeat the experiment using ph.ph. and Compare the result with those obtained With M.O.

Results

Standard sodium hydroxide Vs. hydrochloric acid

Indictor :

Nb.	Volume of NaOH(ml)	Burette readings (HCl)		Volume of sodium hydroxide (ml)
		Initial ml	Final ml	
1.	5 ml			
2.	5 ml			