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Analytical chemistry

Lecture 2

Volumetric analysis

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Introduction

❖Chemical analysis plays an important role in study of composition or constituents of substances or material.

❖The chemical analysis is broadly divided into two types:

- Qualitative analysis
- Quantitative analysis

❖It uses titration to determine the concentration of a solution by carefully measuring the volume of one solution needed to react with another.

- The volumetric is a chemical analytical procedure based on measurement of volumes of reaction in solutions.
- The weight of the required constituents is indirectly obtained by measuring the volume of a solution of known composition required to react with a known volume of a solution containing an unknown weight of the desired constituent.
- This is done by a process known as titration which is divided into four types depending upon the nature of the chemical reaction . The four types are:

a. Acid – base or neutralization methods

b. Precipitation methods

c. Complex metric methods

d. Oxidation – reduction methods

- In volumetric analysis, concentration of substances are found out by volume determination.

- The unit used for measurement of volume of a liquid or solution is “litre”.

- The litre is defined as:

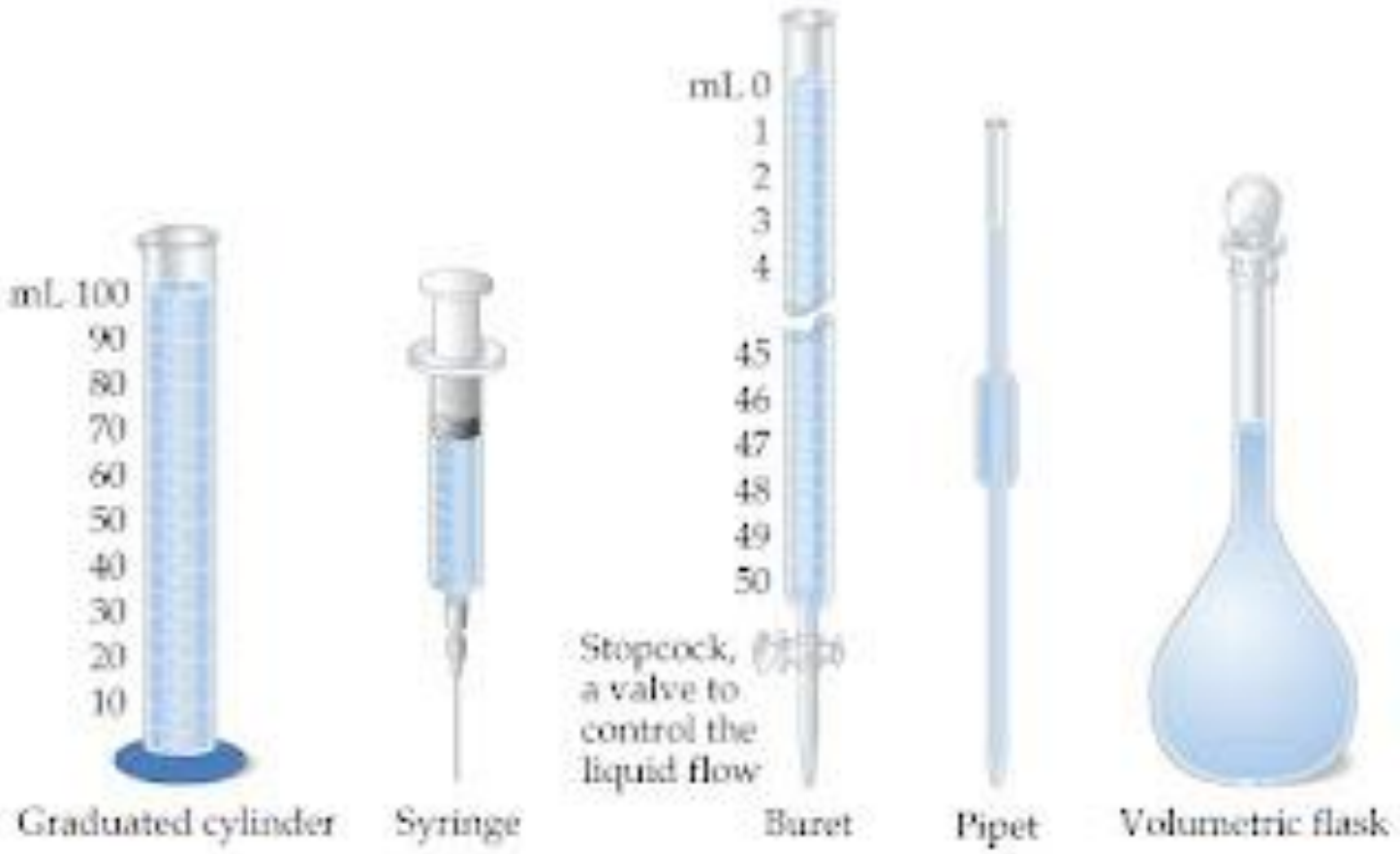
the volume of one cubic decimeter or one kilogram of water at its maximum density at 4°C.’

- The **millilitre** is the thousandth part of a litre.
- The cubic centimeter **(cm3)** is the volume occupied by a cube such that each edge of the cube is one centimeter in length.
- The relationship between millilitre and cubic centimeter is

1000 ml = 1000.028 cc

The term **ml** is more correct

what tool is used to measure liquid volume



Accuracy and the Measurement of Volume

ACCURACY : is the error associated with how close a measurement is to the true or actual value. If an instrument gives values that are very close to the true value we say that it is **ACCURATE.**

Example: A graduated cylinder upon measuring the same sample three times gave 566 mL, 584 mL, and 541 mL.The average of these three values is 563.7 mL. If the true value was 563.688 mL, we would say that the average was accurate but the individual measurements were neither accurate nor precise.

- ***PRECISION :*** is the error associated with how close several measurements of the same quantity are to each other. If an instrument upon repeated measurements gives values that are very close to each other we say that the instrument is **PRECISE**.

- **Example:** If the measurements in the above example were 563 mL, 564 mL, and 564 mL (average = 563.7 mL) and the true value was 563.688 mL then the measurements are both precise and accurate. The last case is, ofcourse, the idea

Methods of Expressing Concentration of solutions

There are many systems of expressing the contraction of solutions.

- Weight of solute present in a given volume of solution.
- Moles of solute present in one litre of solution, called **molarity**.
- Gram equivalents of solute present in one litre of solution, called **normality**.
- Percentage of solute by weight in a solution of known **specific gravity**.

1-Weight of Solute per Unit Volume of Solution

- In preparation of solution using this system, a known weight of the solute is dissolved and diluted to known volume.
- If accuracy is required, the solute is weighed and transferred to a volumetric flask, and diluted to a known volume.
- The concentration is usually expressed as grams of solute per millilitre of solution.
- Any multiple or fractional part of such solution will contain a known weight of solute.

2. Molarity

a. A mole : The molecular weight expressed in grams of any substance is called as mole or gram molecule of the substance. For example, sodium chloride has molecular weight 58.5g of sodium chloride means one mole of it.

b. Mill mole : The mole is very large unit, hence a smaller unit which is one thousandth of it, known as mill mole is used.

Thus 1 mole = 1000 mill moles.

c. Molar Solution : A molar solution is defined as the solution containing one mole of the solute in a litre of its solution. For example 40g of NaOH is one litre of solution is called as 1M NaOH solution.

$$\text{Number of Moles} = \frac{\text{Weight of solute in grams}}{\text{Molecular weight of the solute}}$$

Molarity of Solution : It is defined as the number of moles of the solute present in one litre of its solution. It can also be defined as number of millimoles of a solute present in one millilitre of its solution.

$$\text{Molarity} = \frac{\text{Number of moles of the solute}}{\text{Volume of the solution in litre}}$$

Number of moles = Molarity x Litre

$$\text{Molarity} = \frac{\text{Number of millimoles of the solute}}{\text{Volume of the solution in millilitre}}$$

Number of millimoles = Molarity x MilliLitres

3. Normality

The concentration of solution can also be expressed in terms of normality.

Various terms involved in it are :

Equivalent Weight : The equivalent weight of a substance (element or compound) as:

"The number of parts by weight of it, that will combine with or displace directly or indirectly 1.008 parts by weight of hydrogen, 8 parts by weight of oxygen, 35.5 parts by weight chlorine or the equivalent parts by weight of another element".

Milliequivalent Weight : It is obtained by dividing the equivalent weight by 1000.

Gram Equivalent Weight : It is the equivalent weight expressed in grams.

Equivalent weight of a substance = 1 equivalent of a substance = Equivalent weight of substance in grams.

Milligram Equivalent Weight : It is obtained by dividing the gram equivalent weight by 1000.

Normality of Solution :

Normality is a system of expressing on centration based on number of equivalents of solute present in one litre of solution or the number of milliequivalents of solute present in one millilitre of a solution.

$$\text{Normality} = \frac{\text{Number of equivalents of the solute}}{\text{Volume of titration in litre}}$$

$$= \frac{\text{Number of milliequivalents of the solute}}{\text{Volume of the solution in millilitre}}$$

Number of gram equivalents = Normality x Litres


Thank You
For Your
Attention