ANALYTICAL CHEMISTRY

Introduction to Chemical Analysis

by
Wan Norfazilah Wan Ismail
Faculty of Industrial Sciences & Technology
norfazilah@ump.edu.my

Chapter Description

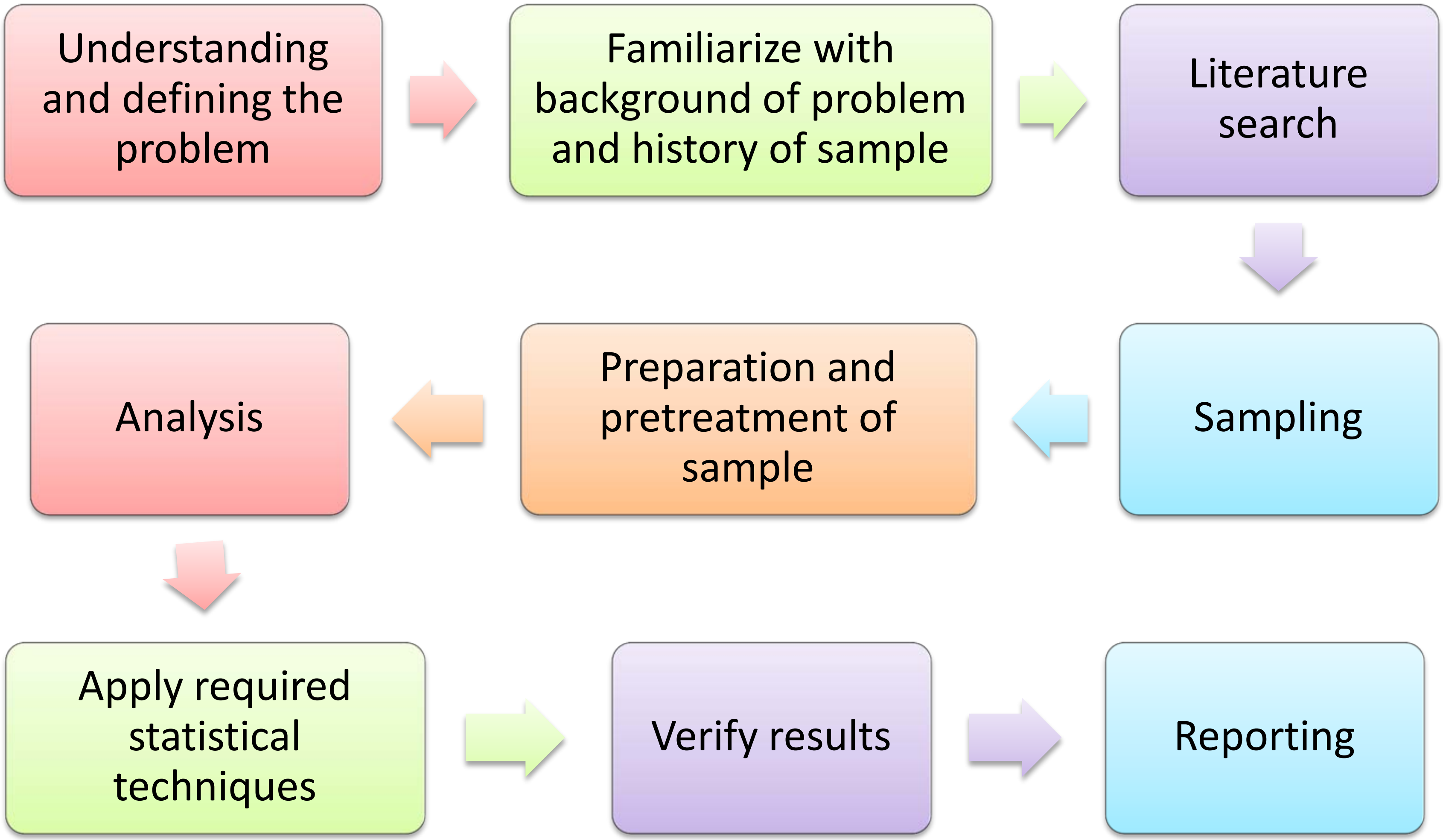
- Aims
  - To instil the understanding of the basic principles of the quantitative analytical chemistry and how the principles are utilized in the analytical laboratory.
  - Systematic guidance towards achieving more knowledge and skills in the data handling applications and quantitative analytical methods.

- Expected Outcomes
  - State the steps in chemical analysis and interpret the given problem.
  - Describe the suitable analytical techniques to solve the given problem.
  - Understand and apply the basic aspects of chemical analysis such as concentration calculations and preparation of solution.

Contents

- Analytical Methodology
- Selection of Analytical Techniques
- Concentration Units
- Preparation of Solutions
- Dilution
- Chemical Stoichiometry

ANALYTICAL METHODOLOGY



SELECTION OF ANALYTICAL TECHNIQUE

Qualitative

- Identity of analyte

Quantitative

- Concentration of analyte
- Measured signal
- Precision depends on instrumentation and/or fundamental phenomena

CONCENTRATION UNITS

Name	Component measured by	Total sample measured by	Abbreviation	Units used
Molar concentration				
Molarity	Number	Volume	M	mol L^{-1}
Formality	Number	Volume	F	mol L^{-1}
Normality	Number	Volume	N	Normal L^{-1}
Molality	Number	Weight	m	mol kg^{-1}
Percent Composition				
Weight-to-weight	Weight	Weight	w/w	%(w/w)
Weight-to-volume	Weight	Volume	w/v	%(w/v)
Volume-to-volume	Volume	Volume	v/v	%(v/v)

MOLAR CONCENTRATION

$$\text{Molar concentration, C} = \frac{\text{no. mol solute}}{\text{no. L solution}} \; @ \; \frac{\text{no. mmol solute}}{\text{no. mL solution}}$$

One **mole**: contains 6.022 x 10^{23} of molecules

Atomic weight: the number of grams containing one Avogadro's number of **atoms** of the element

Molecular weight: number of grams that contains one Avogadro's number of **molecules** of the substance

Molar concentration: the number of moles of that species that is contained in one liter of **solution** (unit: molarity, M)

Analytical molarity: total number of moles of the **solute** in one liter of solution

Species molarity: the number of moles of a **particular species** in one liter of a solution at equilibrium

MOLAR CONCENTRATION

Formality: the number of formula weights per liter of solution

$$F = \frac{\text{no. F W}}{\text{no. L solution}}$$

Molality: the number of moles of the substance per kilograms of the solvent

Normality: widely used in redox reaction. The normality of redox reagent is *n* times the molarity, where *n* is the number of electrons donated or accepted by the species in a chemical reaction.

$$N = nM$$

PERCENT COMPOSITION

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

Weight-to-weight:

$$\text{Weight percent, \% w/w} = \frac{\text{mass of solute}}{\text{weight of solution or mixture}} \times 100$$

Weight-to-volume:

$$\text{Volume percent, \% v/v} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

Volume-to-volume:

$$\text{Volume percent, \% w/v} = \frac{\text{mass of solute}}{\text{volume of solution}} \times 100$$

PERCENT COMPOSITION

The weight-to-weight unit can also be expressed as a fraction.

These units of concentration are usually used to express very low concentrations.

Parts per million (ppm):

$$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of sample}} \times 10^6$$

or **mg/L** = ppm

Parts per billion (ppb):

$$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of sample}} \times 10^9$$

or **µg/L** = ppb

Parts per trillion (ppt):

$$\text{ppt} = \frac{\text{mass of solute}}{\text{mass of sample}} \times 10^{12}$$

or **ng/L** = ppt

UNIT CONVERSION

Mass

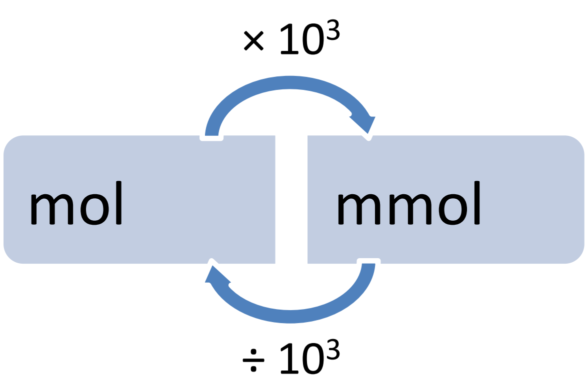
ng	10^{-9} g
µg	10^{-6} g
mg	10^{-3} g
g	10^{3} mg @ 10^{-3} kg
kg	10^{3} g

Volume

µL	10^{-3} mL
mL	10^{3} µL @ 10^{-3} L
L	10^{3} mL
cm^3	mL
dm^3	L
m^3	10^{3} L

Concentration

ppt	ng/L
ppb	µg/L
ppm	mg/L
M	mol/L @ mmol/mL



PREPARATION OF SOLUTION

Usual step: weigh a certain quantity of the reagent and dissolve it in a solvent in a volumetric flask.

Tips:

1) know your **reagent** and **solvent**
2) know the **molarity** and **volume** that you need
3) start calculating, get the **weight** of **reagent**
4) **weigh** your reagent using analytical balance
5) **dissolve** the reagent in the solvent using volumetric flask

A GOOD analytical chemist very concern on ACCURACY!

DILUTION

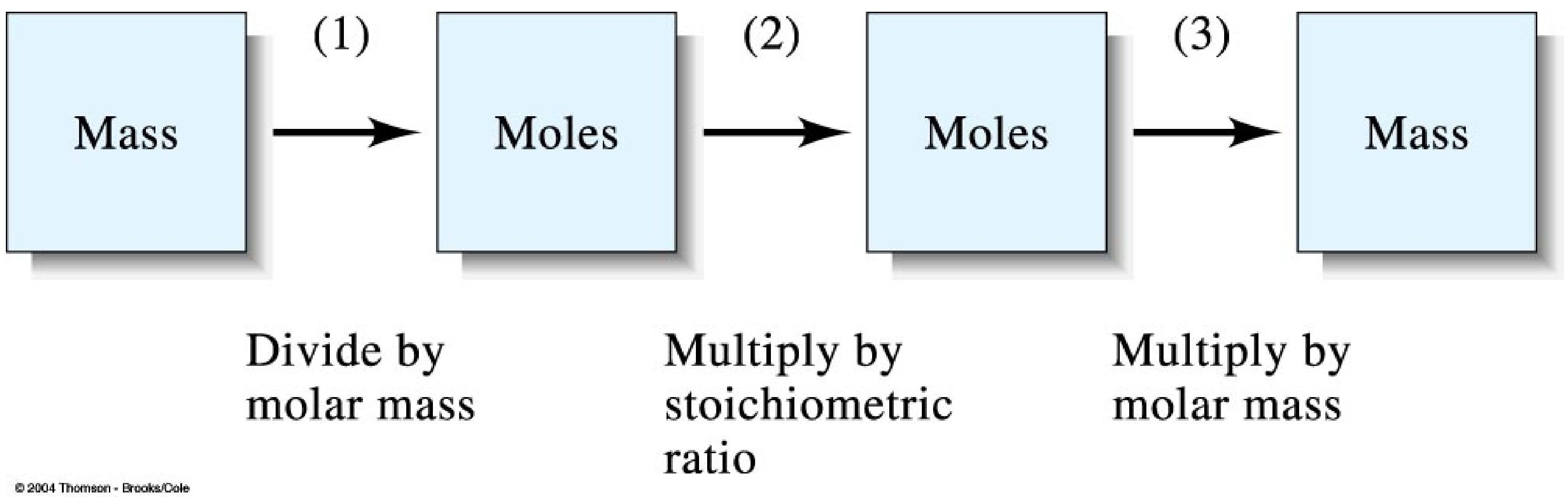
Dilute solution (with low concentration) can be prepared **from a more concentrated** solution. A known volume of the concentrated solution can be transferred into a new flask and diluted to the required volume or weight.

$$M_1V_1 = M_2V_2$$

CHEMICAL STOICHIOMETRY

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

The stoichiometry of a reaction is the relationship among the number of moles of reactants and products as shown by a balanced equation.



CHEMICAL STOICHIOMETRY

A balanced chemical equation is a statement of the combining ratios or stoichiometry in units of moles among the reacting substances and their products.

- Transformation of the known mass of a substance in grams to a corresponding number of moles
- Multiplication by a factor that accounts for the stoichiometry
- Reconversion of the data in moles back to the SI units called for in the answer

Author Information

Wan Norfazilah Wan Ismail

Industrial Chemistry Programme
Faculty of Industrial Sciences & Technology
Universiti Malaysia Pahang