Al-Mustaqbal University

College of Science

Analytical Chemistry I

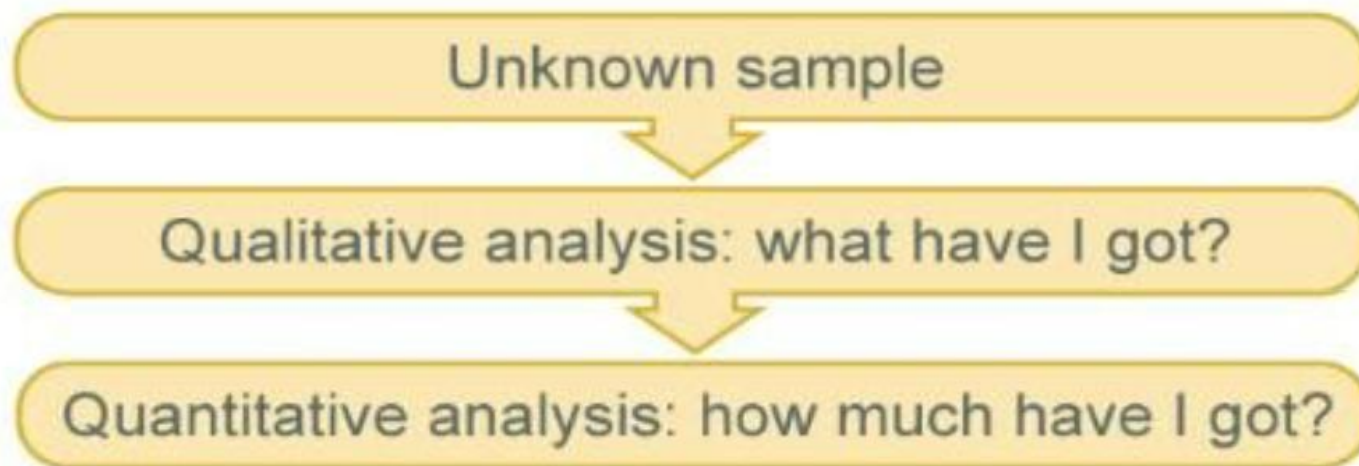**First Year Students / 1st Semester**

2025-2026

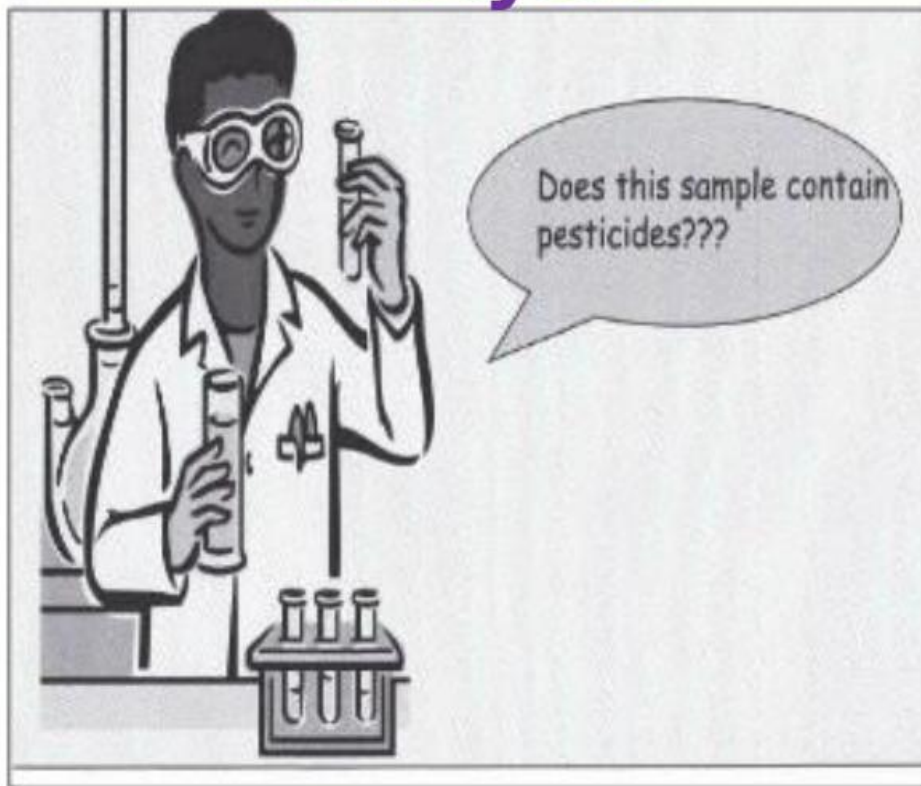## Classification of Analytical Methods and Chemical Analysis

By

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DISCIPLINE OF ANALYTICAL CHEMISTRY

Qualitative	Quantitative
To determine the presence or absence of a particular compound in a sample.	Indicates the amount of particular compound in the sample.

Unknown sample

⬇

Qualitative analysis: what have I got?

⬇

Quantitative analysis: how much have I got?

Qualitative Analysis

Does this sample contain pesticides???

Quantitative Analysis

How much pesticides are contained in this sample???

- **Analytical Chemistry** deals with methods for determining the chemical composition of samples.
  - Qualitative Analysis (identification) provides information about the identity of species or functional groups in the sample (an analyte can be identified).
  - Quantitative Analysis provides numerical information of analyte (quantitate the exact amount or concentration).

Classification of Analytical Methods

1. Classical methods

Qualitative – **identification by color, indicators, boiling or melting points, odour**

Quantitative – **mass or volume (e.g. gravimetric, volumetric)**

Gravimetric Methods – the mass of the analyte or some compound produced from the analyte was determined.

Titrimetric Methods – the volume or mass of a standard reagent required to react completely with the analyte was measured.
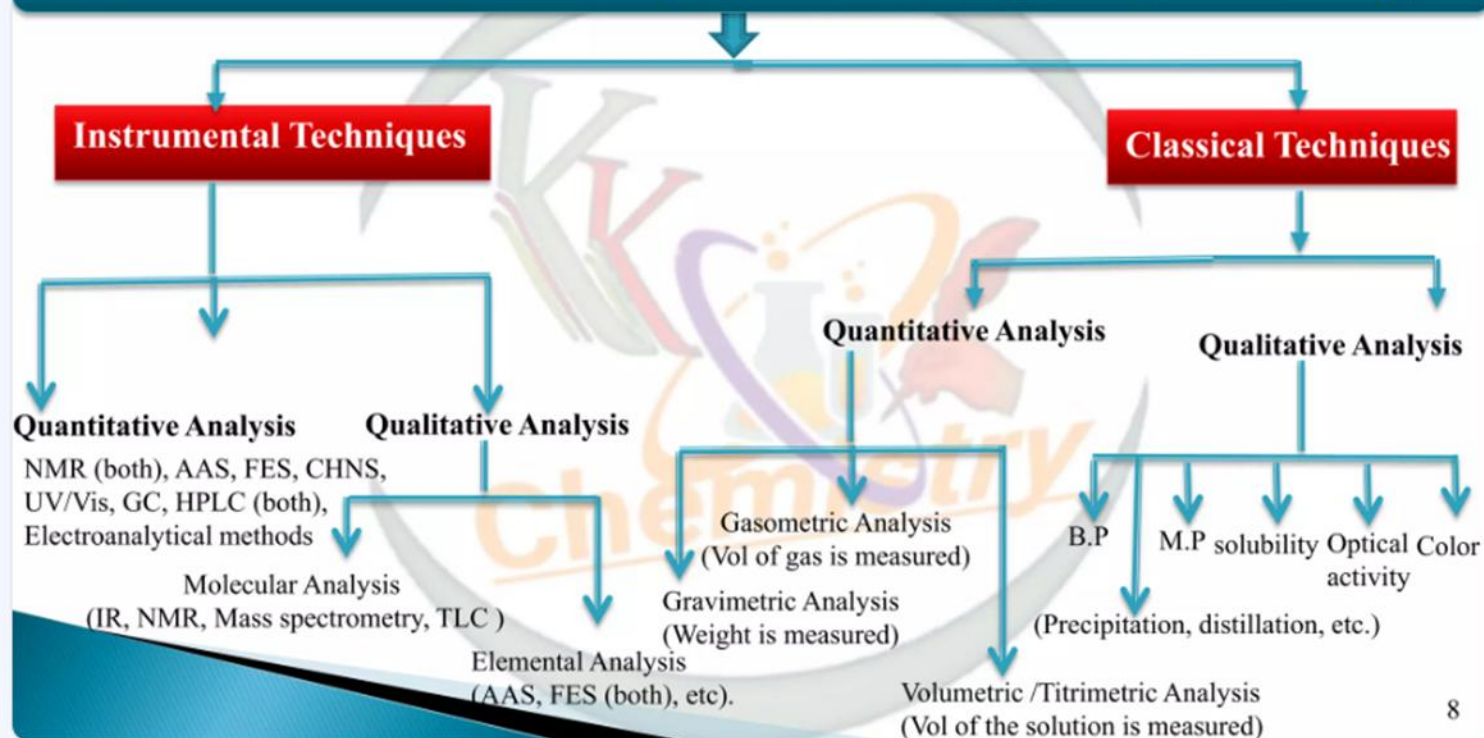
2. Instrumental methods

Qualitative – **chromatography, electrophoresis and identification by measuring physical property (e.g. spectroscopy, electrode potential)**

Quantitative – **measuring property and determining relationship to concentration (e.g. spectrophotometry, mass spectrometry)**

Classifications of Analytical Techniques (Summary)

Instrumental Techniques

Classical Techniques

Quantitative Analysis
NMR (both), AAS, FES, CHNS,
UV/Vis, GC, HPLC (both),
Electroanalytical methods

Qualitative Analysis

Molecular Analysis
(IR, NMR, Mass spectrometry, TLC)

Elemental Analysis
(AAS, FES (both), etc).

Quantitative Analysis

Gasometric Analysis
(Vol of gas is measured)

Gravimetric Analysis
(Weight is measured)

Volumetric /Titrimetric Analysis
(Vol of the solution is measured)

Qualitative Analysis

B.P   M.P solubility Optical Color
activity

(Precipitation, distillation, etc.)

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Instrumental methods

Electrochemistry

Thermal Analysis

Separation

Spectroscopic

Other Techniques

Separation Methods

Chromatography

- Gas chromatography
- High Performance Liquid Chromatography
- Liquid Chromatography
- Thin Layer Chromatography
- Ion Exchange Chromatography
- Paper Chromatography
Column Chromatography

Electrophoresis

Extraction

Spectroscopic Methods

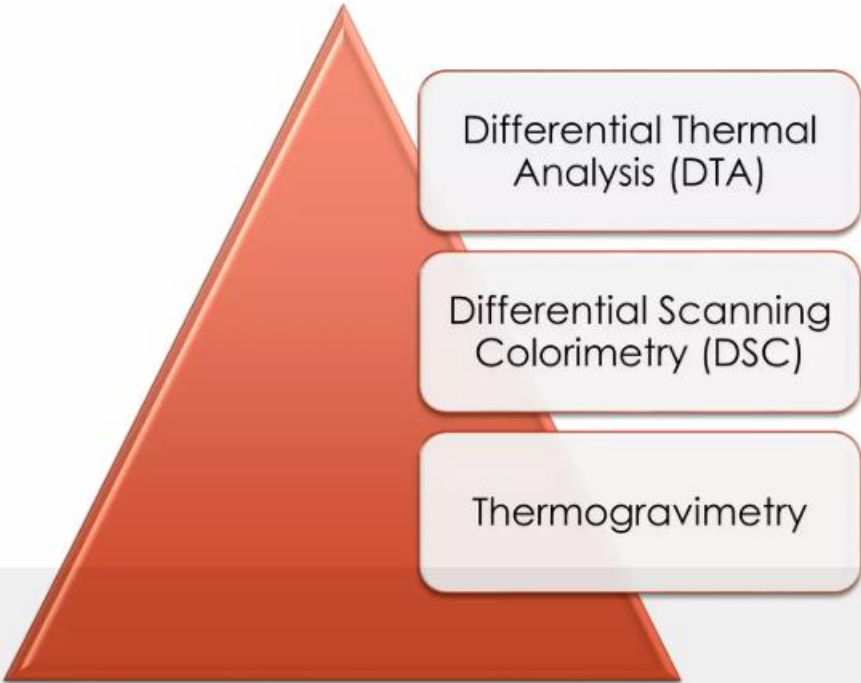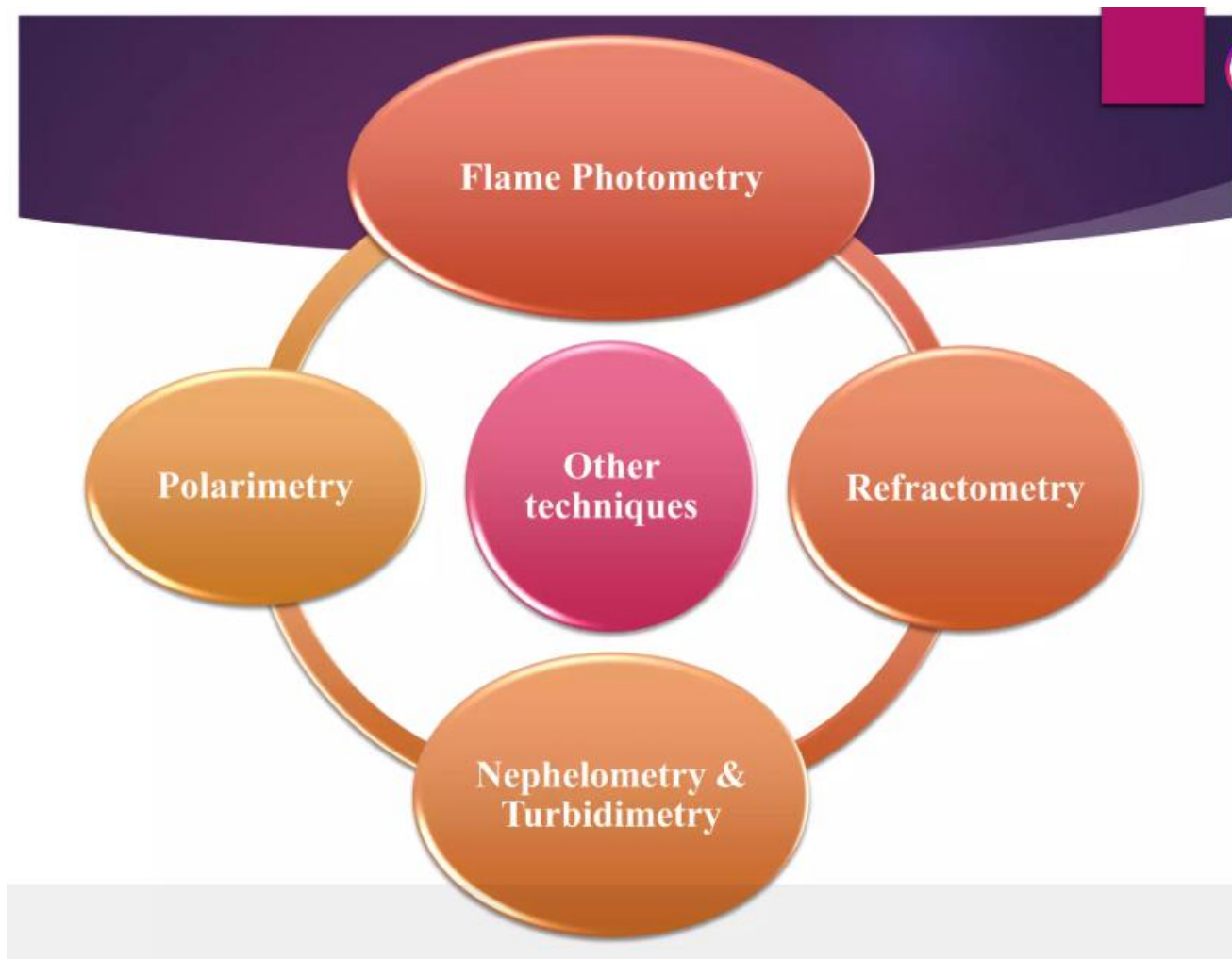|		
Atomic Absorption Spectroscopy	**NMR Spectroscopy**	**Mass Spectrometry**
Absorption Spectroscopy	**X-ray Diffraction**	**Fluorescence Spectroscopy**

Thermal Methods

Differential Thermal Analysis (DTA)

Differential Scanning Colorimetry (DSC)
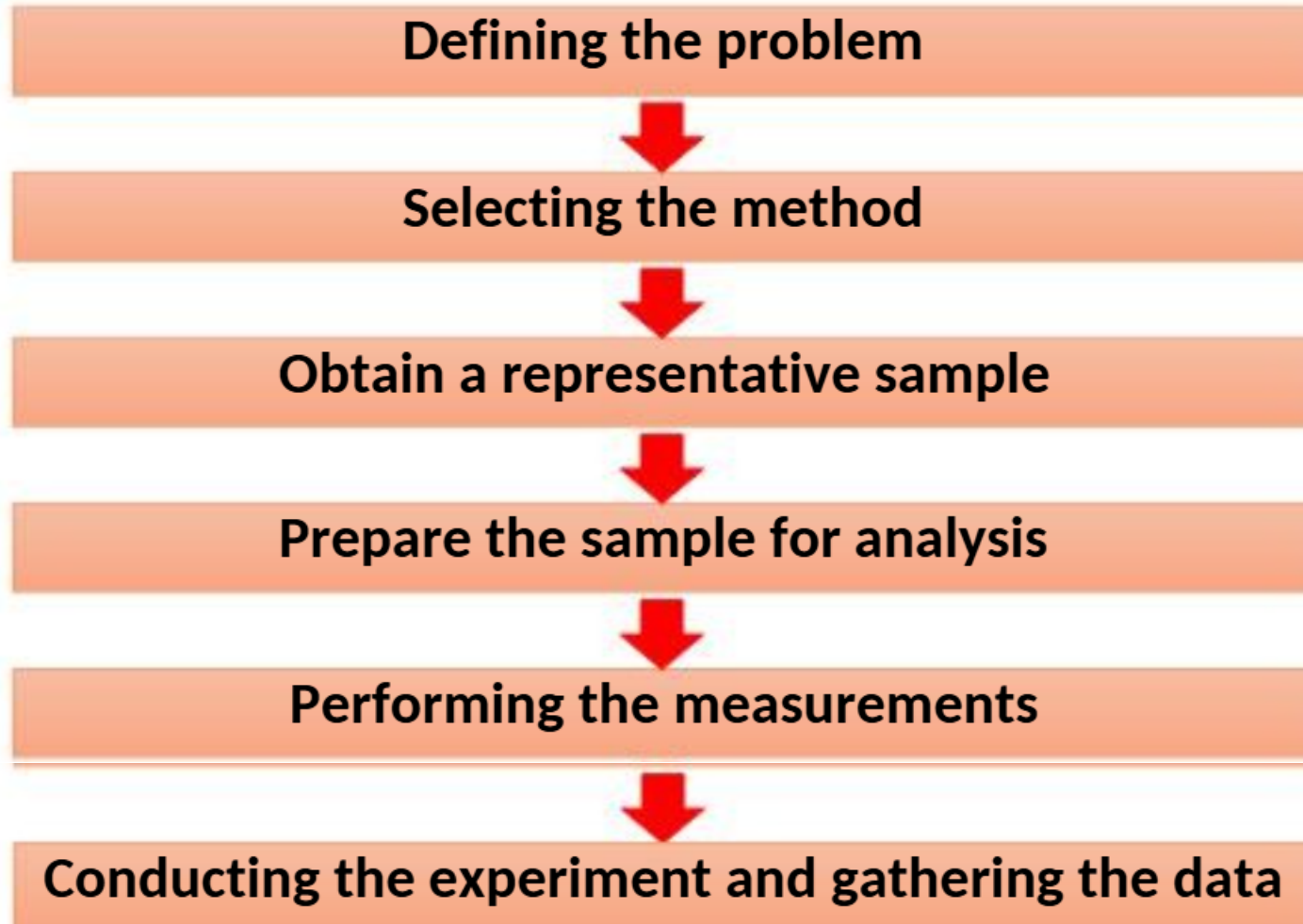
Thermogravimetry

Types and steps in chemical analysis

CHEMICAL ANALYSIS

- Chemical analysis is more than just **detecting or determining** the **general composition** or a **specific component** of a **sample**.

- Related to the **measurements** and **characterization** of a **chemical species** that **contain in a sample**.

- Determine **WHAT** and **HOW MUCH** **specific chemical contain in a sample**.

SOME APPLICATIONS OF CHEMICAL ANALYSIS

- Analysis of carbon monoxide in air.

- Determination of glucose in blood.

- Determination of heavy metals in river water.

- Determination of pesticide residues in food.

STEPS IN AN ANALYSIS

Defining the problem

Selecting the method

Obtain a representative sample

Prepare the sample for analysis

Performing the measurements

Conducting the experiment and gathering the data

Define the Problem

Factors

- What is the problem—what needs to be found? Qualitative and/or quantitative?
- What will the information be used for? Who will use it?
- When will it be needed?
- How accurate and precise does it have to be?
- What is the budget?
- The analyst (the problem solver) should consult with the client to plan a useful and efficient analysis, including how to obtain a useful sample.

Select a Method

Factors

- Sample type
- Size of sample
- Sample preparation needed
- Concentration and range (sensitivity needed)
- Selectivity needed (interferences)
- Accuracy/precision needed
- Tools/instruments available
- Expertise/experience
- Cost
- Speed
- Does it need to be automated?
- Are methods available in the chemical literature?
- Are standard methods available?

Obtain a Representative Sample

Factors

- Sample type/homogeneity/size
- Sampling statistics/errors

Prepare the Sample for Analysis

Factors

- Solid, liquid, or gas?
- Dissolve?
- Ash or digest?
- Chemical separation or masking of interferences needed?
- Need to concentrate the analyte?
- Need to change (derivatize) the analyte for detection?
- Need to adjust solution conditions (pH, add reagents)?

Perform Any Necessary Chemical Separations

- Distillation
- Precipitation
- Solvent extraction
- Solid phase extraction
- Chromatography (may be done as part of the measurement step)
- Electrophoresis (may be done as part of the measurement step)

Perform the Measurement

Factors

- Calibration
- Validation/controls/blanks
- Replicates

Calculate the Results and Report

- Statistical analysis (reliability)
- Report results with limitations/accuracy information

3) OBTAIN A REPRESENTATIVE SAMPLE

o **Sampling**: Process to get a **representative** and **homogeneous** sample

o Chemical analysis usually performed on **only a small portion** of the material.

o That sample must **represent the bulk of sample.**

o The suitable sampling method differ from one substance to another depending on **homogeneity.**

- **Homogeneous**: Substance that has the **same composition** throughout the sample.

- **Heterogeneous**: Substance that has **different composition** from one reagent to another reagent. Its parts can be distinguish visually or with the aid of microscope.

Homogeneous

Heterogeneous

- **Proper procedure** must be used to **store** both **samples and standards.**

- All sample must be properly **labeled** and **recorded**.

4) SAMPLE PREPARATION

Steps of sampling bulk materials

1.   **Bulk sample** must be **reduced** in size to obtain a **laboratory sample** of several grams from which a few grams to milligrams will be taken to be analyzed (analysis sample).

2.   Size reduction may require taking portions (e.g. two quarters) and mixing, in several steps, as well as crushing and sieving to obtain a uniform powder

Why sample pre-treatment is important????

➢Laboratory samples are often subjected to physical or chemical pretreatment where it is **converted to a form that is suitable for the measurement**.

➢**During pretreatment**:

i)   reduce and remove interferences

ii) adjust analyte concentrations to a range suitable for measurement

iii) produce species from analyte that have quantitatively measurable properties.

5) PERFORMING THE MEASUREMENT

- **Analysis**: Incorporates the measurement of the concentration of the analyte in replicates and comparing with standards.

- **Replicates**: A **portion of a materials** of approximately the **same size** or **quantity** that undergo the **same analysis/ method** at the **same time** and **same place.**

- Replicate measurements are necessary to obtain the **measurement uncertainty**.

- Uncertainty is important as it indicates the **reliability of the measurements.**

6) CONDUCTING EXPERIMENTS & ANALYSING DATA

- Performed the experiments on the prepared samples based on **method define**.

- Performed a **blank analysis**.

-A blank contains the reagents and solvents use in analysis, (no analyte)

- Run a **statistical analysis** (e.g. Standard deviation)

- Deliver a **clearly written, complete report and their limitations.**