COMMON TECHNIQUES OF ANALYTICAL CHEMISTRY

Method	**Principle Applications**	**Molecular Phenomenon**	**Advantages (qualitative analysis)**	**Advantages (quantitative analysis)**	**Sample Quantity**	**Method Limitation**	**Sample Limitation**
Ultraviolet and Visible Spectrophotometry	Quantitative analysis especially as end methods	Excitation of valence electrons	Special applications	High precision and sensitivity	0.01 mg	Little information on molecular structure	Soluble in uv-transparent solvent
Infrared Spectroscopy	Structural determination and identity of organic compounds	Excitation of molecular vibrations by light absorption	Identification of functional groups	Widely applicable	10 μg to 10 mg	Medium sensitivity. No size information	Avoid aqueous solutions
Raman Spectroscopy	Structural determination and identity of organic compounds. Symmetry of molecular groups in solid state	Excitation of molecular vibrations by light scattering	Identification of functional groups (different from IR) Use of aqueous solutions	Special Applications	0.01 mg	Low sensitivity. No direct size information	Sample must avoid fluorescence. Avoid turbidity. Restriction on colour.
Nuclear Magnetic Resonance	Structural determination and identity of organic compounds, molecular conformation	Reorientation of magnetic nuclei in a magnetic field	Determines chemical type and number of atoms (eg. ^{1}H, ^{19}F, ^{13}C,etc.), molecular configuration and conformation, detects impurities	Standards not required. No chemical or physical alteration of a neat sample	10 mg	Medium sensitivity. Most useful information from a limited number of elements (H, C, F, P, Si, Sn, N)	Liquid or soluble solid preferred. Wide variety of solvent choices
Mass Spectrometry	Structural determination and identity of organic compounds. Analysis of trace volatiles in nonvolatiles	Ionization of molecule and cracking of molecule into fragment ions	Presicion molecular weight, masses of fragment ions, very high sensitivity, impurity detection	High sensitivity	< 1 mg	Cannot always determine isomeric structures	Difficult to analyse nonvolatile samples

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Atomic Emission Spectroscopy	Qualitative analysis for 25 elements using simultaneous detection. Quantitative analysis for all elements emitting in uv/vis spectrum	Light emission from excited electronic states of atoms	General for all metallic elements; simultaneous analysis of metallic elements	High sensitivity in many cases	0.25 – 2 g	Limited sensitivity for halogens and other nonmetals. Not suitable for quantitative microanalysis	Most organic liquid and solid samples require wet digestion prior to analysis
Atomic Absorption Spectroscopy	Precision quantitative analysis for a given metal; trace analysis for a given metal	Absorption of atomic resonance line	(Not applicable)	Fast, reliable analysis for a given element; high sensitivity in some cases; simplicity.	100 mg	Metals analysed individually but not simultaneously. Usually not applicable to nonmetals.	Element being analysed must be in a solution (many solvent choices).
Gas Chromatography	Multicomponent quantitative analysis of volatile organics; highly efficient separation technique	Partitioning between vapour phase and substrate	Separates materials for examination by other techniques.	Widely applicable to volatile materials. Multicomponent analysis. High sensitivity in certain cases.	1 mg	Identifies materials only in special cases	> 1 torr vapour pressure at sample inlet temperature
Liquid Chromatography	Separation technique for less volatile and ionic materials; multicomponent quantitative analysis.	Partitioning between liquid solution and substrate	Separates materials for examination by other techniques.	Multicomponent analysis of less volatile materials	10 mg	Method development is time consuming.	None