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Quantitative analysis applications

Quantitative analysis is a chemical analysis performed to find the amount of each component present in a material. It is done by either a classical or instrumental procedure.

A quantitative investigation means that the amount (quantity) or relative amount of each component present is determined. In a pure substance, the entire **mass**, or 100%, is composed of a single component. In materials composed of two or more substances, a quantitative investigation would determine the mass or relative mass present for each component within the sample. It is not always necessary to find quantitative values for all components that make up a substance. In most cases it is sufficient to analyze the material for one or perhaps more components of interest. The amount of active medicine within an antacid tablet, for example, is significant, whereas the fillers, binders, colorants, and flavoring agents present are of lesser importance.

Method	Response
Potentiometry:	Many chemical reactions produce electric energy, a battery for example. The amount of chemical to produce a measured potential is calculated.
Coulometry:	The amount of electrical current and the duration over which it flows is a measure of the amount of chemical substance producing the current.
Conductimetry:	The number of charged chemical components in a solution determine the resistance or conductance of a solution to the passage of electrical current.

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Voltammetry:	The magnitude of electric potential necessary to cause the breakdown of a chemical substance and the current resulting from that breakdown are related to the amount of chemical present.
Ultraviolet, visible, infrared, and x-ray spectometry:	The extent to which these rays are absorbed by a sample depends upon the amount of sample present
Thermogravimetry:	The loss in weight of a substance as it decomposes upon heating is proportional to the amount of substance initially present.
Nuclear magnetic resonance:	For chemicals showing magnetic properties the strength of the magnetism is related to the amount of substance present.
Nuclear activation analysis:	The amount of radioactivity produced by a substance is proportional to the amount of material emitting radiation.
Mass spectrometry:	The intensity of each component fraction present as a chemical is broken apart relates to the amount initially present.

The general steps in the analytical processes

1. ***Formulating the question:*** Translate general questions into specific questions to be answered through chemical measurements.
2. ***Selecting analytical procedures:*** Search the chemical literature to find appropriate procedures or, if necessary, devise new procedures to make the required measurements.
3. ***Sampling*** is the process of selecting representative material to analyze. If you begin with a poorly chosen sample or if the sample changes between the time it is collected and the time it is analyzed, results are meaningless.

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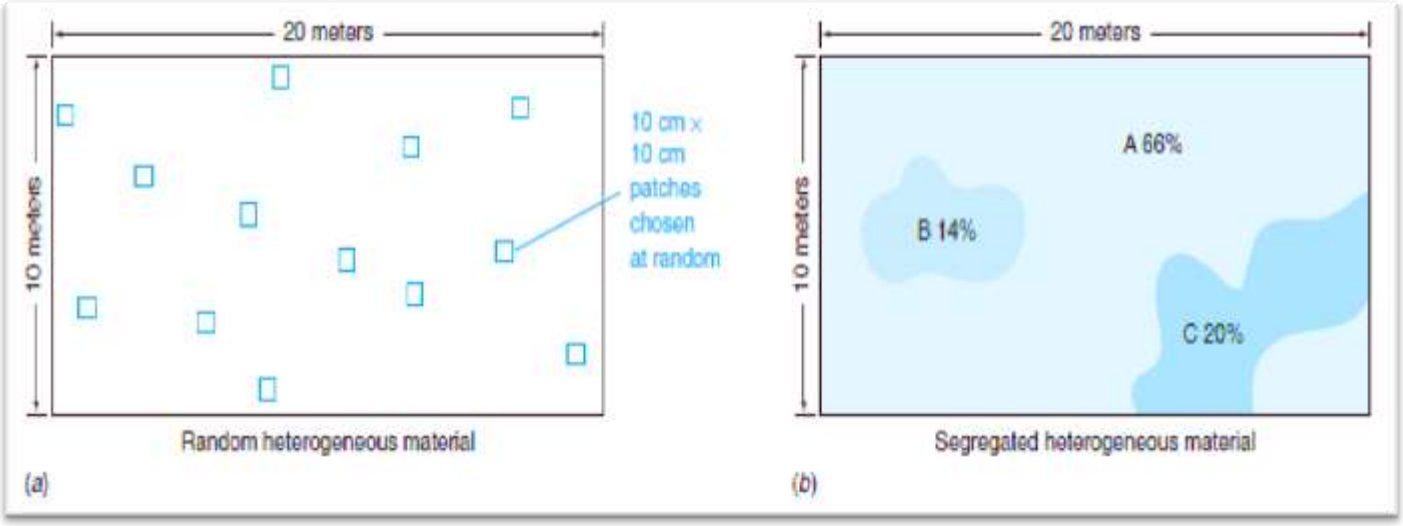

Figure (1) samples distribution

4. ***Sample preparation***

Converting a representative sample into a form suitable for analysis is called *sample preparation*, which usually means dissolving the sample. Samples with a low concentration of analyte may need to be concentrated prior to analysis. It may be necessary to remove or *mask* species that interfere with the chemical analysis. For a chocolate bar, sample preparation consisted of removing fat and dissolving the desired analytes. Fat was removed because it would interfere with chromatography, Figure (2).

5. ***Analysis*:** Measure the concentration of analyte in several identical **aliquots** (portions). The purpose of replicate measurements (repeated measurements) is to assess the variability (uncertainty) in the analysis and to guard against a gross error in the analysis of a single aliquot, Figure (3).

The uncertainty of a measurement is as important as the measurement itself because it tells us how reliable the measurement is. If necessary, use different analytical methods on similar samples to show that the choice of analytical method is not biasing the result. You may also wish to construct several different samples to see what variations arise from your sampling and sample preparation procedure.

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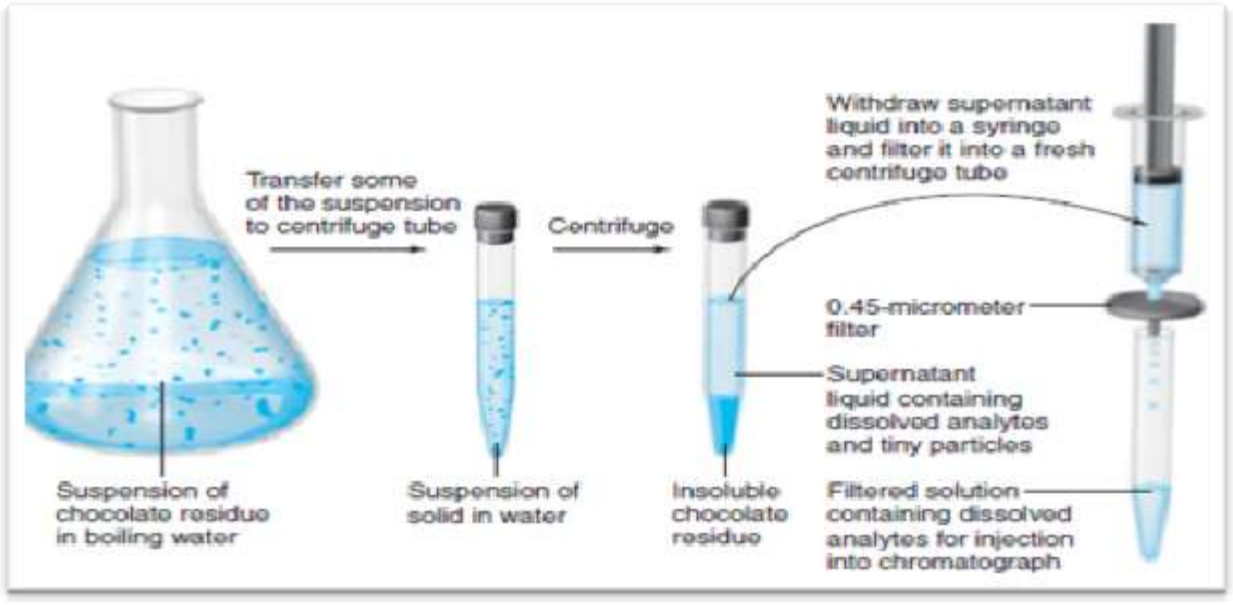

Figure (2) Centrifugation and filtration are used to separate undesired solid residue from the aqueous solution of analytes.

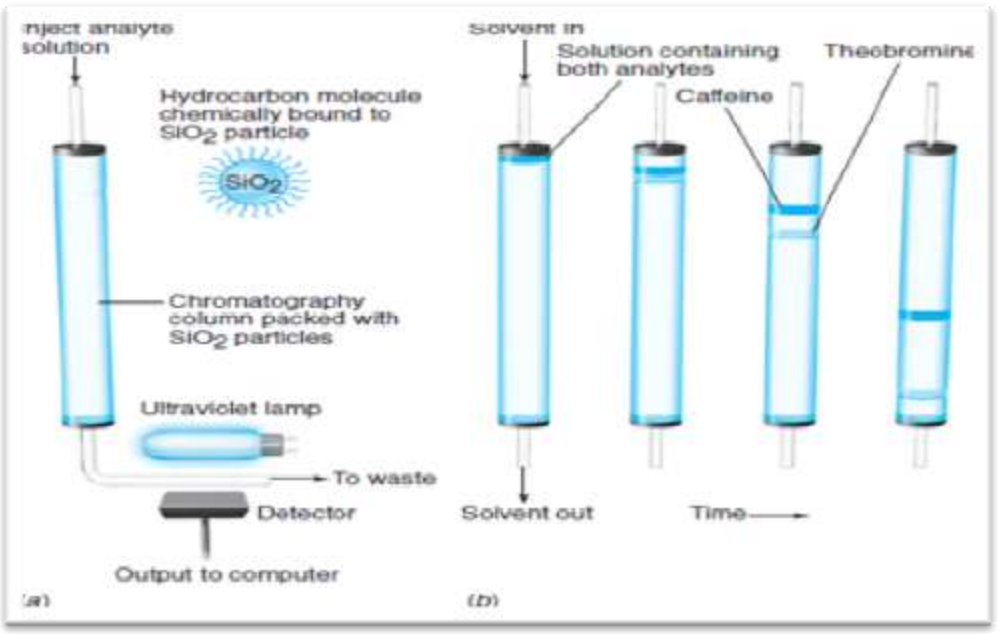

Figure (3) Principle of liquid chromatography. (*a*) Chromatography apparatus with an ultraviolet absorbance monitor to detect analytes at the column outlet. (*b*) Separation of caffeine and theobromine by chromatography. Caffeine has greater affinity than theobromine for the hydrocarbon layer on the particles in the column. Therefore, caffeine is retained more strongly and moves through the column more slowly than theobromine.

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6. ***Reporting and interpretation:*** Deliver a clearly written, complete report of your results, highlighting any limitations that you attach to them. Your report might be written to be read only by a specialist (such as your instructor), or it might be written for a general audience (such as a legislator or newspaper reporter). Be sure the report is appropriate for its intended audience, Figure (4).

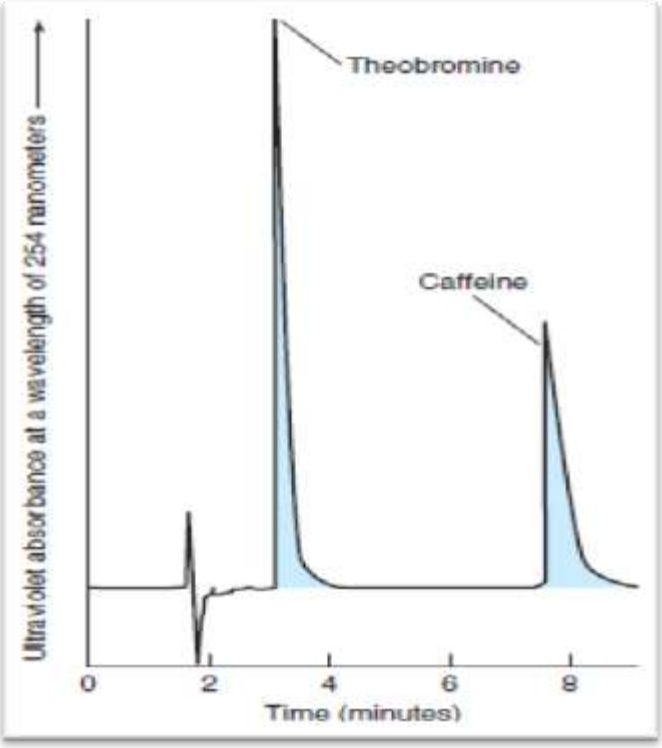

Figure (4) Chromatogram of 20.0 microliters of a standard solution containing 50.0 micrograms of theobromine and 50.0 micrograms of caffeine per gram of solution.

7. ***Drawing conclusions*** once a report is written, the analyst might not be involved in what is done with the information, such as modifying the raw material supply for a factory or creating new laws to regulate food additives. The more clearly a report is written, the less likely it is to be misinterpreted by those who use it.

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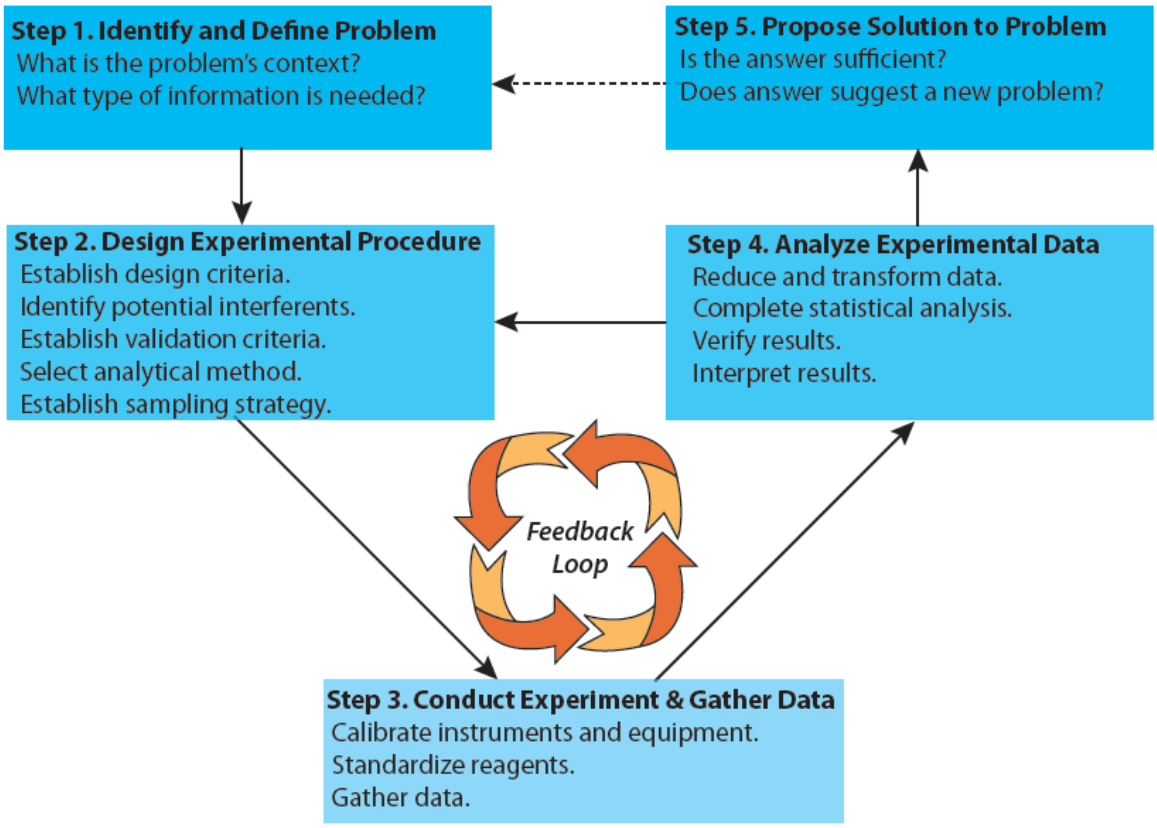
TABLE 0-1 Analyses of dark and white chocolate

Analyte	Grams of analyte per 100 grams of chocolate: Dark chocolate	White chocolate
Theobromine	0.392 ± 0.002	0.010 ± 0.007
Caffeine	0.050 ± 0.003	0.000 9 ± 0.001 4



Flow diagram showing one view of the analytical approach to solving problems

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Coulometry:	

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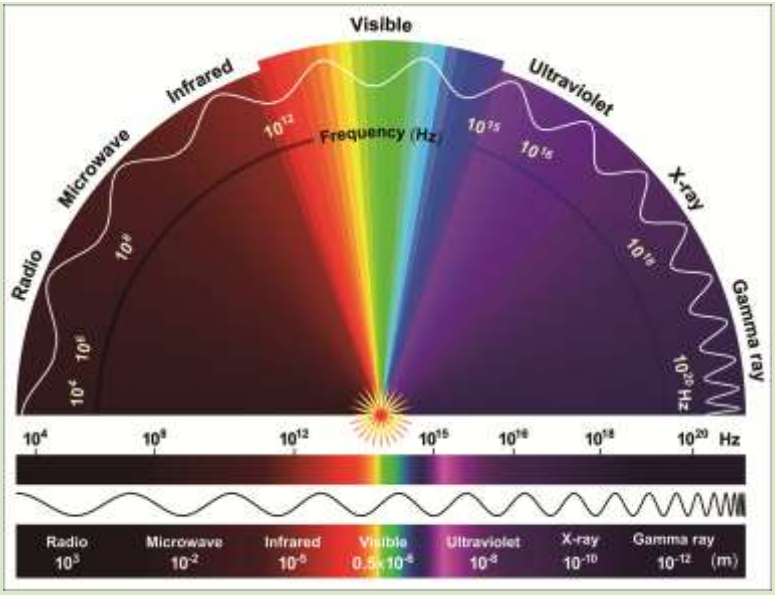
Conductimetry:	
Voltammetry:	
Ultraviolet, visible, infrared, and x-ray spectometry:	

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Thermogravimetry:	
Nuclear magnetic resonance:	

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Nuclear activation analysis:	
Mass spectrometry:	

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