

## Analytical Chemistry Vocabulary for Unit 1

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| <b>Absolute error</b>                | An accuracy measurement equal to the numerical difference between an experimental measurement and its true (or accepted) value.   |
| <b>Absolute standard deviation</b>   | A precision estimate based on the deviations between individual members in a set and the mean of that set (see Equation 6-4).   |
| <b>Absorbance, A</b>                 | The logarithm of the ratio between the initial power of a beam of radiation $P_0$ and its power after it has traversed an absorbing medium, P. $A = \log(P_0/P) = -\log(P/P_0)$ .   |
| <b>Accuracy</b>                      | A measure of the agreement between an analytical result and the true or accepted value for the measured quantity. This agreement is measured in terms of error  |
| <b>Aliquot</b>                       | A volume of liquid that is a known fraction of a larger volume.   |
| <b>Analysis of Variance (ANOVA)</b>  | A collection of statistical procedures for analysis of responses from experiments. Single-factor ANOVA allows comparison of more than two means of populations.   |
| <b>Analyte</b>                       | The species in a sample about which analytical information is sought.   |
| <b>Analytical balance</b>            | An instrument for accurately determining mass.  |
| <b>Angstrom, Å</b>                   | A unit of length equal to $1 \times 10^{-10}$ meter.  |
| <b>Arithmetic mean</b>               | Synonymous with <i>mean</i> or <i>average</i> .   |
| <b>Asbestos</b>                      | A fibrous mineral, some varieties of which are carcinogenic. It was once used as a filtering medium in a Gooch crucible but is currently subject to stringent regulation  |
| <b>Aspirator</b>                     | A device that can be attached to a laboratory faucet to create a vacuum for filtering solutions. Water from the faucet passes through a narrowed channel where the pressure is lowered by the Venturi effect. A hose is connected to the device at the narrowed channel where the vacuum is produced. |
| <b>Assay</b>                         | The process of determining how much of a given sample is the material indicated by its name.  |
| <b>Average</b>                       | A number obtained by summing the values in a data set and dividing the sum by the number of data points in the set. Synonymous with <i>mean</i> or <i>arithmetic mean</i> .   |
| <b>Bias</b>                          | The tendency to skew estimates in the direction that favors the anticipated result. Also used to describe the effect of a <i>systematic error</i> on a set of measurements. Also a dc voltage that is applied to a circuit element.   |
| <b>Blank determination</b>           | The process of performing all steps of an analysis in the absence of sample. Used to detect and compensate for systematic errors in an analysis   |
| <b>Buoyancy</b>                      | The displacement of the medium (usually air) by an object, producing an apparent loss of mass. A significant source of error when the densities of the object and the comparison standards (weights) differ.  |
| <b>Buret</b>                         | A graduated tube from which accurately known volumes can be dispensed.  |
| <b>Calibration</b>                   | The empirical determination of the relationship between a measured quantity and a known reference or standard value. Used to establish analytical signal versus concentration relationships in a calibration or working curve.  |
| <b>Cell</b>                          | (3) In an electronic balance, a system of constraints that assure alignment of the pan.   |
| <b>Coefficient of variation (CV)</b> | The relative standard deviation, expressed as a percentage  |
| <b>Confidence interval</b>           | Defines bounds about the experimental mean within which—with a given probability—the true mean should be located.   |
| <b>Confidence limits</b>             | The values that define the confidence interval.   |
| <b>Constant error</b>                | A systematic error that is independent of the size of the sample taken for analysis. Its effect on the results of an analysis increases as the sample size decreases.   |
| <b>Constant mass</b>                 | The condition in which the mass of an object is no longer altered by heating or cooling.  |
| <b>Control chart</b>                 | A plot that demonstrates statistical control of a product or a service as a function of time.   |
| <b>Dalton</b>                        | Unit of mass. One Dalton is equal to one unified atomic mass unit.  |
| <b>Decantation</b>                   | The transfer of supernatant liquid and washings from a container to a filter without disturbing the precipitated solid in the container.  |

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| <b>Degrees of freedom</b>                        | The number of members in a statistical sample that provide an independent measure of the precision of the set.   |
| <b>Density</b>                                   | The ratio of the mass of an object to its volume, normally measured in units of g/cm <sup>3</sup> for liquids and solids and g/L for gases. The SI unit is kg/m <sup>3</sup> .   |
| <b>Desiccants</b>                                | Drying agents.   |
| <b>Desiccator</b>                                | A container that provides a dry atmosphere for the cooling and storage of samples, crucibles, and precipitates.  |
| <b>Detection limit</b>                           | The minimum amount of analyte that a system or a method is capable of measuring.   |
| <b>Determinate error</b>                         | A class of errors that at least, in principle, has a known cause. Synonym for systematic error.  |
| <b>Deviation</b>                                 | The difference between an individual measurement and the mean (or median) value for a set of data.   |
| <b>Diffusion</b>                                 | The migration of species from a region of high concentration in a solution to a more dilute region.  |
| <b>Electroanalytical methods</b>                 | A large group of methods that have in common the measurement of an electrical property of the system that is proportional to the amount of analyte in the sample.  |
| <b>Electronic balance</b>                        | A balance in which an electromagnetic field supports the pan and its contents. The current needed to restore the loaded pan to its original position is proportional to the mass on the pan.   |
| <b>Empirical formula</b>                         | The simplest whole-number combination of atoms in a molecule.  |
| <b>Eppendorf pipet</b>                           | A type of micropipet that delivers adjustable volumes of liquid.   |
| <b>Error</b>                                     | The difference between an experimental measurement and its accepted value.   |
| <b>F-test</b>                                    | A statistical method that permits comparison of the variances of two sets of measurements.   |
| <b>Formality, F</b>                              | The number of moles of solute contained in each liter of solution. A synonym of <i>molar analytical concentration</i> .  |
| <b>Formula mass</b>                              | The sum of atomic masses in the chemical formula of a substance. A synonym for <i>gram formula weight and molar mass</i> .   |
| <b>Fritted-glass crucible</b>                    | A filtering crucible equipped with a porous glass bottom. Also called a sintered-glass crucible.   |
| <b>Gaussian distribution</b>                     | A theoretical bell-shaped distribution of results obtained for replicate measurements that are affected by random errors.  |
| <b>Gross error</b>                               | An occasional error, neither random nor systematic, that results in the occurrence of a questionable outlier result.   |
| <b>Gross sample</b>                              | A representative portion of a whole analytical sample, which with further treatment, becomes the laboratory sample.  |
| <b>Histogram</b>                                 | A bar graph in which replicate results are grouped according to ranges of magnitude along the horizontal axis and by frequency of occurrence on the vertical axis.   |
| <b>Hypothesis testing</b>                        | The process of testing a tentative assertion with various statistical tests. See <i>t-test</i> , <i>F-test</i> , <i>Q-test</i> , and <i>ANOVA</i> .  |
| <b>Indeterminate error</b>                       | Synonymous with <i>random error</i> .  |
| <b>Intercept, <i>b</i>, of a regression line</b> | The y value in a regression line when the x value is zero; in an analytical calibration curve, the hypothetical value of the analytical signal when the concentration of analyte is zero.  |
| <b>Internal standard</b>                         | A known quantity of a species with properties similar to an analyte that is introduced into solutions of the standard and the unknown; the ratio of the signal from the internal standard to the signal from the analyte serves as the basis for the analysis. |
| <b>Kilogram</b>                                  | The base unit of mass in the SI system.  |
| <b>Least-squares method</b>                      | A statistical method of obtaining the parameters of a mathematical model (such as the equation for a straight line) by minimizing the sum of the squares of the differences between the experimental points and the points predicted by the model.             |
| <b>Liter</b>                                     | One cubic decimeter or 1000 cubic centimeters.   |
| <b>Lower control limit, LCL</b>                  | The lower boundary that has been set for satisfactory performance of a process or measurement.   |
| <b>Macro analysis</b>                            | Analysis of samples of masses more than 0.1 g.   |
| <b>Major constituent</b>                         | A constituent whose concentration is between 1% and 100%.  |
| <b>Masking agent</b>                             | A reagent that combines with and inactivates matrix species that would otherwise interfere with the determination of an analyte.   |

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| <b>Mass</b>   | An invariant measure of the amount of matter in an object.   |
| <b>Matrix</b>   | The medium that contains an analyte.   |
| <b>Mean</b>   | Synonym for arithmetic <i>mean</i> and <i>average</i> ; used to report what is considered the most representative value for a set of measurements.   |
| <b>Measuring pipet</b>                                    | A pipet calibrated to deliver any desired volume up to its maximum capacity; compare with volumetric pipet.  |
| <b>Median</b>   | The central value in a set of replicate measurements. For an odd number of data points, there are an equal number of points above and below the median; for an even number of data points, the median is the average of the central pair.                              |
| <b>Meniscus</b>   | The curved surface displayed by a liquid held in a vessel.   |
| <b>Method uncertainty, <math>s_m</math></b>               | The standard deviation associated with a measurement method; a factor, with the sampling standard deviation, $s_s$ , in determining the overall standard deviation, $s_o$ , of an analysis.  |
| <b>Micro analysis</b>                                     | Analysis of samples with masses from 0.0001 to 0.01 g.   |
| <b>Microgram, <math>\mu\text{g}</math></b>                | $1 \times 10^{-6}$ g.  |
| <b>Microliter, <math>\mu\text{L}</math></b>               | $1 \times 10^{-6}$ L.  |
| <b>Milligram, mg</b>                                      | $1 \times 10^{-3}$ g or $1 \times 10^{-6}$ kg.   |
| <b>Milliliter, mL</b>                                     | $1 \times 10^{-3}$ L.  |
| <b>Millimole, mmol</b>                                    | $1 \times 10^{-3}$ mol.  |
| <b>Minor constituent</b>                                  | A constituent whose concentration is between 0.01% (100 ppm) and 1%.   |
| <b>Molar analytical concentration, <math>c_x</math></b>   | The number of moles of solute, X, that has been dissolved in sufficient solvent to give one liter of solution. Also numerically equal to the number of millimoles of solute per milliliter of solution. Compare with <i>equilibrium molar concentration</i> .          |
| <b>Molar concentration, M</b>                             | The number of moles of a species contained in one liter of solution or the number of millimoles contained in one milliliter.   |
| <b>Molar mass, <math>M</math></b>                         | The mass, in grams, of one mole of a chemical substance.   |
| <b>Molar species concentration</b>                        | The equilibrium concentration of a species expressed in moles per liter and symbolized with square brackets [ ]; synonymous with <i>molar equilibrium concentration</i> .  |
| <b>Mole</b>   | The amount of substance that is $6.022 \times 10^{23}$ particles of that substance.  |
| <b>Molecular formula</b>                                  | A formula that includes structural information in addition to the number and identity of the atoms in a molecule.  |
| <b>Normal error curve</b>                                 | A plot of a Gaussian distribution of the frequency of results from random errors in a measurement.   |
| <b>Null hypothesis</b>                                    | A claim that a characteristic of a single population is equal to some specified value or that two or more population characteristics are identical; statistical tests are devised to validate or invalidate the null hypothesis with a specified level of probability. |
| <b>Outlier</b>  | A result that appears at odds with the other members in a data set   |
| <b>Parts per million, ppm</b>                             | A convenient method of expressing the concentration of a solute species that exists in trace amounts; for dilute aqueous solutions, ppm is synonymous with <i>milligrams of solute per liter of solution</i> .   |
| <b>Pipet</b>  | A tubular glass or plastic device for transferring known volumes of solution from one container to another.  |
| <b>Population mean, <math>\mu</math></b>                  | The mean value for a population of data; the true value for a quantity that is free of systematic error.   |
| <b>Population of data</b>                                 | The total number of values (sometimes assumed to be infinite) that a measurement could take; also referred to as a <i>universe of data</i> .   |
| <b>Population standard deviation, <math>\sigma</math></b> | A measure of precision based on a population of data.  |
| <b>Precision</b>  | A measure of the agreement among individual data in a set of replicate observations  |
| <b>Proportional error</b>                                 | An error whose magnitude increases as the sample size increases.   |
| <b>p-Value</b>  | An expression of the concentration of a solute species as its negative logarithm; the use of p-values permits expression of enormous ranges of concentration in terms of relatively small numbers  |
| <b>Q test</b>   | A statistical test that indicates—with a specified level of probability—whether an outlying measurement in   |

a set of replicate data is a member of a given Gaussian distribution.

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| <b>Quality assessment</b>  | A protocol to assure that quality control methods are providing the information needed to evaluate satisfactory performance of a product or a service.  |
| <b>Quality assurance</b>   | A protocol designed to demonstrate that a product or a service is meeting criteria that have been established for satisfactory performance.   |
| <b>Random errors</b>   | Uncertainties resulting from the operation of small uncontrolled variables that are inevitable as measurement systems are extended to and beyond their limits.  |
| <b>Range, <math>w</math>, of data</b>                            | The difference between extreme values in a set of data; synonymous with <i>spread</i> .   |
| <b>Reagent-grade chemicals</b>                                   | Highly pure chemicals that meet the standards of the Reagent Chemical Committee of the American Chemical Society.   |
| <b>Reference standards</b>                                       | Complex materials that have been extensively analyzed; a prime source for these standards is the National Institute of Standards and Technology (NIST).   |
| <b>Regression analysis</b>                                       | A statistical technique for determining the parameters of a model. See also <i>least-squares method</i> .   |
| <b>Relative error</b>  | The error in a measurement divided by the true (or accepted) value for the measurement; often expressed as a percentage.  |
| <b>Relative standard deviation (RSD)</b>                         | The standard deviation divided by the mean value for a set of data; when expressed as a percentage, the relative standard deviation is referred to as the <i>coefficient of variation</i> .   |
| <b>Replicate samples</b>   | Portions of a material, of approximately the same size, that are carried through an analysis at the same time and in precisely the same way.  |
| <b>Residual</b>  | The difference between the value predicted by a model and the experimental value.   |
| <b>Rubber policeman</b>  | A small length of rubber tubing that has been crimped on one end; used to dislodge adherent particles of precipitate from beaker walls.   |
| <b>Sample matrix</b>   | The medium that contains an analyte.  |
| <b>Sample of data</b>  | A finite group of replicate measurements.   |
| <b>Sample standard deviation, <math>s</math></b>                 | A precision estimate based on deviations of individual data from the mean, $\bar{x}$ , of a data sample; also referred to as the <i>standard deviation</i> .  |
| <b>Sampling</b>  | The process of collecting a small portion of a material whose composition is representative of the bulk of the material from which it was taken.  |
| <b>Sampling uncertainty, <math>s_s</math></b>                    | The standard deviation associated with the taking of a sample; a factor—with the method uncertainty—in determining the overall standard deviation of an analysis.   |
| <b>Semimicro analysis</b>  | Analysis of samples with masses from 0.01 g to 0.1g.  |
| <b>Semimicroanalytical balance</b>                               | A balance with a capacity of about 30 g and a precision of 0.01 mg.   |
| <b>SI units</b>  | An international system of measurement that uses seven base units; all other units are derived from these seven units.  |
| <b>Significant figure convention</b>                             | A system of communicating to the reader information concerning the reliability of numerical data in the absence of any statistical data; in general, all digits known with certainty, plus the first uncertain digit, are considered significant. |
| <b>Slope, <math>m</math>, of a calibration line</b>              | A parameter of the linear model $y = mx + b$ ; determined by regression analysis.   |
| <b>Specific gravity, <math>sp\ gr</math></b>                     | The ratio of the density of a substance to that of water at a specified temperature (ordinarily 4°C).   |
| <b>Spread, <math>w</math>, of data</b>                           | A precision estimate; synonymous with <i>range</i> .  |
| <b>Standard deviation about regression, <math>s_r</math></b>     | The standard error of the deviations from a least-square straight line. A synonym of <i>standard error of the estimate</i> .  |
| <b>Standard deviation, <math>\sigma</math> or <math>s</math></b> | A measure of how closely replicate data cluster around the mean; in a normal distribution, 67% of the data points can be expected to lie within one standard deviation of the mean.   |
| <b>Standard error of the estimate</b>                            | Synonym for <i>standard deviation about regression</i> .  |

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| <b>Standard error of the mean, <math>s_m</math> or <math>S_m</math></b> | The standard deviation divided by the square root of the number of measurements in the set.   |
| <b>Standard reference materials (SRMs)</b>                              | Samples of various materials in which the concentration of one or more species is known with very high certainty.   |
| <b>Statistical control</b>  | The condition in which performance of a product or a service is deemed within bounds that have been set for quality assurance; defined by upper and lower control limits.   |
| <b>Statistical sample</b>   | A finite set of measurements, drawn from a population of data, often from a hypothetical infinite number of possible measurements   |
| <b>Stoichiometry</b>  | The combining ratios among molar quantities of species in a chemical reaction.  |
| <b>Systematic error</b>   | Errors that have a known source; they affect measurements in one and only one way and can, in principle, be accounted for. Also called <i>determinate error</i> or <i>bias</i> .  |
| <b>t-test</b>   | A statistical test used to decide whether an experimental value equals a known or theoretical value or whether two or more experimental values are identical with a given level of confidence; used with $s$ and $x$ when good estimates of $\sigma$ and $\mu$ are not available. |
| <b>Tare</b>   | A counterweight used on an analytical balance to compensate for the mass of a container; the act of zeroing a balance.  |
| <b>Trace constituent</b>  | A constituent whose concentration is between 1 ppb and 100 ppm.   |
| <b>Transfer pipet</b>   | Synonym for volumetric pipet.   |
| <b>Triple-beam balance</b>  | A rugged, albeit primitive in the age of electronic balances, laboratory balance that is used to weigh approximate amounts.   |
| <b>Ultramicro analysis</b>  | Analysis of samples whose mass is less than $10^{-4}$ g.  |
| <b>Ultratrace constituent</b>   | A constituent whose concentration is less than 1 ppb.   |
| <b>Universe of data</b>   | Synonymous with a <i>population of data</i> .   |
| <b>Variance, <math>\sigma^2</math> or <math>s^2</math></b>              | A precision estimate consisting of the square of the standard deviation. Also a measure of column performance; given the symbol $\tau^2$ where the abscissa of the chromatogram has units of time.  |
| <b>Volume percent (v/v)</b>   | The ratio of the volume of a liquid to the volume of its solution, multiplied by 100%.  |
| <b>Volumetric flask</b>   | A container for preparing precise volumes of solution.  |
| <b>Volumetric pipet</b>   | A device that will deliver a precise volume from one container to another; also called a measuring pipet.   |
| <b>Weighing bottle</b>  | A lightweight container for the storage and weighing of analytical samples.   |
| <b>Weighing by difference</b>   | The process of weighing a container plus the sample, followed by weighing the container after the sample has been removed or before it has been placed in the container.  |
| <b>Weight</b>   | The attraction between an object and its surroundings, terrestrially, the Earth.  |
| <b>Weight percent (w/w)</b>   | The ratio of the mass of a solute to the mass of its solution, multiplied by 100%.  |
| <b>Weight/volume percent (w/v)</b>                                      | The ratio of the mass of a solute to the volume of solution in which it is dissolved, multiplied by 100%.   |
| <b>Wet ashing</b>   | The use of strong liquid oxidizing reagents to decompose the organic matter in a sample.  |