Dosing a chemical species in a solution

Dosing a chemical species in solution means determining its **molar quantity** or its **molar or mass concentration** in the solution.
It is often used to verify the quality or the validity of a solution.
2 types of processes are used:

Non-destructive process: dosing by calibration

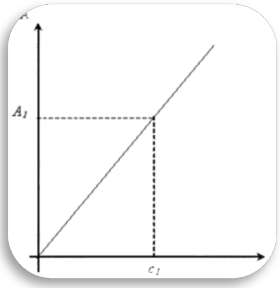
Ex: spectrophotometry
The chemical species involved is not consumed.

1. Definition

When preparing a series of increasingly diluted daughter solutions from a colored stock solution, we obtain a series of solutions whose concentrations are known and whose colors become increasingly lighter.
This series of solutions is called a "color scale."
Dosing a colored solution by calibration involves determining the concentration of that solution either by comparing its color with the colors on the color scale with the naked eye, or by comparing the absorbance of the solutions using a spectrophotometer.

2. Using a spectrophotometer

- Prepare a color scale for the colored species by diluting a stock solution. Each daughter solution has a known concentration.
- Measure the absorbance of each solution in the color scale.
  Work with a wavelength for which absorption will be as high as possible.
- Plot a graph showing the absorbance of the solutions in the color scale as a function of their concentration.
  According to Beer-Lambert's law, the calibration curve obtained is a straight line passing through the origin, with a slope k.
- Determination of an unknown concentration
  To determine the concentration of the same-colored species in a solution of unknown concentration, simply measure its absorbance. By plotting the value on the calibration curve, we can read the value of its concentration.



Note: Axis must be labelled and graduated.
The graph must have a title.
Data points are never connected, but a best-fit line is added.

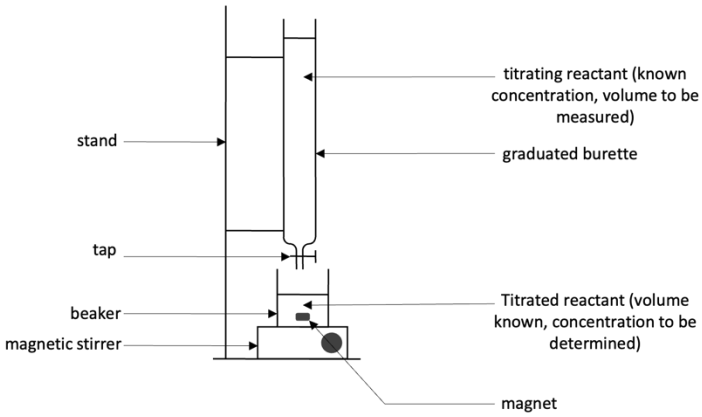
Destructive process : titration

This type of measurement is done using a chemical reaction. This involves the consumption of the chemical species. This process is known as titration.

1. Basic concept of titration

The species of unknown concentration (titrated reactant), in a solution of known volume, is made to react with a species of known concentration (titrating reactant).
The reaction taking place is the titration reaction.
The measurement of the volume of titrating solution needed to reach equivalence will then lead to the determination of the unknown concentration.

2. Diagram of a titration device



3. Equivalence of a titration

Equivalence corresponds to the **stoichiometric mixture** of reactants for the reaction involved. The two reactants are then **simultaneously limiting**, having been completely consumed.
They are said to have been **introduced in stoichiometric proportions**.

$aA + bB \rightarrow cC + dD$ Then: $\frac{n_A}{a} = \frac{n_B}{b}$

Equivalence corresponds to a change of the limiting reactant:

- **Before equivalence**, it is the titrating reactant that is limiting.
- **At equivalence**, both reactants are limiting simultaneously.
- **After equivalence**, it is the titrated reactant that is limiting.

4. Criteria for a good titration reaction

For a reaction to be used as a titration support, it must meet the following criteria:

- It must be **complete**, i.e., the limiting reagent must be consumed entirely.
  When the titration support reaction is an oxidation-reduction reaction, it can always be considered complete.
- The reaction must be **rapid**, i.e., each time titrant reagent is added, a new intermediate state is quickly reached.
- **Equivalence** must be **easy to determine**.
  It can, for example, be identified by a change in the color of the solution in the beaker. This is referred to as colorimetric titration.