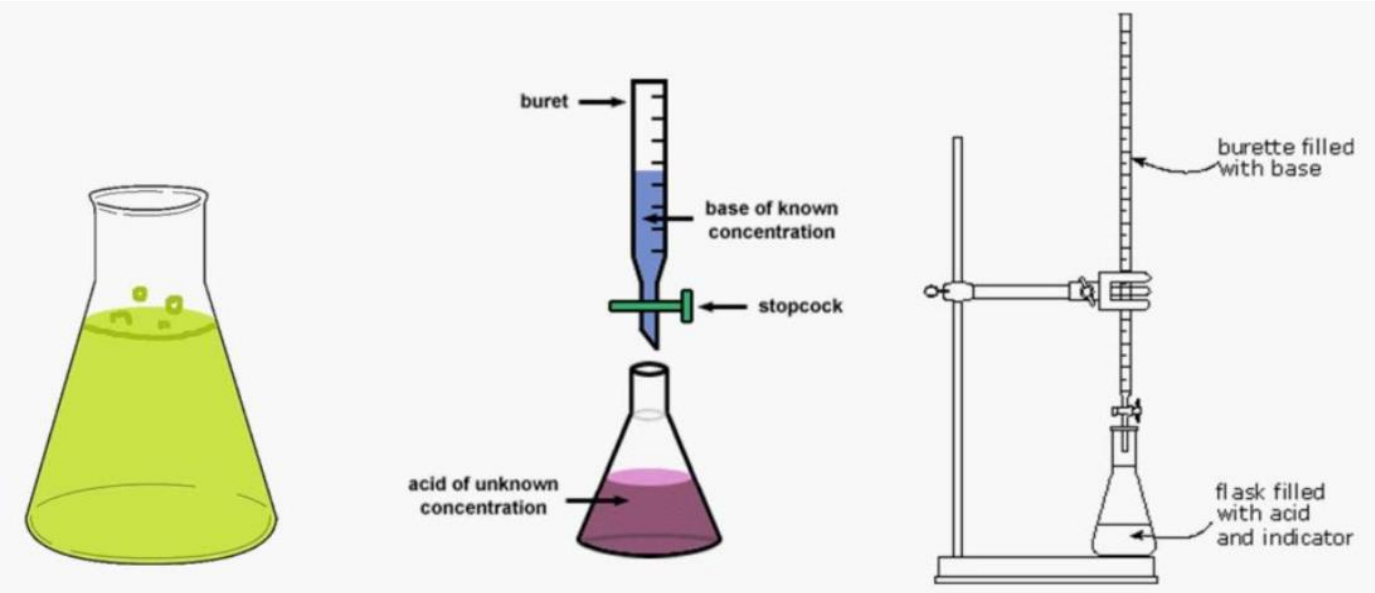
Fundamentals of Analytical Chemistry

م.د.مسار علي عواد

• Titration

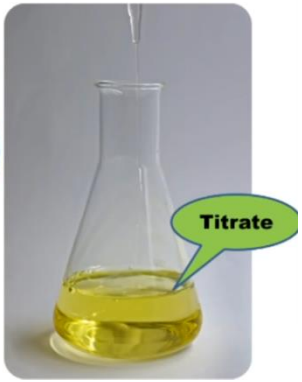
- ❑ **Analytical method in which a standard solution is used to determine the concentration of an unknown solution.**
- ❑ **A quantitative and volumetric technique, to determine the unknown concentration of a solution by the known concentration of a solution in the presence of indicator is called Titration.**
- ❑ **is used to determine the unidentified concentration of a known analyte**



Some Terms Used in Volumetric Titrations

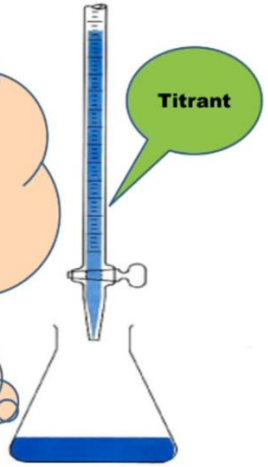
TITRATE

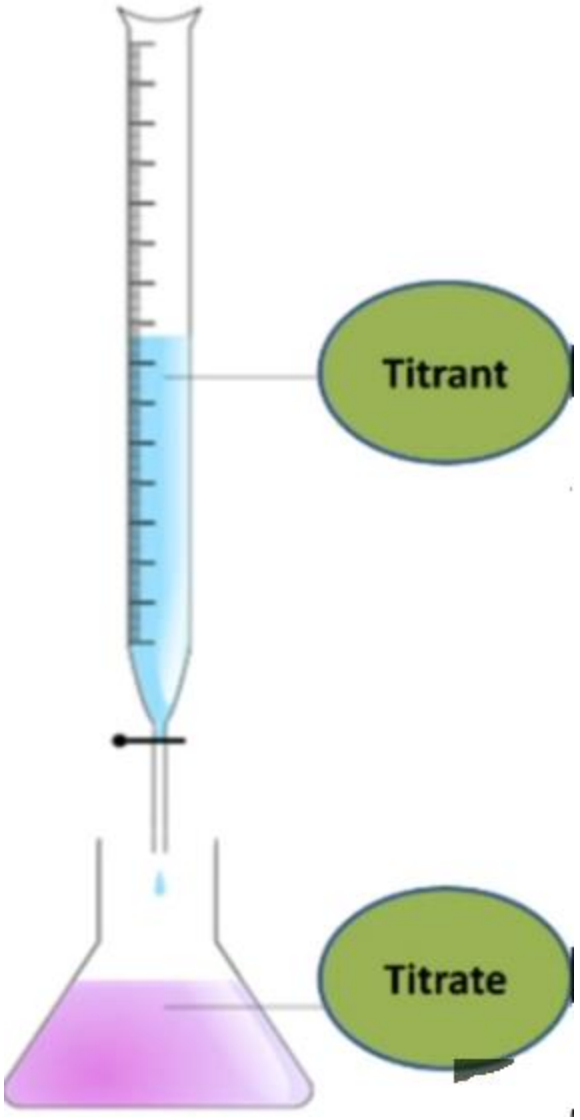
The substance being titrated (taken in conical flask) is known as titrate



TITRANT

The solution of known concentration used in titration (added from burette) are known as titrant





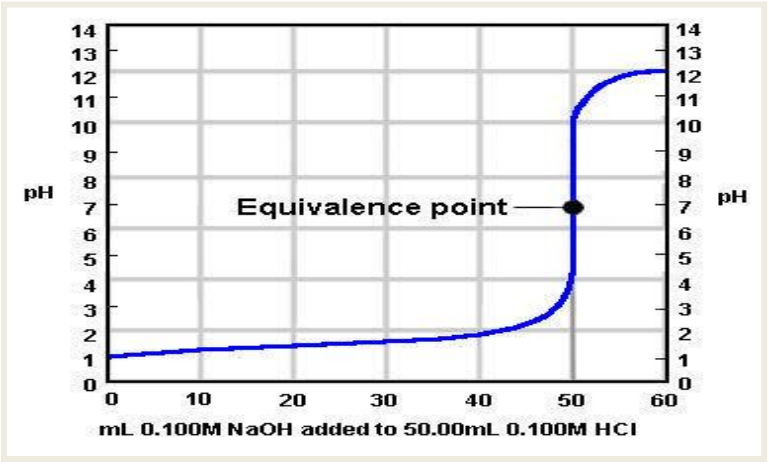
• Equivalence point (endpoint)

–Point at which equal amounts of H_3O^+ and OH^- have been added.

–is the point in a titration when the amount of added standard reagent is equivalent to the amount of analyte.

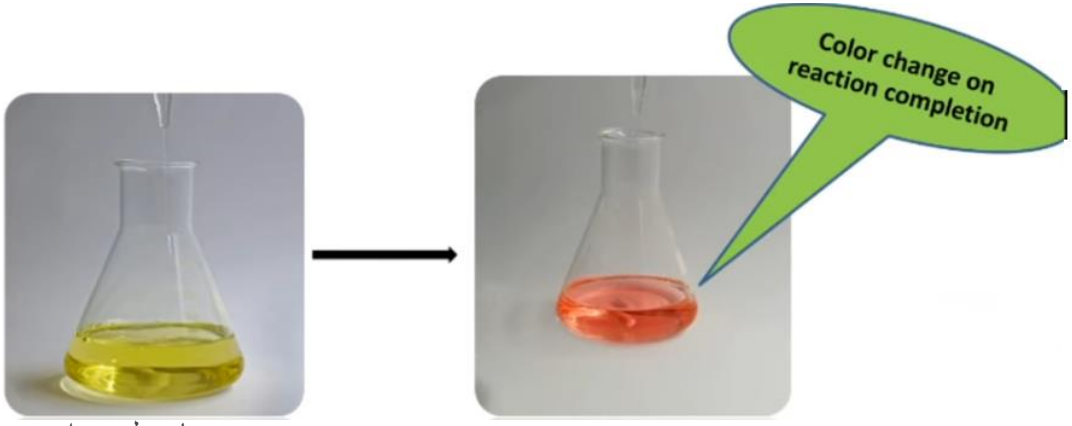
–Determined by…

- indicator color change



The **end point**

The **end point** is the point in a titration when a physical change occurs that is associated with the condition of chemical equivalence.



A standard solution

A **standard solution** is a reagent of known concentration. Standard solutions are used in titrations and in many other chemical analyses.

A primary standard solution is a highly purified compound that serve as a reference material in all volumetric titration methods.

primary standard solution

- **-Stability toward air.**
- **High purify.**
- **Absence of hydrate water**
- **Ready availability at modest cost**
- **Reasonable solubility in the titration medium.**
- **Reasonable large molar mass so that the relative error associated with weighing the standard is minimized**

A secondary standard

A **secondary standard** is a compound whose purity has been determined by chemical analysis . The secondary standard serves as the working standard material for titrations and for many other analyses.

The *ideal* standard solution for a titrimetric method will

- react rapidly with the analyte so that the time required between additions of reagent is minimized;
- be sufficiently stable so that it is necessary to determine its concentration only once.
- react more or less completely with the analyte so that satisfactory end points are realized;
- undergo a selective reaction with the analyte that can be described by a balanced.

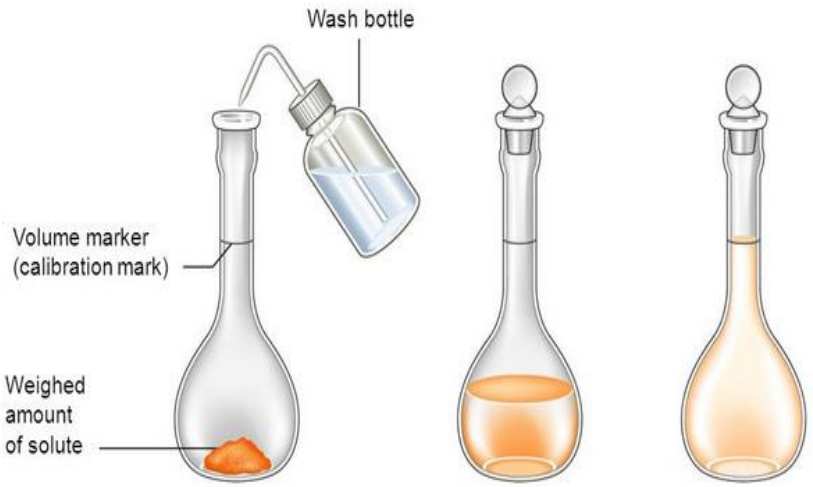
A standard solution

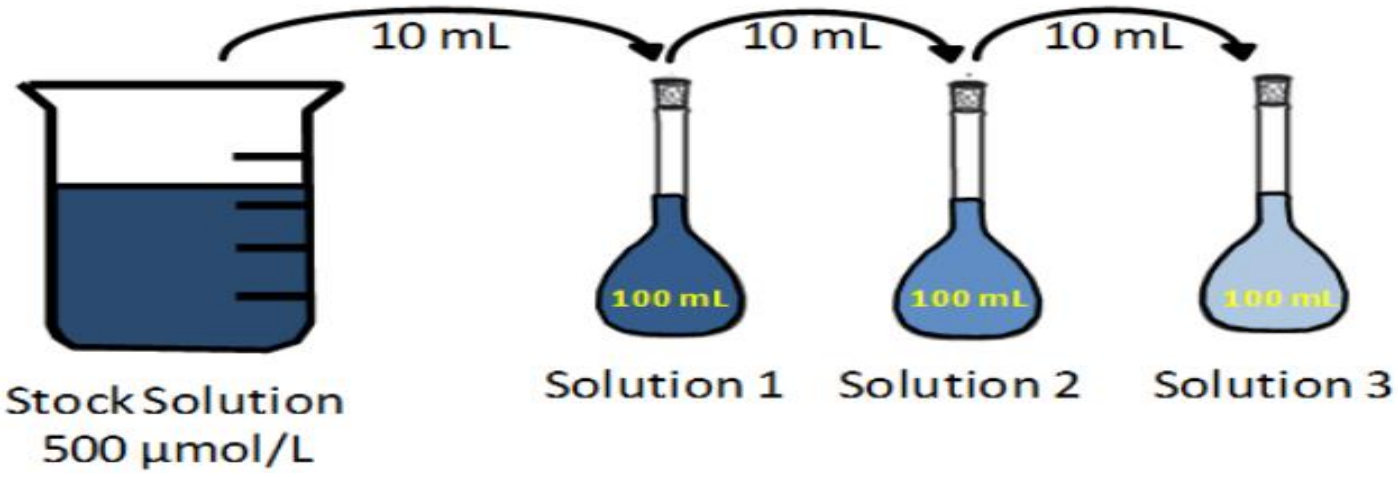
Primary standard

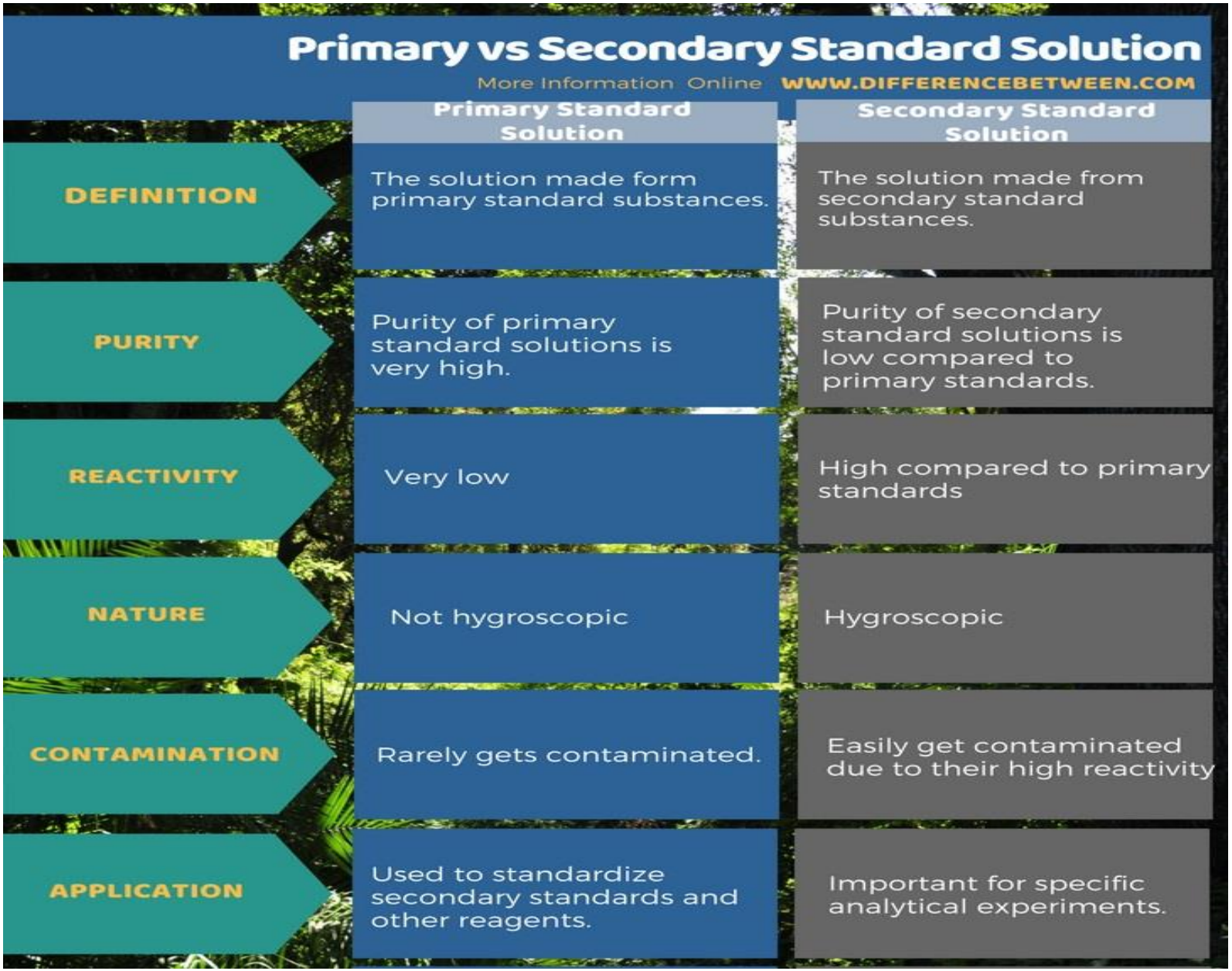
- HCl ,H3SO4
- NaOH , NH3
- KMnO4

Secondary standard

- Oxalic acid ,benzoic acid
- Borax,sodium carbonate
- K2Cr2O7,
- Na2C2O4



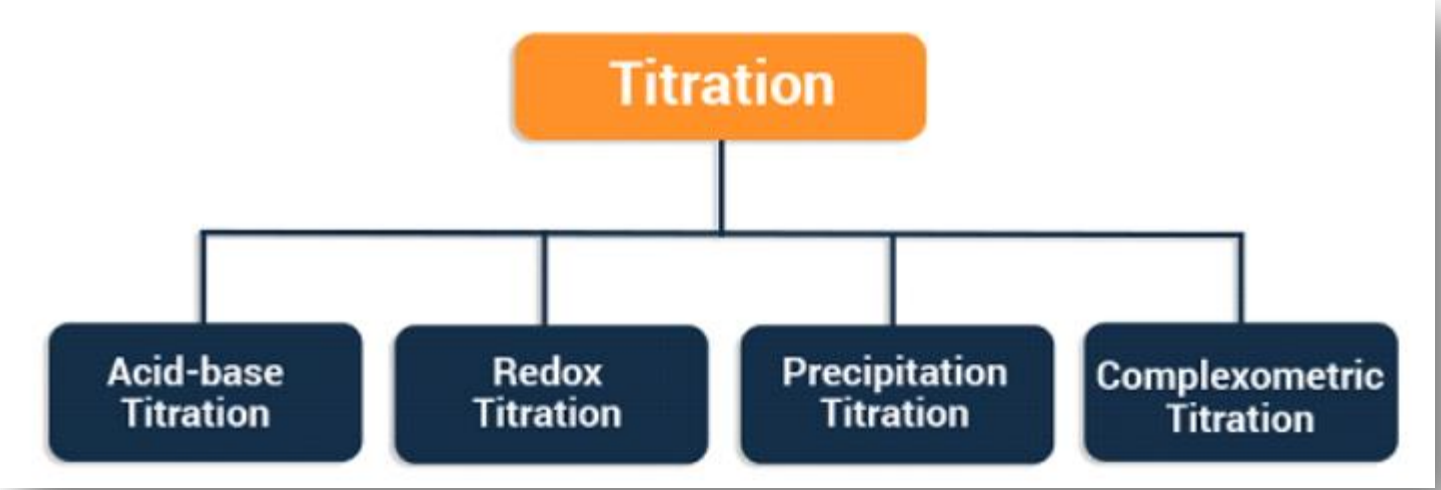



Primary vs Secondary Standard Solution
More Information Online WWW.DIFFERENCEBETWEEN.COM
Primary Standard Solution
Secondary Standard Solution
DEFINITION
The solution made form primary standard substances.
The solution made from secondary standard substances.
PURITY
Purity of primary standard solutions is very high.
Purity of secondary standard solutions is low compared to primary standards.
REACTIVITY
Very low
High compared to primary standards
NATURE
Not hygroscopic
Hygroscopic
CONTAMINATION
Rarely gets contaminated.
Easily get contaminated due to their high reactivity
APPLICATION
Used to standardize secondary standards and other reagents.
Important for specific analytical experiments.

Types of Titration

Titrations can be classified as:

Based on the strength of reagents used:

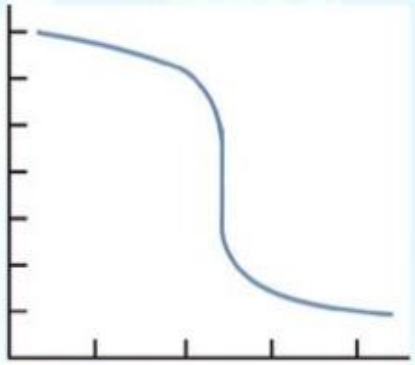


- Acid-base reactions.
  - Na_2CO_3, $Na_2B_4O_7$, $KH(C_8H_4O_4)$, HCl (cbpt.)
- Complex formation reactions.
  - $AgNO_3$, NaCl
- Precipitation reactions.
  - $AgNO_3$, KCl
- Redox reactions.
  - $K_2Cr_2O_7$, $Na_2C_2O_4$, I_2

Type of Titrations based on Chemical Reactions

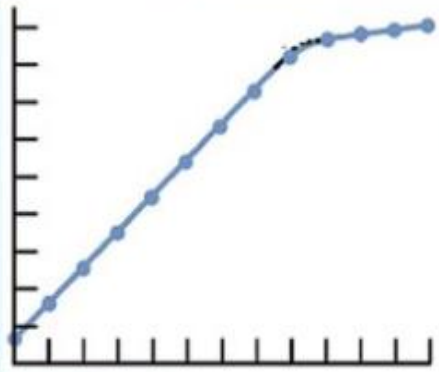
- Acid-Base Titrations, example:
  $H^+ + OH^- \rightarrow H_2O$ $\quad K = 1/K_w$
- Precipitation Titrations, example:
  $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$ $\quad K = 1/K_{sp}$
- Redox Titrations:
  $5\ H_2O_2 + 2\ MnO_4^- + H^+ \rightarrow 5\ O_2 + 2\ Mn^{2+} + 8H_2O$
- Complexometric Titrations, example:
  $EDTA + Ca^{2+} \rightarrow (Ca\text{–}EDTA)^{2+}$

Type of Titration Curves



Type	Example.	y-axis	x-axis
Acid-base	HCl/NaOH	pH	V. NaOH
Precipitation	Ag^+/Cl^-	pAg^+	V. Ag^+
Complexation	Ca^{2+}/EDTA	pCa^{2+}	V. EDTA
Redox	MnO_4^-/Fe^{2+}	Potential	V. Fe^{2+}

V. = volume



Type	Example	y-axis	x-axis
Spectro-photometric	apotransferrin/ Fe^{3+}	Absorbance	V. Fe^{3+}
Thermo-metric	H_3BO_4/ NaOH	Temperature	V. NaOH