TITRATION

TDC Part III
Paper VI
Inorganic Chemistry
Department of Chemistry

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Procedure:

- A typical titration begins with a beaker or flask containing a precise volume of the titrand and a small amount of indicator placed underneath a calibrated burette containing the titrant. Small volumes of the titrant are then added to the titrand and indicator until the indicator changes, reflecting arrival at the endpoint of the titration.

- Depending on the endpoint desired, single drops or less than a single drop of the titrant can make the difference between a permanent and temporary change in the indicator. When the end point of the reaction is reached, the volume of reactant consumed is measured and used to calculate the concentration of analyte

Preparation techniques

- Typical titrations require titrant and analyte to be in a liquid (solution) form. Though solids are usually dissolved into an aqueous solution, other solvents such as glacial acetic acid or ethanol are also used. [2]
- Concentrated analytes are often diluted to improve accuracy.

- Many non-acid-base titrations require a constant pH throughout the reaction. Therefore a buffer solution may be added to the titration chamber to maintain the pH.[3]
- In instances where two reactants in a sample may react with the titrant and only one is the desired analyte, a separate masking solution may be added to the reaction chamber which masks the unwanted ion.[4]

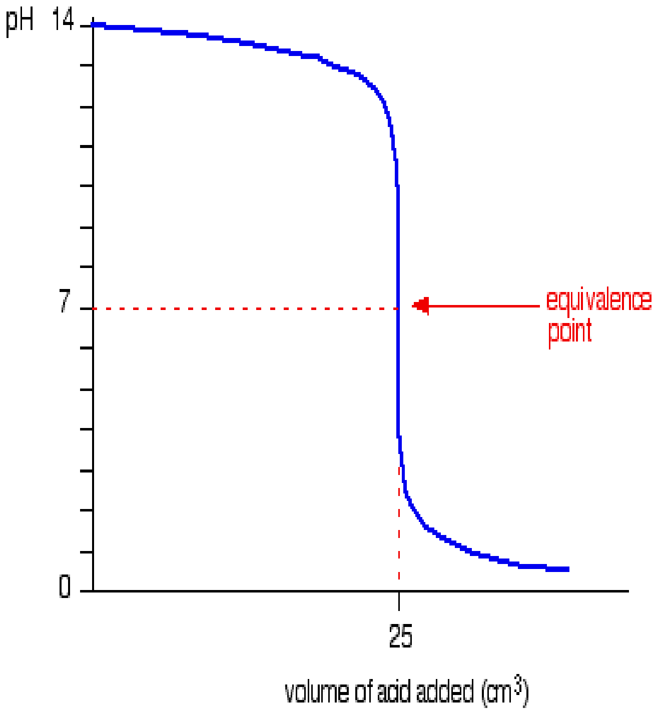
- Some redox reactions may require heating the sample solution and titrating while the solution is still hot to increase the reaction rate. For instance, the oxidation of some oxalate solutions requires heating to 60 °C (140 °F) to maintain a reasonable rate of reaction.[5]

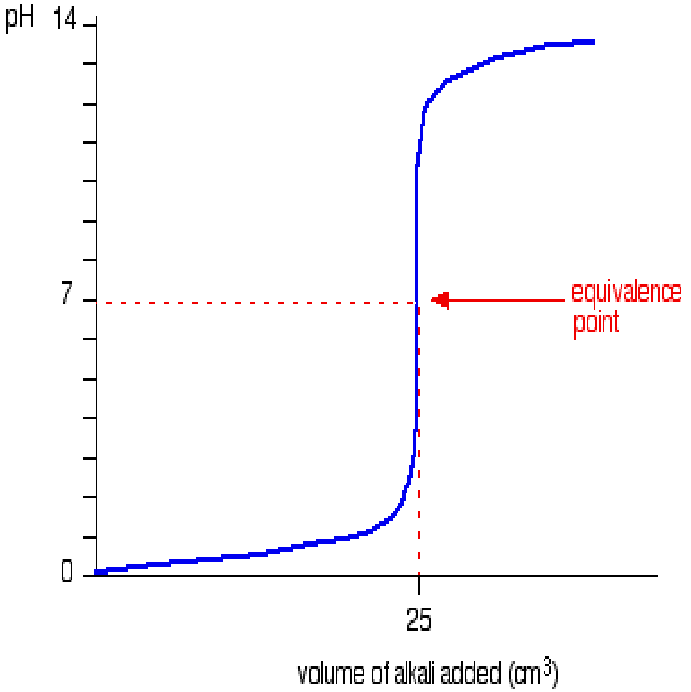
Titration curves

- A titration curve is a curve in the plane whose *x*-coordinate is the volume of titrant added since the beginning of the titration, and whose *y*-coordinate is the concentration of the analyte at the corresponding stage of the titration (in an acid-base titration, the *y*-coordinate is usually the pH of the solution).[6]

- In an acid-base titration, the titration curve reflects the strength of the corresponding acid and base. For a strong acid and a strong base, the curve will be relatively smooth and very steep near the equivalence point. Because of this, a small change in titrant volume near the equivalence point results in a large pH change and many indicators would be appropriate (e.g. phenolphthalein or bromothymol blue).

Strong acid and strong base curve

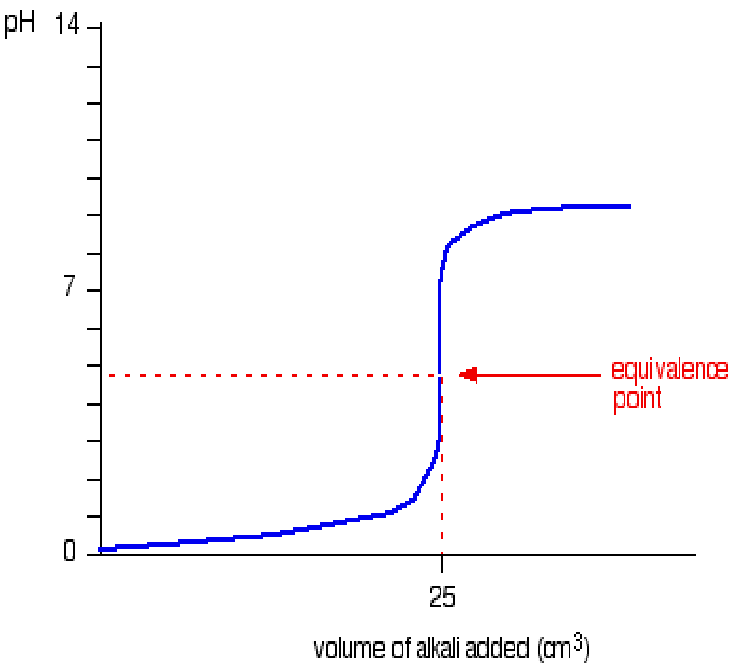


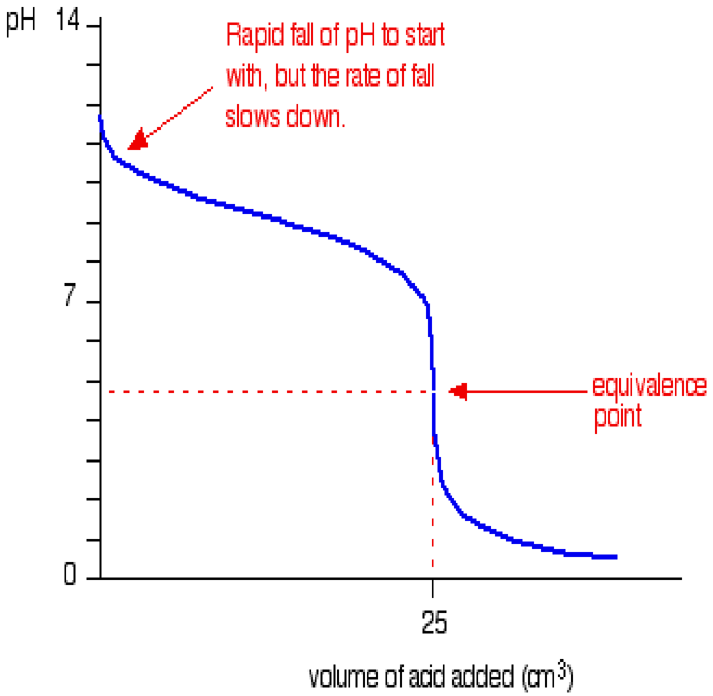


- If one reagent is a weak acid or base and the other is a strong acid or base, the titration curve is irregular and the pH shifts less with small additions of titrant near the equivalence point. For example, the titration curve for the titration between oxalic acid (a weak acid) and Na OH (a strong base), the equivalence point occurs between pH 8-10,

- Indicating the solution is basic at the equivalence point and an indicator such as phenolphthalein would be appropriate.
- Titration curves corresponding to weak bases and strong acids are similarly behaved, with the solution being acidic at the equivalence point and indicators such as methyl orange and bromothymol blue being most appropriate.

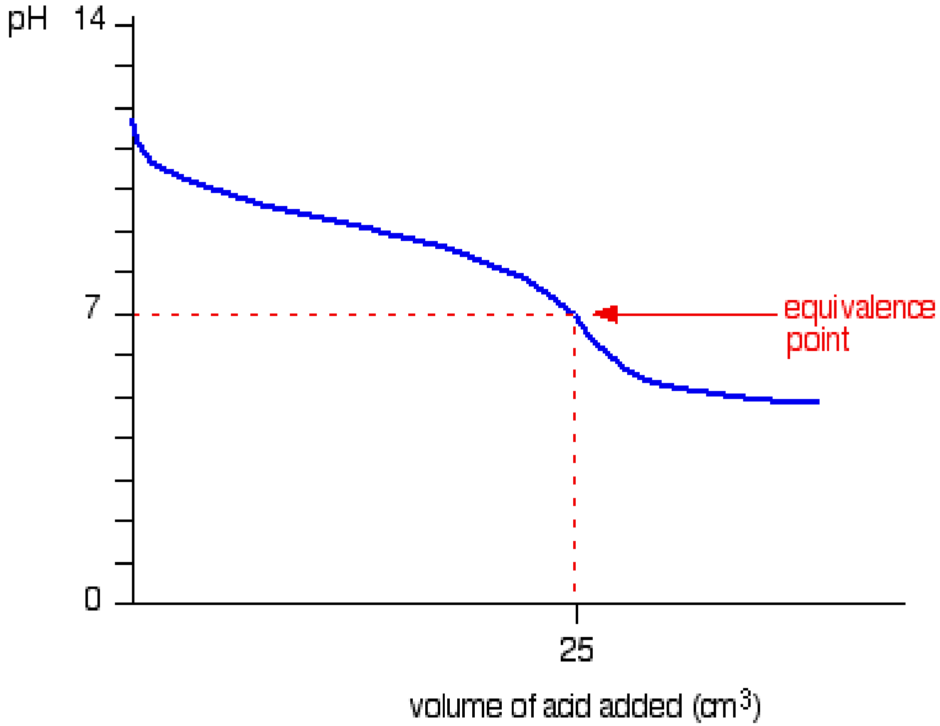
Strong acid and weak base curve





- Titrations between a weak acid and a weak base have titration curves which are highly irregular. Because of this, no definite indicator may be appropriate and a pH meter is often used to monitor the reaction.[7]
- The type of function that can be used to describe the curve is called a sigmoid function.

Weak acid and weak base curve



Endpoint and equivalence point

- Although equivalence point and endpoint are used interchangeably, they are different terms. *Equivalence point* is the theoretical completion of the reaction: the volume of added titrant at which the number of moles of titrant is equal to the number of moles of analyte, or some multiple thereof (as in polyprotic acids).

- *Endpoint* is what is actually measured, a physical change in the solution as determined by an indicator or an instrument mentioned above.[8]
- There is a slight difference between the endpoint and the equivalence point of the titration. This error is referred to as an indicator error, and it is indeterminate.[9]