

YEAR 12 CHEMISTRY: ACID-BASE TITRATIONS

Acid-base titrations are a means of finding the concentration of an "unknown" acid or base solution by measuring the volume of the unknown that is required to react with a known volume of a "standard" solution. This type of work is also called "volumetric analysis".

1 Preparation of a primary standard.

- (a) Calculate the mass of solid needed to make the required volume of the concentration of solution needed.
- (b) Weigh out, accurately, approximately this mass.
- (c) Dissolve the weighed primary standard solid in distilled water, and make up to the mark in the appropriate volumetric flask.
- (d) Calculate the exact molarity of the solution you have made up.

2 Titration of an unknown solution with the primary standard

- (a) Choose which reagent solution will be delivered from the burette (it is a good practice to avoid using solutions which may damage a burette, eg alkaline solutions).
- (b) Pipette the other solution into a conical flask.
- (c) Add 2 or 3 drops of a suitable indicator to the solution in the flask (eg for a titration between strong acid like HCl and a weak base like Na_2CO_3 , use methyl orange).
- (d) Record the volume reading on the burette (should be able to read to 2 decimal places).
- (e) Add the solution from the burette until the colour of the solution in the conical flask is the transitional colour (eg for methyl orange, a pale orange colour).
- (f) Record the final volume reading on the burette (should be able to read to 2 decimal places).
- (g) Calculate the volume delivered from the burette, by subtraction.
- (i) Repeat the procedure until at least 2 volumes delivered agree, to ± 0.1 mL.
- (j) Average those results that agree, and calculate the molarity of the unknown solution.
- (k) The concentration of the unknown is now known, and it may be used as a secondary standard.

3 Titration of an unknown solution with a secondary standard

This procedure is the same as for titration with a primary standard.

SUMMARY OF PROCEDURES IN ACID-BASE TITRATIONS

Primary standard used	anhydrous Na_2CO_3 dissolved in distilled water
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Titrated against	dilute HCl solution (which becomes a secondary standard)
Indicator used	methyl orange
Secondary standard titrated against	NaOH solution (which may become a secondary standard) or NH ₃ solution
Indicators used	HCl vs NaOH: any
	HCl vs NH ₃ : methyl orange
	NaOH vs CH ₃ COOH: phenolphthalein

MINIMISING ERRORS

Rinsing procedures

- (a) Rinse delivery equipment (pipette, burette) before use with the solution to be delivered
- (b) Rinse volumetric & conical flasks before use with distilled water
- (c) Rinse storage equipment (stock bottle) before use with the solution to be stored

Using equipment

- (a) Make sure that equipment is used correctly:
 - * don't blow the last drop out of a pipette
 - * remove air bubbles from the tap of a burette before use
 - * read volumes so as to minimise error
- (b) Retain solutions from previous titrations in a series to compare final colours
- (c) use a minimum, but consistent, amount of indicator

Safety

- (a) Wear safety glasses, shoes, lab coat if available
- (b) Clean up spills immediately
- (c) Label all beakers & storage glassware
- (d) Use a pipette filler
- (e) When filling volumetric flasks or burettes, ensure that
 - * the liquid being poured is below eye level
 - * no air locks occur
- (f) Ensure you have enough elbow room to work safely before starting the titration.

SUMMARY OF ACID-BASE TITRATIONS

STANDARD USED	EXPT	TITRATED AGAINST	INDICATOR USED
PRIMARY STANDARD: anhydrous Na_2CO_3 dissolved in distilled water	45	dilute hydrochloric acid solution	methyl orange
SECONDARY STANDARD: dilute hydrochloric acid solution	46	dilute sodium hydroxide solution	any

SECONDARY STANDARD: dilute sodium hydroxide solution	47	vinegar (dilute acetic acid solution)	phenolphthalein
SECONDARY STANDARD: dilute hydrochloric acid solution	48	ammonia solution	methyl orange