

Titration - Lab Report

by Thomas Lumsden

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TITRATION LAB REPORT

Thomas Lumsden

OME Chemistry

2427105

excellent title page

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vey good, detailed ToC

1. Introduction

a) Purpose of experiment

The purpose of this titration experiment is to aim to accurately measure the concentration of the given solution, which in this case is hydrochloric acid (HCl). This is achieved by reacting it with sodium hydroxide (NaOH) using titration.

clear and concise purpose

b) Hypotheses undergoing testing

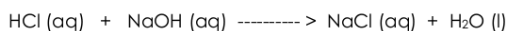
In adding sodium hydroxide to the hydrochloric acid solution, the end point of the experiment is achieved when the equivalence point is reached which is when the moles of the acid are equal to the moles of the base, this occurs when the colour of the added indicator suddenly changed, and neutralisation has taken place.

correct and relevant hypothesis

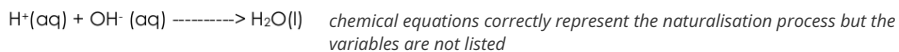
c) Variables & Equations

When the H^+ ions and basic OH^- are balanced and achieve a pH strength of 7.0 will determine the neutralisation of the sample [1].

The reaction between the hydrochloric acid and sodium hydroxide causes the complete separation of the two resulting in a water-based solution. The equation being:



The products of the previous equation, NaCl (sodium chloride dissolved in water) and H_2O can be determined to be table salt and water. This is known as the Net Ionic Equation:



2. Results

a) Experimental Data

Flask	1	2	3	4
V_{HCl} (mL) from pipette	25.00	25.00	25.00	25.00
Initial burette reading	0.00	17.75	31.70	14.75
Final burette reading	17.75	34.60	47.95	31.50
V_{NaOH} (mL)	16.75	16.85	16.15	16.75
Moles of NaOH	1.671×10^{-3}	1.681×10^{-3}	1.611×10^{-3}	1.671×10^{-3}
Moles of HCl	1.671×10^{-3}	1.681×10^{-3}	1.611×10^{-3}	1.671×10^{-3}
Molarity of HCl (mol/L)	0.06684	0.06724	0.06444	0.06684

* volumes of NaOH solution should differ by no more than 0.10 mL for the same volumes of HCl (result 3 is off)

b) Key Findings & Patterns

The key findings that were determined when doing this experiment were that the higher the volume of sodium hydroxide that was used, the higher the molarity of the hydrochloric acid. *this is a pattern among your data. why do you think it is like that?*

3. Discussion

a) Interpretation of experimental data

The difference between the initial and final burette reading determined the volume of NaOH was used in that trial. The results that were gathered showed that when a higher volume of Sodium Hydroxide (NaOH) was used, the closer the solution got to its equivalence point, until it eventually reaches it or become too diluted. *not clear*

During the 4 trials of this experiment I conducted, I over diluted the solution causing it to turn a dark pink/ purple. This is shown as the volume of NaOH used ranges since I was trying to reach as close to the equivalence point as possible.

b) Relevance of experiment in OME

Titration has many factors that can relate it to OME, one being that it could be used as part of chemical testing procedures to assess the composition or stability of explosive materials. This is shown when doing propellant stability tests using the Bergmann-Junk method, which is when gases are absorbed into hydrogen peroxide and the acidity level is titrated against a standard sodium hydroxide solution in order to analyse how well a propellant retains its performance [2]. *relevant example*

c) Limitations or potential error

There are multiple cases for potential error when conducting a titration experiment, including not getting rid of any air bubbles that are trapped in the burette, the meniscus of the solution in the burette isn't on the 0 line, and leaving the funnel in the top of the burette after transferring the solution are all factors that can cause inaccurate readings in the experiment. *all correct*

4. Conclusion

a) Summary of main findings

In conclusion, the experiment of titration was successfully conducted and was able to gather consistent results. The concentration of the unknown solution of hydrochloric acid was found to be around 0.06 *titration is so precise and accurate method that the determined concentration is not 'around'; it's exact*

b) Future research

An area for further research that I have identified is conducting titration experiments with different chemicals and being able to use different indicators and be able to neutralise different colours.

5. References

[1] Skousen, J.; Renton, J.; Brown, H.; Evans, P.; Leavitt, B.; Brady, K.; Cohen, L.; Ziemkiewicz, P. Neutralization potential of overburden samples containing siderite. *J. Environ. Qual.* **1997**, 26, 673–681.

[2] United Nations, INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES. **2021**, 3, 12.

6. Appendix

a) Materials & Equipment

Chemicals:

- ~ 100 mL of **standard** NaOH solution, **$M_b = 0.09977 \text{ mol/L}$** in a labelled beaker
- ~ 100 mL HCl solution with an unknown concentration in a labelled beaker
- Phenolphthalein indicator (colourless in acidic solution, pink in basic solution)

Equipment:

- 1x Burette, 50 mL attached to a burette stand with clamp
- 1x Pipette, 10 mL OR 5 mL, with pipette filler
- 3x Erlenmeyer (conical) flasks, 100 mL
- 1x Small funnel to fill the burette
- 1x Plastic pipette
- 1x Wash bottle with deionised water
- 1x Graduated cylinder, 100 mL
- 1x White tile or white paper to go under the titration flask
- 1x Beaker for the waste

b) Experimental procedure

- **Step 1:** wash
 - Pipette - with deionised water from the wash bottle followed by a small volume of HCl
 - Burette - with deionised water from the wash bottle followed by a small amount of NaOH (discard); use the funnel to pour a few mL of NaOH
 - Erlenmeyer (conical flask) - with a small amount of deionised water
- **Step 2:** Using a small funnel, fill the burette with standard NaOH solution, running some of the solution through the tap, until the bottom of meniscus is just on the zero level. Ensure that there are no air bubbles trapped.

- **STEP 3:** Using the pipette filler place 25 mL of HCl solution in the three clean conical flasks
- **STEP 4:** Add 3-4 drops of phenolphthalein indicator to each flask with acid and swirl gently, then add approximately 10 mL of deionised water using a graduated cylinder
- **STEP 5:** Using the tap of the burette run the NaOH solution in the first conical flask, mixing thoroughly, until the solution changes colour to pink. This step is called rough titration and should allow you to estimate the volume of NaOH needed to neutralise the measured volume of HCl.
- **STEP 6:** Repeat step 5 for the next sample of HCl
- **STEP 7:** This time:
 - Run the NaOH into the acid /indicator/water mix until the volume of NaOH is within 2 mL of what it was in the rough titration (Step 5)
 - At this point run the base at a slower rate (dripping it slowly and shaking the solution in the flask) so you can read the volume of HCl required to neutralise the solution to one drop (0.05 mL). Note: Take an accurate reading within 0.05 mL and take the reading at the first colour change in the solution
- **STEP 8:** Repeat steps 6 and 7 until a satisfactory result is obtained
 - Two volumes of NaOH solution differ by no more than 0.10 mL for the same volumes of HCl

6b) Original data sheet

University of Wales Trinity Saint David – CMAF Programme

DATA SHEET to RECORD OBSERVATIONS, CALCULATIONS and RESULTS

STUDENT'S NAME: Thomas Lunnell
PARTNER'S NAME: Andrew Campbell

REPORT IS DUE MONDAY 23, 2025 @ 3.00 pm submitted via Moodle
(DO: March 26, 2025 @ 3.00 pm)

TITRATION DATA SHEET
 Molarity of the standard base solution: **NaOH** = 0.09977 mol/L

FLASK	1 rough titration	2	3	4
V acid (mL) from pipette	25	25	25	25
initial burette reading	1	17.78	31.7	44.78
final burette reading	17.78	34.6	47.68	51.8
V used (mL)	16.78	16.89	15.98	16.78
Moles of NaOH	1.61x10 ⁻³	1.61x10 ⁻³	1.61x10 ⁻³	1.61x10 ⁻³
Moles of HCl	1.61x10 ⁻³	1.61x10 ⁻³	1.61x10 ⁻³	1.61x10 ⁻³
Molarity of HCl	0.06684	0.06724	0.06444	0.06684

Precision and Accuracy
 You should record pipette and burette readings to the nearest 0.05 cm³ (approximately one drop). Consecutive titrations should agree to within 0.10 cm³ and, you should repeat the titration until this is achieved.

End

Titration - Lab Report

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

51 / 100

Engagement with Literature Skills 8/15

Two sources are cited: one environmental chemistry study and one OME guideline. While these are relevant, especially the Bergmann-Junk method in the UN reference, there's minimal engagement with peer-reviewed titration-specific literature. References are in IEEE format, but source integration is surface-level.

Feedback: Add more academic sources related to titration and OME and integrate them more meaningfully into the discussion.

Knowledge and Understanding Skills 11/20

Purpose and hypotheses are stated clearly, and correct balanced chemical and net ionic equations are included. Variables are not identified at all. There's a clear link between the colour change and the reaction endpoint. However, there's limited theoretical explanation of titration principles, and key terms (e.g., standard solution, endpoint, indicator behaviour) are only briefly mentioned.

Feedback: Good foundational understanding; extend the introduction with deeper explanation of key titration concepts and terminology. When you say 'what', add 'why'.

Cognitive and Intellectual Skills 13/25

The results are mostly logically interpreted, and limitations are acknowledged (e.g., colour overshooting, reading error). The statement that more NaOH volume leads to higher HCl molarity is not technically accurate—it reflects potential over-titration rather than a trend. OME applications are correctly referenced with one solid example, but broader industrial relevance or data comparisons are missing.

Feedback: Good interpretation and error awareness; expand comparison with other sources.

Practical Application Skills 12/25

All calculations are correct but there are errors in significant figures related to inaccurate reading of burette and pipette. The inclusion of four trials is strong, however the difference in volumes of NaOH is more than 0.10 mL. The conclusion would benefit from clearer reference to calculated average

concentration, which is vaguely mentioned as "around 0.06".

Feedback: Well executed and structured experiment; would benefit if you showed how the moles and molarity were calculated.

Transferable/Professional Skills 7/15

The report is well-organised with logical sectioning and a contents page. Passive voice is not consistently used, and language is occasionally informal. Minor grammar issues are present (e.g., "it's" instead of "its"). Formatting is clear and easy to follow.

Feedback: Solid structure and presentation; proofreading and consistent use of passive voice would enhance professionalism.

PAGE 1

Text Comment. excellent title page

PAGE 2

Text Comment. vey good, detailed ToC

PAGE 3

Text Comment. clear and concise purpose

Text Comment. correct and relevant hypothesis

Text Comment. chemical equations correctly represent the naturalisation process but the variables are not listed

PAGE 4

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Text Comment. precision of pipette and burette is 0.05 mL; sig figs!

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Text Comment. all calculations are correct :-)

Text Comment. * volumes of NaOH solution should differ by no more than 0.10 mL for the same volumes of HCl (result 3 is off)

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PAGE 5

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