

Titration Lab Report

by Pippa Shay

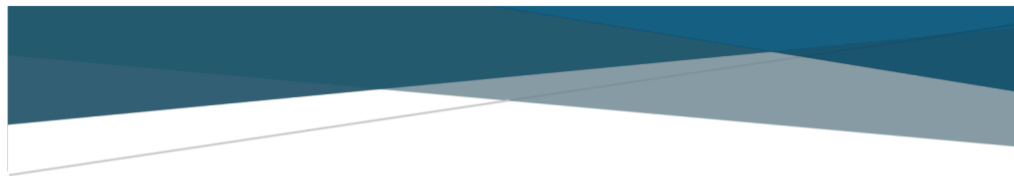
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Lab Report 2 – Titration

Chemistry ACDB4011

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2417658

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detailed ToC with section/subsection page numbers

Section 1: Introduction

1.1 The Purpose

The purpose of this experiment was to determine the concentration of a solution of hydrochloric acid by completing a neutralisation titration by using standard sodium hydroxide, with a molarity of 0.09977 mol/L. *clear and concise purpose*

1.2 The Hypothesis

The aim of this experiment is to accurately measure the molarity of a solution of hydrochloric acid using a neutralisation reaction. *it is still purpose/aim; hypothesis would be 'molarity of HCl solution can be measured accurately from the neutralisation reaction with standard solution of NaOH solution...'*

1.3 The Variables

The control variables were:

- The ambient temperature
- The amount of hydrochloric acid
- The amount of indicator
- The pressure

The independent variable was the amount of sodium hydroxide, and the dependant variable was the colour of the solution in the conical flask *at the equivalence point*

variables are correctly identified

Section 2: Results

2.1 Table of Results

Flask	1 st titration	2nd	3 rd
Volume of HCl (mL)	25.00	25.00	25.00
Initial burette reading	0.00	20.70	23.20
Final burette reading	20.70	37.20	40.20
Volume of NaOH (mL)	20.70	16.50	17.00
Moles of NaOH	0.002065	0.001646	0.001696
Moles of HCl	0.002065	0.001646	0.001696
Molarity of HCl	0.08261	0.06585	0.06784

Table 1 – Results from Titration

all calculations are correct

volumes of NaOH solution should differ by no more than 0.10 mL for the

2.2 Key Findings

The first titration was done with the first batch of standard sodium hydroxide whilst the second titration was done with a mixture of the two NaOH standard solutions and the third titration done only with the second standard solution of NaOH meaning the titrations did not get more accurate as the molarities of NaOH were most likely different. The molarity of the HCl was most likely around 0.66 mol/L.

2.3 Calculations

The moles of NaOH were found by using the formula $M = n/v$, where M stands molarity, n stands number of moles and v stands for volume. For example, with the first titration the formula would be rearranged to $n = M \times v = 0.09977 \text{ mol/L} \times 0.02070 \text{ L} = 0.002065 \text{ mol}$. When the equivalence point in this experiment is reached the number of moles of the base equal the number of moles of the acid, meaning there was 0.002065 mols of HCl. Using the same formula the molarity of the HCl can then be found, $0.002065 \text{ mol} / 0.02500 \text{ mL} = 0.08261 \text{ mol/L}$. *ml correctly converted into L; well done*

Section 3: Discussion

3.1 General Overview

The titration is complete when the equivalence point is reached, this is when the number of moles of the base match the number of moles of the acid [3]. However, in this experiment the use of phenolphthalein indicator helpfully changes the colour of the solution to pink once the equivalence point has been reached. This titration found that the rough molarity of the HCl solution was found to be roughly 0.66 mol/L. Without further testing there is no major significance of the results as the molarity of the NaOH solution changed meaning the titrations did not get more accurate. However, it does show the rough molarity of the HCl solution. *very good overview*

3.2 Relevance to OME

Titration is used to check propellants when conducting quality control checks [1]. Similarly, titration is also used to calculate the percentage of nitrogen in nitrocellulose and the percentage of nitrocellulose in double based propellants [2]. *excellent examples; they could be elaborated more*

3.3 Limitations and Errors

Whilst completing this experiment the sodium hydroxide standard solution ran out. It was then topped up with a different sodium hydroxide standard solution, so the results vary as they were taken with different sodium hydroxide solutions so most likely different molarities. If this experiment was to be repeated it would be better to do it with only one sodium hydroxide standard solution so each titration would become more accurate leading to a more accurate calculation of the HCl's molarity. *you are very right here*
what about parallax error?

Section 4: Conclusions

4.1 Summary

The findings of this experiment do support the hypothesis as a molarity for the HCl was found. This experiment would be useful when it is important to find out an accurate concentration of a solution as long as all other variables are kept the same.

4.2 Directions for Further Use

To make this experiment more accurate it should be completed again with only one standard solution of NaOH. Further research could be done to see if titrations would be useful to quality check other OME related products as it is a very accurate way of discovering the concentration of a solution.

Section 5: References

- [1] R. J. Baczuk, R. J. DuBois, "Nonaqueous Titrimetric Determination of Ammonium Perchlorate in Double-Base Propellant" *Analytical Chemistry* Vol; 38, Issue: 4, pages 623-625, 1966.
- [2] R. H. Pierson, E. C. Julian, "Titrimetric Determination of Nitrogen in Nitrocellulose and of Nitrocellulose in Double-Base Propellants" *Analytical Chemistry* Vol; 31, Issue: 4, pages 589-592, 1959.
- [3] A. M. Helmenstine. (2020, January. 27.) Equivalence Point Definition [Online]. Available: [Equivalence Point Definition](#)

Section 6: Appendix

6.1 Materials and Methods

The required equipment:

- A burette, 50 mL attached to a burette stand with clamp
- A pipette, 10 mL or 5 mL, with pipette filler
- 3x Erlenmeyer flasks, 100 mL
- A small funnel to fill the burette
- A plastic pipette
- A wash bottle with deionised water
- A graduated cylinder, 100 mL
- A white tile or white paper to go under the titration flask
- A beaker for the waste

The required chemicals:

- ~100 mL of standard NaOH solution, molarity of 0.09977 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)

Procedure:

- 1 Wash all equipment – discarding all washings
 - Pipette – use deionised water then a small volume of HCl
 - Burette - use deionised water then a small volume of NaOH

- Erlenmeyer – use a small amount of deionised water
- Using the small funnel fill the burette with standard NaOH solution, run the solution through the tap until the bottom of the meniscus is level with the zero line.
 - Use the pipette to put 25 mL of HCl in each conical flask
 - Add 3–4 drops of phenolphthalein indicator to each flask and gently swirl then add 10 mL of deionised water to each flask
 - Using the burette, run the NaOH solution into the first conical flask, mixing continuously until the solution changes colour to pink
 - Repeat step 5 two more times with the other two conical flasks, running each one slower once near the volume of the last titration.

6.2 Scan of Original Data Sheet

University of Wales Trinity Saint David – DMU Programme

DATA SHEET TO RECORD OBSERVATIONS, CALCULATIONS AND RESULTS

STUDENT'S NAME: Pipie Shy

PARTNER'S NAMES: Charlotte McConne

REPORT IS DUE MARCH 21, 2025 @ 3.00 pm submitted via Moodle

(DD: March 28, 2025 @ 3.00 pm)

TITRATION DATA SHEET

Molarity of the standard base solution: $M_{NaOH} = 0.09977$

FLASK	1 rough titration	2	3	4
$V_{HCl}(mL)$				
from pipette	25.00	25.00	25.00	
Initial burette reading	0.00	20.70	23.20	
Final burette reading	20.70	37.20	40.20	
$V_{NaOH}(mL)$	20.70	16.50	17.00	
Moles of NaOH	0.002075	0.001646	0.001696	
Moles of HCl	0.002075	0.001646	0.001696	
Molarity of HCl	0.08261	0.06585	0.06784	

different bottles of HCl used.

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.

7

Figure 1 - Sheet

Original Data

Titration Lab Report

GRADEMARK REPORT

FINAL GRADE

62/100

GENERAL COMMENTS

Engagement with Literature Skills 10/15

The report cites three relevant sources, including two older but still credible Analytical Chemistry studies and one general chemistry website. The OME-related citations (on nitrocellulose and perchlorate analysis) are appropriate. IEEE formatting is used properly and where relevant they are smoothly integrated into the narrative.

Improvement: Tie the literature better to your experiment.

Knowledge and Understanding Skills 12/20

The report clearly defines the purpose and variables but hypothesis resembles the aim. You show a good understanding of titration theory and stoichiometry. The correct formulae are applied, and molarity is calculated appropriately. Significant figures are consistent but the unit of molarity is missing in the table.

Improvement: Show the chemical equation/net ionic equation describing the process of titration.

Cognitive and Intellectual Skills 14/25

You correctly acknowledged a critical issue of using two different NaOH solutions and used it to discuss the result validity. Inability to calculate precise average well explained. Error analysis is present but general and parallax error is not mentioned.

Improvement: discuss the errors in more detail. Use the scientific vocabulary to describe the process precisely.

Practical Application Skills 14/25

The method is written clearly and logically, and steps follow standard lab practice. Data is correctly laid out, and moles are calculated with reasonable logic, including conversion from mL to L. However, data inconsistency due to switching solutions limits the validity of the findings (**you are NOT marked down because of that!**). Significant figures and units are mostly correct. Relevance to OME demonstrated in two relevant examples but could be analysed in more detail. **Improvement:** When you say 'what'

always try to say also 'why' to build strong analytical narration.

Transferable/Professional Skills 12/15

The report is well organised and uses mostly formal tone. The layout is simple but effective.

PAGE 1

Text Comment. professional title page

PAGE 2

Text Comment. detailed ToC with section/subsection page numbers

PAGE 3

Text Comment. clear and concise purpose

Text Comment. it is still purpose/aim; hypothesis would be 'molarity of HCl solution can be measured accurately from the neutralisation reaction with standard solution of NaOH solution...'

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Text Comment. variables are correctly identified

Text Comment. it is 21.20 in your partner's report

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Text Comment. volumes of NaOH solution should differ by no more than 0.10 mL for the same volumes of HCl; you clearly explain why they are not. well done!

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PAGE 4

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Text Comment. very good overview

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Text Comment. what about parallax error?

PAGE 5

PAGE 6
