

NCEA Review and Maintenance Programme – 2027 updates

Review and maintenance work has been undertaken for NZC NCEA for 2027. This pdf document contains the updated assessment materials for **Chemistry Level 2**. In January 2027, Levels 2 and 3 assessment materials will be updated on TKI. For external assessment specifications, refer to the NZQA website.

Subject: Chemistry Level 2

Product	What's changed?
AS2.1a 91910 Internal Assessment Activity	Amendment made to example in the Assessment Schedule to better align with expected responses at Excellence level.

Contents

Product	Page
AS2.1a 91910 Internal Assessment Activity	2



National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Internal Assessment Resource

Chemistry Level 2

This resource supports assessment against Achievement Standard 91910 version 2

Standard title: Carry out a practical investigation into a substance present in a consumer product using quantitative analysis

Credits: 4

Resource title: Analysis of white vinegar

Resource reference: Chemistry 2.1A v2

This resource:

- Clarifies the requirements of the standard
- Supports good assessment practice
- Should be subjected to the school's usual assessment quality assurance process
- Should be modified to make the context relevant to students in their school environment and ensure that submitted evidence is authentic

Date version published
by Ministry of Education

January 2027 Version 2
To support internal assessment from 2027

Authenticity of evidence

Teachers must manage authenticity for any assessment from a public source, because students may have access to the assessment schedule or student exemplar material.

Using this assessment resource without modification may mean that students' work is not authentic. The teacher may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform.

Internal Assessment Resource

Achievement standard:	Chemistry 91910
Standard title:	Carry out a practical investigation into a substance present in a consumer product using quantitative analysis
Credits:	4
Resource title:	Analysis of white vinegar
Resource reference:	Chemistry 2.1A v2

Teacher guidelines

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource.

Teachers need to be very familiar with the outcome being assessed by the achievement standard. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing students against it.

Context/setting

This activity requires students to carry out a comprehensive practical investigation into the acetic (ethanoic) acid present in a sample of white vinegar using quantitative analysis. Using quantitative analysis means that students will carry out a titrimetric analysis to gather data, followed by carrying out calculations to draw a conclusion. General instructions for the investigation will be provided to students in writing, including a general procedure (method), and the chemicals that the students are to use.

While it is preferable for each student to carry out the practical titration process individually, this may not be feasible where equipment is limited or in a case of disability. In such cases students might share tasks amongst a group but teachers would need to use their school's authenticity procedures to ensure that each student has clear understanding of all criteria involved in the analysis process. Providing a general procedure means students are to be given guidance about the overall approach they are to take, including the reactions occurring and balanced full equations. Students are required to trial and modify this procedure before carrying it out, which will generally involve identifying significant variables to control, and determining an appropriate dilution of the consumer product to enable quality data to be gathered. Titre results should be at least 5 mL and usually less than 30 mL.

Students will use their modified procedure to determine the concentration of acetic (ethanoic) acid in a sample of white vinegar. They will use quantitative calculations to determine the concentrations of any standard solution used in the investigation, as well as the concentration of the acetic (ethanoic) acid, in units appropriate for the sample being tested (grams per litre or percentage w/v).

Students will be provided with the relationships $n=cV$ and $n=m/M$ and must use these formulae, and stoichiometric principles, to independently carry out their quantitative calculations.

The pipette size may be varied depending on what is available, but 20 or 25 mL is preferable. The concentration of the sodium hydroxide solution provided to the students should be approximately 0.100 mol L^{-1} and must be accurately known. The white vinegar

being investigated should be relatively fresh (not expired) and free of any additives which may impact on the ability of the students to gather quality data and/or prepare accurate dilutions.

It is anticipated that this investigation will be introduced at the end of a unit of work that has provided students with knowledge of the preparation of standard solutions, carrying out dilutions, relevant quantitative calculations, the use of titration equipment, and the appropriate use of vocabulary, symbols and conventions.

The context for this investigation is the analysis of white vinegar. You will need to ensure that students have learned about titrations, the use of observable colour changes to determine an end point of a titration, and in particular the use of appropriate indicators to determine the end point in acid-base titrations.

It may be appropriate to use a similar acid base titration in investigating the concentration of another species in a formative assessment prior to this investigation, e.g. ammonia in a cleaner using a standardised solution of sulfuric acid and methyl orange as the indicator.

This activity requires students to present their investigation as a written report. Other suitable presentation formats could include a PowerPoint file or wall poster.

Conditions

Students will need time to develop the skills involved in the type of investigation outlined in the activity. This could take up to five or six weeks.

Students will undertake all work in this assessment individually.

The assessment task will require up to 5 teaching periods.

Resource requirements

Students require access to:

- 20.0 or 25.0 mL pipette (the task and schedule is based on a 25 mL pipette)
- 10.0 or 25.0 mL measuring cylinders
- 100 or 250 mL volumetric flasks
- Burette (preferably 50.0 mL)
- 3 conical flasks (100 - 250 mL)
- undiluted white vinegar
- standard sodium hydroxide solution (approximately 0.100 mol L^{-1})
- distilled water
- phenolphthalein indicator solution
- wash bottle.

- Teacher note: Students are to be provided with the unmodified vinegar, and hydroxide solution with concentration $\sim 0.100 \text{ mol L}^{-1}$. As part of the development of the student's investigation it is expected that they will independently discover that they need to prepare a diluted sample as the volume of hydroxide solution necessary to completely react the acetic acid will initially exceed the burette capacity. This can be determined by initial trials using a 10 mL or 25 mL measuring cylinder.
- A 10 x dilution is common, but may not be appropriate in some instances. Titres should be at least 5 mL, but no more than the maximum volume of the burette used in the analysis.
- The dilution necessary will be based upon the concentration of acetic acid ions in the vinegar, and the concentration of the sodium hydroxide solution used in the investigation.

Additional information

The teacher should carry out the procedure prior to the student practical assessment to determine the appropriate dilution factor and expected titre for the acetic (ethanoic) acid sample being analysed.

White vinegar is the best to use as the more common malt vinegar is coloured and makes detection of the end-point more difficult. It would be possible to use other colourless vinegars such as rice-wine vinegar.

Other possible contexts

Other possible contexts for a quantitative investigation include: redox, complexometric, precipitation, and other suitable acid-base reactions.

Internal Assessment Resource

Achievement standard:	Chemistry 91910
Standard title:	Carry out a practical investigation into a substance present in a consumer product using quantitative analysis
Credits:	4
Resource title:	Analysis of white vinegar
Resource reference:	Chemistry 2.1A v2

Student instructions

Introduction

This assessment activity requires you to carry out a practical investigation into the concentration of acetic (ethanoic) acid present in white vinegar.

You will have up to five class periods to carry out the investigation and complete the written report.

You will be assessed on the comprehensiveness of your practical investigation, which involves:

- trialling and modifying the provided procedure and/or vinegar provided
- calculating the concentration of the standard solutions used in the investigation
- using the procedure to collect accurate and valid data
- processing the data to reach a conclusion
- justifying the modifications made in terms of the validity and accuracy of the investigation
- evaluating the outcome of the investigation in relation to the vinegar
- reporting your investigation in a written report.

Make sure you show all working, give your answers to three significant figures, and use appropriate units.

The following instructions provide you with a structure that will allow you to demonstrate the outcomes required for successful completion of this standard.

Background

Vinegar is a common ingredient in many food recipes. The acetic (ethanoic) acid it contains adds a sour taste to many dishes. Acetic (ethanoic) acid is obviously an acid and is found in varying concentrations in vinegar. Typically, the range of concentrations is given as between 5%- 8% for standard white vinegar and about 15% or more for pickling vinegar.

Task

Your task is to carry out an investigation into the concentration of acetic (ethanoic) acid in a specific commercial white vinegar. The product label provided by the manufacturer will give an indication of the expected concentration of the acetic (ethanoic) acid in the sample.

The procedure you will use for the titrimetric analysis of acetic (ethanoic) acid (CH_3COOH)

present in a solution is given in Resource B, and the procedure and data you will use in the standardisation of the sodium hydroxide solution is given in Resource A.

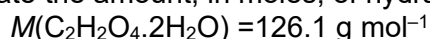
Part A: Preliminary Calculations

Before starting your investigation, you are to carry out quantitative calculations to determine the concentration of the sodium hydroxide solution used in your titrimetric analysis. The solution has been titrated against a primary standard solution of oxalic acid. The data related to the standardisation is provided to you in Resource A.

You need to use stoichiometric principles and the relationships $n=m/M$ and $n=cV$, in the determination of the concentrations of these solutions.

Oxalic acid standard solution

Calculate the amount, in moles, of hydrated oxalic acid dissolved into the volumetric flask.



Leave sufficient space for students to write their answers.

Use the known amount of hydrated oxalic acid, and the volume of the volumetric flask provided, to calculate the concentration of the oxalic acid standard solution.

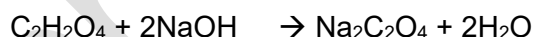
Leave sufficient space for students to write their answers.

Standardisation of sodium hydroxide solution

Use the known volume and concentration of the oxalic acid solution to calculate the amount, in moles, of oxalic acid used in the standardisation.

Leave sufficient space for students to write their answers.

The balanced equation for the overall procedure used in the titration is:



Calculate the amount, in moles, of sodium hydroxide reacted in the standardisation.

Leave sufficient space for students to write their answers.

Use the volume, and amount, of sodium hydroxide reacted in the standardisation to determine the concentration of the sodium hydroxide solution. Give your answer to three significant figures.

Leave sufficient space for students to write their answers.

Part B: Practical activity**Procedure**

Make sure you know the purpose of the investigation. Determine what chemicals and equipment you have been provided with. Familiarise yourself with the requirements of the titrimetric analysis as detailed in Resource B.

Plan your practical work and conduct trials, using a 10.0 mL measuring cylinder, to determine how you should modify your procedure and/or commercial vinegar sample.

Record significant variables which you have controlled, with a description of what the variables are, and how they have been controlled.

Collect primary data

Using your modified procedure, carry out the titrimetric analysis to collect and record relevant primary data with correct units. The accuracy of your data will contribute to the determination of your grade.

Interpret the data

Carry out quantitative calculations to determine the concentration of ethanoic acid in the commercial white vinegar in. To enable you to evaluate the outcome of your investigation, your final result should also be calculated in appropriate units to allow comparison with the concentration given on the label of the commercial white vinegar.

You need to make use of stoichiometric principles and the relationships $n=m/M$ and $n=cV$, in the determination of the concentration.

Results

Leave sufficient space for students to write their answers.

Calculations

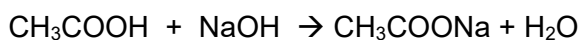
Calculate the average titre volume for the sodium hydroxide.

Leave sufficient space for students to write their answers.

Use the known concentration of sodium hydroxide to calculate the amount, in moles, of sodium hydroxide.

Leave sufficient space for students to write their answers.

The balanced equation for the overall procedure used in the titration is:



Calculate the concentration of acetic (ethanoic) acid in your diluted vinegar sample. Give your answer with appropriate units to three significant figures.

Leave sufficient space for students to write their answers.

Use this value and the molar mass of CH_3COOH of 60.1 g mol^{-1} to calculate this concentration in appropriate units.

Leave sufficient space for students to write their answers.

Use these concentrations and information on how you diluted your sample, to calculate the concentration of the **original** white vinegar.

Leave sufficient space for students to write their answers.

Part C: Reporting on your investigation

Produce a comprehensive and detailed report on your investigation.

The report should include:

- an outline of the purpose of the investigation
- a description of your modified procedure – this must include a description of:
 - how significant variables were controlled, and
 - any modifications made to the method and/or vinegar during the course of the investigation
- a record of the data gathered in the investigation
- a complete account of the quantitative calculations used in the determination of the concentration of all standard solutions, processing of the raw data, and the determination of the concentration of the acetic (ethanoic) acid
- a conclusion giving the concentration of the acetic (ethanoic) acid in the vinegar
- a discussion of the investigation which includes:
 - justification of the modifications made to the procedure and/or vinegar in relation to the validity of the titration data, and
 - explanation of how your procedure and control of certain variables improved the quality of the investigation, and
 - evaluation of the outcome of your investigation by comparing the concentration you determined to the concentration stated in the data.

Your investigation report should be handed in alongside this investigation booklet.

Resource A – Standard Solution

Teacher note: This resource sheet may be provided to students completely filled in, or, depending on the task you chose to set students, you may get them to prepare their own primary standard and use it to standardise the hydroxide.

Overview

Sodium hydroxide cannot be used accurately as a primary standard in your investigation. Prior to carrying out the investigation, the hydroxide solution must be standardised using a standard solution of hydrated oxalic acid, $\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

The balanced equation for the overall procedure can be summarised as follows:



Preparation of oxalic acid solution

1.46 g of hydrated $\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ was weighed on a laboratory balance and added to a 250 mL volumetric flask. The flask was then made up to volume using distilled water and shaken until all the solid had fully dissolved.

Standardisation of sodium hydroxide solution

The sodium hydroxide solution was titrated against 25.0 mL samples of the oxalic acid standard solution using the method described above.

The titration data gathered is provided in the table below:

Titration	Rough	1	2	3	4
Initial Reading	0.2 mL	22.9 mL	2.1 mL	24.3 mL	5.8 mL
Final Reading	22.9 mL	45.0 mL	24.3 mL	46.8 mL	27.9 mL
Titre					

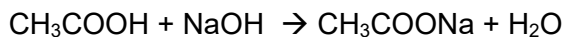
Teacher note: The data above is provided to give a concentration of sodium hydroxide solution of approximately 0.100 mol L^{-1} . The sodium hydroxide solution used in the investigation should be prepared as close to this value as possible. Alternatively, you may wish to standardise the solution yourself and change the data values in the table.

Resource B – Titrimetric Analysis of Acetic (ethanoic) Acid

Overview

A sample containing acetic (ethanoic) acid (CH_3COOH) can be titrated with sodium hydroxide and the end-point determined using phenolphthalein as an indicator (the first permanent pink colour).

The balanced equation for the overall procedure can be summarised as follows:



The following solutions and equipment will be provided:

sample of vinegar

sodium hydroxide solution (Concentration = _____ mol L^{-1})

25.0 mL pipettes

10.0 or 25.0 mL measuring cylinders

burette

3 conical flasks

distilled water

phenolphthalein indicator solution

wash bottle

Procedure

- Measure a 25.0 mL aliquot of the diluted vinegar solution into a conical flask.
- Add 10 drops of the phenolphthalein solution.
- Titrate the solution in the flask with the sodium hydroxide solution provided until the first sign of pink appears and lasts for at least 10s.
- Repeat the procedure until three concordant results are obtained.

Key Information

$$M(\text{CH}_3\text{COOH}) = 60.1 \text{ g mol}^{-1}$$

$$n = m/M$$

$$n = cV$$

Assessment schedule: Chemistry 91910 – Analysis of white vinegar

Evidence/Judgements for Achievement	Evidence/Judgements for Achievement with Merit	Evidence/Judgements for Achievement with Excellence
The student carries out a practical investigation into a substance present in a consumer product using quantitative analysis. They do this by using titrimetric analysis and quantitative calculations to gather and process primary data, determine a concentration value for a relevant substance involved in the investigation, and writing a conclusion that is related to the concentration. In their investigation the student has: • Trialled and determined if the white vinegar and/or titration procedure required modification. Example: <i>After trialling the vinegar from the bottle, it was determined that the acetic acid was too strong and had to be diluted by a factor of 10 to get appropriate titres from the burette.</i> • Outlined two or more significant variables and how they have been controlled in the gathering of the primary data. Examples: <i>In my investigation I controlled the concentration of the sodium hydroxide by ensuring that all glassware was cleaned appropriately, and the samples were extracted from the same bottle each time.</i> <i>Concentration of the sodium hydroxide: Kept consistent by keeping the stock bottle top on to reduce reaction with carbon dioxide in the air and</i>	The student carries out an in-depth practical investigation into a substance present in a consumer product using quantitative analysis. They do this by using results from preliminary trials to independently modify the procedure and/or consumer product, then using titrimetric analysis and quantitative calculations to gather and process quality data to determine the concentration of standard solutions and sodium hydroxide in white vinegar and writing a conclusion that gives the concentration. In their investigation the student has: • Trialled and independently modified the provided procedure. • Outlined two or more significant variables and how they have been controlled in the gathering of the primary data. • Carried out their modified procedure involving titrimetric analysis. • Recorded initial and final volumes for the sodium hydroxide solution used. • Calculated titre volumes, of which at least three fall within a quality concordance range. • Calculated an average titre value using only concordant titre values. • Determined the concentration of the sodium hydroxide solution and the acetic acid solution. • Written a valid conclusion for their investigation that relates to the calculated concentration of the acetic acid in the vinegar.	The student carries out a comprehensive practical investigation into a substance present in a consumer product using quantitative analysis. They do this by independently modifying a procedure, then using titrimetric analysis and quantitative calculations to gather and process primary data to determine the concentration of sodium hydroxide in white vinegar, writing a conclusion that evaluates the concentration, and a justification of the modifications made in their investigation. In their investigation the student has: • Trialled and independently modified the provided procedure. • Outlined two or more significant variables and how they have been controlled in the gathering of the primary data. • Carried out their modified procedure involving titrimetric analysis. • Recorded initial and final volumes for the sodium hydroxide solution used. • Calculated titre volumes, of which at least three fall within a quality concordance range. • Calculated an average titre value using only concordant titre values. • Determined the concentration of the sodium hydroxide solution and acetic acid in the undiluted vinegar in g L⁻¹ or %. • All calculations have been completed with correct units and the final concentration has been given to three significant figures.

<i>all titration tests were carried out on the same day.</i> <i>Volume measurements: Ensured that all measurements were consistent in being equally recorded from the bottom of the meniscus in all flasks/pipettes/burettes.</i> <i>Accurate and consistent end point: I swirled the flask gently to ensure mixing but not vigorously to avoid reaction with carbon dioxide in the air. I also stopped the titration when the faintest pink colour was detectable and remained after swirling for 10s.</i> <i>Cleanliness of flasks: Ensured that the conical flasks used in each test were thoroughly washed prior to carrying out the test to remove all contaminants.</i> - Recorded initial and final volumes for the sodium hydroxide solution used. - Calculated titre volumes, of which at least three fall within an appropriate concordance range. - Calculated an average titre value. - Determined the concentration of either the acetic acid solution, or sodium hydroxide solution, with use of stoichiometric principles, and the relationships $n=cV$ and $n=m/M$. Example: Standard oxalic acid solution $n(\text{oxalic acid}) = m/M = 1.46 \text{ g} / 126.1 \text{ g mol}^{-1}$ $n(\text{oxalic acid}) = 0.0116 \text{ mol}$ $c(\text{oxalic acid}) = n/V = 0.0116 \text{ mol} / 0.250 \text{ mL}$ $c(\text{oxalic acid}) = 0.0463 \text{ mol L}^{-1}$ Standardised sodium hydroxide solution	Example: <i>In my investigation I determined the concentration of acetic acid in the white vinegar was 0.863 mol L^{-1} which equates to 51.8 g L^{-1} or 5.18% which is less than the concentration given in the data of 60.0 g L^{-1}.</i> - There is no penalty for omitting units or inappropriate use of significant figures. - Explained how controlling certain variables improved the quality of the investigation. Example: <i>By controlling significant variables in my experiment that were not outlined in the provided method, such as using exact volumes and avoiding changes to the concentrations of the chemicals used, it ensured that the data I gathered was more accurate and reliable. For example, I used a 25 mL pipette when transferring the vinegar from the sample bottle into a 250 mL volumetric flask, then carefully diluted this to the exact volume in the flask, which gave me an exact 10x dilution. If the solution was more or less concentrated through mishandling, the data I gathered would not be reliable.</i> <i>The examples above are indicative samples only.</i>	- Written a valid conclusion for their investigation that relates to the calculated concentration of the acetic acid in the vinegar. - Justified the modifications made to the procedure in relation to the validity of the titration data and accuracy of the investigation. Example: <i>The concentration of the acetic acid was too high in the white vinegar when I trialled the method, and I was unable to get the indicator to change colour even after 50 mL had been added. By diluting the vinegar down by a factor of 10 I was able to get more realistic titre values in the titration of around 18 mL. This titre value allowed me to obtain data values within a range of 0.3mL and are more reliable than smaller titre volumes.</i> - Evaluated the outcome of the investigation in relation to the white vinegar analysed. Example: <i>The concentration of acetic acid that was determined in the investigation was 51.8 g L^{-1}. This was less than the concentration given on the manufacturer's label of 60.0 g L^{-1} (6.00%) and could be due to a number of reasons such as a fault in the manufacturing or quality control process.</i> <i>Overall, I believe that my modified procedure was followed correctly and it is more likely that either the vinegar had broken down prior to me testing it, or the manufacturer has reported an incorrect concentration or the product is past its use by date. Alternatively, if the student determines that the concentration of acetic acid is actually greater than that stated on the bottle, then the manufacturer may have allowed for a reduction in concentration over the time period until the use by date.</i>
--	--	--

Average titre = 22.1 mL (using concordant data) $n(\text{oxalic acid}) = cV = 0.0463 \text{ mol L}^{-1} \times 0.0250 \text{ L}$ $n(\text{oxalic acid}) = 0.00116 \text{ mol}$ $n(\text{NaOH}) = 2 \times n(\text{oxalic acid}) = 2 \times 0.00116 \text{ mol}$ $n(\text{NaOH}) = 0.00232 \text{ mol}$ $c(\text{NaOH}) = n/V = 0.00629 \text{ mol} / 0.0221 \text{ L}$ $c(\text{NaOH}) = 0.105 \text{ mol L}^{-1}$ <i>Diluted acetic acid</i> Average titre = 20.6 mL $n(\text{NaOH}) = cV = 0.105 \text{ mol L}^{-1} \times 0.0206 \text{ L}$ $n(\text{NaOH}) = 0.00216 \text{ mol}$ $n(\text{acetic acid}) = n(\text{NaOH}) = 0.00216 \text{ mol}$ $c(\text{acetic acid}) = n/V = 0.00216 \text{ mol} / 0.0250 \text{ L}$ $c(\text{acetic acid}) = 0.0863 \text{ mol L}^{-1}$ A minor error in the calculation is allowed but the concentration determined must be a sensible one. - Written a conclusion for their investigation which is related to the calculated concentration of the acetic acid in the diluted vinegar. Example: <i>In my investigation I determined the concentration of acetic acid in the diluted vinegar was 0.0863 mol L⁻¹.</i> - There is no penalty for omitting units or inappropriate use of significant figures. - There is no penalty for an error in the calculation of the oxalic acid or sodium hydroxide being carried through to the acetic acid calculation. Concentration of acetic acid in original vinegar is 10x higher than diluted sample = 0.863 mol L⁻¹. $= 0.863 \text{ mol L}^{-1} \times 60.1 \text{ g mol}^{-1} = 51.9 \text{ g L}^{-1}.$		<i>The examples above are indicative samples only.</i>
--	--	---

<i>The examples above are indicative samples only.</i>		
--	--	--

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.