

Ethanoic acid (acetic acid) content in vinegar

Commercial vinegar usually contains about 3-5% ethanoic acid (CH_3COOH) by mass. The purpose of this experiment is to determine the exact ethanoic acid content of a commercial brand of vinegar. This is achieved by titration against standard approximately 0.1 mol L^{-1} NaOH from Experiment 3.

Ethanoic acid reacts with hydroxide ion according to the equation $\text{CH}_3\text{COOH}(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$

The pH at the equivalence point of this reaction is approximately 8.7, making phenolphthalein (pink to colourless when the pH changes from 10 to 8.3) a suitable indicator.

Equipment required

Hydrometer (1-1.5 range) or balance

Vinegar (40 mL)

Volumetric flask (250 mL)

Washbottle

Conical flask (250 mL)

Pipettes (20 mL and 25 mL)

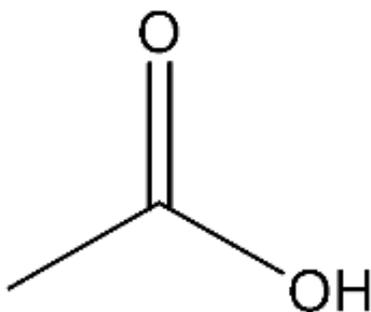
Burette and stand

Funnel

Beakers (two 100 mL)

Standard sodium hydroxide solution [NaOH] approximately 0.1 mol L^{-1} from Experiment 3 (150 mL)

Phenolphthalein (a few drops)



Procedure

#1 Determine the density of the vinegar by weighing out a known volume delivered from a pipette or by using a hydrometer.

#2 Using a pipette place 25.0 mL of vinegar into a 250 mL volumetric flask. Make the volume up to precisely 250.0 mL with distilled water. Mix well by repeatedly inverting the volumetric flask.

#3 Titrate the diluted vinegar from a burette against 20 mL portions of standard NaOH solution each with 1-2 drops of phenolphthalein indicator. Record your results as before

Processing of results, and questions

1 Calculate the number of moles of NaOH in the 20 mL samples used.

2 Write the equation for the reaction of ethanoic acid with sodium hydroxide and calculate the average number of moles of ethanoic acid used in the titrations.

3 Calculate the concentration of ethanoic acid in the diluted vinegar.

4 Determine the concentration of ethanoic acid in the undiluted vinegar.

5 Calculate the mass of ethanoic acid in 1000 mL of undiluted vinegar.

6 Use the density of the vinegar to calculate the mass of 1000 mL of vinegar.

7 Determine the mass of ethanoic acid per 100 g of vinegar, that is, the percentage by mass of ethanoic acid in the vinegar.

8 What volume of the undiluted vinegar would be required in a titration with 20 mL of 0.1 mol L⁻¹ NaOH solution, using phenolphthalein as indicator?

9 Suppose that methyl orange, which changes colour at about pH 3.7, had been used instead of phenolphthalein in your experiment. Would you expect the calculated percentage of ethanoic acid to be too high or too low? Explain.