Titration of a weak acid with a strong base with the aid of a suitable indicator (Item No.: P7510700)

Curricular Relevance

Area of Expertise: Chemistry
Education Level: Age 14-16
Topic: Inorganic chemistry
Subtopic: Quantitative analysis: titrations
Experiment: Titration of a weak acid with a strong base with the aid of a suitable indicator

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Difficult	10 Minutes	30 Minutes	2 Students

Additional Requirements:

Experiment Variations:

- Datalogging: P7510762

Keywords:

weak acids, weak bases, pH-value, neutralisation, indicators, amount of substance, concentration, volumetric (titrimetric) analysis

Information for teachers

Introduction

Application
Acid-base titration combined with indicators is a method in analytical chemistry for the preliminary assessment of corresponding solutions. As a result, the first conclusions concerning the concentration of the analysed substance can be made. In general, a more precise analysis is then performed with the aid of pH electrodes.

Experiment set-up

Educational objectives
The aim of this experiment is to show and explain to the students how indicators can be used in analytical chemistry and to familiarise them with the fundamental principles of titration.

Task
During this experiment, the students have to determine the unknown concentration of an acetic acid solution (solution to be analysed) with the aid of a suitable indicator (here: phenolphthalein). For this purpose, a known volume of the acid is titrated with a volume of a sodium hydroxide solution of a known concentration (standard solution) until the indicator changes colour. The used volume of the standard solution and its concentration are then used to calculate the concentration of the solution being analysed.

Prior knowledge
The students should have already gained experimental experience concerning the handling of acids and bases.
They should be familiar with the mode of operation of volumetric measuring instruments (graduated pipette, burette, pipettor bulb).

Principle
This titration is a volumetric method for determining the concentration of acids and bases.

A weak acid, acetic acid, of unknown concentration but known volume is filled into a vessel and a suitable indicator (here: phenolphthalein) is added. The solution of the base, sodium hydroxide, with a known concentration (standard solution) is filled into the burette and added dropwise to the solution being analysed until the indicator changes colour. The volume, which can be read off the burette, and the known concentration of the acid are then used to calculate the concentration of the base.

Notes concerning the set-up and execution of the experiment
Prepare the following solutions:
0.1 M sodium hydroxide solution: Dissolve 0.8 g sodium hydroxide in 200 ml distilled water.
0.1 M acetic acid: Add 250 ml distilled water to a suitable volumetric flask, pipette 2.8 ml of concentrated acetic acid and fill up to 500 ml with distilled water.

During the set-up of the experiment, it must be ensured that the burette is properly fastened to the support rod so that the students can precisely read the height of the liquid column.

The dripping rate of the burette should not be too high in order to ensure that the result is as precise as possible. A too low dripping rate should also be avoided, since this would unnecessarily extend the entire experiment.

Disposal
After use, the solutions can be collected in the collecting tank for waste acids and bases for disposal.

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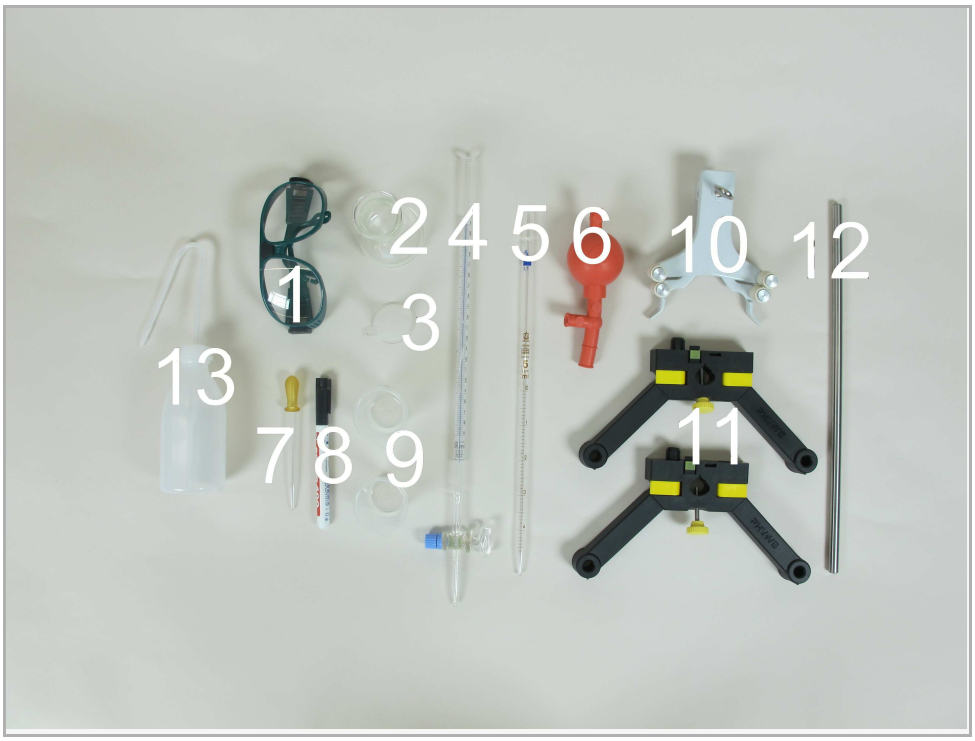
Equipment

Position No.	Material	Order No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Erlenmeyer wide neck, boro, 100 ml	46151-00	1
3	Funnel, plastic, dia 40 mm	36888-00	1
4	Burette, 10 ml, grad. 0.05 ml	47152-01	1
5	Graduated pipette, 5 ml	36599-00	1
6	Pipettor, bulb, 3 valves, 100 ml max.	47127-02	1
7	Pipette with rubber bulb	64701-00	1
8	Laboratory pencil, waterproof	38711-00	1
9	Beaker, 50 ml, low form, plastic	36080-00	2
10	Burette clamp, roller mount., 1 pl.	37720-01	1
11	Support base, variable	02001-00	1
12	Support rod, stainless steel, l = 370 mm, d = 10 mm	02059-00	1
13	Wash bottle, 250 ml, plastic	33930-00	1
	Sodium hydroxide, 500 g	30157-50	
	Water, distilled, 5 l	31246-81	
	Acetic acid 99-100%, 500 ml	31301-50	
	Phenolphthalein, 0.5% in ethanol, 100 ml	31715-10	



Safety information



Hazard and precautionary statements

Acetic acid (0.1 M)

H226:	Flammable liquid and vapour.
H290:	May be corrosive to metals.
P234:	Keep only in original container.
H314:	Causes severe skin burns and eye damage.

Sodium hydroxide (0.1 M)

H290:	May be corrosive to metals.
P234:	Keep only in original container.
P390:	Absorb spillage to prevent material damage.

Phenolphthalein (0.5% in ethanol):

H226:	Flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces. — No smoking.

Hazards

- Acids and bases have a strong irritating effect!
- Wear protective glasses!

Titration of a weak acid with a strong base with the aid of a suitable indicator **(Item No.: P7510700)**

Introduction

Application and task

How can we determine the concentration of a weak acid?

Application
We encounter acids everywhere in our everyday life. They are present in the form of vinegar or in a car's battery. They are everywhere. In order to be able to handle acids safely, it is important to know their concentration.
An important method for determining the concentration of an acid relies on so-called indicators and on the reaction between acids and bases. This method is known as titration.

Experiment set-up

Task
Determine the concentration of an acetic acid solution with a volumetric titration. Use phenolphthalein as indicator and a 0.1 M sodium hydroxide solution as standard solution.

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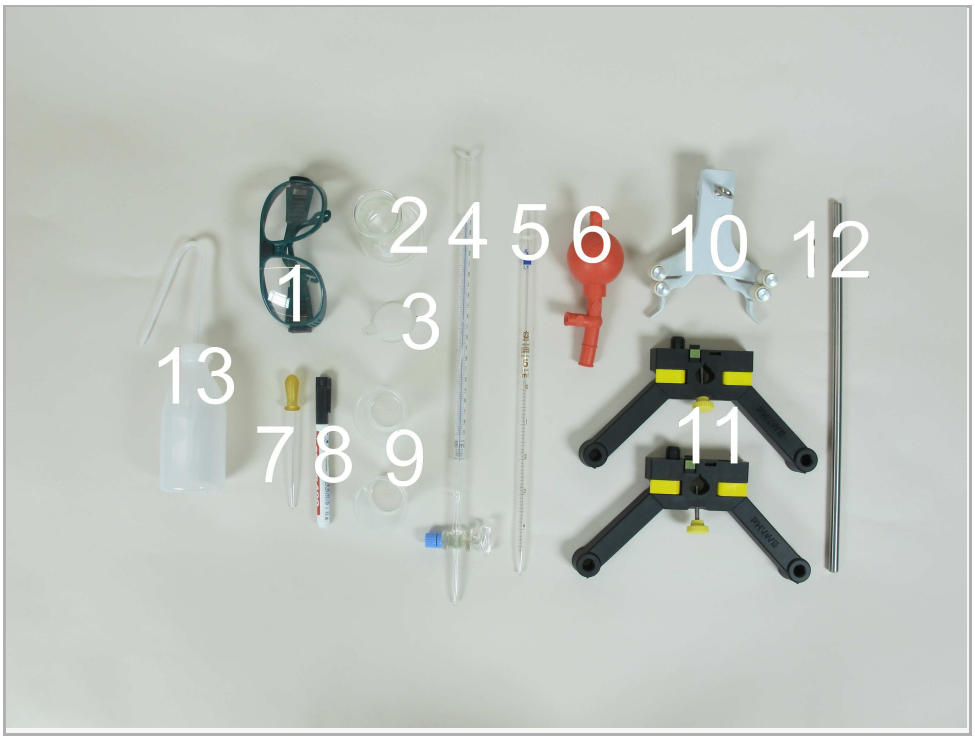
Equipment



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Set-up and procedure

Set-up

Hazards

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Set-up
Combine the two halves of the support base (Fig. 1).

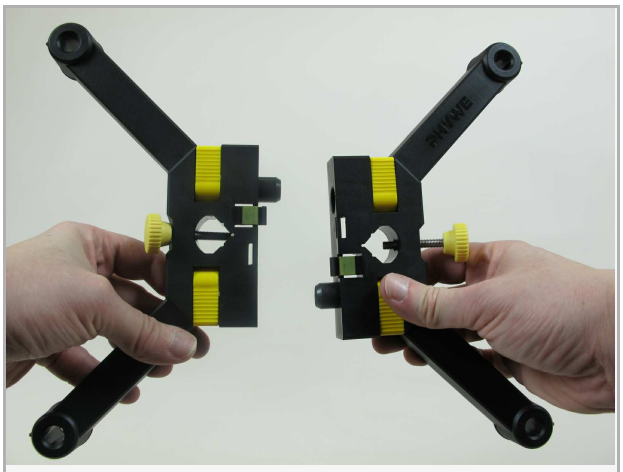

Fig. 1

Fasten the support rod in the support base (Fig. 2).

Fig. 2

Attach the burette clamp to the support rod (Fig. 3).

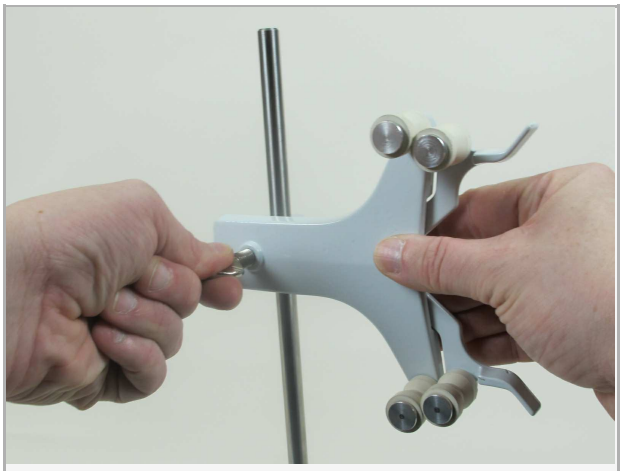

Fig. 3

Compress the two levers of the burette clamp with your thumb and index finger (Fig. 4) and position the burette between the four rubber rollers (Fig. 5). Secure the burette in place by slowly releasing the two levers.

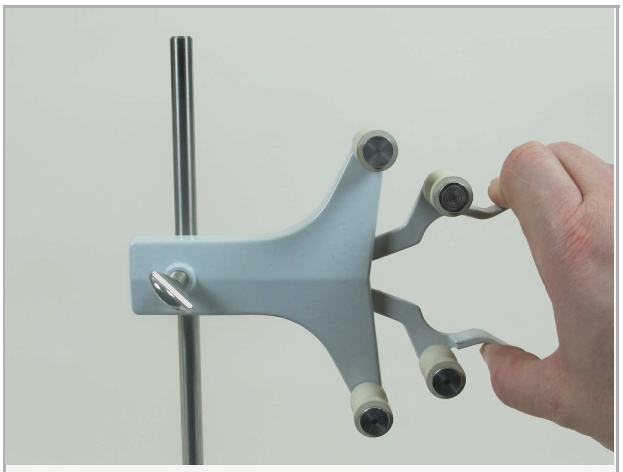

Fig. 4

Fig. 5

Fill the burette with the 0.1 molar sodium hydroxide solution with the aid of the funnel. Use the two laboratory beakers for this purpose and label them in order to avoid any confusion.
Fill the 10-ml-burette carefully up to above the top calibration mark. Ensure that there are no air bubbles inside the burette and that none of the liquid flows over (Fig. 6).

Fig. 6

Position a laboratory beaker under the stopcock of the burette and open the stopcock carefully. Let some of the sodium hydroxide solution flow out until the liquid column reaches the upper calibration mark (Fig. 7).

Fig. 7

A concave curve, the so-called meniscus (from Greek "meniskos" = crescent), forms on the surface of the liquid column in the burette. In order to identify precisely when the liquid column reaches the upper calibration mark, the lowest point of this curve must be used for orientation. Your eyes should be precisely on the same level as the calibration mark (Fig. 8).

Fig. 8

Attach the pipettor bulb to the graduated pipette (Fig. 9). Compress valve "A" with your thumb and index finger. Use the other fingers to press the air out of the pipettor bulb (Fig. 10).

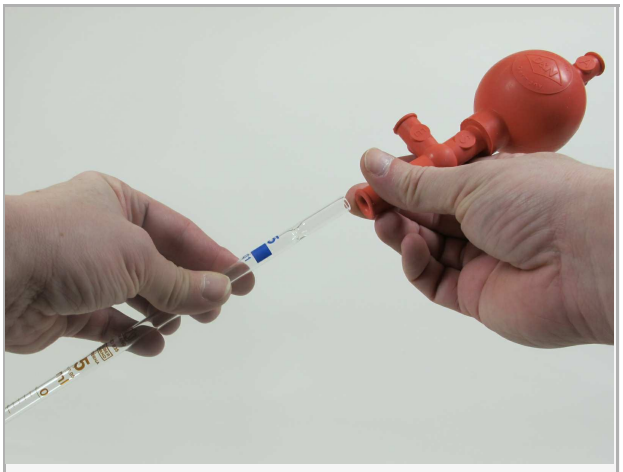
Fig. 9


Fig. 10

Hold the graduated pipette in a vertical position and plunge its tip into the acetic acid solution. Carefully compress valve "S" so that the pipette is slowly filled with the acid. Do not fill the pipette too quickly. Ensure that there are no air bubbles in the liquid. Caution: Ensure that no liquid penetrates the pipettor bulb! Fill the pipette approximately up to the six-millilitre-mark (Fig. 11).

Fig. 11

Compress valve "E" and let some of the acetic acid solution flow out of the graduated pipette until it is precisely filled with 5 ml of the liquid (Fig. 12).
Read the filling level off as described above.

Fig. 12

Remove the graduated pipette carefully from the acetic acid solution and insert it into the Erlenmeyer flask. Compress valve "E" in order to transfer its content completely into the flask (Fig. 12).
During this process, a small drop will remain in the tip of the graduated pipette. This has been taken into consideration during the calibration of the pipette so that it does not need to be removed from the pipette.

Position the Erlenmeyer flask under the stopcock of the burette and add some water by way of the wash bottle. There should not be more than approximately 2 cm of liquid in the flask (Fig. 13).

Fig. 13

Use the pipette with the rubber bulb to add 3 to 5 drops of phenolphthalein to the acetic acid solution (Fig. 14).

Fig. 14

Procedure

Procedure
Adjust to a medium dripping rate by carefully turning the stopcock of the burette.
It must be possible to observe separate drops.
Gently swirl the Erlenmeyer flask with the acid to and fro (Fig. 15). Avoid splashes (attention: irritating!).

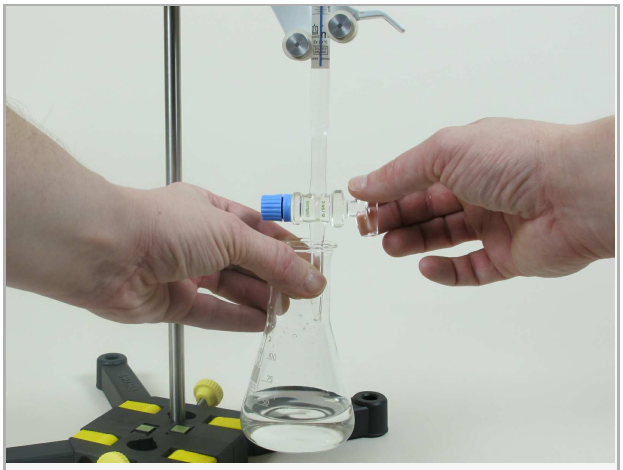

Abb. 15

Once the colour of the solution changes, reduce the dripping rate by carefully turning the stopcock of the burette.

Titrate carefully until change in colour remains permanent, close the stopcock.

Read the used volume of sodium hydroxide solution off the burette and note it down.

Also note the change of colour.

Disposal
After use, the solutions can be collected in the collecting tank for waste acids and bases for disposal.

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Report: Titration of a weak acid and a strong base with the aid of a suitable indicator

Result - Observation 1

Briefly describe the colour gradient during the titration.

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Result - Observation 2

How many milliliters of sodium hydroxide solution were added to the acetic acid solution until the colour changed?

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Evaluation - Question 1

Note down the mathematical equation to calculate the concentration of acetic acid.

Evaluation - Question 2

Calculate the concentration of acetic acid.

Evaluation - Question 3

During this experiment, you used the indicator phenolphthalein. Why is phenolphthalein more suitable than other indicators for this titration?

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