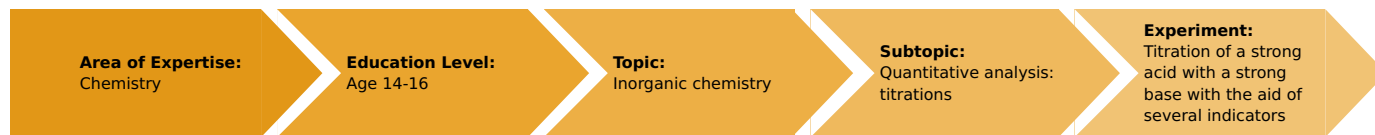


Titration of a strong acid with a strong base with the aid of several indicators (Item No.: P7510600)

Curricular Relevance



Difficulty



Difficult

Preparation Time



10 Minutes

Execution Time



30 Minutes

Recommended Group Size



2 Students

Additional Requirements:

Experiment Variations:

Keywords:

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

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. Furthermore, a special focus is set on indicators and their various colour transition ranges.

Task

During this experiment, the students have to determine the unknown concentration of hydrochloric acid (solution to be analysed) with the aid of several indicators. 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).

A basic knowledge of indicators and how to handle those is advised.

Principle

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

An acid, hydrochloric acid, of unknown concentration but known volume is filled into a vessel and a suitable indicator (one of three possible options) 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 and further analysed until the indicator changes colour. The volume, which can be read off the burette, and the known concentration of the base are then used to calculate the concentration of the acid.

Notes concerning the set-up and execution of the experiment

Label the beakers appropriately and prepare the following solutions:

0.1 M sodium hydroxide (Dissolve 0.8 g of sodium hydroxide in 200 ml distilled water)

0.1 M Hydrochloric acid (Add 250 ml of distilled water to a suitable vessel, pipette 4.16 ml of hydrochloric acid, 37% 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.

Divide the students in group, each group will conduct the experiment with one indicator.

Disposal

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

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 | |
| | Hydrochloric acid, 37%, 1000 ml | 30214-70 | |
| | Water, distilled, 5 l | 31246-81 | |
| | Methyl orange solution, 0.1%, 250 ml | 31573-25 | |
| | Phenolphthalein solution, 0.5% in ethanol, 100 ml | 31715-10 | |
| | Bromothymol blue, 0.1%, 50 ml | 48004-05 | |



Safety information



Hazard and precautionary statements

Hydrochloric acid (0.1 M)

- H290: May be corrosive to metals.
P234: Keep only in original container.
P390: Absorb spillage to prevent material 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 strong acid with a strong base with the aid of several indicators

(Item No.: P7510600)

Introduction

Application and task

How can you determine the concentration of a strong acid?

Application

We encounter acids in our everyday life as well as in chemistry classes. They are present in your favourite drink or in your salad dressing, but not all acids are harmless.

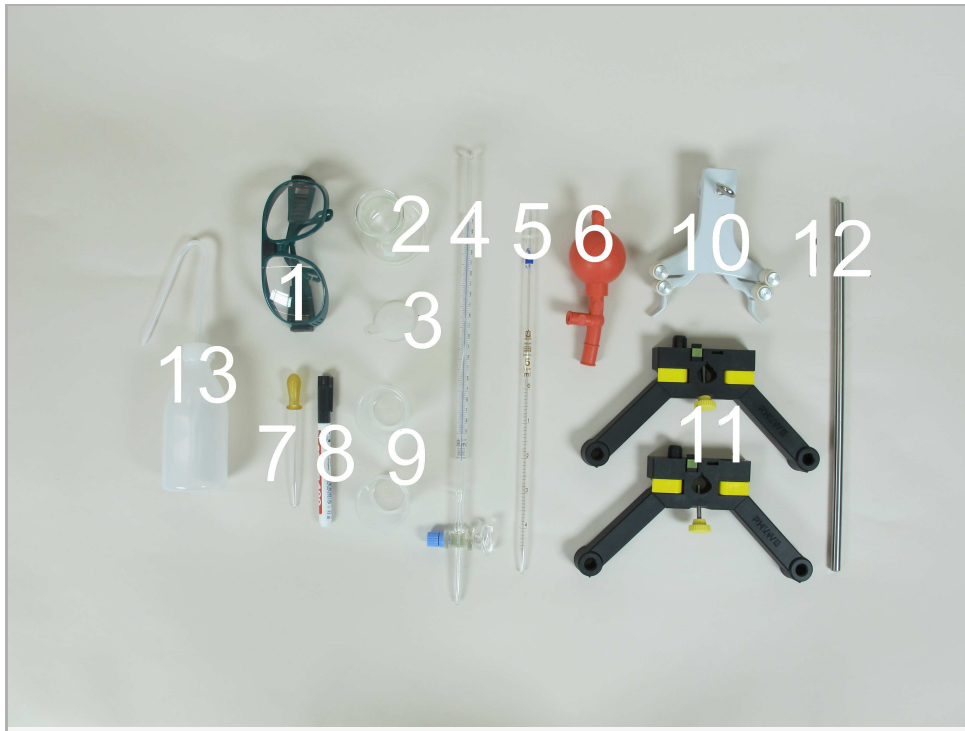
In order to handle acids safely, it is important to know the strength of an acid and how to measure it. One possibility to investigate the strength of an unknown acid is the use of an indicator.



Task

Determine the concentration of hydrochloric acid with volumetric titration. Use an indicator (one of three possible indicators) and a base (sodium hydroxide) as standard solution. Share your results with the other groups.

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 |
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| | Sodium hydroxide, 500 g | 30157-50 | |
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| | Water, distilled, 5 l | 31246-81 | |
| | Methyl orange solution, 0.1%, 250 ml | 31573-25 | |
| | Phenolphthalein solution, 0.5% in ethanol, 100 ml | 31715-10 | |
| | Bromothymol blue, 0.1%, 50 ml | 48004-05 | |

Set-up and Procedure

Set-up

Hazards

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



Set-up

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

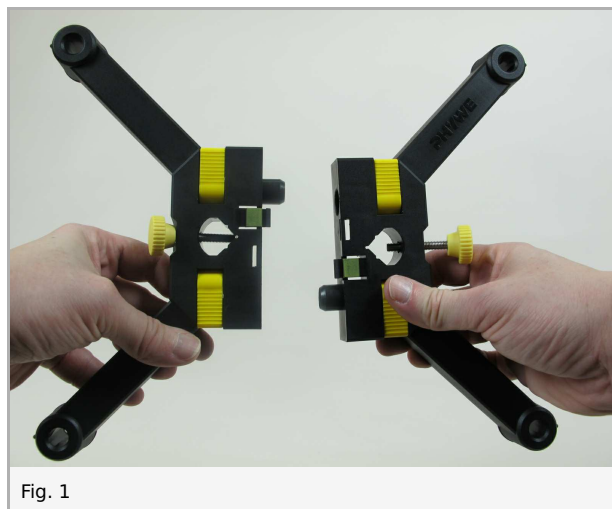


Fig. 1

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.

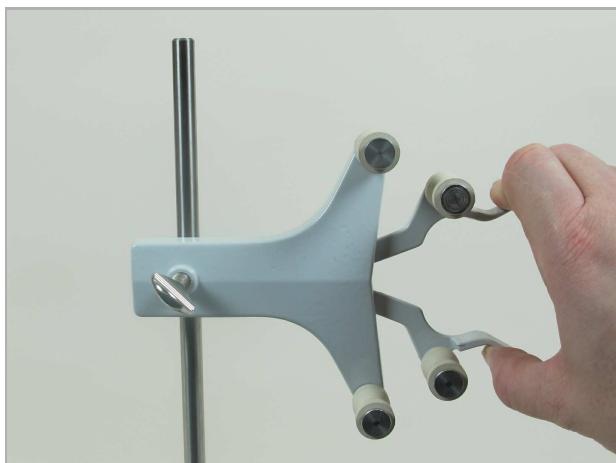


Fig. 4



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 hydrochloric 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 hydrochloric 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 hydrochloric 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 chosen indicator to the hydrochloric 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!).



Fig. 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 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.

Report: Titration of a strong acid and a strong base with the aid of several indicators

Result - Observation 1

Briefly describe the colour gradient of each indicator during the titration.

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Result - Observation 2

How many milliliters of sodium hydroxide solution were added to the hydrochloric acid solution until the colour changed (**each indicator**)?

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Evaluation - Question 1

Determine the concentration of hydrochloric acid (with **each** indicator).

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Evaluation - Question 2

Interpret your results. Why is it so important to use a suitable indicator when conducting (successful) titrations?

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