Titration of a weak acid with a weak base with the aid of a suitable indicator

Chemistry > Inorganic chemistry > Acids, bases, salts

Chemistry > Analytical Chemistry > Titration

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	30 minutes

This content can also be found online at:

http://localhost:1337/c/638c550323a87a0003a27326

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Teacher information

Application

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Experimental setup

Acid-base titration with the help of indicators is used in analytical chemistry for the preliminary examination of corresponding solutions. With their help, initial statements can be made about the concentration of the substance under investigation. An exact examination is then usually carried out fully automatically with the help of suitable pH electrodes.

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Other teacher information (1/3)

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Prior knowledge

In this experiment, the practical basics of acid-base titration will be introduced. Great importance is attached to the use of volumetric measuring instruments (burette, graduated pipette, pipetting ball). The students should have gained first experimental experience in dealing with acids and bases. The mode of action of indicators should be known.

Principle

Acid-base titration is a measurement-analytical method for determining the concentration of corresponding substances.

In this experiment, a weak acid (acetic acid) of unknown concentration with known volume is presented. A suitable indicator (bromothymol blue) is added. The solution of a weak base of known concentration (ammonia solution) is filled into the burette and then added drop by drop to the analysis solution until the colour change of the indicator. The concentration of the acid is then calculated from the volume read off the burette and the concentration of the base.

Other teacher information (2/3)

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Learning objective

The students should be shown examples of the use of indicators in analytical chemistry. Special emphasis should be placed on giving the students a first overview of the basics of dimensional analysis. The students should practise working with acids and alkalis as well as with the common volumetric measuring instruments and indicators.

Tasks

The students are to determine the unknown concentration of an acetic acid solution with the help of a suitable indicator (here: bromotyhmol blue). To do this, a known volume of this acid is titrated with a volume of an ammonia solution of known concentration. The concentration of the acetic acid is then calculated from the consumed volume of the titrated solution and its concentration.

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Other teacher information (3/3)

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Preparation

The solutions used in the experiment (0.1 molar acetic acid, 0.1 molar ammonia solution, bromothymol blue) must be prepared and labelled in appropriate beakers.
A 0.1 M acetic acid solution must be prepared (place 250 ml distilled water in a suitable container, pipette 2.8 ml concentrated acetic acid and fill to 500 ml with distilled water).

A 0.1 M ammonia solution must be prepared (fill 7.51 ml of 25% ammonia solution to 1 l with dist. water).

Disposal

The used solutions can be disposed of in the collection container for acid and base waste.

Safety instructions

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- Acids and bases cause severe burns.
- Use protective goggles/gloves!
- The general instructions for safe experimentation in science lessons apply to this experiment.
- For H and P phrases, please refer to the safety data sheet of the respective chemical.

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Student information

Motivation

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Vinegar

How can you determine the concentration of a weak acid?

Acids play an important role in our everyday lives. Whether in food, for example, as vinegar, or in cars as battery acid. They can be found everywhere.

In order to handle an acid safely, it is important to know how concentrated it is.

One way to determine the concentration of an acid is titration.

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Task

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Experimental setup

Determine the concentration of an acetic acid solution by titration. Use bromothymol blue as an indicator to show the equivalence point for the reaction between acetic acid and ammonia solution.

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Equipment

Position	Material	Item No.	Quantity
1	Burette with straight stopcock, 25 ml Graduation 0.1 ml	47153-01	1
2	Pipette with rubber bulb	64701-00	1
3	Erlenmeyer flask, Borosilicate, wide neck, 100 ml	46151-00	1
4	Funnel, diameter = 40 mm, plastic (PP)	36888-00	1
5	Graduated pipette, 5 ml : 0,1	36599-00	1
6	Protecting glasses, clear glass	39316-00	1
7	Pipettor,bulb,3 valves,100ml max.	47127-02	1
8	Burette clamp, roller mount.,1pl.	37720-01	1
9	Support base, variable	02001-00	1
10	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
11	Wash bottle, 250 ml, plastic	33930-00	1
12	Laboratory pen, waterproof, black	38711-00	1
13	Ammonia solution, 25%, 250 ml	30933-25	1
14	Bromothymol blue, 0.1% sol. 50 ml	48004-05	1
15	Water, distilled 5 l	31246-81	1
16	Acetic acid 99...100%, 500 ml	31301-50	1
17	Beaker, 50 ml, plastic (PP)	36080-00	2

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Set-up (1/6)

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1. Put the two halves of the support base together (**Fig. 1**).
2. Attach the support pole to the support base (**Fig. 2**).
3. Attach the burette clamp to the support pole (**Fig. 3**).

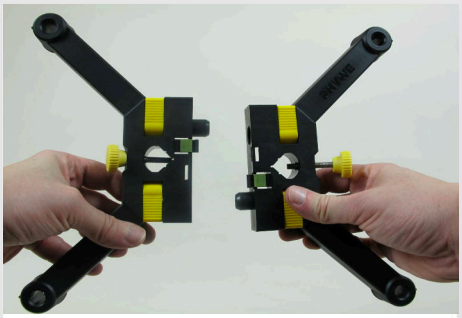

Fig. 1

Fig. 2

Fig. 3

Set-up (2/6)

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Press the two levers of the burette clamp together with your thumb and forefinger (**Fig. 4**) and place the burette between the four rubberised rollers (**Fig. 5**). Fix the burette by slowly releasing the two levers.

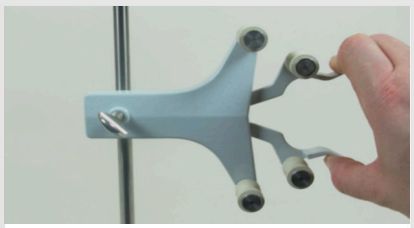

Fig. 4

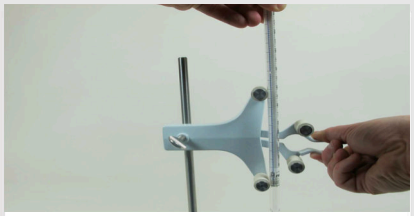

Fig. 5

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Set-up (3/6)

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Fill the burette with the 0.1 molar ammonia solution using the funnel. Use the two laboratory beakers for this. Label the laboratory beakers to avoid any risk of confusion.

Carefully fill the burette to the top of the scale. Make sure that there are no air bubbles in the burette and that nothing overflows (**Fig. 6**).

Place one of the laboratory beakers under the tap of the burette and open it carefully. Drain as much ammonia solution as necessary until the liquid column reaches the top of the burette (**Fig. 7**).

Fig. 6

Fig. 7

Set-up (4/6)

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A downward curvature forms on the surface of the liquid column in the burette, the so-called meniscus (Greek meniskos = half moon). To measure exactly when the liquid column touches the top of the burette, orientate yourself on the lowest point of this curvature. Your eyes should be exactly at the level of the calibration line (**Fig. 8**).

Put the pipetting ball on the graduated pipette (**Fig. 9**). Press the valve "A" together with your thumb and index finger. Press air out of the pipetting ball with the other fingers (**Fig. 10**).

Fig. 8

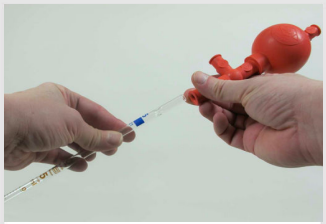

Fig. 9

Fig. 10

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Set-up (5/6)

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Hold the pipette vertically and insert its tip into the prepared acetic acid. By carefully squeezing the valve "S", the pipette slowly fills with the acid. Make sure that the pipette does not fill too quickly. There must be no air bubbles in the liquid. Caution: No acid should get into the pipetting ball!

Fill the graduated pipette to about six millilitres (**Fig. 11**).

Squeeze the valve "E" and let as much acid run out of the graduated pipette until there is exactly 5 ml of liquid in it (**Fig. 12**).

The reading of the filling level is done here as described above.

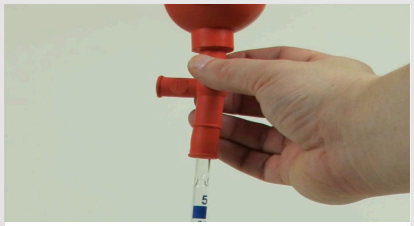

Fig. 11

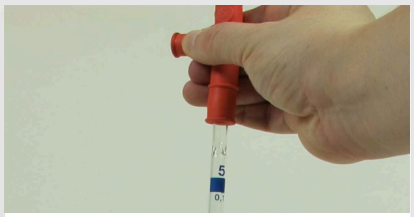

Fig. 12

Set-up (6/6)

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Carefully remove the graduated pipette from the acetic acid and insert it into the Erlenmeyer flask. Squeeze the valve "E" to empty it completely into the vessel.

A small drop remains in the tip of the graduated pipette when it runs out. This has already been taken into account when calibrating the pipette so that it does not have to be removed from the pipette.

Place the Erlenmeyer flask under the tap of the burette and fill up with a little water using the spray bottle (**Fig. 13**). There should not be more than two centimetres of liquid.

Using the pipette with rubber cap, add 3 to 5 drops of bromothymol blue to the acid solution (**Fig. 14**).

Fig. 13

Fig. 14

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Procedure (1/2)

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By carefully turning the tap of the burette, a medium dripping speed is set.
It must be possible to observe individual drops.
The Erlenmeyer flask with the acid is carefully swirled back and forth (**Fig. 15**). There must be no splashes (**Attention: Acid!**).
As soon as a colour change appears in the acid solution, reduce the dripping speed by carefully turning the burette tap.
After the first drop, where the colour change remains permanent, the burette tap is closed. The volume of ammonia solution consumed is read off the burette and noted.
The observed colour change is noted.

Fig. 15

Procedure (2/2)

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Disposal

The solutions used in this experiment can be disposed of in the acid and base waste container.

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Report

Observation 1

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What does the colour change of the indicator look like during the titration?

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Observation2

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How much ammonia solution was needed until the colour change?

Task 1

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Why can't the consumed volume of ammonia solution be used to calculate the acetic acid concentration?

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Task 2

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Explain why there are different results with different implementations!

Task 3

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Drag the terms into the correct gaps in the text.

The mass concentration _____ is the _____ of the mass _____ of a dissolved substance and the _____ of the solution. The unit of the amount of substance concentration is _____, that of the amount of substance is _____.

- mol
- volume (V)
- (c)
- (n)
- quotient
- mol/L

Check

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Task 4

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What is an acid-base reaction also called?

- ○ Protolysis
- ○ Contolysis
- ○ Neutrolysis

Check

Chemistry lab

Task 5

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Which of the following substances acts as the measuring solution in this experiment?

- ○ Ammonia
- ○ Acetic acid
- ○ Bromotyhmol blue

Check

various substances

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Slide	Score / Total
Slide 24: Substance concentration	0/6
Slide 25: Acid Bases Reaction	0/1
Slide 26: Measurement solution	0/1

Total 0 / 8

Solutions | Repeat | Export text

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