Titration of a weak base with a strong acid 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
hard	2	10 minutes	30 minutes

This content can also be found online at:

http://localhost:1337/c/638c7a2f23a87a0003a27387

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Teacher information

Application

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Experimental setup

Acid-base titration using 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. A precise examination is then usually carried out with the help of pH electrodes.

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Other teacher information (1/3)

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Prior knowledge

The students should have first gained experimental knwoledge in dealing with acids and bases. The functioning of volumetric measuring instruments (graduated pipette, burette, pipetting ball) should be known to the students.

Principle

This titration is a measurement-analytical procedure for determining the concentrations of acids and bases.

Here, a weak base of unknown concentration with known volume is presented and a suitable indicator (here: methyl orange) is added. The solution of the acid with known concentration (measured solution) is filled into the burette and dripped into the analysis solution up to the transition point of the indicator. Finally, the concentration of the base is calculated from the volume read off the burette and the known concentration of the acid.

Other teacher information (2/3)

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Learning objective

The students should be shown and taught the use of indicators in analytical chemistry as well as the basics of dimensional analysis by way of example.

Tasks

The students are to determine the initially unknown concentration of an ammonia solution (analysis solution) with the help of a suitable indicator (here: methyl orange). A known volume of the base is titrated with a volume of a hydrochloric acid solution of known concentration (standard solution) until the colour of the indicator changes. The concentration of the analysis solution is then calculated from the consumed volume of the measuring solution and its concentration.

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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.

Other teacher information (3/3)

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Notes on set-up and procedure

Prepare 0.1 M ammonia solution (1 ml conc. ammonia solution to 100 ml water). However, the concentration does not have to be adhered to exactly.
A 0.1 M hydrochloric acid solution must be prepared (first prepare 250 ml distilled water in a suitable vessel, pipette 4.16 ml 37% hydrochloric acid and fill up to 500 ml with distilled water).
When setting up, make sure that the burette is attached to the stand in such a way that the students can accurately read the height of the liquid column.
The dripping speed of the burette should not be set too fast so that the result is as accurate as possible. It is also important to avoid dripping too slowly, otherwise the experiment would be unnecessarily prolonged.

Disposal

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

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Student information

Motivation

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Soapsuds

How can you determine the concentration of a weak base?

We encounter bases everywhere in everyday life. Be it as soap suds or as important components of the genetic material (DNA). They can be found everywhere.

In order to be able to handle bases safely, it is important to know their concentration.

An important method of determining the concentration of bases uses so-called indicators and the reaction between acids and bases. This method is called titration.

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Task

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Experimental setup

Determine the concentration of an ammonia solution with the help of a titration. Use methyl orange as the indicator and a 0.1 molar hydrochloric acid solution as the acid.

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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	Methyl orange soln., 0.1% 250 ml	31573-25	1
15	Water, distilled 5 l	31246-81	1
16	Hydrochloric acid 37 %, 1000 ml	30214-70	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 rod to the support base (**Fig. 2**).
3. Attach the burette clamp to the support rod (**Fig. 3**).

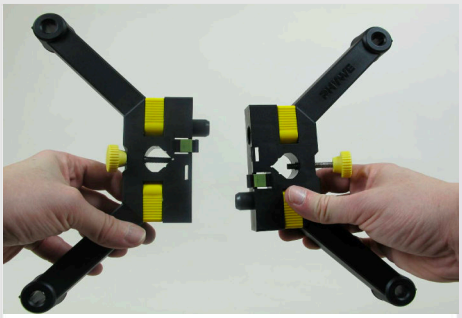

Fig. 1

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.

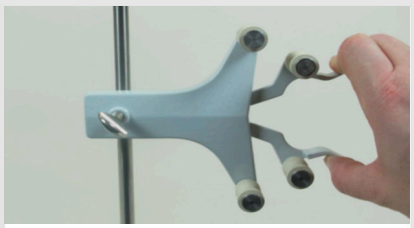

Fig. 4

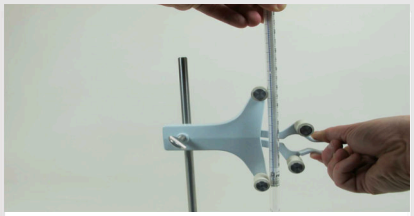

Fig. 5

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Set-up (3/6)

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Fill the burette with 0.1 molar hydrochloric acid using the funnel. Use the two laboratory beakers and label them to avoid any risk of confusion.

Carefully fill the 10 ml burette to above the upper calibration mark. Make sure that there are no air bubbles in the burette and that nothing is overflowing (**Fig. 6**).

Place one of the laboratory beakers under the tap of the burette and open it carefully. Drain off as much hydrochloric acid as necessary until the topmost calibration mark is reached by the liquid column (**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

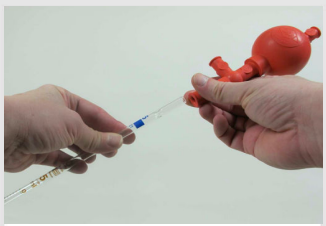

Fig. 9

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 ammonia solution. By carefully squeezing the valve "S", the pipette slowly fills with the base. Make sure that the pipette does not fill too quickly. There must be no air bubbles in the liquid. Caution: No liquid should get into the pipetting ball!

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

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

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

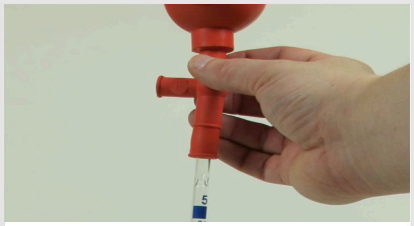

Fig. 11

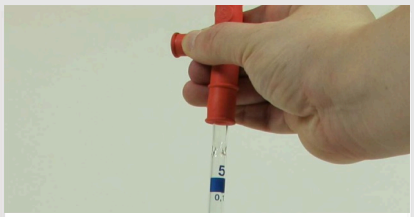

Fig. 12

Set-up (6/6)

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Carefully remove the graduated pipette from the ammonia solution 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 squirt bottle (**Fig. 13**). There should be no more than about two centimetres of liquid in the flask.

Using the pipette with rubber cap, add 3 to 5 drops of methyl orange to the ammonia solution (**Fig. 14**).

Fig. 13

Fig. 14

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Procedure (1/2)

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By carefully turning the burette tap, a medium drip speed is set.
It must be possible to observe individual drops.
The Erlenmeyer flask with the base is carefully swirled back and forth (**Fig. 15**). There must be no splashes (**Attention: corrosive!**).
As soon as a change in colour appears in the solution presented, 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 hydrochloric acid 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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Briefly describe the colour gradient during titration.

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Observation 2

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How many millilitres of hydrochloric acid were added to the ammonia solution until the colour changed?

Task 1

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What is the mathematical relationship that can be used to calculate the concentration of the ammonia solution presented?

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Task 2

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What is the concentration of the ammonia solution?

Task 3

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Drag the terms into the correct gaps in the text.

Acid-base titration is used to determine the concentration of a solution. In this experiment, we looked for the concentration of a _____. _____ served as the indicator. The concentration of the _____ was known. This was dripped into the solution to be investigated until it came to the _____ of the indicator. By reading the _____ of the acid, we could determine the _____ of the base.

weak base
strong acid
concentration
Methyl orange
turnover point
volume

Check

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Task 4

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The moral mass *M* is an important quantity in titration experiments. In which unit is it measured?

- ☐ kg - mol $^{-1}$
- ☐ km - mol $^{-1}$
- ☐ kg - mol

Check

Chemistry lab

Task 5

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How do you measure the strength of an acid?

- ○ pK_b-value
- ○ pK_s-value
- ○ Smell

Check

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Slide	Score / Total
Slide 24: Acid Bases Titration	0/6
Slide 25: Molar mass	0/2
Slide 26: Strength of an acid	0/1

Total 0 / 9

Solutions | Repeat | Export text

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