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

This content can also be found online at:

http://localhost:1337/c/634991120379bd0003f78969

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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 student should have first gained experimental knowledge 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 acid of unknown concentration with known volume is presented and a suitable indicator (here: phenolphthalein) is added. The solution of the base with known concentration (measured solution) is filled into the burette and now added drop by drop to the analysis solution up to the transition point of the indicator. Finally, the concentration of the acid is calculated from the volume read off the burette and the known concentration of the base.

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 acetic acid solution (analysis solution) with the help of a suitable indicator (here: phenolphthalein). A known volume of this acid is titrated with a volume of a sodium hydroxide solution of known concentration (standard solution) until the indicator changes colour. The concentration of the analysis solution is then calculated from the consumed volume of the standard solution and its concentration.

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Other teacher information (3/3)

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Preparation

A 0.1 M acetic acid solution must be prepared (prepare 250 ml dist. water in a suitable vessel, pipette 2.8 ml concentrated acetic acid and fill to 500 ml with dist. water).

A 0.1 M sodium hydroxide solution must be prepared (dissolve 0.8 g sodium hydroxide in 200 ml dist. water).

Notes on set-up and procedure
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 acids and bases.

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. Be it in food, e.g. 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 phenlophthalein as an indicator to show the equivalence point for the reaction between acetic acid and caustic soda.

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Equipment

Position	Material	Item No.	Quantity
1	Burette with straight glass stopcock, 10 ml	47152-03	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	Phenolphthalein, 0,5% soution in ethanol, 100 ml	31715-10	1
14	Water, distilled 5 l	31246-81	1
15	Sodium hydroxide, pellets, 500 g	30157-50	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 (1/7)

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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 rod (**Fig. 3**).

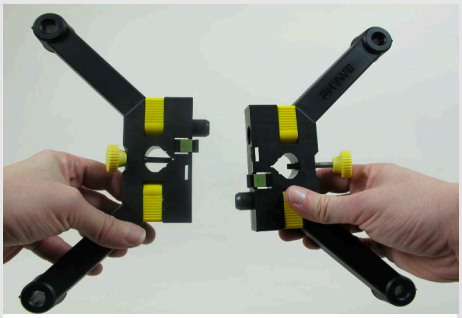

Fig. 1

Fig. 2

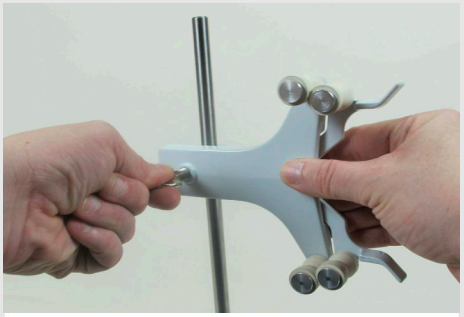

Fig. 3

Set-up (2/7)

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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.

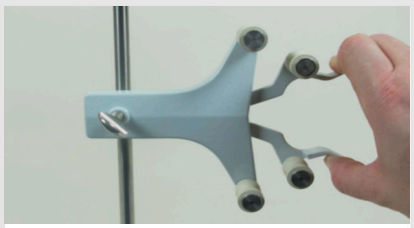

Fig. 4

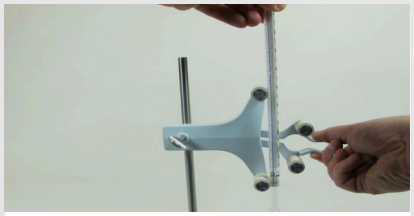

Fig. 5

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Set-up (3/7)

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Fill the burette with the 0.1 molar sodium hydroxide solution using the funnel. Use the two laboratory beakers and label them to avoid 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 overflows (**Fig. 6**).

Place one of the laboratory beakers under the tap of the burette and open it carefully. Drain off as much sodium hydroxide solution until the liquid column has reached the top calibration mark (**Fig. 7**).

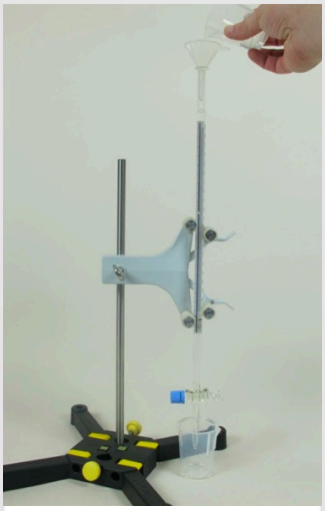

Fig. 6

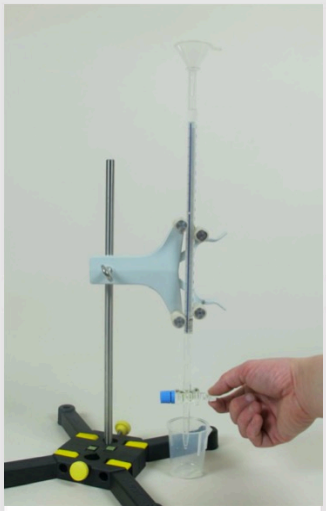

Fig. 7

Set-up (4/7)

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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**).

Place 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

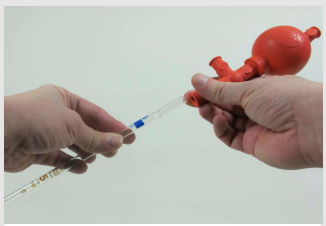

Fig. 9

Fig. 10

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Set-up (5/7)

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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.

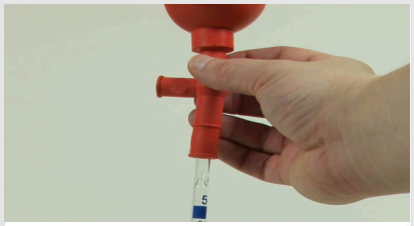

Fig. 11

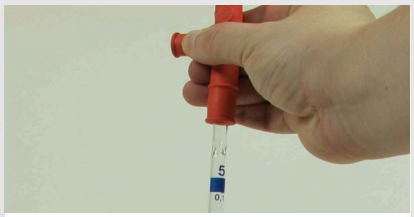

Fig. 12

Set-up (6/7)

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Fig. 13

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 (**Fig. 12**).

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.

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Set-up (7/7)

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Fig. 14

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

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 sodium hydroxide solution consumed is read off the burette and noted.
The observed colour change is noted.

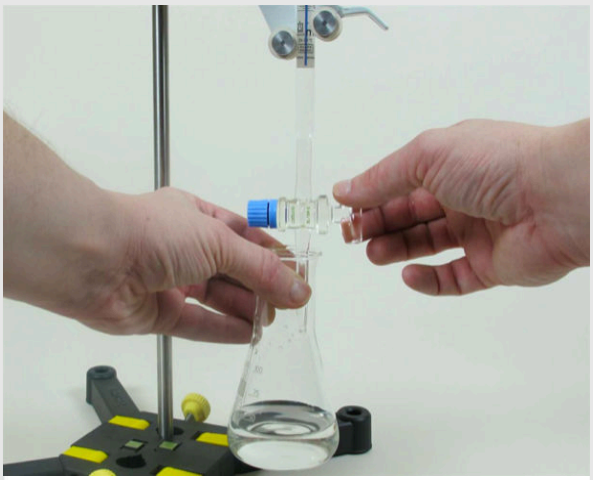

Fig. 15

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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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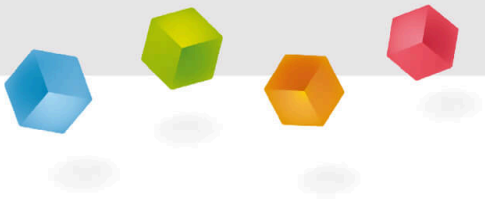

Report

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Observation 1

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How does the colour of the indicator change during the experiment?

Observation 2

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How much caustic soda had to be added to the acid solution up to the colour change point?

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Task 1

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What is the mathematical relationship that can be used to calculate the concentration of the acid?

Task 2

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What is the concentration of the acetic acid presented?

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Task 3

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Why was phenolphthalein chosen as the indicator for this titration?

Task 4

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Drag the terms into the correct gaps in the text.

When titrating a weak acid with a strong base, there is not only an _____ at which the _____ is completely dissociated, but also a _____ at which half of the acid originally present is dissociated.

acid

half-equivalence point

equivalence point

Check

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Task 5

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How do you recognise weak acidity?

- [ ] Weak acids are not dangerous.
- [ ] It is only partially ionised in an aqueous solution.
- [ ] The reaction equilibrium is on the side of the reactants.

Check

Chemistry lab

Task 6

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In which unit is the concentration of the amount of substance measured?

- ○ mol/l
- ○ kg/mol^{-1}

Check

Experiment

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Slide	Score / Total
Slide 26: Titration of weak acid	0/3
Slide 27: Weak acid	0/2
Slide 28: Substance concentration	0/1

Total 0 / 6

Solutions | Repeat | Export text

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