The effect of acids and bases on natural and synthetic indicators (Item No.: P7510200)

Curricular Relevance

Area of Expertise: Chemistry

Education Level: Age 14-16

Topic: Inorganic chemistry

Subtopic: Acids and bases, proton transfer

Experiment: The effect of acids and bases on natural and synthetic indicators

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	20 Minutes	2 Students

Additional Requirements:

- Beetroot dye
- Flower dye
- Natural dye (red cabbage juice)

Experiment Variations:

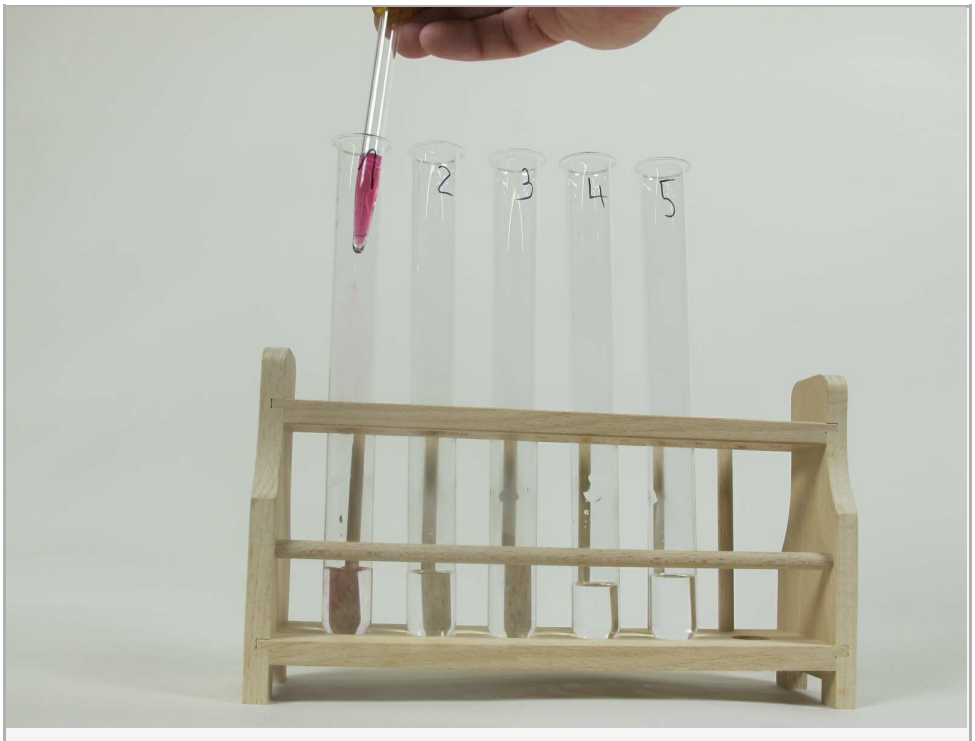
Keywords:

acid, base, indicator, pH-value

Information for teachers

Introduction

Application
Synthetic indicators can aid in the identification of unknown substances, for example first classifications of acids and bases.



Experiment set-up

Educational objectives
Indicators are dyes, which identify acids or bases with a change of colour. Indicators can be either synthesized or natural dyes.

Task
The students will gain first experience with indicators and how they work.

Prior knowledge
This experiment serves as an introduction into the topic 'Acids, bases and indicators'. No prior knowledge required.

Principle
Indicators are organic dyes. They show structural changes with a varying pH value. The structural change in the molecule is responsible for the change in colour.

Notes concerning the experiment and set-up
Prepare the following solutions:
5% hydrochloric acid (Add 50 ml distilled water to a suitable volumetric flask, pipette 13 ml of hydrochlorid acid, 37 % and fill up to 100 ml with distilled water)
10% acetic acid (Add 50 ml distilled water to a suitable volumetric flask, pipette 11 ml of concentrated acetic acid and fill up to 100 ml with distilled water)
5%ige NaOH (Dissolve 5 g NaOH in 95 g distilled water)
5%ige KOH (Dissolve 5 g KOH in 95 g distilled water)

Prepare the following natural indicators (dyes):
Beetroot dye: Cut a beetroot into pieces and cover them with hot water. Wait 10 minutes and filter the solution.
Red Cabbage/flower: Add 4 spoons of sand and 10 ml of methylated spirit with red cabbage/flower to a mortar. Grind with a pestle. Add another 5 ml of methylated spirit. Grind for 5 minutes. Add another 5 ml of methylated spirit and grind for 3 minutes. Filter the solution.

The colours of the flower dyes in table 1 relate to a very suitable indicator, a cornflower extract.
The experiment can be used as an introduction to acids, only Evaluation - Question 3 in the report required a deeper understanding of the topic, it can also be used to introduce polyprotic acids.

Divide the students in groups, each group will conduct the experiment with only one indicator. The group's results should be exchanged among one another.

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

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Equipment

Position No.	Material	Order No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Test tube rack, d = 22 mm, wood, for 6 test tubes	37685-10	1
3	Wash bottle, plastic, 250 ml	33930-00	1
4	Pipette with rubber bulb	64701-00	6
5	Laboratory pencil, waterproof	38711-00	1
6	Test tubes, d = 18 mm, l = 18 cm, glass, 100 pc	37658-10	5
	Potassium hydroxide, 500 g	30103-50	
	Litmus solution, 100 ml	30127-10	
	Sodium hydroxide, 500 g	30157-50	
	Hydrochloric acid, 37 %, 1000 ml	30214-70	
	Water, distilled, 5 l	31246-81	
	Acetic acid, 99-100%, 500 ml	31301-50	
	Methyl orange, 0.1 %, 250 ml	31573-25	
	Phenolphthalein, 0.5 % in ethanol, 100 ml	31715-10	
Additional material			
	Beetroot		
	Flowers		
	Natural dye (red cabbage)		

Safety information

Hazard and precautionary statements

Hydrochloric acid (5%)

H314:	Causes severe skin burns and eye damage.
H335:	May cause respiratory irritation.
H290:	May be corrosive to metals.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P309 +P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Acetic acid (10%)

H226:	Flammable liquid and vapour.
H314:	Causes severe skin burns and eye damage.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P307 + P310:	IF exposed: Immediately call a POISON CENTER or doctor/physician.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Sodium hydroxide (5%)

H314:	Causes severe skin burns and eye damage.
H290:	May be corrosive to metals.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P309 +P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses. Continue rinsing.

Potassium hydroxide (5%)

H314:	Causes severe skin burns and eye damage.
H302:	Harmful if swallowed.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. Remove contact lenses. Continue rinsing.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes.
P309 +P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Phenolphthalein

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

Hazards

- Acids and bases are irritating.
- Wear protecting glasses!

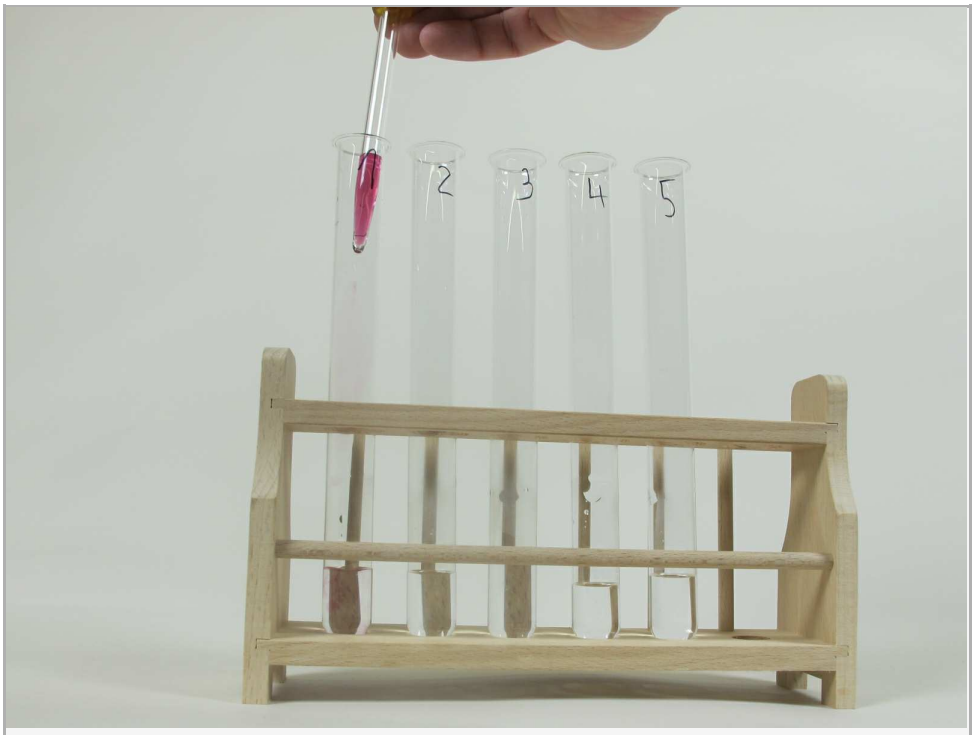
The effect of acids and bases on natural and synthetic indicators (Item No.: P7510200)

Introduction

Application and task

How can you distinguish acids from bases?

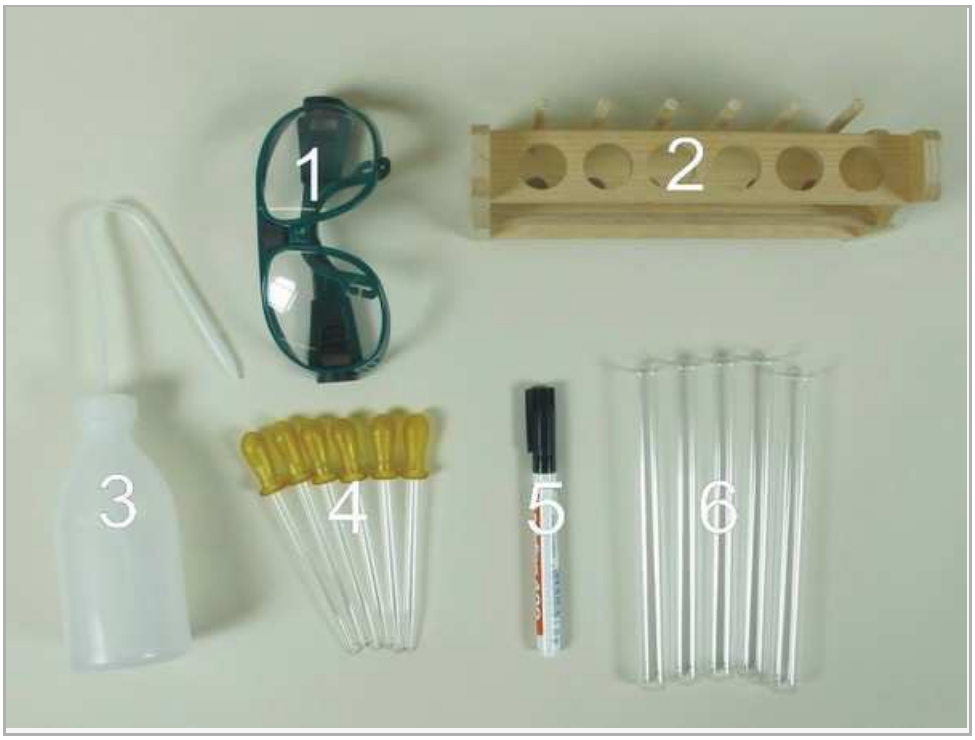
Application
We encounter acids and bases in our everyday life as well as in the occasional chemistry lesson. They are present in the form of vinegar or in soaps. They are everywhere. In order to be able to handle acids and bases safely, it is important to identify those. One method to distinguish acids from bases is the use of indicators.



Experiment set-up

Task
Examine the different effects acids and bases have on natural as well as synthetic indicators.

Equipment



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	Phenolphthalein, 0.5 % in ethanol, 100 ml	31715-10	
Additional material			
	Beetroot		
	Flowers		
	Natural dye (red cabbage)		

Set-up and procedure

Set-up

Hazards

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




Set-up

Number the test tubes from 1 to 5 (Fig. 1).

Fig. 1

Put the test tubes next to each other in the test tube rack (Fig. 2) and label the pipettes (Fig. 3).

Fig. 2

Fig. 3

Procedure

Procedure
Use a pipette to fill test tube 1 with distilled water (fill level ca. 2 cm). Use the appropriate pipette (for each solution) to fill the test tubes with the same amount (fill level ca. 2 cm) as listed below:

- test tube 2: hydrochloric acid
- test tube 3: acetic acid
- test tube 4: sodium hydroxide solution
- test tube 5: potasssium hydroxide solution

Use a new pipette to add a few drops of your chosen indicator to each test tubes. Note down your observations. Exchange your results with the other groups.

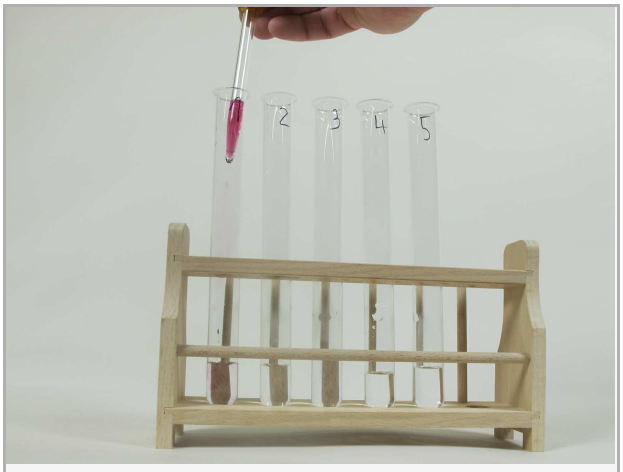

Fig. 4

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

Report: The effect of acids and bases on natural an synthetic indicators

Result - Observations

Briefly describe your observations during the experiment (for example, the change of colour).

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Result - Table 1

Complete the table below with your notes.

Indicator	H_2O	HCl	$C_2H_4O_2$	NaOH	KOH
Beetroot	wine red 1	brown red 1	brown red 1	brown green 1	brown green 1
Red cabbage	purple 1	red 1	red 1	blue green 1	blue green 1
Flower	dark purple 1	red 1	red 1	blue purple 1	blue purple 1
Litmus	dark purple 1	red 1	red 1	blue 1	blue 1
Methyl orange	yellow/orange 1	red 1	red 1	yellow 1	yellow 1
Phenolphthalein	colourless 1	colourless 1	colourless 1	pink 1	red purple 1

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
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Evaluation - Question 1

Make assumptions concerning the experiment and your observations.

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Evaluation - Question 2

Which indicator is not suitable to identify acids?

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Evaluation - Question 1

The indicator bromthymol blue is yellow when in acidic pH range and blue when in alkaline pH range. Which conclusion can you make, when the indicator shows a green colour?

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