Acids and their effect on indicators (Item No.: P7510100)

Curricular Relevance

Area of Expertise: Chemistry
Education Level: Age 14-16
Topic: Inorganic chemistry
Subtopic: Acids and bases, proton transfer
Experiment: Acids and their effect on indicators

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

Additional Requirements:

- Coke, 500 ml
- Vinegar, 500 ml

Experiment Variations:

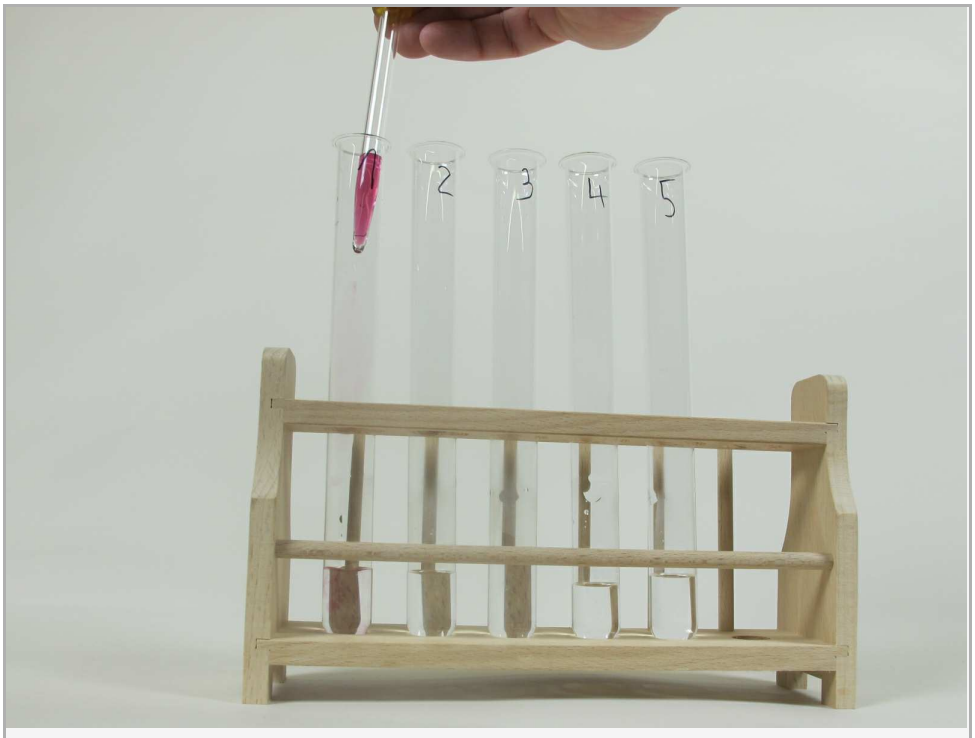
Keywords:

acid, base, pH-value, indicator

Informations for teachers

Introduction

Application
Synthetic indicators support the identification of unknown substances. With their assistance, a first attempt to classify the strength of various acids is possible.



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.

Furthermore, the students will receive a brief introduction to the concept of acid strength.

Task
During this experiment, the students examine acids and learn that an indicator shows different colour shades due to the individual strength of an acid.

Prior knowledge
The experiment is meant to give a first introduction to the topic 'acid strength and indicators', therefore the students do not need prior knowledge.

Prinzip
Indicators are organic dyes. Different pH-values lead to a structural change of the molecules. The structural remodeling is responsible for the change in colour. When comparing acids of an equal concentration, one can observe different pH-values.
The strength of an acid refers to the ability to liberate a proton in a solution.
Strong acids dissociate completely in a solution, whereas weak acids only partially dissociate (resulting in a higher pH-value).
The pK_a-value is a parameter to measure acid strength. The lower the value of pKa, the stronger the acid (and vice versa).
The pK_a is equal to the pH-value at half neutralization (i.e. 50 % of the protons are still able to be deliberated).

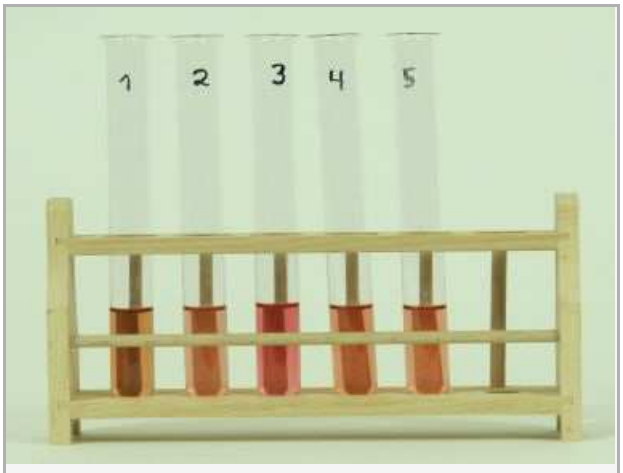
Notes concerning the set-up and execution of the experiment
Prepare a 0.1 M solution of the acids mentioned below.

Hydrochloric acid: Add 250 ml distilled water to a suitable volumetric flask, pipette 4.16 ml of hydrochlorid acid, 37 % and fill up to 500 ml with distilled water.
Sulphuric acid: Add 250 ml distilled water to a suitable volumetric flask, pipette 26.7 ml of sulphuric acid, 10 % and fill up to 500 ml with distilled water.
Nitric acid: Add 250 ml distilled water to a suitable volumetric flask, pipette 32.5 ml of nitric acid, 10% and fill up to 500 ml with distilled water.

The choice of indicators for this experiment is freely selectable. Depending on your taste, you can also use methyl orange, thymol blue or an universal indicator.

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

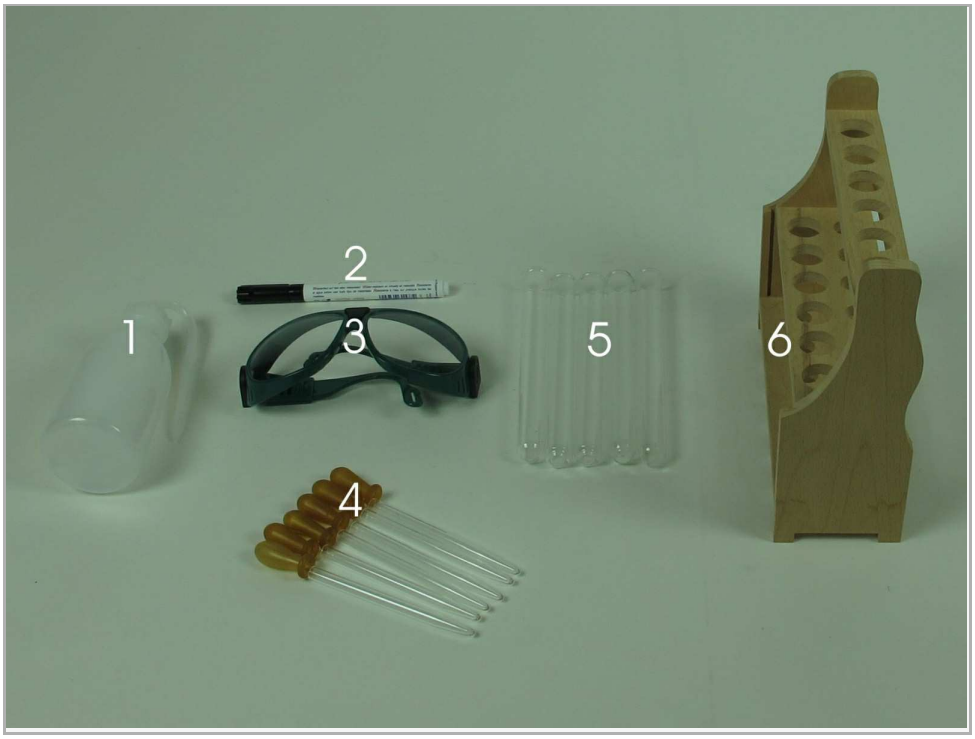
Sample solution



Exemplary-result

Equipment

Position No.	Material	Order No.	Quantity
1	Wash bottle, 250 ml, plastic	33930-00	1
2	Laboratory pencil	38711-00	1
3	Protecting glasses, clear glass	39316-00	1
4	Pipette with rubber bulb	64701-00	6
5	Test tubes	36293-00	5
6	Test tube rack, wooden	40569-10	1
	Water, distilled, 5 l	31246-81	
	Hydrochloric Acid, 37%, 1000 ml	48452-70	
	Sulphuric acid, 10 %, 1000 ml	31828-70	
	Nitric acid, 10%, tech. gr. 1000 ml	31817-70	
	Litmus solution, 100 ml	30127-10	
Additonal material			
	Coke		
	Vinegar		



Safety information

Hazard and precautionary statements

Hydrochloric acid	
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.
Sulphuric acid	
H290:	May be corrosive to metals.
H234:	Keep only in original container.
P390:	Absorb spillage to prevent material damage.
Nitric acid	
H272:	May intensify fire; oxidiser.
H314:	Causes severe skin burns and eye damage.
P220:	Keep/Store away from clothing/.../combustible materials.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310:	Immediately call a POISON CENTER or doctor/physician.

Hazards

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

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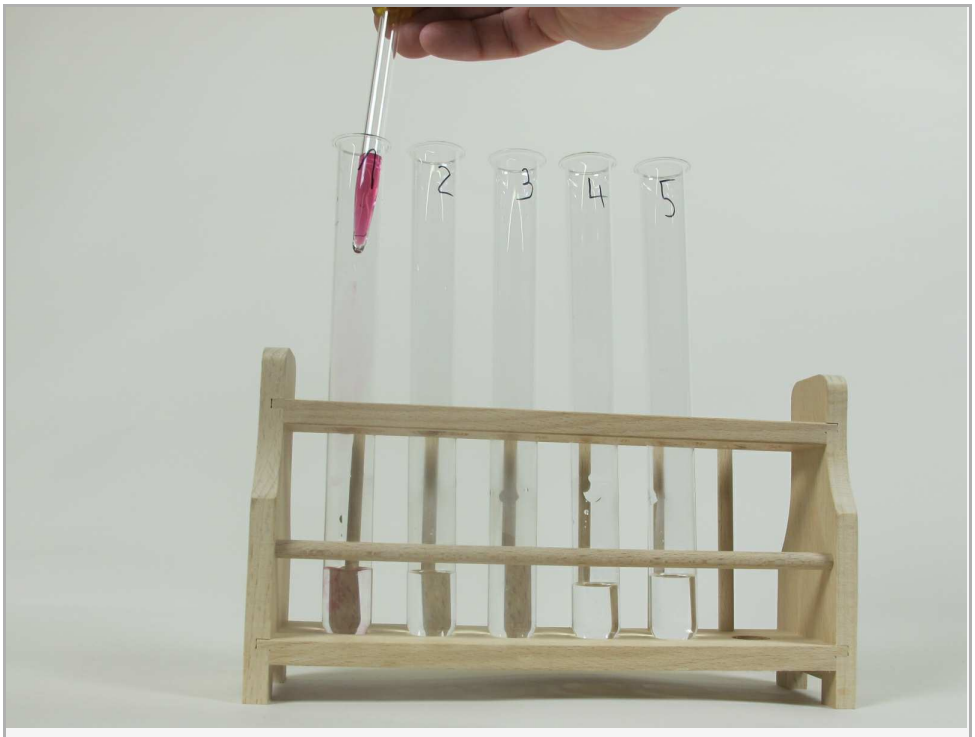
Introduction

Application and task

Why is one acid stronger than the other?

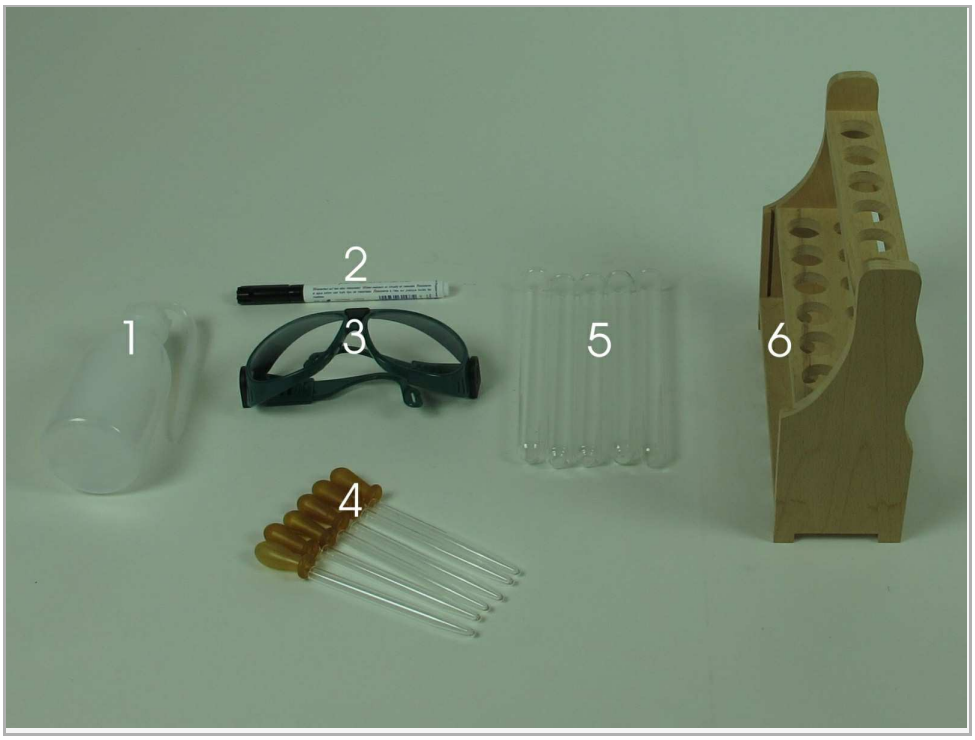
Application
We encounter acids in our everyday life as well as in chemistry classes. They are present in your favourite drink or in your salad dressing, but not all acids are harmless.
In order to handle acids safely, it is important to know the strength of an acid and how to measure it. One possibility to investigate the strength of an unknown acid is the use of an indicator.



Experiment set-up

Task
Examine the effect of different acids on the indicator litmus. Note your assumptions for test tube 1 and 2 before starting the experiment, also note your observation during the experiment regarding the individual colour change.

Equipment



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Additonal material:			
	Coke		
	Vinegar		

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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 one quarter of test tube 1 with diluted coke (10 ml coke to 100 ml distilled water), repeat the procedure and fill one quarter of test tube 2 with vinegar. Fill one quarter of test tube 3 with hydrochloric acid, one quarter of test tube 4 with sulphuric acid and one quarter of test tube 5 with nitric acid. Use the labelled pipettes for each of the acids or solutions.
Next, use a new pipette to add 3 drops of the indicator litmus to each of the test tubes (Fig. 4). Note your observation regarding the change of colour.

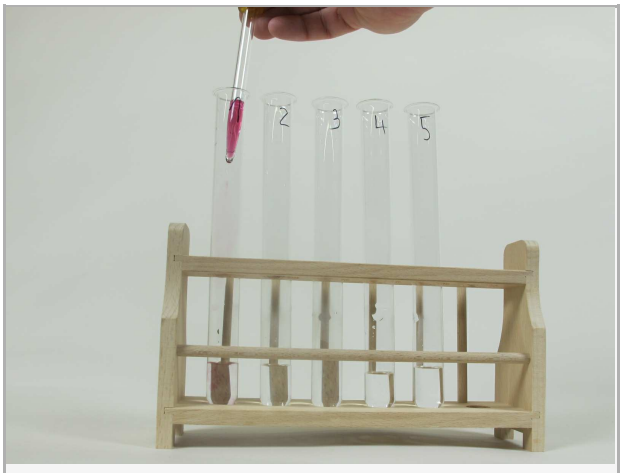

Fig. 4

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

Report: Acids and their effect on indicators

Result - Table 1

Complete the table below. Note the change of colour and also the intensity of colour in brackets (1=strong, 5=weak).

Test tube	Solution	Observations
1	Coke	bright red (4) 1
2	Vinegar	bright red (5) 1
3	Hydrochloric acid	red (1) 1
4	Sulphuric acid	bright red (2) 1
5	Nitric acid	bright red (3) 1

Evaluation - Question 1

How can you calculate an acid's strength?

(Note: pK_a-value)

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Evaluation - Question 2

Explain the term acid strength. What makes an acid weak, what makes it strong?

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Evaluation - Question 3

What is the reason that the test tubes 3,4 and 5 show different shades of red?

1. .....