Identification of buffers with indicators (Item No.: P7510300)

Curricular Relevance

| Area of Expertise: Chemistry | Education Level: Age 14-16 | Topic: Inorganic chemistry | Subtopic: Acids and bases, proton transfer | Experiment: Identification of buffers with indicators |
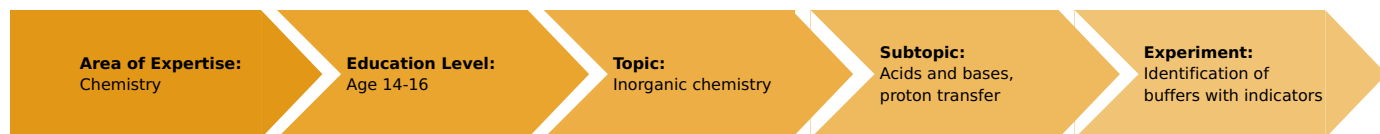
Difficulty	**Preparation Time**	**Execution Time**	**Recommended Group Size**
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:	**Experiment Variations:**

Keywords:

buffer solutions, acids, bases, indicators

Information for teachers

Introduction

Application

Buffer solutions usually consist of a weak acid and its conjugate base. Acids neutralise hydroxide-ions, bases on the other hand oxonium-ions. A buffer solution is produced by adding an equimolar mixture of a weak acid and its salt (e.g. acetic acid and sodium acetate) or a weak base and its salt (e.g. ammonium chloride and ammonia).

Experiment set-up

Educational objectives

The students will get an introduction to buffers and how they work.

Task

The students will examine the basic characteristics of a buffer solution by adding a strong base (here: NaOH) and a strong acid (here: HCl) to a buffer solution (here: acetate buffer).

Prior knowledge

The students should have already gained experimental experience concerning the handling of acids and bases.

Principle

Buffer solutions usually consist of weak acids and their conjugate bases. Acids neutralise hydroxide-ions, bases on the other hand oxonium-ions. A buffer solution is produced by adding an equimolar mixture of a weak acid and its salt (e.g. acetic acid and sodium acetate) or a weak base and its salt (e.g. ammonium chloride and ammonia).

In this experiment, the students investigate the effect of buffer solutions with an indicator, which is added to all test tubes (here: thymol blue). The students pipette small amounts of a strong acid (HCl) and a strong base (NaOH) to a buffer solution. The same amount of acid/base will be added to a water solution. When comparing the different outcomes, it becomes clear that the test tubes containing a buffer solution, in contrary to the test tubes with simply water, do not show a change in colour.

Notes concerning the set-up and execution of the experiment

Prepare a 0.1 M solution of the acids mentioned below.

<u>Hydrochloric acid:</u> 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.

<u>Acetic acid:</u> Add 250 ml distilled water to a suitable volumetric flask, pipette 2.80 ml of concenctrated acetic acid and fill up to 500 ml with distilled water.

<u>Sodium acetate:</u> Dissolve 4.1 g in 500 ml distilled water.

<u>Sodium hydroxide:</u> Dissolve 0.8 g in 200 ml distilled water.

Also prepare:

<u>Acetate buffer:</u> For 1 liter acetate buffer add 500 ml 0.1 M acetic acid to 500 ml 0.1 M sodium acetate solution.

<u>Thymol blue:</u> Dissolve 0.05 g thymol bue in 100 ml ethanol.

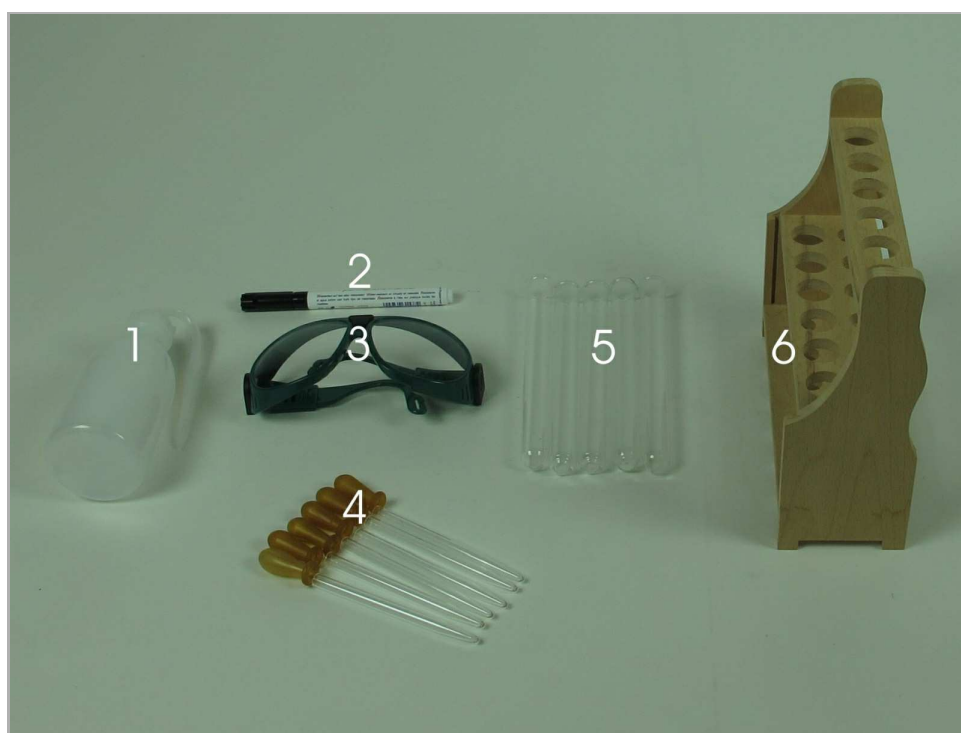**Disposal**

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

Sample solution

Exemplary result

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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	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	3
5	Test tube, 180x18 mm, 100 pcs	37658-10	(4)
6	Test tube rack f. 6 tubes, wood	37685-10	1
	Ethyl alcohol, absolute 250 ml	30008-25	
	Sodium acetate trihydrate, 250 g	30149-25	
	Sodium hydroxide, pellets, 500 g	30157-50	
	Water, distilled, 5 l	31246-81	
	Acetic acid 99...100%, 500 ml	31301-50	
	Thymol blue indicator, 5 g	31896-02	
	Hydrochloric acid, 37%, 1000 ml	48452-70	

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Safety information

Hazardous and precautionary statements

Hydrochloric acid (0.1 M)

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.

Sodium hydroxide (0.1 M)

H290:	May be corrosive to metals.
P234:	Keep only in original container.
P390:	Absorb spillage to prevent material damage.

Acetic acid (0.1 M)

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.

Ethanol, absolute

H225:	Highly flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces. — No smoking.
P233:	Keep container tightly closed.
P240:	Ground/bond container and receiving equipment.
P403 + P235:	Store in a well-ventilated place. Keep cool.

Hazards

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

Identification of buffers with indicators (Item No.: P7510300)

Introduction

Application and task

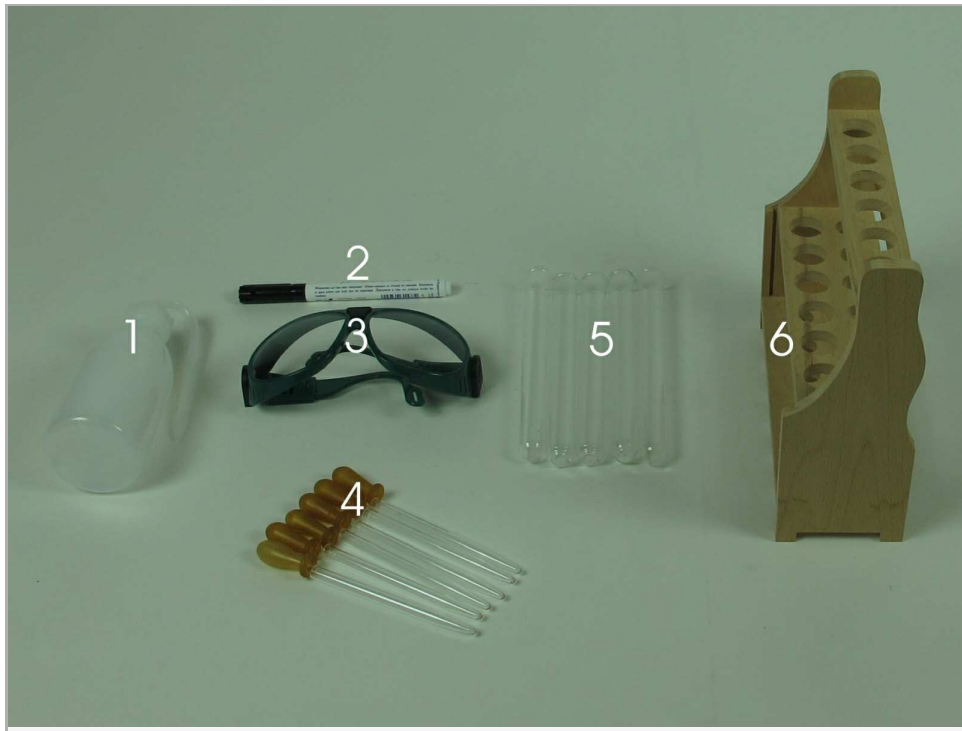#### What is a buffer solution?

Application

Buffer solutions are used in chemistry laboratories to conduct experiments with a constant pH-value. However, buffer systems also play an important role in our body. The physiological and required pH-value in many organism such as the human body is 7.4. Many reactions only work with a pH-value close to this value (e.g. enzymes). However, the pH-value in the human body varies all the time due to acidic or alkaline metabolic products. Buffer systems are therefore needed to keep the physiological pH constant, which is crucial to our survival.

Experiment set-up

Task

Investigate the effect of strong acids (HCl) and strong bases (NaOH) on buffer solutions with an indicator (thymol blue). In the next step, add a strong acid (HCl) and a strong base (NaOH) to a water solution with an indicator (thymol blue). Compare the results. Note your observations.

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Set-up and procedure

Set-up

Hazards

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

Setup

Number the test tubes from 1 to 4 and put the the test tubes next to each other into the test tube rack (Fig. 1). Label the pipettes (Fig. 2).

Fig. 1

Fig. 2

Fill the test tubes 1 and 3 one fifth full with distilled water and test tubes 2 and 4 one fifth full with the prepared buffer solution (Fig. 3). Add 3 drops of thymol blue to each of the test tubes, use the labelled pipette (Fig. 4).

Fig. 3
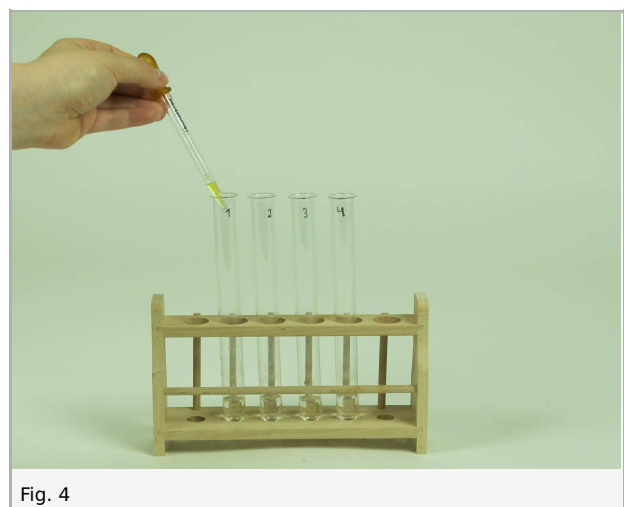
Fig. 4

Procedure

Procedure
Use the labelled pipettes (HCl, NaOH).
Add 2 drops of NaOH to test tubes 1 and 2 (Fig. 5).
Add 2 drops of HCl to test tubes 3 and 4 (Fig. 6).
Note your observations.

Fig. 5
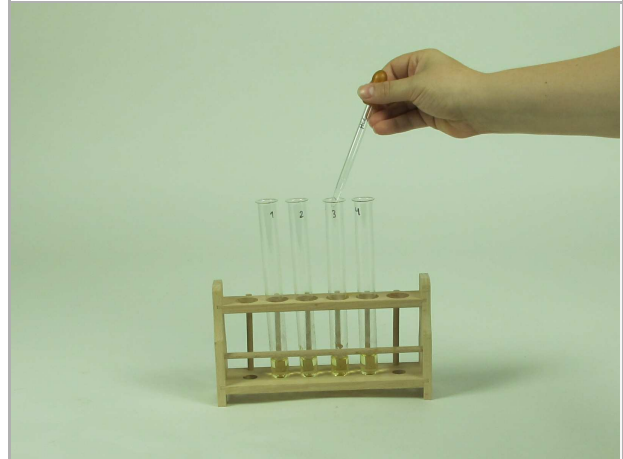
Fig. 6

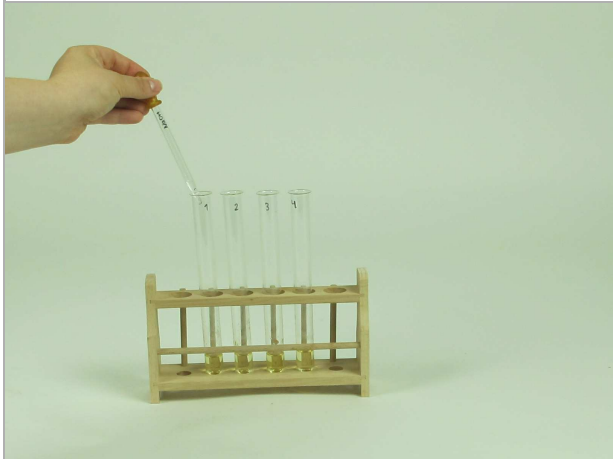### Disposal
Put the content of all the test tubes into the collecting tank for acids and alkalis.

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Report: Identification of buffers with indicators

Result - Table 1

Note your observations in the table below.

Test tube	Colour (without HCl/NaOH)		Colour (with HCl/NaOH)	
1	light brown	1	blue	1
2	light brown	1	light brown	1
3	light brown	1	red	1
4	light brown	1	light brown	1

Evaluation - Question 1

Explain your observations.

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Evaluation - Question 2

Explain briefly how buffers work.

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