# Erasmus Plus Project
# 2016-1-PL01-KA219-026303_2

# “Moving forward with key competences”

Chemistry experiments to be used in class

## Sommario

# Topic 1: Proof of alkali metals according to their flame colouration - Student Worksheet

Why do fireworks light up in different colours?

Materials:

| Equipment | chemicals |
|---|---|
| • watch glass<br>• magnesium sticks<br>• gas burner<br>• small beaker<br>• cobalt blue glass | • hydrochloric acid<br>• lithium chloride<br>• sodium chloride<br>• potassium chloride |

Carrying out the experiment:

1. Put a little bit of the hydrochloric acid into the beaker and add some of the lithium chloride onto the watch glass.
2. Dip the magnesium stick shortly into the acid und heat it up in the flame. Repeat this as often as necessary until there is no more colouring of the flame.
   Then, dip the stick again into the acid before you apply some salt onto the stick of the watch glass. Now, hold the stick with the salt sidewise into flame.
3. Repeat the process with the other types of salt as well.

Task:

Fill in the grid by naming the colour of the flames of the different types of salt.

| salt | flame colouration |
|---|---|
| **lithium chloride** | |
| **sodium chloride** | |
| **potassium chloride** | |

**Student's copy**

Answer to our question:

Student's copy

# Topic 1: Proof of alkali metals according to their flame colouration – Teacher Worksheet

Learning preconditions:

- didactical:
  - The students know the different alkali metals and their characteristics.
  - The students know that salts of the alkali metals are products of the reactions of alkali metals with halogens.
  - The students are able to name the salts.

- teaching methods:
  - The students are able to carry out experiments independently, especially the handling of the gas burner must be familiar.

Lesson plan:

| stages | didactics | methods | materials/media |
|---|---|---|---|
| Opening | Presenting the problem<br>Presentation of a picture showing a firework. | class discussion | computer, projector, picture |
| introduction | Naming the problem<br>a) Description of the picture.<br>b) Why do fireworks light up in different colours? | class discussion | |
| Practice | Carrying out the experiment regarding the flame colouration<br><br>The students set up the experiment independently, carry it out and note down their observations.<br>After the experiment, they remove the equipment and work in groups on the tasks on the exercise sheet. | experiment | exercise sheet, materials, poss. visual aid for weaker students |
| evaluation | evaluation<br>**a)** Students present their results.<br>**b)** Reference to the context and answering the question | class discussion | exercise sheet, |

**Teacher's copy**

Opening

Source : https://umwelt.bussgeldkatalog.org/wp-content/uploads/sites/4/2015/02/feuerwerk-erlaubnis-300x199.jpg

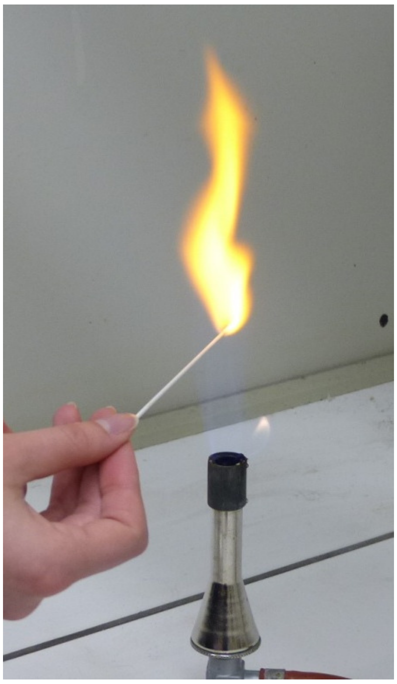
Solutions to the exercise sheet:

| salt | flame colouration |
|---|---|
| **lithium chloride** | red |
| **sodium chloride** | yellow |
| **potassium chloride** | purple |

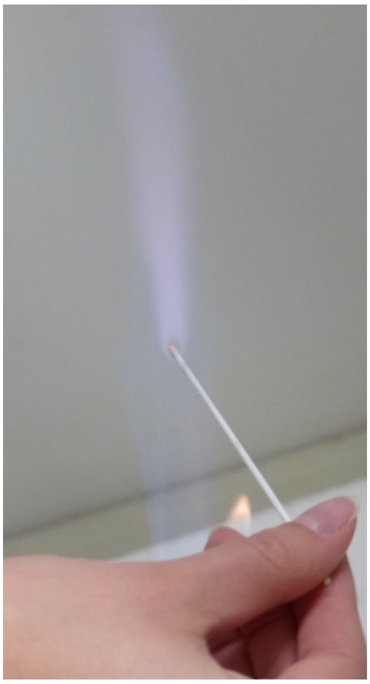
Answer to our question:

Fireworks contain salts of the alkali metals which produce coloured flames at high temperatures. Each salt has a characteristic flame colouration determined by the alkali metal. Therefore, the colour of the flames can be used to clearly identify the alkali metal.

**Teacher's copy**



Flame colouration: natrium chloride



Flame colouration: potassium chloride

Teacher's copy

## Topic 2: The electrolytes– Student Worksheet

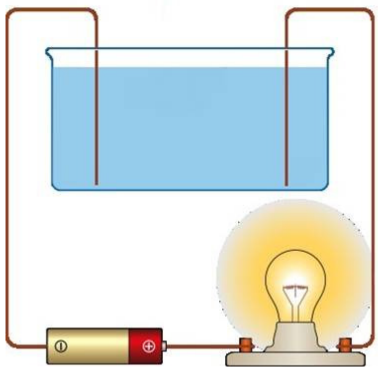
**Purpose of the experiment:** In this experiment, you will construct an electrical circuit and study the electrical conductivity of water and two water solutions. You will then identify the solutions as electrolytic and non-electrolytic.

**Knowing:** An electrolyte is a susbstance that produces an electrically conducting solution when dissolved in a polar solvent, such as water.

**Materials:**

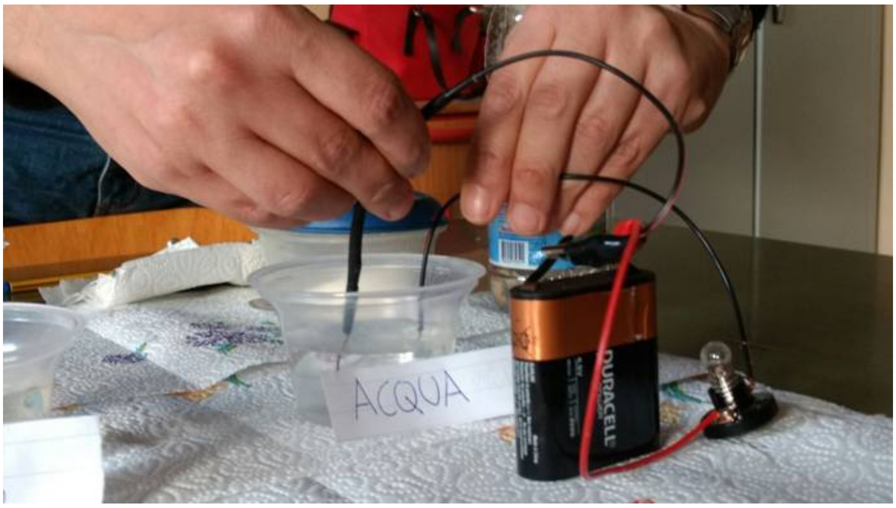
- one 4.5V battery,
- copper electric wire,
- one 1.5V light bulb with a lamp holder,
- two alligator clips,
- three transparent plastic containers,
- a teaspoon,
- water,
- cooking salt,
- table sugar.

Assemble the materials to construct the circuit shown in figure.



Student's copy

**How to carry out the experiment:**
Pour water in the three containers.
Put sugar in the second container, and stir until the sugar dissolves.
Put salt in the third container, and stir until the salt dissolves.
Dip the ends of the wire into the water without them touching each other.
The light bulb is off.




Dip the ends of the wire into the sugar solution without them touching each other. The light bulb is off.


Dip the ends of the wire into the salt solution without them touching each other. The light bulb is on.

**Student's copy**


**Let's discuss the result of the experiment:**
The salt solution conducts electric current, while the water and the sugar solution do not conduct it. Therefore cooking salt is an electrolyte, and table sugar is a non-electrolyte.
Questions:

1. Why do cooking salt solutions conduct electric current, while sugar solutions do not?
2. What happens to the salt, when it is dissolved in the water?
3. What happens to the sugar, when it is dissolved in the water?
4. Since cooking salt in solid state does not conduct electricity, what is the role of water in the studied phenomenon?
5. In which direction do $Na^+$ and $Cl^-$ ions move?
6. Hypothesize and write equations of the chemical reactions which take place in the solution.

**Student's copy**

## Topic 2: The electrolytes – Teacher Worksheet

**Purpose of the experiment:** In this experiment, you will construct an electrical circuit and study the electrical conductivity of water and two water solutions. You will then identify the solutions as electrolytic and non-electrolytic.

**Knowing:** An electrolyte is a susbstance that produces an electrically conducting solution when dissolved in a polar solvent, such as water. The dissolved electrolyte separates into cations and anions, which disperse uniformly through the solvent. Electically, such a solution is neutral. If an electrical potential is applied to such a solution, the cations of the solution are drawn to the electrode that has an abundance of electrons, while the anions are drawn to the electrode that has a deficit of electrons. The movement of anions and cations in opposite directions within the solution amounts to a current.

**Materials:**

- one 4.5V battery,
- copper electric wire,
- one 1.5V light bulb with a lamp holder,
- two alligator clips,
- three transparent plastic containers,
- a teaspoon,
- water,
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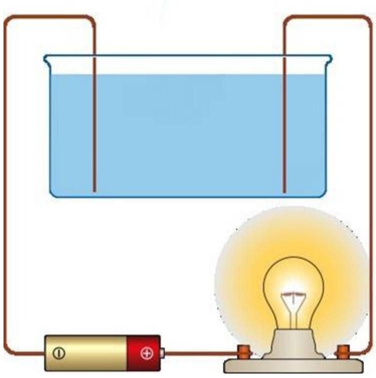
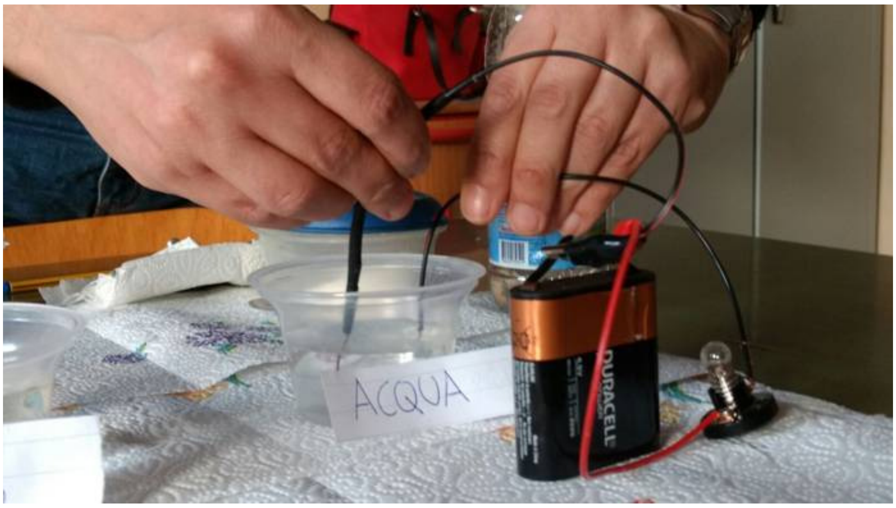
- table sugar.

Assemble the materials to construct the circuit shown in figure.



Teacher's copy

**How to carry out the experiment:**
Pour water in the three containers.
Put sugar in the second container, and stir until the sugar dissolves.
Put salt in the third container, and stir until the salt dissolves.
Dip the ends of the wire into the water without them touching each other.
The light bulb is off.




Dip the ends of the wire into the sugar solution without them touching each other. The light bulb is off.


Dip the ends of the wire into the salt solution without them touching each other. The light bulb is on.

Teacher's copy


**Result of the experiment:**
The salt solution conducts electric current, while the water and the sugar solution do not conduct it. Therefore cooking salt is an electrolyte, and table sugar is a non-electrolyte.

Teacher's copy

# Topic 3: Soapmaking in two methods– Student Worksheet

## Experiment 1.

***Soapmaking in neutralisation reaction.***

**Educational aids:**

**equipment:** evaporating dish, tripod, wire gauze, Bunsen burner, stir stick.
**chemicals:** sodium hydroxide, stearic acid, phenolphthalein acid.



1. Do the experiment according to the instruction:
   a) pour some concentrated solution of sodium hydroxide into the evaporating dish,
   b) add a few drops of phenolphthalein acid,
   c) add slowly stearic acid till the mixture thickens and the raspberry colour fades away,
   d) heat up the evaporating dish stirring the mixture,
   e) observe what happens in the evaporating dish,
   f) cool down the mixture,
   g) check if the mixture dissolves in water.

   Observations:

   ______________________________________________
   ______________________________________________
   ______________________________________________

   Conclusions:

   ______________________________________________
   ______________________________________________
   ______________________________________________

2. Write down the chemical reaction:
   stearic acid + sodium hydroxide → stearate + water
   ……………………………………………………………………….

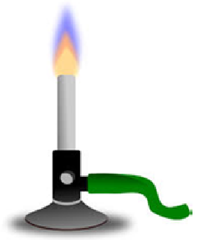
**Student's copy**

# Experiment 2.

## *Soapmaking in saponification reaction.*

**Educational aids:**

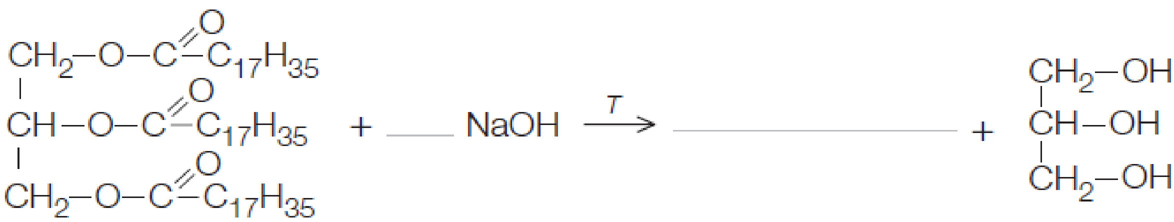
**equipment:** evaporating dish, tripod, wire gauze, Bunsen burner, stir stick.
**chemicals:** sodium hydroxide, solid butter.




1. Do the experiment according to the instruction:
   a) put some fat in the evaporating dish,
   b) add some sodium hydroxide,
   c) heat up the evaporating dish stirring the mixture for about 10 minutes,
   d) leave the mixture to cool down.

2. After cooling, check what is the substance like in touch. Put a little amount of it in a test tube filled with distilled water. Observe what happens in the evaporating dish and in the test tube.

3. Complete the chemical reaction:




4. Underline the correct information on the basis of the carried out experiment.

**Observations:**
The mixture in the evaporating dish *boils over / lathers/bubbles / burns.*
You can smell *rancid butter / bad eggs / soap.*
The product is *white / yellow /orange* mass, slippery in touch.
After adding distilled water and shaking it, the product *dissolves/ doesn't dissolve*.

**Conclusions:**
There was a reaction of *throwing off sediment / esterification / hydrolysis*.
One of its products is *soap / ester / carboxylic acid*.

# Topic 3: Soapmaking in two methods – Teacher Worksheet

**Goals:** introducing students to methods of soapmaking.

**Operational goals**:
- ✓ soapmaking in neutralisationreaction,
- ✓ soapmaking in saponificationreaction.

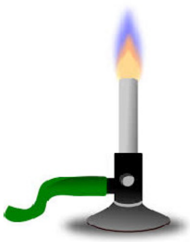
**Main knowledge of students:**

Student:
- ✓ can define the term soap,
- ✓ lists methods of soapmaking,
- ✓ can define terms: neutralisation reaction, saponification reaction,
- ✓ can write down chemical reactions,
- ✓ describes how to make soap from fat and in the neutralisation reaction.

**Method:**
- ✓ discussion withstudents (questions and answers),
- ✓ doing experiments.

**Educational aids – Experiments**

| **Equipment:** | **Chemicals** |
|---|---|
| - test tube,<br>- evaporating dish,<br>- tripod,<br>- wire gauze,<br>- Bunsen burner,<br>- stir stick. | - sodium hydroxide,<br>- stearic acid,<br>- phenolphthalein acid,<br><br>- solid fat (butter or lard) |



Lesson plan:

1. Presenting the topic: soapmaking in neutralisation and saponification reaction.

2. Experiment 1 – making soap in neutralisation reaction.
   Students do the experiment according to the instruction in the worksheet, supervised by the teacher, write down their observations and complete the exercises.
   Instruction:
   a) they pour some concentrated solution of sodium hydroxide into the evaporating dish and add a few drops of phenolphthalein acid.
   b) they add slowly stearic acid till the mixture thickens and the raspberry colour fades away.
   c) they heat up the evaporating dish stirring the mixture; *the mixture starts to bubble and it smells like a soap. After cooling , the mixture becomes white and slippery. It dissolves in water.*
   d) chemical reaction: $C_{17}H_{35}COOH + NaOH \rightarrow C_{17}H_{35}COONa + H_2O$

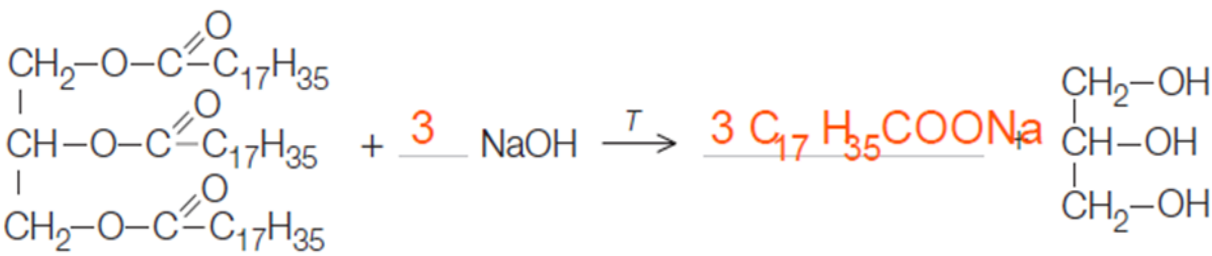
**Teacher's copy**

3. Experiment 2 – making soap in saponification reaction.

   Students do the experiment according to the instruction in the worksheet, supervised by the teacher, write down their observations and complete the exercises.

   Instruction:

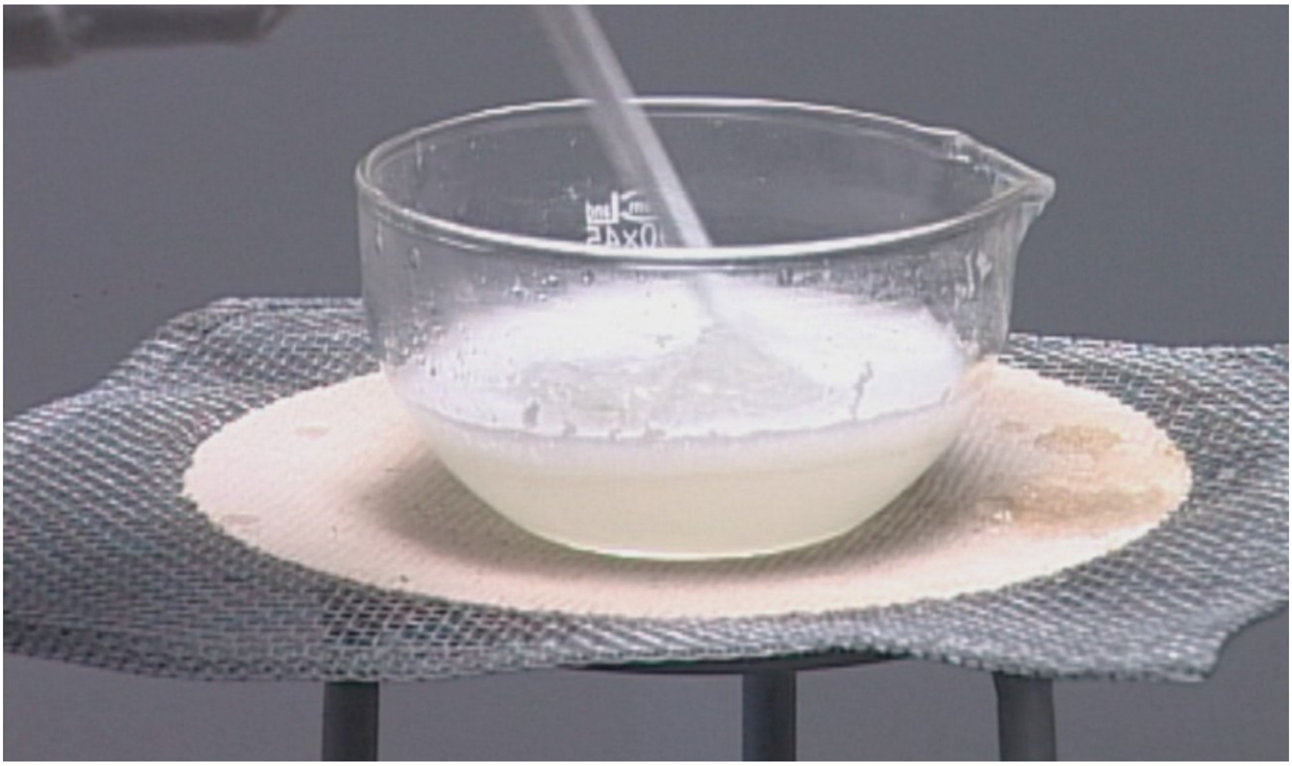
   a) they put some fat in the evaporating dish and add some sodium hydroxide.
   b) they heat up the evaporating dish stirring the mixture; it starts to bubble and it smells like soap;
   c) the reaction breaks the triglyceride into the glycerine and soap molecules.




**Observations:**
The mixture in the evaporating dish *boils over / lathers(bubbles) / burns.*
You can smell *rancid butter / bad eggs / soap*.
The product is *white / yellow / orange* mass, slippery in touch.
After adding distilled water and shaking it, the product *dissolves / doesn't dissolve*.

**Conclusions:**
There was a reaction of *throwing off sediment / esterification / hydrolysis*.
One of its products is *soap / ester / carboxylic acid*.

**Teacher's copy**



Teacher's copy

# Topic 4: Removing water from hydrates – Student Worksheet

## Experiment

### *Removing water from cobalt (II) chloride hexahydrate*

**Educational aids:**

**equipment:**test tube, test-tube rack, test tube holder,Bunsen burner,spatula
**chemicals:**cobalt (II)chloride hexahydrate



3. Do the experiment according to the instruction:
   h) place a few crystals of cobalt (II) chloride hexahydrate into test tubes,
   i) heat the bottom of one test tube in a Bunsen burner flame and record your observations.

Observations:

______________________________________________
______________________________________________
______________________________________________

Conclusions:

______________________________________________
______________________________________________
______________________________________________

4. Write the formulas and the names of the hydrates:

*A.* ______________________________ - $CuSO_4 \bullet 5H_2O$
*B. magnesium sulphate-water(1/7) -* ______________________
*C.* ______________________________ -$Na_2SO_4 \bullet 10\ H_2O$

**Student’s copy**

# Topic 4: Removing water from hydrates – Teacher Worksheet

**<u>Goals:</u>** introducing students to the structure of the hydrates.

**<u>Operational goals</u>**:

- ✓ removing water from cobalt (II) chloride hexahydrate ,

**<u>Main knowledge of students:</u>**

Student:

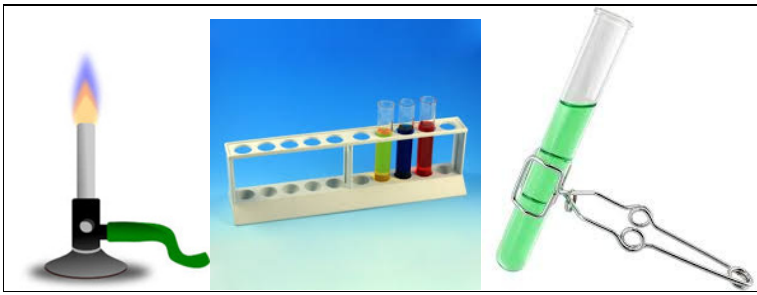
- ✓ can define the term 'hydrate',
- ✓ can predict the behaviour of hydrates during heating up,
- ✓ can describe the differences in properties of hydrates and anhydrous salts.

**<u>Method:</u>**

- ✓ discussion with students (questions and answers),
- ✓ doing an experiment.

**<u>Educational aids – Experiments</u>**

| **Equipment:** | **Chemicals** |
|---|---|
| - test tube,<br>- test-tube rack,<br>- test tube holder<br>- Bunsen burner,<br>- spatula | **-** cobalt (II)chloride hexahydrate |



**Teacher's copy**

Lesson plan:

4. Presenting the topic: removing water from cobalt (II) chloride hexahydrate.

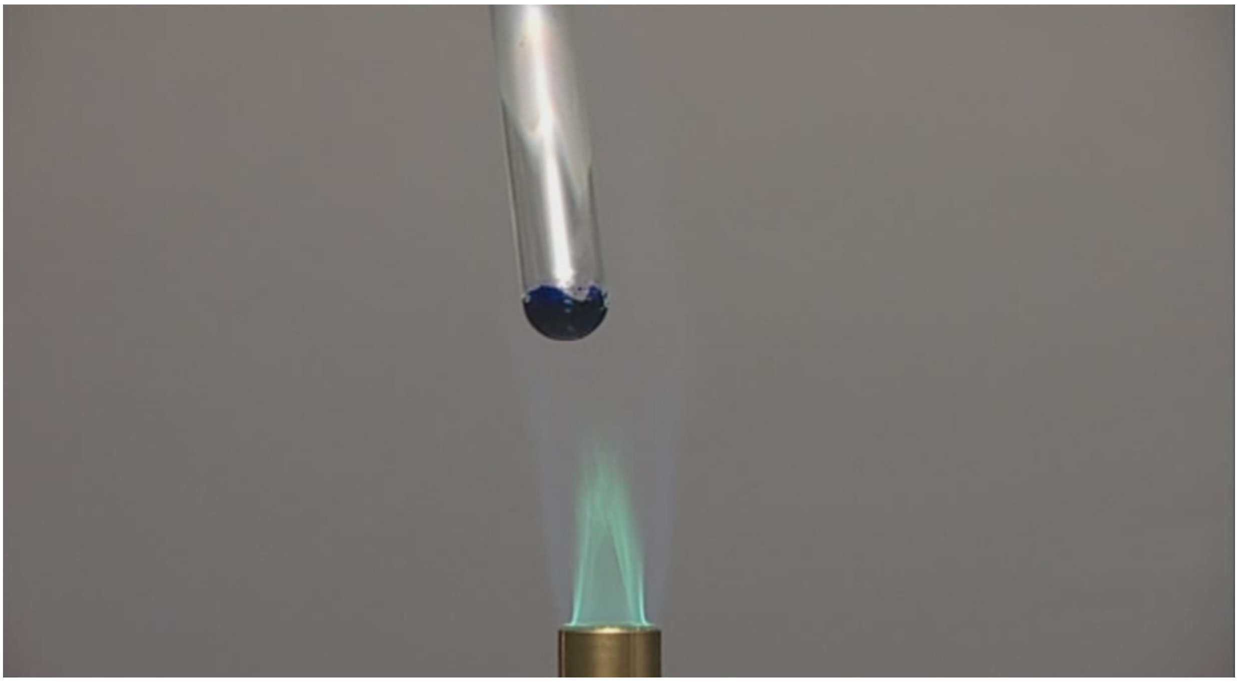
5. Experiment:

   Students do the experiment according to the instruction in the worksheet, supervised by the teacher, write down their observations and complete the exercises.

   Instruction:

   e) they place a few crystals of cobalt (II) chloride hexahydrate into test tubes,
   f) they heat the bottom of one test tube in a Bunsen burner flame and record their observations.
   g) while heating, cobalt (II) chloride hexahydrate turns from red to blue upon hydration, because of heating , water is removed, hydrate is red, anhydrous salts is blue,
   h) students write the formulas and names of the hydrates:

*A. copper(II)sulfate-water(1/5)_________________- $CuSO_4 \cdot 5H_2O$*
*B. magnesium sulphate-water(1/7) - $MgSO_4 \cdot 7\ H_2O$*
*C. sodium sulfate-water(1/10)____________________-$Na_2\ SO_4 \cdot 10\ H_2O$*



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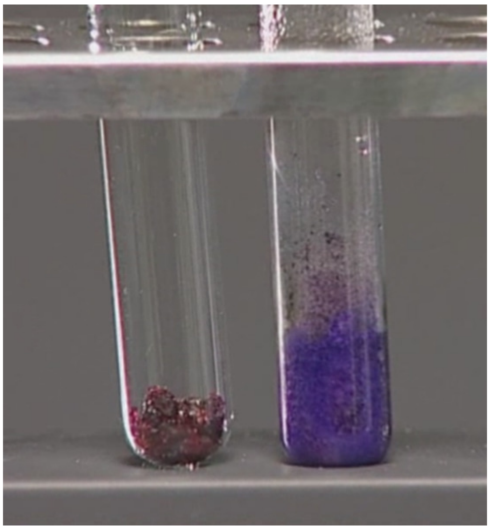
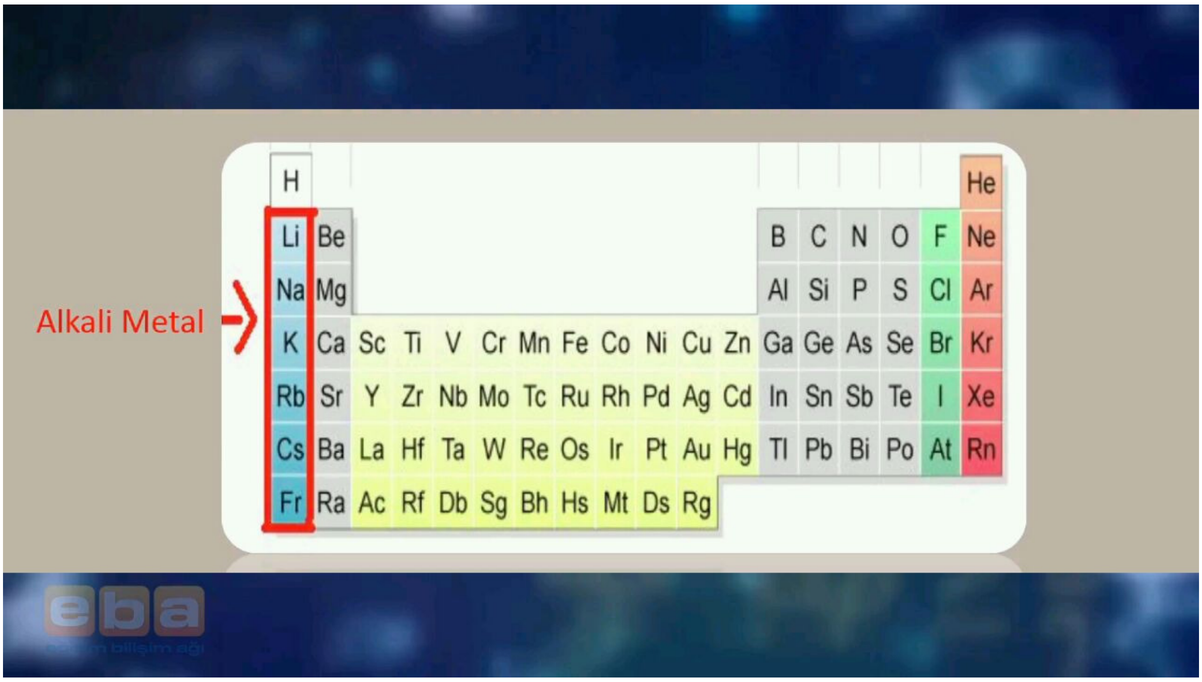


Teacher’s copy

Chemistry experiments to be used in class

## Topic 5: Alkali Metal' s Reaction With Water– Student Worksheet

Experiment: Sodium (Na)' s reaction with water
Needings: Gloves, glasses, test tube, pure water, hexane, sodium, phenolphthalein
Reason: To see alkali metal' s reaction with water
Knowing: Sodium is an element that takes place in group 1A. 1A group elements are called Alkali Metals. Alkali Metals are active so they don' t exist freely, they exist as compound. They transmit electricity and heat very well. When alkali metals and water react, it causes hydroxide, hydrogen gas and heat. It is an exothermal reaction because it causes heat.

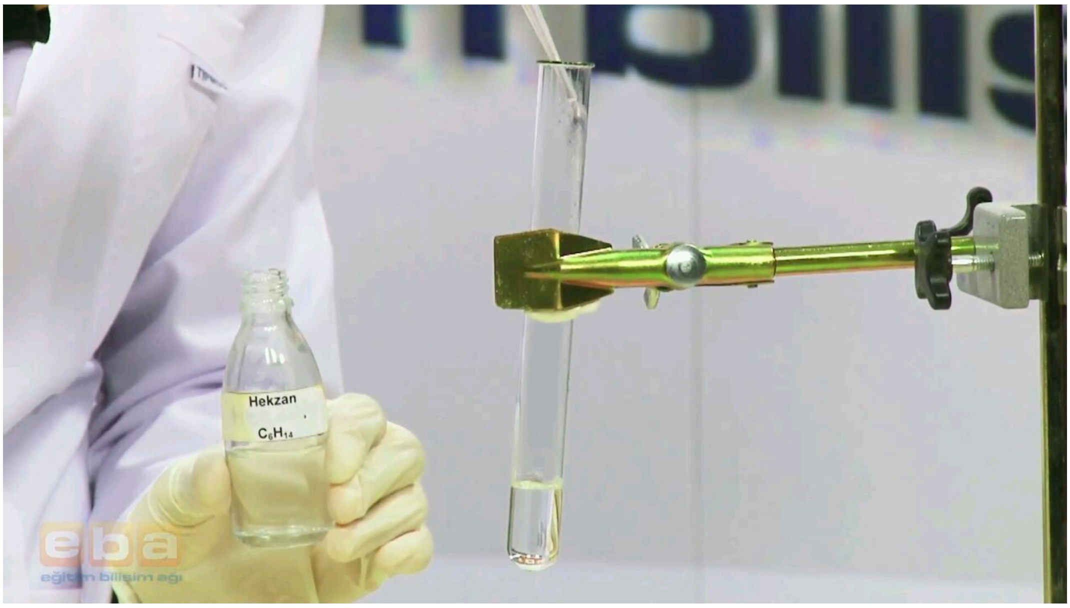



**Student's copy**

How To Carry out The Experiment

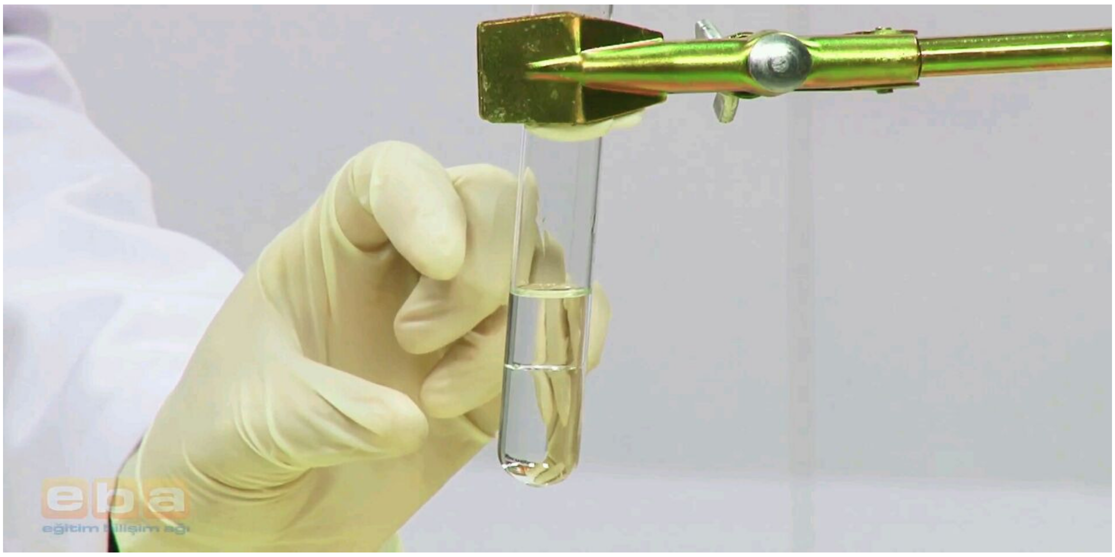
-Wear your gloves
-Wear your glasses
-Put some water to the test tube


Put some phenolphthalein to test tube which has water in it.
Then put some hexane in it.




When you put hexane you'll have two different liquid phases.

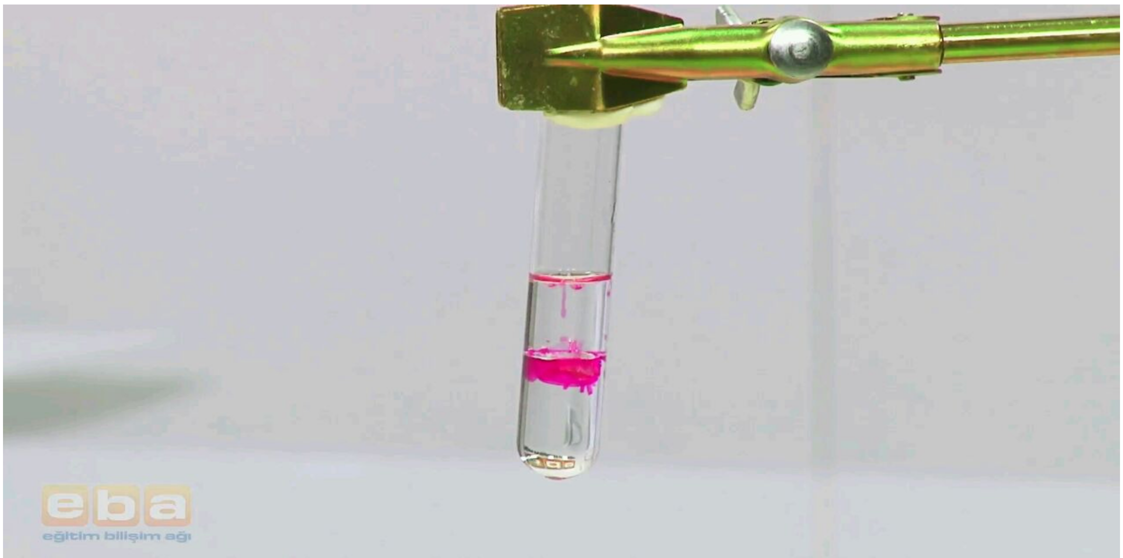
**Student's copy**




Finally put sodium to the test tube


Then write your observations

**Student's copy**




Let's discuss:

1- After the reaction, we can test the liquids pH and think about what the liquid is.
2- By looking at the experiment you do, write an equation about it.
3- How much $H_2$ (p) we gotafter 23gr Na metal's react with water?

**Student’s copy**

# Topic 5: Alkali Metal' s Reaction with Water – Teacher Worksheet

Experiment: Sodium (Na)' s reaction with water
Needings: Gloves, glasses, test tube, pure water, hexane, sodium, phenolphthalein
Reason: To see alkali metal' s reaction with water
Knowing: Sodium is an element that takes place in group 1A. 1A group elements are called Alkali Metals. Alkali Metals are active so they don' t exist freely, they exist as compound. They transmit electricity and heat very well. When alkali metals and water react, it causes hydroxide, hydrogen gas and heat. It' s an exothermal reaction because it causes heat.

## How to carry out the experiment

-Wear your gloves
-Wear your glasses
-Put some water to the test tube
Put some phenolphthalein to test tube which has water in it.
Then put some hexane in it.
When you put hexane you'll have two different liquid phases.
Finally put sodium to the test tube
Then write your observations.

**Let' s Discuss:**
-After the reaction, we can test the liquids ph and think about what the liquid is.
-By looking at the experiment you do, write an equation about it.
-How much $H_2$ (p) we got after 23gr Na metal' s react with water

**Let' s Discuss:**
1- As the reaction resulted in NaOH, the liquid in the cap pH>7
2- $Na_{(k)} + H_2O_{(s)} \Rightarrow NaOH + ½\ H_{2(g)}$
3- 23g Na ⇒ 1 mol Na
$Na_{(k)} + H_2O \Rightarrow NaOH + ½\ H_{(g)}$
1 mol 0.5mol
1 mol $H_2$ ⇒ 22,4L
0,5 mol $H_2$ ⇒ 11,2L

**Teacher's copy**

## Topic 6: Mixtures and separation of the Mixtures methods– Student Worksheet

**OBJECTIVE OF THE EXPERIMENT**: The objective of this experiment is observing different methods to separate mixtures.

**MIXTURE**: a mixture is a material system made up of two or more different substances which are mixed but are not combined chemically. Substances can be combined in any ratio to form a mixture. They don't have to be in a specific ratio.

**APPARATUS AND MATERIALS**

.Magnet

.Wood shaving

.İron powder

.Salt .Water (50 ml) .Beaker (100)

.Filter paper

.Funnel

.Glass rod

.Natural gas

.Trivet

.Bunsen burner

.A spoon

**THE PROCEDURE**

A Little salt, a little sand, a little iron powder are mixed in the beaker (100ml).The mixture is poured onto a piece of clean paper and a magnet is touched to the mixture. The iron powder that is on the magnet is put on another piece of paper.

The remaining mixture is put in the beaker that contains 50 ml of distilled water. The salt and the sand sink in the water, because their density is bigger than of water.

The wood shaving that is on the water is put on another piece of paper with a spoon.

The remaining mixture (salt and sand) is stirred with a glass rod in the beaker and it is dissolved well. If it is dissolved completely, the solution is filtered. The grains that on the filter paper are resolved. Then we boil the solution in the beaker. Finally, water evaporates and the salt is resolved in this way.

**Student's copy**

**LET'S DISCUSS THE RESULT OF THE EXPERİMENT**

1- Which characteristic of iron did we usefor separating it from mixture?
2- Write the separation techniques we used respectively.
3- Design an experiment about how to get the salt inside a broken jar by makinguse of this experiment.

Student's copy

# Topic 6: Mixtures and separation of the Mixtures methods – Teacher Worksheet

**OBJECTIVE OF THE EXPERIMENT**: The objective of this experiment is observing different methods for separate mixtures.

**MIXTURE**: mixture is a material system made up of two or more different substances which are mixed but are not combined chemically. Substances can be combined in any ratio to form a mixture. They don't have to be in a specific ratio.

**APPARATUS AND MATERIALS**

.Magnet

.Wood shaving

.İron powder

.Salt .Water (50 ml) .Beaker (100)

.Filter paper

.Funnel

.Glass rod

.Natural gas

.Trivet

.Bunsen burner

.A spoon

**THE PROCEDURE**

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The remaining mixture is put in the beaker that contains 50 ml of distilled water. The salt and the sand sink in the water. Because their density is bigger than of water.

The wood shaving that is on the water is put on another piece of paper with a spoon.

The remaining mixture (salt and sand) is stirred with a glass rod in the beaker and it is dissolved well. If it is dissolved completely, the solution is filtered. The grains that on the filter paper are resolved. Then we boil the solution in the beaker. Finally, water evaporate and the salt resolved in this way.

**Teacher's copy**

**RESULT OF THE EXPERIMENT**

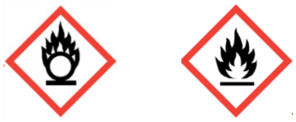
As a result of the experiment, we resolved the mixture of iron powder, wood shaving, salt and sand with separation methods. We use separation with magnet, separation with density difference, separation with draining, separation with evaporation. We learned methods for separation solid-solid mixture thanks to this experiment.

Teacher's copy

# Topic 7: Combustion/Burning – Student Worksheet

## ACCIDENT PREVENTION, RULES

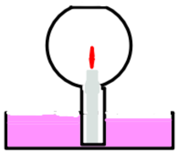
rubber gloves
goggles
protective clothing



| NECESSARY MATERIALS | NECESSARY DEVICES |
|---|---|
| tealight candle<br>4 candle sticks (different heights (2-8 cm))<br>coloured water<br>magnesium turnings<br>approximately 20 $cm^3$ acetic acid (vinegar) of 20% dilution<br>limestone powder<br>limewater | match<br>spirit burner<br>porcelain plate<br>boiling flask<br>crystallizing dish<br>tweezers<br>glass trough<br>beaker<br>straw<br>Erlenmeyer flask |

## EXPERIMENT 1: THE CONDITIONS OF BURNING

Put a candle in the middle of the crystallizing dish. Light it carefully and stick down with a drop of wax. Pour a bit of the coloured water into the dish. Cover it carefully with the boiling flask. Note the changes.



| Observation | Explanation |
|---|---|
| | |
| | |

**Student’s copy**

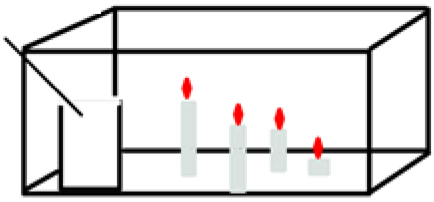
## EXPERIMENT 2: THE BURNING OF MAGNESIUM

Pick up the magnesium turnings with the tweezers. Light the spirit burner and hold the magnesium into the flame. When it breaks into flames, burn it above the porcelain plate.
**Work really carefully!** Do not look into the flame!

| Observation | Explanation |
|---|---|
| | |

## EXPERIMENT 3: PRODUCTION OF THE CARBON-DIOXIDE AND ITS CHARACTERISTICS

Put 4 spoons of limestone powder into a beaker. Place this into a glass trough. Fix the candles of different heights to the bottom of the trough with a paraffin. Light the candles then pour the acetic acid into the beaker.




| Observation | Explanation |
|---|---|
| | |
| | |

## EXPERIMENT 4: TEST FOR THE PRESENCE OF THE CARBON-DIOXIDE

Gently blow air into the limewater which is in the Erlenmeyer flask with the help of a straw.

| Observation | Explanation |
|---|---|
| | |

**Student's copy**

## TASKS, QUESTIONS

A student carried out the following experiment. What do you think the student experienced? What can be the explanation? Could you give a title to the experiment?

1. Mixed alcohol with water in a beaker with the rate of 1 to 1.
2. Dipped a paper handkerchief into the compound with the help of tongs.
3. Carefully held the impregnate handkerchief with the tongs above the flame of the Bunsen burner until it ignited.

| Observation | Explanation |
|---|---|
| | |

**Student's copy**

# Topic 7: Combustion/Burning – Teacher Worksheet

## ACCIDENT PREVENTION, RULES

rubber gloves
goggles
protective clothing


## BACKGROUND INFORMATION FOR TEACHERS

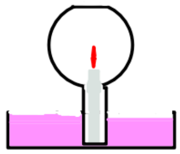
Combustion or burning is one of the most important chemical reactions. During combustion there is a reaction between materials and oxygen and new materials, oxides are formed. Burning produces heat in large quantities. So burning is an exothermic reaction. Ethyl alcohol, charcoal, natural gas all contain coal. In the process of burning carbon dioxide arises. Carbon + oxygen = carbon dioxide
Slow and the quick burning are different.
**Quick burning** is a reaction between a combustible material and the oxygen on high temperature it produces light in a form of glow of flames. Combustible material, oxygen and ignition temperature (that lowest temperature on which the material starts burning) are essential components. Burning lasts until one of the components does not run out.
**Slow burning:** For this reaction high temperature is not essential and flames do not it. This reaction is e. g. when butter turns rancid, the corrosion of iron. If heat accumulates process and reaches the ignition temperature, auto-ignition takes place.
We need energy to sustain life functions. This is provide for by the slow burning of nutrients in the body cells. To produce energy the cells use the oxygen content of the inhaled air. The respiratory organs are responsible for the necessary oxygen uptake and the carbon-dioxide disposal. The „slow burning” or cellular respiration is the biological oxidation. Its basics were discovered by Albert Szent-Györgyi.

| NECESSARY MATERIALS | NECESSARY DEVICES |
|---|---|
| tealight candle | match |
| 4 candle sticks (different heights (2-8 cm)) | spirit burner |
| coloured water | porcelain plate |
| magnesium turnings | boiling flask |
| approximately 20 $cm^3$ acetic acid (vinegar) of 20% dilution | crystallizing dish<br>tweezers |
| limestone powder | glass trough |
| limewater | beaker |
| | straw |
| | Erlenmeyer flask |

Teacher’s copy

## EXPERIMENT 1: THE CONDITIONS OF BURNING

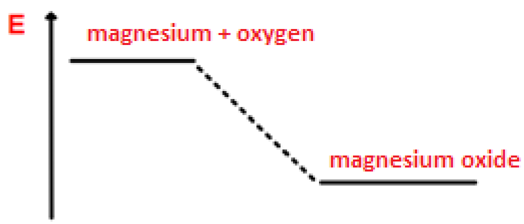
Put a candle in the middle of the crystallizing dish. Light it carefully and stick down with a drop of wax. Pour a bit of the coloured water into the dish. Cover it carefully with the boiling flask. Note the changes.



| Observation | Explanation |
|---|---|
| The candle light extinguishes in a short while. | One of the essential components of burning the oxygen runs out. |
| The coloured water raises in the flask, approximately to the fifth of it. | The flask was filled with air and approximately 21% of air is oxygen. The used up oxygen was replaced by water. |

## EXPERIMENT 2: THE BURNING OF MAGNESIUM

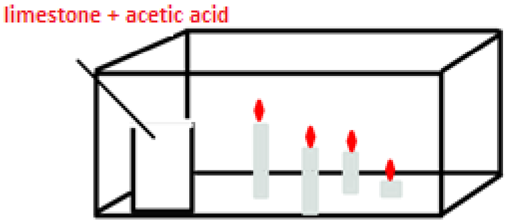
Pick up the magnesium turnings with the tweezers. Light the spirit burner and hold the magnesium into the flame. When it breaks into flames, burn it above the porcelain plate.
**Work really carefully!** Do not look into the flame!

| Observation | Explanation |
|---|---|
| The magnesium ignites, it burns with strong white flames. The magnesium turns into a white powdery solid material. | magnesium + oxygen = magnesium oxide<br>It is a chemical reaction because from two materials form a new material. The new material is the product of the combustion: magnesium oxide<br>According to energy change it is an exothermic reaction where heat is produced.<br><br> |

Teacher's copy

## EXPERIMENT 3: PRODUCTION OF THE CARBON-DIOXIDE AND ITS CHARACTERISTICS

Put 4 spoons of limestone powder into a beaker. Place this into a glass trough. Fix the candles of different heights to the bottom of the trough with a paraffin. Light the candles then pour the acetic acid into the beaker.




| Observation | Explanation |
|---|---|
| The limestone powder starts to fizz from the acetic acid. | Gas is produced. |
| First the smallest candle extinguishes then the others in order of their height. | The gas produced is carbon-dioxide. Carbon-dioxide does not burn so it does not fuel burning.<br>Carbon-dioxide has higher volumetric mass density compared to air so it accumulates at the bottom of the glass trough. This gives the order of extinguish. |

## EXPERIMENT 4: TEST FOR THE PRESENCE OF THE CARBON-DIOXIDE

Gently blow air into the limewater which is in the Erlenmeyer flask with the help of a straw.

| Observation | Explanation |
|---|---|
| The limewater turns cloudy. | For testing the presence of carbon-dioxide we use limewater. The product of oxidation in our body is carbon-dioxide.<br>Carbon dioxide reacts with limewater to form calcium carbonate and water. Calcium carbonate is insoluble and forms a white precipitate. |

## TASKS, QUESTIONS

A student carried out the following experiment. What do you think the student experienced? What can be the explanation? Could you give a title to the experiment?

4. Mixed alcohol with water in a beaker with the rate of 1 to 1.
5. Dipped a paper handkerchief into the compound with the help of tongs.
6. Carefully held the impregnate handkerchief with the tongs above the flame of the Bunsen burner until it ignited.

Teacher's copy

| Observation | Explanation |
| --- | --- |
| The alcohol started to burn with blue flames but the handkerchief did not ignite. | The observed phenomenon is caused by the presence of water as it takes up some of the produced heat, warms up and evaporates. |

The title of the experiment: The 'fireproof' handkerchief.

| NECESSARY MATERIALS | NECESSARY DEVICES CM |
| --- | --- |
| 4 $cm^3$ 96% alcohol<br>4 $cm^3$ water | handkerchief<br>thongs<br>beaker<br>Bunsen burner |

Teacher's copy

# Topic 8:Comparing flame temperature - Student Worksheet

## ACCIDENT PREVENTION, RULES

Pay attention:
- when positioning the glass appliances;
- hot iron looks exactly like iron at room temperature.
- usage of the spirit burner (first light the match then open the gas);

## NECESSARY TOOLS AND MATERIALS

| | |
|---|---|
| spirit burner | water at room temperature |
| gas burner | calorimeter with thermometer |
| metal ball with known specific heat (e.g.:copper) | scales |

## 1. PREPARATION

During laboratory experiments we usually need to heat substances. For this, we use spirit burner or gas burner. Estimate the temperature of flames of the two tools. To estimate we will need the knowledge from physics classes as well. Summarize them with filling the gaps in:

*During thermic reaction, the objects with ………………………………………… give out …………………… that is absorbed by objects with ………………………………………. The process lasts till the two objects ………………….. becomes equal. If we consider the system to be isolated, then the …………………. change of the objects is the same. If only thermal change takes place (no change in state of matter), then you can give the required temperature for heating and cooling with the following equation:*

$$Q = c \cdot m \cdot \Delta t$$

If a certain object's temperature cannot be measured directly (e.g.: it is out of the range of the available thermometers) we need apply a „trick". In this case, to define the temperature of the flame we hold a metal ball in the flame for 1 minute, then suddenly cool it in a given amount of water.

## 2. TESTING THE FLAME OF THE SPIRIT BURNER

During the thermic reaction of the metal ball and the flame we can define the flame's temperature as constant because it is not an isolated system: we constantly supply the spirit so there is no heat loss. Therefore $t_{0,iron} = t_{flame}$. Measure the required masses.

| | mass | temperature before reaction | temperature after reaction | Δt | specific heat |
|---|---|---|---|---|---|
| metal ball | | | | | |
| water | | | | | |

Heat transmission of the metal ball: $Q_1 =$

The change in the water's temperature: $Q_2 =$

Based on law of conservation of energy:

The change in the metal ball's temperature:

The initial temperature of the ball, thus the temperature of flame: $t_{flame} =$

## 3. TESTING THE FLAME OF THE GAS BURNER

The process is similar to the testing of the spirit burner. Fill in the table.
The measured data changes with the mutual temperature data. As an alternative (if the position of the metal object is well defined with a stand) we can try that the students open the stopcock of the gas burner in different range so they can measure the differences in the flame temperature.

| | mass | temperature before reaction | temperature after reaction | Δt | specific heat |
|---|---|---|---|---|---|
| metal ball | | | °C | | |
| water | | | | | |

Heat transmission of the metal: $Q_1 =$

The change in the water's temperature: $Q_2 =$

Based on law of conservation of energy:

The change in the metal ball's temperature:

The initial temperature of the ball, thus the temperature of flame:

$$t_{flame} =$$

The method of the calculation is similar to the previous.

**Student's copy**

# Topic 8:Comparing flame temperature - Teacher Worksheet

## ACCIDENT PREVENTION, RULES

Pay attention:
- when positioning the glass appliances;
- the hot iron looks exactly like iron at room temperature.
- usage of the spirit burner (first light the match then open the gas);

## NECESSARY TOOLS AND MATERIALS

| | |
|---|---|
| spirit burner | water at room temperature |
| gas burner | calorimeter with thermometer |
| metal ball with known specific heat (e.g.:copper) | scales |

## PRIORY STUDENT KNOWLEDGE

The student should know about specific heat capacity, thermic reactions and should be familiar with the law of conservation of energy.

## 4. PREPARATION

During laboratory experiments we usually need to heat substances. For this, we use spirit burner or gas burner. Estimate the temperature of flames of the two tools. To estimate we will need the knowledge from physics classes as well. Summarize them with filling the gaps in:
*During thermic reaction, the objects with **higher temperature** give out **heat** that is absorbed by objects with **lower temperature**. The process lasts till the two objects **temperature** becomes equal. If we consider the system to be isolated, then the **energy** change of the objects is the same. If only thermal change takes place (no change in state of matter), then you can give the required temperature for heating and cooling with the following equation:*

$$Q = c \cdot m \cdot \Delta t$$

If a certain object's temperature cannot be measured directly (e.g.: it is out of the range of the available thermometers) we need apply a „trick". In this case, to define the temperature of the flame we hold a metal ball in the flame for 1 minute, then suddenly cool it in a given amount of water.

**Pease note that the result of the measurement highly depends on the length of time we keep the object in the flame. If we would like to get similar results we should do the timing. (For advanced students it could be interesting to draw the graph of the temperature change of the object. In that case we have to make sure that the circumstances of the measurement are constant. E.g. use the same burner, hold the metal object in the same height in the flame.)**

Teacher's copy

## 5. TESTING THE FLAME OF THE SPIRIT BURNER

During the thermic reaction of the metal ball and the flame we can define the flame's temperature as constant because it is not an isolated system: we constantly supply the spirit so there is no heat loss. Therefore $t_{0,iron} = t_{flame}$. Measure the required masses.

| | mass | temperature before reaction | temperature after reaction | Δt | specific heat |
|---|---|---|---|---|---|
| metal ball | 108.5 g | $t_{flame}$ | 39 °C | $t_{flame}$-39 °C | 450kJ/kg°C |
| water | 300g | 24 °C | | 15°C | 4200kJ/kg°C |

Heat transmission of the metal ball: $Q_1$ =450·108.5·($t_{flame}$-39)

The change in the water's temperature: $Q_2$ =4200·300·15

Based on law of conservation of energy: $Q_1 = Q_2$

The change in the metal ball's temperature: $(t_{flame} - 39) = \frac{4200 \cdot 300 \cdot 15}{450 \cdot 108.5} = 387°C$

The initial temperature of the ball, thus the temperature of flame: $t_{flame} = 426°C$

## 6. TESTING THE FLAME OF THE GAS BURNER

The process is similar to the testing of the spirit burner. Fill in the table.
The measured data changes with the mutual temperature data. As an alternative (if the position of the metal object is well defined with a stand) we can try that the students open the stopcock of the gas burner in different range so they can measure the differences in the flame temperature.

| | mass | temperature before reaction | temperature after reaction | Δt | specific heat |
|---|---|---|---|---|---|
| metal ball | 108.5 g | $t_{flame}$ | °C | | 450kJ/kg°C |
| water | | °C | | | 4200kJ/kg°C |

Heat transmission of the metal: $Q_1 =$

The change in the water's temperature: $Q_2 =$

Based on law of conservation of energy:

The change in the metal ball's temperature:

The initial temperature of the ball, thus the temperature of flame:

$$t_{flame} =$$

**Teacher's copy**

The method of the calculation is similar to the previous.

**Note:**

**The flame temperature is higher in this case, there can be a reasonably high difference between the values measured by the students (just like in case of the spirit burner) even if we do the timing together.**

**For more accurate measurement we can use calorimeter, in this case we have to calculate with the heat absorbed by the calorimeter. This is calculated as $Q_{kal} = C \cdot \Delta t_{kal}$ where C is the thermal capacity of the calorimeter and $\Delta t_{kal}$ equals with $\Delta t_{water}$.**

Teacher's copy

# Topic 9: A measurement process of an acid-base titration with a pH-tracer - Student Worksheet

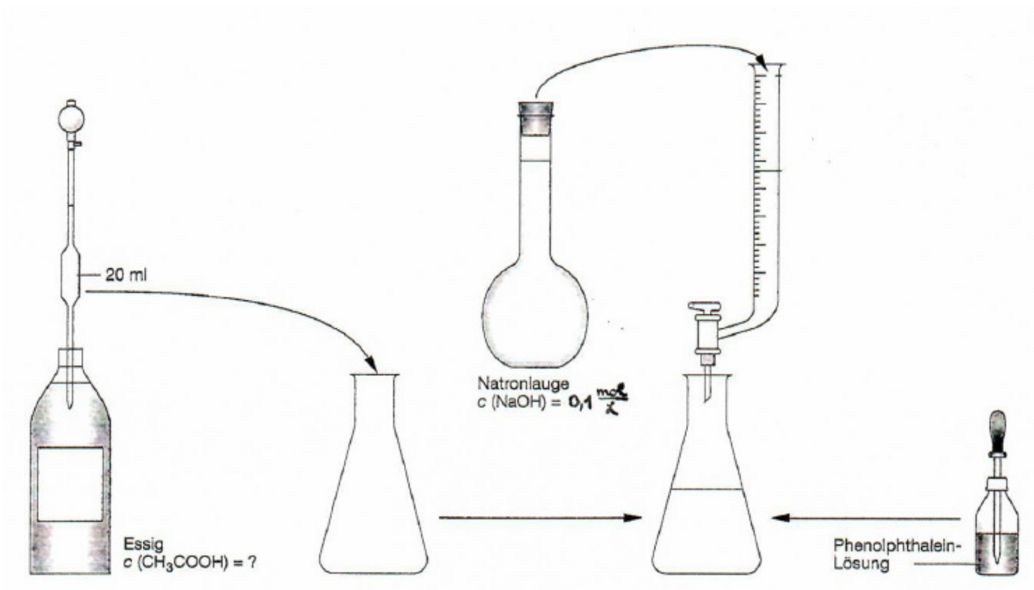
<u>How much acetic acid does vinegar contain?</u>

<u>Materials:</u>

| Equipment | chemicals |
|---|---|
| - 1 stand with a burette<br>- 1 Erlenmeyer flask<br>- 1 graduated cylinder<br>- 1 funnel<br>- 1 empty beaker glass<br>- 1 magnetic stir bar<br>- 1 magnetic stirrer | - vinegar<br>- causticsoda<br>c(NaOH) = 0,1 mol/l<br>- tracer: phenolphthalein<br><br> |

<u>Carrying out the experiment:</u>

1. Read "How to carry out a titration".
2. Use a graduated pipette and take an exact measurement of 2mL of vinegar and fill it in the Erlenmeyer flask, along with 20 mL of distilled water.
3. Add a bit of phenolphthalein.
4. Carefully fill caustic soda in the burette.
5. Position the test solution under the burette.
6. Open the burette stopcock and let the base trickle into the solution.
7. Stop as soon as a constant colour change can be detected.
8. Note down the position of the base in the burette.



Data sheet: Acetic acid

formula: $CH_3COOH$
molar mass: 60,05 g/mol
occurence: Acetic acid develops through out the process of fermentation in alcoholic solutions
use: Vinegar consists of fermentation products or of diluted synthetical vinegar and contains 5% acetic acid (percent by weight). Acetic acid is plays a significant role as a flavouring substance. Vinegar concentrate for chemical detergents contains up to 25 % of acetic acid. This can be used for example for the removal of calcium deposits. Due to its germicidal effects, acetic acids are also used for the conservation of food.

<u>tasks:</u>

1. How much caustic soda did you use in the course of the titration? V(NaOH)=__________
2. State the reaction equation for the neutralisation of the acetic acid with the caustic soda.
3. Calculate the concentration of substance of the acetic acid. Use the given formulas.

| | | | |
|---|---|---|---|
| (I) | $c = \frac{n}{V}$ | n: | Stoffmenge in mol |
| (II) | $n = c \cdot V$ | V: | Volumen in ml (oder l) |
| (III) | $n = \frac{m}{M}$ | c: | Konzentration in mol/l |
| (IV) | $m = n \cdot M$ | m: | Masse in g |
| | | M: | molare Masse in g/mol |

chart1: Figures and equations for the evalaution of the titrations

**Student's copy**

**4.** Calculate the percent by weight (w) of the acetic acid in 1 litre of water. (Take into consideration that 1 litre of vinegar equals 1000g.

Information:
The so-called percent by weight (w) indicates the percentage of a dissolved substance with reference to the total volume of a substance.

$$\boldsymbol{w} = \frac{\boldsymbol{m}\,(\boldsymbol{substance}) * \mathbf{100}\%}{\boldsymbol{m}\,(\boldsymbol{solution})}\ ;\boldsymbol{unit}:\%$$

**Student's copy**

# Topic 9: A measurement process of an acid-base titration with a pH-tracer - Teacher Worksheet

## Learning preconditions:

- didactical:
    - knowledge of characteristic particles in acid and alkaline solutions, hydronium ion ($H_3O^+_{(aq)}$)and hydroxide ion ($OH^-_{(aq)}$)
    - knowledge of the acid-base-theory according to Brönsted
    - knowledge of the neutralisation reaction
    - knowledge of the pH-value as an indicator for the concentration on hydronium ions resp. hydroxide ions in a solution.

- Teaching methods:
    - The students are able to determine the pH-value of a solution with a pH-meter.
    - The students know how to carry out measurement process of an acid-base titration, using a pH-meter.

- Possible difficulties
    - no explicit knowledge of acetic acid
    - no explicit knowledge of the calculation or percentages by weight (w)

## Lesson plan:

| stages | Didactics | methods | materials / media | Additional information |
|---|---|---|---|---|
| 1: opening | Presenting the problem: presentation of a fictional newspaper article | Class discussion | computer, data projector, newspaper article | Collective reading |
| 2: introduction | Naming the problem How much acetic acid can be found in the vinegar of the popular brand *delikato?* | Class discussion | | What's the highest possible concentration of acetic acid in vinegar? |
| 3: practice | Carrying out the experiment The students set up the experiment, carry it out, and note down their observations.<br><br>After the experiment, the students dismount the set-up and work in groups on the accompanying tasks | experiment | Materials, worksheet | |
| 4: evaluation | Evaluation **a)** Students present their results | Class discussion | Document viewer | |

| | | | | |
|---|---|---|---|---|
| | **b)** Reference to the context and answering the question | | | |

**opening:**

WILD
INDIVIDUELL • ORIGINELL

# Skandal!

## Bürger verätzt sich mit Salat die Mundhöhle!


Cloppenburg – Sauer macht ja bekanntlich lustig. Davon hat ein 40 jähriger Mann aus Cloppenburg am letzten Donnerstag zur Mittagszeit jedoch nichts gemerkt. Er verätzte sich nämlich die Mundhöhle, als er seinen Salat aß. Grund dafür war anscheinend das selbstgemachte Dressing auf Essigbasis. Ersten Vermutungen zufolge war bei der Produktion des Essigs etwas schiefgelaufen sodass dieser eine viel zu hohe Konzentration an Essigsäure enthielt. Die Ermittlungen laufen jedoch noch. Die Frau des Mannes erlitt glücklicherweise keine Verletzungen, da der Ehemann als Erstes von dem Salat aß. Den Bürgern wird geraten bis zur Klärung des Vorfalls auf den Verzehr von Essig der Marke „delikato" zu verzichten.

*Scandal!*
*Salad burns (vitriolises) oral cavity*
*There is a German saying – what's sour makes you happy. Well, this didn't apply for a 40-years old man from Cloppenburg. When eating a salad, he literally burnt his oral cavity. Even though investigations are still being carried out, we can assume that the concentration of acetic acid was way too high in the vinegar he used for his self-made salad dressing.*
*We therefore strongly recommend not to use the vinegar of "delikato" at the moment.*

Answers:
task 1:

$$V(NaOH) = 0,0168\ L$$

(Note: possible value – basis for the calculations)

**Teacher's copy**

task2:

$$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$$

task 3:

$$n\,(CH_3COOH) : n\,(NaOH) = 1{:}1$$

$$n\,(CH_3COOH) = n\,(NaOH)$$

$$c\,(CH_3COOH) * V(CH_3COOH) = c(NaOH) * V(NaOH)$$

$$c\,(CH_3COOH) = \frac{c\,(NaOH) * V\,(NaOH)}{V(CH_3COOH)}$$

$$c\,(CH_3COOH) = \frac{0,1\,mol * L^{-1} * 0,0168\,L}{0,002\,L}$$

$$c\,(CH_3COOH) = 0,84\frac{mol}{L}$$

task 4:

$$m\,(CH_3COOH) = n\,(CH_3COOH) * M(CH_3COOH)$$

$$m\,(CH_3COOH) = c(CH_3COOH) * V\,(CH_3COOH) * M\,(CH_3COOH)$$

$$m(CH_3COOH) = 0,84\frac{mol}{L} * 1L * 60,05\frac{g}{mol}$$

$$m\,(CH_3COOH) = 50,44g$$

$$w = \frac{m(CH_3COOH)}{m\,(solution)} \quad , \quad 1\,Liter = 1000g$$

$$w = \frac{50,44\,g * 100\%}{1000g} = 5,044\%$$

Teacher's copy

# Topic 10: **A natural pH indicator using red cabbage -** Student Worksheet

Why does red cabbage extract change color in contact with different solutions?

<u>Materials:</u>

| Equipment | Substances |
|---|---|
| • safety gloves<br>• safety glasses<br>• sticks<br>• indicator paper<br>• a source of heat to extract the juice (for example an electric stove)<br>• small seven beakers<br>• an Erlenmeyer Flask<br>• a pan<br>• a knife | • Lemon juice<br>• Vinegar<br>• Carbonated lemon soda<br>• Water<br>• Soap<br>• Baking soda<br>• Bleach<br>• A red cabbage |

Carrying out the experiment:

- In order to help the juice come out, thinly slice a part of cabbage and put it in a pan.
- Add tap water to cover the sliced cabbage and place the pan on to the source of heat.Let it boil for a few minutes, the water will be come darkpurple and now you can stop the heat and remove the pan from the fire. Remove all the solid part from the liquid and filter with a colander.
- It could be a very dark purple, but for regular use youhave to dilute it with water, this is the neutral indicator.
- Drainthrough a cloth to get rid of any veggie residue.
- Transfer the liquid to an Erlenmeyer flask.

Now to test the pH-indicator, use different types of product, commonly available solutions:

1. Lemon juice
2. Vinegar
3. Carbonated lemon soda
4. Water
5. Soap and water solution
6. Baking soda and water solution
7. Bleach.

- Put these solutions into seven different beckers.
- Before testing the solutions with the red cabbage extract, you can test the pH with an indicator paper (more precise). Dip a small stick into one of the solutions and then touch the paper. Check the corresponding pH value.
- In order to test your product add some red cabbage indicator in the solution you want to test and see the color of the indicator change.

**Student's copy**

Task:

Fill in the grid inserting the color obtained after adding the indicator and the pH value obtained from the map.

| | **COLOR** | **pH** |
|---|---|---|
| *Lemon juice* | | |
| *Vinegar* | | |
| *Carbonated lemon soda* | | |
| *Water* | | |
| *Soap and water solution* | | |
| *Baking soda and water solution* | | |
| *Bleach* | | |

Answer these questions:

1)Which solution is the most basic?

2)Which solution is the most acid?

3) Compare the pH values (obtained with the paper indicator) and the colors obtained in the seven beakers. What happened?

**Student's copy**

# Topic 10: **A natural pH indicator using red cabbage -** Teacher Worksheet

Learning preconditions:

- didactical:
    - The students know the concept of acid and base.
    - The students know the concept of pH and pH-indicator.
- teaching methods:
    - The students are able to carry out experiments independently, especially the handling of the gas burner or the use of an electric stove must be familiar.

Lesson plan:
Introduction: presenting the experiment.
Practice: carrying out the experiment - the students will note down their observations.
Evaluation and class discussion: after the experiment, students remove the equipment. They work in groups on the tasks on the exercise sheet. Then they present their result

Materials:

| Equipment | Substances |
|---|---|
| • safety gloves<br>• safety glasses<br>• sticks<br>• indicator paper<br>• a source of heat to extract the juice (for example an electric stove)<br>• small seven beakers<br>• an Erlenmeyer Flask<br>• a pan<br>• a knife | • Lemon juice<br>• Vinegar<br>• Carbonated lemon soda<br>• Water<br>• Soap<br>• Baking soda<br>• Bleach<br>• A red cabbage |

Carrying out the experiment:

- In order to help the juice come out, thinly slice a part of cabbage and put it in a pan.
- Add tap water to cover the sliced cabbage and place the pan on to the source of heat. Let it boil for a few minutes, the water will be come dark purple and now you can stop the heat and remove the pan from the fire. Remove all the solid part from the liquid and filter with a colander.
- It could be a very dark purple, but for regular use you have to dilute it with water, this is the neutral indicator.
- Drain through a cloth to get rid of any veggie residue.
- Transfer the liquid to an Erlenmeyer flask.

Now to test the pH-indicator, use different types of product, commonly available solutions:

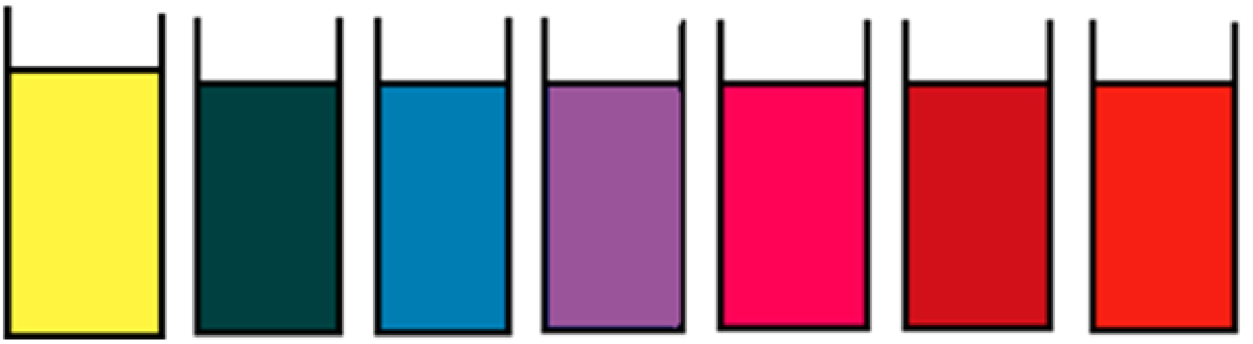
1. Lemon juice
2. Vinegar
3. Carbonated lemon soda
4. Water
5. Soap and water solution

6. Baking soda and water solution
7. Bleach.

- Put these solutions into seven different beckers.
- Before testing the solutions with the red cabbage extract, you can test the pH with an indicator paper (more precise). Dip a small stick into one of the solutions and then touch the paper. Check the corresponding pH value.
- In order to test your product add some red cabbage indicator in the solution you want to test and see the color of the indicator change.

Solutions to the exercise sheet:

- The lemon juice changes the solution to a bright red color. (strongest acid)
- The vinegar changes it to a pink - or less bright red - color.
- The lemon soda (sprite) changes it to a pink shade (fuchsia)
- The water being neutral retains the purple color.
- The soap and water solution changes to a blue shade which means now we have stepped over to the alkaline zone.
- The baking soda and water solution turns it to a bluish-green solution.
- The bleach turns it into a light yellow color. (strongest base)




<u>Answers to the questions and explanation of what happened.</u>

The pH indicates the concentration of $H^+$ ions that an acid releases in an aqueous solution. It is the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions.

With this experiment we can learn how to create a pH indicator with red cabbage.

This vegetable is a universal indicator, it means that with different colors it indicates the type of pH solution: red when the liquid is acid (pH low) and green/blue when alcaline (pH high). This property is due to a pigment inside the juice: the anthocyanins.

Comparing the pH values (obtained with the paper indicator) and the colors obtained in the seven beakers, we realize that the color is pink-red in the acid zone, whereas ~~a~~ blue/green in the alcaline zone.

So changing color in contact with acids and bases, the red cabbage extract is a universal indicator of pH, the degree of acidity and basicity of a substance.

What happened? The red cabbage leaves contain the anthocyanins (natural dyes), i.e. molecules that react and make the solution change color when in contact with acids and bases. The change of color is called end-point.

**Teacher's copy**

Through this experiment, one can also easily demonstrate the concept of acids and bases. The acids neutralize the alkalis and vice versa, so it means that by mixing together the solutions at the ends, the colors should be erased and get a purple color (like the water solution).

You can also try this experiment with other solutions to see what you get (for example sugar solution, sanitizer, toothpaste and water)

**Teacher's copy**

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**"Moving forward with key competences"**

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