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 • magnesium sticks • gas burner • small beaker • cobalt blue glass	• hydrochloric acid • lithium chloride • sodium chloride • 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 Presentation of a picture showing a firework.	class discussion	computer, projector, picture
introduction	Naming the problem a) Description of the picture. b) Why do fireworks light up in different colours?	class discussion	
practice	Carrying out the experiment regarding the flame colouration The students set up the experiment independently, carry it out and note down their observations. 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 **a)** Students present their results. **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.

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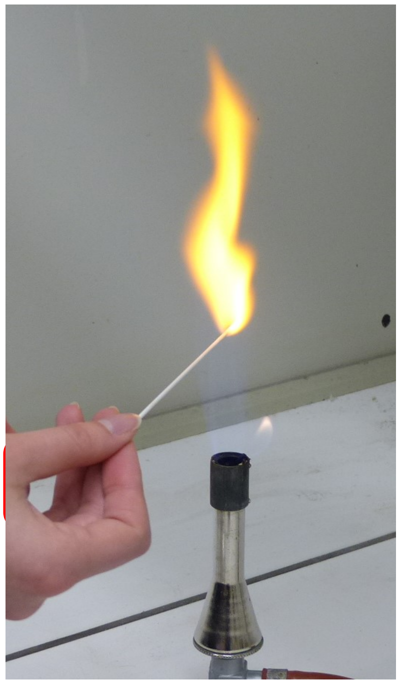
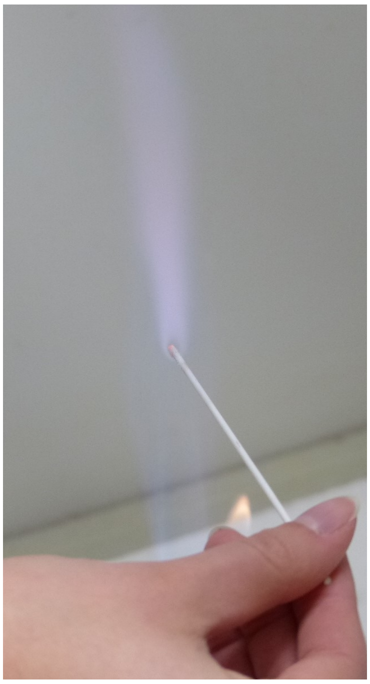


flame colouration: natrium chloride



flame colouration: potassium chloride

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Topic 2: The electrolytes – Student Worksheet

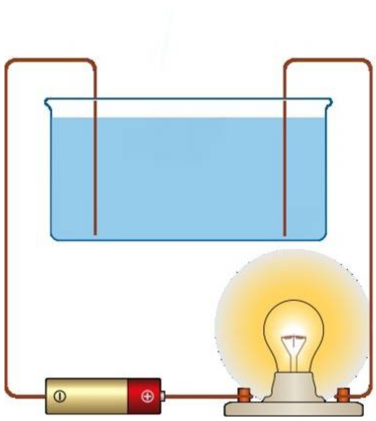
Purpose of the experiment: In this experiment, you will construct an electrical circuit and study the electrical conductivity of water and two water solutions. You will then identify the solutions as electrolytic and non-electrolytic.

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

Materials:

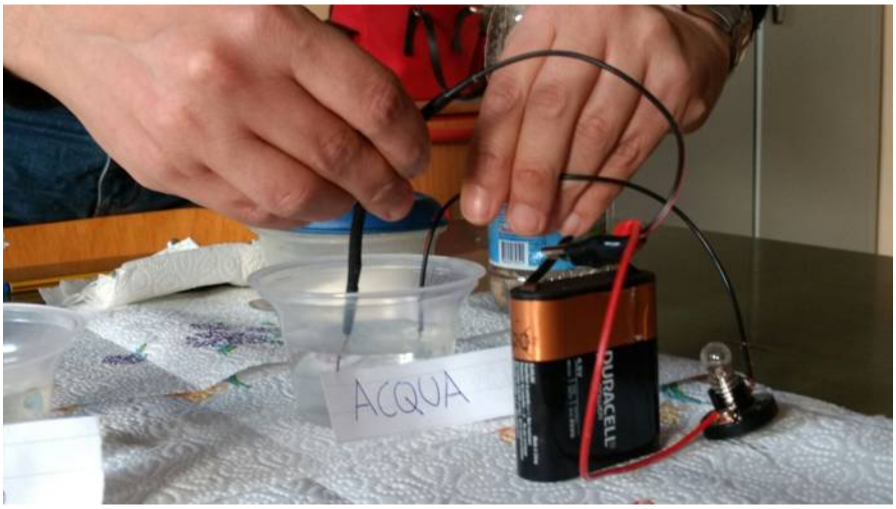
- one 4.5V battery,
- copper electric wire,
- one 1.5V light bulb with a lamp holder,
- two alligator clips,
- three transparent plastic containers,
- a teaspoon,
- water,
- cooking salt,
- table sugar.

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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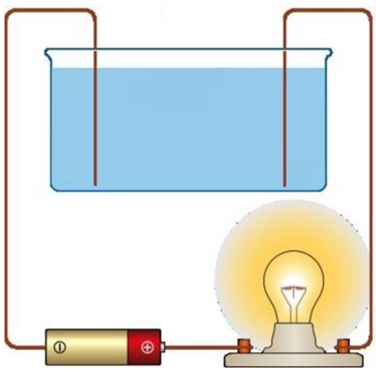
Assemble the materials to construct the circuit shown in figure.



Teacher's copy

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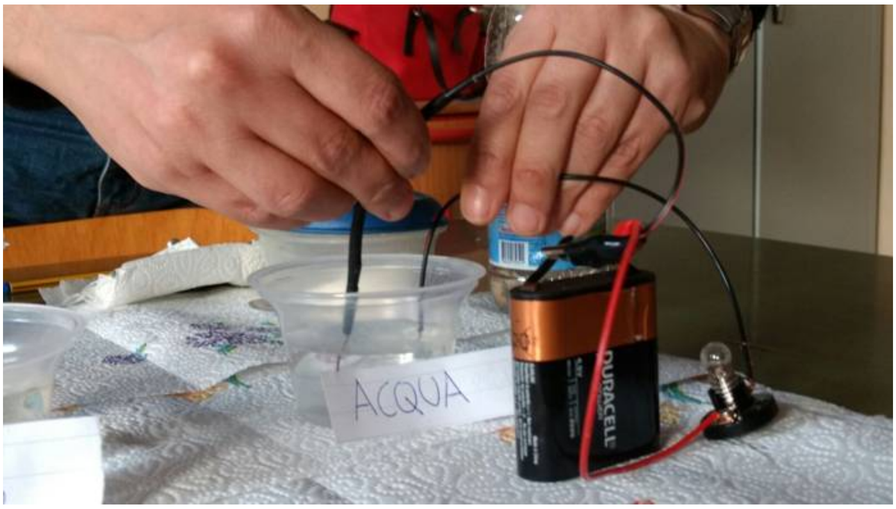
Put sugar in the second container, and stir until the sugar dissolves.
Put salt in the third container, and stir until the salt dissolves.
Dip the ends of the wire into the water without them touching each other.
The light bulb is off.



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.

<u>Educational aids:</u>

<u>equipment:</u> evaporating dish, tripod, wire gauze, Bunsen burner, stir stick.
<u>chemicals:</u> 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.

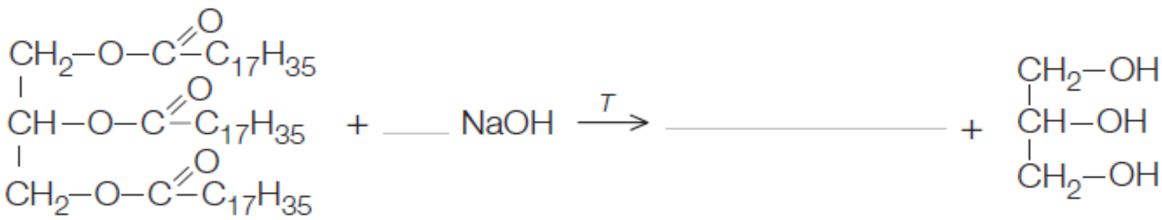
Educational aids:

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 neutralisation reaction,
- ✓ soapmaking in saponification reaction.

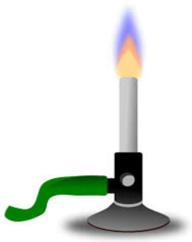
Main knowledge of students:

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 with students (questions and answers),
- ✓ doing experiments.

Educational aids – Experiments

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



Teacher's copy

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: $C_{17}H_{35}COOH + NaOH \rightarrow C_{17}H_{35}COONa + H_2O$

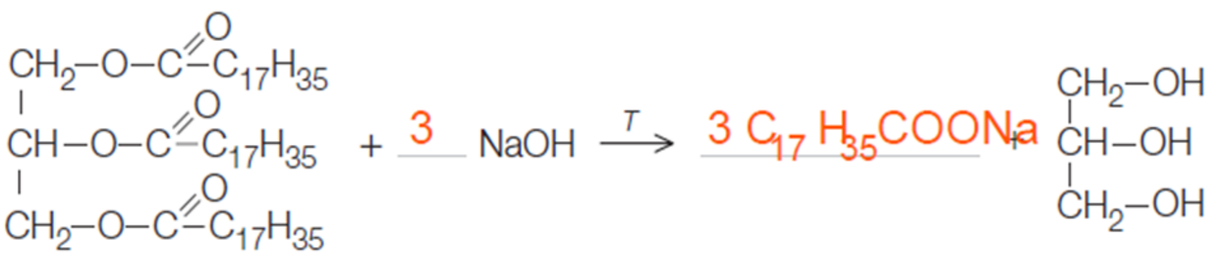
Teacher's copy

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

Chemistry experiments to be used in class

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

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: - test tube, - test-tube rack, - test tube holder - Bunsen burner, - spatula	**Chemicals** - 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:

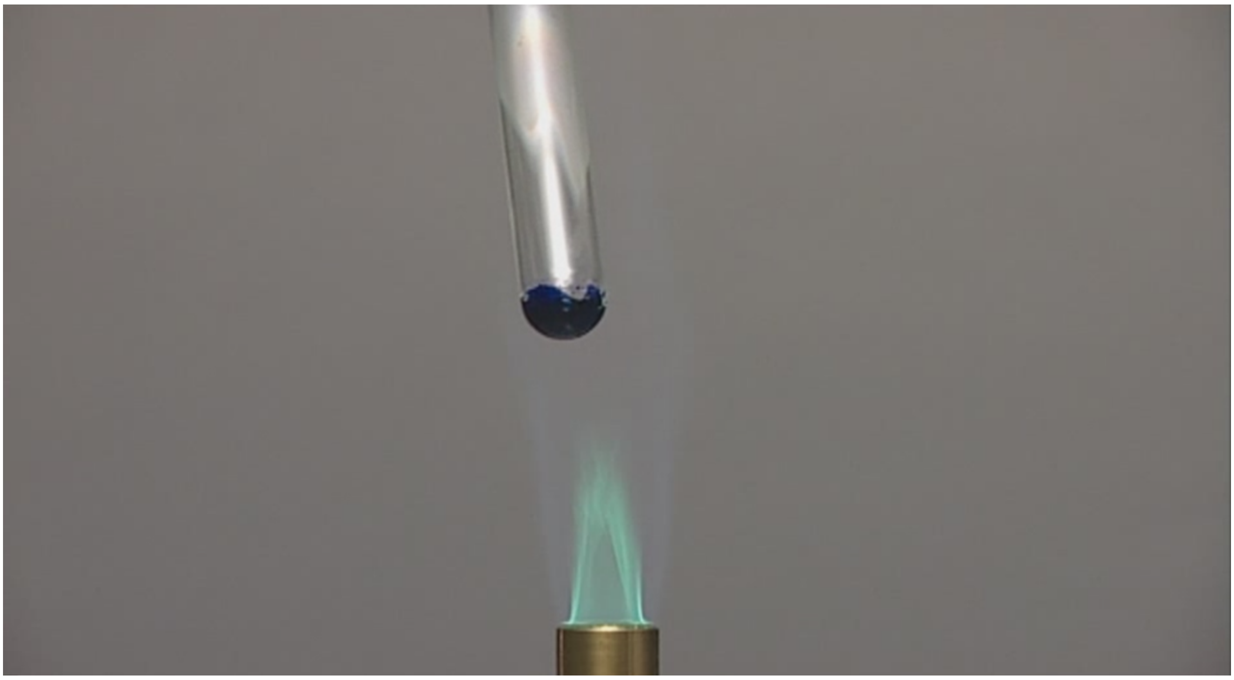
   e) they place a few crystals of cobalt (II) chloride hexahydrate into test tubes,

   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)*____________________-$Na_2SO_4 \cdot 10\,H_2O$



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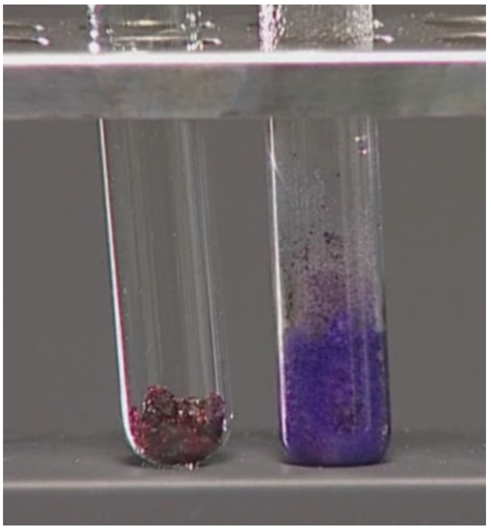
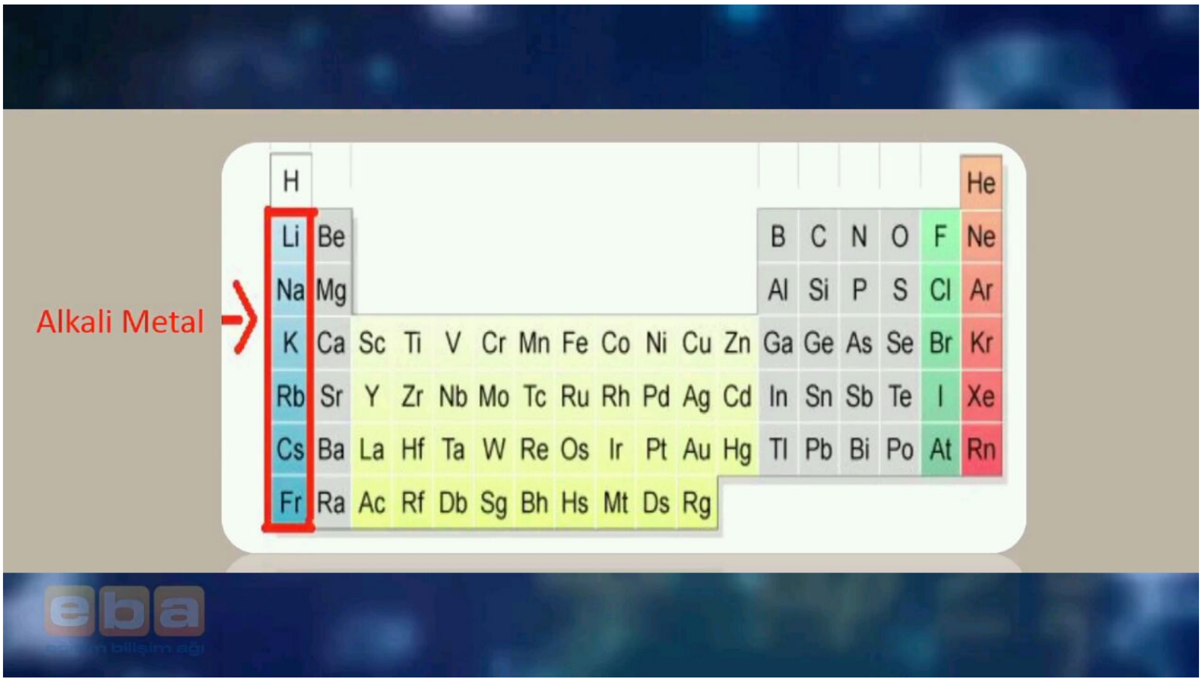


Teacher's copy

Chemistry experiments to be used in class

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

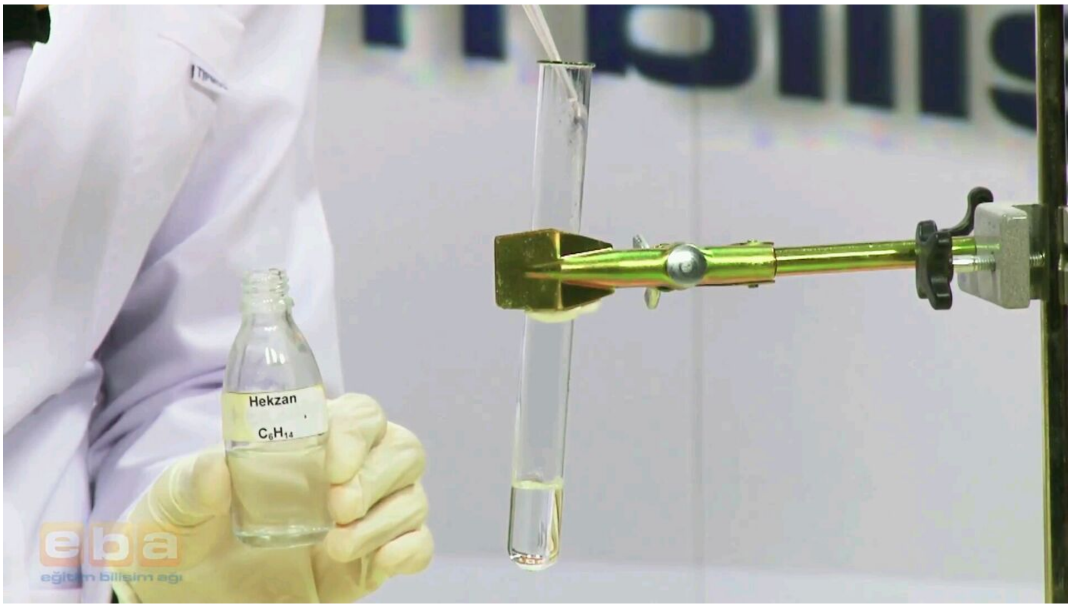
Experiment: Sodium (Na)' s reaction with water
Needings: Gloves, glasses, test tube, pure water, hexane, sodium, phenolphthalein
Reason: To see alkali metal' s reaction with water
Knowing: Sodium is an element that takes place in group 1A. 1A group elements are called Alkali Metals. Alkali Metals are 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 iss an exothermal reaction because it causes heat.



Student's copy

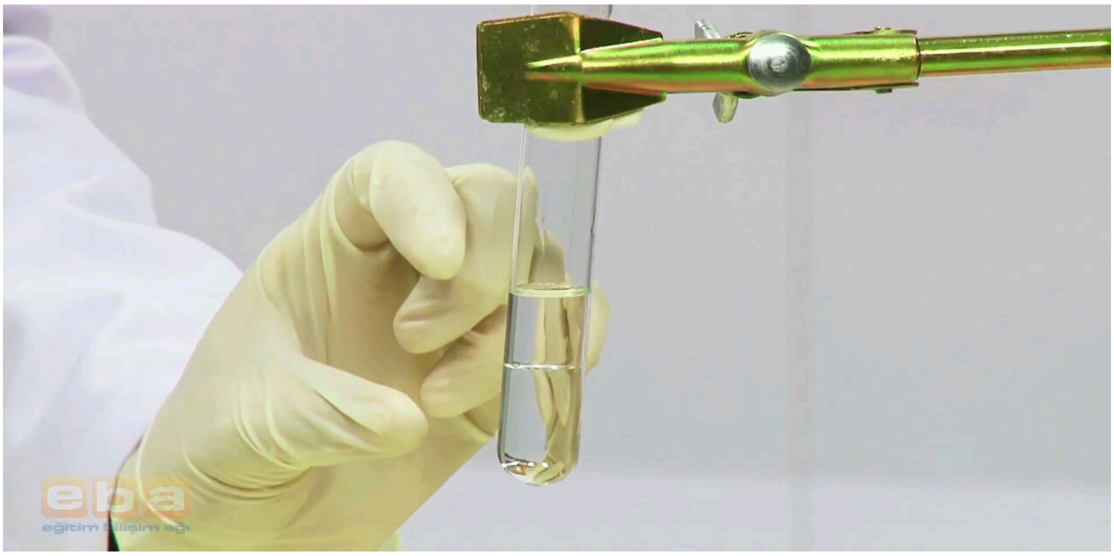
How To Carry out The Experiment
-Wear your gloves
-Wear your glasses
-Put some water to the test tube

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.

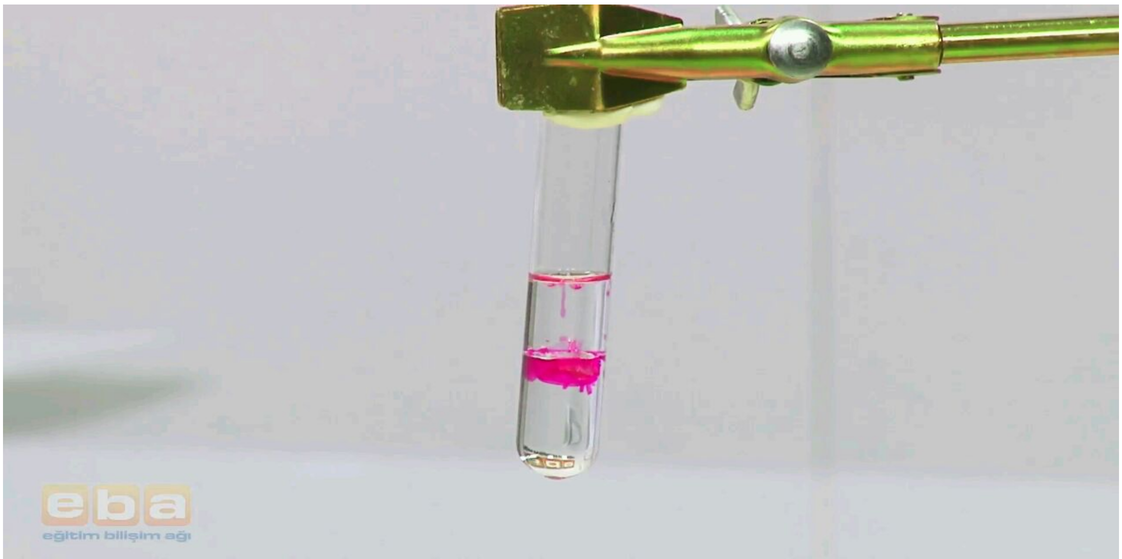
Student’s copy



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 H2 (p) we got after 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 H2 (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- $Na_{(k)} + H_2O_{(s)} \Rightarrow NaOH + \frac{1}{2} H_{2(g)}$
3- 23g Na ⇒ 1 mol Na
$Na_{(k)} + H_2O \Rightarrow NaOH + \frac{1}{2} H_{(g)}$
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 use for 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 making use of this experiment.

Student's copy

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

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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.

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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 salid-salid mixture thanks to this experiment.

Teacher’s copy

Topic 7: Combustion/Burning – Student Worksheet

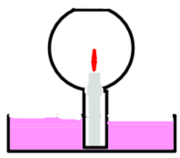
ACCIDENT PREVENTION, RULES

rubber gloves
goggles
protective clothing

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

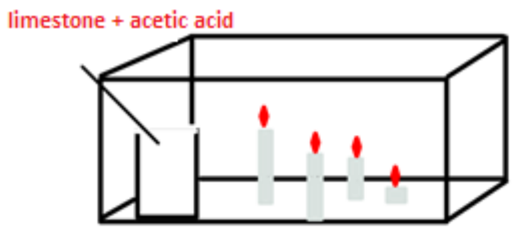
EXPERIMENT 2: THE BURNING OF MAGNESIUM

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

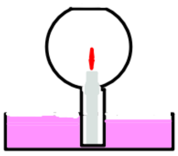
Combustion or burning is one of the most important chemical reactions. During combustion there is a reaction between materials and oxygen and new materials, oxides are formed. Burning produces heat in large quantities. So burning is an exothermic reaction. Ethyl alcohol, charcoal, natural gas all contain 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
limestone powder	tweezers
limewater	glass trough
	beaker
	straw
	Erlenmeyer flask

Teacher's copy

EXPERIMENT 1: THE CONDITIONS OF BURNING

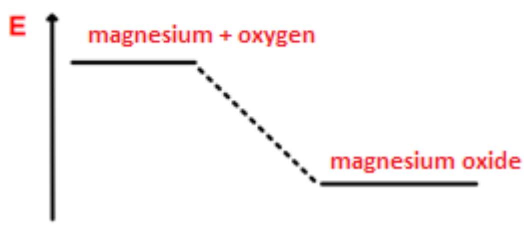
Put a candle in the middle of the crystallizing dish. Light it carefully and stick down with a drop of wax. Pour a bit of the coloured water into the dish. Cover it carefully with the boiling flask. Note the changes.



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 It is a chemical reaction because from two materials form a new material. The new material is the product of the combustion: magnesium oxide According to energy change it is an exothermic reaction where heat is produced. 

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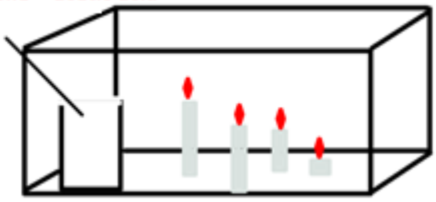
EXPERIMENT 3: PRODUCTION OF THE CARBON-DIOXIDE AND ITS CHARACTERISTICS

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. 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. 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.

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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 4 cm^3 water	handkerchief thongs beaker 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.)

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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: $Q_1 = 450 \cdot 108.5 \cdot (t_{flame} - 39)$

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

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

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

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 Δt_{kal} equals with Δt_{water}.

Teacher's copy

The present work was produced within the

Erasmus Plus Project

2016-1-PL01-KA219-026303_2

"Moving forward with key competences"

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