**TEACHER’S NOTES FOR STUDENT SHEETS OF THE FIRST SCHOOL YEAR (2021/2022.)**

[**MTA-ELTE Research Group on Inquiry-Based Chemistry Education**](https://mta.hu/kozoktatas-fejlesztesi-kutatasi-program/scientific-foundations-of-education-research-program-of-the-hungarian-academy-of-sciences-111618)

[**Research Programme for Public Education Development of the Hungarian Academy of Sciences**](https://mta.hu/kozoktatas-fejlesztesi-kutatasi-program/research-programme-for-public-education-development-of-the-hungarian-academy-of-sciences-111934)

The student sheets are not intended to be stand alone. They were used in class with an accompanying dialogue from the teacher. In other words, the teachers talked students through the sheets. Each following teacher’s note was part of a teacher guide file containing detailed instructions for teachers on how to prepare and guide the students through the activities. Those files are available in Hungarian at the following links:

Student sheet 1: **„What is essential is invisible to the eye.”** [1. feladatlap: „Ami igazán lényeges, az a szemnek láthatatlan.”](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa29NIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--967259ecd7cc73ff456252f95bee31e270610a76/1_Reszecskek_2022_07_10_HONLAPRA.docx?disposition=attachment)

Student sheet 2: **“Let's bake, let's bake something…”** [2. feladatlap: Süssünk, süssünk valamit…](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa1FNIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--c65ce7598abaf06244db98f2e4ecb26fa8387a7b/2_Anyagok_tulajdonsagai_2022_07_10_HONLAPRA.docx?disposition=attachment)

Student sheet 3: **The drowning duck** [3. feladatlap: „A fuldokló kacsa”](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa1VNIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--9b33e4fa2448eb0af2b8ff21c9020ac96d736ae7/3_Oldekonysag_2022_07_10_HONLAPRA.docx?disposition=attachment)

Student sheet 4: **“Let the bubbling begin!“** [4. feladatlap: „Induljon a pezsgés!”](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa1lNIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--6110e2e2f53f8992db06145ec0836e80902ca50e/4_Oldatkoncentracio_2022_07_10_HONLAPRA.docx?disposition=attachment)

Student sheet 5: **“I love you like people love... salt.”** [5. feladatlap: „Úgy szeretlek, mint az emberek a… sót.”](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa2NNIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--49f0b32f7ec19504bbf9d53e444a1d4560b1350b/5_Keverekek_szetvalasztasa_2022_07_10_HONLAPRA.docx?disposition=attachment)

Student sheet 6: **“They feed the fire, yet it goes out…”** [6. feladatlap: „ Megrakják a tüzet, mégis elaluszik...”](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBa2dNIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--a83bede0ceec37028f501cf37b6c1df16763e112/6_%C3%89g%C3%A9s_2022_07_10_HONLAPRA.docx?disposition=attachment)

Note: The text in red (including possible answers to the questions) are not part of the students' worksheets. Exceptions are words/phrases crossed out in red in the teacher's notes. These are written in black and are not crossed out on the students' worksheets.

**Teacher notes for Student sheet 1: „What is essential is invisible to the eye.”**

(type 1: ‘step-by-step’ version for Group 1 students)

The phrase in the title is spoken by the fox to the little prince in Antoine de Saint-Exupéry's famous book, but it is also true in chemistry. **All matter consists of very tiny, therefore invisible particles** that are **constantly in motion**. But with clever tricks, we can find out how invisible particles behave. For example, if you put the candies in water, you can follow the movement of the invisible particles of coloured icing with your eyes, because there are so many of them. (The particles move in zigzags because of the collisions between them, but only the spread of the coloured patch is visible.) This now allows you to investigate **how the speed of the particles' movement depends on temperature**.

MATERIALS AND EQUIPMENT: Smarties or M&M's candies of the same colour and shape, warm tap water, cold tap water, matching white heatproof bowls/plates, ruler, mobile phone with camera and stopwatch, glass.

|  |  |  |
| --- | --- | --- |
| Experiment 1: cold water +  coloured candy | Experiment 2: lukewarm water  (cold and warm) + coloured candy | Experiment 3: warm water +  coloured candy |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

THE STEPS OF THE EXPERIMENTS:

1. Pour a glass of cold tap water into one of the plates.

2. In the other plate, pour half a glass of cold tap water and half a glass of warm tap water.

3. In the third plate, pour one glass of warm tap water.

4. When the water stops moving, place a coloured candy in the middle of each plate.

5. Record the time it takes for each coloured patch to reach the edge of the plate, for example, or a marked distance, or take a photograph of the distance the coloured patches have travelled in a given time.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

OBSERVATION: The coloured patch needs the shortest time to reach the edge of the plate in warm water, and it takes the longest in cold water. / The coloured patch covers the greatest distance in warm water, and in cold water it covers the shortest distance at the same time.

Explanation:At higher temperatures, particles move **~~slower/~~faster.**

CONCLUSION: **At higher temperatures**, particles are more likely react when they collide. So at higher temperatures, chemical changes take place **~~more slowlyslower/~~more quickly**.

LET'S THINK! Glow sticks are not used only at parties, concerts and festivals. They also play an important role in earthquakes, storms and floods when lives need to be saved. When the chemical processes in the glow sticks are slower, they glow longer, which can be important when using them.

Should we keep the glow sticks at a low or high temperature immediately before use **to keep them** **lit for a long time**?

Circle the vertical arrows pointing upwards if you need to increase the amount under the arrow, or downwards if you need to decrease the amount under the arrow to keep the rod lit as long as possible.

So, it is best to store the glow sticks **in the fridge~~/at a warm~~****~~place~~** immediately before use.

↑↓

↑↓

↑↓

Temperature

of glow stick

The speed of the motion of the particles

Operating time of the glow stick

The speed of chemical processes

↑↓

**Teacher notes for Student sheet 1: „What is essential is invisible to the eye.”**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the Explanation and the CONCLUSION sections:

WHAT DID YOU HAVE TO CHANGE DURING THE EXPERIMENT?

The temperature of the water.

WHAT DID YOU HAVE TO OBSERVE OR MEASURE?

The speed at which the colour patch spreads.

HOW COULD YOU TEST OR MEASURE THAT?

a) How long it takes the coloured patch to travel a given distance. OR:

b) In a given time, how far will the coloured patch travel.

**Teacher notes for Student sheet 1: „What is essential is invisible to the eye.”**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between MATERIALS AND APPLICATION and Experience are replaced by the following sections:

WHAT DO YOU HAVE TO CHANGE DURING THE EXPERIMENT?

The temperature of the water.

WHAT DO YOU HAVE TO OBSERVE OR MEASURE?

The speed at which the colour patch spreads.

HOW CAN YOU OBSERVE OR MEASURE THIS?

a) How long it takes the coloured patch to travel a given distance. OR:

b) In a given time, how far will the coloured patch travel.

|  |  |  |
| --- | --- | --- |
| Experiment 1: cold water +  coloured candy | Experiment 2: lukewarm water  (cold and warm) + coloured candy | Experiment 3: warm water +  coloured candy |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

WHICH OF THE FOLLOWING SHOULD BE THE SAME IN EACH EXPERIMENT? Mark with a positive sign (+)!

**+** The colour of the candies. **+** The size of the candies. **+** The volume of water.

**+** The shape and size of the plate/dish. **+** The shape of the candies.

Would the M&M's sugar-coated peanuts be suitable for this experiment? Why?

No, because they are not the same shape and size.

THE STEPS OF THE EXPERIMENTS: (Steps 1 to 3 can be swapped if students work quickly/simultaneously.) E.g.:

1. Pour a glass of cold tap water into one of the plates.

2. In the other plate, pour half a glass of cold tap water + half a glass of warm tap water.

3. In the third plate, pour one glass of warm tap water.

4. When the water stops moving, place a coloured candy in the middle of each of the three plates.

5. Measure the time it takes for the coloured patches to reach the edge of the plate, for example, or a marked distance, or take a photograph of the distance the coloured patches have travelled in a given time.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 1

**Teacher notes for Student sheet 2: “Let's bake, let's bake something…”**

(type 1: ‘step-by-step’ version for Group 1 students)

A good cook knows what makes a cake light and and airy. You could say that every kitchen is a laboratory, and the cooks use chemistry to make meals from the ingredients, hopefully with delicious results. To do this, it helps to know the **properties of each ingredient (or substance). The properties of a substance are determined by its particles**. This determines what **changes** can take place between them. In **physical changes**, only the **interactions between particles** change. In **chemical changes**, the **particles change** **too**, producing a **different material**.

Baking powder is a mixture of **baking soda** (known chemically as sodium bicarbonate), an acid (such as **tartaric acid**) and **starch**. When it **is exposed to** **water (moisture), carbon dioxide gas is produced**, which fluffs up the cake. The following experiment will help you to find out **which of the three ingredients** in baking powder **is NOT REQUIRED for the development of the new quality substance**, carbon dioxide gas.

MATERIALS AND EQUIPMENT: baking soda, tartaric acid, starch, water, a white tile/white plastic box/emptied pill container, (eye or nose) dropper, spoons/straws cut at an angle, toothpicks.

|  |  |  |
| --- | --- | --- |
| Experiment 1: baking soda + starch + water | Experiment 2:  tartaric acid + starch + water | Experiment 3: baking soda + tartaric acid + water |

THE STEPS OF THE EXPERIMENT (Use a clean toothpick for each mixing!)

1. Put small amounts of baking soda and starch on one part of the tile, mix them with a toothpick.
2. Put small amounts of tartaric acid and starch on another part of the tile, mix them with a toothpick.
3. Put small amounts of baking soda and tartaric acid on the third part of the tile, mix them with a toothpick.
4. Drop some water on each of the solid mixtures.
5. Note in which case bubbling/bubble formation is observed.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

OBSERVATION: In the case of baking soda + tartaric acid mixture effervescence/bubbling is observed, but not in the case of the other two mixtures.

Explanation: The reaction among baking soda, tartaric acid and water produces a different substance, carbon dioxide gas.

As the gas evolves, the particles **have changed~~/have not changed~~**. A **~~physical/~~chemical** change has taken place.

The third ingredient of baking powder is starch, which is used to absorb the moisture in the air to prevent it from starting the reaction.

LET’S THINK! In chemistry, it is known that **carbonates and bicarbonates react with acids**. This is the reason for the disappearance of the nose and other features of limestone sculptures over time. The sculptures are made of **calcium carbonate**. This reacts with **acid rain** to produce carbon dioxide gas.

Some people suggest that **baking powder** should be sprinkled with an **acid** such as vinegar or lemon juice, before use. This advice can be found on one website, **'Baking powder should be sprinkled with 1 tablespoon of lemon juice'.** Is this sensible?

Give reasons for your answer based on what you have learned above.

~~YES /~~ NO, because then the sodium bicarbonate in the baking powder would react with the acid of the lemon juice much too early (and this way the carbon dioxide gas would be released before baking, so it would not raise the cake).

**Teacher notes for Student sheet 2: “Let's bake, let's bake something…”**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the Explanation and the LET’S THINK! sections:

WHAT DID YOU HAVE TO CHANGE DURING THE EXPERIMENT?

Which component has been left out of the mixture.

WHAT DID YOU HAVE TO OBSERVE OR MEASURE?

Which combination of substances produces a gas.

HOW COULD YOU TEST OR MEASURE THAT?

Does the addition of water (moisture) cause any effervescence/bubbling?

WHICH OF THE FOLLOWING STATEMENTS WAS OR WERE IMPORTANT IN THE EXPERIMENTS? Mark with a positive sign (+)!

(-) The volume of water had to be the same.

**+** We have always studied the reaction of two substances in water.

**+** All possible pairings had to be included. (-) The amount of solids had to be the same.

**Teacher notes for Student sheet 2: “Let's bake, let's bake something…”**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between MATERIALS AND EQUIPMENT and Experience are replaced by the following sections:

WHAT DO YOU HAVE TO CHANGE DURING THE EXPERIMENT?

Which component is left out of the mixture.

WHAT DO YOU HAVE TO OBSERVE OR MEASURE?

Which combination of substances produces a gas.

HOW CAN YOU TEST OR MEASURE THIS?

Does the addition of water (moisture) cause any effervescence/bubbling?

|  |  |  |
| --- | --- | --- |
| Experiment 1: baking soda + starch + water | Experiment 2:  tartaric acid + starch + water | Experiment 3: baking soda + tartaric acid + water |

WHICH OF THE FOLLOWING STATEMENTS IS OR ARE IMPORTANT WHILE DOING THE EXPERIMENTS? Mark with a positive sign (+)!

**(-)** The volume of water have to be the same.

**+** We always study the reaction of two substances in water.

**+** All possible pairings have to be included. **(-)** The amount of solids have to be the same.

THE STEPS OF THE EXPERIMENT (Use a clean toothpick for each mixing!) E.g.:

1. Put a little baking soda and a little starch on one part of the tile, mix them with a toothpick.
2. Put a little tartaric acid and a little starch on another part of the tile, mix them with a toothpick.
3. Put a little baking soda and a little tartaric acid on the third part of the tile, mix them with a toothpick.
4. Drop some water on each of the solid mixtures.
5. Note in which case bubbling/bubble formation is observed.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 2

**Teacher notes for Student sheet 3: The drowning duck**

(type 1: ‘step-by-step’ version for Group 1 students)

Ducks often reach out with their beaks to the base of their tail feathers and stroke their feathers with the secretions of their fat glands. This layer of fat prevents their feathers from getting wet when they duck under water, as fat is insoluble in water. This is why we need to use dishwashing liquid for washing up greasy dishes, detergent for washing ourselves. Also soap, shampoo and shower gel when taking a shower. These are substances with dual solubility. One end of their particles is soluble in water, the other end is soluble in oil or grease. They can therefore also dissolve greasy substances in water. Unfortunately, household wastewater containing detergents, dishwashing liquid, soap, shampoo, etc. can end up in natural waters. Could this have an impact on the lives of waterfowl? The following experiments model the role of the fat layer in waterproofing the feathers of waterfowl. We will investigate what happens when waterfowl with greased feathers are submerged in clean water or in water with detergent. In the experiments, pieces of paper are used as models for the waterfowl.

MATERIALS AND EQUIPMENT: pieces of printer paper, grease, dishwashing liquid, water, 3 bowls, toothpicks, ear cleaner sticks

|  |  |  |
| --- | --- | --- |
| Experiment 1: untreated paper +  tap water | Experiment 2: greased paper +  tap water | Experiment 3: greased paper + water containing washing up liquid |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

THE STEPS OF THE EXPERIMENT:

1. Using an ear cleaner stick and a toothpick, apply a thin but even coat of grease to both sides of two of three pieces of paper of the same shape.
2. Fill two bowls with tap water and the third with water containing dishwashing liquid.
3. Using the ear cleaner stick and toothpick, place the untreated piece of paper in one of the tap water bowls, one of the greased pieces of paper in the other tap water bowl, and the other greased piece of paper in the bowl that has water containing dishwashing liquid in it.
4. Using a clean toothpick, push each piece of paper under the water an equal number of times and observe the phenomenon.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

OBSERVATIONS: Untreated paper pushed under the surface of the water sinks permanently. A piece of grease-treated paper will float on the surface even after repeated submersion, while in water containing dishwashing detergent it will sink quickly and remain there.

Explanation: Fat particles and water particles **~~mix/~~do not mix** with each other. Dishwashing detergent particles and water particles **mix~~/do not mix~~**. Dishwashing detergent particles and fat particles **mix~~/do not mix~~**.

CONCLUSION: Dishwashing detergent **~~prevents/~~helps** the mixing of water particles and fat particles, so the ducks' feathers **get wet~~/do not get wet~~**, therefore the density of the ducks' body becomes **~~lower/~~higher** than the water, so they **sink~~/do not sink~~**.

LET’S THINK! "*Frequent and thorough hand washing is one of the most effective ways to protect against infection. The most important is washing your hands with warm running water and soap..."* they advise on koronavirus.gov.hu. They added that if you cannot wash your hands with running water, rub your hands thoroughly with an alcohol-based hand sanitiser for at least 30 seconds, which is also effective against the virus.

A képen fegyver látható

Automatikusan generált leírásThe particles that make up the outer coat of the coronavirus (and bacteria) have **dual solubility**. In the picture, their **water-soluble** ends are indicated by circles and their **grease-soluble** ends by wavy lines. The particles in the picture are similar to the dual solubility particles of dishwashing detergents and soaps. In the coronavirus, the particles form a **double layer** with the grease-soluble ends facing each other. The water-soluble ends face both the aqueous solution inside the virus and in the external aqueous medium. This explains why the **dual solubility particles of the soap disintegrate the outer coat of the virus** and destroy it. If alcohol can be used for this **what is the solubility of the alcohol particles**?

Alcohol has dual solubility.

**Why do you think so?**

If it has a similar effect to soap, its solubility should be similar too.

**Teacher notes for Student sheet 3: The drowning duck**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the Explanation and the CONSEQUENCE sections:

WHAT DID YOU HAVE TO CHANGE DURING THE EXPERIMENT? (**ONLY ONE THING CAN BE CHANGED AT A TIME!)**

Whether the paper was greasy or not and whether the water was clean or contained dishwashing detergent.

WHAT DID YOU HAVE TO OBSERVE OR MEASURE?

The behaviour of untreated and greased pieces of paper in clean water and water containing dishwashing detergent.

HOW COULD YOU TEST OR MEASURE THAT?

In all three experiments, the pieces of paper were pushed (with a toothpick) under the surface of “water” and checked to see if they came up to the surface of the “water” or stayed down.

**Teacher notes for Student sheet 3: The drowning duck**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between MATERIALS AND EQUIPMENT and OBSERVATIONS are replaced by the following sections:

WHAT DO YOU HAVE TO CHANGE DURING THE EXPERIMENT? **(ONLY ONE THING CAN BE CHANGED AT A TIME!)**

Whether the paper is greasy or not and whether the water is clean or contains dishwashing detergent.

WHAT DO YOU HAVE TO OBSERVE OR MEASURE?

The behaviour of untreated and greased pieces of paper in clean water and water containing dishwashing detergent.

HOW CAN YOU TEST/MEASURE THIS?

In all three experiments, the pieces of paper have to be pushed (with a toothpick) under the surface of “water” and checked to see if they come up to the surface of the “water” or stay down.

|  |  |  |
| --- | --- | --- |
| Experiment 1: untreated paper +  tap water | Experiment 2: greased paper +  tap water | Experiment 3: greased paper + water containing washing up liquid |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

WHICH OF THE FOLLOWING SHOULD BE THE SAME IN EACH EXPERIMENT? Mark with a positive sign (+)!

**+** The type of paper from which the pieces are cut. **+** The volume of water. **+** The temperature of the water.

**+** The number of times the pieces of paper are pushed under water.

**+** The shape of the pieces of paper. **+** The ratio of water to detergent. **(-)** The shape of the bowl.

THE STEPS OF THE EXPERIMENT: E.g.:

1. Using an ear cleaner stick and a toothpick, apply a thin but even coat of grease to both sides of two of three pieces of paper of the same shape.
2. Fill two bowls with tap water and the third with water containing dishwashing liquid.
3. Using the ear cleaner stick and toothpick, place the untreated piece of paper in one of the tap water bowls, one of the greased pieces of paper in the other tap water bowl, and the other greased piece of paper in the bowl that has water containing dishwashing liquid in it.
4. Using a clean toothpick, push each piece of paper under the water an equal number of times and observe the phenomenon.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 3

**Teacher notes for Student sheet 4: “Let the bubbling begin!“**

(type 1: ‘step-by-step’ version for Group 1 students)

**What a solution can be used for is mainly determined by its concentration.** For example, we don't like soups that are too salty or not salty enough. Hydrogen peroxide solution for hair colouring can be bought by hairdressers in a 12% concentration. However, it is too concentrated for throat disinfection. It would not only kill the germs but also hurt your throat. Therefore, pharmacies dispense a 3% hydrogen peroxide solution for this purpose, but it must be diluted before gargling. Hydrogen peroxide dissolved in the solution eventually decomposes into water and oxygen gas and loses its effect. Therefore, it is best to buy Hyperol tablets from the pharmacy. Three tablets dissolved in 100 cm3 of water make a 1% by weight solution of hydrogen peroxide. The decomposition of dissolved hydrogen peroxide can be accelerated by mixing yeast with warm water. If dishwashing detergent is added, the oxygen gas makes a spectacular foam. **It can be assumed that the more concentrated the solution, the more oxygen gas is produced. With the dishwashing liquid, more foam is produced.**

MATERIALS AND EQUIPMENT: 9 Hyperol tablets, a sachet of dried yeast mixed in warm water, dishwashing liquid, cold water, three 1.5 litre-PET bottles of, four 250 cm3 graduated beakers, 4 glass rods, 1 spoon, 1 funnel, ruler, mobile phone with camera and stopwatch, safety glasses.

|  |  |  |
| --- | --- | --- |
| Experiment 1: 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution | Experiment 2: 3 Hyperol tablets dissolved in 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution | Experiment 3: 6 Hyperol tablets dissolved in 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

THE STEPS OF THE EXPERIMENTS:

1. Pour 100-100 cm3 of water into the three numbered beakers. To measure the volume, use the scale on the sides of the beakers.

2. Place 3 Hyperol tablets in the second beaker and 6 Hyperol tablets in the third beaker and stir to dissolve.

3. Add a spoonful of dishwashing liquid to each of the three beakers and mix.

4. Pour the solutions from the three beakers into the numbered empty PET bottles using a funnel.

5. Pour 100 cm3 of warm tap water into the fourth beaker and mix in a small sachet of dried yeast.

6. Using the scale on the side of the fourth beaker, divide the yeast and water mixture into three equal parts and pour them into the 3 PET bottles using a funnel, then shake the open bottles thoroughly.

7. After waiting for one minute, measure the height of the foam above the surface of the liquid with a ruler.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

OBSERVATION: A 12 cm high foam layer was formed with the more concentrated solution and 6 cm high with the diluted solution. For water without hydrogen peroxide, virtually no foam was formed.

Explanation: With a more concentrated solution, **~~less/~~more** material reacts and therefore **~~less/~~more** oxygen gas evolves in the reaction.

LET’S THINK! An aqueous solution of hydrogen peroxide is used for disinfection, haemostasis, cleaning wounds and abrasions **ON THE OUTSIDE** (i.e. on the skin). It is not swallowed when gargling but is spat out. Hydrogen peroxide is very reactive and kills germs. However, many pseudo-scientific websites recommend drinking hydrogen peroxide solution to cure all kinds of diseases from AIDS to cancer. Is it advisable to use it **INSIDE**? What effect would a hydrogen peroxide solution have on our digestive system? Would you drink it? (You can also think of sodium hypochlorite solution, which is also a disinfectant. Is that okay to drink?)

ANSWER: We must not drink the hydrogen peroxide solution because it would hurt the throat and the stomach.

**Teacher notes for Student sheet 4: “Let the bubbling begin!“**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the Explanation and the LET’S THINK! sections:

WHAT DID YOU HAVE TO CHANGE DURING THE EXPERIMENT? **(ONLY ONE THING CAN BE CHANGED AT A TIME!)**

The concentration of the hydrogen peroxide solution.

WHAT DID YOU HAVE TO OBSERVE OR MEASURE?

The amount of foam produced.

HOW COULD YOU TEST OR MEASURE THAT?

A ruler was used to measure the height of the foam produced.

WHICH OF THE FOLLOWINGS HAD TO BE THE SAME IN EACH EXPERIMENT? Mark with a positive sign (+)!

**+** The shape and the size of the bottles. **(-)** The distance between the bottles. **+** The volume of the water.

**+** The temperature of the water. **+** The volume of the washing up liquid. **+** The time of shaking. **+** The amount of yeast. **+** The constitution and the size of tablets.

**Teacher notes for Student sheet 4: “Let the bubbling begin!“**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between MATERIALS AND EQUIPMENT and Experience are replaced by the following sections:

WHAT DO YOU HAVE TO CHANGE DURING THE EXPERIMENT? **(ONLY ONE THING CAN BE CHANGED AT A TIME!)**

The concentration of the hydrogen peroxide solution.

WHAT DO YOU HAVE TO OBSERVE OR MEASURE?

The amount of foam produced.

HOW COULD YOU TEST OR MEASURE THAT?

A ruler was used to measure the height of the foam produced.

|  |  |  |
| --- | --- | --- |
| Experiment 1: 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution | Experiment 2: 3 Hyperol tablets dissolved in 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution | Experiment 3: 6 Hyperol tablets dissolved in 100 cm3 water + 1 spoonful of dishwashing liquid + one third of the yeast solution |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

WHICH OF THE FOLLOWINGS SHOULD BE THE SAME IN EACH EXPERIMENT? Mark with a positive sign (+)!

**+** The shape and the size of the bottles. **(-)** The distance between the bottles. **+** The volume of the water.

**+** The temperature of the water. **+** The volume of the washing up liquid. **+** The time of shaking. **+** The amount of yeast. **+** The constitution and the size of tablets.

THE STEPS OF THE EXPERIMENTS: E.g.:

1. Pour 100-100 cm3 of water into the three numbered beakers. To measure the volume, use the scale on the sides of the beakers.

2. Place 3 Hyperol tablets in the second beaker and 6 Hyperol tablets in the third beaker and stir to dissolve.

3. Add a spoonful of dishwashing liquid to each of the three beakers and mix.

4. Pour the solution from the three beakers into the numbered empty PET bottles using a funnel.

5. Pour 100 cm3 of warm tap water into the fourth beaker and mix in a small bag of dried yeast.

6. Using the scale on the side of the fourth beaker, divide the yeast into three equal parts and pour them into the 3 PET bottles using a funnel, then shake the open bottles thoroughly.

7. After waiting for one minute, measure the height of the foam above the surface of the liquid with a ruler.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 4

**Teacher notes for Student sheet 5: “I love you like people love... salt.”**

(type 1: ‘step-by-step’ version for Group 1 students)

That's what the princess in the folk tale told her father, who banished his youngest daughter for this. But table salt is important for flavouring our food. It helps to keep our body's salt and water balance. The story has a happy ending. The old king realised the importance of salt. Imagine the princess and the prince visited a seaside village where sea salt is produced. Pools of sea water evaporate in the warmth of the sun. Eventually sandy, muddy salt remains. It is washed with clean seawater to dissolve the salt. The brine (salt solution) collected is evaporated to crystallise the salt. The princess collected three samples of the salt/sand mixtures, all of the same weight, each from a different location. The following experiments will help you decide which of the 3 samples contained the most salt.

MATERIALS AND EQUIPMENT: three mixtures of kitchen salt and sand of the same weight but different composition in 3 beakers or glasses per group, tap water, 3 empty beakers or glasses, 3 glass rods or spoons, (kitchen) scale with ±1 g accuracy; optional: 100 cm3 measuring cylinder, 1 pair of tweezers, clamp stand, filter ring, funnel, 3 pieces of folded filter paper

|  |  |  |
| --- | --- | --- |
| Experiment 1: Sample 1 + 100 cm3 water, measure the mass of the decanted/filtered solution. | Experiment 2: Sample 2 + 100 cm3 water, measure the mass of the decanted/filtered solution. | Experiment 3: Sample 3 + 100 cm3 water, measure the mass of the decanted/filtered solution. |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

THE STEPS OF THE EXPERIMENTS:

1. Add 100 cm3 or 100 g of water to each of the three salt and sand mixtures.

2. Stir the contents of each of the three beakers / glasses with a glass rod or spoon for half a minute.

3. Weigh 3 empty, dry beakers or glasses using a (kitchen) scale and record the masses.

4. Decant or filter for 5-5 minutes all three brines being above the sand into each of the three beakers / glasses that you have weighed.

5. Weigh the combined mass of the brines and the beakers / glasses.

6. Calculate the mass of the filtered brines in all three cases.

After the experiments, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

OBSERVATION: Weights of the brine solutions: Sample 1 e.g. **91** g; Sample 2 e.g. **97** g; Sample 3 e.g. **108** g.

Explanation: Table salt is **soluble~~/insoluble~~** in water, but sand is **~~soluble/~~insoluble** in water. From the mass of the brine, we can conclude that the sample with the most salt was the one from which the solution filtered (or carefully poured off) had the **~~least/~~most** mass. Therefore, the Sample **3** contained the most salt.

The exact salt content of the samples cannot be calculated, as sand (and paper in case of filtration) always retains some of the solution. However, if there is more salt in the mixture, the mass of the resulting brine will be **~~smaller/~~larger** if the same mass of water is added. Of mixtures of the same mass, the one with the most salt has the **least~~/most~~** sand in it. Less sand retains **less~~/more~~**solution. Therefore, the retention of solution by sand does not change the fact that the mixture with the most salt gives the solution with the **~~least/~~most** mass.

LET'S THINK! Salt can have both positive and negative effects on us. For example, salting roads in winter melts dangerous, slippery ice. However, salty water also accelerates the rusting of metal parts in cars. Plants also suffer from too much salt. The human body needs about 5 g a day of sodium chloride (that is the chemical name for table salt). However, over time too much salt can cause high blood pressure. Unfortunately, throughout history, the evil side of human nature has invented a variety of torturing methods to upset the body's salt-water balance. Drinking too much water or eating too much salty food without water can be equally deadly. Therefore, the active ingredients in infusions and injections are dissolved in a solution of sodium chloride at 0.9% by weight

(*w* = 0.9%). This is a safe concentration for the human body. In the diagram below, relate the salinity of the infusion to the corresponding physiological effect. (Hint: Think about what happens to a cherry when it gets too much rainwater.)

Too dilute, salt content: *w* < 0,9%

Too concentrated, salt content: *w* > 0,9%

Optimal, salt content: *w* = 0,9%

The cells do not swell or shrink.

The cells absorb water, swell and become damaged.

The cells lose water, shrink and become damaged.

**Teacher notes for Student sheet 5: “I love you like people love… salt.”**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the Explanation and the LET’S THINK! sections:

WHAT WERE DIFFERENT DURING THE EXPERIMENTS?

The mass of salt and sand in the sample.

WHAT DID YOU HAVE TO OBSERVE OR MEASURE?

The mass of the dry, empty beakers/glasses and the mass of the solution decanted/filtered from above the settled sand.

HOW COULD YOU TEST OR MEASURE THAT?

By using a (kitchen) scale.

WHICH OF THE FOLLOWINGS WAS OR WERE IMPORTANT IN THE EXPERIMENTS? Mark with a positive sign (+)!

**+** The mass of the water. **+** The water temperature. **(-)** The material of glass rod / spoon used for stirring. **+** The time of stirring. **+** (The material of filter paper.) **+** The time of decantation/(filtering). It was not (and should not have been without cleaning!) necessary to use the same glass rod/spoon to mix the solutions.

**Teacher notes for Student sheet 5: “I love you like people love... salt.”**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between MATERIALS AND EQUIPMENT and Experience are replaced by the following sections:

WHAT ARE DIFFERENT DURING THE EXPERIMENTS?

The mass of salt and sand in the sample.

WHAT DO YOU HAVE TO OBSERVE OR MEASURE?

The mass of the dry, empty beakers/glasses and the mass of the solution decanted/filtered from above the settled sand.

HOW COULD YOU TEST OR MEASURE THAT?

By using a (kitchen) scale.

WHICH OF THE FOLLOWINGS IS OR ARE IMPORTANT IN THE EXPERIMENTS? Mark with a positive sign (+)!

**+** The mass of the water. **+** The water temperature. **(-)** The material of glass rod / spoon used for stirring.

**+** The time of stirring. **+** (The material of filter paper.) **+** The time of decantation/(filtering). It is not (and should not be without cleaning!) necessary to use the same glass rod/spoon to mix the solutions.

|  |  |  |
| --- | --- | --- |
| Experiment 1: Sample 1 + 100 cm3 water, measure the mass of the decanted/filtered solution. | Experiment 2: Sample 2 + 100 cm3 water, measure the mass of the decanted/filtered solution. | Experiment 3: Sample 3 + 100 cm3 water, measure the mass of the decanted/filtered solution. |
| number of repetitions in class: | number of repetitions in class: | number of repetitions in class: |

THE STEPS OF THE EXPERIMENTS: E.g.:

1. Add 100 cm3 or 100 g of water to each of the three salt and sand mixtures.

2. Stir the contents of each of the three beakers / glasses with a glass rod or spoon for half a minute.

3. Measure the mass of 3 empty, dry beakers or glasses using a (kitchen) scale and record the masses.

4. Decant or filter for 5-5 minutes all three brines (saline solutions) being above the sand into each of the three beakers / glasses that you have weighed.

5. Weigh the combined mass of the brines (saline solutions) and the beakers / glasses.

6. Calculate the mass of the filtered brines (saline solutions) in all three cases.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 5

**Teacher notes for Student sheet 6: “They feed the fire, yet it goes out…”**

(type 1: ‘step-by-step’ version for Group 1 students)

This Hungarian folk song continues “... there is no love that does not pass away." , suggesting that both fire and love "burn" **only under certain conditions**. Fire was already known to prehistoric man and used to scare away wild animals and cook meat. Our households and industries could not survive without it, but the **destructive power of fire can be fatal**. Many times in human history, outbreaks of fires have killed many people. It is important therefore to light a fire only when you can control it and put it out when needed. Some materials burn very slowly and do not produce flames. For a fire to start, three conditions must be met.

What are these? 1. combustible substance 2. oxygen 3. ignition temperature

We will now show that these conditions are indeed necessary for combustion.

Watch the teacher's demonstration experiment!

(Experiment demonstrated by the teacher: a piece of paper tissue is dipped into the mixture of 50% by volume ethyl alcohol and 50% by volume water and then it is ignited/lit.

Observation: Despite of the flames, the paper tissue does not burn.

Explanation: The heat generated by the burning of ethyl alcohol is used to evaporate the water. Therefore, the paper does not reach the temperature at which it would ignite.)

Which of the conditions was missing in the experiment for the paper to ignite?

The ignition temperature.

Do the following two experiments to prove that the other two conditions are necessary for combustion too!

|  |  |
| --- | --- |
| Experiment 1: absence of combustible substance | Experiment 2: absence of oxygen |

MATERIALS AND EQUIPMENT: candle, matches, beaker, aluminium foil on watch glass, metal tweezer

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

EXPERIMENT 1: Try to ignite the aluminium foil.

OBSERVATION: The aluminium foil **~~will/~~ will not** ignite.

CONCLUSION: Therefore, the **combustible material~~/oxygen/ignition temperature~~** as a condition for combustion is missing.

EXPERIMENT 2: Place the beaker over the burning candle.

OBSERVATION: The candle under the beaker **goes out~~/flames~~**.

Explanation: Thus, the **~~combustible material/~~oxygen~~/ignition temperature~~** as a condition for combustion is

missing. There is increasingly less oxygen and more carbon dioxide under the beaker.

CONCLUSION: If you do not want the fire to burn, you must remove one of the conditions.

LET’S THINK! The frequency of forest fires has increased in the last few years. They not only cause immense damage locally, but also contribute to climate change globally. Forest fires produce significant amount of carbon dioxide by burning part of the wood's carbon content, and the smoke and soot released pollute the air. Smoke can travel long distances and carry large amounts of soot particles, even to the ice sheets at the poles.

**Circle the up or down arrows in the diagram that show the change of the amount as the frequency of forest fires increases.**

Frequency of

forest fires

Amount of soot on the

surface of polar ice

Amount of light

reflected by ice

Temperature near

to surface of earth

Amount of water

evaporated from

oceans to air (that has

a greenhouse effect)

hous

Temperature

of air



This circle process is **self-accelerating~~/self-slowing~~.**

**Teacher notes for Student sheet 6: “They feed the fire, yet it goes out…”**

(type 2: ‘step-by-step’ version + scheme of experimental design for Group 2 students)

Same as type 1, but it also includes the following questions between the CONCLUSION and the LET’S THINK! sections:

HOW WERE THE CONDITIONS CHANGED DURING THE EXPERIMENTS? **(ONLY ONE THING AT A TIME!)**

In both experiments, we removed one condition and left the others unchanged.

WHAT DID YOU NEED TO OBSERVE?

Whether combustion will persist if the condition is removed.

**Teacher notes for Student sheet 6: “They feed the fire, yet it goes out…”**

(type 3: experimental design following a scheme version for Group 3 students)

Same as type 1, but the sections between Explanation and the **Experiment 1** are replaced by the following sections:

HOW SHOULD THE CONDITIONS BE CHANGED DURING THE EXPERIMENTS? **(ONLY ONE THING CAN BE CHANGED AT A TIME!)**

In both experiments, we remove one condition and leave the others unchanged.

WHAT DO YOU NEED TO OBSERVE?

Whether combustion will persist if the condition is removed.

MATERIALS AND EQUIPMENT: candle, matches, beaker, aluminium foil on watch glass, metal tweezer

|  |  |
| --- | --- |
| Experiment 1: absence of combustible substance | Experiment 2: absence of oxygen |

THE STEPS OF EXPERIMENT 1:

1. We light a candle.
2. We try to light the aluminium foil.

THE STEPS OF EXPERIMENT 2: E.g.:

1. The burning candle is covered with a beaker.

After the experiments are done, write down your observations. Complete the text by writing the correct words, **underlining** or **framing** the correct words or **~~crossing out~~** the incorrect ones.

END OF THE TEACHER NOTES FOR STUDENT SHEET 6