Teaching Module Sustainability

Worksheets for use in elementary school classes

These worksheets are based on a one-week research course for elementary school students, which is part of the Forscherwelt or Researchers' World education initiative. The teaching concept and program were developed under the guidance of Prof. Dr. Katrin Sommer, Chair of Chemistry Didactics at Ruhr University Bochum, Germany, with the support of Henkel experts. The experiments are suitable for third or fourth grade students.

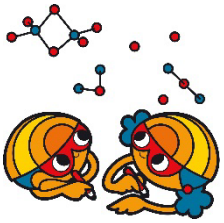
Symbols used

Problem/question

Assumption

Experiment instructions

Observations



Record your observations

Results

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Chair of Chemistry Didactics

Saving electricity – saving energy

You can save electricity, and therefore energy, at home too.

Pia's father, for example, says that the water you use for cooking pasta boils more quickly if you cover the pot with a lid. He says you use less electricity before the water starts to boil if the pot is covered with a lid than if it is uncovered. Is that right?

What experiment can you do to find out if what Pia's father says is true?
Each research group has the following materials available for the experiment:

- 1 liter (34 fl. oz.) water in a measuring cup
- 1 large beaker
- 1 hotplate magnetic stirrer
- Aluminum foil
- 1 stopwatch
- 1 thermometer
- 8 boiling stones (which are put into the water to be boiled)

Assignment: Discuss with your partners how you can work with the other groups to answer the question.

TIP:
When researchers want to compare something, they often carry out two experiments. The two experiments must be carried out in the same way, the only difference being the specific aspect (in this case with or without lid) you want to investigate.

Write down the <u>method</u> that you and the others plan to use to test the claim made by Pia's father:

_____

_____

_____

_____

_____

Name:_____

Saving electricity – saving energy

To answer the question being investigated, we will split into two groups.
The first group will heat the water in a container with a lid. This group will be called the **experimental group**.
The other group will heat the water in a container without a lid. This group will be called the **control group**.

Put 1 liter (34 fl. oz.) of water into a large (tall) beaker.
Measure the temperature of the water.

Temperature: _____

The water should be about 20°C/68°F (± 3°C/5°F).
Put 8 boiling stones into the water and place it on the hotplate.

Tick the group to which you belong.

☐ **Experimental group:** Fold a piece of aluminum foil in half so that the foil is doubled. Use the foil as a lid to cover the beaker. Carefully pierce a hole in the center through which you can insert the thermometer. Plug in the hotplate and turn it to the highest setting. Use the stopwatch to time how long it takes for the water to start boiling. Write down how many minutes it takes for the water to reach 40°C (104°F), 60°C (140°F), 80°C (176°F) and finally 99°C (210°F). Enter the figures in the table on the next page.

☐ **Control group:** Leave the beaker uncovered and carefully put the thermometer into it. Plug in the hotplate and turn it to the highest setting. Use the stopwatch to time how long it takes for the water to start boiling. Write down how many minutes it takes for the water to reach 40°C (104°F), 60°C (140°F), 80°C (176°F) and finally 99°C (210°F). Enter the figures in the table on the next page.

Saving electricity – saving energy

Speak to your neighboring control or experimental group and enter their figures in the table, using a different color.

	Experimental group Time with lid (mm:ss)	Control group Time without lid (mm:ss)
40°C/104°F		
60°C/140°F		
80°C/176°F		
99°C/210°F		

Was Pia's father right? Record the results of your investigations:

_____

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Recyling of paper

How can recycled paper be produced from cardboard packaging?

Waste paper and cardboard are collected in a waste paper bank. The waste paper can be used to produce recycled paper.

Work with partners.

1. Weigh out 15 g (0.5 oz.) of cardboard. Tear the card into pieces the size of your thumbnail and put the pieces of card into a tall container.
2. Use the measuring cylinder to measure 200 ml (7 fl. oz.) of water and add the water to the pieces of card in the tall container.
3. Blend the card and water mixture until you have a gray pulp. You should not be able to see any large pieces of card in the pulp.
4. Put the pulp into a shallow dish and add 1 liter (34 fl. oz.) of water. Stir the card and water mixture vigorously by hand.
5. Use the fly screen as a sieve: Two of you stretch the fly screen across the sink and hold it tightly. Another one then pours the pulpy mixture onto the fly screen so that excess water can drip through. When the mixture stops dripping, put the fly screen containing the pulp onto the table, place a piece of fabric on top and turn both over.
6. Roll the rolling pin over the screen several times.
7. You can then put the piece of fabric with the “paper” onto the drying rack to dry.

Name:_____

Renewable raw materials /1

Detection of Starch

What is a raw material?

Pens, paper, T-shirts, toys – virtually everything we come across in our daily lives is produced from a variety of raw materials. Wood is the raw material from which furniture or paper is made, for example, while cotton is the raw material generally used to make T-shirts. Plastic toys are produced from crude oil, another raw material.
Raw materials are therefore the basic materials from which products are made for us in one or more steps.

What does renewable mean?

Plants grow relatively quickly and are then harvested. At this point, new plants or seeds are planted. They are called “renewable raw materials.”
Crude oil, which can be used to produce a whole range of things from gasoline to plastic, does not grow back. Once all the crude oil on Earth has been used, it cannot simply be “planted” again. Crude oil is **not** a renewable raw material. This means we should use it as efficiently and as sparingly as possible.

Starch

You may have heard the word “starch” before. You sometimes need to use cornstarch for baking, for example. This type of starch looks similar to flour and has similar properties. Flour also contains starch.
It is not just for baking that starch can be used, however. Starch is also used as a basic material (or raw material) for adhesives – for a glue stick, for example.

Where does starch actually come from? From plants? Do you have any idea which plants contain starch?

Today you will learn how to detect the presence of starch.

You can use a substance called Lugol’s solution to detect the presence of starch. Lugol’s solution is a pink to purple colored liquid that contains iodine. You may be familiar with iodine from its use in medicine. Iodine-containing medicine is used to disinfect a wound, for example. Iodine also has another property, however: It turns dark blue or black when starch is present.

Now conduct an experiment.

1. First use a small spatula to put a spatula tip of lime powder onto a watch glass.
2. Add 2 ml (½ teaspoon) of water and carefully stir the mixture.
3. Then add 2-4 drops of Lugol's solution to it.

4. Use another spatula to put a spatula tip of cornstarch onto a second watch glass.
5. Add 2 ml (½ teaspoon) of water and carefully stir the mixture.
6. Then add 2-4 drops of Lugol's solution to the test tube.

Record your observations:

_____

_____

Which foods contain starch?
Starch is present in a number of foods. You will be shown a selection of different types of food.

1. First think about which of the foods you are shown could contain starch. Tick the respective box in the table below.
2. After that you can start testing the food samples. To do this put a small sample on a watch glass and add some drops of Lugol's solution.
   Eventually, you might have to grind the sample first e.g. when you are investigating hard grains. Please clean the materials and your hands after each test to avoid cross contamination.

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Food	I assume: Yes, it contains starch	I assume: No, it doesn't contain starch	Result: Yes, it contains starch	Result: No, it doesn't contain starch
Potato				
Cucumber				
Rice				
Sweet corn				

Renewable raw materials /2

Obtaining starch from food

You have now learned that starch is present in potatoes, wheat, rice and corn. To use this starch to make an adhesive, you must first find a way of getting the starch out of the food.

Here are the instructions you need to conduct the experiment – but somehow they have gotten mixed up. First put the sentences below in the correct order. Then cut out the individual boxes and glue them in the right order into your notebook or onto a new sheet of paper in your science folder.

Put the remaining mixture back into the first bowl and repeat steps two and three, but using only 200 ml (7 fl. oz.) of water.

After that wait five minutes and then carefully strain off the liquid. Leave the white residue at the bottom in the bowl.

Put the residue into a dish and place the dish in the oven at 180°C (350°F) for 20 minutes.

Add 300 ml (10 fl. oz.) of water to the grated food in the plastic bowl and stir with a glass rod.

Choose one of the foods (3-6 potatoes or 150 g (5 oz.) of cornmeal) and grate if necessary (into a first plastic bowl).

Put a dish towel above a second plastic bowl, pour in the mixture and squeeze out the water (liquid). Collect this liquid in a bowl and wait until some sediment settles at the bottom.

Renewable raw materials /3

Starch paste containing soap

Soap is said to make a starch paste more solid. Try it out!

1. Use a potato grater to grate about a quarter of a bar of soap.
2. In a 150 ml (5 fl. oz.) beaker, dissolve 1 g (¼ teaspoon) of the grated soap in 14 ml (1 tablespoon) of water as thoroughly as possible; this will produce a lather.
3. Add 4 g (1 teaspoon) of starch to the lather mixture produced and mix well with the glass rod.
4. Heat the mixture on a hotplate to a temperature of about 70°C (162°F), stirring occasionally with the glass rod.

5. Repeat steps 2) to 4) using 2 g (½ teaspoon), 3 g (¾ teaspoon) and 4 g (1 teaspoon) of soap.

Which of the 4 glue stick substances is most similar to the original glue stick?
How much soap, water and starch did you use for this sample?

Write down the recipe (also known as the formulation):

_____

_____

_____

_____

_____

Name:_____

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Protecting our health /1

Healthy teeth are attractive ☺
Bad teeth don't just look bad; they can also cause other diseases.
Taking good care of your teeth protects your health – and gives you a dazzling smile!

What causes bad teeth? Sugar?
No – not the sugar itself. Small organisms in our mouth, bacteria, turn sugar into acid. The acid attacks our teeth and leads to tooth decay, also called caries, if we don't clean our teeth well with toothpaste.

Detecting the presence of acids

1. Write the names of the liquids to be tested on the test tubes.
2. Guess which liquid is the most acidic, second most acidic, etc. and write down the order here:

1._____

2._____

3._____

4._____

5._____

Name:_____

3. Put about a three-finger width of each liquid into a test tube.
4. Insert the names of the liquids in the table below.
5. Using tweezers, hold an indicator paper in each sample and make a note of the **number**/color that becomes visible.
6. Tick the boxes in the table accordingly.

	Very acidic ----------neutral						
liquid	1	2	3	4	5	6	7

Results:

Order the liquids according their acidity:

1._____

2._____

3._____

4._____

5._____

Name:_____

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Protecting our health /2

Eggshells in acid – eggshells as a model substance for teeth

We will be using eggshells as a model substance for teeth. Just like eggshells, teeth contain calcium. Experiments show that acid attacks eggshells, or rather the calcium contained in the eggshells. Toothpaste protects our teeth from acid.
Caries bacteria in the mouth turn the sugar in our mouths into acid. Cleaning our teeth regularly with toothpaste protects our teeth from acid and thus from caries.

What effect does acid have on the eggshell?

Work with your partner.

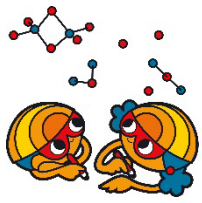
1. Weigh your eggshell and make a note of its weight. (A) _____g
2. Put the piece of eggshell into a beaker and add enough vinegar to cover the eggshell completely. Wait for 15 minutes.
3. Carefully dry the eggshell.
4. Weigh the dry eggshell again. (B)_____g
5. Calculate the difference between the first and second times that you weighed the eggshell. TIP: To find the difference, you need to subtract one number from another. (A)_____g – (B)_____g = _____g
6. Write down what happened:

_____

_____

_____

_____



Protecting our health /3

Cleaning your teeth regularly with toothpaste protects them from caries.

How can you show that toothpaste protects your teeth from acid?

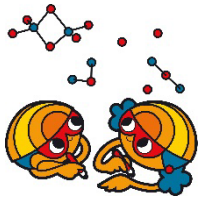
Work with your partner to devise an experiment with the model substance that you have learned about. You can use toothpaste, vinegar and beakers for your experiment.

Default solution:

Work with your partner.

1. Divide your egg into two halves by drawing a line in the center.
2. Rub toothpaste into one side and wait for three minutes.
3. Carefully remove the toothpaste with a piece of paper towel.
4. Put the egg carefully into the beaker and add enough vinegar to completely cover the egg.

What do you observe? Record your observations:



_____

_____

_____

Name:_____

Protecting our health /3

Toothpastes contain a substance known as fluoride. Fluoride protects the surface of the teeth from acid. Toothpaste also contains other substances that help to clean your teeth when you brush them.

Which substances in toothpaste help to remove food and plaque from your teeth?

Investigate whether you can use toothpaste, table salt, lime (calcium carbonate) or detergent to clean a coin.

Work in a group of four. Each student receives a different “cleaning agent.”

Put a small amount of your cleaning agent onto a cloth and rub the coin for 10 minutes.
Compare your coin with the coins cleaned by your neighbors.
What cleaned the coins best and what wasn’t as good? Make a note of the order.

_____

_____