Soaps and detergents

Introduction

This module is about soaps and detergents. We thought that since you use them in your daily life, it might be fun to find out more about them and do some experiments using them!

The module is divided into three parts. In the first part we look at why we need soap and how it works. In the second part we look at why we need detergents and how they are different from soaps and finally in the third part we explore the effects of using detergents on the environment.

Soaps and detergents

Teacher Note

Introduction

This module is about soaps and detergents. It has been designed for students' use with the teacher acting as a facilitator. The aim of the module is to help students relate chemistry with their everyday life. Since soaps and detergents are used in daily life, students will understand more about them through this module while conducting experiments related to them. A big aspect of this module is to do experiments and understand the process of scientific enquiry. Students should be encouraged in this process.

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PART 1 – Need for soap

1. It would be good to begin with a discussion about what soap does and why we need it. Points that could be brought up are: Is just water sufficient to clean everything? What kind of substances would water not clean? So what 'action' would soap need to be able to do to clean. The aim of the discussion is to get students to see that soap acts as an emulsifier, that is, it allows oil and water to mix. (It is not necessary to use terms such as emulsion and emulsifier)
2. After the discussion, students should be asked to write down why they think we need soap and to make a list of substances they think we won't be able to clean without soap.
3. ***Activity 1a:*** This activity is to demonstrate the emulsifying property of soaps. Using a detergent would work better to exhibit this property to the students. This activity will further lead to the cleansing action of soap. Two possible extensions have been suggested. The first one is to use different kinds of soap. This could be linked to differing cleansing abilities of different soaps. A bathing, laundry and dishwashing soap could be used and their emulsifying abilities could be compared in an approximate way. The second extension involves recording how long it takes for the layers of oil and water to separate. The dishwashing soap will not emulsify oil and water forever. They will eventually separate. Students might notice this if they leave the experiment aside for a while. A discussion could be had about why it would still be useful to use soap.
4. ***Activity 1b:*** Having the students work in pairs or groups of three would work well for this activity. Give students instructions about things to do before and after an experiment. Emphasis should be laid on reading all the instructions carefully before starting off the activity, collecting the materials

from the teacher and involving every member of the group in the activity. Observation and recording is an important aspect of the scientific process, underline the importance of this to the students. A discussion with the entire class should be done. It is a good opportunity to understand what students have learnt from the activity, to introduce them to new terms and consolidate their learning. Extensions to this activity have been suggested in the activity sheet. These could also be carried out to test students' predictions.

A video showing this experiment can be found at: https://www.youtube.com/watch?v=Hr6dZ6aWpF4

5. ***Activity 1c:*** This activity is optional because it requires sodium hydroxide, a strong alkali. If it is done with students, extreme care should be taken that they do not handle the chemical. In case anyone comes in contact with it, they should wash it off with soap and water. This particular method of making soap is the cold process method. It requires two weeks for the saponification reaction to be completed. The soap is not ready to be used before that since there still might be some unreacted sodium hydroxide, which is extremely corrosive.

   But if this activity can be done, it should be since the students understand the process of soap making and what it requires. It also fun for them to use something they have made. If fragrances are not available, things like cinnamon powder, besan, etc. could be added to the soap instead.

   This could also be later connected to acids and bases when students learn about them.

PART 2 – Need for detergents

1. This section of the material is trying help students see that soap does not lather easily in hard water and therefore the need for detergents. Since students have not been introduced to the terms hard and soft water, they see this through different sources of water, which they have studied about in earlier classes.
2. ***Activity 2a:***
   a. Students can be asked to collect water from different sources and bring them to class. In case, that is not possible distilled water can be used for rainwater. To make hard water: powder a 2 inch piece of chalk and mix in 100 ml water and leave to stand for a couple of days. Chalk is only partially soluble in water so filter this solution before use.
   b. The soap solution could be made earlier by the teacher if the class time is not sufficient for finishing the activity. Make sure that a liquid soap or a detergent is not used since it will form a good lather with all water samples.

c. Students could be introduced to the term 'hard water' without going into the chemistry. They can be told that water that forms less lather than distilled water is called ***hard water*** and water that forms more or as much lather as distilled water is called ***soft water***.

d. Connections should be made with which sources are important for human use therefore should be conserved and protected from contamination. This activity shows that rainwater is soft water and can therefore be used for many different activities. This should be connected to rainwater harvesting.

3. A possible whole class project could be to research the history of soaps and detergents and make a timeline of this. This could then be recorded on a long sheet of paper with illustrations and displayed along a wall in the classroom.

   A history of soap

   a. History of soap is not very clear.

   b. **3000 BC** – First use of soap solutions by Sumerians in the form of slurry of ash and water. Temple priests would use this to purify themselves and wash their robes with. (1)

   c. During the excavation of ancient Babylonian sites, a formula for soap consisting of water, alkali, and cassia oil was found written on a clay tablet dated around **2200 BC**. (2)

   d. The Ebers papyrus, an Egyptian medical document from about **1550 B.C.**, describes combining animal and vegetable oils with alkaline salts to form a soap-like material used for treating skin diseases, as well as for washing. (3)

   e. A popular Roman legend is that the word 'soap' is derived from Mount Sapo, where animals were sacrificed. Rainwater washed a mixture of melted animal fats and wood ashes into the River Tiber below. There, the soapy mixture was found to be useful for washing clothing and skin. (No evidence has been found to indicate any place like this ever existed.)

   f. By contrast, Pliny the Elder, in the **First Century AD**, describes soap as 'an invention of the Gauls for giving a reddish tint to the hair'.

   g. Soap making was an established craft in Europe by the **seventh century**. Vegetable and animal oils were used with ashes of plants, along with fragrance. Gradually more varieties of soap became available for shaving and shampooing, as well as bathing and laundering.

   h. Soap is a luxury item until the **1800s**, when French chemist Nicholas Leblanc discovers cheap way to extract soda ash from salt.

   i. **1823 –** Modern soap making is born when Michel Eugene Chevreul, another French

chemist, discovers the reaction involved in the formation of soap.

j. **1916** – first synthetic detergent in Germany in response to a shortage of fats and oils. Also driven by the need to have a cleaning agent that did not combine with the mineral salts in water.

k. **1960s/1970s**: Concerns about water pollution from detergents building up in rivers and seas lead to the development of the first biodegradable surfactants.

l. Since late 1900s we have had a lot of different detergents being developed such as laundry powders with enzymes, liquid-washing soaps, fabric softeners, stain removers, and combinations of these in one.

4. ***Activity 2b:*** This is an extension of the previous activity but with detergents. The aim of this activity is for students to see that soapless detergents do no form scum with hard water. Students should also see that the lathering and cleaning capacity of detergents is generally better than soap's.
5. ***Activity 2c:*** A scavenger hunt is game that can be played with kids where they are given a list of things they need to find. This particular scavenger is getting them familiar with some common chemicals that are found in soapless detergents and how they are present in most cleaning agents around us. This activity will later connect to the impact of these chemicals on humans, other animals and the environment.

PART 3 – Problems with detergents

1. This section of the material is looking at the problems with detergents.
2. The student note begins with asking students to think about what happens to the dirty water from their house. This is a good point to have a whole class discussion about the disposal of waste water and help students become aware of generally what happens to waste we generate.
3. ***Think, research and draw:*** This activity is trying to see what students have understood about the problems with detergents and whether they can apply this. The poster can be a fun way to this. This is a good resource for alternatives to everyday cleaning products the students would use at home. https://static1.squarespace.com/static/559d276fe4b0a65ec3938057/t/56093657e4b0829832b3c938/1443444311894/Household_cleaning_factsheet.pdf
4. ***Plan and do:*** This part requires students to plan an experiment. You can help them think of the different ways they could test this. The students should understand what the different processes in scientific experimentation are. This could be brought out by asking them questions like:

a. What are you trying to find out?
b. How will you find this out?
c. What all will you need for the experiment?
d. What do you think you will observe?
e. How will you know if your prediction is correct?

References:

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Activity 1a: Mixing oil and water?

What you need:

- A small bottle with a lid
- Water
- Ink
- Cooking oil
- Dish washing liquid or detergent

What to do:

- Pour about 1/2 cup water to the bottle.
- Add about 1 teaspoon of ink to the water and stir until it is mixed well.
- Next add1/2 cup oil into the jar. The volume of water and oil should be about the same.
- Close the lid on the jar tightly and shake it for 15-20 seconds.
- Put the bottle down for about 3 minutes and observe what happens.

What did you observe?

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- Next, take the lid off the bottle and add 2 teaspoons of dishwashing soap.
- Close the bottle tightly and shake again for another 15-20 seconds.
- Put the bottle down again and observe what happens to the oil and water after the dish soap has been added it.

What did you observe?

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Possible extension:

- You could also time how long it takes for the water and oil to separate in both the experiments you did; the one with just water and oil, and with water, oil and soap.
- The experiment could be repeated using different kinds of soaps.
- The experiment could be repeated using water from different sources.

Activity 1b: Swirling milk kaleidoscope

What you need:

- liquid dishwashing soap
- Earbuds
- White or light colored plate or shallow bowl
- Food coloring (red, yellow, green, blue)
- Droppers
- Milk at room temperature

What to do:

- Pour milk into the plate to just completely cover the bottom. Let it settle down and stop moving.
- Put one drop of each food color on the milk. Make sure not to stir it or shake it.
- Observe what happens to the food coloring in the milk.

What did you observe?

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- Dip the earbud into the soap and then touch it to the center of the milk. Hold it there for a few seconds and observe what happens. Make sure to hold it completely still and not move it around at all.
- Observe what happens.

What did you observe?

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- Dip another earbud into the soap and touch the milk in another spot and see what happens.

Draw what you saw:

Discussion:

- What is the difference between your first observation and your second observation? Why do you think this was so?
- What do you think the soap does? Think about the action of soap with oil/ fat. Milk has fat in it.
- Does the food colour have anything to do with reaction?
- What do you think would happen if you used water instead of milk?
- What do you think would happen of you used cream instead of milk?

Possible extensions:

- The experiment can be repeated with water, milk with different fat content to see how it affects the reaction. Students should use their understanding from this experiment and extend it to predict the outcomes of these.
- The type of dish detergent used could also be varied.