RET Program
UPR Mayaguez
University of Wisconsin
MAS Integrated School, MASIS Inc.

Instructional Module

Audience

Middle School / High School (Chemistry)
This lab is intended for students ages 13 -14 years at the middle school level and all ages at the high school level. Based on the materials intended for each lab set up and roles for each lab group member, the ideal audience size is 6 groups of 4 students maximum; 8 groups of 3 to 4 students would work for larger class sizes. An important factor is the location of this lab – it must be performed in a large space with multiple accesses to water, hoses or sinks.

Time Frame

(5 days)

- Day 1 (Introduction *Emulsion and Surfactants* - 50 min)
  - Set-up: 5 minutes
  - Focus: 5 minutes
  - Activity: 20 minutes
  - Close: 10 minutes
  - Clean up: 10 minutes

- Day 2 (*Experiment Liquid Soap I* – 50 min)
  - Set-up: 5 minutes
  - Focus: 5 minutes
  - Activity: *25* minutes
  - Close: 10 minutes
  - Clean up: 5 minutes

- Day 3 (Experiment: *Liquid Soap II* - 50 min)
  - Set-up: 5 minutes
  - Focus: 5 minutes
  - Activity: 25 minutes
  - Close: 10 minutes
  - Clean up: 5 minutes

- Day 4 (*Test the Liquid Soap / Lab Report 50 min*)
  - Set-up: 5 minutes
  - Focus: 5 minutes
  - Activity: 25 minutes
  - Close: 10 minutes
  - Clean up: 5 minutes

Day 5 (*Lab Report / Discussion - 50 min*)
- Set-up: 5 minutes
- Focus: 5 minutes
- Activity: 25 minutes
- Close: 10 minutes
- Clean up: 5 minutes

Objective(s)

Obtain a soap by reacting a strong base, such as sodium hydroxide, with a vegetable oil.

After completing the module, students will be able to:

1. Define the terms of emulsion, saponification and surfactant.
2. Learn how emulsions and surfactants act in daily basis and in industries.
3. Describe how emulsifiers acts in an emulsion.
4. Use pH paper to determine if soap is acidic or alkaline.
5. Manufacture a soap sample.

National Science Education Standards addressed in this module:

MIDDLE SCHOOL
MS-PS1 ***Matter and Its Interactions***

Performance Expectations
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Disciplinary Core Ideas

PS1.A *Structure and Properties of Matter*

- ✓ In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide.

In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.

- ✓ The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Disciplinary Core Ideas

PS1.B: *Chemical Reactions*

- ✓ Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.
- ✓ The total number of each type of atom is conserved and thus the mass does not change.

HIGH SCHOOL
HS-PS1 ***Matter and Its Interactions***

Performance Expectations

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Disciplinary Core Ideas

PS1.B *Chemical Reactions*

- ✓ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Activities Materials

- Lab coat
- Safety glasses
- Gloves
- Hot plate
- Dropper
- Hand blender
- Beakers
- Graduated cylinder
- pH paper
- Analytical scale
- Artificial color
- Essences
- Coconut oil
- Canola oil
- NaOH (Sodium Hydroxide)
- Liquid glycerin
- Distilled water

Day 1: Emulsions and Surfactants

Introduction

Soap is the term for a salt of a fatty acid or for a variety of cleansing and lubricating products produced from such a substance. Household uses for soaps include washing, bathing, and other types of housekeeping, where soaps act as ***surfactants***, emulsifying oils to enable them to be carried away by water. In industry, they are used as thickeners, components of some lubricants, and precursors to catalysts.

Putting two or more liquids together creates an ***emulsion*** if the liquids do not mix. ***Immiscible liquids*** do not mix together. For example, if you add oil to water, the oil floats on the surface of the water. And if you shake the two together then leave them to stand, tiny droplets of oil float upwards. These droplets join until eventually the oil is floating on the water again. To stop the two liquids separating, we need a substance called an ***emulsifier***.

FIG 1.1

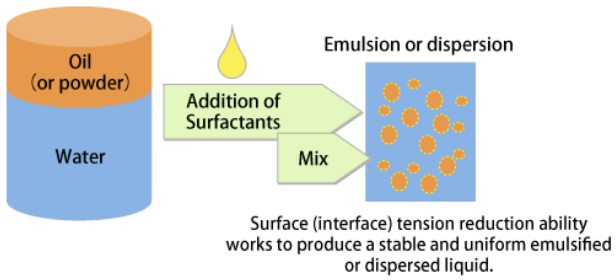

Figure 1 Surfactant acting on an emulsion

Emulsifiers are molecules that have two different ends: a hydrophilic end (water-loving) that forms chemical bonds with water but not with oils , and a hydrophobic end (water-hating) that forms chemical bonds with oils but not with water. Soaps and cleansing agents are emulsifiers and surfactants.

Saponification is a process by which triglycerides are reacted with sodium or potassium hydroxide to produce glycerol and a fatty acid salt, called "soap." The triglycerides are most often animal fats or vegetable oils. When sodium hydroxide is used, a hard soap is produced. Using potassium hydroxide results in a soft soap.

Emulsion and Surfactant Demonstration

The emulsion demonstration is a demo which students can visualize how two liquids (water and oil) cannot be in one phase unless you shake it very well. This will help them understand how liquids have same volume but different densities and how a surfactant can act in an emulsion.

Materials:

- Canola oil
- Water
- Beaker
- Liquid dishwasher
- Graduated cylinder

Procedure:

1. Put on gloves and safety glasses.
2. Add 10 mL of water in a beaker.
3. Add 10 mL of canola oil in the same beaker that has the water.
4. Take the liquid dish soap and add it to the emulsion.
5. Shake the mixture very well and observe how the two phases merge in only one.

Day 2: Lab Activity – Liquid Soap I

Introduction

Legend has it that the word soap comes from Mount Sapo, a hill in Rome that was the site of animal sacrifice. According to the legend, animal fat and ashes washed down the mountain with the rain, producing sudsy river water that was used to wash clothes. It's an interesting story, but there is no factual evidence for this legend.

Soap is the term for a salt of a fatty acid or for a variety of cleansing and lubricating products produced from such a substance.

Household uses for soaps include washing, bathing, and other types of housekeeping, where soaps act as surfactants, emulsifying oils to enable them to be carried away by water. In industry, they are used as thickeners, components of some lubricants, and precursors to catalysts.

Materials:

- Lab coat
- Safety glasses
- Gloves
- Hot plate
- Hand blender
- Beakers
- Graduated cylinder
- Analytical scale
- Coconut oil
- Canola oil
- NaOH (Sodium Hydroxide)
- Distilled water

Procedure:

1. Put on lab coat, safety glasses and gloves.
2. Take a 250 mL beaker and add 33 mL of distilled water.
3. Measure 14 g of NaOH.
4. Add the NaOH carefully to the beaker with water. (This reaction is dangerous and hot, do not inhale it).
5. Take a 400 - 600 mL beaker and measure its mass. Write the mass of the beaker (It must be clean and dry)
6. Measure 70 g of canola oil and add it to a beaker of 400 - 600 mL.
7. Take the coconut oil, measure 30 g and add it to the beaker that has the canola oil.
8. Pour the NaOH & water to the beaker with the oils.
9. Use a hand blender to mix it approximately for 15 minutes. (You need to see like a lotion consistency).
10. Let the mixture rest for 24 hours.

Day 3: Lab Activity – Liquid Soap II

The teacher will review with the students the previous class and the

Materials:

- Lab coat
- Safety glasses
- Gloves
- Hot plate
- Dropper
- Beakers
- Graduated cylinder
- Analytical balance
- Artificial color
- Essences
- Liquid glycerin
- Distilled water

Procedure:

1. Take the mixture from part I and measure it in grams; then subtract the mass of the empty beaker to find the mass of the mixture.
2. After measuring the mixture, take the result and multiply it by 3. *Example: 92 g (3) = 276 g*.
3. Melt your mixture (oils, NaOH) because it is going to be in a solid state.
4. Using the mass of your mixture, measure the same mass of distilled water. Add the weighed amount of distilled water to the mixture.
5. Add 10 mL of liquid glycerin to the mixture.
6. Take the artificial colors or essences and add the amount you want. Example: 3 drops of color, 5 drops of essence.
7. Mix all the components and let it rest for 24 hours.

Day 4: Liquid Soap Test & Lab Report

Materials:

- Distilled water
- pH paper

Students will measure the pH of the soap solution using either a pH meter or pH paper. They must record the pH of the solution; also, they will test and compare their soaps. The teacher will let the students talk about the fragrances they have used and the consistency of their soaps.

*The teacher will provide the lab report assessment.

Day 5: Lab Report and Discussion

The teacher will verify and discuss the student's lab report.

References

Larson-Smith, K., & Pozzo, D. (2012). *Pickering Emulsions Stabilized by Nanoparticle Surfactants* . Washington, United States: American Chemical Society.

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Crotty D. & Gavaghan M., (2013, June). *Making Soap*. Retrieved July 20, 2019, from https://www.juliantrubin.com/encyclopedia/chemistry/soap_experiments.html

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Authors

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Mentors:

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- ✓ Claribel Acevedo Vélez – Chemical Engineering Ph.D.
- ✓ Nelson Cardona Martínez, Chemical Engineering Ph.D. – PI and WI$(PR)_2$EM Director

LAB REPORT

Name: _____ Group: _____ Date: _____

Lab Partner: _____ Score: _____/ x points

Teacher: _____

<table>
<tr><td>Materials:</td><td rowspan="2">Procedure: (Describe the steps performed to complete each task during the laboratory.)</td></tr>
<tr><td>Before

Mass of the beaker: _____

NaOH: _____

Distilled water: _____

Coconut oil: _____

Canola oil: _____</td></tr>
<tr><td>After

Mass of the mixture: _____

pH of your soap (after drying): _____

pH of the commercial soap: _____</td><td>Color, texture and appearance of your soap:</td></tr>
<tr><td colspan="2">Mathematical calculations</td></tr>
</table>

Assessment Question: *You must answer it in complete sentences.*

1. Define the following terms: emulsion, saponification, surfactant.

2. Compare the color, texture and appearance of the homemade soap versus your favorite brand of hand soap.

3. Is the homemade soap solution acidic or basic? Explain.

4. Write you conclusions:

Teacher's signature: _____ Date: _____