

### **Instructors Notes: Soap**

Estimated Time: 4 weeks

The laboratory could be shortened by up to two weeks by missing out the detergent synthesis and the analysis of the waste water.

#### **Check in week**

After Check-in go over the lab with the students and explain the purpose:

i.e. to synthesize and investigate the action of soaps and detergents.

The students should fill out planning sheet 1 before they leave the lab so that they will be able to start laboratory work next week.

During week 2 the students will first be investigating and explaining the solubility of the soap starting materials, as a precursor to the synthesis.

We want them to understand that the starting fats and oils are relatively non-polar and certainly with the long hydrocarbon chain they will not be soluble in water.

Have students come up with a range of solvents to try.

Eg water, acetone, ethanol, hexane.

Make sure they understand and outline a method for testing solubility. – It does not need to be quantitative but they should start with the same amount of oil or fat and solvent for each test.

Each student within a group will make one batch of soap using a different starting material. They should record who will do what, and what reaction conditions they will use.

#### **Week one**

1. Students will begin by doing the solubility tests on the fats and oils – try to make sure that they understand the reasons behind the insolubility of fats in aqueous solutions.
2. Then they can **each** do a soap synthesis Each student should use a difference fat or oil as the basis for the soap. – **make sure they use appropriate caution when they heat the saponification mixture – it can splatter out of the container.** Make sure that they continue heating until two layers are not observed and everything seems to be in one phase.
3. They can filter the soap wash it with cold water and let it dry before weighing. Note that the soaps from different starting materials have quite different properties. The solid fats tend to give more solid soaps – while those from olive oil and liquid vegetable oil are more difficult to handle. If students make sure the solution is ice cold before they filter this problem will not occur.
4. Make sure that they retain the waste water (filtrate) for use later in the project ( they will analyze it)
4. If and time remains they can start to do some solubility testing on the soap that they have produced – on very small amounts so that the yield will not be affected.

#### **Week 2 Major Points:**

1. Students should weigh the soap that they produced last week.
2. Prepare at least two batches of detergent. Make sure students understand the hazards of dealing with conc. sulfuric acid and 6M NaOH – the solutions must be added very carefully with plenty of stirring. The phenolphthalein will tell them when the solution has been neutralized – that is when the reaction is finished.
3. **Make sure that they keep the waste (filtrate) water from the synthesis for next week.**

- Begin testing of the soap,
  - Solubility** – compare and contrast the solubility of the soap with that of the beginning lipid
  - Lathering action** – if all else fails jiggle a solution of the soap in a test tube with a test tube brush.
  - Cleansing ability** – a good substitute for dirt is the oil that was used a starting material. – they can test to see how much oil can be dispersed by a known mass of soap
- Based on the results of the tests – decide which is the best recipe and make another batch for next week. **Make sure they keep the waste water for next week.**

### Week 3

- Students should have samples of soap, detergent, and waste water from both preparations.
- Have students repeat the solubility, lathering action, and cleansing ability tests on the soap and detergent so that they can compare the action of the two types of cleanser.
- The waste waters will be contaminated with acid or base, plus some unused starting material,

Students need to find out what the contaminants are, and find a way to remove them

- If the waste water is acidic – it can be neutralized with base (and vice versa for base). The remediation should be done quantitatively – that is the students should do a titration to neutralize the contaminant. Before they do the titration have them do a rough calculation to estimate how much acid or base they need to add to the waste water to remediate it.
- Make sure that they understand and can perform a titration – there is video on SuperChemLab to help.
- Note the titrations should be done in triplicate.
- 1M HCl and 1M NaOH are available.

### TA Notes Soap Week 4

- This week students will investigate the effects of the contaminated water on the soap and detergent. There are three samples of contaminated water.

Sample A	0.1 M HCl
Sample B	0.1 M CaCl <sub>2</sub>
Sample C	0.1 M Mg(NO <sub>3</sub> ) <sub>2</sub>

- Students should perform pH measurements, and anion and cation tests to identify the contaminants.
- All three samples will give a scum with the soap but for different reasons. Sample A precipitates the carboxylic acid.  
Samples B and C will precipitate the Ca or Mg salt of the carboxylic acid.
- Sample A can be remediated by neutralizing the acid
- Sample B and C can be remediated by complexing the Ca<sup>2+</sup> or Mg<sup>2+</sup> with EDTA to form a soluble complex – then the soap will be the usual Na<sup>+</sup> salt and will be soluble.
- The detergent will not form the same type of scum with the 2+ ions.