CHM 156

Prelab for Lab 5

1. What is the objective of this experiment?

2. Is there any safety concerns you need to pay attention in this experiment?

3. What equation is used in today's experiment?

4. Use your own words to write down the experimental procedures in sequential order.

6

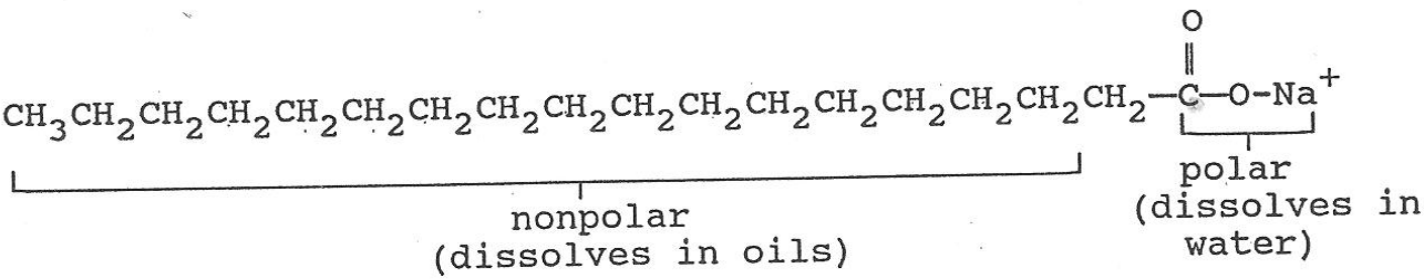
PREPARATION AND PROPERTIES OF A SOAP

Objective: To prepare a soap from vegetable oil.

Background:

A soap is the sodium or potassium salt of a long-chain fatty acid. The fatty acid usually contains 12 to 18 carbon atoms. Solid soaps usually consist of sodium salts of fatty acids, whereas liquid soaps consist of the potassium salts of fatty acids.

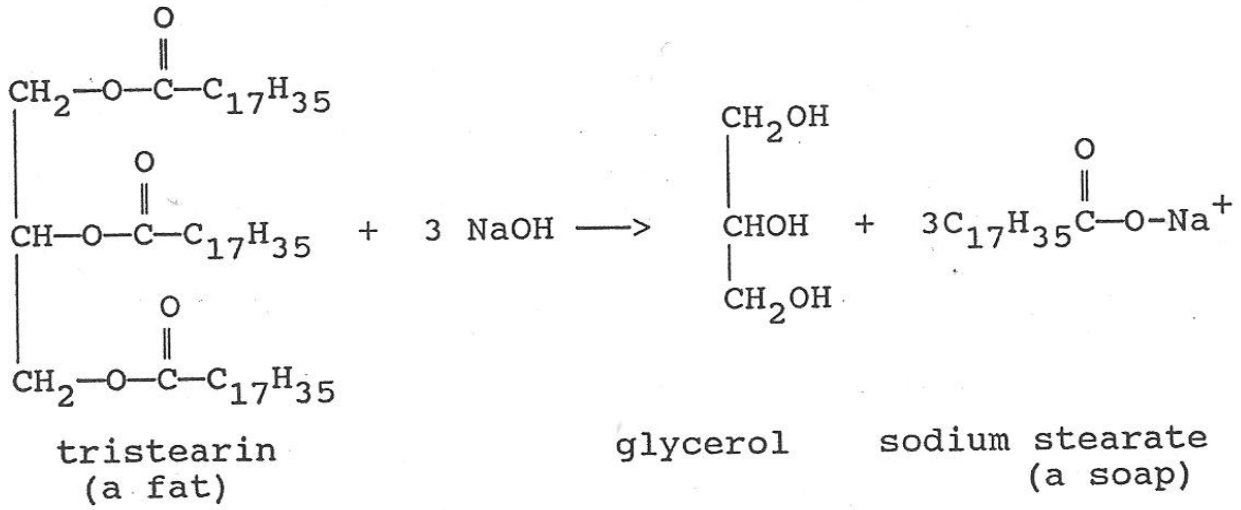
A soap, such as sodium stearate, consists of a nonpolar end (the hydrocarbon chain of the fatty acid) and a polar end (the ionic carboxylate).



Because "like dissolves like", the nonpolar end (hydrophobic or water hating) of the soap molecule can dissolve the greasy dirt, and the polar or ionic end (hydrophilic or water loving) of the molecule is attracted to water molecules, therefore, the dirt from the surface being cleaned will be pulled away and suspended in water. Thus, soap acts as an emulsifying agent, a substance used to disperse one liquid (oil molecules) in the form of finely suspended particles or droplets in another liquid (water molecules).

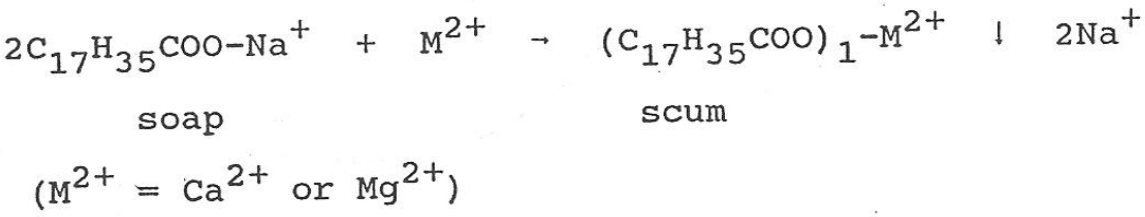
Treatment of fats or oils with strong bases such as lye (NaOH) or potash (KOH) causes them to undergo hydrolysis (saponification) to form glycerol and the salt of a long-

chain fatty acid (soap).

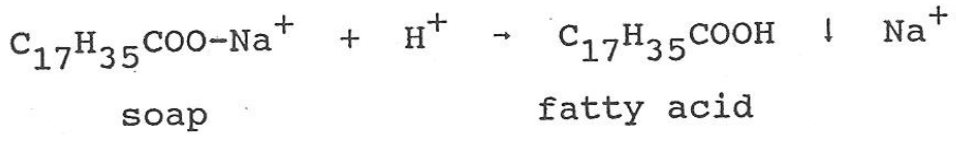


Because soaps are salts of strong bases and weak acids, they should be weakly alkaline in aqueous solution. However, a soap with free alkali can cause damage to skin, silk, or wool. Therefore, a test for basicity of the soap is quite important.

Soap has been largely replaced by synthetic detergent during the last two decades because soap has two serious drawbacks. One is that soap becomes ineffective in hard water, which contains appreciable amounts of Ca^{2+} or Mg^{2+}.



The other is that, in an acidic solution, soap is converted to free fatty acid and therefore loses its cleansing action.



Procedure:

Measure 23 mL of a vegetable oil into a 250-mL Erlenmeyer flask. Add 20 mL of ethyl alcohol (as a solvent) and 20 mL of 25% sodium hydroxide solution. While stirring the mixture constantly, the flask with its contents is heated gently in a boiling water bath

(a 600-mL beaker containing about 200 mL of tap water and a few boiling chips; See Figure 1.).

After being heated for about 20 min, the odor of alcohol will disappear, indicating the completion of the reaction. A pasty mass containing a mixture of the soap, glycerol, and excess sodium hydroxide is obtained. Use an ice-water bath to cool the flask with its contents. To precipitate or "salt out" the soap, add 150 mL of a saturated sodium chloride solution to the soap mixture while stirring vigorously. This process increases the density of the aqueous solution; therefore, soap will float out from the aqueous solution. Filter the precipitated soap with the aid of suction and wash it with 10 mL of ice cold water. Observe the appearance of your soap and record your observation.

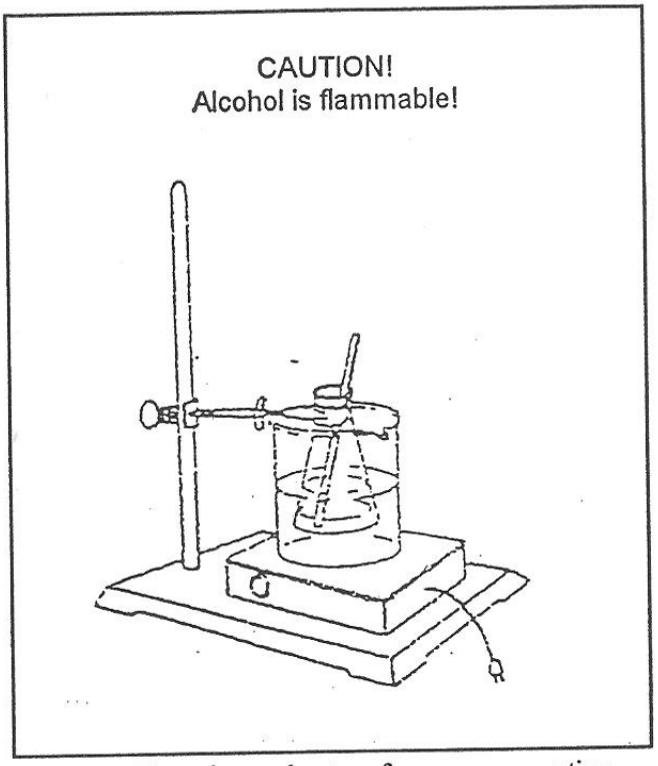


Figure 1. Experimental set-up for soap preparation.

Properties of a Soap

1. Emulsifying Products. Add five drops of mineral oil in a test tube containing 5 mL of water and shake well. A temporary emulsion of tiny oil droplets in water will be formed. Repeat the same test but this time add a small piece of the soap you have prepared before shaking. Compare the relative stabilities of the two emulsions and record your observation on the Report Sheet.

2. Hard Water Reactions. Place about one-third spatulaful of the soap you have prepared in a 50-mL beaker containing 25 mL of water. Warm the beaker with its contents to dissolve the soap. Pour 5 mL of a soap solution into each of five test tubes (nos. 1, 2, 3, 4, and 5). Test No. 1 with two drops of a 5% solution of calcium chloride, No. 2 with two drops of a 5% solution of magnesium chloride, No. 3 with two drops of a 5% solution of iron(III) chloride, and No. 4 with tap water. The No. 5 tube will be used for a basicity test which will be performed later. Record your observations on the Report Sheet.

3. Alkalinity (Basicity). Test the soap solution No. 5 with a wide-range pH paper. What is the approximate pH of your soap solution? Record your answer on the Report Sheet.

NAME _____ SECTION _____

Instructor's Initials _____

REPORT SHEET

Describe the appearance of soap.

1. Stability of oil emulsion

   a) without soap

   b) with soap

2. Hard water reactions

   Tube No. 1

   Tube No. 2

   Tube No. 3

   Tube No. 4

3. Alkalinity

   pH of soap solution =