Activity 1  What Makes a Good Soap?

**GOALS**

In this activity you will:

- Recognize that soaps are chemicals that vary in their characteristics.
- Consider the importance of market research in product design.
- Examine sampling issues in administering a survey.
- Compare the information provided by a qualitative experiment.

**What Do You Think?**

Soap is a multi-billion dollar industry; some of the biggest corporations in the U.S. are soap companies.

- How many different cleaning products does your family have at home?
- Why are there so many?
- Are they all needed?

The *What Do You Think?* questions are provided to get you engaged in the activity. They are meant to grab your attention. They are also used to find out what you already know or think you know. Don’t worry about being right or wrong. Discussing what you think you know is an important step in learning.

Record your ideas about these questions in your *Active Chemistry* log. Be prepared to discuss your responses with your small group and the class.

**Investigate**

About a month ago, your teacher instructed you to make several soaps using a recipe. The reason you needed to make the soaps ahead of time is that the chemical reaction of soap-making, called saponification, is very slow. It takes anywhere from 3–8 weeks for the process to complete.
In this activity, you will create and use a survey to learn more about what your consumers want, so that you can design a soap to meet their needs. You will also invent a laboratory test to determine which soaps are most effective, and you'll practice the test on several commercial soaps.

**Part A: Market Research**

1. Think about your kitchen, bathroom and storage areas. List at least five different types of household cleaners in one minute. Then combine your list with the other students in your group and describe each type of cleaner.
   a) Write down your group’s entire list in your *Active Chemistry* log.

2. How do the cleaners differ from each other?
   a) Organize your list by focusing on the differences between cleaners. Write down lists under different categories in your *Active Chemistry* log. Some categories to consider might include shampoos, liquid soaps, special purpose soaps (hand soap, dish soap, laundry soap), etc. How did you decide which cleaner belongs in which category?
   b) Define your categories, and write down these definitions in your *Active Chemistry* log.

3. Focus on bar soaps only.
   a) With your group, list the qualities you look for in a bar soap. Decide which of these qualities are most important.

4. Using your list of important qualities, write a survey to discover what features other people think are most important in a bar soap. Your survey should have between 5 and 10 questions.
   a) Write down your survey questions in your *Active Chemistry* log.

5. You will need to get five people to answer your survey.
   a) In your group, decide together on this question: Does it matter which five people you choose to answer your survey? Explain your answer.

6. Combine your survey results with the results of the other members of your group. Organize the responses and decide on the qualities of a bar soap that are most important to consumers, including yourselves. Discuss the qualities and make some preliminary decisions on what you will design into your own bar-soap recipe.
   a) Keep notes from your conversation in your *Active Chemistry* log. You will refer back to these later in the chapter.

**Part B: Testing the Effectiveness of a Bar Soap**

1. Look over your list of most important qualities from Step 6 of Part A. Choose one quality that you think you can measure in different bar soaps to help determine a bar soap’s effectiveness. You should be able to measure a result for each bar soap rather than just describe it. One example may be how much time it requires for a piece of each bar soap to dissolve in water, if you think that affects the cleaning ability of the soap. Your teacher will list materials that are available for you to use in the test that you design. You will need to ask about any other materials you may need.
   a) Brainstorm some ideas with your group and write down in your *Active Chemistry* log some possibilities for tests you could do.
2. Your teacher will lead a class discussion about the different ways of measuring soap effectiveness that different groups have thought about. Once some ideas have been discussed, confer with your lab partners and choose a test the group wants to use. You will use this test now to compare several commercially available soaps, and you will use the same test later in this chapter to evaluate the soaps that you make.

3. Invent a procedure that you will use to test the effectiveness of soaps, and write down general notes on the steps of your procedure. You should do some brainstorming to invent your own test. Your teacher may be able to help you with some suggestions. Once you have invented a test, describe your procedure to your teacher, who must approve the procedure before the next step.

   a) After you receive your teacher’s approval, write down your procedure in your Active Chemistry log before you do the test.

4. Perform the test and note any modifications of the procedure. You will use your test again in this chapter, so it is important that you develop a procedure that is repeatable and gives reliable results.

5. Use your test to compare two commercially available bar soaps provided by your teacher.
   a) Note the results in your Active Chemistry log.
   b) After conducting the test, ask yourself: Was this test a good way to measure what I wanted to test? What changes would improve my test? Write down your thoughts on these questions in your Active Chemistry log.

6. Dispose of the materials as directed by your teacher. Clean up your workstation.

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**CLEANING AGENTS**

**Removing Unwanted Substances**

Soaps and other cleaning agents allow you to remove unwanted substances from your body, your clothes, or other objects. Some substances, like a splash of muddy water, can be removed very easily. Others, like grease from an auto-repair shop, are very hard to remove. You use soaps to help you remove the more difficult ones. In this chapter, you will begin to learn why some materials are more difficult to remove than others and what soap does to make it easier to remove them. You will also learn how soaps differ from each other and...
from the other classes of cleaning agents that you listed. You will also begin to see how understanding the structure of a chemical helps you to predict how it will behave.

**How Cleaning Agents Differ**

Cleaning agents differ in many ways. They differ in the materials they are intended to clean. For example, some are meant to be used on the body, while others are not. They also differ in how harsh they are. Very harsh cleaners usually clean so thoroughly that they strip away all protective coatings. Cleaners also differ in the kinds of dirt they will dissolve and wash away. And of course, different cleaners have different ingredients.

Soaps and shampoos are usually made from naturally occurring animal or vegetable fats and oils. Solid bar soaps most often contain sodium ions. As you know from making your soap, bar soaps begin as liquids and become harder as the soap-making (saponification) reaction occurs over several weeks.

The process for making liquid soaps is slightly different. Liquid soaps usually contain potassium ions, so these soaps are made using potassium hydroxide instead of sodium hydroxide. Potassium soaps are generally softer and more soluble in water than sodium soaps. The addition of extra water to a soap made with potassium ions keeps it from hardening.

**Soap Scum**

The biggest drawback to soaps is the formation of soap scum. Soap scum, such as a bathtub ring, is an insoluble white or yellowish residue that can collect over anything you wash with soap. Soap scum is most noticeable in places with hard water. Hard water is water that is rich in salts of calcium and magnesium. These salts are dissolved in water as it flows through the ground. They are present in varying amounts depending on where you live. When the calcium or magnesium ions in the hard water replace the sodium or potassium ions in the soap molecules, the soap molecules with calcium or magnesium ions attached to them precipitate as soap scum. In places with hard water, you need much more soap to get something clean than in places with soft water. Soap scum can be removed with commercial products containing sodium hydroxide or ammonia.
Other Cleaners

Detergents are a different class of cleaners that resolves the problem of soap scum. Detergents are chemicals that have sodium and potassium ions combined with slightly different chemical structures than those of soaps. This change of chemical structure creates compounds that are water soluble even when combined with calcium and magnesium ions. There is no such thing as detergent scum. Another difference between soaps and detergents is that soaps are made of materials found in nature while detergents are synthetic, although some of the ingredients in detergents may be natural.

Abrasive cleaners have grit mixed into soap in very high percentages and work just like sandpaper to remove dirt. Some hand cleaners also employ this principle.

Waterless hand cleaners are usually soaps mixed into ethanol (grain alcohol) or turpentine (paint cleaner). There are a few advantages to dissolving the soaps with these solvents instead of water. One advantage is that ethanol and turpentine are better at dissolving some dirt, so they help the soap clean.

Some household cleaners, such as window cleaners, tile cleaners, all-purpose surface cleaners, and toilet bowl cleaners, do not contain much, if any, soap. These cleaners work not by just dissolving the dirt, but by reacting with what needs to be removed (cleaned away). The reaction forms substances that either dissolve or can be washed away readily. These cleaners must be used and disposed of carefully so that they do as little damage as possible to the environment.
Soap Business

Have you ever received a phone call from a “market researcher” asking your opinions on a topic? If you were going into the soap business, you would probably want to do some market research before you began. The survey you designed represents a very simple form of market research. The answers to your survey will help you decide what you want your soap to do and how it should be better than other soaps.

Market researchers have to think about whose opinions to collect. You probably found that some people take their choice of soaps very seriously. Others have very little interest. You may have decided to give different weights to different opinions, depending on how strongly they are held. If you make a soap that appeals strongly to men, but women make 80% of the buying decisions, your soap may not be very successful.

Designing a Test for Soap Effectiveness

In designing a test for soaps, the requirement of a measurable result may seem difficult. Scientists often prefer experiments with results that can be measured numerically (called quantitative) to tests that do not give some kind of numerical answer (called qualitative). Reaching for measurements often gives much more information about the topic being explored than qualitative experiments do. Also, it is much easier to compare the results from two different materials when those results are numerical. If your test only asks, “Is the material cleaner after washing with your soap than before?” you won’t be able to say which cleans better. It is worth the extra time to devise a quantitative experiment, because it will give you much more information.

What Do You Think Now?

At the beginning of this activity you were asked:

• How many different cleaning products does your family have at home?
• Why are there so many?
• Are they all needed?

Revisit your answers. How has this activity changed the way you view cleaning products in your home?
Reflecting on the Activity and the Challenge

In this activity, you have begun the process of choosing a specific objective, which is a very important step for any project you begin. You have to decide exactly where you are trying to go in order to have a chance of getting there. It is also crucial to have some way of telling whether you are getting closer to or further from your goal. A well thought-out test should do that for you. A valid test will also help you to persuade buyers. After you have finished creating your new and improved soap, you will need to convince others of its merits in order to sell it. If your test is believable to others, you might use it as the basis of an advertising campaign.

1. a)  Walk around your home and make a list of the different cleaning agents in your home.

   b)  Categorize the cleaning agents in your home according to the categories of cleaning agents described in the Chem Talk section.

   c)  Are there any cleaning agents that don’t fit into a category? How would you describe this category?

   d)  Are there any cleaning agents that might fit into more than one category? Explain.

2. Describe two real-world situations where a survey like yours would be used.

3. Describe two qualitative measurements you have done at some point in a science class. Then describe two quantitative measurements you have done. For each of these quantitative measurements, explain the advantage the numerical measurement gave you over a qualitative measurement.

4. Look back over your notes from the soap effectiveness test you did in Part B. Write a procedure for this test so that someone in another chemistry class could repeat your test on the same soaps you tested and obtain the same results.

5. Soaps can contain either sodium ions or potassium ions. Look at the periodic table—what do the elements sodium and potassium have in common?

6. Soft freshwater:
   
   a) contains few magnesium and calcium ions  
   b) contains many magnesium and calcium ions  
   c) contains few sodium and potassium ions  
   d) contains many sodium and potassium ions

7. Which soap is more likely to sell well?
   
   a) One designed to clean paper towels  
   b) One designed to clean the underside of a cement truck  
   c) One designed to clean lawn mowers  
   d) One designed to clean pans
8. Preparing for the Chapter Challenge

Take the time now to clearly state the goal of your research for the Chapter Challenge. What soap do you want to compete against? In what way will you plan to have your soap be better than the soap you chose to compete against? You may modify this goal as you learn more about soaps, but it is important that you begin with a clear goal. Write down your clearly stated goal in your Active Chemistry log and discuss this with your teacher.

Inquiring Further

Market-research methods

Research different methods of deciding whom to include in a market-research survey. Redesign your survey more professionally, based on what you learned. Conduct your survey (you’ll need to interview at least 40 people to have good statistics) and analyze the results numerically, calculating averages and standard deviations for each question.