# Module 2: Classifying Matter and Changes

# Introduction

## MIXTURES

Mixtures are physical combinations of different types of matter. There are two types of mixtures – heterogeneous and homogeneous. In heterogeneous mixtures, there are distinct, separate phases of the different types of matter. Oil and vinegar make a heterogeneous mixture. In homogeneous mixtures, the phases are so well combined that the entire sample has the same properties. Salt and water form a homogeneous mixture.

Mixtures can be separated by physical means as you will see in this experiment. Milk is a mixture* composed of proteins, fats, sugars, minerals and vitamins dispersed in water to make a liquid solution. When this mixture is disturbed by the addition of acid (vinegar) a change occurs in the protein structure causing the proteins, mostly casein, to coagulate (clump together). The clumps are commonly called curds. The remaining liquid solution, called whey, contains water, sugars and a small amount of unchanged proteins. In this experiment, you will add acid (vinegar) to milk and observe this change. Next, you will separate the components of this mixture by gravity filtration; the protein will be collected in a coffee filter while everything else drains through. After the separation, you will see if the process is reversible by mixing the separated components together in an attempt to remake the milk.

*Despite the fact that homogenized milk looks like a homogeneous mixture, it is actually considered to be a heterogeneous mixture by chemists because of the size of the particles in the mixture and their ability to scatter light. Technically speaking, homogeneous liquids are clear (like clear juices and sodas) and heterogeneous liquids are not (like paint and laundry detergents).

## COMPOUNDS

Compounds are individual types of matter; they are pure substances made from the combination (not mixture) of two or more elements bonded together. Sugar is an example of a compound. It comprises carbon, oxygen and hydrogen bonded together. While mixtures like milk can be separated by physical means, compounds like sugar can only be separated by chemical means. In this experiment, you will break down sucrose, a simple compound commonly known as sugar. Heating sucrose will cause it to decompose into carbon, carbon dioxide and water. Carbon dioxide and water are released. You will “see” the carbon dioxide released as “bubbles”. You will see the water released as steam. The black mass remaining is just carbon.

$$\text{sucrose} \rightarrow H_2O_{(gas)} + CO_{2(gas)} + \text{carbon}$$

## OBSERVING THE COLOR OF MATTER

Note about observations: White and colorless are words to describe colors. Snow and paper are white, but windows are colorless. “Clear” is NOT a color; it refers to the fact that light can pass through (transparency). Therefore:

- Water is clear and colorless.
- Coke is clear and brown.
- Gatorade is clear and comes in all kinds of colors.
- Milk is NOT clear and is white.

# Pre-Laboratory Exercise

Name: _____

Read section 3.2 of your textbook. Then answer the questions below:

1) Consider two boxes with the following contents: the first contains 100 individual nuts and 100 individual bolts; the second contains the same number of nuts and bolts with the difference that each bolt is screwed into a nut. Which box has contents that are analogous to a mixture and which box has contents that are analogous to a compound.

    a. 1st box;  b. 2nd box;

2) Consider the characteristics of two breakfast cereals. “Tri Flakes” is a cereal that contains a fused three-layered flake with a corn flake, a wheat flake and a rice flake fused together. “Crispy Corn ‘N Fruit” is a cereal that contains corn flakes and dried fruit. Which cereal has contents that are analogous to a mixture and which cereal has contents that are analogous to a compound.

    a. Crispy Corn ‘N Fruit;  b. Tri Flakes;

3) Either explain your answer to #1 or #2.

Read section 3.3 and 3.4 of your textbook and fill in the table below:

| Chemical | Element or Compound? | Property | Physical or Chemical change? |
|---|---|---|---|
| Aluminum | | a. Good conductor of heat<br>b. Generates a colorless, odorless gas when added to sulfuric acid<br>c. Can be formed into thin foils | a.<br>b.<br>c |
| Sodium Bicarbonate | | a. White powder<br>b. Bubbles and foams when mixed with vinegar<br>c. Converted to salt when mixed with hydrochloric acid | a.<br>b.<br>c |

**Procedures:** Gather the following materials in your kitchen: baking soda, salt, sugar, vinegar, coffee filter, frying pan, aluminum foil, four colorless glasses. Conduct these three experiments and record your observations in the data table. (Either directly on this word document. Or print, complete and scan).

**Part 1: Milk and Vinegar**

1) Put ½ cup milk in a colorless glass.
2) Add 2 tablespoons of vinegar (note: vinegar is 5% acetic acid in water).
3) Observe what happens.
4) Wait ~15 minutes. (You can move on to part 2 while you wait.)
5) Set a coffee filter in another colorless glass and pour the milk/vinegar mixture into it.
6) Filter. (This will take a while. You can move on to part 3 while you're filtering.)
7) The chemical on the filter paper is a protein called casein ($C_{81}H_{125}N_{22O}O_{39}P$)
8) The solution coming through the filter should look clear. Chemicals that pass through a filter are called filtrate.
9) Take a picture of the filtration process and submit it with your data sheets.
10) Mix the casein back into the filtrate to "remake" the milk.

| **Classifying Matter** | | | |
|---|---|---|---|
| | Observations (Description of Matter before or after the change). | State of Matter<br>Solid?<br>Liquid?<br>Gas? | Class of Matter:<br>Pure Element?<br>Pure Compound?<br>Homogeneous Mixture?<br>Heterogeneous Mixture? |
| Milk | | | |
| Vinegar | | | |
| Milk/Vinegar mixture | | | |
| Casein (the white clumps) | | | |
| Filtrate | | | |
| Casein/Filtrate mixture | | | |
| **Classifying Change** | | | |
| | Observations of Change | Physical or Chemical Change.<br>If chemical: identify new chemical | |
| Mixing of Milk and Vinegar | | | |
| Filtering of Casein from Milk | | | |
| Mixing of Casein and Filtrate | | | |

**Part 2: Sugar and Salt**

1) Make two small boats of aluminum foil to serve as containers. They should fit in your cupped hand.
2) Put ~1 tsp. of sugar, $C_{12}H_{22}O_{11}$, in one boat.
3) Put ~1 tsp. of salt, NaCl, in the other boat.
4) Put the two boats in a frying pan on your stove.
5) Turn the heat to high.
6) Observe the chemicals and complete the data table. (You will know you are done when the steam stops coming off the aluminum boat with the sugar. This takes a while.)
7) When they have cooled down, taste the material in the sugar boat and in the salt boat. (It is okay – I tried it myself!)
8) Take a picture of the two chemicals after heating and submit with your data sheets.

| **Classifying Matter** | | | | |
|---|---|---|---|---|
| | Observations (Appearance) | Observations (Taste) | State of Matter Solid? Liquid? Gas? | Class of Matter: Pure Element? Pure Compound? Homogeneous Mixture? Heterogeneous Mixture? |
| Aluminum Foil before heating. | | | | |
| Sugar before heating. | | | | |
| NaCl before heating. | | | | |
| Aluminum Foil after heating. | | | | |
| “Sugar” after heating. | | | | |
| NaCl after heating. | | | | |

| **Classifying Change** | | |
|---|---|---|
| | Observations of Change – describe everything you saw. | Physical or Chemical Change. If chemical: identify new chemical |
| Sugar melts | | |
| Sugar Decomposes | | |
| Salt is heated. | | No Change. |

# Post Lab Questions

1) Were the CHEMICAL changes reversible (could you get back to the chemicals you started with)?

2) Which of the PHYSICAL changes were reversible?

3) If you used 5.2 g of milk for the experiment in part 1 and the protein on the filter in the end weighed 2.0 g, what percentage of the milk was protein?

4) What did your tasting observations tell you in part 2?

5) If you had weighed the sugar you used in part 2, how would the mass of the carbon compare in the end? Why?

**6) Important: Make sure you submit two pictures neatly labeled (see part 1, step 9 and part 2, step 8) along with your college ID or your picture to get points on this lab.**