Lab 4

Types of Matter

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Learning Objectives

- Classify matter as either a pure substance or a mixture
- Separate a mixture of soluble and insoluble material
- Use the laboratory technique of gravity filtration to separate the components of a mixture
- Quantitatively determine the percent recovery of each component in a mixture

INTRODUCTION

Elements and compounds are **pure substances**. A pure substance is any substance that has a fixed composition and cannot be purified any further, such as distilled water, diamonds, or chemical compounds. Most of the materials we encounter in everyday life are not pure substances. Materials such as cement, paper, soil, and ink are formed from a physical combination of various substances and are called **mixtures**. A homogeneous mixture has a uniform distribution of its particles and does not separate on standing, such as air; a heterogeneous mixture does not have a uniform distribution of its particles and does separate on standing, such as milk (Figure 1).

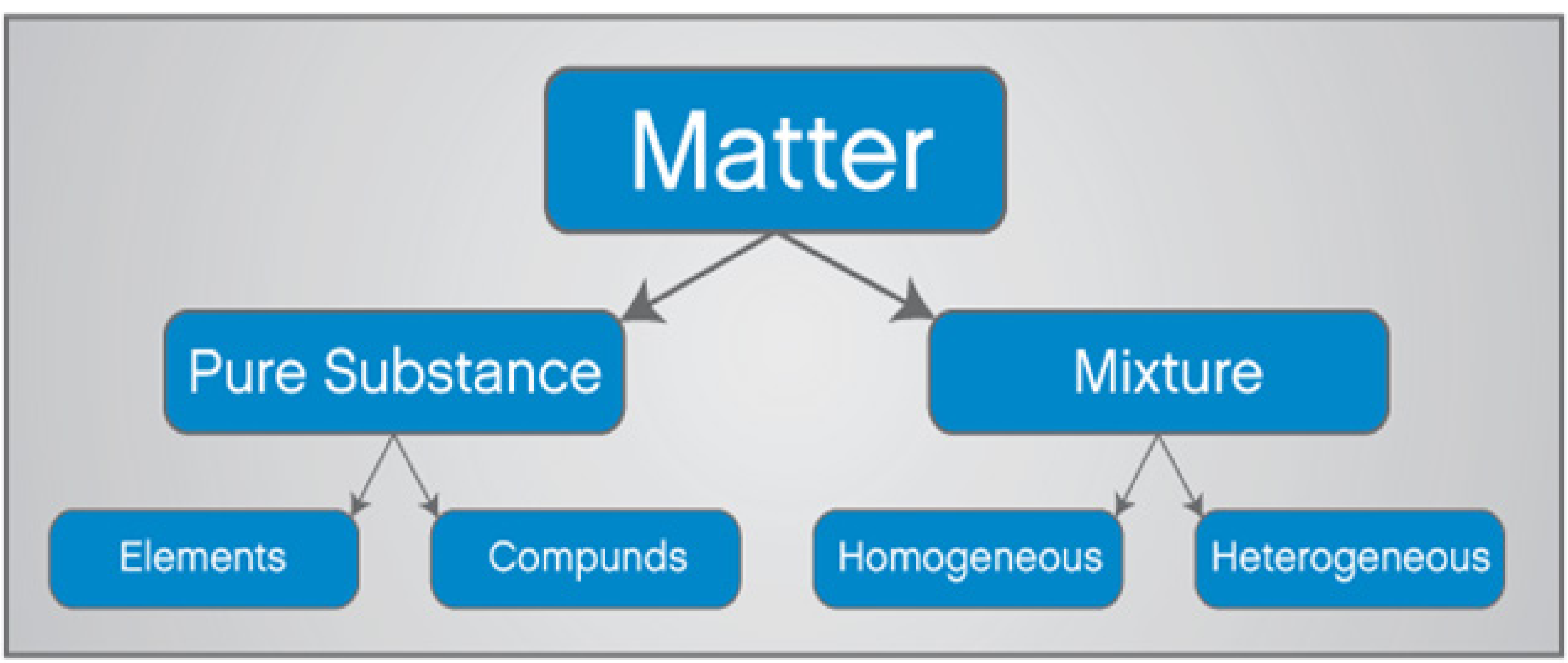

Figure 1. All matter can be classified into two broad categories: pure substances and mixtures.

THE LAW OF CONSERVATION OF MASS

The law of conservation of mass states that matter can be changed from one form into another; mixtures can be separated or made; and pure substances can be decomposed, but the total amount of mass remains constant. We can state this important law in another way. The total mass of the universe is constant within measurable limits; whenever matter undergoes a change, the total mass of the products of the change is, within measurable limits, the same as the total mass of the reactants.

Types of Matter

PHYSICAL AND CHEMICAL PROPERTIES

Unlike mixtures, the composition of a pure substance (Figure 2) is constant, and thus pure substances have characteristic **physical properties** that do not change. Examples of physical properties that can be used to describe pure substances include solubility, density, boiling point, and melting point. On the other hand, a mixture results from the combination of two or more pure substances that do not react chemically. The physical properties of a mixture depend on its composition, because the amounts of each substance making up a mixture can vary. By taking advantage of the unique physical properties of individual components within a mixture, it should be possible to separate a mixture into its components. Mixtures have the following fundamental properties:

- **Each component of a mixture retains its chemical identity and, hence, its own properties.**
- **Composition of a mixture may vary, while that of its components is fixed.**

Figure 2. **Water that is free of pollution such, as distilled water, is considered to be a pure substance.**

MIXTURES

Mixtures can be separated into their components by using physical methods like evaporation, crystallization, and filtration. For example, if one component in a mixture of two solids is soluble in water, while a second component is not, adding water to the mixture and filtering the residue can separate the water-soluble component from the insoluble component of the mixture. Subjecting the mixture to such a physical change would change the ratio of components of the mixture. This leads to one of the definitions of a mixture: a substance whose composition can be altered by a physical change.

SEPARATION TECHNIQUES

Chemists often need to separate mixtures of two or more substances. Because a mixture is a physical combination of materials, the components may be separated using physical changes. There are different ways of accomplishing such a process. One common laboratory technique involves the use of **gravity filtration**. The technique of gravity filtration can be used when a heterogeneous mixture contains both a solid and a liquid component. In gravity filtration, a mixture is poured through a piece of filter paper placed inside a funnel. The solid components of the mixture become trapped in the filter paper, while the liquid components drain into a receiving container. Once the components have been separated, it will become necessary to measure the mass percent of each recovered component.

Percent recovered is a convenient way to express the actual composition of a mixture in terms of the amount of each component. The sum of the percent recovered in a mixture equals 100%. The mass percentage of each component in a mixture is calculated as follows:

$$Percent\ Recovery = \left(\frac{amount\ pure\ product\ recovered\ in\ g}{amount\ of\ crude\ material\ used\ in\ g}\right) \times 100$$

Experiment 1

Classification of Matter

Experiment Inventory

Materials	Labware
*Internet Access	None
*Five items or substances in your home	
*Pen/Pencil	

Note: You must provide the materials listed in *red.

EXPERIMENT 1: CLASSIFICATION OF MATTER

In this experiment, you will classify matter as either a pure substance or a mixture.

PROCEDURE

- [ ] 1. Review the list of items in column 1 of Table 1 on the Experiment 1 Data Sheet.
- [ ] 2. Classify each item in Table 1 as either a pure substance or a mixture (including the five items from your home that you selected).
- [ ] 3. If the material is a pure substance, further classify it as either an element or a compound.
- [ ] 4. If the material is a mixture, further classify it as homogeneous or heterogeneous.

Data Sheet

Experiment 1 Data Sheet

Table 1: Identification of Matter

Item	Pure Substance or Mixture	Element or Compound	Homogeneous or Heterogeneous
Orange Juice (water and pulp)			
Pure Air			
Magnesium (Mg)			
Baking Soda ($NaHCO_3$)			
Pacific Ocean (water and salt)			
Pure Water (H_2O)			
Sidewalk Cement			
Selection # 1 ____________			
Selection # 2 ____________			
Selection # 3 ____________			
Selection # 4 ____________			
Selection # 5 ____________			

Experiment 2

Separation of a Mixture of Sand and Salt

Experiment Inventory

Materials

8 g Sand/Salt Mixture

Sterno® Cooking Fuel

Matches

*Distilled Water

*Safety Cup of Water

*Calculator

Labware

(1) 100 mL Graduated Cylinder

(1) 100 mL Beaker

(1) 250 mL Erlenmeyer Flask

(1) 250 mL Wash Bottle

(1) Wire Mesh Stand

(1) Filter Paper (round)

(1) Plastic Spoon

(1) Funnel

(1) Digital Scale

(1) Metal Spatula

(1) Hot Pad

(1) Insulated Glove

Note: You must provide the materials listed in *red.

EXPERIMENT 2: SEPARATION OF A MIXTURE OF SAND AND SALT

In this experiment, you will separate the components of a mixture and determine the percent of each substance.

PRELIMINARY PROCEDURES

Read through the entire lab TWICE. Formulate a mental picture of what you will be doing. Make sure your workspace is free from clutter and distractions. Follow good laboratory safety procedures (e.g., wearing appropriate clothing, tying back your hair, wearing safety glasses).

PROCEDURE

Experiment Demo

☐ 1. Place a 100 mL beaker on the digital scale. Press the (0/T) button on the right-hand scale of the scale. Your scale should now read 0.0 g. Key Technique

☐ 2. Carefully pour 8 grams of the sand and salt mixture into the beaker. Record the exact mass in Table 2 on the Experiment 2 Data Sheet. Make sure to take the mass of only the sand and salt sample; do not include the beaker.

☐ 3. Measure out 50 mL of distilled water using the 100 mL graduated cylinder.

☐ 4. Remove the beaker from the digital scale. Add the water to the beaker, and gently stir the sample with a plastic spoon for several minutes. Be careful not to spill.

- [ ] 5. Use the digital scale to obtain the mass of the round filter paper. Record the mass of the filter paper in Table 2 on the Data Sheet.
- [ ] 6. Use the digital scale to determine the mass of the clean, dry, Erlenmeyer flask as well. Record the mass of the flask in Table 2 on the Data Sheet.
- [ ] 7. Prepare a filtering funnel as shown in Figure 3. Fold the filter paper in half twice to make four quarters. Place the paper in the funnel so that three quarters are open on one side, and one quarter is on the opposite side. Seat the filter paper into the funnel by moistening the paper with a small amount of distilled water (Figure 4). **Key Technique**

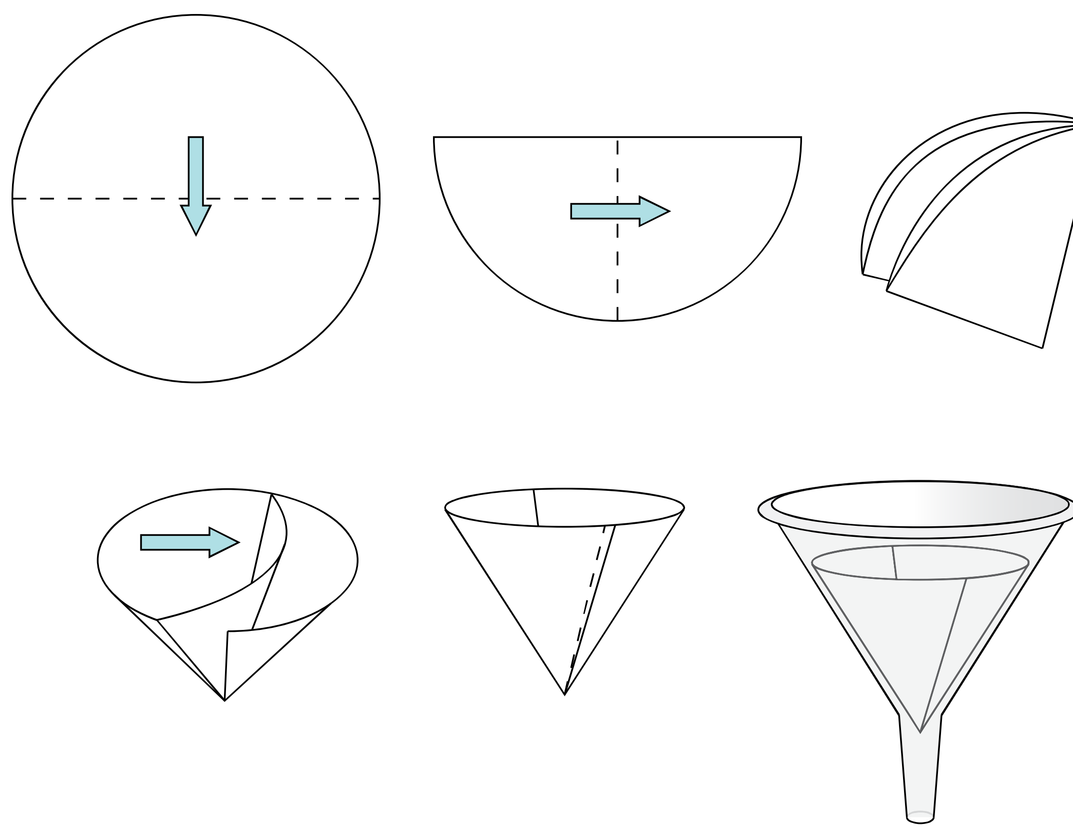

Figure 3: Step-by-step process of folding the filter paper so that it will fit into the funnel.

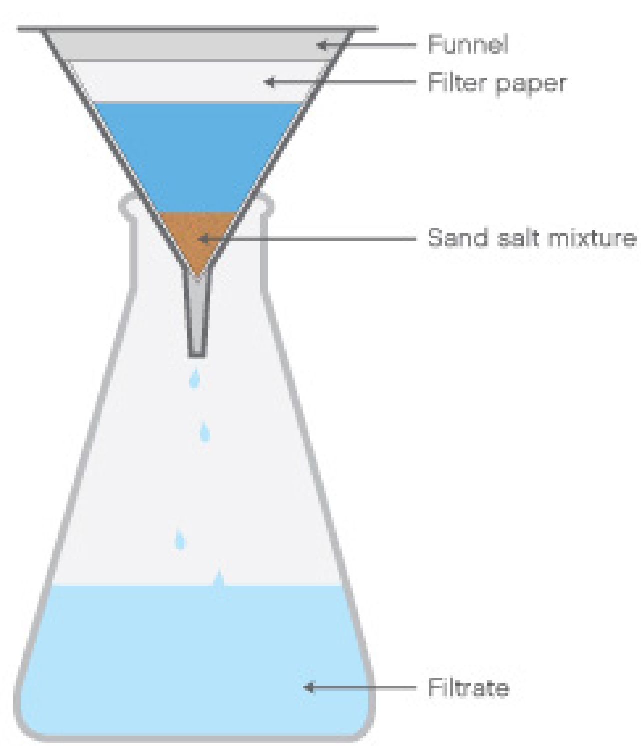

Figure 4: Gravity filtration setup.

- [ ] 8. Use the 100 mL graduated cylinder to measure an additional 100 mL distilled water. Then transfer the entire 100 mL of distilled water into the wash bottle.
- [ ] 9. Slowly and carefully, filter the mixture. To do this, pour as much water as possible into the funnel, and then use a plastic spoon to scoop out the remaining sand. Make sure all the sand stays inside the filter paper.
- [ ] 10. Rinse off the plastic spoon and the beaker with as little water from the wash bottle as possible (too much water will slow down the filtering process). Then, pour the water from the beaker into the funnel.
- [ ] 11. After all the distilled water has dripped from the end of the funnel, wait an additional 5 minutes to make sure that all of the water has been filtered.
- [ ] 12. Carefully remove the filter paper from the funnel, and put it in a safe place to dry overnight. Air-drying will take anywhere from 5 to 18 hours, depending on the humidity of your climate.
- [ ] 13. Choose an area that is well-ventilated (yet not windy), and place your Sterno® can on a heat-resistant surface.
- [ ] 14. Thoroughly read all of the directions on your Sterno® can, and then use your metal spatula to pry open the lid. Put the lid aside, being careful not to touch any of the contents. If you accidently touch the contents, wash your hands before you proceed with the experiment.
- [ ] 15. Touch a lit match to the Sterno® contents, and drop the match into the contents. The contents will flame up immediately. Under bright lights, you may not be able to see the flame but know that it is there. **Key Technique**

LAB SAFETY: ***Both the matches and the Sterno® can cause fire or burns to skin, clothing, or lab materials if the flame comes into contact with them. Do not stick any body part, loose clothing, or other flammable items in or near the flame. Be sure you have your safety glasses on, and never leave any burning fuel unattended!! Do this experiment in a well-ventilated area, and have a safety cup of water and/or a fire extinguisher nearby.***

- [ ] 16. Use your metal spatula to slide the Sterno® cooking fuel can under the wire mesh stand.
- [ ] 17. Carefully place your Erlenmeyer flask on top of the wire mesh stand (Figure 5).
- [ ] 18. Evaporate the water in the flask by boiling the filtrate until the contents are dry.

    Be careful not to heat too long or too intensely because continuing to heat a dry flask will cause it to crack or explode.

- [ ] 19. When all the water has evaporated, use the insulated glove to place the hot flask on an insulator pad to cool.

    Do not place the hot flask directly on the counter because it can crack the glass!

- [ ] 20. To extinguish your Sterno® cooking fuel, carefully place its lid back on top of the can. *Do not blow out the flame*. Once the can is cooled (look at the temperature indicator on the label), snugly fit the cover onto the can and store it in a safe place away from heat or flames (Figure 6). **Key Technique**
- [ ] 21. Once the Erlenmeyer flask has cooled, use the digital scale to weigh the flask and its contents (dried salt). Make sure your scale is reading 0.0 g before you place the Erlenmeyer flask on it. Record your data in Table 2 on the Data Sheet.
- [ ] 22. When the filter paper (which contains your sand) is dry, make sure your scale is reading 0.0 g, and then place your dried filter paper with the sand onto the scale and determine the mass. Record your data in Table 2 on the Data Sheet.

Figure 5: The water will evaporate and the salt can make popping or cracking noises.

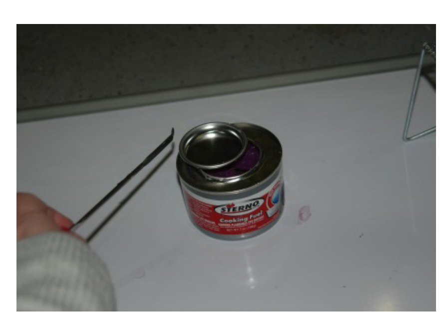

Figure 6: The flame must be snuffed out. Placing the lid on top of the can will remove the oxygen source.

Experiment 2 Data Sheet

ANALYSIS

When water is added to a mixture of NaCl (sodium chloride) and SiO_2 (silicon dioxide or sand), the water dissolves the NaCl, leaving the sand behind:

$$NaCl\,(s) + SiO_2\,(s) + H_2O\,(l) \rightarrow NaCl\,(aq) + SiO_2\,(s)$$

The mass of the sand can then be determined by filtering the saltwater/sand mixture to remove the sand from the solution, drying the premassed filter paper with the sand in it, then measuring the mass of the dried sand/filter paper combination. The mass of the NaCl is determined by evaporating the H_2O from the solution in a pre-massed Erlenmeyer flask and measuring the mass of the remaining NaCl and flask combined.

Table 2: Sand and Salt Separation Data

Material	Mass (g)
Sand/salt packet	
Filter paper	
Empty Erlenmeyer flask	
Dried salt in Erlenmeyer flask	
Dried sand and filter paper	

CALCULATIONS

Hint: When doing your calculations, keep in mind that the mass of the sand should not be greater than the original starting value of the sand/salt mixture. If this occurs, it is due to the sand not being thoroughly dry or an error in a calculation. The percent of sand and the percent of salt should add up to 100% and should not exceed 100%.

1. Determine the mass of sand. Show your work.

$$Mass\ of\ dry\ sand\ and\ filter\ paper - Mass\ of\ dry\ filter\ paper = Mass\ of\ sand$$

2. Determine the percent of sand in your original sand + salt mixture. Show your work.

$$Percent\ of\ sand = \frac{Mass\ of\ sand}{Mass\ of\ sand\ and\ salt\ mixture} \times 100$$

3. Determine the mass of salt. Show your work.

$$Mass\ of\ cooled\ flask\ and\ contents - Mass\ of\ dry\ empty\ flask = Mass\ of\ salt$$

4. Determine the percent of salt in your original sand + salt mixture. Show your work.

$$Percent\ of\ salt = \frac{Mass\ of\ salt}{Mass\ of\ sand\ and\ salt\ mixture} \times 100$$