Experiment 2

Separation of a Mixture

Pre-Lab Assignment

Before coming to lab:

- Read the lab thoroughly.
- Answer the pre-lab questions that appear at the end of this lab exercise.

Purpose

A heterogeneous mixture of iron (Fe), salt (NaCl), and sand (SiO_2) will be separated by physical means and the percent composition of each will be determined.

Background

Matter can be classified by composition as a pure element, pure compound, homogeneous mixture, or heterogeneous mixture. A pure element is its simplest form as it is found on the periodic table (including diatomic and polyatomic elements). A pure compound is made up of a single type of molecule where each atom is chemically bonded to the others. A mixture is a combination of multiple molecules or elements that are not chemically bonded. Homogeneous mixtures have a uniform composition throughout and heterogeneous mixtures are varied.

Iron (Fe) is a pure element while salt (NaCl) and sand (SiO_2) are pure compounds. When all three are added together, they make a heterogeneous mixture. It is very common to find mixtures in the laboratory setting. For many experiments, each component must be carefully separated from the others before it can be identified, measured, or tested to ensure that the results are accurate and not contaminated by other compounds.

Matter can undergo either physical or chemical changes. Physical changes involve altering the appearance but not the composition of a substance. Chemical changes alter the very internal make-up of the substance, usually by a chemical reaction. The methods used in this lab are physical changes as the Fe, NaCl, and SiO_2 do not change in composition.

The mass percent of a component is defined by Eqn. 1. Each component will need to be isolated and then weighed in order to calculate its mass percent accurately. The sum of the mass percents of all components in a mixture should equal 100% (the total mixture).

$$\text{mass percent} = \frac{\text{mass component}}{\text{mass total mixture}} \times 100 \qquad \text{Eqn. 1}$$

Example Problem: Calculating the Mass Percent of Components in a Mixture

An empty evaporating dish weighed 25.5000 g. To it, a mixture of Fe, NaCl, and SiO_2 was added and the dish and mixture weighed 30.0600 g. After a magnet was used, the mixture and the dish weighed 28.9500 g. Deionized water was added, stirred, and then decanted. The extraction was repeated four times. The remaining solid was dried and weighed 26.6850 g in the dish. Calculate the mass percent of Fe, NaCl, and SiO_2 in the original sample.

Step 1: Find the mass of the mixture.

30.0600 g – 25.5000 g = 4.5600 g mixture

Step 2: Find the mass of Fe

30.0600 g – 28.9500 g = 1.1100 g Fe

Step 3: Find the mass of NaCl

28.9500 g – 26.6850 g = 2.2650 g NaCl

Step 4: Find the mass of SiO_2

26.6850 g – 25.5000 g = 1.1850 g SiO_2

Step 5: Find the mass percent of each component

$$\%\ \text{Fe} = \frac{1.110\ \text{g Fe}}{4.560\ \text{g mixture}} \times 100 = 24.34\%\ \text{Fe}$$

$$\%\ \text{NaCl} = \frac{2.265\ \text{g NaCl}}{4.560\ \text{g mixture}} \times 100 = 49.67\%\ \text{NaCl}$$

$$\%\ \text{SiO}_2 = \frac{1.185\ \text{g SiO}_2}{4.560\ \text{g mixture}} \times 100 = 25.99\%\ \text{SiO}_2$$

Procedure

Part I: Separation of Fe

1. Weigh a clean, dry evaporating dish on the digital balance. Record all digits shown on the screen on your data sheet.

2. Your instructor will assign an unknown mixture to you. Add approximately 3 grams of the sample to the evaporating dish and weigh again. Record the actual new mass on your data sheet.

3. Place the evaporating dish on a magnetic stir plate. Add a magnetic stir bar provided by your instructor to the evaporating dish and stir slowly. Do not allow any of the mixture to spill out over the sides of the evaporating dish.

4. After 15 minutes or when it appears that all of the Fe is now attracted to the magnetic stir bar, remove the stir bar to a weigh boat, being careful to not disturb the Fe or to spill any of the remaining mixture. Dispose of the Fe filings in the labeled waste container and return the stir bar to your instructor.

5. Reweigh the evaporating dish and remaining mixture. Record the mass on your data sheet.

Part II: Extraction of NaCl

1. Add approximately 10 mL of deionized water to the remaining mixture in the evaporating dish. Stir thoroughly for 2-3 minutes with a glass stir rod and then decant the liquid into a 100 mL beaker.

2. Repeat Step 1 three more times, for a total of four extractions. All four portions of deionized water should be added to the same 100 mL beaker to make 40 mL total. Dispose of this solution down the sink.

Part III: Drying of SiO_2

1. Set up an iron ring and wire gauze as a shelf on which to place the evaporating dish and remaining mixture. Place the evaporating dish on top of the wire underneath a heat lamp to dry thoroughly. Make sure that the heat lamp is far enough away from the lab counter to avoid causing damage.

2. Wait at least 10 minutes or until the remaining mixture appears to be completely dry. Turn off the heat lamp and allow the evaporating dish to cool to room temperature. Weigh it and the remaining mixture, recording the mass in your data sheet.

3. Return the sample to the heat lamp and continue to dry it for an additional five minutes. Turn off the heat lamp and allow the dish to cool to room temperature. Weigh it and the remaining mixture again, recording the mass in your data sheet. It should match the mass in Step 2 to three decimal places. If it does not, repeat Step 3 again until two consecutive weights match within three decimal places of one another.

4. Once finished, the solid may be disposed of in the trash can.

Part IV: Calculations

1. Calculate the mass of the original mixture, mass of Fe, mass of NaCl, and mass of SiO_2 from your data.

2. Calculate the mass percent of Fe, NaCl, and SiO_2 from your data.

Experiment 2—Data Sheet

Name: ____

Unknown #: ___________________________________

1. Mass of evaporating dish (g) ______________________________

2. Mass of evaporating dish and mixture (g) ______________________________

3. Mass of evaporating dish and mixture after magnet (g) ______________________________

4. Mass of evaporating dish and mixture after extraction and drying (g)

   First weight ______________________________

   Second weight ______________________________

5. Mass of mixture (g) ______________________________
show calculation:

6. Mass of Fe (g) ______________________________
show calculation:

7. Mass of NaCl (g) ______________________________
show calculation:

8. Mass of SiO_2 (g) ______________________________
show calculation:

9. Mass Percent Fe (%) ______________________________
show calculation:

10. Mass Percent NaCl (%) ______________________________
show calculation:

11. Mass Percent SiO_2 (%) ______________________________
show calculation:

Experiment 2—Post-Lab Assignment

1. Give three reasons why your percent composition of Fe, NaCl, and SiO_2 in your mixture may be inaccurate.

2. A student performed the identical experiment to isolate Fe, NaCl, and SiO_2 in a mixture. They performed every step correctly *except* they failed to stir the mixture long enough with a magnet and some Fe was left behind. How will this error affect (too high, too low, no effect) the mass percent of Fe, NaCl, and SiO_2 in the mixture? Explain each answer.

3. A student performed the identical experiment to isolate Fe, NaCl, and SiO_2 in a mixture. They performed every step correctly *except* they extracted with 10 mL of deionized water only once rather than the recommended four times. How will this error affect (too high, too low, no effect) the mass percent of Fe, NaCl, and SiO_2 in the mixture? Explain each answer.

4. In this experiment, the mass of NaCl was measured indirectly only. Design an experimental procedure that would allow the mass of NaCl to be measured directly.

5. An empty evaporating dish weighs 25.1295 g. When unknown mixture is added, the dish and mixture weigh 29.9745 g. After removing the Fe with a magnet, the dish and remaining mixture weigh 28.2374 g. After extraction of the NaCl and drying the remaining solid, the dish and the final mixture weigh 26.8938 g. Calculate the mass and mass percent of Fe, NaCl, and SiO_2 in the sample. Show all your work.

Experiment 2—Pre-Lab Assignment

Name: ____

For all calculations, show all work and draw a box around the final answers.

1. What compound is separated by a magnet in this experiment?

2. What compound is separated by extraction in this experiment?

3. What is the purpose of drying the remaining solid after extraction under a heat lamp?

4. An empty evaporating dish weighs 20.000 g. An unknown mixture containing Fe, NaCl, and SiO_2 is added and the dish and mixture together weigh 35.000 g. It is stirred thoroughly with a magnet which is then removed, and the remaining dish and mixture weigh 29.550 g. After extracting with several portions of water and drying the remaining solid, the remaining mixture and dish weigh 29.680 g. Calculate the mass and mass percent of Fe, NaCl, and SiO_2 in this sample. Show all your work.