**Lab: 2**

**Name of student: ………………………………**

# Separation of Components of a Ternary Mixture by Physical Processes

**Introduction**

A mixture is a combination of two or more pure substances in a variable composition that do not react chemically and the components retain their individual identities and properties. The components could be either elements or compounds. Each component has a different set of physical and chemical properties. These properties can be used to identify and/or separate a particular substance. In this experiment, you will separate a three-component mixture based on the differences of their physical properties (boiling point, melting point, solubility in a given solvent, etc.). Useful physical processes for the separation of mixtures include the following:

**Filtration** is the process of straining a solid from a liquid by using a filter paper or other porous material.

**Extraction** is the removal of one substance from a mixture because of its greater solubility in a given solvent.

**Decanting** is the pouring of a liquid from a solid-liquid mixture, leaving the solid behind.

**Distillation** is the purification of a liquid by heating it to its boiling point, causing vaporization, and then condensing the vapors into the liquid state and collecting the liquid. Separation of two or more liquids requires that they have different boiling temperatures.

**Sublimation** is the process to pass directly from the solid state to the gaseous state without the appearance of the liquid state.

**Centrifuging** is the process of separating a suspended solid from a liquid by whirling the mixture at high speed.

**Chromatography** is the process of separating a mixture by the distribution of its components between two phases, one phase being stationary and the other phase moving. Some examples of chromatography are Gas Chromatography, Paper Chromatography, and Thin-Layer chromatography.

In this experiment, you will separate the components of a mixture containing sodium chloride, ammonium chloride and silicon dioxide. By measuring the mass of the original mixture and determining the mass of the pure components, you will calculate the mass percent of each component in the original mixture.

Chemists often illustrate a separation procedure by means of a flow chart as shown below. By looking up the physical properties of each component in the mixture, they can decide what physical separation techniques will best allow them to separate the mixture. In the prelab for this experiment, you will look up the relevant physical properties of these three components and fill out the flow chart with the missing substances and techniques shown as question marks.

 Mixture of NH4Cl, NaCl & SiO2

????????????

|

???????? ????????

??????????

|

???????? ????????

????????? ?????????

??????? ???????? ????????

???????

# Procedure

Obtain an unknown solid mixture from the instructor. Record its identity **(number or letter).**

**Sublimation of NH4Cl**

Weigh a clean, dry, evaporating dish **(dish#1)** and accurately weigh the **total solid mixture**­ into it. Place the evaporating dish on a hot plate **in the hood**. Gently and slowly heat the mixture until the white fumes disappear (it may take about an hour). Stir the mixture frequently to facilitate the sublimation of the ammonium chloride. After the white fumes disappear, continue heating the mixture until **no white solid (NH4Cl) condenses** on a stirring rod that held above the evaporating dish.At this point, all the NH4Cl should be sublimed and the mixture will have remaining two components (NaCl and SiO2). Allow the evaporating dish to cool and record its mass.

**Extraction of NaCl**

Weigh a second, clean, dry, evaporating dish (dish#2). Add about 5-7 mL of distilled water to the NaCl-SiO2 mixture and stir gently for 5 minutes. Carefully decant the liquid from the first evaporating dish into the second evaporating dish, leaving the solid behind. Add 5-7 mL more of distilled water to the first dish and gently stir for 5 minutes. Decant the liquid into the second evaporating dish. Repeat this process a third time with 5-7 mL more of distilled water. This process effectively extracts the NaCl (**dish#2**) from the SiO2 (**dish#1**). Both components are not pure at this moment with the water mixed with them.

**Drying of SiO2**

Place the evaporating dish containing the wet SiO2 **(**dish #1) on a hot plate and **slowly** heat the mixture with stirring until the lumps break up and the sand appears dry (no sand particle should stuck on the stirring rod). Allow the dish to cool to room temperature and weigh to find the mass of SiO2 in the original sample.

**Drying of NaCl**

Set the **dish#2** containing the NaCl-water solution on a hot plate. Gently heat the solution with a **low** heat to avoid boiling the solution too vigorously and losing the product. When most of the water is gone, **reduce** the heat to avoid splattering of the NaCl. Place a watch glass over the dish to avoid loss of NaCl. When no water is seen condensing on the watch glass then the sample is dry. Allow the dish to cool and record its mass to find the mass of NaCl in the original mixture.

**Calculation of Mass Percent**

Determine the percent by mass of **each component** in your mixture using the following formula:

Mass percent of Component = $\frac{Mass of component}{Mass of Mixture}$ x 100

**Data and Calculations Mixture ID**

|  |  |
| --- | --- |
| 1. Mass of dish #1 plus mixture |  |
| 2. Mass of evaporating dish #1 |  |
| 3. Mass of mixture |  |
| 4. Mass of dish #1 plus NaCl and SiO2 |  |
| 5. Mass of NH4Cl  |  |
| 6. Mass of dish #1 plus dry SiO2 |  |
| 7. Mass of SiO2  |  |
| 8. Mass of dish #2 plus dry NaCl |  |
| 9. Mass of evaporating dish #2 |  |
| 10. Mass of NaCl  |  |

**Calculations: Show all work**

* 1. Percent NH4Cl in the mixture.
	2. Percent SiO2 in the mixture.
	3. Percent NaCl in the mixture.
	4. Calculate the percent recovery using the following formula

Total percent recovery = $\frac{Total mass of recovered NH4Cl, SiO2 and NaCl }{Mass of Mixture}$ x 100

* 1. Percent lost.

# Prelab

# Separation of Components of a Ternary Mixture by Physical Processes

1. Watch **­this** video >>> <https://www.youtube.com/watch?v=tQdvPTPlU1M>

Find at least three differences and three similarities between this lab instruction and the video.

|  |  |  |
| --- | --- | --- |
|  | **Similarities** | **Differences** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |

1. Using the CRC Handbook of Chemistry and Physics or other reliable resources, look up the following physical properties of ammonium chloride (NH4Cl), silicon dioxide (SiO2, sand), and sodium chloride (NaCl, table salt). Must write you source.

# Physical Properties

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Formula** | **Melting Point****(**°**C)** | **Solubility\*** | **Appearance** |
| Sodium Chloride (Table Salt) | NaCl |  |  |  |
| Ammonium Chloride  | NH4Cl |  |  |  |
| Silicon Dioxide (Sand) | SiO2 |  |  |  |

\* Solubility: Grams of solute per 100 g of water

1. Using the above physical properties, complete the flow chart given on the **page-2** of this lab by giving the reagents and/or conditions necessary to affect each indicated separation step and how the components will be separated. **Use a separate page for drawing this flow chart.**
2. A student is given a 6.216 g mixture of iron filings, calcium chloride and sand. He separates the mixture and recovers 2.524 g of iron, 1.932 g of sand and 1.523 g of calcium chloride. Calculate the percentage of each component he recovered from the original mixture and the percent of material he lost during the separation process.