Chem1020 Separation of Components of a Mixture

Objectives:

- To separate a mixture into its component pure substances.
- To calculate the composition percentage of each isolated substance.

Text references:
mixture, pure substances, states of matter, solutions, filtration, evaporation, sublimation

Discussion:
Many reactions carried out in the laboratory produce mixtures. In order to obtain pure substances from mixtures, physical methods are often used. In this experiment you will be given a solid sample of a mixture of ammonium chloride, sand, and sodium chloride. The physical methods that will be used include sublimation, filtration, and evaporation.

Sublimation is a process in which some substances change from solid state to gaseous state without the appearance of the liquid state. Many, but not all substances are able to undergo this type of state-transition. Sublimation of dry ice (solid carbon dioxide), ice (solid water), and iodine are commonly observed. Among the components in today's mixture, ammonium chloride is the only one that can easily sublime when heated (you already observed this in the Observation Experiment). So, the first part of the experiment will involve heating up the solid mixture to get rid of ammonium chloride. *What two components of the mixture remain after this process?*

The remaining solid mixture now contains sand and sodium chloride only. These two components have very different solubility in water. Therefore, filtration is a very useful method to separate them. Adding water to the solid mixture will dissolve only sodium chloride, while sand remains undissolved. The resulting mixture containing dissolved sodium chloride and undissolved sand is poured through a filter paper, a porous paper that allows liquids to pass through while retaining any solids. The liquid (containing dissolved salt) that has passed through the filter paper is called the **filtrate**; the solid on the paper is the **residue**.

The clear filtrate is also called a **solution**, in which sodium chloride is called **solute** and water is **solvent**. Water and sodium chloride have very different boiling points, and therefore evaporation can be used to separate them. By heating up the solution slowly in an evaporating dish, the sodium chloride solute will remain as a solid after the water solvent has evaporated. However, in today's experiment, this step is not necessary to figure out what amount (mass) of sodium chloride was present in the original mixture that was given to you. The mass of sodium chloride can be determining the mass of ammonium chloride and sand from prior steps and subtracting them from the total mass of the mixture.

Calculations:

After separating the components of this mixture, you will need to determine the mass and percentage of each. To determine the percentage, the mass of a specific component is divided by the total mass of the mixture sample and multiplied by 100.

Example: You isolate 1.70 g of sand from a mixture of total mass = 3.89 g.

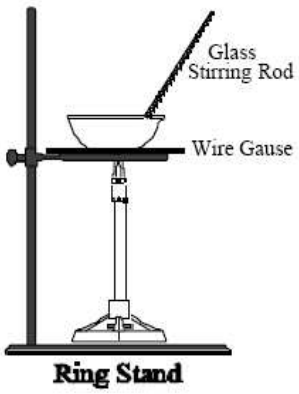
$$\text{Thus, percentage of sand} = \frac{1.70\text{g of sand}}{3.89\text{g of mixture}} \times 100\% = 43.7\%$$

Procedure:

You will need to do FIVE mass measurements, which are underlined below. Failure to carry out all five of them will prevent you from completing the lab! You MUST use the same balance for all five measurements. Never place any object directly on the balance. Make sure you have a weighing paper on it. Before you take your first mass measurement, place this paper on the balance and rezero (tare) it to cancel the mass contributed by the paper. Retain this paper during subsequent measurements.

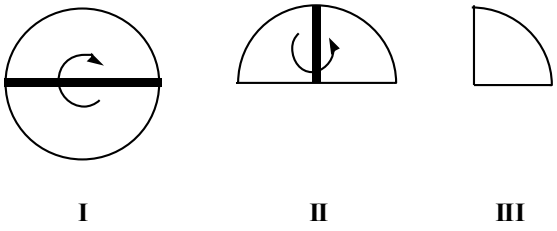
I. Sublimation of ammonium chloride

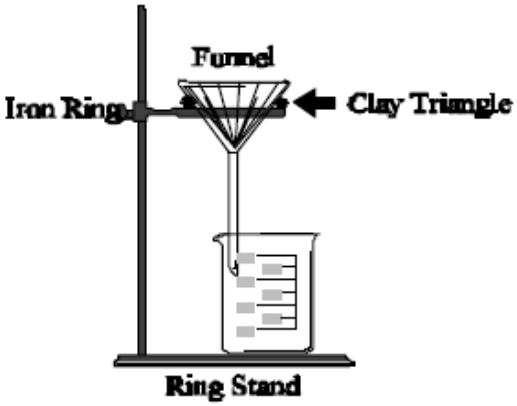
1. Weigh and record the mass of a clean, dry evaporating dish.
2. Carefully transfer all of your unknown mixture into the evaporating dish. Weigh and record the total mass of evaporating dish and the mixture sample.
3. Assemble a wire gauze, ring clamp, and ring stand **in the hood** as shown in the diagram on the right. Place the evaporating dish with sample on the wire gauze and start heating with a burner, until white fumes cease and the yellow color in the solid mixture disappears (*this could take some time, be patient*). After this point, gently stir the mixture to see if any new fumes emerge. If you observe more fumes, keep stirring until fumes cease. If no fumes emerge, you may turn off the burner and stop heating.
4. Use crucible tongs to take off the evaporating dish and let it cool to the degree that your bare hands can handle it **(never put hot or even warm objects onto the balance!).** If you need to transport the dish while it is still warm, use a small beaker provided on your benchtop.
5. Weigh and record the mass of the evaporating dish and the remaining solid.



II. Separation of sand by filtration:

1. Add about 30-40 mL distilled water to the solid mixture in the evaporating dish; stir gently.
2. Obtain a piece of filter paper and *with a pencil* write your name on it. Fold it (see diagram below on the left); <u>determine and record its mass</u>.





3. Set up a funnel with filter paper (see the diagram above on the right). The funnel should be supported on a ring stand. The folded filter paper is placed in the funnel and wetted down with the solvent (distilled water) so that the paper adheres to the funnel. Place a 150 mL beaker under the funnel stem to collect the filtrate.
4. Pour the contents from the evaporating dish onto the filter paper along a glass stirring rod to direct the flow. Allow the solution to pass through and using a wash bottle containing distilled water, wash any residue from the evaporating dish onto the filter paper. **Also use the wash bottle to wash the solid remaining on the filter paper to make sure it is free of sodium chloride solution**. Do not try to stir the solid content on the filter paper which may inadvertently tear the paper and render a repetition of this step
5. After the filtration is complete, remove the filter paper with the residue, place it on a watch glass and carefully transport it to the drying oven. Total drying time is approximately 15 minutes.
6. While the sand is being dried, clean up your used glassware, benchtop, and fume hood area according to instruction.
7. After the sand is dried, carefully remove the watch glass/filter paper assembly (use tongs to take this out of the oven, do not touch it with bare hands! You may also need an insulating pad to support the assembly while transporting it back to your bench. Allow the sand and filter paper to cool. <u>Reweigh the filter paper with the dry sand and record the mass (don't weigh the watch glass!)</u>.

III. Sodium chloride:

The amount of sodium chloride may be determined indirectly without evaporating the water away from the sodium chloride solution. Add the masses of ammonium chloride and sand; subtract this sum from the mass of the original mixture sample to indirectly obtain the mass of sodium chloride.

Waste Disposal

Dispose of used sand in the designated waste container. Used filter paper may be disposed of in the trash can. Clean glassware as instructed by lab instructor.

Separation of Components of a Mixture

Name_____Date_____ Lab Section_____

Unknown number _____ Balance number_____

Data (When in doubt, weigh it! Record all digits shown on the balance display with unit "g")

Mass of evaporating dish _____

Mass of evaporating dish and mixture _____

Mass of dish and mixture after heating _____

Mass of empty filter paper _____

Mass of filter paper and sand after drying _____

Calculations (Keep two decimal places for each "mass" result and one decimal place for each "percentage" result)

Mass of total sample mixture _____

Mass of ammonium chloride _____

Mass of sand _____

Mass of sodium chloride _____

Percentage of ammonium chloride _____

Percentage of sand _____

Percentage of sodium chloride _____

Post-Lab Questions

1. In your procedure, the mass of sodium chloride was calculated (inferred) from the original mass of the sample and the masses of the two other components of the mixture. Describe a different way you could have determined the amount of sodium chloride in your sample:

2. List one benefit and one drawback of determining the sodium chloride mass by subtraction (as you did as part of your laboratory procedure).

Pre-lab exercise for Separation of a mixture Lab
(Complete and check answers before coming to lab)

1. Which part of experiment needs to be done in the fume hood? Explain why.

2. A solid mixture of ammonium chloride, salt, and sand has a mass of 23.54 g before heating. After the heating, the mass is 18.56 g.
   1) Calculate the difference between these two mass measurements.

   2) Which physical process causes this difference?

   3) What components of the mixture are present AFTER the heating?

3. How many mass measurements are needed in order to calculate the percent of all three components of the mixture?

4. A 6.04 g sample of a charcoal and sodium chloride mixture was separated by dissolving the sodium chloride in water and filtering out the charcoal. The charcoal was dried. The filtrate (sodium chloride solution) was then heated until all the water had evaporated, leaving the dry sodium chloride.
   1). If 4.19 g of charcoal was separated out, what is its percentage in this mixture?

   2). Given the information in question 1), how many grams of sodium chloride would you expect to obtain when you evaporated the filtrate to dryness?