Separation of a Binary Mixture

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Purpose of the Experiment

- To gain more experience using common lab equipment including top loading balances, graduated cylinders, beakers and Bunsen burners.
- To practice making measurements and reporting them correctly.
- To learn several useful techniques for the chemistry lab including: extraction, gravity filtration, and evaporation.

Background Required:

Complete the online prelab assignments for "Separation of a Mixture" BEFORE the start of the lab session.

You will work in pairs for this experiment.

Discussion:

A compound is a pure substance that is composed or two or more elements in a fixed ratio. Sodium chloride (NaCl) is an example of a compound. Note that the composition of a compound is fixed. That is, sodium chloride is made up of one sodium cation per chloride anion. There is no other ratio of cations to anions that will make up sodium chloride. A compound can be separated into the elements which make it up by CHEMICAL methods only. This means that a chemical reaction is needed to separate sodium from chlorine in the compound sodium chloride. We show chemical reactions through balanced equations:

$$2NaCl\ (s) \rightarrow 2Na\ (s) + Cl_2\ (g)$$

A mixture results when two or more pure substances are combined. Unlike a pure compound, the composition of a mixture can vary. For example, we could have a sand/salt mixture that is 80% sand and 20% salt, a mixture that is 20% sand and 80% salt, or numerous other possible compositions. A mixture can be separated by PHYSICAL methods. This means that our sand/salt mixture can be separated into sand and salt without chemically altering the salt (NaCl) and sand (SiO_2) components. We use differences in physical properties of the two substances to separate them by physical methods. For example, salt is soluble in water, but sand is not. Thus, the difference in the physical property of solubility can be used to separate these two substances by a technique known as extraction.

A very common example of a physical property being used to separate components of a mixture is in the purification of water by filtration. Undesirable impurities in water can be removed by passing the water through special filters which absorb the impurities. Cations such as sodium, calcium, iron, and copper, and anions such as chloride and bromide are removed using ion exchange resins. Any particles in the water are also removed during the filtration. The deionized water we use in the lab is prepared this way.

In this lab, you will make a sand/salt mixture, and then use a combination of extraction, decantation, filtration and evaporation to separate the mixture back into the two individual components. Key terms are defined below:

Extraction: The process of separating components of a mixture based on differences in the solubility of one component in a particular solvent.

Decantation: The process of separating a solid component of a mixture from a liquid component by allowing the solid to settle to the bottom on a container, and then pouring the liquid into another container without disturbing the solid.

Filtration: The process of separating a solid component of a mixture from a liquid component by pouring through a filter. The solid that remains on the filter is called the residue. The liquid that passes through the filter is called the filtrate.

Evaporation: The process of separating a liquid solvent from a dissolved solute by heating until the solvent has vaporized. The solute will remain after evaporation of the solvent.

Equipment:

Ring stand, ring, wire gauze	Sand (silicon dioxide)
Salt (sodium chloride)	Filter paper discs
Drying oven	Bunsen burner
Top-loading balance	2 - 150 mL beakers, 1- 50 mL beaker
Watchglass	Small plastic funnel
Glass stir rod with rubber policeman	Beaker tongs

Safety: Always wear your safety goggles while in the lab room. Do not dispose of anything in the drain unless specifically directed to by your instructor. Use caution with the Bunsen burner.

Procedure:
1. Have one lab partner weigh between 0.75-1.25 g of SAND into a 50 mL beaker, and the other partner weigh between 0.75-1.25 g of SALT into a 150 mL beaker using a top loading balance. Follow the steps outlined below for weighing the salt and sand:
    a. Place a piece of weighing paper on the balance pan
    b. Set your beaker on top of the weighing paper
    c. Press zero/tare and wait for the balance to read 0.00 g
    d. Add salt OR sand using your aluminum scoop until your mass is in the correct range. Wait for the digital readout to stabilize.
    e. Record the mass of the salt OR sand in the data section
    f. Remove the beaker with salt OR sand and return to your lab bench
2. Add the salt to the sand so that both components are in the 150 mL beaker. You now have your sand/salt mixture.
3. Weigh your watchglass with a piece of filter paper and record the mass in the data table.

Extracting the Salt:
1. Add approximately 30 mL of deionized water to your mixture and stir for a few minutes so that the salt dissolves in the water. After stirring for a few minutes, allow the remaining solid to settle to the bottom of the beaker.

Gravity Filtration:

1. Label a clean, dry 150 mL beaker with the number 2, and weigh it on the top loading balance. Record the mass in the data section. This is Beaker 2 and it will be used in your gravity filtration to collect the filtrate.
2. Set up a gravity filtration as demonstrated by your instructor. Beaker 2 goes under the funnel to catch the filtrate. If you are unsure, ask your instructor for help! Use only ONE piece of filter paper.
3. Carefully decant the liquid from your mixture into the filter paper in the funnel .
4. Pour the remaining liquid and solid sand into the filter paper. Use a small amount (about 5 mL) of deionized water and your rubber policeman to dislodge any remaining sand from the beaker into the filter paper.
5. Use a small amount of additional deionized water (~5 mL) to rinse any residue from your beaker or rubber policeman into the filter paper.

Evaporating the Solvent (Water):

1. Carefully remove the filter paper with sand from the funnel and place it on the weighed watch glass. Label a piece of paper with your initials and place the watchglass in the drying oven on the paper. Leave watch glass in the oven until the sand is dry (~30 min).
2. Set up a ring stand and Bunsen burner as demonstrated by your instructor. If you are unsure, ask your instructor for help.
3. Heat the filtrate to a medium boil over a blue flame until enough water has evaporated to see a wet slurry of salt. At this point, reduce the size of your flame and heat slowly until the water has completely evaporated. Avoid splattering of the salt crystals by keeping your flame low. Remove the burner briefly if splattering begins to occur.
4. Once the water is completely gone, use your beaker tongs to place the beaker on your white non-asbestos pad. Allow the beaker and salt to cool to room temperature (5-10 minutes) before using the same top loading balance to find the mass of the beaker and salt. Record this mass in the data section. CAUTION: The balances can only measure the mass of objects at room temperature! If you do not cool the beaker before weighing it then you will not get an accurate mass and your results will suffer.
5. CAUTION: Do not discard the salt until you have completed the calculations and checked in with your instructor. When your instructor approves, you can use water to rinse the salt into a labeled waste container for sodium chloride.

Recovery of Sand:

1. Check your watch glass to see if the sand is completely dry. If so, use a paper towel to remove the hot watchglass from the oven and place it on the benchtop to cool. When the watch glass with filter paper and sand has reached room temperature, weigh it on the same balance you used to get the initial mass of the watch glass and filter paper. Record this mass in your data table.
2. After recording the mass, the sand and filter paper can be discarded in the trash container.

Data, Calculations and Discussion

Complete all calculations on the table and answer the discussion questions with your partner before leaving. Staple and turn in only the last two pages on the due date.

Name_______________________ **Partner**________________________ **Section #**________

Data Table	**Results**	
Starting mass of salt (g)		
Starting mass of sand (g)		
Mass of clean, dry 150 mL beaker (Beaker 2) (g)		
Mass of Beaker 2 with salt residue (g)		
Mass of watchglass and filter paper (g)		
Mass of watchglass, filter paper and sand(g)		
Calculations (Show set-up)		
Mass of your mixture, g: starting mass of salt + starting mass of sand		
Mass of salt recovered, g: mass of Beaker 2 with salt residue – mass of Beaker 2		
Mass of sand recovered, g: mass of watchglass, filter paper, sand – mass of watchglass, filter paper		
Percent recovery of salt: <u>mass of salt recovered</u> x 100% starting mass of salt		
Percent recovery of sand: <u>mass of sand recovered</u> x 100% starting mass of sand		
Percent recovery of mixture: <u>(mass of salt recovered + mass of sand recovered)</u> x 100% mass of your mixture		
Theoretical percent salt (or sand) in your mixture: <u>starting mass of salt (or sand)</u> x 100% mass of your mixture	**<u>Salt</u>**	**<u>Sand</u>**
Experimental percent salt (or sand) <u>mass of salt (or sand) recovered</u> x 100% mass of your mixture		
Percent error for salt or sand <u>Experimental % - Theoretical %</u> x 100% Theoretical % salt (or sand)		

Discussion Questions (Complete with your partner before leaving lab):

1. Which percent recovery was closer to100%, the salt or the sand?

2. What are two experimental errors (not calculation errors) that might have caused your lower percentage recovery of the salt or sand?

3. Do your experimental percentages of salt and sand add up to 100%? Should they? Why or why not?

4. Using the salt recovery data, what are the percentages of salt and sand in your mixture?

5. Using the sand recovery data, what are the percentages of salt and sand in your mixture?

6. You are given an unknown mixture of salt and sand to analyze using today's procedure. You can use either the salt recovery data or the sand recovery data (but not both) to determine the percent of each in the mixture. You are also being graded on accuracy, so you want to get the lowest experimental error. Based on your data, should you chose to report the final percentages of salt and sand in the unknown mixture based on salt recovery data or sand recovery data *and why*?