(Take student picture against White board at the beginning of class)

SEPARATION OF A BINARY MIXTURE

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Purpose of the Experiment

- To gain experience using common lab equipment, especially Bunsen burners.
- To practice making measurements and reporting them correctly.
- To learn simple techniques for separation of substances based on physical properties
- To master the concept and calculation of mass percent composition

PreLab Assignment:
Complete the online prelab assignment and Lab Procedure Outline as your instructor assigned.

Background Information:
A compound is a pure substance that is composed of two or more elements in a fixed ratio. Sodium chloride (table salt) is an example of a compound. The elemental composition of a compound is fixed. For example, sodium chloride is composed of the element sodium and chlorine in a fixed ratio of one sodium to one chlorine as shown by its formula: NaCl. There is no other ratio of sodium to chlorine that is the compound we call table salt. **Compounds such as sodium chloride can be separated into their elements only by chemical methods**. This means that a chemical reaction must be performed to destroy the sodium chloride and produce the free elements sodium and chlorine.

Mixture, however, are different than compounds. When two or more pure substances are combined, we create a mixture. Unlike a pure compound, the composition of a mixture can vary. For example, we could have a mixture of sand and table salt that is 80% sand and 20% salt, a mixture that is 10% sand and 90% salt, or numerous other combinations. **Mixtures can be separated into their components based on differences in the physical properties of the components.** This means that our sand and table salt mixture can be separated into sand and salt without chemically altering the salt (NaCl) or sand components. How can we do this? We know salt will dissolve in water, but sand is will not. Thus, this difference in the physical property of solubility can be used to separate these two substances by a technique known as extraction. Water is added to the salt /sand mixture and mixed. The salt dissolves into the water or, in other words, the salt is *extracted* from the mixture into the water. Now we have a mixture of salt water and sand. It is easy to separate the salt water from the solid sand using a technique called filtration.

Filtration is a very common example of a physical property being used to separate components of a mixture. Filtration can use differences in physical properties such as particle size, solubility, ionic charges and surface affinities to separate many types of mixtures. In our sand/salt water mixture, we can use filter paper to separate the undissolved solid sand from the salt water liquid. The salt water passes through the filter while the wet sand remains on the filter paper. To recover the separated sand and salt, we just evaporate the water from each, using the difference in the boiling points (another physical property) between the water and the salt or sand.

In this lab, you and your partner will prepare a sand/salt mixture, and then use a combination of extraction, filtration and evaporation to separate the mixture back into the two individual components. These processes are defined as follows:

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

A combination of extraction and filtration will allow us to physically separate the salt and sand. We will then use evaporation to remove residual water from the sand and the water in the water from the salt. Your results will include the masses of salt and sand that you recover, which will allow you to compare your experimental recoveries with your starting masses of salt and sand. You will calculate the mass percent of sand and salt in your original mixture using the starting mass of the mixture and the individual masses of salt and sand as follows:

$$\text{Mass percent salt } (\textit{or sand}) \text{ in the mixture} = \frac{\text{Mass of salt } (\textit{or sand})}{\text{Mass of mixture}} \times 100\%$$

Using the true values for the mass percent salt and salt in the mixture and your experimental values, you will be able to calculate your present errors.

Equipment:

Ring stand, ring, wire gauze	Sand (silicon dioxide, SiO_2)
Salt (sodium chloride, NaCl)	Filter paper discs
Drying oven	Bunsen burner
Top-loading balance	1 each: 50, 150, 250 mL beaker
Watchglass	Small plastic funnel
Glass stir rod with rubber policeman	Beaker tongs

Safety: Always wear your safety goggles while in the laboratory. Use caution with the Bunsen burner. Handle your hot beaker only with beaker tongs. Follow all waste disposal instructions given in the procedure.

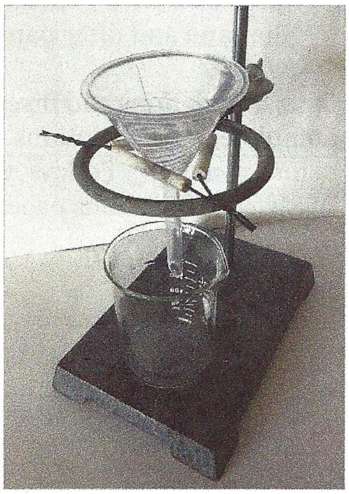
Procedure:

1. Have one lab partner weigh between 1 and 1.25 g of SAND into a 50 mL beaker, and the other partner weigh between 1 and 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. Carefuly add salt OR sand using your aluminum scoop (or the salt pour spout) until your mass is in the correct range. Wait for the digital readout to stabilize.
    e. Record the mass (all digits!) of the salt and sand in the data section and take the beaker back to your lab station
2. Add the ~~salt~~ Sand to the ~~sand~~ Salt 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 all digits in the data table.**

Extracting the Salt:

1. Add approximately 30 mL of deionized water to the beaker containing your mixture and stir for a few minutes so that the salt is completely dissolved in the water.

Gravity Filtration:



1. Weigh a clean, dry **250** mL beaker on the top loading balance. Record the mass (all digits) in the data section.
2. Set up the gravity filtration equipment as demonstrated by your instructor. The 250 mL beaker goes under the funnel to catch the filtrate. Use only one piece of filter paper.
3. Carefully decant some of the liquid from your mixture into the filter paper in the funnel.[pp[6ws
4. Swirl the beaker and pour the remaining liquid and sand into the filter paper. Use a small amount (about 5 mL) of deionized water and the rubber end of your stir rod to push 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 stir rod 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, ring, wire gauze and Bunsen burner as demonstrated by your instructor. Make sure the ring is no higher than 4 inches from the top of the burner.
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 weighing the beaker with salt on the same balance used before. Record this mass (all digits). CAUTION: Make sure you cool the beaker to room temperature before weighing it. The balances accurately measure only the mass of objects at room temperature.
5. Do not discard the salt until you have had your salt recovery calculations checked by your instructor. After your calculations have been approved, the salt can be rinsed down the sink with water.

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 watch glass and place it on the bench top to cool. When the watch glass 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 (all digits) in your data table. 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. Follow your instructor's directions for turning in the Data, Calculations and Discussion Questions pages.

Name________________________**Partner**______________________ #______

Data Table	**Values (units)**	
Starting mass of salt (g)		
Starting mass of sand (g)		
Mass of 250 mL beaker (g)		
Mass of 250 mL beaker with salt residue (g)		
Mass of watchglass and filter paper (g)		
Mass of watchglass, filter paper and sand(g)		
Calculations (Show set-up below with *numbers and units*)		
Mass of your mixture, g: starting mass of salt + starting mass of sand		
Mass of salt recovered, g: mass of beaker **with salt residue** – mass of beaker		
Mass of sand recovered, g: mass of watchglass, filter paper, sand – mass of watchglass, filter paper		
Percent recovery of salt: $\frac{\text{mass of salt recovered}}{\text{starting mass of salt}} \times 100\%$		
Percent recovery of sand: $\frac{\text{mass of sand recovered}}{\text{starting mass of sand}} \times 100\%$		
Theoretical mass percent salt (and sand) in your mixture: $\frac{\text{starting mass of salt (or sand)}}{\text{mass of your mixture}} \times 100\%$	<u>Salt</u>	<u>Sand</u>
Experimental mass percent salt (or sand) $\frac{\text{mass of salt (or sand) recovered}}{\text{mass of your mixture}} \times 100\%$		
**Percent error for salt or sand *(Do the subtraction first and check SFs* $\frac{\text{(Experimental mass \% - Theoretical mass \%)}}{\text{Theoretical mass \% salt (or sand)}} \times 100\%$ example: $\frac{50.0-51.12}{51.12} \times 100 = \frac{-1.12}{51.12} \times 100$ Salt / Sand Result from subtraction: -1.12 / ______ Number of significant figures: 2 / ______		

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

1. Your percent recoveries for salt and sand should each be approximately 100%. If either (or both) of your salt or sand percent recoveries is greater than 105% or less than 95%, discuss any experimental errors or observations you made that could explain your results.

2. **Error Analysis**: A student's recoveries of salt and sand were: Salt: <u>120%</u> Sand: <u>80%</u>
   Describe **one** <u>experimental</u> error (<u>not</u> a weighing or data recording error) that could explain **both** the high salt recovery and low sand recovery.

3. How many significant figures should there be in the answer to this calculation?

   $$\frac{(56.62 - 55.92)}{55.92} \times 100\%$$

   What kind of value is being calculated by this expression?

4. Which procedure (the sand recovery procedure **or** the salt recovery procedure) do you think would consistently give the most accurate results based on your experience today? Explain your answer.