Separating a Mixture Lab

Purpose: The purpose of this lab is to: learn to use equipment in the chemistry lab, separate a mixture of three substances using physical separation techniques, and test the accuracy of your separation techniques.

Background: *Matter* is the material of the universe and can be defined as anything that has mass and takes up space. Most of the matter around us consists of mixtures of many substances. Soil, air, lemonade, and wood are all mixtures—the main characteristic of a mixture is that it has an unfixed, or variable, composition. For example, soil is a mixture of many substances with varying proportions, depending on the type of soil and where it is found.

Mixtures can be classified has either heterogeneous or homogeneous. A *heterogeneous mixture* is a mixture that is not uniform in composition. If one portion of the mixture were to be sampled, its composition would be different from the composition of another portion. Soil, containing bits of decayed material along with sand, silt, and clay, is a heterogeneous mixture. Other examples of heterogeneous mixtures are sand in water and oil-and-vinegar salad dressing.

A *homogeneous mixture*, also called a *solution*, is a mixture that has a completely uniform composition. The components of the mixture are evenly distributed throughout the sample. Air, salt water, and brass are examples of homogeneous mixtures, or solutions. Air is a gaseous solution consisting of a mixture of gases, salt water is a liquid solution, and brass is a solid solution of copper and zinc.

Mixtures, both homogeneous and heterogeneous, can be separated into pure substances by physical methods. A *pure substance* is one with a uniform and definite composition. Pure substances can be divided into two groups—elements and compounds. *Elements* are the simplest forms of matter, which cannot be decomposed into simpler substances by any chemical or physical means. Elements can combine with one another to form compounds. *Compounds* are substances composed of two or more elements chemically combined that can be separated into simpler substances only by chemical means. Characteristics that allow you to distinguish one type of matter from another are called *properties*. A *physical property* is a quality or condition of a substance that can be observed or measured without changing the identity of the substance. Physical properties can help to identify a substance. Some examples of physical properties of matter are color, solubility, mass, odor, magnetism, density, melting point, and hardness. A *chemical property* is the ability of a substance to undergo chemical reactions and to form new substances. Chemical properties can also help to identify a substance. Some examples of chemical properties of matter are the ability to rust, corrode, decompose, or react.

Mixtures are simply a heterogeneous or homogeneous physical blend of two or more substances. They can be separated based solely on physical properties, or by undergoing physical changes. A *physical change* alters a substance without changing its composition. For example, the melting of ice, the freezing of water, the evaporation of water, or the bending of a piece of metal are all physical changes which do not change the identity of the substance. Physical separation techniques—such as filtration, evaporation, or distillation—are ways to separate a mixture into its component parts. Undergoing the physical separation will not alter the properties of each component part before mixing and after separation. For example, imagine making a mixture of sugar in water. The sugar can be recovered by evaporation of the water; the water can be recovered by condensation. The sugar has the same properties before mixing and after separation. The same is true of the water.

Compounds, on the other hand, can be made or separated based on chemical properties, or by undergoing chemical changes. A *chemical change*, sometimes called a chemical reaction, is one in which a given substances becomes a new substance or substances with different properties and different composition. For example, the burning of leaves, the baking of bread, and the rusting of iron are all chemical changes in which the original substance has changed to a completely different substance with different properties and a different chemical composition. The original substance cannot be recovered easily (except perhaps by another chemical change). For example, imagine burning sugar, which is combining it with oxygen. The resulting product is very different from the starting material and the original sugar cannot be recovered.

Materials:

Iron filings, Fe	Sand, SiO_2	Sodium chloride, NaCl
Water, H_2O	Weighing paper	Notebook paper
Magnet in baggie	400-mL beaker	250-mL beaker
Filter paper	Funnel	Ring stand
Iron ring	Wire gauze	Bunsen burner
Matches	Goggles	Beaker tongs

Pre-Lab Questions:

List the three starting substances and determine whether each is an element, compound, or mixture.

Draw a model of each starting substance, using shapes to show individual atoms & molecules.

Substance	Picture

STOP

Procedure:

1. Weigh out *approximately* 1 grams of iron filings, 1 grams of sand, and 3 grams of salt by getting the mass of the empty dish and adding enough until the mass reading is #-point-something. Use a separate weighing dish for each.

Initial mass of iron: ______________
Initial mass of sand: _____________
Initial mass of salt: ______________

2. Carefully observe each of the three pure substances.

Physical properties of iron: ___________________________
Physical properties of sand: __________________________
Physical properties of salt: ___________________________

3. Test each substance with a magnet by running a magnet underneath each weighing dish. *Keep the magnet in your baggie.*

What happens to the iron when exposed to the magnet? __________
What happens to the sand when exposed to the magnet? __________
What happens to the salt when exposed to the magnet? ___________

4. Combine the three substances together in a **dry** 400-mL beaker.

How does the mixture look compared to the 3 separate materials? ___________

<u>Prediction</u>: **How will you begin to separate the iron, sand, and salt mixture into three separate piles of iron, sand, and salt?**

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STOP

5. Pour the prepared mixture onto one side of a full sheet of notebook paper. **Keeping the magnet in its bag**, pass the magnet over the mixture, moving the magnetic materials to the clean part of the paper. Completely separate the magnetic material using your fingers. Collect it in a weighing dish and re-mass it on the balance. Give this separated substance to your teacher for recycling purposes.

Physical properties of the separated material: ____________________

Final mass of the separated material: ___________________________

Identity of the separated material: _____________________________

What items are still mixed together? ____________________________

6. Pour the remaining mixture on the notebook paper back into the 400 mL beaker. Set this aside.

7. Take the mass of a piece of filter paper.

Mass of filter paper: ___________________________

8. Take the mass of an empty 250-mL beaker.

Mass of empty 250-mL beaker: ___________________________

9. Set up a filtering apparatus as shown below. Place the empty 250 mL beaker from step #8 underneath the funnel. Check your filtering apparatus with your teacher before proceeding to step 10.

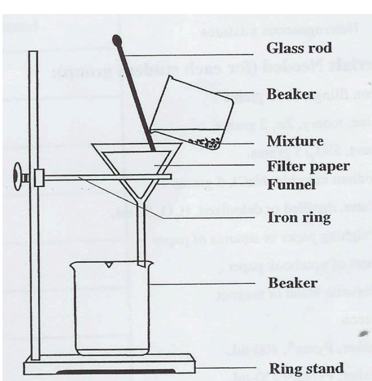
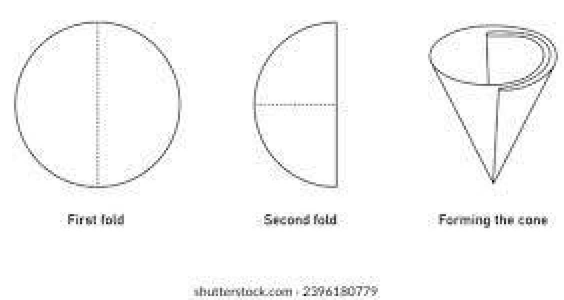


Figure 1: Filtering Apparatus



STOP

10. Add about 50 mL of water directly to the 400 mL beaker containing the mixture and swirl the beaker gently. Pour the contents of the 400-mL beaker into the funnel. Take care that no material is poured over the edges of the filter paper.

11. Rinse the 400 mL beaker and any solid it contains using the wash bottle. Use as little water as possible. Pour this rinse into the funnel. Repeat as necessary to ensure that all contents of the beaker are poured into the funnel.

12. When there are no drops coming from the bottom of the funnel, remove the filter paper from the funnel, unfold it, and place it on a piece of notebook paper. Label the notebook paper with your group's names. Place this paper in a secure part of the room (identified by your teacher) to allow the filter paper to dry. Also, place the 250 mL beaker (and its contents) on the paper, too. This will allow your filter paper to dry overnight and some of the water from your beaker to evaporate.

Day 2

13. Set up an apparatus for heating water in a beaker.
    a. Attach an iron ring to the ring stand. Place the wire gauze on the iron ring. Position the Bunsen burner under the wire gauze.
    b. Using beaker tongs, place the 250 mL beaker on the wire gauze.

14. Using the Bunsen burner, bring the mixture to a boil and allow most of the liquid to evaporate. Turn the flame down if splattering occurs. When only a small bit of liquid remains, turn off the heat and allow the remaining liquid to evaporate.

15. When the beaker is cool and dry, examine the contents, identify the material, and record observations in your data table. Take the mass of the beaker plus the separated material, and record the mass in your data table.

Physical properties of the substance in the beaker: ______________
Mass of beaker and substance: _______________________
Final mass of substance: _________________________________
Identity of substance in beaker: ________________________________

16. When the filter paper is dry, make observations of the contents, identify the material, and record observations in your data table, take the mass of the filter paper and its contents and record this mass in your data table.

Physical properties of the substance on the filter paper: _________

Mass of filter paper and substance: ______________________

Final mass of substance: _______________________________

Identity of substance on the filter paper: ______________________

Calculations/ Conclusions:

Show all work for calculations, and include units.

1. When you combined the three starting substances, they formed a mixture. Was your mixture homogeneous or heterogeneous? List at least one specific indication that you created a mixture as opposed to a new compound. ____
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2. Draw a model of the starting mixture at the particle level. Use the same shapes you did in Pre Lab question #2 and include a legend.

3. What was the first substance you separated from the mixture? _______

What method did you use to separate this substance from the mixture? ________________________

Why did this work? ____

4. What was the initial (*theoretical*) mass of your iron? ______________

What was the final mass of the iron you *actually* recovered? _________

HINT: Refer to Steps 1 & 5 in the procedure.

Calculate the percent yield of how much you recovered. Show your work in the space provided.

$$percentyield = \left(\frac{actualyield}{theoreticalyield}\right) \times 100\%$$

5. What substances were left in the mixture once you separated out the iron? _______________

6. Why did we add water to the remaining mixture? ____________________

7. What component of the mixture got trapped in the filter paper? _______________________

Where did the salt go? ____

8. What was the initial (*theoretical*) mass of your sand? ______________

What was the final mass of the sand you *actually* recovered? ________

HINT: Refer to Steps 1 & 16 in the procedure.

Calculate the percent yield of how much you recovered. Show your work in the space provided.

$$percentyield = \left(\frac{actualyield}{theoreticalyield} \right) \times 100\%$$

9. What was the initial (*theoretical*) mass of your salt? _____________

What was the final mass of the salt you *actually* recovered? _________

HINT: Refer to Steps 1 & 15 in the procedure.

Calculate the percent yield of how much you recovered. Show your work in the space provided.

$$percentyield = \left(\frac{actualyield}{theoreticalyield} \right) \times 100\%$$

10. The salt water that passed through the filter paper and landed in the beaker is called a filtrate. Was the filtrate an element, compound, homogeneous mixture, or heterogeneous mixture? _________________ Draw a model of the filtrate at the particle level. Use the same shapes you did in Pre Lab question #2 and include a legend.

11. What properties of the three starting substances did you use to separate out each material? Were these properties physical or chemical?

To separate out the …	We used …	Is it a physical or chemical property?
Iron		
Sand		
Salt		

12. What experimental error(s) may have caused the differences between actual yield and theoretical yield? List **specific** errors that may have occurred in your procedure. "Human error" is not an acceptable answer. Assume the balances are accurate.

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