Laboratory 3
Mixtures and Pure Substances

Matter can be classified into two groups: mixtures and pure substances. Mixtures are the most common form of matter and consist of mixtures of pure substances. They can be homogeneous mixtures (uniformly mixed) or heterogeneous mixtures (not uniformly mixed). Mixtures can be separated using physical processes that do not involve the changing of the nature of the pure substances that are in the mixture. Pure substances can either be compounds (combinations of more than one type of element) or elements. The elements in compounds can only be separated by chemical processes that change the nature of the pure substance. In turn, elements can combine to form compounds through a chemical process that changes their nature. Below is a chart summarizing this classification of matter.

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Matter
   /\  
 /   
Pure Substances             Mixtures
   /\  
 /   
Elements                 Compounds
                 Separated by chemical processes
   /\  
 /   
Homogeneous          Heterogeneous
                 Separated by physical processes
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In this unit we will explore the general properties of matter including separation methods and classification techniques. In doing so, we will use some new lab equipment.

**The Burner**: The laboratory burner comes in several models. Each model has basically two controls. One controls the amount of gas entering the burner and the other controls the amount of air. The more air allowed to enter the burner, the hotter the flame. The amount of gas entering the burner is controlled by using the
adjustment on the burner and the spigot on the lab bench. The bench spigot should be on full. Be sure that the spigot on the lab bench is completely closed when you are finished. Be careful in using the burner. The flame is often hard to see and placing body parts or flammable material near it is hazardous. Also, be careful where you place objects heated by the flame. Do not leave the burner unattended.

**Gravity Filtration:** The use of gravity to separate solids and liquids using a properly folded and moistened filter paper in a filter funnel. This is probably the most common type of laboratory separation technique.

**Buchner Funnel Filtering Setup:** The Buchner funnel, along with the correct size filter paper can be used with a filter flask to separate heterogeneous mixtures using a vacuum source. The vacuum source we will use is called an aspirator. It is connected to the water faucet and the movement of the water through the aspirator creates a vacuum in the filter flask. This vacuum accelerates the filtering process. Below is a diagram of the filtering setup.
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**The Centrifuge:** The centrifuge separates heterogeneous mixtures using centrifugal force. The centrifuge must be balanced by placing equal mass objects opposite each other. Generally a blank test tube filled to the same level as the sample test tube and placed in the opposite position as the sample test tube will prevent the spinning centrifuge from shaking or rotating off balance.

**Distillation Apparatus:** The distillation set up below will enable you to separate homogeneous and heterogeneous mixtures. You can use a boiling flask with a side arm or a boiling flask with an one-hole stopper and bent glass tubing. Let all hot objects cool for 3 minutes before placing them under tap water.

If you need to make a one-hole stopper with a piece of bent glass tubing do the following:

1. Cut about a 6-inch of glass tubing using by scratching the desired location of the cut with a file. Then, using both hands (one hand on each side of the scratch), snap the tubing by bending the tubing away from you sharply. Use the burner on maximum heat (full air) to polish the ends of the tubing. Hold the tubing with tongs and heat a large area (1-2 inches) where you desire the bend (in the middle) by moving the tubing back and forth in the flame. Cool the tubing by placing it out of the way where it will not be touched accidentally or burn the surface of the counter. After 3 full minutes, using the tongs, run the tubing under tap water to cool completely.
2. To insert the tubing into the stopper, lubricate with glycerin, or other suitable lubricant, around the hole of the stopper. Carefully slide the tubing through the hole. If it does not slide easily, DO NOT FORCE IT! Contact the instructor. Glass tubing breaks easily and can cause serious injury to your hand.
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Procedure

Part 1: Pure Substances-Element to Compound

1. Cut about 1/2 inch of magnesium ribbon and take it to your desk.
2. Light a burner and medium heat (medium air).
3. Hold the ribbon with your tongs in one hand and a clean, empty medium sized test tube in the other using a test tube holder or clamp.
4. Light the magnesium ribbon. When it begins to burn drop it into the test tube. Observe the white solid on the walls of the test tube.
5. Add a few drops of dilute hydrochloric acid (6 M HCl) to the test tube and observe the reaction with the white sediment.

Part 2: Pure Substances-Compound to Element

1. Dissolve about 0.5 g of a soluble copper salt (copper(II) chloride, copper(II) nitrate, etc) in 10 mL water in a large test tube.
2. Place a small piece of zinc metal in the solution. Observe the copper metal forming on the surface of the zinc. What do you observe?

Part 3: Mixtures-Homogeneous

1. Set up the 400 mL beaker with ice and water as shown in the discussion section.
2. Dissolve 3 g of sodium chloride (NaCl) in about 20 mL water.
3. Place the solution into the boiling flask of the distillation set up described above.
4. Heat the flask moderately until just boiling. Be careful not to overheat. Move the flame out from under the flask if bubbling is too vigorous. When the amount of liquid becomes less than 3-5 mL, turn heat down or remove the burner. Gently heat the remainder until all the liquid is gone from the flask.
and the NaCl crystals have formed. **Remove rubber hose from test tube before shutting off burner otherwise you may get a vacuum.**

4. How could you demonstrate that the sodium chloride was no longer present in the water?

**Part 4: Mixtures-Heterogeneous Separation**

1. Mix about 10 mL of the calcium chloride (CaCl₂) and 10 mL of the sodium carbonate (Na₂CO₃) into a small beaker and mix. Notice the precipitation (formation of a solid).
2. After stirring, place about 2 mL of the mixture into a small test tube.

**Centrifugation:**

3. Place the test tube in the centrifuge with a similar test tube filled to the same level with water directly opposite in the centrifuge.
4. Centrifuge for 3-5 minutes. Observe the separation of the precipitate from the solution.

**Vacuum Filtration:**

5. Using the Buchner Funnel filtering set up described above, place an appropriately sized filter paper inside the funnel. Turn on the water to draw the vacuum. Wet the filter paper with water to form a seal with the funnel.
6. Slowly pour the solution, using a stirring rod as shown in the figure, into the Buchner funnel. The solid retained by the filter paper is called the filtrate. Observe the separation of the solid from the liquid.
7. Which separation was accomplished more rapidly? Which was more efficient?
Part 5: Mixtures-Heterogeneous

1. Pour about 1 mL of a mixture of white and dark colored heterogeneous powder into your clean and dry 10 mL graduated cylinder.

2. Place a clean paper towel on your desktop and pour the mixture onto the paper towel.

3. Wrap a paper towel around a magnet and draw the magnet through the powder. Observe what happens.
1. Match the following with their proper classification by writing the letter of the correct match in the space provided.
   _____ Orange Juice  
   _____ Apple Juice  A. Element
   _____ Granite Rock  B. Compound
   _____ Milk  C. Homogeneous Mixture
   _____ Salt Water  D. Heterogeneous Mixture
   _____ Carbon Dioxide
   _____ Oxygen
   _____ Air
   _____ Water

2. Give three examples of chemical processes.

3. Give three examples of physical processes and indicate on what physical constant the separation is based. (e.g. distillation of a liquid mixture is based on the difference in boiling points of each component in the mixture).
Report for Lab 3

Part 1: Pure Substances-Element to Compound

1. What is the chemical process used in this experiment?

2. What is the white compound formed in this experiment?

3. What happens to the white compound when the acid is added? What does it form?

Part 2: Pure Substance-Compound to Element

1. What is the reactant that is changed in this experiment?

2. What is the product formed?

3. What is the chemical process used to form the element?
Part 3: Mixtures-Homogeneous

1. What is/are the pure substance(s) used to make the homogeneous mixture?

2. What are the pure substances formed at the end of the experiment?

3. What is the process used in this experiment and what kind of process is it?

Part 4: Mixtures-Heterogeneous

1. What are the two processes used in this experiment and what kind of processes are they? Explain.

2. Is the separation 100% complete after the two separations?

3. What further processes may be necessary to facilitate complete separation?

Part 5: Mixtures-Heterogeneous

1. What would be your guess as to the composition of the dark colored portion of the mixture?
Materials Required:

Chemicals:

1. Magnesium Ribbon (0.5 inch per group)
2. 6 Molar HCl (0.5 mL per group)
3. Copper (II) chloride or Copper (II) nitrate (1 gram per group)
4. Zinc Pieces (one piece per group)
5. Sodium chloride (3 grams per group)
6. 0.1 M Calcium chloride (10 mL per group)
7. 0.1 Molar sodium carbonate (10 mL per group)
8. Unknown mixture (Iron filings and sodium chloride) (1 cc per group)

Equipment:

1. Distillation apparatus (1 per group)
2. Buchner funnel filter setup (1 per group)
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