The Properties of Matter

Most substances that we encounter or use everyday are not pure substances, consisting of a single kind of matter, rather they are mixtures of substances. Examine the label on your favorite shampoo or breakfast cereal and you will find a list of ingredients. In order to obtain information about the fundamental nature of matter the chemist must work with pure substances since these contain a single set of properties. This requires a set of criteria by which a pure substance may be identified. The criteria are based upon characteristics or physical properties of the substances.

Classification of Matter: In this experiment you will classify several substances according to physical state. From the appearance of the substance, you will classify it as homogeneous or heterogeneous. In other words, if the sample appears uniform throughout (same color and texture of particles) then the sample can be classified as homogeneous. Liquids that you classify as homogeneous will be further tested to determine whether they are mixtures or pure substances. Mixtures can be separated by physical methods, such as boiling off the liquid.

Separation of a Mixture: Many techniques have been devised to separate mixtures such as filtration, distillation (separation based on boiling point), and chromatography. Chromatography takes advantage of the a substance's attraction to a surface. An eluting solvent pulls the various components of a mixture apart sequentially, with the component least attracted to the surface coming off first.

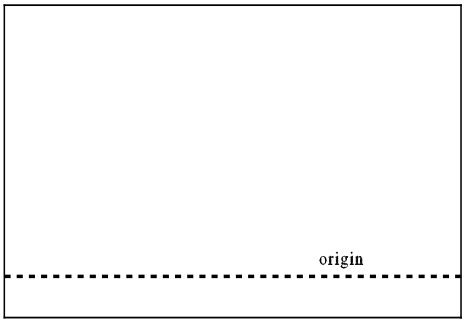
A quantitative determination can be used to identify the components of the mixture. In a solvent chromatography system using the same absorbant at a fixed temperature, each substance can be characterized by a constant retention factor:

$$R_f = \frac{\textit{distance from origin to center of spot}}{\textit{distance from origin to solvent front}}$$

<u>PROCEDURE:</u> PART I: SEPARATION OF A MIXTURE BY CHROMATOGRAPHY

1. Obtain a chromatography jar. In the HOOD, use a graduated cylinder to measure 25 mL of eluting solvent and pour it into a chromatography jar, screw on the lid and shake it up. This allows the atmosphere within the beaker to become saturated with solvent vapor and helps to give a better and faster chromatographic separation. Return to your lab bench

2. Obtain a piece of chromatography paper. Place the chromatography paper on top of another piece of paper. Draw a faint pencil line about 2 cm from the long edge of the paper. (You must use pencil; do not dig a groove into the paper.) This line will indicate the origin. Make six "x's" on the origin line, about 2 cm from the edge and about 2 cm apart. Label the 6 x's as follows:



Fe; Cu; Co; Mix (Fe,Cu,&Co); Unk#; Pen
(Remember to record unknown number!)

4. Use a capillary tube to transfer a drop of each solution to the appropriate x on the origin. The spot should be about 0.5 cm in diameter. Do not let spots overlap! If necessary, dry the spots with a hair dryer.

5. Form the paper into a cylinder without overlapping the edges. Staple the paper at the top and bottom. Carefully place the paper into the jar, taking care that the origin is at the bottom, that the origin line remains above the solvent and that the paper does not touch the sides of the beaker. Replace the plastic lid and wait as the solvent moves up the paper. Do not move the beaker!

***While you are waiting for the solvent to rise (about 75 minutes), complete part II.**

6. When the solvent has risen to within 2 cm of the top of the cylinder (or your instructor calls time), remove the cylinder from the beaker and quickly mark the solvent front with a pencil. Remove the staples. Do NOT lay the chromatography paper on the lab benches until step 8! In the hood, gently dry the chromatography paper with a blow dryer.

7. Working in the hood, spray the paper with the staining reagent provided to develop unique colors for each of the ions. Gently dry the paper again, in the fume hood.
   **Dispose of the eluting solvent in the waste container; rinse and dry the jar.*

8. Observe and record on the data sheet the colors of the spots produced by the three ions in each chromatogram. Measure and record (to the nearest 0.1 cm) the distance between the origin and the solvent front. (This is typically the distance the front edge of the spot made with the pen traveled.) Next measure and record (to the nearest 0.1 cm) the distance between the origin and the <u>center</u> of each spot. Calculate the R_f value for each metal ion. Use this information to deduce the composition of the unknown solution, which may contain one, two or all three ions.

<u>PROCEDURE PART II:</u> CLASSIFICATION OF MATTER

In test tubes obtain a small sample of each of the following substances: granite, copper, salt solution, alcohol and the three samples labeled "A", "B", "C". (For liquids, use a dropperful of the substance.) Examine each sample both with the naked eye and with a magnifying glass to determine whether the sample is homogeneous or heterogeneous. (Ignore differences in particle size). Record other physical properties such as physical state, color, odor (remember to waft liquid odors to smell!). Liquids will be further tested to determine whether they are mixtures or pure substances.

Place about 2 mL (40 drops) of the liquid to be tested on a watch glass. Place the watch glass on a hot plate and heat. Observe carefully until all the liquid evaporates. Watch for color of vapor! Use your observations to decide if the sample is a pure substance or a mixture. For example, if an obvious solid residue remains after the liquid is completely evaporated, this would indicate the sample was a mixture. Also, change in the color of the vapor indicates a mixture.

**<u>Clean-up:</u> Return the solids to their containers. Liquids may be washed down drain.*

The Properties of Matter

Name:_____
Lab Partner:

Average distance solvent front travels from the origin_____

Ion(s)	Color(s) after spraying	Distance of each spot from the Origin	Calculation setup for R_f of each spot	R_f
Fe^{3+}				
Cu^{2+}				
Co^{2+}				
Fe^{3+} Cu^{2+} Co^{2+}				
Unknown code _____ # of spots _____				

What metal ions were present in your unknown? _____

Postlab Questions:

1. Name two properties you used to determine the ions in your unknown.

2. Is pen a mixture or pure substance? From this lab, how do you know? Why should you use an ordinary black lead pencil when writing on the chromatography paper?

3. A student stopped the chromatography <u>after</u> the solvent reached the top of the paper. How would this affect their calculations of R_f?

Part II: Classification of matter

Substance	Color or Appearance	Odor	Homogeneous or Heterogeneous	Heating Results? (be descriptive!)	Mixture or Pure Substance? ***Why?***
Granite				XXXXXX	
Copper wire				XXXXXX	
salt H_2O					
Alcohol					
Unknown A				XXXXXXX	
Unknown B					
Unknown C					

Postlab Questions

3. Identify the following as a mixture or pure substance.

orange juice _____ cement _____ brass _____ lead _____