Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_

**Separating a Mixture by Physical Properties**

**An Inquiry Lab**

PURPOSE

* Students will identify physical properties of substances and determine how these properties can be used to separate the substances from a mixture.
* Students will design and carry out a procedure that separates a mixture into pure substances and recovers as much of each as possible.
* Students will calculate the percent recovery for each substance in the mixture

PRE LAB QUESTIONS

1. Differentiate between chemical and physical properties. Provide an example of each.
2. What is the difference between a compound and a mixture?

BACKGROUND INFORMATION

All forms of matter can be classified as pure substances or as mixtures of two or more sub­stances. Mixtures have variable composition and can be separated by taking advantage of the differences in physical properties of each substance.

Filtration is a method of separation based on particle size. In order to use this method, the substances that make up the mixture must have distinctly different size particles. The open­ings in the filter must be large enough to let one substance through and small enough to keep another substance from getting through.

Gravity separation uses differences in density to separate different substances. Particles of greater density will settle toward the bottom of the mixture.

Decanting is a type of gravity separation that can be used to separate a liquid/solid mixture by pouring the liquid off slowly while the more dense solid settles to the bottom of the container. Buoyancy refers to the be­havior of a substance or object in water; If the density of a substance or object is greater than the density of water, it will sink in water. If the density of a substance or object is less than the density of water, it will float. A substance that floats can be skimmed off the mixture.

Magnetism can be used to separate substances that are attracted by a magnet from sub­stances that are not attracted by a magnet.

Evaporation is another separation technique in which a soluble substance is dissolved in a liquid, and the liquid is allowed to evaporate. The other substance will remain in the solid state. This method takes advan­tage of the differences in solubility between components in a mixture. If one of the substances in a mixture is soluble in water and another is not, water can be added to the mixture to dis­solve the soluble substance and remove the insoluble substance by filtration.

TECHNIQUE TIPS FOR SUCCESSFUL SEPARATION AND RECOVERY

* + Magnetism - Put the wand in the mixture and stir with the wand.
  + Filtering - Fold the filter paper in half twice to ¼ the original size. Open the folded filter paper so that it forms a cone shape. Wet the filter paper within the funnel to help it stick.
  + Sifting - Make sure a mixture is completely dry before pouring it into the sieve.
  + Evaporating - To reduce the volume of the solution more quickly, gently heat it on a hotplate until little solution remains. Allow the remaining water to evaporate overnight. The solid can then be scraped from the container. Evaporation will occur more readily in a container with a large surface area.
  + If a substance is damp, spread it out on a paper towel until it is dry. After it is dry, re­turn it to the appropriate cup.

MATERIALS

* Funnel
* Erlenmeyer f1ask
* Filter paper
* Magnet
* Sieve
* Hot plate (or Bunsen burner with ring stand and wire gauze)
* Plastic spoon
* Shallow pan
* Balance
* Spray bottle containing distilled water
* (6) plastic cups
* Deli container (to use as extra catch tray, mixing container, etc.)
* Samples of the following substances: sand, salt, pebbles, pop beads, and steel nuts

PROCEDURE

1. Consider properties such as particle size, density (> or < 1.0 g/mL), magnetic attraction, and solubility. Some of the properties can be determined via visual inspection while others require testing. Identify these properties for each sample substance and write them in a data table entitled "Table of Properties".
2. Design a procedure that will separate a mixture of the five sample substances back into their original substances and recover as much of each as possible. Draw a diagram that illustrates your procedure. Indicate the separation method used and the substance or substances that will be recovered at each step.
3. Write your initials and period on a piece of filter paper and find the mass. Record this information in your data section.
4. Find the mass of your empty evaporation container and record in the data section.
5. Write the name of each substance in your mixture on a different plastic cup. Find the mass of each empty cup and record it in a second data table entitled “Masses of Mixed and Recovered Substances”. The remaining data for this lab will be entered into this second data table.
6. Add one spoonful of each substance to the appropriately labeled cup. Find the mass of each cup and its contents and record it in the second data table.
7. Calculate the mass of each substance alone and record it in the data table.
8. Pour all five of the substances into a single clean empty cup and stir the mixture.
9. Re-read the Background Information and Technique Tips for Separating.
10. Carry out the separation procedure you designed. As each substance is recovered, put it back into the appropriately labeled cup.
11. For each substance, find the mass of the cup and the recovered contents, and record it in the “...Recovered Substances” Data Table.
12. Determine the mass of each recovered substances alone. Record this calculated mass in the data table as well.

**HINT: Do not use too much water for the step that involves dissolving a substance (50 mL or less should be sufficient). Otherwise, the evaporation step will take a VERY long time.**

DATA TABLE

**Table of Properties**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Particle Size** | **Density < or > 1g/mL** | **Magnetic Attraction** | **Solubility in water** |
| Salt |  |  |  |  |
| Sand |  |  |  |  |
| Steel nuts |  |  |  |  |
| Pop beads |  |  |  |  |
| Pebbles |  |  |  |  |

**Recovered Substances**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Substance** | **Mass of empty cup** | **Mass of cup + substance** | **Mass of substance only** | **Mass of container + recovered substance** | **Calculate mass of recovered substance** | **% of substance recovered** |
| Salt |  |  |  |  |  |  |
| Sand |  |  |  |  |  |  |
| Steel nuts |  |  |  |  |  |  |
| Pop beads |  |  |  |  |  |  |
| Pebbles |  |  |  |  |  |  |

Mass of evaporation dish: \_\_\_\_\_\_\_\_\_\_\_ Mass of filter paper: \_\_\_\_\_\_\_\_\_\_\_\_

DATA PROCESSING

Determine the percent recovery of each substance. Show all work and clearly label each calculation.

Mass of recovered substance

Initial mass of substance

% of substance recovered = ( ) x 100

CONCLUSION/ANALYSIS:

Paragraph 1: For each separation step, identify the specific property or properties and technique(s) that you used for the final separation of that component.

Paragraph 2: For each substance, propose a way to improve the results.