Mrs. Nielsen AP Chemistry

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. A spherical, helium-filled balloon has a diameter of 21.3 cm. The density of helium is 0.1786 g/L. How many moles of helium are contained within the balloon?

3. Earth's atmosphere is 78% N_2 and 21% O_2 and 1% water vapor, Ar, and other gases. Use an Internet search or other reference to find information to help you estimate the density of Earth's atmosphere. Indicate the temperature for your prediction.

4. Which is more buoyant, Helium gas or the gases that make up Earth's atmosphere? Which is a pure substance? A mixture?

5. A cylindrical water tower is 6.16 m high and 0.75 m in diameter and is completely filled with water. If the water has a mass of 2.9 $x10^3$ kg, find the density of the water in the tower.

6. What are the two types of vaporization?

7. Explain why liquid water evaporates. Include a drawing in *particle view* to accompany your explanation.

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.
- 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 flask
- Filter paper
- Magnet
- Sieve
- Hot plate (or Bunsen burner with ring stand and wire gauze)
- Plastic spoon
- Shallow pan
- Balance
- Wash bottle containing distilled water
- (5) 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 table entitled "Table of Properties" in the OBSERVATIONS section of your lab notebook.
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 the DATA section of your lab notebook.
4. Find the mass of your empty evaporation container and record in the DATA section of your lab notebook.
5. Write the name of each substance in your mixture on a different plastic cup. Find the mass of each empty cup (or zero the balance) and add one spoonful of each substance to the appropriately labeled cup. Record the mass of each substance *before mixing* in a table entitled "Masses of Mixed and Recovered Substances" in the DATA section of your lab notebook. The remaining data for this lab will be entered into this data table.
6. Pour all five of the substances into a single clean empty container and stir the mixture.
7. Re-read the Background Information and Technique Tips for Separating.
8. Carry out the separation procedure you designed. As each substance is recovered, put it back into the appropriately labeled cup.
9. Find the mass of each *recovered substance*, "...Recovered Substances" data table.
10. Clean up your lab station and return materials to the appropriate location as you found them.

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 PROCESSING

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

CONCLUSION AND EVALUATION:

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. If you got 100% recovery, indicate that you had a perfect recovery for that substance.