Iron Fortified Cereal Lab

Introduction

All matter is composed of atoms, as we know well. Matter can be one of three things: an element, a compound or a mixture. An element is a pure substance that consists of only one kind of atom. Elements exist in their standard states as solids, liquids and gasses. A compound is also a pure substance but one that consists of more than one kind of atom. These atoms are chemically bonded to one another and the physical and chemical properties of a compound depend on the kind of atoms and the way they are bonded together. Mixtures are combinations of pure substances. If they are homogenous, all the components of the mixture are distributed evenly just like sugar dissolved in water. If a mixture is heterogeneous then its components are distributed unevenly like the raisins and flakes in raisin bran cereal.

Mixtures are further characterized by the fact that they can be separated into their components without undergoing a chemical reaction. Compounds, such as water (H_2O), cannot be separated into their components without causing a chemical change. To make hydrogen (H_2) and oxygen (O_2) from water you have to supply energy to break the chemical bonds. Mixtures can be separated by physical processes such as filtering or distilling. Salt and sand can be separated by putting the mixture in water. First you filter out the sand after you have dissolved the salt. Then you boil the water until all you have left is the salt (this is distillation). In this lab we will use another method of separation to extract one component of a mixture.

The methods used for separating mixtures depend on the physical properties of the substance involved. In this case, the physical property we will exploit is the fact that iron is attracted by magnetic fields. Other physical properties include melting point, boiling point, vapor pressure, heat capacity, volume, temperature, mass and density. Physical properties can be contrasted with chemical properties which you can only discover by combining different substance and finding out what happens. For instance, a chemical property of salt is that when it is dissolved in water it increases the rate of rusting in iron. For that matter, the fact that iron rusts is a chemical property: rust is a compound of iron and oxygen created by a chemical reaction. We will talk more about chemical properties in later classes.

In this experiment you will separate the iron from a serving of cereal two different ways. In the first method, you will crush the cereal and place it in a beaker partially filled with water. You will then use a magnetic stirrer to collect the iron from the cereal. This will be set aside to dry while you follow the procedure for the second method. The second separation also involves crushing the serving of cereal but this will be a dry separation. You will place the crushed cereal on a piece of paper and carefully use the magnet to remove the iron. The magnet will be held underneath the paper and dragged so that it passes through all of the cereal several times. Make sure to agitate the crushed cereal so you don't miss any iron! Finally, you will measure how much iron you recovered. It will be interesting to see whether it is the same as stated on the box's nutrition information. A regular classroom balance with a precision of 1/100 g will be used as well as a more precise balance so that levels of precision can be compared. If there is time, we will do a 'large' batch of cereal consisting of 3 or more servings to see if that improves the accuracy of the experiment.

Name:
Date:

Mixture Separation Experiment

Always use ink when recording experimental data. Also, do not scratch out mistakes completely: simply cross them out with a neat line and write the correction. Record data as soon as you obtain it, don't depend on your memory! Always record measurements with the correct number of significant figures and *always* write down the units!

Pre-lab Questions Answer using complete sentences unless the question is *purely* mathematical.

1) Is the iron in our food any different from the iron that is used to make pots and pans, cars and trains, or steel? Why or why not?

2) What is the difference between our measurements and those of 'real scientists' in terms of accuracy? Is there a difference in the level of precision? If so, what?

3) What is the difference between a physical property and a chemical property?

4) Define these words: element, compound, homogeneous mixture, heterogeneous mixture.

5) Convert the following masses into the SI unit for mass (kg):

0.003 g 3×10^3 g 4.01 g 5.67×10^{-4} g

Materials

- 2 servings cereal
- 600 mL beaker
- magnetic stir bar
- 2 watch glasses
- a piece of paper
- mortar & pestle
- some tap water
- magnetic stirrer
- a magnet

Iron Separation: Method 1

Read the introduction carefully before proceeding! For fun, you could float a few flakes on some water and try to move them around using your magnet. Write it down if you manage to do it.

Procedure:

1) Obtain as close to exactly one serving cereal as possible (by mass). Write down its mass.

2) Crush the cereal to a fine powder in the mortar and pestle, you may have to do it a little at a time. Collect the crushed cereal in your 600 mL beaker

3) Cover the crushed cereal in your beaker with tap water. Don't add more than just enough to cover! Put the beaker on the stirrer mechanism with the stir bar in the bottom.

4) Set the stirrer running. Your iron will collect on the stir bar without any further intervention. Let it go for a few minutes and contemplate how your life has brought you to this point.

5) Once you have let the stirrer do its work for at least five minutes (time it if you have to) stop the mechanism and retrieve the stir bar with your magnet. Be careful not to brush any iron off of the stir bar or to rinse it off to vigorously. You don't want to lose any iron!

6) Find the mass of a watch glass using both the classroom balance and the more precise balance. You'll need this later when you try to find how much iron you have.

7) Wipe the iron off the stir bar onto the watch glass that you found the mass of in the previous step. Weigh this once the iron is completely dry using both the classroom balance and the more precise balance. It is important to find the mass of the iron alone, that is without some unknown amount of water or bits of cereal. You should do method 2 before finding this mass. If necessary, the watch glass can be heated to encourage drying.

Iron Separation: Method 2

Procedure

1) Obtain as close to exactly one serving cereal as possible (by mass). Write down its mass.

2) Crush the cereal to a fine powder in the mortar and pestle, you may have to do it a little at a time. Put the crushed cereal on a piece of paper, leaving one side free of cereal as a collection site for the iron you're going to pull out of the mixture.

3) Run the magnet under the crushed cereal several times, shaking the cereal around so you don't miss any particles. You should spend several minutes doing this (time it if you have to).

4) Collect your iron on the empty part of your paper. Simply remove the magnet from beneath it to leave an easy-to-weigh pile of iron.

5) Find the mass of a second watch glass using both the classroom balance and the more precise balance. Put your iron on the watch glass and find its mass, again using both scales.

Name:
Date:

Data and Results

Write your data using scientific notation!

Iron Fortified Cereal Identity: _____ Iron per Serving: _____ (g)

Method 1: Water Separation

Mass of cereal (g): _____
Mass of watch glass (g): _____ (classroom balance)
Mass of glass and iron (g): _____ (classroom balance)
Mass of iron (g): _____ (classroom balance)
Mass of watch glass (g): _____ (more precise balance)
Mass of glass and iron (g): _____ (more precise balance)
Mass of iron (g): _____ (more precise balance)

Method 2: Paper/Magnet Separation

Mass of cereal (g): _____
Mass of watch glass (g): _____ (classroom balance)
Mass of glass and iron (g): _____ (classroom balance)
Mass of iron (g): _____ (classroom balance)
Mass of watch glass (g): _____ (more precise balance)
Mass of glass and iron (g): _____ (more precise balance)
Mass of iron (g): _____ (more precise balance)

Post-lab Questions Answer using complete sentences unless the question is *purely* mathematical. Use a separate piece of paper to answer these questions. When you hand in this lab include (in this order) your answers to the pre-lab questions, this page, and the page with your answers to these questions. Typing your answers won't get you extra credit but it will earn my gratitude!

1) What is the amount of iron that the label states is in every serving of cereal?

2) What is the average amount of iron you recovered (add the result for the more precise balance measurement for both methods and divide by two)?

3) Compare the two values from the previous questions by subtracting the smaller one from the bigger one. Is there a difference? If so what is it?

4) What was the difference between the values found using the two methods? If your water method sample had a larger mass, speculate about why you might have found that result.

5) Why do you think I had you measure the mass using two different scales with different levels of precision? Does one of the scales give a more *accurate* result than the other? Why or why not?

6) Was any of your individual results close to the amount or iron that the nutrition facts label shows should be present in each serving? How close was it? Speculate about why your answer is different from that given on the package.

7) The amount of iron in the package is given with a certain number of significant figures. Compare your result and this amount once they are expressed with the same number of significant figures. In general, what is the purpose of using significant figures?

8) Was there any uncertainty in the measurements that were used to determine what to put on the nutrition facts label? Why or why not?

9) Which method of separation worked better do you think? What was it that made it work better? Refer specifically to your experience in the lab!

10) What is the difference between data and results?