Measuring Mass: A Means of Counting

Goals

- Properly use a top loading balance to determine the mass of a sample .
- Use molar masses to connect the measured mass of a sample to the number of particles in that sample.
- Use safe and good lab practice to characterize matter.
- Apply principles to samples of both pure substances and mixtures.
- Apply dimensional analysis techniques to count small particles such as atoms and molecules.

Introduction

Our world contains groupings of objects everywhere, a dozen eggs, a pair of socks, a gross of pencils. These collections are convenient "packets" of individual pieces. The individual pieces of pure substances can be described by chemical formulas, e.g., H_2O is the chemical formula for water. This formula indicates that each molecule of water consists of two atoms of hydrogen combined with one atom of oxygen. The mass of this molecule is the sum of the masses of the atoms combined to form this compound. We cannot directly measure the mass of one molecule of water but we can recognize its relative mass and use a convenient "packet" of molecules to describe real world quantities. The **mole** is the chemist's standard collection of particles and is defined **as the amount of substance in a sample that contains as many units as there are atoms in exactly 12 grams of carbon-12**. That number of carbon-12 atoms is **6.022×10^{23}** and is known as **Avogadro's number**.

1 mole carbon atoms = 12.0 g C = 6.02×10^{23} atoms C

1 mole H_2O = 2(1.01 g H) + 1(16.00 g O) = 18.02 g H_2O = 6.022×10^{23} molecules of water

Using these relationships, any mass of water can be converted into a number of molecules:

$$100.00 \text{ g } H_2O \left(\frac{1 \text{ mol } H_2O}{18.02 \text{ g } H_2O}\right)\left(\frac{6.022 \times 10^{23}}{1 \text{ mol}}\right) = 3.34 \times 10^{24} \text{ molecules } H_2O$$

In this lab you will measure amounts of substances. You will then calculate the number of particles contained in the sample, numbers that cannot be counted-- only calculated.

Safety

Act in accordance with the laboratory safety rules of Cabrillo College.
Wear safety glasses at all times.
Avoid contact* with all chemical reagents and dispose of reactions using appropriate waste container.

Materials:

Reagent Central solutions include:

sucrose ($C_{12}H_{22}O_{11}$), sodium chloride (NaCl), chalk (calcium carbonate)

✔**Check out** a sample containing:
Glass slides (assumed to be pure silicon dioxide), polystyrene peanuts, sulfur, fluorite, hematite (or other minerals as provided by stockroom)

Equipment: Balance Plastic spoons

Experimental Procedure

1. Using a weighing paper or boat and balance, "weigh" one level teaspoon of sodium chloride and record its mass in your laboratory notebook. Using the same balance as before measure the mass of one teaspoon of water and one of sucrose. Record your measurements.
2. "Weigh" a glass slide, and record its mass in your laboratory notebook. Repeat for the piece of chalk and a polystyrene peanut.
3. "Weigh" a piece of sulfur, and record its mass in your laboratory notebook. Repeat for a piece of fluorite and a piece of hematite.
4. A nickel coin is a mixture of metals called an alloy. It consists of 75% copper and 25% nickel. Design and carry out an experiment to find out how many nickel atoms there are in one 5-cent piece. Record your experiment procedure in your laboratory notebook. Show all your calculations and give your final answer with the correct number of significant figures and in scientific notation.

Data Analysis

For each of the masses recorded perform the following calculations. Report your answers with the proper number of significant figures.
Use the formula to determine the molar mass in units of g/mol.
Use the molar mass to determine the number of moles in the sample.
Use the number of moles of the substance and molar ratios to calculate the moles of each element within the sample.
Use the moles of each element along with Avogadro's number to calculate the number of atoms of each element within the sample.