1. To develop a new system for counting small particles.
2. To determine the relative mass of different small particles by comparison with an arbitrarily chosen mass.
3. To better understand the mole system and the atomic masses listed on the Periodic Table.

## Introduction:

Counting a large number of anything (eggs, sheets of paper, or beans) is a timeconsuming, tedious task. One way to minimize the difficulty of such a job is to use units larger than "one" in the counting process. It's quicker and easier to count 15 dozen eggs than 180 individual eggs. Two reams of paper is the same to an office supply store manager as 1000 sheets, without counting single sheets in the process.

In chemistry, we have a similar system for counting small particles (atoms or molecules) that is somewhat different from a dozen or a ream, but which has similar advantages. In order to help you understand this chemistry system, this experiment will be done using different kinds of beans.

In this experiment, we will count beans in groups called bags; you will determine the number of beans in a bag by relating to an arbitrary standard of mass. As you will see, this procedure will allow you to avoid the burden of actually counting large numbers of beans. The second part of the experiment will show us how a bag of beans is related to a mole of particles (atoms or molecules.)

## Procedure

1. Record a simple description (color, shape, relative size) of each type of bean in the data table.
2. Weigh and record the mass of an empty paper cup. Count out exactly 100 beans of one type, discarding any beans that differ greatly from the "average bean." Weigh and record the mass of the cup of beans.
3. Repeat Step 1 for each type of bean.
4. Calculate the average mass of one bean of each type and record it in the data table.
5. Determine the relative mass of each type of bean by comparison to the lightest type of bean. Record these values in the data table.

$$
\text { Relative mass }=\frac{\text { Average mass of beans }}{\text { Average mass of lightest bean - type }}
$$

6. Weigh out the relative mass (in grams) of one kind of bean; count and record the number of beans you just weighed.
7. Repeat Step 5 for each type of bean.

Data Table \#1: Mass of Different Beans

| Type of bean |  |  |  |  |
| :---: | :--- | :--- | :--- | :--- |
| Description of <br> bean |  |  |  |  |
| Mass of beans <br> \& cup (g) |  |  |  |  |
| Mass of cup <br> (g) |  |  |  |  |

## Show one set data calculations.

Calculation Data Table \#2

| Mass of beans <br> (g) |  |  |  |  |
| :---: | :--- | :--- | :--- | :--- |
| Average mass <br> (g/bean) |  |  |  |  |
| Relative <br> mass (see <br> formula in \#5) |  |  |  |  |
| \# of beans in a <br> relative mass if <br> rel. mass was in <br> grams |  |  |  |  |

## Analysis:

1. If a bag is defined as the number of beans in 1.00 g of the lightest bean, how many beans are in a bag?
2. What statement can you make about the number of beans in a relative mass of each type of bean?
3. What statement can you make about the mass of a bag of beans whose relative mass is: 3.5 ? 2.6? 17?
4. Calculate the number of bags that can be made from 1000 beans.
5. If you wanted 1000 of the heaviest bean used in this experiment, how could you measure out that approximate number without counting individual beans?
6. Relate each type of bean to an element on the Periodic Table. Explain how you chose.
7. What is the relative mass of O compared to H ? Show work.
8. How many moles can you make from 480 g of C ?
9. How many atoms are in 4.0 g of $\mathrm{H}_{2}$ ?

## Connecting to Chemistry --use these ideas in your lusion!)

