Understanding the Mole

Bean Lab (Relative Mass)

Introduction:

The relative mass of an object is how many times more massive the object is than a standard object. The atomic masses of atoms are all relative masses. They can be considered relative to any particular element. Historically, both oxygen and carbon have served as the reference standard. For our purposes we can also consider atomic masses relative to the least massive element--hydrogen, with an atomic mass of approx. one. Fluorine, with a relative mass of 19, is 19 times more massive than hydrogen, etc. In this laboratory exercise you deal with the relative masses of beans. Then you will be asked to draw a parallel to the atomic masses of elements.

Target:

Students are able to determine the relative mass of different small particles by comparison with an arbitrarily chosen mass. This will develop an understanding of the mole concept and molar masses of elements through an analogy with a model system.

Procedure:

Part I. Be sure to use the same balance for the entire activity.

1. In a beaker, count out exactly 100 beans of one type. Discard any beans that differ greatly from an average bean. If you fail to do this, your results will not be accurate.
2. Put a beaker on the balance. Find the mass of the beaker. This you will need to subtract later. Add the 100 beans to the beaker; record their mass to the **nearest 0.01 g**.
3. Each team member is responsible for one type of bean provided.

Data:

	Lima	Pinto	Black	Lentil
Mass of 100 beans (g)				
Average Mass of one bean (g)				
Relative mass of beans				
Calculated number of beans in one relative mass. Round to the nearest whole number				
Measured number of beans in one relative mass				

Calculations:

1. Calculate (**do not weigh**) the mass of one bean of each type. Record the value in the data table. [Note: "Calculate" means to take the total mass of 100 beans and divide by 100 rather than weighing one particular bean.]
2. Determine the relative mass of each type of bean by comparison to the lightest type of bean. Record these values in the data table.

   $$\text{Relative Mass} = \frac{\text{Avg. Mass of Bean}}{\text{Avg. Mass of Lightest Bean}}$$

3. Calculate the number of beans in one relative mass of each bean. Do this by dividing the relative mass by the average mass of one bean. **Number of beans is = (one Relative mass/Average mass of one bean)**
4. Check your calculated results by following these steps: Weigh out the relative mass of each kind of bean (in grams) and count the number of beans weighed.
   a. Place the plastic cup on the balance pan and add beans of your type until the balance contains **one relative mass** of your type bean. (don't forget to subtract the weight of the cup)
   b. Count the beans. Record this as the measured number of beans in one relative mass.
   c. Pour the beans into a pile. Retain your separate piles of relative masses of beans. You will answer questions about them later. (Each team member is responsible for his or her type bean.)

Part II.

Below is a chart reporting the average masses of individual atoms. Calculate the relative mass of each element and record it in the chart. Then look up the molar mass (atomic mass) of each element on a periodic table and record it in the table.

Atom	Mass of one atom (g)	Mass relative to hydrogen	Atomic Mass	Number of atoms in a relative mass in grams
Hydrogen	1.66×10^{-24}			
Carbon	2.00×10^{-23}			
Iron	9.30×10^{-23}			
Aluminum	4.49×10^{-23}			
Zinc	1.08×10^{-22}			
Lead	3.44×10^{-22}			
Copper	1.05×10^{-22}			

1. How do the atomic masses found on the periodic table compare to the relative masses you calculated?
1. What did you find out about the number of atoms of each element in one relative mass?
2. One **mole** of atoms contains how many atoms?
3. How many **atoms** are in one mole of uranium atoms?
4. How many **grams** are in one mole of uranium atoms?