Name _____ Period _____

Chemistry of the Earth Lab 5 – The "Beanium" Isotope 50 Points

Lab Introduction

Elements normally have 1 – 4 isotopes, or subatomic particle configurations with different numbers of neutrons and their corresponding mass numbers. Since atoms are really small, counting elements of a specific isotope require a "mass spectrometer," a piece of laboratory equipment that separates atoms by mass, then shows the ratio of the isotopes on a display. To simulate the mass spectrometer we will be separating the atoms mechanically (*by hand*), then counting and weighing the groups of atoms.

In this lab we will be measuring the mass of an individual "beanium" isotopes by measuring the mass of the entire sample of a specific "isotope" (*color*), then counting the beans in the sample. The mass of a single atom can be found using the equation below:

$$\text{mass/bean} = \text{mass}_{\text{all beans}} / \text{number}_{\text{all beans}}$$

The mass/bean ratio is known as the atomic mass, or the mass of a single atom. To find the isotopic and percent abundances for the isotopes of "beanium" we find the total number of beans for all isotopes, then compare that to the number of beans of each bean type:

$$\text{Total Beans} = \text{Beans}_A + \text{Beans}_B + \text{Beans}_C$$

$$(\textit{Isotopic}) \text{ Abundance} = \text{Beans}_A / \text{Total Beans}$$

The other abundances for beans B and C can be found by repeating the measurements above. The average atomic mass of all isotopes of the beans is the average mass of the beans based on their percent abundances. For real elements this number of found at the bottom of the element square (*in the units of amu or grams*). The equation to find the atomic mass of "beanium" is given below:

$$\text{Avg Atomic Mass} = (\text{Mass}_A \cdot \text{Abundance}_A) + (\text{Mass}_B \cdot \text{Abundance}_B) + (\text{Mass}_C \cdot \text{Abundance}_C)$$

The average atomic mass can then be compared with other samples of the "beanium" isotope to find the average atomic mass of the entire class sample.

Lab Objectives

By the end of this lab, students will

- Simulate the roll of a mass spectrometer in finding information about isotopes of an atom;
- Find the percent abundance and average atomic mass of beanium;
- Compare percent abundance and average atomic mass for each groups samples to the overall values for the same measurement;

Safety Precautions

1. This lab uses non-chemical substances and does not require the use of goggles, but caution should be used anyway to avoid getting the isotopes in your eyes;
2. The isotopes are small and round, leading to a tripping hazard if the isotopes fall on the group. Use caution to keep the round isotopes on the table and keep them off the floor.

Procedure

1. Obtain the mass of a single weighing boat, and record it in the space provided. You will need to subtract this mass from all other measurements in this lab;
2. Separate the beans from the sample into three weighing boats, counting the beans as they go into the boats. Record the number of beans on the data table;
3. Weigh each boat and record the data on the data table.

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Lab Data and Post-Lab Questions

Lab Data Table

	Isotope A Brown	Isotope B Black	Isotope C White
Bean Count (*Each Isotope*)	36	65	85
Mass of All Beans (*Each Isotope*)	10.7g	13.2g	12.6g
Total Bean Count (*All Beans from Isotopes A, B, & C*)	36 + 65 + 85 = = 186		

Lab Calculations

	Isotope A	Isotope B	Isotope C
Fractional Abundance (*Bean Count / Total Bean Count*)	$\frac{36}{186} = 0.194$	$\frac{65}{186} = 0.349$	$\frac{85}{186} = 0.457$
% Abundance (*Frac Abun x 100%*)	x100% = 19.4%	x100% = 34.9%	x100% = 45.7%
Mass of 1 Bean (*Total Mass / Count*)	$\frac{10.7}{36} = 0.30$	$\frac{13.2}{65} = 0.20$	$\frac{12.6}{85} = 0.15$
Partial Mass (*Frac Abun x Mass 1 Bean*)	= 0.30 x 0.194 = = 0.058	= 0.20 x 0.349 = = 0.070	= 0.15 x 0.457 = = 0.069
Average Atomic Mass	= 0.058 + 0.070 + 0.069 = 0.197g ← Avg for 1 bean		

Post Lab Questions

Define Fractional Abundance	Define Average Atomic Mass
Which isotope is the least stabile? (*Based on number of atoms of that isotope*)	Which isotope contributes the most of the average atomic mass of the atom?