**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date:\_\_\_\_\_\_\_\_\_\_\_\_\_ Period:\_\_\_\_

**Isotopes and Atomic Mass: Vegium**

**Background Information:**
The name atom comes from the Greek word "ἄτομος"—*átomos*, which means uncuttable or indivisible, something that cannot be divided further. The concept of an atom as an indivisible component of matter was first proposed by early Indian and Greek philosophers. In the 17th and 18th centuries, chemists provided a physical basis for this idea by showing that certain substances could not be further broken down by chemical methods. During the late 19th and early 20th centuries, physicists discovered subatomic components and structure inside the atom, thereby demonstrating that the 'atom' was divisible. An atom is classified according to the number of protons in its nucleus: the number of protons determines the chemical element, and the number of neutrons determines the isotope of the element.

Isotopes are atoms of the same element having different **mass numbers** due to different numbers of neutrons in their nuclei. The average atomic mass of an element, found on a periodic table, is the ***weighted average of the masses of all the isotopes*** of that element. The weighted average takes into account both the mass and the relative abundance of each isotope as it occurs in nature. In the laboratory, the relative abundances and masses of isotopes can be measured by an instrument called a **mass spectrometer**, which separates particles, by mass. The mass and relative abundance of each particle is recorded. From these data, a weighted average can be calculated to determine the **average atomic mass** of the element.

In this lab, a sample of the fictitious element vegium will be used as a scientific model to investigate average atomic mass. The three different isotopes of vegium are beanium, peaium, and soupium. As in real elements, these isotopes are collections of atoms having different masses. You will obtain a sample of vegium and determine the percent abundance and mass of each isotope. Unlike real isotopes, the individual atoms of the same isotope of vegium differ slightly in mass, so you will determine the average mass of each type of isotope. Then you can calculate the weighted average mass, or “average atomic mass” of vegium. In this model, each piece represents an atom.

**Problem Statement:** The purpose of this experiment is to determine the average atomic mass of the fictitious element vegium based on the abundance and mass of the different vegium isotopes. The type of particle used to represent the isotopes will be constant.

**Pre-lab Questions:**

1. What is an isotope?

1. What is the difference between the mass number and the average atomic mass of an element?
2. How is the mass number calculated? Show an equation.
3. How is the average atomic mass calculated? Show an equation.
4. Name the scientific instrument that is used to separate the isotopes of a particular element and explain how it does this.
5. Silicon has 3 isotopes. Use the table below to calculate the average atomic mass of silicon. Show all work.
Mass and Percent abundance of 3 Si isotopes

|  |  |  |
| --- | --- | --- |
| **Isotope** | **Mass (amu)** | **Percent abundance (%)** |
| Si-28 | 27.962 | 99.759 |
| Si-29 | 28.985 | 0.037 |
| Si-30 | 29.684 | 0.204 |

1. Describe how the average atomic mass of silicon compares to the masses of the 3 silicon isotopes. Which mass is it most similar to and which mass is it most different from? Explain why.

**Hypothesis:** Write a hypothesis using a science text or a reliable website to make and explain a prediction. Follow your EDR.

**Materials:**

 Sample of vegium, weighing paper and balance

**Procedure:**

1. Divide your sample into beanium (big with spots), peaium (white with dark dot), and soupium (all black).
2. Mass all the beanium in a group, then mass the peaium, and then mass all of the soupium. Record in the data table.
3. Count the total number of beanium, peaium and soupium. Record these values in the data table. Add up the total number of atoms.
4. Return your vegium to the cup.

**Data:** Mass and Number of 3 Vegium Isotopes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Beanium | Peaium | Soupium |  |
|  Total mass of each group (g) +/- 0.005g |  |  |  |  |
|  Number of “isotopes” in each group |  |  |  | Total number of atoms: |

**Calculations:** Follow each step on your EDR including labels, formulas, and your work in each calculation. *The first calculation is set up for you.*

1. Using your data, find the average mass of one beanium atom. Repeat this for a peaium and a soupium atom.
2. Determine the percent of each “isotope” of vegium. This is called “percent abundance.”
3. Using the percent abundance and the average mass, calculate the weighted mass of each “isotope”.

weighted mass = (isotope mass) X (percent abundance as decimal)

1. Calculate the average atomic mass of your vegium sample (this is the “weighted average” of the entire sample).

average atomic mass = sum of weighted masses

1. Average Mass of Isotope (label)

Ave mass isotope = total mass isotope / number of isotopes (formula)

**Beanium: Peaium Soupium:**

**Graph:**

Use Excel or Google Charts to make a graph showing the average mass of each isotope (calculation # 1) AND the average atomic mass of vegium (calculation #4). Attach the graph to this lab.

**Analysis / Conclusion Questions:**

1. Record the average atomic mass of vegium for at least 5 groups in your class and identify 2 similarities and 2 differences in the values calculated.
2. Explain why the average atomic mass of your vegium sample might be different than the atomic mass for other groups?
3. Evaluate your hypothesis. Include numbers from your data / results.

4. Based on your graph and calculations, identify the isotope mass that is closest to the average atomic mass of vegium and explain why this occurs.

5. Based on the procedure you followed, identify a logical source of experimental error and explain how it impacted your data?

6. Based on your data and calculations, explain why the atomic mass of an element is a ***weighted***

***average*** based on relative abundance versus a straight average that does not take into account the
abundance of each isotope.

7. Describe how the “vegium” **model** is useful and identify its flaws.