BAG O' ISOTOPES

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Annotation

In this activity, students will learn to calculate average atomic mass using the fictional element legumium.

Primary Learning Outcome:

Students will be able to define the terms *isotope* and *average atomic mass*.

Students will be able to use correctly isotope notation to represent an isotope.

Students will be able to calculate the average atomic mass of an element given data from a representative sample of different isotopes and their atomic masses.

Assessed GPS:

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

a. Develop and use systematic procedures for recording and organizing information.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

c. Recognize the relationship between accuracy and precision.
d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.

SPS1. Students will investigate our current understanding of the atom.

a. Examine the structure of the atom in terms of
   - proton, electron, and neutron locations.
   - atomic mass and atomic number.
   - atoms with different numbers of neutrons (isotopes).
   - atoms with different numbers of protons.

Duration:

Preparation: 60 minutes
Introduction: 10 minutes
Student Assignment: 30 minutes
Conclusion: 5 minutes
Total Class Time: 45 minutes

Materials and Equipment:

For Teacher Preparation:

1. 1-lb. Bag of large lima beans
2. 1-lb. Bag of baby lima beans
3. 1-lb. Bag of navy beans

4. Snack size plastic zipper bags (1 per group)

Per Group:
1. 1 Snack size plastic zipper bag containing 8 large lima beans, 11 baby lima beans, and 15 navy beans

Per Student:
1. Bag O' Isotopes Student Handout

Safety:
There are no significant safety concerns associated with this activity.

Technology Connection:
Not applicable.

Procedures:
Teacher Preparation:
For each group, prepare a "Bag O' Isotopes" containing 8 large lima beans, 11 baby lima beans, and 15 navy beans.

Estimated Time:
60 minutes

Introduction:
Explain to students that isotopes are different versions of atoms having the same number of protons but different numbers of neutrons. These different versions vary in mass but are all atoms of the same element because they each have the same number of protons. Often one isotope of an element is more common than the others. Hydrogen provides an example for discussion of isotopes. The three isotopes of hydrogen (*i.e.* protium, deuterium, and tritium) all share similar chemical properties because each one is made of one proton and one electron. Protium, the most common isotope of hydrogen, contains only a proton in its nucleus. Deuterium, the second-most common isotope, contains one proton and one neutron in its nucleus. Tritium, an unstable and uncommon isotope, contains one proton and two neutrons in its nucleus. Isotopes are represented by including the mass number and atomic number along with the chemical symbol for the element. For example, tritium would be represented as:

$$^{3}_{1}\mathrm{H}$$

where 3 is the mass number and 1 is the atomic number. The number of neutrons can then be calculated by subtracting the atomic number (*i.e.* the number of protons in the atom) from the mass number (*i.e.* the combined number of protons and neutrons). In this example, 3-1 = 2 neutrons. Finally, the atomic mass listed for an element in the periodic table is an average atomic mass for all of the isotopes of the element as they are found in nature. The average atomic mass is a weighted average, so the more commonly found isotopes have a greater effect on the average than rare isotopes. *(Source: Dobson, K., J. Holman, and Michael Roberts. 2001.*

Holt Science Spectrum: A Physical Approach. Holt, Rinehart, and Winston. Austin, TX, USA. Pp. 83-84.)

Now, explain to students that in this activity they will calculate the average atomic mass of the newly discovered element legumium. The three isotopes of legumium are represented by the three types of beans found in each Bag O' Isotopes.

Estimated Time:
10 minutes

Student Assignment:
Students should follow directions to complete the student handout.

Estimated Time:
30 minutes

Conclusion:
Collect handouts and review a sample calculation. Answer any questions.

Estimated Time:
5 minutes

Assessment:
Assessment should be based on completion of the student handout.

Name:

Date:

Class Period:

BAG O' ISOTOPES
Student Handout

Introduction:
Scientists have recently discovered the element legumium. Your assignment is to calculate the average atomic mass of legumium based on the samples provided. The atomic number of legumium is 4. The smallest of the isotopes, legumium-4, has an atomic mass of 4 atomic mass units (amu). Legumium-5, the intermediate isotope, has an atomic mass of 5 amu. The largest isotope, legumium-6, has an atomic mass of 6 amu.

Terms:

- _____ are different versions of atoms having the same number of _____ but different numbers of _____.
- The _____ is a weighted average of all of the isotopes of an element as they are found in nature.
- Isotope notation includes _____, _____, and _____.

Purpose:
To calculate the average atomic mass of the newly discovered element, legumium.

Materials:
Per Group:
1. 1 Bag o' Isotopes

Procedure:
1. Count and record in the table below the total number of isotopes in the sample.
2. Count and record in the table below the number of each legumium isotope.
3. Record the masses (provided in the introduction) of each legumium isotope in the table below.
4. Calculate the average atomic mass of legumium using the following equation.

$$\text{Average Atomic Mass} = \frac{(\#\text{ Isotope 1})(\text{Mass Isotope 1}) + (\#\text{ Isotope 2})(\text{Mass Isotope 2}) + (\#\text{ Isotope 3})(\text{Mass Isotope 3})}{\text{Total \# Isotopes 1, 2, \& 3}}$$

Data and Calculations:
Total Number of Legumium Isotopes in Sample:_____

Isotope	Quantity	Mass (amu)	Total Mass (amu)

Total Mass of Legumium Isotopes in Sample:_____

Average Atomic Mass of Legumium:_____

Discussion Questions:

1. Calculate the number of neutrons in each legumium isotope.

2. According to the sample, which legumium isotope is most abundant in nature?

3. For each legumium isotope, give the proper isotope notation.

4. If additional legumium-5 isotopes were added to the sample, how would the average atomic mass of legumium be affected?