Unit 7 - Atomic Structure

Lab: Atomic Mass of Candium

Read this First:

Isotopes are atoms of the same element with the same atomic number (number of protons) but different masses due to different numbers of neutrons in the nuclei. The atomic mass of an element is the weighted average of the masses of the different isotopes. The weighted average takes into account both the masses of the isotopes and the percent abundance of each isotope as it occurs in nature. Therefore the most abundant isotope contributes the most to the overall atomic mass of the element.

You already know about this. There are 3 naturally occurring isotopes of oxygen: O-16, O-17, and O-18. On the periodic table the atomic mass of oxygen is 15.999 u. So, which of the three isotopes must be the most abundant? _____

In the laboratory, an instrument called a mass spectrometer can measure the mass of each isotope and can determine the relative abundances of each isotope in a sample of an element. Because we do not have a mass spectrometer and because knowing how to do a weighted average is a skill you need, today you are going to be the mass spectrometers. During this lab you will carefully measure and record data which will enable you to perform the calculations to determine the atomic mass of the fictitious element Candium.

There are three isotopes of Candium – M&Mium, Skittlitium, and Reeses Piecium. In this model each piece of candy represents an atom. You will obtain a sample of Candium and determine the average mass, relative abundance, percent abundance each isotope in your sample. Like real isotopes, skittles, M&Ms and Reeses pieces all have different masses. However, unlike real isotopes each candy's mass is a little different because of the manufacturing process. Because of this difference, we will use the average mass of each candy type for our calculations.

Safety:

Before obtaining your sample, WASH YOUR HANDS! Obtain a clean piece of paper towel to place your Candium sample on.

Procedure:

1. Do not dispose/eat any of your sample of Candium atoms until your teacher has given you permission!!
2. Separate out all of your atoms by isotope. M&Ms have an M, Skittles have an S and Reeses Pieces are not marked.
3. Count the TOTAL number of atoms in your sample, and the number of each isotope you have in your sample to find the relative abundance of each isotope. Enter your data in the table.

Relative Abundance of Each Isotope (counts)			
# of M&Mium	# of Skittlitium	# of Reese Piecium	TOTAL # of atoms

4. Now, you will convert those counts into percents. Remember, calculating percent is always:

% = (PART/WHOLE) X 100

Also, remember that percents must always add up to 100!

Percent Abundance of Each Isotope (percentages)			
% M&Mium	% Skittlitium	% Reese Piecium	TOTAL %
			100%

5. Now measure the total mass of each type of isotope using an electronic balance. Be sure to put your atoms on a clean paper towel (zero the balance) if you want to eat them. Record your data in the table.

Total Mass of Each Isotope (grams)		
Total mass of M&Mium	Total mass of Skittlitium	Total mass of Reese Piecium

6. Calculate the average mass of each isotope. Remember, we have to do this with our candies because each one is not made exactly the same. We don't have to do this calculation with real atoms. **(average mass = total mass of isotope type/# of that isotope)**

Average Mass of Each Isotope (grams)		
Average mass of M&Mium	Average mass of Skittlitium	Average mass of Reese Piecium

7. NOW you are ready for the main point of this lab – finding the ATOMIC MASS of Candium. Here is the equation you will use (it is NOT in Table T – you WILL have to memorize it!) For the masses of the isotopes, you will use the ***average*** masses since we are working with candies, not atoms.

$$\text{Atomic mass} = \frac{(\%\ \text{isotope 1} \times \text{mass isotope 1}) + (\%\ \text{isotope 2} \times \text{mass isotope 2}) + (\%\ \text{isotope 3} \times \text{mass isotope 3})}{100}$$

8. Show your calculation of Candium's atomic mass here. Be sure to use the ESA method to show your work. Circle your answer.

9. In your own words what does weighted average mean?

10. Give two examples outside chemistry where weighted average could/should be used instead of a simple average.

11. Why are atomic masses on the periodic table not whole numbers?

12. How are the following isotopes of hydrogen alike? Different? H-1, H-2, H-3

13. Copper has two isotopes, Copper – 63 and Copper – 65. The relative abundance of Cu-63 is 69.1%. What is the weighted average atomic mass of Copper? (Assume the mass of Cu-63 is 63.000 u and the mass of Cu-65 is 65.000 u).

14. **(IB Only)** Only two isotopes of Boron occur in nature. One isotope is well known: Boron – 11 with a relative abundance of 80.39%. If the weighted average atomic mass of the element Boron is 10.811 u, what is the mass of one atom of the other isotope?