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CTE Science Laboratory Investigation

THE ATOMIC MASS OF COINIUM

**Introduction**

Having worked as closely as you have with the periodic table of the elements, you are by now aware that there are some numbers on it that can be distressing to the uninitiated. As a prime example, take atomic mass. We know that atomic mass is equal to the number of protons plus the number of neutrons. So for carbon, which has six protons and six neutrons, we would, quite reasonably, expect the atomic mass to be 12 daltons. This number reported on the table, though, is not 12. It’s 12.011. How can this be? Can you have 0.011 of a neutron or proton lying around? You cannot.

Before you get your brain tied into a knot trying to figure out this mess, recall that there are different versions of atoms, called isotopes, that have different numbers of neutrons. So while most of the carbon atoms have six neutrons, there are a few out there that have seven. Some even have eight. The number that is reported on the periodic table is the *average* of all the different isotopes of carbon out there relative to their abundance. So the fact that the number given for the atomic mass on the table is 12.011 tells us that most carbons have six neutrons, and only a small percentage have more. If a larger percentage had more, then the number would be farther away from twelve.

This fact is why, when we are doing calculations with atomic masses, we can safely round to the nearest whole number. Because in the sample of chemical that we are using, most of the atoms of any given element will be of average atomic mass, and only a small portion will have a different number of neutrons. In this investigation, we are taking advantage of the fact that the US Mint changed the composition of a penny in 1982 because the cost of copper meant that making a penny cost more than one cent. Starting in 1983, a penny was made of zinc and simply coated with copper, instead of being entirely copper. Thus, we can consider pre- and post-1983 pennies as individual atoms of two isotopes of the one-cent coin.

**Purpose**

The purpose of this investigation is to help you understand how the relative abundance of a particular isotope contributes to the number that is reported for its mass on the periodic table. You’ll also practice with careful measurement and calculation skillz.

**Materials**

PENCIL Digital balance

“Coinium” samples Weighing container

**Procedure**

1. Obtain a closed container of coinium. DO NOT open it until the end of the experiment!
2. Find the mass of the entire container plus the sample inside. Record this on your data table.
3. Subtract the mass of the container to find the mass of the sample by itself. Record this on your data table.
4. Obtain 10 pre-1982 pennies and find their mass. Divide by 10 to find the average mass and record it on your data table.
5. Obtain 10 post-1982 pennies and find their mass. Divide by ten to find the average mass and record it on your data table.
6. Use the formula below to calculate how many pre- and post-1982 pennies you think are in the container. This represents the relative abundance of each type of penny. Record the data on your data table. Show your work in your lab notebook.
7. When you have calculated how many pre- and post-1982 pennies you think are in your sample, have your teacher open your container so you can check. If you’re correct, you automatically score a 100 on the lab and you don’t have to do any of the analysis questions!

Let X = the number of pre-1982 pennies, and

Let 10-X = the number of post-1982 pennies,

So to solve for X:

**X (mass of pre-1982 penny) + (10-X)(mass of post-1982 penny) = mass of coinium sample**

**Analysis**

QUESTION 1: Why are isotopes of atoms with more neutrons usually more radioactive?

QUESTION 2: Why is a calculation like this useful? That is, why would a scientist want to know how many of what type of atom are in a particular sample of a chemical?

QUESTION 3: What might happen if a scientist wanted to make a 2 M solution of NaCl, but he or she didn’t know the exact atomic mass of the sample of NaCl he or she was using?

QUESTION 4: Radioactive isotopes of carbon exist, and in fact, you are made of some of them. The half-life of the isotope carbon-14 is about 5,730 years. It can be used to date historical artifacts based on how much of it has decayed. It is not, however, useful in dating bones or items that are millions of years old. Why is this?

QUESTION 5: Why is it appropriate that you are not allowed to look in the container throughout this experiment? That is, what does that simulate to a real-life scientist? (hint: think about what each individual penny represents)

QUESTION 6: What are two things that you would change about this lab if you could?