

**Exercise 2: Pennium****Objective:**

- a. Determine the mass and relative abundance of two “isotopes” of pennies.
- b. Illustrate the principle of averages and standard deviations, and how they can be used to distinguish between random and systematic errors.

During the 1980s, copper prices on the spot market were so high that the US Mint spent more than one cent to make a copper penny. Starting sometime during that decade, the US Mint decided to change the composition of a penny from a 95% copper/5% zinc alloy to a 97.6% zinc/2.4% copper mixture, with the copper primarily in the cladding of the penny.

**1. Write the formula** for calculating the individual **percent abundances** of two isotopes of an element (let’s call it “pennium”), given that you know the atomic masses (mass numbers) of the two pennium isotopes, as well as the overall (average) atomic mass of pennium. Hint: Let  $x$  = the percent abundance of isotope 1 of pennium. What must the percent abundance of isotope 2 be? Further hint: The math is remarkably similar to the analysis found on pages 70 and 71 of the text.

**Materials needed:**

- A roll of pennies from before 1982
  - A roll of pennies from after 1982
  - A roll of pennies with mixed dates
  - Electronic balance
- (Note: a roll of pennies should contain 50 coins)

**Remember:** Use the **same balance** for the entire lab.

**Procedure** (work in pairs, but each person should turn in their own exercise):

2. a. Weigh the **roll** of pennies from before 1982. Write this mass down, along with the proper units.
- b. Weigh the roll of pennies from after 1982. Write this mass down.
- c. Weigh the roll of pennies from the mixed bunch. Write this mass down.

The roll of pennies with mixed dates represents a sample of the element **pennium**.

3. Why did you measure the roll of pennies from before 1982? In other words, what do the “before 1982” pennies represent, in the element pennium analogy? Why did you measure the roll of pennies from after 1982? In other words, what do the “after 1982” pennies represent, in the element pennium analogy?

4. a. What is the **average** mass of a penny from before 1982? Show your work.

b. What is the **average** mass of a penny from after 1982? If you did part a correctly, you need not show your work.

c. What is the **average** mass of a penny with mixed dates? If you did part a correctly, you need not show your work.

5. Using your formula from question 1, calculate the **percent abundance** of the two isotopes of pennium. Please show your work.

6. Enter the group data shown on the Excel spreadsheet on the classroom laptops. Obtain a **class average** for each of the different kinds of pennies.

7. Calculate the **percent difference** between the pennies of your rolls and the class averages for the different kinds of pennies.