Chemistry 101 Names:

Exercise 2: Atoms

Isotopes

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. The metallic composition of the two types of pennies is **not** important for this exercise (i.e., **don't** go looking up the various isotopic masses of zinc and copper).

1. Write the **formula** for calculating the individual **percent abundances** of two isotopes (call them "isotope 1" and "isotope 2") 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.

Obtain**:**

- A roll of pennies from "pre-1982"
- A roll of pennies from "post-1982"
- A roll of pennies that are "mixed"

(Note: a roll of pennies should contain 50 coins)

Use the electronic balances in the back and side of the room. **Remember:** Use the **same balance** for the entire exercise.

2. a. Weigh the set of pennies from "pre-1982". Record this mass in the table on the next page. Remember to write down **all** digits the balance gives you!

b. Weigh the set of pennies from "post-1982". Record this mass in the table.

c. Weigh the set of "mixed" pennies. Record this mass in the table.

Penny roll	“pre-1982”	“post-1982”	“mixed”
Mass (g)			

Please return the pennies to their separate containers on the cart.

3. a. Why did you measure the set of pennies from “pre-1982”? In other words, what do the “pre-1982” pennies represent, in the element pennium analogy?

b. Why did you measure the set of pennies from “post-1982”? In other words, what do the “post-1982” pennies represent, in the element pennium analogy?

4. a. What is the **average** mass of a penny from “pre-1982”? Show your work.

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

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

5. Using your formula from the prelab, calculate the **percent abundance** of the two isotopes of pennium in the “mixed” roll. Please show your work.

6. a. Given that the mass of the neutron is 1.674954×10^{-27} kg, the mass of a proton is $1.6726430 \times 10^{-27}$ kg and the mass of an electron is $9.1093897 \times 10^{-31}$ kg, what is the **mass** (in kg) of a single carbon-12 atom? **Pay attention to sig figs!**

b. Based on the definition of an amu, what is the **mass** (in amu) of a single carbon-12 atom?

c. 1 atomic mass unit has a mass of 1.66054×10^{-27} kg. Use this factor to convert your answer to part b into kg and **compare** it to the answer in part a. Calculate the **difference** in mass.

d. This difference in mass is the amount of matter that is converted to energy which holds the nucleus together (**nuclear binding energy**). Convert this mass to energy (joules) using the famous equation on page 120. One Joule = 1 kg m^2/s^2 and c = 3.00×10^8 m/s.

7. Write the chemical **symbol** for an **isotope** which has 8 protons, 10 neutrons and 10 electrons. Hint: is this isotope also an **ion**?

8. Describe the **subatomic structure** of phosphorus-32, a commonly used "tracer" isotope, indicating the **number** and **placement** of subatomic particles, including the **electron configuration**.

9. The following table shows various properties of chlorine and iodine molecules:

	Molecular formula	Boiling point (K)	Freezing point (K)
Chlorine	Cl_2	239	172
Bromine			
Iodine	I_2	457	386.5

Fill in the information for the missing line of bromine, given that bromine is between chlorine and iodine in group VIIA. **You do not have to look up these values in any reference.**

10. Unlike the text's treatment of electromagnetic (EM) radiation, there is a formula to calculate the number of joules of energy a **photon** of a particular **wavelength** of light contains. The formula is $E = hc/\lambda$, where E is the **energy** of the photon in Joules, h is Planck's constant = 6.626×10^{-34} Js (that is, joules times seconds), c is speed of light = 3.00×10^{8} m/s and l (the Greek letter *lambda*) is the wavelength of the photon in meters.

The text mentions on page 73 that visible light frequencies range from 4.0×10^{-7} m (blue) to 7.0×10^{-7} m (red). **Calculate** the energy of one photon of **blue** light and one photon of **red** light and indicate which is the **more energetic** color.