A Journey Into Atoms, Isotopes, and Ions

Atoms are composed of three subatomic particles known as the protons, neutrons, and the electrons. Their symbols are p^+, n°, and e^-. Both the proton and the neutron have a mass of 1 amu (atomic mass unit) each. In high school the mass of the electron is considered to be zero because it's so much smaller than that.

The atom's mass is measured only in the nucleus, the sum of the protons plus the neutrons in amu's. An atom always has the same number of protons and electrons, since they have equal and opposite charges, and all atoms are electrically neutral.

Once it was thought that all atoms of an element were identical to each other, but we know now that different isotopes exist. Isotopes are chemically identical atoms, with the same number of protons and electrons, but with a slightly different number of neutrons. This gives a slightly different mass, but no change in any chemical properties.

There are nearly 116 types of elements, but over 1000 kinds of isotopes of these.

Each atom has electrons which fly around the nucleus in orbitals (or energy levels). These electrons have a configuration which is on our periodic tables. Only noble gases in group 18 have only completely full orbitals. Other atoms have outer orbitals that are not completely full. The perfection of the noble gases is the primary reason that they do not make bonds with other atoms. Bonding is a way that all the other atoms can obtain that "perfect" electron orbital scheme.

Metals will lose electrons to "get" a noble gas electron configuration, they become isoelectric to a particular noble gas. The non metal atoms will gain electrons to obtain that noble gas electron scheme. Metals will lose enough electrons to become isoelectric to a noble gas, not more or less. Nonmetals will gain enough electrons to get that same noble gas electron arrangement.

The metal atoms that lose electrons form positive cations. Nonmetals which gain extra electrons will form into negative anions. These 2 kinds of ions will only form simultaneously, and will only form when the electron transfer is matched up evenly. For every electron given up by a metal forming a cation, every electron must be transferred to a nonmetal that forms an anion.

These ions are then oppositely charged and wildly attracted together, forming ionic bonds, which hold together these new ionic compounds. Since the electron transfer is perfect, the positive-ness is balanced with negative-ness, the ionic compounds are neutral.

Later in the term we'll see about 2 or more nonmetals bonding (like water). Instead of transferring electrons from one atom to another, they will "share" electrons, to share the full orbital electron configurations. These are called covalent bonds.

These electrons being transferred, or being shared, is what chemical bonding is all about. It's also the main part of chemistry.

In this activity we will examine a series of numbered zip lock bags (don't open them up please), which contain beans and popcorn kernels. We will imagine each baggie to be an atom or an ion. Some atoms will match the periodic table, and some will be isotopes of atoms on the periodic table. Your job is to carefully count the black beans (those are our protons), the white beans (our neutrons), and the popcorn kernels (the electrons), and record that data in the chart. You will then determine which atoms or ions that each bag represents, and answer some questions about them that follow. Count carefully, count twice, think lots.

For example, if a bag were to contain 5 black beans, 7 white beans, and 5 popcorn kernels it would represent the atom boron (B-12). It's electrons are in a 2-3 configuration, and although it is not exactly on the periodic table, five black beans = five protons, it has to be boron. The protons plus the neutrons = 12, so the mass is 12 amu. It's boron, but it's an isotope of boron called B-12.

Patience and smiles are now required. Go on, look, don't open the bags, count, think, smile more. Peace, love, and chemistry.

Symbol would be the element symbol from the periodic table with a mass number following, such as Hg-201 for the most common isotope of mercury. Charge would be Ø (neutral) for all atoms, or the + sign for all cations, or the — sign for all anions. The name would be something like +1 sodium cation, or isotope of carbon, or helium atom.

bag	$\#p^+$	#n°	$\#e^-$	Mass in amu	symbol	Overall charge	name
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

bag	$\#p^+$	#n°	$\#e^-$	Mass in amu	symbol	Overall charge	name
11							
12							
14							
15							
16							
17							
18							
19							
21							
22							
23							
24							
25							
26							

Show what you have learned from your chemical journey so far…

1. How many types of cations were there in the bags? _____

2. How many types of anions were in the bags? _____

3. Which atom in today's activity had three isotopes present? _____

4. What makes atoms isotopes? What's similar, what's different between them? _____

   _____

   _____

5. How do you know when you are looking at an ion in the bag? _____

   _____

6. When particles in bag 3 react chemically with particles from bag 16, what forms? (please give the correct chemical formula + the name of the product)

   _____

7. How about particles from bags 9 + 17? _____

8. Or bags 21 + 22? _____

9. What about when bags 10 + 17 react chemically? _____

10. Which is the most common naturally occurring isotope of antimony? How do you know?

    _____

11. There are three isotopes of hydrogen and the masses of each of them are 1 amu, 2 amu, and 3 amu. Write the three symbols for these three isotopes.

    _____ , _____ , and _____

12. Which is the most common naturally occurring isotope of hydrogen? _____