NS 3.1 (pg 1 of 1) **Atoms and Ions** Name________________________

Each element has unique properties, in spite of the fact that the atoms of all elements are made out of the same parts; protons, neutrons, and electrons. Each element is unique because its atoms contain a unique number of protons, neutrons, and electrons. Much of the chemistry that takes place in the world around us involves electrons jostling around to try to improve how they "feel." In chemical reactions, the protons and neutrons stay put in the nucleus and do not change. All atoms of the same element have the same number of protons in the nucleus, and these do not change during chemical processes. The defining feature of an element, therefore is the number of protons in the nucleus. As you know, this defining number of protons is called the atomic number. This is symbolized by the smaller number on the periodic chart associated with the symbol of the element.

Atoms

When you look up an element in the periodic chart, and look up its atomic number and mass number, assume you are considering an atom, as opposed to an ion. It is very important to pay close attention to this vocabulary.

Atomic number tells you the number of protons in an atom. Atoms are neutral in charge, which of course means that the number of protons must equal the number of electrons.

Mass number is the average atomic mass rounded to the nearest whole number. The mass number is equal to the sum of the protons + neutrons. Thus, to determine the number of neutrons, subtract the atomic number from the mass number.

Ions

During chemical reactions, atoms can lose or gain electrons. In fact they do so on a very regular basis. (Atoms only lose or gain protons and neutrons only during nuclear reactions.) Since electrons are negatively charged, when electron(s) are lost, an atom turns into an ion and ends up with a positive charge. When electrons are gained, an atom turns into an ion and ends up with a negative charge.

Consider bromine as an example: The bromine atom has 35 protons and 35 electrons. When bromine adds one electron the bromine particle still has 35 protons (+) and now would have 36 electrons (−) causing the bromine particle to gain a negative 1 (−) charge. The bromine particle has now become an ion with a negative charge. Negatively charged ions are called anions. The bromine anion would be symbolized Br^{-}

Consider calcium as an example: The calcium atom has 20 protons and 20 electrons. When calcium loses two electrons the calcium particle still has 20 protons (+) and now would have 18 electrons (−) causing the calcium particle to have a positive 2 (+) charge. The calcium particle has become an ion with a positive charge. Positively charged ions are called cations. The calcium cation would be symbolized Ca^{2+}

Remember, ions are not made by losing or gaining protons, only losing or gaining electrons.

Symbolizing atoms, isotopes, ions, molecules:

$$5\,{}^{7}_{3}Li^{+}_{2}$$

- ${}_{3}Li$ the atomic number is sometimes placed in front of the atom as a subscript
- ${}^{7}Li$ the mass number is placed in front of the symbol as a superscript
- Li^{+} the + refers to the +1 charge if the atom has turned into an ion
- Li_2 the 2 refers to 2 Lithium atoms that are stuck together
- 5 Li the 5 refers to 5 lithium atoms that are NOT stuck together

- Never would all 5 of these numbers be placed around a chemical symbol all at the same time. They would be used at different times in different contexts.
- The location of these numbers around the symbol above is not related to the location of the atomic mass and atomic number in the periodic chart. Where the atomic number and atomic mass is placed around the symbol on the periodic chart is entirely up to the author of the chart and how they esthetically like it to be arranged.
- There is second method of representing an isotope that is sometimes used. Neon has three naturally occurring isotopes, of which the one with 10 protons and 10 neutrons is the most common.
  - Neon-20, Neon-21, and Neon-22 (each with 10 neutrons, 11 neutrons, and 12 neutrons respectively)
  - ${}^{20}Ne$, ${}^{21}Ne$, ${}^{22}Ne$