NS F1 (pg 1 of 2) **Atoms and Ions**

Name______________________________Per___

Each element has unique properties, in spite of the fact that the atoms of all elements are made out of the same parts; protons (+ charge), neutrons (neutral), and electrons (− charge). 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 achieve a more favorable arrangement. 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 naming feature of an element, is the number of protons in the nucleus. As you may 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. The larger of the two numbers is the average atomic mass.

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: Anions and Ca+ions

During chemical reactions, atoms can lose or gain electrons. In fact they do so on a very regular basis. (Atoms lose or gain protons and neutrons ***only*** during nuclear reactions, we will not consider this at the time.) 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 steals one electron the bromine particle still has 35 protons (+) but 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 (+) but 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:

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

- ${}_{3}\mathrm{Li}$ the atomic number is sometimes placed in front of the atom as a subscript
- ${}^{7}\mathrm{Li}$ 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.
- Isotopes are particles of an element with different number of neutrons. There are two ways of representing an isotope that are 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 (a −# after the name tells you the mass number)
    - ${}^{20}\mathrm{Ne}$, ${}^{21}\mathrm{Ne}$, ${}^{22}\mathrm{Ne}$ (the mass number also represented top left of a symbol)

tiny bit more on back →

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Mass and Size

Atoms are of course very very very small, but the nucleus of an atom is even SO so so much smaller. Most of the size (or volume of an atom) is caused by the electron cloud, yet nearly all of the heft (mass) of an atom is caused by the protons and neutrons in the nucleus. The electrons themselves are not large in size, but moving so very fast the electrons cause a “cloud” that causes most all of the volume or size of the atom.