Nomenclature & Formula Writing 2

Valence for Representative Elements

INFORMATION

When early chemists first realized that the small number of known **elements** could not possibly account for the large number of known substances (and the properties of those substances), they began to consider the origin of those many substances. Research led them to theorize (and eventually prove) that the elements must combine in some way to create new materials, or **compounds**.

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Further investigation led chemists to determine that elements not only combined to form new compounds (with new properties), but that they did so in specific proportions depending on the elements involved. This means that every molecule of a given compound will have in it the same number of atoms of each element, no matter where the sample is taken from. This is called the **law of definite proportions**.

Metals, Nonmetals, & Their Ions

Metals are found to the left side of the staircase line on the periodic table. There are many more metals than there are nonmetals. The first two groups of representative elements, all of the transition metals, and some of the representative elements to the right of the transition metals block are metals. When metal atoms ionize, they form cations.

Nonmetals are found to the right of the staircase line on the periodic table. All nonmetals except for noble gases are representative elements. When nonmetals ionize, they form anions.

Ionic Valence

Valence, also known as charge, is a measure of the number of bonds that the atom can form with other atoms. The term "valence" is derived from the Latin *valencia*, meaning "capacity" and refers to the combining potential of atoms. *Valence* is not to be confused with the number of *valence electrons* – the two are different, but related in an important way. The charge an atom tends to acquire when ionized is related directly the number of valence electrons the atom possesses.

Since metals form cations, they will lose electrons to do so. *Representative metals lose a number of electrons equal to the number of valence electrons they possess* when they ionize. Forming a positive ion is more energetically favorable because it requires less energy to lose a small number of electrons than to gain a larger number. Atoms seek to achieve a state in which their outermost shell *containing electrons* is full. The phrase "containing electrons" is critical. Atoms ionize in an effort to fill their *outer* shells – positive ions "cheat" by emptying their *outermost* shells, leaving their next-highest shell as the full shell.

Since nonmetals form anions, they must gain electrons to do so. *Nonmetals gain a number of electrons equal to 8 minus the number of valence electrons they possess when neutral*. Again, it is more energetically favorable to gain few than to lose a larger number. A nonmetal ion will gain enough electrons to fill its valence shell.

Group 4 elements (the group with carbon at the top) are balanced between the "gain" and "lose" categories – a sort of "special case." The exact chemistry of this is beyond the scope of this activity; for now, we will assume that *group 4 elements always take a +4 charge*.

An atom's valence is the charge it takes when it fulfills whichever of the two definitions above is appropriate.

Key Questions:

1. What is the charge on all Group 2 metals? What is the charge on Group 5 nonmetals?

2. Why does magnesium form an Mg^{+2} ion instead of an Mg^{-6} ion?

3. Why is it more desirable (to the atom, that is) for a free state (not bonded) atom to be neutral rather than have a full shell (other than noble gases, of course)?