THE PERIODIC TABLE AS AN INSTRUMENT IN TEACHING GENERAL CHEMISTRY

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Most textbooks and most instructors make use of the periodic table to some extent in teaching general chemistry. For example, most instructors show that the elements in group I will lose one electron and take on a charge of +1. The elements in group II will lose two electrons and take on a charge of +2. The elements in group VII gain one electron to complete the octet, and are thus charged —1. However, this paper is concerned with the matter of writing formulas for the —oxy acids and their salts rather than with the simple binary acids and salts. It is concerned with the matter of formulating the negative radicals and determining the charge on these radicals.

Most of the non-metals in groups IV, V, and VI exhibit three valences. The first is what we might term a minimum valence corresponding to the number of electrons required to complete the outer orbit. The second is what we might term a maximum valence, and it is the same as the periodic group number. It corresponds to the maximum number of electrons which might be lost by the atom. The third valence is nearly always two less than the maximum. Elements in group IV show common valences of —4, +4 and +2. Elements in group V show common valences of —3, +5 and +3. Those in group VI show valences of —2, +6 and +4. The minimum valent compounds are the *hydro-* acids and the *-ide* salts. The maximum valent compounds are the *-ic* acids and the *-ate* salts. The compounds which exhibit a valence of two less than the maximum are the *-ous* acids and the *-ite* salts.

This can be illustrated with examples from groups VI, V and IV. (This system does not predict whether a compound will be formed or not. It simply aids in arriving at the formula of the compound if it is formed.)

Acids	Group Radical	Salt	Valence
H_2S—Hydrosulfuric acid	X^{-2}	Na_2S—Sodium sulfide	—2
H_2SO_4—Sulfuric acid	XO_4^{-2}	Na_2SO_4—Sodium sulfate	+6
H_2SO_4—Sulfurous acid	XO_3^{-2}	Na_2SO_3—Sodium sulfite	+4
NH_3—(Not an acid)	X^{-3}	Na_3N—Sodium nitride	—3
HNO_3—Nitric acid	XO_3^{-1}	$NaNO_3$—Sodium nitrate	+5
HNO_2—Nitrous acid	XO_2^{-1}	$NaNO_2$—Sodium nitrite	+3
CH_4—(Not an acid)	X^{-4}	Al_4C_3—Aluminum carbide	—4
H_2CO_3—Carbonic acid	XO_3^{-2}	Na_2CO_3—Sodium carbonate	+4
H_2CO_2—Carbonous acid (not formed	XO_2^{-2}	Na_2CO_2—Not formed	+2

Some of the above looks useless when the particular compound is not formed, or is not stable. However, in many cases, analgous compounds in the same group are formed. There is no carbonous acid, but stannous acid (amphoteric stannous hydroxide) is an analgous compound. There is no sodium carbonite, but sodium stannite and sodium plumbite are analgous compounds. Using this scheme, the student should be able to develop the formulas of these compounds. If the student knows that the formula for sodium sulfate is Na_2SO_4, reasoning from this formula, he might write the sodium *-ate* salts of the other elements in group VI as follows: Na_2SeO_4, Na_2CrO_4, Na_2MoO_4. Na_2TeO_4, Na_2WO_4 and Na_2UO_4.

Suppose the student is asked to write the formula for sodium tungstate; a compound which is entirely new to him. He sees that tungsten is in group VI, and reasons hat it is analgous to Na_2SO_4. Hence, he should write Na_2WO_4. He might also reason it out in this manner. Tungsten is group VI and hence, will show a valence of +6 in the tungstate salts. It will require four atoms of oxygen to give the radical a negative valance. He then writes $W^{+6}O_4^{-8}$. Getting the algebraic sum of +6 and —8, he sees that the radical is WO_4^{-2}. In addition to the fact that this scheme requires less memory work on the part of the student it also prepares him for work in balancing oxidation-reduction equations, and for later work in oxidation-reduction titrations.

The group VII elements require special treatment due to the fact that they have five rather than three common acids and salts. Here the minimum valent acid is still the *hydro-* acid. But since there are four *oxy* acids, the *-ous* and *-ic* endings are not sufficient. Hence, the maximum valent acid (+7) is preceeded by *per-* as in *perchloric acid.* The next acid with a valence of two less than the maximum (+5) is the *ic* acid. The next is the *-ous* acid with a valence of +3. Finally the *hypo- -ous* acid has a valence of +1. Examples:

Acid	Valence	Salt
HCl—Hydrochloric acid	—1	NaCl—Sodium chloride
$HClO_4$—Perchloric acid	+7	$NaClO_4$—Sodium perchloriate
$HClO_3$—Chloric acid	+5	$NaClO_3$—Sodium chlorate
$HClO_2$—Chlorous acid	+3	$NaClO_2$—Sodium chlorite
HClO—Hypochlorous acid	+1	NaClO—Sodium hypochlorite

It will be readily noted that certain common compounds such as $KMnO_4$, $KReO_4$, KIO_4, etc. are logically named according to this system.

Any scientific system should enable the user to expand his knowledge. This system enables students to write many compounds from their names, and also enables them to predict the formulas and names for many compounds. The alternative to the system seems to be the old method of committing the radicals and valences to memory.