CHEMICAL NOTATION

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For people who are curious about atoms, the building-blocks of molecules, I recommend watching the Khan Academy online video, *Introduction to the Atom*. http://www.khanacademy.org/science/chemistry/v/introduction-to-the-atom

A chemical formula is a method of representing a chemical compound, a molecule, or a radical group by a symbol for the elements. In a compact form, the chemical formula state the elements involved and proportion of atoms of each element. This shorthand is frequently used by ceramists to discuss materials, as well as scientists.

One molecule of a compound called water is made of two atoms of the element hydrogen and one atom of the element oxygen, written as the chemical formula **H_2O.**

There is no rule about order of symbols, but it is usual to put oxygen last and put other elements in an order which makes sense as a description. When speaking of chemical compounds, a chemical formula represents one molecule of the compound, as well as shorthand for the compound itself. The number below and after a symbol indicates the number of atoms of the preceding element

H_2O = water (two hydrogen atoms and one water atom)
Fe_2O_3 = red iron oxide (two iron atoms and three oxygen atoms)
MnO_2 = manganese dioxide (one manganese atom and two oxygen atoms)

Two conventions exist to indicate that groups of elements are present:

1. Use of large full stops as in the representation of lead bisilicate (one molecule of lead oxide and two molecules of silica):

$PbO{\bullet}2SiO_2$ or
$PbO{\bullet}Si_2O_4$ or
$PbSi_2O_5$

But **$PbO{\bullet}2SiO_2$** is most graphic. The large 2 refers to the whole molecule of silica, SiO_2, not just the silica.

Other examples of formulas using full stops:
kaolin $Al_2O_3{\bullet}2SiO_2{\bullet}2H_2O$
borax $Na_2O{\bullet}B_2O_3{\bullet}10H_2O$

2. Use of brackets. Certain groups of elements always appear together, but they are not molecules and so cannot be isolated by full stops. Nor can they be given large numerals to denote more than one of the group is present. In such cases brackets are used. Eg. Copper sulfate is written $CuSO_4$

The SO_4 denotes a sulfate group, but is not a molecule in itself. When this group is combined with iron and forms ferric sulfate if becomes necessary to express two atoms of iron combined with three groups of sulfate:
$Fe_2(SO_4)_3$

The brackets enclose the group and the figure three denotes the number of radicals present in the same way the two subscript denotes the number of iron atoms.

Certain groups of elements often appear together. These radicals are written after the element to which they are attached. Some common ones

CO_3	a carbonate group.	Example **$CaCO_3$**	calcium carbonate or whiting
NO_3	a nitrate group	Example **KNO_3**	potassium nitrate
SO_4	a sulfate group	Example **$BaSO_4$**	barium sulfate

It is common among potters to divide complex minerals into smaller compounds for convenience in notation.

For example, **dolomite**, which is a single crystal structure created by double carbonate of calcium and magnesium, can be written as:

$CaMg(CO_3)_2$ which may be easier to read as:
$CaCO_3{\bullet}MgCO_3$ which indicates calcium carbonate + magnesium carbonate

kaolin which may be written as $Al_2Si_2O_5(OH)_4$ is usually written:
$Al_2O_3 \bullet 2SiO_2 \bullet 2H_2O$ which indicates alumina, silica, and water in the expanded formula which potters use to highlight the familiar oxides and compound that make up the materials used in glazes and clays.

See Frank Hamer's book ***The Potters Dictionary of Materials and Techniques***, a reference book in the UF Architecture and Fine Arts Library.

See also Charles McKee *Ceramics Handbook* p. 15 for a list of oxides used in ceramics, or Daniel Rhodes ***Clay and Glazes for the Potter*** pp. 130-131 for a table of ceramics raw materials, p. 314 for elements and oxides.