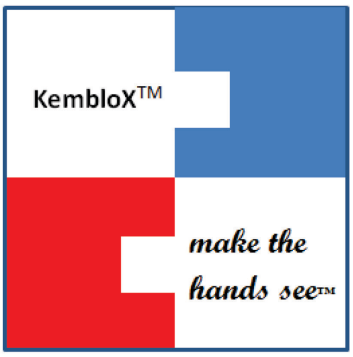

KembloX™

make the hands see™

CLASSROOM AND LABORATORY ACTIVITIES

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Ionic Compounds modeling with the KembloX™ system

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Introduction

Atoms in compounds can bind together in various ways. This laboratory session is for modeling ionic compounds. In ionic compounds, atoms tend to become anions (ions that have more electrons than protons, and therefore are NEGATIVELY charged), or cations (ions that have fewer electrons than protons, and therefore are POSITIVELY charged). Based on the periodic table of elements, one can predict the type of ion associated with a given atom, especially for main group elements. Ionic compounds are compounds in which the atoms are held together by electrostatic attraction between anions (ions that are negative due to an **excess** of electrons) and cations (ions that are positive due to a **deficit** of electrons). This charge difference is illustrated in KembloX™ by using blocks with posts (extra electrons) and wells (electron deficit). KembloX™ helps students visualize the formula unit of ionic compounds, in which the total transfer of electrons occurs. Also, it illustrates the difference between compounds in which the cation can have different charge (e.g. Iron(II) and Iron(III), or copper(I) and copper(II)). A formula unit is the simplest formula for an ionic compound.

Description

KembloX™ contains a color-coded chart comprising a list of anions and cations. Monatomic ions are marked with colors in the periodic table area of the chart, while the polyatomic ions are listed separately. The charges of the ions covered by this kit are presented in the chart by color stripes in their Periodic Table box, and by color in the list of polyatomic ions. The colors correspond to the common charge of the ion (if more than one charge is possible, then two stripes appear in the box, with the most common charge in the upper position). The shaded area in the periodic table indicates that the respective elements result in monatomic anions. Formula units for any combination of two ions that contain color in the chart can be built based on the present kit; that means over 3500 ionic compounds.

In addition to the color coded chart, the KembloX™ system also comprises blocks similarly color-coded, according to the **number** of charges: one, two, three, or four charges. The same color is used whether the charges are positive (deficit of electrons) or negative (excess electrons); the monatomic anions are shaded in the periodic table, while the charge is explicit in the list of polyatomic ions. Extra electrons (negative charges) are represented by posts; thus the blocks with posts represent anions. The positive charges (lack of electrons) are represented by wells; hence blocks with wells represent cations.

The full kit comprises six four-charge units (three anions and three cations), eight three-charge units (four anions and four cations), six two-charge units (three anions and three cations), and eight one-charge units (four anions and four cations). This kit covers all the possible ionic formula units. One of each is presented below:

Cations Anions

Once assembled in a valid representation of a formula unit, one can tell anions from cations from the signs engraved on the bottom of the blocks.

Safety

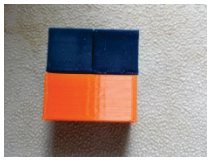
No special safety measures are necessary, except the common sense ones (e.g. do not put the blocks in your mouth, etc.).

Procedure

Rules of the game

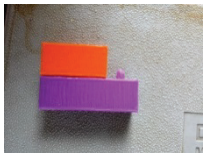
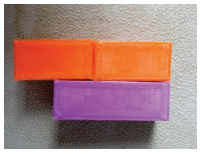
A valid representation of a formula unit will use a combination of blocks, assembled according to the following criteria:

a) The model of the formula unit has no wells or posts exposed; this ensures the electrical neutrality of the compound.
b) The model of the formula unit has one type of cation and one type of anion. KembloX™ does not cover double salts, such as dolomite $CaMg(CO_3)_2$. This does not limit the number of ions involved, as for example in Ca_3P_2, with a total of 5 ions.

For example the (ionic) compound of calcium (calcium ion) and chlorine (chloride ion), calcium chloride, would look like:  therefore the formula would be $CaCl_2$.

As another example, the (ionic) compound of calcium (calcium ion) and oxygen (oxide ion), calcium oxide, would look like:  therefore the formula would be CaO.

The three formula units shown below are invalid constructs: the first one (leftmost) has two dissimilar cations (or two dissimilar anions), the second one has an unbalanced negative charge, and the third has an unbalanced positive charge.

One kit is sufficient for any ionic compound comprising the color-coded species covered in the chart included in the KembloX™ system.

Activity

Each team will have a KembloX™ system. Each team will receive several slips describing the formula units to be built. After finishing each model, including the hand-drawn sketch, the compound will be inspected and graded by the instructor. The team can proceed to the next model.

A typical slip will have enough information to have all the boxes completed by the student; the type and/or the amount of information provided/required is at the instructor's discretion. An example is provided below.

Example:

Assignment slip

Student Name1 Name2

	CATION	ANION	Compound
Formula			
Name			Sodium nitride

Sketch (approximately) the ions and the compound

Student-filled slip:

Student Name1 John Deer Name2 Jane Doe

	CATION	ANION	Compound
Formula	Na^{+}	N^{-3}	Na_3N
Name	Sodium	Nitride	Sodium nitride

Sketch (approximately) the ions and the compound