Ionic Compounds Modeling with the KembloX™ System

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Introduction

As we know, matter is made of atoms. Atoms in compounds can bind together in various ways. Two of the most important binding modes are: the ionic bond and the covalent bond. This class activity relates to compounds with ionic bonds.

Atoms may become ions: anions (ions that are negatively charged due to an **excess** of electrons compared with the neutral atom) or cations (ions that are positively charged due to a **deficit** of electrons compared with the neutral atom). Ionic compounds are compounds in which oppositely charged ions are held together by electrostatic attraction. The *formula unit* is the simplest integer ratio of atoms present in an ionic compound; sometimes it is called the *empirical formula*.

In many instances, one can predict the type of ion associated with a given atom based on the periodic table of the elements, especially for main group elements. The KembloX™ system comprises a more extensive chart of the most common ions, both monatomic and polyatomic.

The charge of the ions is illustrated in KembloX™ by using blocks with posts (extra electrons) and wells (electron deficit). KembloX™ helps students visualize the formula unit (a.k.a. empirical formula) of ionic compounds. KembloX™ also clearly illustrates the difference between compounds in which the cation can have different charges (*e.g.,* Iron(II) and Iron(III), or Copper(I) and Copper(II)).

Kemblox classroom activities can easily be customized according to the instructors' preferences. Depending on the course structure, the following topics could benefit from this activity: formula unit (aka empirical formula) (https://kemblox.org/kemblox-for-formula-units-empirical-formulas/); ion names, both monatomic and polyatomic, and nomenclature of ionic compounds, including Stock notation (https://kemblox.org/naming-ionic-compounds-nomenclature/).

Description

Although a detailed description of the KembloX™ system is available online (https://kemblox.org/description-of-the-kemblox-system/), the following is a brief 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 in the chart can be built based on the full KembloX™ kit (https://kemblox.org/available-systems/); that means over 3500 ionic compounds.

In addition to the color coded chart, the KembloX™ system also comprises similarly color-coded blocks, according to the **magnitude** of the charge: 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: the blocks with posts represent anions. The positive charges (lack of electrons) are represented by wells: the blocks with wells represent cations.

A valid representation of an ionic compound will have no posts and no wells exposed.

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

The KembloX™ system can represent compounds that contain one type of cation and one type of anion. It cannot represent double salts.

Safety

No special safety measures are necessary, except the common sense ones. Children under 5 should not handle blocks from the KembloX™ kit, as they might present a choking hazard.

Procedure

Building a model

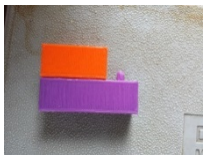
A valid representation of a formula unit will use a combination of blocks, assembled according to the following criteria:

a) The model of the formula unit has no wells or posts exposed; this illustrates 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, however, 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 following three formula units are invalid constructs: the first one (leftmost) has two dissimilar cations (or anions), the second one has an unbalanced negative charge, and the third has an unbalanced positive charge.


Model Activity

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

A typical worksheet will have enough information for students in the team to complete all of the empty boxes; the type and/or the amount of information provided/required is at the instructor's discretion. An example is as follows.

Assignment worksheet

Student Name 1 Student Name 2

	CATION	ANION	Compound
Formula			
Name			Sodium nitride

Sketch the ions and the compound

Student-completed worksheet:

Student Name 1 John Deer Student Name 2 Jane Doe

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

Sketch the ions and the compound (colors are close to the ones used in the KembloX™ system

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