Laboratory Investigation Name _____

Chemistry: Form L4.6A Date _____ Period _____

Formulas from Puzzle Pieces

PROBLEM

How can puzzle pieces be used to determine formulas?

INTRODUCTION

The formulas of compounds can be determined by making sure their oxidation states add up to zero. This can be more easily visualized with puzzle pieces. An element with an oxidation state of +1 is represented by a puzzle piece with one tab jutting out. An element with an oxidation state of + 2 is represented by a puzzle piece with two tabs jutting out. On the other hand, negative ions have indentations. An element with an oxidation state of −1 has one indentation and an element with an oxidation state of −2 has two indentations. See Figure 1 below.

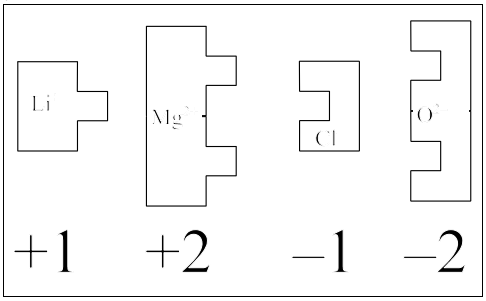

Figure 1. The number of tabs and indentations show the oxidation state.

To get the correct formula for a compound, the puzzle pieces for the ions need to be put together so there are no tabs or indentations left over. See Figure 2 to the right. Putting the pieces together in this fashion makes the positive charge equal and opposite to the negative charge, giving the compound a total charge of zero.

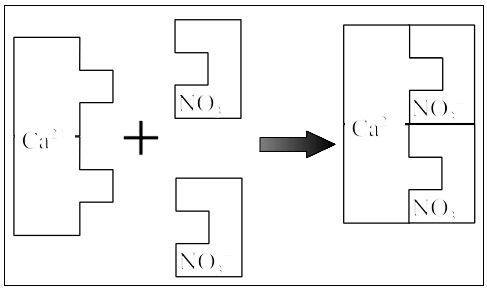

Figure 2. One calcium ion reacts with two nitrate ions to form calcium nitrate: $Ca^{+2} + 2NO_3^- \rightarrow Ca(NO_3)_2$

MATERIALS (*per group*)

Puzzle pieces, scissors

PROCEDURE

1. Cut out the puzzle pieces from the puzzle sheets provided.

2. Use the puzzle pieces to construct a model of the compound formed from the combination of the ions Fe^{2+} and Cl^-.

3. Make a drawing of the model of the compound in the space provided in the observations section of the laboratory investigation.

4. Based on the model, write the formula of the compound in the space provided in the observations section of the laboratory investigation.

5. Repeat the procedures in steps 2 through 4 for each of the following ion combinations: [a] Fe^{3+} and Cl^-; [b] NH_4^+ and PO_4^{3-}; [c] Ag^+ and Cl^-; [d] Mg^{2+} and O^{2-}; [e] Ca^{2+} and F^-; [f] Al^{3+} and Br^-; [g] Fe^{3+} and CO_3^{2-}; [h] Na^+ and S^{2-}; [i] Li^+ and $S_2O_3^{2-}$; [j] K^+ and O^{2-}; [k] Cu^{2+} and ClO_3^-; [l] Fe^{3+} and OH^-; [m] Cs^+ and P^{3-}; [n] Mg^{2+} and N^{3-}; [o] H^+ and SO_4^{2-}; [p] Ag^+ and S^{2-}; [q] Ca^{2+} and $Cr_2O_7^{2-}$; [r] Au^+ and CrO_4^{2-}; [s] Mg^{2+} and MnO_4^-; [t] Na^+ and As^{3-}; [u] Ca^{2+} and HCO_3^-; [v] Cu^+ and HSO_4^-; [w] H^+ and Cl^-; [x] Mg^{2+} and SO_3^{2-}; [y] Fe^{2+} and O^{2-}.

Fe^{2+} and Cl^{-}	Cs^{+} and P^{3-}
Fe^{3+} and Cl^{-}	Mg^{2+} and N^{3-}
NH_4^{+} and PO_4^{3-}	H^{+} and SO_4^{2-}

Ag^{+} and Cl^{-}	Ag^{+} and S^{2-}
Mg^{2+} and O^{2-}	Ca^{2+} and $Cr_2O_7^{2-}$
Ca^{2+} and F^{-}	Au^{+} and CrO_4^{2-}

Al^{3+} and Br^{-}	Mg^{2+} and MnO_4^{-}
Fe^{3+} and CO_3^{2-}	Na^{+} and As^{3-}
Na^{+} and S^{2-}	Ca^{2+} and HCO_3^{-}

Li^{+} and $S_2O_3^{2-}$	Cu^{+} and HSO_4^{-}
K^{+} and O^{2-}	H^{+} and Cl^{-}
Cu^{2+} and ClO_3^{-}	Mg^{2+} and SO_3^{2-}

Fe^{3+} and OH^-	Fe^{2+} and O^{2-}

CONCLUSIONS

1. Why do FeO and Fe_2O_3 have different formulas even though they are composed of the same elements? _____

2. How do the puzzle pieces for Al^{3+} and Fe^{3+} compare? Why? _____

3. When a compound forms from Li^+ and $S_2O_3^{2-}$, what is the:
   (a) formula? _____
   (b) sum of the oxidation states of the metal ions? _____
   (c) sum of the oxidation states of the nonmetal ions? _____
   (d) sum of the oxidation states of the compound? _____

4. How can puzzle pieces be used to determine formulas? _____