POGIL Activity: Constructing Ionic Compounds

Purpose
- To learn how to explain why stable ionic compounds are formed from a combination of cations and anions.
- To learn how to explain why different quantities of ions combine in different compounds.
- To learn how to explain the purposes for superscripts and subscripts in chemical formulas.
- To learn how to name and write the formulas for binary and ternary ionic compounds.

Materials
1 bundle of cards

Procedure
1. Sort the cards into piles by color. What are the common characteristics (other than color) of the cards in each pile?
   a. Yellow
   b. Green
   c. Gray
   d. Pink

2. In this activity, you will be constructing formulas for ionic compounds. Ionic compounds are formed when two ions are bound together. From what you know about electrostatic forces, if you have an ion represented by a yellow card, which color(s) of cards could it bond with to form an ionic compound? Explain your answer.
3. Notice that each card has a different height. Look at all of the shortest cards. What do they have in common? Repeat this logic for the medium and tall cards.
   a. Short
   b. Medium
   c. Tall

4. What do you think the total charge will be for a stable ionic compound (made up of positive and negative ions)? Why? What implications does this have for the height of the cards in an ionic compound formed in this activity?

PART I: BINARY IONIC COMPOUNDS

5. Using a single yellow card labeled $\text{Al}^{3+}$, choose a single green card that will make a stable ionic compound. Fill in the first line of the Data Table 1 (page 5), after the example, sodium oxide.

6. How is an ionic compound named, related to the names of the ions of which it is composed? Which ion comes first?

7. What part of the chemical formula tells you how many of each ion you have? Where is it written in relation to the ion’s symbol?

8. Notice that charges are not written in the chemical formula of the compound. Why do you suppose that is?
9. Now, using the same yellow \( \text{Al}^{3+} \) card, pair it with the appropriate number of green \( \text{Cl}^- \) cards. Complete another line in the data table for this new compound.

10. Repeat step 9 using cards for \( \text{Al}^{3+} \) and \( \text{O}^{2-} \).

11. Complete the rest of the table by combining different yellow cations and green anions (remember that each ionic compound will only contain one type of cation and one type of anion).

PART II: TERNARY IONIC COMPOUNDS

12. Now you will be working with the gray and pink cards, so you can set the yellow and green ones aside for the moment.

13. Why do you think that these compounds are called “ternary” instead of “binary”? What is different about the symbols for the ions on the grey and pink cards compared to the green and yellow cards?

14. Using a single ammonium card, choose a single pink card that will create a stable ionic compound. Complete the first row of Data Table 2 for this compound.

15. In Part I of the activity, you learned that subscripts in a chemical formula indicate how many ions are present. What do you need to change about this definition to make it more precise, given the new formulas you have just encountered?

16. Now make a new ionic compound from the \( \text{NH}_4^+ \) and \( \text{SO}_4^{2-} \) cards. Complete the next line in Data Table 2.
17. How did you indicate the number of ammonium ions in your compound? What additional marks were necessary?

18. Complete the rest of Data Table 2 (page 6) by combining different gray and pink cards. Remember that each ionic compound will only contain one type of cation and one type of anion.

19. Collect all the cards. Clip them together and return them to your teacher.
<table>
<thead>
<tr>
<th>Name of positive ion (cation)</th>
<th>Name of negative ion (anion)</th>
<th>Name of compound</th>
<th>Symbol of cation</th>
<th># of cation cards</th>
<th>Symbol of anion</th>
<th># of anion cards</th>
<th>Chemical Formula</th>
<th>Sum of charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Sodium</td>
<td>Oxide</td>
<td>Sodium oxide</td>
<td>Na⁺</td>
<td>2</td>
<td>O²⁻</td>
<td>1</td>
<td>Na₂O</td>
<td>0</td>
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</tbody>
</table>

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### Data Table 2: Ternary Ionic Compounds

<table>
<thead>
<tr>
<th>Name of positive ion (cation)</th>
<th>Name of negative ion (anion)</th>
<th>Name of compound</th>
<th>Symbol of cation</th>
<th># of cation cards</th>
<th>Symbol of anion</th>
<th># of anion cards</th>
<th>Chemical Formula</th>
<th>Sum of charges</th>
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Conclusion

1) Why do chemists use superscripts? Give an example.

2) Why do chemists use subscripts? Give an example.

3) Why do chemists use parentheses? Give an example.

4) Explain the significance of making the card heights of all the cations and anions in a compound equal.
5) Now it’s time to practice formula writing without using the ion cards! Name and write the formulas for five additional compounds that do not appear in the two data tables. You may use any combination of the ions used in this activity, as long as new compounds are named.

<table>
<thead>
<tr>
<th>Name of Compound</th>
<th>Chemical Formula</th>
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6) How would you explain the process of writing ionic chemical formulas to someone unfamiliar with the process? Be specific and detailed in your response.