



Science Objectives

- Students will understand that the chemical formula identifies each constituent element by its chemical symbol.
- Students will understand that a subscript after the chemical symbol indicates the number of atoms of each element found in each discrete molecule of that compound.
- Students will recognize that the valence of an element determines the ratio that atoms will combine with one another to form a neutral compound.
- Students will understand that atoms always combine with one another in simple whole number ratios.

Vocabulary

- cation
- anion
- ionic compound
- ionic charge
- valence

About the Lesson

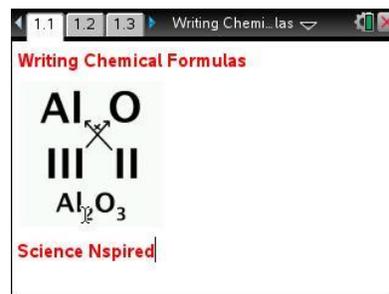
- This lesson involves students practicing writing chemical formulas for ionic binary compounds. The activity consists of four parts:
 - Students will write chemical formulas given a cation and an anion.
 - Students will determine the charge of a transition metal given a formula of a compound.
 - Students will write chemical formulas given the name of a compound.
 - Students will name a compound given its formula.
- As a result, students will:
 - Reinforce understanding of the concept of ionic charges necessary to write the chemical formula of ionic compounds.
 - Recognize that the valences of the elements determine the ratio of the elements in a compound.

TI-Nspire™ Navigator™

- Send out the *Writing_Chemical_Formulas.tns* file.
- Monitor student progress using Class Capture.

Activity Materials

- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Open a document
- Move between pages
- Use a minimized slider
- Type formula in ChemBox
- Open Directions Box

Tech Tips:

- Make sure that students properly capitalize the formulas when using ChemBox.
- In order to access Directions for each page, press **menu** and select **Writing Formulae > Directions**.

Lesson Materials:

Student Activity

- Writing_Chemical_Formulas_Student.doc
- Writing_Chemical_Formulas_Student.pdf
- Writing_Chemical_Formulas.tns
- Periodic table of elements.

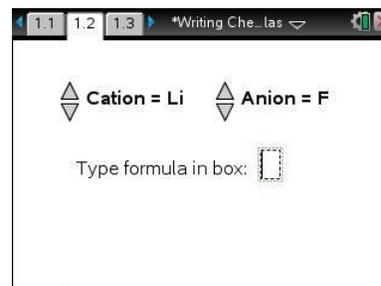


Discussion Points and Possible Answers

Have students answer all questions on the student worksheet.

Move to page 1.2.

- Students are to review the directions given in the pop-up information box. They can close the Directions box by clicking . They can view the directions again by pressing . In this part of the activity students will write a chemical formula for a given cation and anion pair.



- Using the Periodic table, determine the valence of Li and F and record it in the table below in the corresponding boxes. Explain your answer.

Answer: Li is in group 1, it has a valence 1+. F is in group 7 and has a valence 1-.

- What are ionic charges of the given cation and anion, Li and F? Why?

Answer: Valences help to determine the ionic charge. The lithium ion Li^+ has a charge of 1+, the fluorine ion, F^- is 1-. **Note:** The 1 is ignored when determining the ionic charge in group 1 and group 7 elements.

- What is the simplest ratio of positive and negative ions that is needed to produce a neutral compound?

Answer: the ratio is 1 Li to 1 F.

- Determine the chemical formula for the Li and F compound. Check your answer by typing the formula in the ChemBox on page 1.2 Then write correct formula in the corresponding box in the table below.

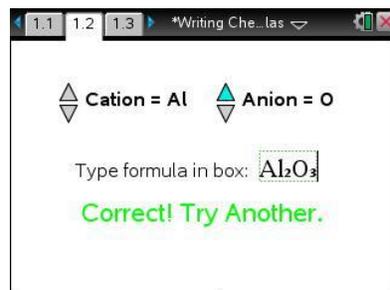
| | Anions – | F | Cl | Br | O | S | N | P |
|-----------|----------|------------------|-------------------|-------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Cations + | Valence | 1- | 1- | 1- | 2- | 2- | 3- | 3- |
| Li | 1+ | LiF | LiCl | LiBr | Li ₂ O | Li ₂ S | Li ₃ N | Li ₃ P |
| Na | 1+ | NaF | NaCl | NaBr | Na ₂ O | Na ₂ S | Na ₃ N | Na ₃ P |
| K | 1+ | KF | KCl | KBr | K ₂ O | K ₂ S | K ₃ N | K ₃ P |
| Mg | 2+ | MgF ₂ | MgCl ₂ | MgBr ₂ | MgO | MgS | Mg ₃ N ₂ | Mg ₃ P ₂ |
| Ca | 2+ | CaF ₂ | CaCl ₂ | CaBr ₂ | CaO | CaS | Ca ₃ N ₂ | Ca ₃ P ₂ |
| Sr | 2+ | SrF ₂ | SrCl ₂ | SrBr ₂ | SrO | SrS | Sr ₃ N ₂ | Sr ₃ P ₂ |
| Al | 3+ | AlF ₃ | AlCl ₃ | AlBr ₃ | Al ₂ O ₃ | Al ₂ S ₃ | AlN | AlP |



2. Students are to click the up or down arrows to select different cation and anion combinations.
- Q5. Determine the valence of each cation and anion and record them in the table above in the corresponding boxes. Explain your answers.

Answer: Na and K are in group 1 and have valences of 1+. Mg, Ca, and Sr are in group 2 and have valences of 2+, Al is in group 3 and has a valence of 3+. Cl and Br are in group 7 and have valences of 1-, O and S are in group 6 and have valences of 2-, N and P are in group 5 and have valences of 3-.

- Q6. Determine the chemical formula for each cation and anion combination. Check your answer by typing the formula in the ChemBox on page 1.2 Then write correct formula in the corresponding box in the table above.



- Q7. Explain how to choose the subscripts in a chemical formula of an ionic compound given the valences of the anion and cation.

Answer: The subscripts are the numbers in the simplest ratio of anions and cations that is needed to produce a neutral compound in each case. The ionic charge is determined by the valence of an element. For example, since charge of Al is +3 and charge of O is -2, two aluminum ions (charge +6) will balance three oxygen ions (charge -6). Thus the ratio of Al to O is 2 to 3 to produce the neutral compound. The resulting formula is Al_2O_3 .

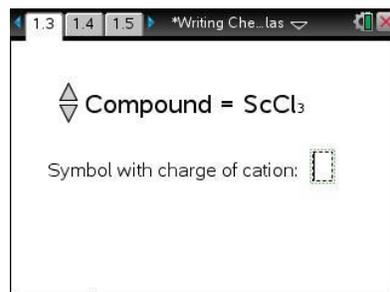
Move to page 1.3.

3. Students are to review the directions given in the pop-up information box. They can close the Directions box by clicking . They can view the directions again by pressing .

In this part of the activity students will determine the charge of the transition metal in the given compound.

- Q8. Given the correct chemical formula for a compound containing transition metal, how can you determine the charge of the metal cation?

Answer: The charge of the metal cation can be found knowing the ionic charge of the anion and number of anions and cations in the compound and using the fact that total charge of the compound is zero.





Q9. What is the ionic charge of the anion in the given compound ScCl_3 ? Explain your answer.

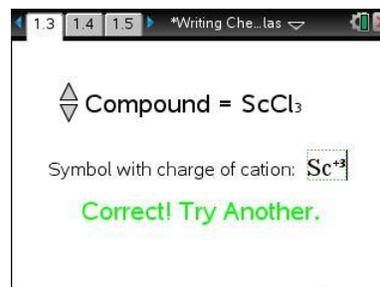
Answer: The anion is Cl, located in group 7, so its valency is 1- and its charge is -1 .

Q10. What is the ionic charge of the cation in the given compound ScCl_3 ? Explain your answer.

Answer: Since there are three atoms of Cl, so the total charge of atoms of Cl is -3 . Thus, the charge of one atom of Sc is $+3$ in order to have neutral compound.

4. Students need to type their answer in the ChemBox on page 1.3 to check it. They need to use ^ to insert superscript for the charge.

5. Students are to click the up or down arrows to select all available compounds.



Q11. For each given compounds complete the table below and determine the ionic charge of the metal in the compound. Check your answer by typing the ion formula in the ChemBox on page 1.3.

| Compound | Anion | | | Cation | | | |
|-------------------------|--------------|--------------------|--------------|--------------|--------------------|--------------|-------------------|
| | Ionic Charge | Number of Elements | Total Charge | Total Charge | Number of Elements | Ionic Charge | Formula |
| ScCl_3 | -1 | 3 | -3 | +3 | 1 | +3 | Sc^{3+} |
| CoF_2 | -1 | 2 | -2 | +2 | 1 | +2 | Co^{2+} |
| VCl_4 | -1 | 4 | -4 | +4 | 1 | +4 | V^{4+} |
| CrBr_3 | -1 | 3 | -3 | +3 | 1 | +3 | Cr^{3+} |
| MnCl_2 | -1 | 2 | -2 | +2 | 1 | +2 | Mn^{2+} |
| FeCl_2 | -1 | 2 | -2 | +2 | 1 | +2 | Fe^{2+} |
| Cu_2O | -2 | 1 | -2 | +2 | 2 | +1 | Cu^+ |
| ZnF_2 | -1 | 2 | -2 | +2 | 1 | +2 | Zn^{2+} |
| FeCl_3 | -1 | 3 | -3 | +3 | 1 | +3 | Fe^{3+} |
| MnCl_4 | -1 | 4 | -4 | +4 | 1 | +4 | Mn^{4+} |
| MnBr_4 | -1 | 4 | -4 | +4 | 1 | +4 | Mn^{4+} |
| CrP_2 | -3 | 2 | -6 | +6 | 1 | +6 | Cr^{6+} |
| MnS_5 | -2 | 5 | -10 | +10 | 1 | +10 | Mn^{10+} |
| Mn_2O_7 | -2 | 7 | -14 | +14 | 2 | +7 | Mn^{7+} |
| CuCl_2 | -1 | 2 | -2 | +2 | 1 | +2 | Cu^{2+} |



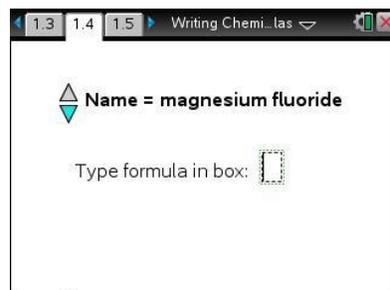
Q12. Explain why you could not use periodic table to determine ionic charge of the metal in these compounds.

Answer: transition metals have variable valency because they have unfilled d-orbitals.

Move to page 1.4.

6. Students are to review the directions given in the pop-up information box. They can close the Directions box by clicking . They can view the directions again by pressing .

In this part of the activity students will write the chemical formula given the name of a compound.



Q13. Determine the chemical formula for each compound given in the table below. Record your formula in the table. Check your work by typing the formula in the ChemBox.

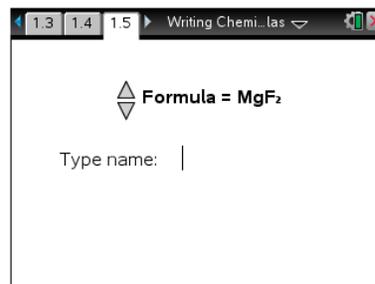
Teacher Tip: Discuss with the students chemical names and suffixes. Point their attention to the fact that there is a big difference between the "ide", "ate" and "ite" suffixes. As a general rule an "ide" suffix indicates an element, e.g. sulfide S^{2-} , nitride N^{3-} and phosphide P^{3-} .

| | | | |
|---|--|--|--|
| Magnesium fluoride MgF₂ | Barium nitride Ba₃N₂ | Sodium bromide NaBr | Lithium chloride LiCl |
| Calcium iodide CaI₂ | Aluminum iodide AlI₃ | Calcium oxide CaO | Magnesium sulfide MgS |
| Lithium oxide Li₂O | Cesium nitride Cs₃N | Aluminum oxide Al₂O₃ | Lithium nitride Li₃N |
| Calcium nitride Ca₃N₂ | Aluminum chloride AlCl₃ | Calcium phosphide Ca₃P₂ | Iron (II) chloride FeCl₂ |
| Zinc (II) oxide ZnO | Magnesium bromide MgBr₂ | Tin (II) sulfide SnS | Tin (IV) bromide SnBr₄ |
| Copper (I) oxide Cu₂O | Silver (I) bromide AgBr | Iron (III) sulfide Fe₂S₃ | Nickel (III) sulfide Ni₂S₃ |
| Manganese (II) bromide MnBr₂ | Sodium nitride Na₃N | Mercury (II) oxide HgO | Mercury (I) oxide Hg₂O |
| Tin (IV) oxide SnO₂ | Potassium iodide KI | Potassium nitride K₃N | Barium sulfide BaS |
| Nickel (II) oxide NiO | Aluminum nitride AlN | Lead (II) sulfide PbS | Lead (IV) sulfide PbS₂ |
| Cadmium sulfide CdS | Tin (II) nitride Sn₃N₂ | Strontium sulfide SrS | Cobalt (III) oxide Co₂O₃ |
| Barium hydride BaH₂ | Iron (II) iodide FeI₂ | Silver (I) chloride AgCl | |



Move to page 1.5.

7. Students are to review the directions given in the pop-up information box. They can close the Directions box by clicking . They can view the directions again by pressing .



In this part of the activity, students will name the given ionic binary compounds.

- Q14. How many elements are in binary ionic compounds? What are they?

Answer: there are two elements, first one is a metal and second one is a non-metal

- Q15. For each given formula record the names of the metal element, non-metal element, and the chemical name of the compound. Check your answer by typing the name of the compound at the cursor next to "Type name:" Then complete the table below and on the next page.

| Chemical Formula | Cation | Anion | Chemical name |
|--------------------------------|-----------|------------|--------------------|
| MgF ₂ | magnesium | fluorine | magnesium fluoride |
| Ba ₃ N ₂ | barium | nitrogen | barium nitride |
| NaBr | sodium | bromine | sodium bromide |
| LiCl | lithium | chlorine | lithium chloride |
| CaI ₂ | calcium | iodine | calcium iodide |
| AlI ₃ | aluminum | iodine | aluminum iodide |
| CaO | calcium | oxygen | calcium oxide |
| MgS | magnesium | sulfur | magnesium sulfide |
| Li ₂ O | lithium | oxygen | lithium oxide |
| Cs ₃ N ₂ | cesium | nitrogen | cesium nitride |
| Al ₂ O ₃ | aluminum | oxygen | aluminum oxide |
| Li ₃ N | lithium | nitrogen | lithium nitride |
| Ca ₃ N ₂ | calcium | nitrogen | calcium nitride |
| Ca ₃ P ₂ | calcium | phosphorus | calcium phosphide |
| FeCl ₂ | iron | chlorine | iron (II) chloride |
| ZnO | zinc | oxygen | zinc (II) oxide |
| MgBr | magnesium | bromine | magnesium bromide |
| SnS | tin | sulfur | tin (II) sulfide |
| SnBr ₄ | tin | bromine | tin (IV) bromide |
| Cu ₂ O | copper | oxygen | copper (I) oxide |



| Chemical Formula | Cation | Anion | Chemical name |
|--------------------------------|-----------|----------|------------------------|
| AgBr | silver | bromine | silver (I) bromide |
| Fe ₂ S ₃ | iron | sulfur | iron (III) sulfide |
| Ni ₂ S ₃ | nickel | sulfur | nickel (III) sulfide |
| MnBr ₂ | manganese | bromine | manganese (II) bromide |
| Na ₃ N | sodium | nitrogen | sodium nitride |
| HgO | mercury | oxygen | mercury (II) oxide |
| Hg ₂ O | mercury | oxygen | mercury (I) oxide |
| SnO ₂ | tin | oxygen | tin (IV) oxide |
| KI | potassium | iodine | potassium iodide |
| K ₃ N | potassium | nitrogen | potassium nitride |
| BaS | barium | sulfur | barium sulfide |
| NiO | nickel | oxygen | nickel (II) oxide |
| MgS | magnesium | sulfur | magnesium sulfide |
| AlN | aluminum | nitrogen | aluminum nitride |
| PbS | lead | sulfur | lead (II) sulfide |
| PbS ₂ | lead | sulfur | lead (IV) sulfide |
| CdS | cadmium | sulfur | cadmium sulfide |
| Sn ₃ N ₂ | tin | nitrogen | tin (II) nitride |
| Sr ₂ S | strontium | sulfur | strontium sulfide |
| Co ₂ O ₃ | cobalt | oxygen | cobalt (III) oxide |
| BaH ₂ | barium | hydrogen | barium hydride |
| Fel ₂ | iron | iodine | iron (II) iodide |
| AgCl | silver | chlorine | silver (I) chloride |

Tech Tip: The names of compounds should be entered in small case letters with a single space between each word. For transition metals use Roman numerals in parentheses to indicate the charge.

Q16. What is the general rule for naming binary chemical compounds?

Answer: Write the name of the metal. Write the name of the nonmetal using suffix "ide". For transition metals, use Roman numerals in parentheses to indicate the charge.



TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to type the formula in the ChemBox. Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

When students are finished with the activity, discuss general rules for writing chemical formulas and naming binary compounds. Collect student worksheets.

Assessment

- Answers to questions are written into the student worksheet.
- Use QuickPoll to check student work in each part of the activity. Quick Poll could be then saved to Student Portfolio.