

Ionic Compounds Using Polyatomic Ions

Today we will study ionic compounds that use polyatomic ions. **Polyatomic ions are a group of two or more elements that have an overall ionic charge.** Most times the polyatomic ion will function as an anion, but there are a few polyatomic ions that are cations. All of the polyatomic ions that we will use are listed on the back of your periodic table.

Please note: All of the polyatomic ions are written with parenthesis. **You CANNOT change any of the information inside the parenthesis.** Think of anything inside parenthesis as being protected. When you cross oxidation numbers you must write it outside the parenthesis.

Writing ionic compounds that have polyatomic ions is, for the most part, a lot like writing binary ionic compounds. The only difference is one extra step.

Part I: How to Write a Formula for an Ionic Compound that has a Polyatomic Ion.

For the first example I'll use **aluminum** and **phosphite**.

Description of Action	Action
1. Write the symbol of the cation with its charge.	1. Al^{3+}
2. To the right of the cation, write the polyatomic anion and its charge.	2. $\text{Al}^{3+} (\text{PO}_3)^{3-}$
3. Cross each element's oxidation number to the lower right side of the other element's symbol.	3. $\text{Al}^{3+} (\text{PO}_3)^{3-}$ Result: $\text{Al}_3 (\text{PO}_3)_{3+}$
4. Remove all (+) signs, (-) signs and ones.	4. $\text{Al}_3 (\text{PO}_3)_3$
5. Reduce, if necessary. Remember, do not touch anything inside the parenthesis.	5. $\text{Al} (\text{PO}_3)$
6. If there is no subscript outside the anion's parenthesis, remove the parenthesis.	6. Answer: Al PO_3

Please note: Many of the polyatomic ions have very similar names that differ only in one letter. For example, phosphate is $(\text{PO}_4)^{3-}$ and phosphite is $(\text{PO}_3)^{3-}$. **You have to memorize most of the polyatomic ions for the test. Start studying early!!!**

Now you try this one using **calcium** and **chlorate**.

Description of Action	Action
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.

Note: When you say out loud a formula involving parenthesis, you use the word "taken" as in the formula above for calcium chlorate, which is $\text{Ca} (\text{ClO}_3)_2$. You say "Ca Cl O three taken twice."

Try the following for practice: **ammonium** and **nitrate**. (Ammonium is a polyatomic cation.)

More Practice:

1. potassium and chromate
2. magnesium and oxalate
3. strontium and phosphate
4. cesium and sulfite
5. calcium and selenate
6. rubidium and iodate

Part II: Naming Ionic Compounds that have Polyatomic Ions

For the first example we will use our answer from the first example on the other side, **Al PO₃**

Description of Action	Action
1. Write the name of the cation.	1. aluminum
2. To the right of the cation name, write anion's name.	2. aluminum phosphite

That's it! Just two steps. Don't get confused by the lack of parenthesis or any number that may appear outside of it. All that matters is the formula inside the parenthesis or what is left over. Try to name the answer from our second example in the first part, **Ca (ClO₃)₂**

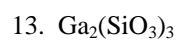
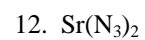
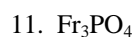
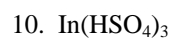
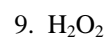
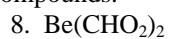
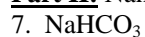
Description of Action	Action
1.	1.
2.	2.

Homework

Part I: For each of the following pairs of elements, write the correct formula.

1. calcium and selenate
2. magnesium and nitrite
3. rubidium and dichromate
4. ammonium and hydroxide
5. lithium and periodate
6. potassium and sulfate

Part II: Name each of the following ionic compounds.



Part III: Write the formula of each ionic compound named below.

16. sodium sulfate

17. cesium nitrate

18. calcium hydroxide

19. strontium hexafluorosilicate

20. gallium permanganate

21. beryllium citrate

22. hydrogen cyanide

23. aluminum hydrogen sulfate

24. lithium perchlorate

25. magnesium thiocyanate

26. potassium tartrate

27. rubidium borate

28. ammonium hypobromite

29. radium hydrogen oxalate

30. francium tetraborate

Part IV: Write the formulas for each of the following polyatomic ions (**These are the ones you have to memorize!!!**):

- | | |
|--------------------|--------------------|
| 1. hydronium - | 2. bicarbonate - |
| 3. perchlorate - | 4. phosphate - |
| 5. ammonium - | 6. hydroxide - |
| 7. acetate - | 8. chlorate - |
| 9. carbonate - | 10. nitrate - |
| 11. phosphite - | 12. sulfite - |
| 13. sulfate - | 14. silicate - |
| 15. nitrite - | 16. chlorite - |
| 17. hypochlorite - | 18. permanganate - |

Part V: Name each of the following polyatomic ions (**These are the ones you have to memorize!!!**):

- | | |
|--|--------------------------------|
| 1. $(\text{C}_2\text{H}_3\text{O}_2)^{1-}$ | 2. $(\text{H}_3\text{O})^{1+}$ |
| 3. $(\text{NO}_3)^{1-}$ | 4. $(\text{PO}_4)^{3-}$ |
| 5. $(\text{SO}_4)^{2-}$ | 6. $(\text{SiO}_3)^{2-}$ |
| 7. $(\text{ClO})^{1-}$ | 8. $(\text{ClO}_4)^{1-}$ |
| 9. $(\text{OH})^{1-}$ | 10. $(\text{NH}_4)^{1+}$ |
| 11. $(\text{ClO}_3)^{1-}$ | 12. $(\text{CO}_3)^{2-}$ |
| 13. $(\text{SO}_3)^{2-}$ | 14. $(\text{NO}_2)^{1-}$ |
| 15. $(\text{ClO}_2)^{1-}$ | 16. $(\text{HCO}_3)^{1-}$ |
| 17. $(\text{PO}_3)^{3-}$ | 18. $(\text{MnO}_4)^{1-}$ |