

Nomenclature Workshop

Introduction to Inorganic Nomenclature

Whenever you begin study of a new field, what do you have to do first? You have to learn the language of that field. Every field of study has its own vocabulary. Thus, before you can communicate you have to learn the words that people use in that field, or you will have a very hard time learning the concepts that are being taught. This is certainly also true in chemistry. In chemistry we use words that you may or may not have heard before such as *electrolysis*, *effusion*, *hybridization*, *resonance*, and *stoichiometry*. Chemists also use words that have a different meaning than the common definition such as the word *mole*. Therefore, a good grasp of the language of chemistry is critical to your success in a chemistry course. However, studying a new language is difficult and not considered enjoyable by many people. Luckily, when instructors teach chemistry they generally try to use the new words only when they need them making the learning of the language much easier.

However, there is one part of the chemical vocabulary that simply can't be put off, and that is the language of chemical nomenclature. When instructors talk about the properties of chemicals (which is what chemistry is!), it is critical that you recognize the chemical that is being discussed. For example, if during the discussion of chemical reactions an instructor mentions that potassium chlorate is heated to produce potassium chloride and oxygen, it is critical that you are able to write the chemical reaction for this process. Thus you must learn chemical nomenclature as soon as possible. As further impetus to your study keep in mind that studies show a good correlation between learning nomenclature and final course grade. That is, students who learn nomenclature early and well have greater success in the course.

How do you learn chemical nomenclature? You practice and practice and practice. The following pages contain notes that have been prepared as an aid in your pre-workshop preparation. Please read these over carefully before coming to the laboratory.

ASSIGNMENT

Complete Worksheets 1 - 4. Answers will be made available after the laboratory due date. For more help please read pages 82-89 in your textbook. Worksheets are due at the beginning of the laboratory class the week of January 20th.

I. IONIC COMPOUNDS

A. Cations

1. Monatomic

- a) Monatomic cations are most commonly formed from metallic elements. They take the name of the element itself:



- b) If an element can form more than one positive ion, the positive charge of the ion is indicated by following the name of the metal with a Roman numeral in parenthesis:



Experience is required to know which elements commonly exist in more than one charge state. An older method still widely used for distinguishing between two differently charged ions of a metal uses the endings -ous or -ic; these endings represent the lower and higher charged ions, respectively. They are used together with the root of the Latin name of the element:



2. Polyatomic

- a) The only common polyatomic cations are those given below:

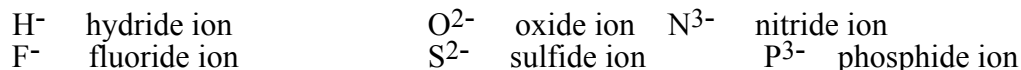


The name mercury(I) ion is given to Hg_2^{2+} because it can be considered to consist of two Hg^+ ions. Mercury also occurs as the monatomic Hg^{2+} ion, which is known as the mercury(II) or mercuric ion.

B. Anions

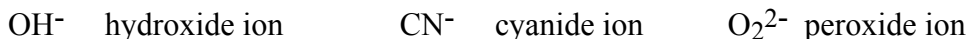
1. Monatomic

Negative ions are called anions. Monatomic anions are most commonly formed from atoms of the nonmetallic elements. They are named by dropping the ending of the name of the element and adding the ending -ide:



2. Polyatomic

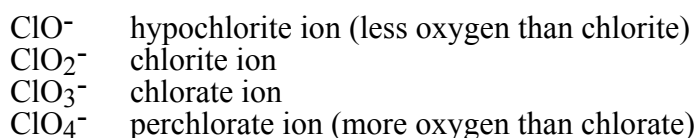
- a) Only a few common polyatomic ions end in -ide:



b) There are many polyatomic anions containing oxygen. Anions of this kind are referred to as oxyanions. A particular element, such as sulfur, may form more than one oxyanion. When this occurs, rules for indicating the relative numbers of oxygen atoms in the anion are used. When an element has two oxyanions, the name of the one that contains more oxygen ends in -ate; the name of the one with less oxygen ends in -ite:

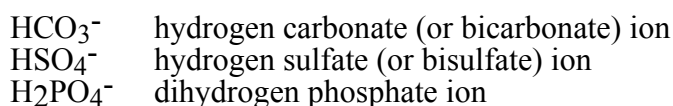


When the series of anions of a given element extends to three or four members, as with the oxyanions of the halogens, prefixes are also employed. The prefix hypo- indicates less oxygen, whereas the prefix per- indicates more oxygen:



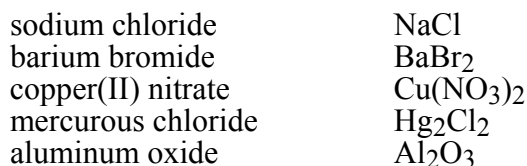
Notice that if these rules are memorized, only the name for one oxyanion in a series is needed to deduce the names of the other members.

c) Many polyatomic anions that have high charges readily add one or more hydrogen ions to form anions of lower charge. These ions are named by prefixing the word hydrogen or dihydrogen as appropriate, to the name of the hydrogen-free anion. An older method which is still used, is to use the prefix bi-:



C. Naming Ionic Compounds

The names of cations and anions are combined to name and write the formulas for ionic compounds:



The overall zero charge is provided for by adjusting the ratios of cations and anions. In the second example, two Br^- anions are required to balance the charge of the single Ba^{2+} cation. In the third example, two nitrate ions, NO_3^- , are required to balance the charge of the Cu^{2+} ion. Notice that the formula for the entire anion must be enclosed in parentheses so that it is clear that the subscript 2 applies to all the atoms of the anion. The final example, aluminum oxide, is a little more complicated in that more than one of both cation and anion are needed to achieve charge balance. Two Al^{3+} cations are needed to balance the total charge of three O^{2-} anions.

II. ACIDS

This important class of compounds are named in a special way. For purposes of naming, the acids may be thought of as formed from hydrogen ions and an anion. When the anion is a simple monatomic species, the name of the acid has a prefix hydro- and an ending, -ic, as in these examples:

chloride ion (Cl^-)	hydrochloric acid (HCl)
sulfide ion (S^{2-})	hydrosulfuric acid (H_2S)

Many of the most important acids are derived from oxyanions. The name of the acid is related to the name of the anion; when the name of the anion ends in -ate, the name of the acid ends in -ic. Anions whose names end in -ite have associated acids whose names end in -ous. Prefixes in the name of the anion are retained in the name of the acid. These rules are illustrated by the oxyacids of chlorine:

hypochlorite ion (ClO^-)	hypochlorous acid (HClO)
chlorite ion (ClO_2^-)	chlorous acid (HClO_2)
chlorate ion (ClO_3^-)	chloric acid (HClO_3)
perchlorate ion (ClO_4^-)	perchloric acid (HClO_4)

III. NON-IONIC COMPOUNDS

Before we end this discussion, we will consider the systematic names of compounds that are nonionic. These are named with the more positively charged element first. The relative number of atoms of each element is indicated by prefixes; for example, mono-, di-, tri-, tetra-, penta-, and hexa-, which mean 1, 2, 3, 4, 5, and 6, respectively. We use the same suffixes in naming the more negative element as is used in naming ionic compounds. Some examples illustrate the rules:

NF_3	nitrogen trifluoride	CO_2	carbon dioxide
N_2F_4	dinitrogen tetrafluoride	SO_2	sulfur dioxide
CO	carbon monoxide	SO_3	sulfur trioxide
CCl_4	carbon tetrachloride	P_2O_5	diphosphorous pentoxide
CHCl_3	chloroform (trichloromethane)	NH_3	ammonia (nitrogen trihydride)

The other rules for naming compounds will be used as the need arises. We will also occasionally encounter common names that are still widely used for certain compounds. These compounds were discovered a long time ago and are commonly used in the applied sciences. The common names of these chemicals must simply be memorized.

In addition, your textbook has a number of problems that you should do.

NOMENCLATURE WORKSHEET 1

Give the formula of the following compounds:

1. sulfur dioxide _____
2. ammonium phosphate _____
3. lithium hydroxide _____
4. sodium sulfate _____
5. cadmium nitrate _____
6. hydrogen peroxide _____
7. silicon dioxide _____
8. ferrous chromate _____
9. carbon tetrachloride _____
10. cobaltous chloride _____
11. diphosphorous pentoxide _____
12. nickel(II) sulfite _____
13. phosphorous pentachloride _____
14. copper(II) sulfate _____
15. mercuric chloride _____
16. silver iodide _____
17. carbon disulfide _____
18. platinum(IV) cyanide _____
19. nitrous oxide (dinitrogen oxide) _____
20. gold(III) chloride _____
21. uranium(VI) fluoride _____
22. stannic fluoride _____
23. water _____
24. sodium thiosulfate _____
25. potassium chlorate _____
26. zinc nitrite _____
27. cobaltic bisulfite _____
28. nitric oxide _____
29. carbon monoxide _____
30. cuprous bromide _____
31. mercurous fluoride _____
32. carbon dioxide _____
33. aluminum carbonate _____
34. cesium oxalate _____
35. barium hypochlorite _____
36. methane _____
37. nitrogen dioxide _____
38. stannous bromide _____
39. magnesium bisulfite _____
40. beryllium periodate _____
41. ammonia _____
42. ferric oxide _____
43. strontium sulfide _____
44. lead(II) bicarbonate _____
45. sodium dichromate _____
46. calcium hydroxide _____

47. calcium carbide _____
48. rubidium chromate _____
49. nickel(II) chlorate _____
50. magnesium nitride _____
51. ammonium sulfide _____
52. aluminum phosphide _____
53. zinc dichromate _____
54. aluminum hydride _____
55. strontium phosphate _____
56. tin(II) phosphate _____
57. chromium(III) nitrate _____
58. cobalt(II) chlorate _____
- _____
59. iron(III) dichromate _____
60. beryllium iodide _____
61. copper(I) carbonate _____
62. mercurous acetate _____
- _____
63. gold(III) perchlorate _____
64. aluminum bisulfite _____
65. ferrous phosphate _____
66. cuprous chloride _____
67. diphosphorous pentoxide _____
68. ammonium nitrate _____
69. mercury(I) sulfate _____
- _____
70. stannic permanganate _____
73. cesium cyanide _____
74. bismuth(III) bisulfate _____
75. magnesium chlorite _____
76. arsenic trichloride _____
77. tin(II) oxide _____
78. lead(II) perchlorate _____
79. iron(II) bromide _____
80. silver sulfite _____
81. potassium permanganate _____
82. stannous sulfate _____
83. cobaltic fluoride _____
84. cesium bromate _____
85. calcium bisulfate _____
86. lithium hydride _____
87. lithium chlorate _____
88. cupric perchlorate _____
89. cesium nitrite _____
90. sodium bisulfate _____
91. hydrochloric acid _____
92. sulfuric acid _____
93. phosphoric acid _____
94. perchloric acid _____
95. hydrobromic acid _____
96. hydroiodic acid _____

71. magnesium dichromate_____

72. mercuric thiosulfate_____

97. nitric acid_____

98. hydrosulfuric acid_____

NOMENCLATURE WORKSHEET 2

Give the names of the following compounds:

1. NaCl _____
2. AgNO₃ _____
3. BaCrO₄ _____
4. KOH _____
5. ZnSO₄ _____
6. MgBr₂ _____
7. Al₂O₃ _____
8. CdCl₂ _____
9. NH₄I _____
10. Fe(OH)₃ a) _____
b) _____
11. Ba₃(PO₄)₂ _____
12. KClO₃ _____
13. Na₂CO₃ _____
14. (NH₄)₂C₂O₄ _____
15. (NH₄)₂CO₃ _____
16. NiF₂ _____
17. Zn(ClO₃)₂ _____
18. Ca(OH)₂ _____
19. BaSO₃ _____
20. AlCl₃ _____
21. Cu₂CO₃ a) _____
b) _____
23. FeO a) _____
b) _____
24. AgC₂H₃O₂ _____
25. Cr₂O₃ _____
26. KBr _____
27. Cd(HSO₄)₂ _____
28. CO₂ _____
29. H₂O₂ _____
30. CaSO₄ _____
31. Ni₃(PO₄)₂ _____
32. AsF₃ _____
33. Co₃(AsO₄)₂ _____
34. ZnCr₂O₇ _____
35. KCN _____
36. Bi(NO₃)₃ _____
37. CaH₂ _____
38. SnS₂ a) _____
b) _____
39. Cr₂(SO₄)₃ _____
40. Hg(BrO₃)₂ _____
41. N₂O₄ _____
42. Pb(HCO₃)₂ _____
43. Na₂Cr₂O₇ _____

Give the formulas:

1. Lead(II) nitrate _____
2. Calcium carbonate _____
3. Ammonium hydroxide _____
4. Potassium chromate _____
5. Cobalt(II) acetate _____
6. Magnesium nitrate _____
7. Copper(II) sulfate _____
8. Sodium sulfite _____
9. Iron(III) bromide _____
10. Copper(I) sulfide _____
11. Silver iodide _____
12. Cadmium bromide _____
13. Tin(IV) oxide _____
14. Sodium bicarbonate _____
15. Aluminum acetate _____
16. Zinc phosphate _____
17. Manganese(II) oxalate _____
18. Barium sulfate _____
19. Vanadium(V) nitrite _____
20. Bismuth(III) bromide _____
21. Potassium permanganate _____
22. Mercuric iodide _____
23. Sodium arsenate _____
24. Ammonium nitrate _____
25. Acetic acid _____
26. Manganese(IV) sulfide _____
27. Silver cyanide _____
28. Copper(II) dichromate _____
29. Cobalt(II) bisulfate _____
30. Stannous fluoride _____
31. Magnesium bicarbonate _____
32. Lead(II) chlorate _____
33. Iron(III) sulfate _____
34. Sodium bisulfate _____
35. Hydrogen sulfide _____
36. Magnesium hydroxide _____
37. Copper(II) bromate _____
38. Carbon tetrachloride _____
39. Nickel(II) acetate _____
40. Ammonia _____
41. Chlorine _____
42. Chromium(III) cyanide _____
43. Sulfur dioxide _____
44. Copper(I) hydroxide _____
45. Sodium peroxide _____
46. Barium nitrite _____
47. Calcium oxalate _____
48. Scandium(III) sulfite _____
49. Silver chromate _____
50. Carbon disulfide _____
51. Aluminum iodide _____
52. Titanium(IV) chloride _____

NOMENCLATURE WORKSHEET 3

Give the names or formulas of the following compounds:

- | | |
|---------------------------------------------------------|---------------------------------|
| 1. CaCl_2 _____ | 1. Sodium sulfide _____ |
| 2. KOH _____ | 2. Magnesium nitrate _____ |
| 3. NH_4Cl _____ | 3. Tin(IV) permanganate _____ |
| 4. BaSO_4 _____ | 4. Antimony(III) iodide _____ |
| 5. CdCO_3 _____ | 5. Copper(II) chromate _____ |
| 6. FeBr_2 _____ | 6. Cadmium hypochlorite _____ |
| 7. Co_2S_3 _____ | 7. Silver acetate _____ |
| 8. $\text{Zn}(\text{NO}_2)_2$ _____ | 8. Cobalt(II) sulfite _____ |
| 9. NiCr_2O_7 _____ | 9. Iron(II) bicarbonate _____ |
| 10. Na_3PO_4 _____ | 10. Lithium phosphate _____ |
| 11. $\text{Fe}(\text{ClO}_4)_3$ _____ | 11. Aluminum oxide _____ |
| 12. Cu_2CO_3 _____ | 12. Manganese(IV) cyanide _____ |
| 13. $\text{Ca}(\text{HCO}_3)_2$ _____ | 13. Ammonium carbonate _____ |
| 14. SnSO_3 _____ | 14. Beryllium nitrite _____ |
| 15. SnO_2 _____ | 15. Tin(IV) phosphate _____ |
| 16. $\text{Al}_2(\text{CrO}_4)_3$ _____ | 16. Iron(II) hydroxide _____ |
| 17. CuCN _____ | 17. Lead(II) dichromate _____ |
| 18. $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3$ _____ | 18. Sodium bromate _____ |
| 19. CrO_3 _____ | 19. Potassium nitride _____ |
| 20. Na_3P _____ | 20. Cobalt(III) oxide _____ |
| 21. $\text{Pb}(\text{OH})_2$ _____ | 21. Strontium bisulfate _____ |
| 22. $\text{Zn}(\text{ClO})_2$ _____ | 22. Antimony(V) sulfate _____ |

Acid Nomenclature - Worksheet 4

Give the formulas of the following compounds:

- | | |
|----------------------------|------------------------------|
| 1. hydrochloric acid _____ | 10. carbonic acid _____ |
| 2. chromic acid _____ | 11. perbromic acid _____ |
| 3. nitrous acid _____ | 12. nitric acid _____ |
| 4. phosphoric acid _____ | 13. hydrofluoric acid _____ |
| 5. chloric acid _____ | 14. sulfurous acid _____ |
| 6. chlorous acid _____ | 15. phosphorous acid _____ |
| 7. acetic acid _____ | 16. hypochlorous acid _____ |
| 8. oxalic acid _____ | 17. hydrosulfuric acid _____ |
| 9. sulfuric acid _____ | 18. arsenic acid _____ |

Give the names of the following compounds (in aqueous solution):

1. H_2SO_3 _____
2. H_3PO_4 _____
3. HNO_3 _____
4. H_3AsO_3 _____
5. HClO _____
6. HBr _____
7. HNO_2 _____
8. $\text{HC}_2\text{H}_3\text{O}_2$ _____
9. H_2CrO_4 _____
10. H_2CO_3 _____
11. $\text{H}_2\text{C}_2\text{O}_4$ _____
12. H_2SO_4 _____
13. HCl _____
14. HClO_4 _____
15. HCN _____