The Periodic Table, and naming inorganic compounds

Why?

The periodic table is a useful visual aid to remembering some of the important properties of each element. Chemists have adopted a set of names and symbols for the various elements, and a system of names and formulae to talk and write about compounds. Although very few chemists know all the intricate rules of nomenclature (which are cataloged in reference books), most chemical authors and speakers assume their audience is familiar with the rules for simple and common compounds.

Learning Objectives

- Understand the arrangement of the periodic table into periods and groups.
- Know names, symbols, and some properties (metal?, common ionic charge?) of common elements.
- Interpret names and formulae for ionic compounds involving elemental and common molecular ions.
- Relate the name to the formula for binary covalent compounds and for some common acids.

Success Criteria

- Fill in, from memory, the names and symbols of the most common elements in the Periodic Table, and, in the future, be able to add additional elements to your memorized table as they are discussed.
- For binary compounds, predict if bonding is ionic or covalent, and relate names to formulae.
- Learn the names and formulae for about 30 common polyatomic ions, and about 10 common acids.

Vocabulary and New Concepts

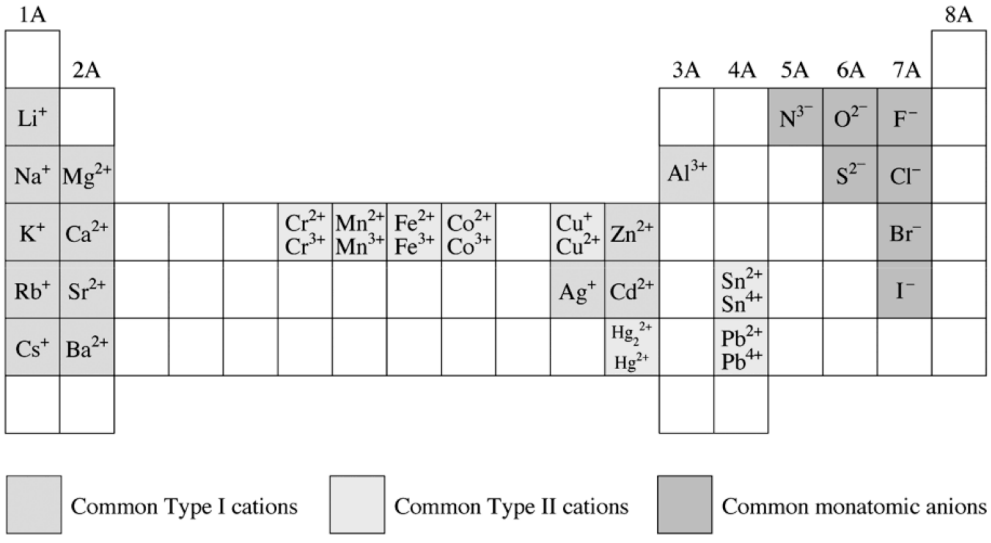
Periodic Table: Period, Group (= Family), Metals, Non-metals, Metalloids (= Semi-metals)
Alkali Metals, Alkaline Earth Metals, Halogens, Noble Gases, Transition Metals, Lanthanides, Actinides
Binary compound, Ionic Compound, Covalent Compound, Acid, Cation, Anion, Polyatomic Ion

Resource

Zumdahl and Zumdahl, *Chemistry* (6th ed.), (hereafter referred to as "Z&Z") section 2.7-2.8 (pp. 58-72).

Focus Information (1 – naming monoatomic ions)

Figure 2.22 (Z&Z; see below) shows charges of monoatomic ions frequently encountered in chemistry.



Additional focus information is found in Z&Z:

- Periodic Table and alphabetical listing of symbols/names inside front cover (and p. 60)
- Rules for naming ionic compounds (rules 1-3 on p. 62, flowchart on p. 65, Tables 2.3 and 2.4.

Key Questions

1. (Z&Z, ch. 2 #22, mod.) What are the meanings of the terms *family* and *period* in connection with the periodic table? For which of these terms is the term *group* also used?

2. What are the names of at least 3 elements in period 3?

3. What are the group numbers for elements that tend to form anions?

4. Where are the transition metals located in the periodic table?

5. What is the charge on ions of the alkaline earth metals?

6. What is the charge on the ions formed by the halogens?

7. Zumdahl and Zumdahl make a distinction between "Type I" and "Type II" cations. What is the difference? (note: this nomenclature is non-standard – would not be recognized by most chemists).

8. What is the difference between the copper(I) and copper(II) ions? What is the difference between the mercury(I) and mercury(II) ions? Which one of these elements (copper or mercury) represents an unusual case?

Exercises

1. The IUPAC (International Union of Pure and Applied Chemistry) suggests using numbers 1-18 for the groups. Add these numbers at the top of the table.

2. (Z&Z, ch. 2, #24) The two most reactive families of elements are the halogens and the alkali metals. How do they differ in their reactivies?

3. Around the edges of the figure, spell the names of each element whose ions appear in the figure above (use arrows to point from the names to the element).

4. "Ferric" is an older name for the iron(III) ion, and "ferrous" is an older name for the iron(II) ion. Predict the charges on the following ions: chromous ____; cobaltic _____; cuprous _____; stannous _____; manganic ____.

5. Write the name for each of the following compounds:

    a. CoS

    b. MgF_2

    c. $CrCl_3$

6. Give the chemical formula for each of the following compounds

    a. Zinc nitride

    b. Cuprous hydride

    c. Ferric oxide

7. What is wrong with the following chemical formula: Br_2Ca?

Problems

These problems refer to the periodic table at the bottom of p. 1 of this exercise.

1. What are the charges and names of the ions formed by the element hydrogen? Add these ions to the figure above.

2. Gallium ions, selenide ions, and carbide ions are not included in the focus information figure, but are found in certain materials. The charges are as expected from the positions in the periodic table. Add these three ions to the periodic table (and their names to the edges of the table).

3. Draw a dark line separating the metals from non-metals. Which elements are considered *metalloids* (also known as *semimetals*)? (If these terms are new to you, what is a good way to find out their meaning?)

4. In addition to symbols for the less common elements, what else is missing from this version of the periodic table?

Focus Information (2 – naming polyatomic ions and acids)

1. Names of polyatomic ions (Table 2.5 and discussion on p. 67)
2. Rules for naming acids (tables and flowchart on p. 72)

Exercises

Fill in the following Tables to help you memorize the names and formulae of polyatomic ions and acids.

1. Table of –ate names of oxoanions of non-metals (arranged as Periodic Table)

Fill in chemical formulae (including charges). Use periodic trends if necessary.

4A	5A	6A	7A
carbonate	nitrate (*)		
	phosphate (*,1,2)	sulfate (*,1)	chlorate(*,‡)
	arsenate (*,1,2)	selenate(1)	bromate(*,‡)
			iodate(*,‡)

2. Table of rules for polyatomic ions and acids "derived from" –ate oxoanions.

Complete the following rules for modifications to –ate oxoanions (see Z&Z, Table 2.5ff):

- (‡) Add one oxygen atom (ionic charge is unchanged)**:** *add per- prefix*
- (*) Remove one oxygen atom (ionic charge is unchanged): _____
- (‡) Remove two oxygen atoms (ionic charge is unchanged): _____
- (1) Add one H^+, but overall charge still negative: _____
- (2) Add two H^+, but overall charge still negative: _____
- (all) Add enough H^+ to give neutral molecule: _____

3. Rule for naming oxoanions of group 6 and 7 transition metals:

Name is similar to the name of the group 6A or 7A oxoanion of same formula (XO_n^{m-})

Identify the two examples from Table 2.5 that are covered by this rule:

4. Table of common polyatomic ions with names NOT covered by rules above

Make a shortened version of Table 2.5, containing only the ions not covered by exercises 1-3:

Focus Information (3 – naming binary covalent compounds)

- Rules for naming binary covalent compounds (rules 1-4 on p. 68, table 2.6).
- Table 2.7 (names of acids that do not contain oxygen).

Key Questions

1. What is a binary compound?

2. How can you predict if a binary compound is covalent?

3. When is the prefix *mono-* used?

4. What suffix is used at the end of the names of binary covalent compounds?

Exercises

1. Write out the rule for naming the acid formed when binary covalent compounds HX are dissolved in water:

2. Name the following binary covalent compounds:

    a. SCl_4

    b. ICl_3

    c. P_2O_5

    d. HBr (dissolved in water)

    e. HBr (pure compound - a colorless toxic gas)

Problems

Write out answers to exercises 12, 13, 67 and 72 from the end of chapter 2 of Z&Z (pp. 77-78)