

ACTIVITY 3– CHEMICAL NAMES AND FORMULAS

Background Information

The elements of the periodic table each have different atomic numbers. The atomic number not only tells us how many protons an element contains, but also the number of electrons in the neutral atom. All isotopes of a given element have the same number of protons. Chlorine-35 and chlorine-37 are examples. They both contain 17 protons and 17 electrons, but they differ in the number of neutrons. The symbols for these two isotopes are $^{35}_{17}\text{Cl}$ and $^{37}_{17}\text{Cl}$.

Ionic compounds

There are two main types of compounds –covalent and ionic. Ionic compounds result when electrons transfer from one element to another. This electron transfer creates ions (an atom or group of atoms that carries an electrical charge). Ionic compounds are held together by electrostatic (attraction between positively and negatively charged species) forces. The electrostatic force is very strong and as a result, ionic compounds have high melting points. Sodium chloride (NaCl) and sodium hydroxide (NaOH) are examples of ionic compounds.

Elements from group IA of the periodic table are metals that form positively charged ions (cations) with a charge of 1+. Elemental

metals from group IIA form ions with a charge of 2+. These ions form as a result of the metals giving up one and two electrons, respectively. On the right side of the periodic table in group VIIA are the halogens (F, Cl, Br, I), which tend to accept an electron to form negatively charged ions (anions) with a 1– charge. Sodium, a highly poisonous metal, gives up an electron to chlorine, a highly poisonous gas, which accepts the electron to form ordinary table salt. The sodium becomes a cation, the chlorine becomes an anion, and the two ions are held together as an ionic compound.

When NaCl is placed in a container of water, the compound separates, or dissociates, into Na^+ and Cl^- ions. Ionic compounds are **electrolytes** – they dissociate in solution, enabling the solution to conduct electricity.

Simple ionic compounds are named by first listing the positive ion (as the name of the element; Na^+ is called sodium) followed by the anion (by taking the root of the element name and adding -ide; Cl^- is called chloride). Subscripts are used to denote multiple ions in the formula.

Sometimes ions exist as a collection of elements. These are known as **polyatomic ions**. When you place an ionic compound that contains a polyatomic ion in an aqueous solution, the polyatomic ion stays together as a unit after dissociation. For example, if you dissolve some KNO_3 (potassium nitrate) in water, the compound dissociates into K^+ and NO_3^- ions.

Some common polyatomic ions

Ion	Name	Examples	
$C_2H_3O_2^-$	acetate	$NaC_2H_3O_2$	Sodium acetate
NH_4^+	ammonium	NH_4Cl	Ammonium chloride
CO_3^{2-}	carbonate	Li_2CO_3	Lithium carbonate
HCO_3^-	hydrogen carbonate (bicarbonate)	$NaHCO_3$	Sodium hydrogen carbonate
CN^-	cyanide	KCN	Potassium cyanide
OH^-	hydroxide	$Ca(OH)_2$	Calcium hydroxide
NO_2^-	nitrite	Na_2NO_2	Sodium nitrite
NO_3^-	nitrate	$Fe(NO_3)_2$	Iron (II) nitrate
PO_4^{3-}	phosphate	$Ba_3(PO_4)_2$	Barium phosphate
SO_3^{2-}	sulfite	$BeSO_3$	Beryllium sulfite
SO_4^{2-}	sulfate	K_2SO_4	Potassium sulfate

If a metal can form cations of differing charges, a Roman numeral in parentheses following the name of the metal specifies the positive charge. Sometimes the different charges are indicated by adding the endings -ous and -ic. The lower of the two possible charges on the ion is indicated using the -ous ending, and the higher charge is specified using the -ic ending.

Monoatomic ions with two possible charges

Ion	Name	Historic, or common name
Fe^{2+}	iron (II)	Ferrous ion
Fe^{3+}	iron (III)	Ferric ion
Cu^{1+}	copper (I)	Cuprous ion
Cu^{2+}	copper (II)	Cupric ion
Co^{2+}	cobalt (II)	Cobaltous ion
Co^{3+}	cobalt (III)	Cobaltic ion
Cr^{2+}	chromium (II)	Chromous ion
Cr^{3+}	chromium (III)	Chromic ion

Covalent compounds

Covalent compounds occur when elements are joined by shared electrons. Water and carbon dioxide are examples of covalent compounds. Simple binary covalent compounds (composed of only two elements) form between two nonmetals. The element farther to the left in the periodic table, and/or closer to the bottom within any group, appears first in the formula. Hydrogen is written as the second element in the compounds it forms with elements in groups IA to VA, and first in the compounds with the groups VIA and VIIA elements.

Covalent compounds are named as follows: the first element in the formula is named first, using the full element name. The second element is named as if it were an anion. Prefixes (mono-, di-, tri-, tetra-, etc.) are used to denote the numbers of each element present. We do not use the prefix mono- for naming the first element.

Simple binary covalent compounds

CO	Carbon monoxide	SF ₆	Sulfur hexafluoride
CO ₂	Carbon dioxide	SO ₃	Sulfur trioxide
CCl ₄	Carbon tetrachloride	AsI ₃	Arsenic triiodide
N ₂ O ₄	Dinitrogen tetroxide*	SeO ₂	Selenium dioxide

Covalent compounds do not dissociate in solution. They may dissolve of course, but the molecular unit remains intact. Therefore, solutions containing covalent compounds are unable to conduct electricity and are called **non-electrolytes**.

*It is common practice to drop the last letter of a prefix that ends in a or o before anions that begin with a vowel.