**ALL SAINTS’ SECONDARY SCHOOL, OYIGBO**

**SS 1 CHEMISTRY**

***LECTURE 6***

**CEMICAL FORMULAE**

***Naming Chemical Compounds***

From the periodic table, we must remember that elements in groups 1, 2 and 3 lose electrons to form positive ions. These positive ions are called CATIONS. Elements in groups 5, 6 and 7 gain electrons to form negative ions and these negative ions are called ANIONS. Also, remember that these charges are regarded to be their valencies. Valency is also known as OXIDATION STATE and it is the combining power of the elements.

***NAMES OF IONS***

1. **Naming positive ions (cations)**

With a few exception (such as NH4+), the positive ions are metal ions. Positive ions are named by the following rules:

1. For a monatomic positive ion, the name is that of the metal plus the word ‘ion.’ Example: Al3+ is called aluminum ion, Ca2+ is called calcium ion and so on.
2. Some cases occur, especially in the transition series (not in the first twenty elements), in which a metal can form more than one type of positive ion. In these cases, the charge of the ion is indicated by a Roman numeral in parentheses immediately following the ion name. example: Cu2+ is called copper (ii) ion, Co3+ is called cobalt (iii) ion, Co2+ is called cobalt ((ii) ion, and so on.
3. **Naming Negative Ions (anions)**

There are two types of negative ions: those having only one atom (monatomic) and those having several atoms (polyatomic).

1. A monatomic negative ion is named by adding ***–ide*** to the stem of the name of the nonmetal element from which the ion is derived. Example: O2- becomes oxide, Cl- becomes chloride, S2- becomes sulphide, and so on.
2. Polyatomic negative ions are common, especially those containing oxygen (called oxoanion). The oxoanion having the greater number of oxygen atoms is given the suffix ***–ate,*** and the oxoanion having the smaller number of oxygen is given the suffix ***–ite.*** For a series of oxoanions having more than two members, the ion with the largest number of oxygen atom has the prefix ***per-*** and the suffix ***–ate.*** The ion having the smallest number of oxygen atom has the prefix ***hypo-*** and the suffix ***–ate.***

**Formulas and Names of Some Common Polyatomic Ions**

|  |  |
| --- | --- |
| Formula | Name |
| CN- | Cyanide ion  |
| CO32- | Carbonate ion |
| HCO3- | Hydrogen carbonate (bicarbonate) ion |
| NO2- | Nitrite ion |
| NO3- | Nitrate ion |
| PO43- | Phosphate ion |
| HPO42- | Hydrogen phosphate ion |
| H2PO4- | Dihydrogen phosphate ion |
| OH- | Hydroxide ion |
| SO42- | Sulphate ion |
| SO32- | Sulphite ion |
| HSO4- | Hydrogen sulphate (bisulphate) ion |
| ClO- | Hypochlorite ion |
| ClO2- | Chlorite ion |
| ClO3- | Chlorate ion |
| ClO4- | Perchlorate ion |
| CrO42- | Chromate ion |
| Cr2O72- | Dichromate ion |
| MnO4- | Permanganate ion |

Compounds are electrically neutral; that is, they have no net electric charge. Thus, in a compound the number of positive and negative ions must be such that the positive and negative charges balance. To achieve this electrical neutrality, the valencies of the cations and anions are interchanged and written as subscript.

***Valencies of elements in the periodic table***

**group 8**

**group 1**

**group 7**

**group 5**

**group 6**

**group 4**

**group 3**

**group 2**

|  |  |  |
| --- | --- | --- |
| H+ |  | He |
| Li+ | Be2+ | B3+ | C4+ | N3- | O2- | F- | Ne |
| Na+ | Mg2+ | Al3+ | Si4+ | P3- | S2- | Cl- | Ar |
| K+ | Ca2+ |

**Examples on Writing Formulae of Chemical Compounds**

1. **Sodium oxide:** Contains sodium ion (Na+) and oxide ion (O2-). The chemical formula is Na2O. the ‘2’ on oxide ion is written as a subscript on sodium. That is, the two negative on oxide needs two positive’s to balance it for the neutral compound to form.
2. **Aluminum sulphide:** Contains aluminum ion ans sulphide ion (Al3+ and S2-). Interchange the valencies; the compound is Al2S3.

*If the ion involved is a polyatomic ion, the polyatomic ion is enclosed in a parenthesis.* *Example:*

1. **Aluminum sulphate:** Contains aluminum ion and sulphate ion (Al3+ and SO42-). Interchange the valencies and enclose the sulphate ion in a parenthesis: the compound is Al2(SO4)3.
2. **Ammonium carbonate:** Contains ammonium ion and carbonate ion (NH4+ and CO32-). The compound is (NH4)2CO3

*If the cation and anion have equal valencies, no need writing then as subscript; just combine the two ions.* *Example:*

1. **Calcium oxide:** Contains calcium ion and oxide ion (Ca2+ and O2-). The compound is CaO
2. **Sodium chloride:** Contains sodium ion and chloride ion (Na+ and Cl-). The compound is NaCl

**IUPAC Nomenclature**

IUPAC stands for International Union of Pure and Applied Chemistry.

Nomenclature simply means naming. This method of naming is a systematic naming through which all the atoms in the molecule and their oxidation numbers are mentioned. This is peculiar with molecules that contain polyatomic anions.

***Note:*** *Valency is also known as OXIDATION STATE or OXIDATION NUMBER.*

The atoms that form polyatomic ions with oxygen have variable oxidation state, (i.e. their oxidation states change based on the number of oxygen in the ion)

***How Do We Know The Oxidation State?***

1. The oxidation sate of oxygen remains -2.
2. The sum of the oxidation state of the atoms is equal to the number of charges on the polyatomic ion.
3. Then, the oxidation state of the other atoms can be calculated.

**Example 1:** SO42-

SO42- = -2

S + (-2 $×$ 4) = -2

S – 8 = -2

S = 8 – 2

S = +6

The oxidation state of sulphur in this ion is +6. During the naming, 6 would be written in a parenthesis in Roman numeral.

So the IUPAC name of SO42- is

*Tetraoxosulphate (vi) ion*

***Note:*** *The number of atoms appear are indicated with* ***mono, di, tri, tetra, penta, hexa,*** *and so on.*

**Example 2:** Cr2O72-

Cr2O2- = -2

2 $×$ Cr + (-2 $×$ 7) = -2

2Cr -14 = -2

2Cr = 14 -2

2Cr = 12

Cr = $\frac{12}{2}$

Cr = +6

The PAC name of Cr2O72- is

*Heptaoxodichromate (vi) ion*

**Example 3:** ClO3-

ClO3- = -1

Cl + (-2 $×$ 3) = -1

Cl -6 = -1

Cl = 6 – 1

Cl = +5

The IUPAC name of ClO3- is

*Trioxochlorate (v) ion*

With these, you can mention the IUPAC name of all the polyatomic anions.

When cations combine with the anions, they for neutral compounds (molecules), and the name starts from the cations

***Example 1:*** KMnO4

**Common name**: potassium permanganate

**IUPAC name**: Potassium tetraoxomanganate (vii)

***Example 2:*** Na2SO3

**Common name:** Sodium Sulphite

**IUPAC name:** Sodium trioxosulphate (iv)

***Example 3:***CaCO3

**Common name:** Calcium carbonate

**IUPAC name:** Calcium trioxocarbonate (iv)

***Example 4:*** NaHSO4

**Common name:** Sodium hydrogen sulphate

**IUPAC name:**

Sodium hydrogen tetraoxosulphate (vi)

***ASSIGNMENT***

1. Write the chemical formula of the following compounds
2. Calcium hydroxide
3. Aluminum trioxocarbonate (iv)
4. Magnesium dioxochlorate (iii)
5. Write the common names and the IUPAC names of the following compounds
6. K2Cr2O7
7. Al(NO3)3
8. NaClO