Ratna Sagar

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9

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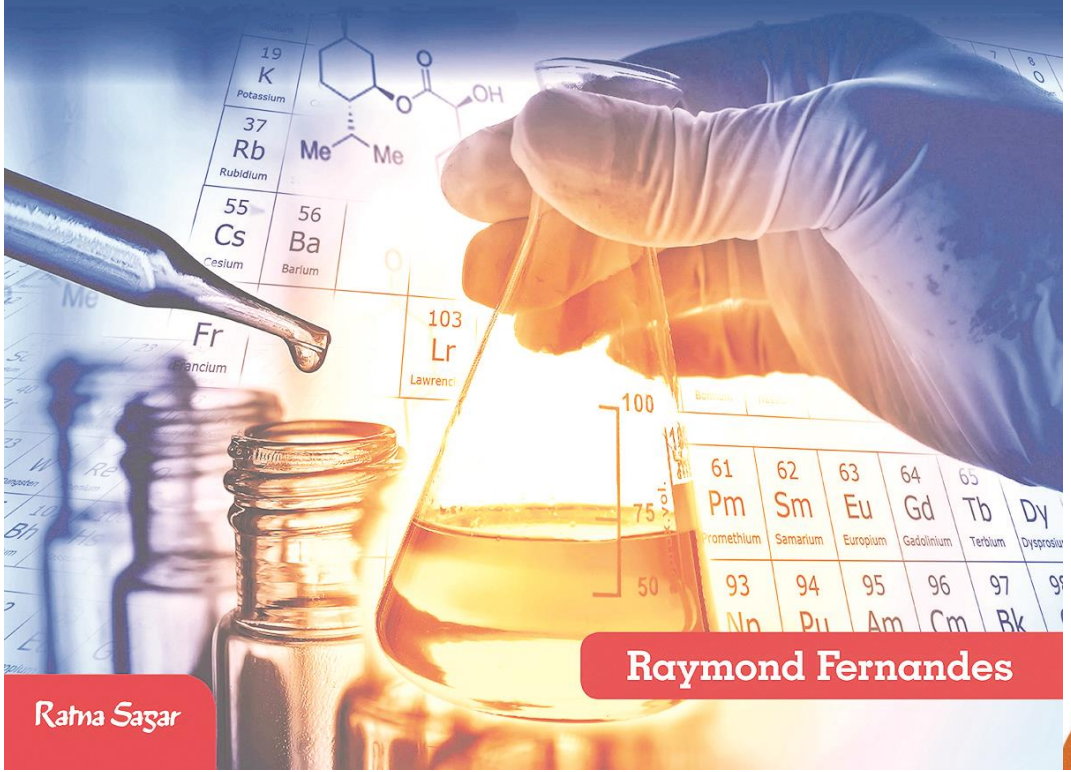
Living Science CHEMISTRY



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ICSE
Living Science
Chemistry

Class 9

Chapter 1 The Language of Chemistry

LEARNING OBJECTIVES

Valency

- **Modern definition of valency**
- **Variable valency**

Radicals

Chemical Formula

- **Writing the chemical formula**

Writing the Name of a Compound

Chemical Equations

- **Writing of a chemical equation**
- **Balanced chemical equation**
- **Balancing by hit and trial method**

Atomic Mass (Atomic Weight)

Molecular Mass

- **Relative molecular mass**
- **Percentage composition of a compound**

What is the Significance of the symbol of an element?

1. Symbol represents name of the element.

2. It represents one atom of the element.

3. It represents a definite mass of the element (equal to atomic mass expressed in grams).

4. It represents mass of the element which contains one Avogadro's number of atoms of that element.

Valency

Valency is the combining capacity of an element. The number of hydrogen atoms that combine with one atom of an element to form a compound is called valency of that element.

Examples: 1. Three atoms of hydrogen combine with one atom of nitrogen to form a molecule of ammonia (NH_3). Hence, the valency of nitrogen is 3.

2. Four atoms of hydrogen combine with one atom of carbon to form a molecule of methane (CH_4). Hence, the valency of carbon is 4.

Modern definition of valency

The valence electrons dictate the valency and chemical reactions of an element. The number of valence electrons of an element which actually takes part in chemical reactions is called the valency of that element.

Metals such as sodium, magnesium and aluminium lose one, two or three valence electrons respectively to form positive ions or **cations**. Therefore, the valency of sodium, magnesium and aluminium is 1, 2 and 3 respectively.

Non-metals such as fluorine, oxygen and nitrogen gain one, two and three electrons respectively in their valence shell to form negative ions or **anions**. Therefore, the valency of fluorine, oxygen and nitrogen is 1, 2 and 3 respectively.

Variable valency

Some elements exhibit more than one valency. These elements are said to possess variable valency. If an element exhibits variable valency then the name of the lower valency is denoted by the suffix –ous and that of higher valency with –ic.

Radicals

A radical may be defined as **an atom or group of atoms of the same or different elements which carries charge and behaves as a single unit.** There are two types of radicals depending upon the charges on them.

1. Basic radical: The radical carrying positive charge is called **basic radical**. It is also called **electropositive radical** or **cation**.

2. Acid radical: The radical having a negative charge on it is called the acid radical. It is also called the **electronegative radical** or **anion**.

Chemical Formula

The chemical formula of a compound is a symbolic representation of a molecule of the compound. It denotes the number of atoms of different elements present in one molecule of the compound.

Writing the chemical formula

Every compound is represented by a chemical formula. The following steps should be followed in writing the chemical formula.

Step 1 The symbol of the positive atom or basic radical is placed on the left-hand side and the symbol of the negative atom or acid radical is placed on the right-hand side.

Step 2 The valencies of the symbols are written below them.

Step 3 Interchange the valencies of the symbol and shift it to the lower right corner of the symbol. The valency numbers become subscripts of the corresponding symbols.

Step 4 Reduce the valency numbers to a simple ratio by dividing with a common factor, if required.

Writing the Name of a Compound

Compounds formed by the combination between metals and non-metals: In writing the formula of such compounds, the metal element is written on the left hand side and the non-metal element is written on the right hand side.

Examples: NaCl - Sodium chloride, KI - Potassium iodide

2. Compounds formed by the combination between two different non-metal elements: The less electronegative non-metal is written on the left hand side and the more electronegative nonmetal is written on the right hand side.

Examples: HCl - Hydrogen chloride H_2S - Hydrogen sulphide

3. Compounds containing three elements one of which is oxygen:

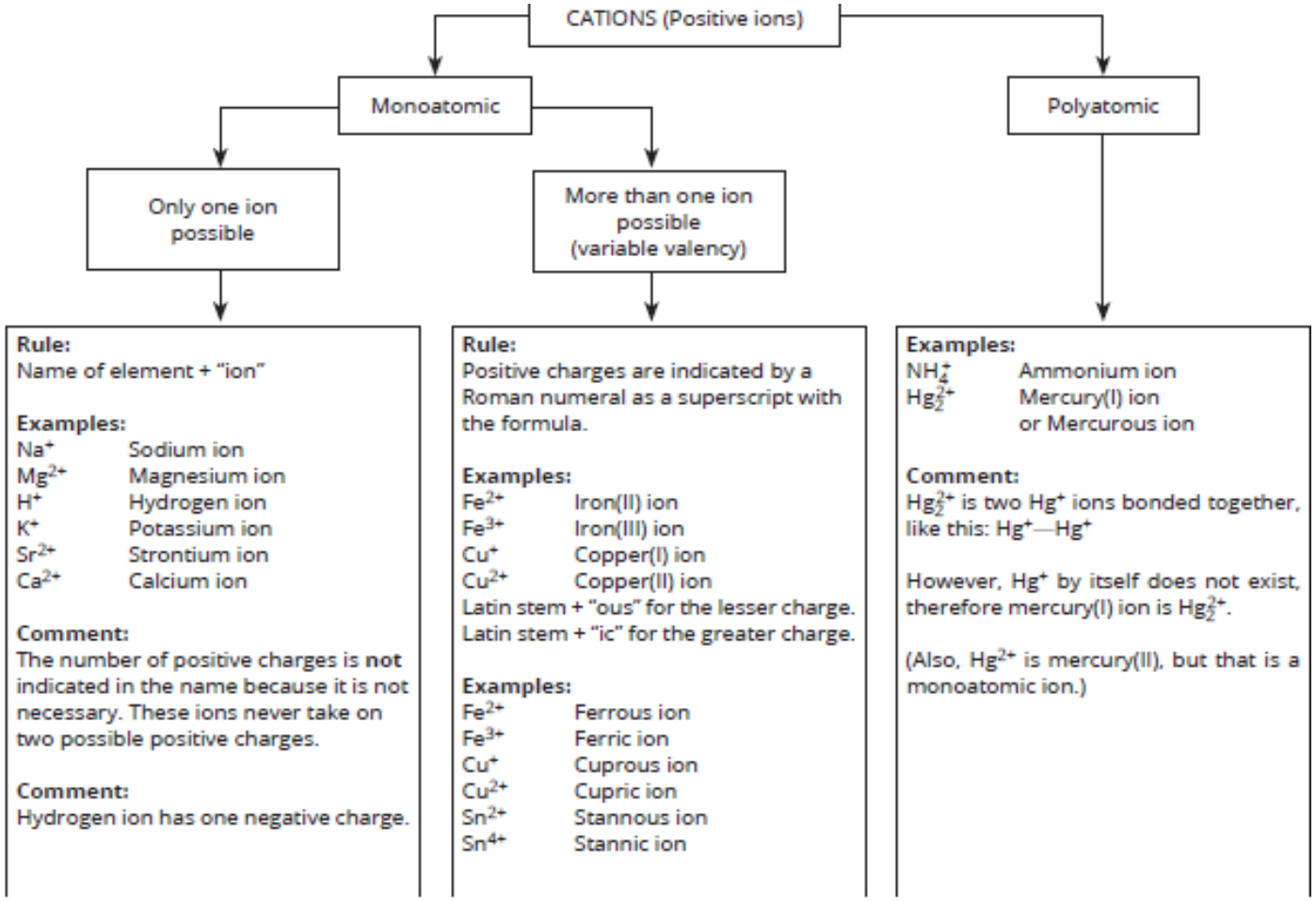
- Compounds containing three elements one of which is oxygen are named with **–ate** ending, if there is only one such compound.
- If there are two compounds, the one with more oxygen is named with **–ate** ending and the one with less oxygen is named with **–ite** ending.

Examples: $NaNO_3$ Sodium nitrate $NaNO_2$ Sodium nitrite

4. Naming of compounds with variable valencies: If a metal forms two series of compounds, these are differentiated by endings. The ending **–ic** is given to the name of the compound in which the metal shows the higher valency. The ending **–ous** is given to the name of the compound in which the metal is having lower valency.

Examples: CuCl - Cuprous chloride $Cu(NO_3)_2$ - Cupric nitrate

Flowchart for naming of cations



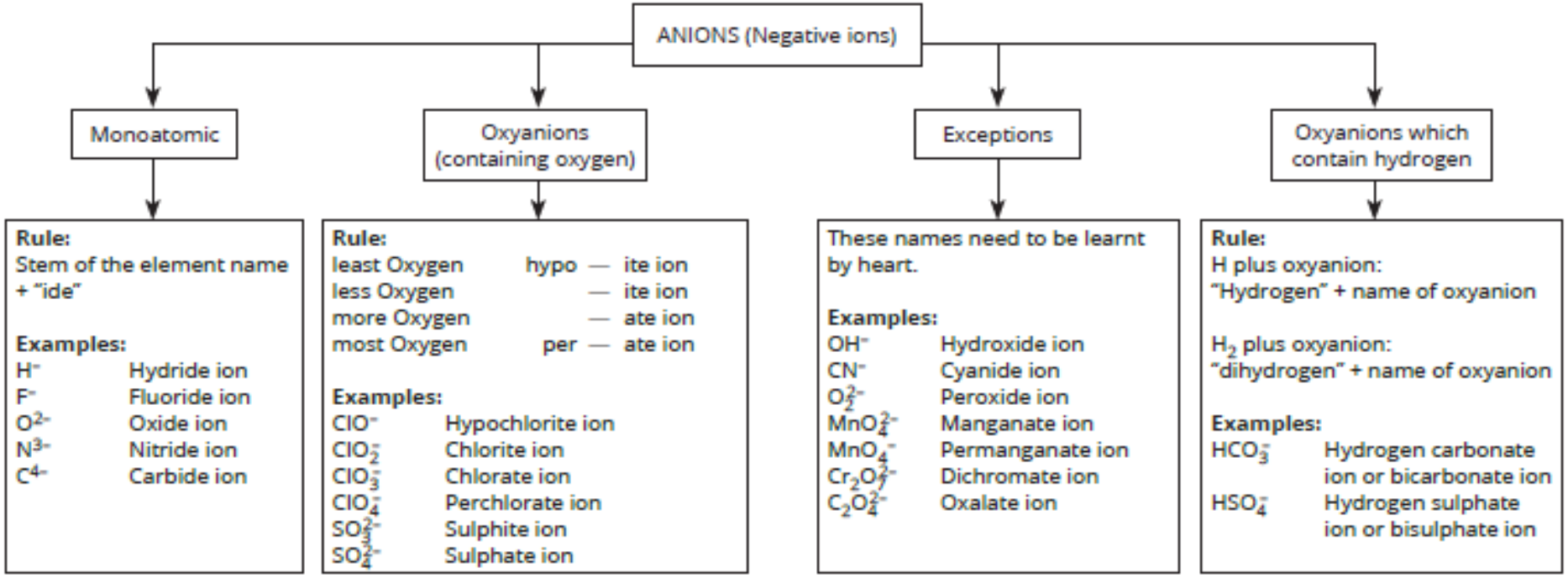
Naming bases

- Bases containing OH radical are named as **hydroxides**.

Examples: NaOH - Sodium hydroxide

$Ca(OH)_2$ - Calcium hydroxide

Flowchart for naming of anions



Naming acids

Acid are generally named according to their anions.

- The names of binary acids or hydra acids are given by adding the prefix **hydro–** and the suffix **–ic** to the name of the second element.

Examples: HCl - Hydrochloric acid

HBr - Hydrobromic acid

Chemical Equation

A **chemical equation** is a symbolic representation of a chemical reaction using symbols and chemical formulae of the substances involved in the reaction.

Writing of a chemical equation

In a chemical change, the substances which react are called **reactants** and the substances produced are called **products**.

1. The symbols and formulae of the reactants are written on the left hand side with plus (+) sign between them.

2. The symbols and formulae of the products are written on the right hand side with plus (+) sign between them.

3. An arrow () sign is inserted between the reactants and the products. The arrow points from reactants to products.

Examples of chemical equations

$ZnCO_3 \longrightarrow ZnO + CO_2$ (on heating)

$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

Balanced chemical equation

If in a chemical equation the number of atoms of each element in the reactants is equal to the number of atoms of each element in the products, the chemical equation is called a **balanced chemical equation**.

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

The number of atoms on the two sides of the equation are equal. Hence the equation is balanced.

Unbalanced chemical equation

If in a chemical equation the number of atoms of each element in the reactants is not equal to the number of atoms of each element in the products, the chemical equation is called **unbalanced chemical equation** or **skeletal equation**.

Balancing by hit and trial method

There are many methods to balance a chemical equation. The best technique however is the **hit and trial method**. In this method it is advisable to balance the hydrogen atoms last and the oxygen atoms just before balancing the hydrogen atoms.

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$$

Atomic Mass (Atomic Weight)

The mass equal to 1/12th of the mass of a 12C atom is called one atomic mass unit. Nowadays, amu has been replaced by ‘u’ which is known as unified mass.

1 atomic mass unit = 1 u = Mass of one ^{12}C atom/ 12

Mass of one ^{12}C atom = 1.9924×10^{-23} g

$$1\ u = (1.9924 \times 10^{-23}) / 12\ g = 1.66 \times 10^{-24}\ g$$

Thus, mass of one ^{12}C atom is 12 u.

The relative atomic mass (*Ar*) of an element is the average mass of an atom of an element as compared to 1/12th the mass of one carbon-12 atom.

Relative atomic mass of an element (*Ar*) =

Average mass of one atom of the element /

1/ 12 × (mass of one ^{12} C atom)

Molecular Mass

Relative molecular mass

The relative molecular mass (M_r) of a compound is the average mass of its one molecule as compared to 1/ 12th the mass of one carbon-12 atom.

Relative molecular mass (M_r) =

(Average mass of one molecule of the compound) /

1/ 12 × (Mass of an atom of ^{12}C)

Molecular mass (*M*)

The average mass of one molecule of a compound in atomic mass unit is called **molecular mass** (*M*). Hence,

Molecular mass (*M*) = $M_r \times 1$ u = M_r u

The molecular mass (*M*) has the unit of mass, i.e. g, kg or u. The magnitudes of molecular mass (*M*) and relative molecular mass (M_r) are equal but they differ only in their units.

Example

Water: The molecular formula of water is H_2O.

Molecular mass =

(2 × Atomic mass of hydrogen) + (1 × Atomic mass of oxygen)

= (2 × 1 u) + (1 × 16 u) = 18 u

Sulphuric acid: The molecular formula is H_2SO_4.

Molecular mass

= (2 × Atomic mass of hydrogen) + (1 × Atomic mass of sulphur)

+ (4 × Atomic mass of oxygen)

= (2 × 1 u) + (1 × 32 u) + (4 × 16 u) = 98 u

Percentage composition of a compound

A compound contains two or more elements combined in a certain fixed ratio. The percentage composition of a compound is the mass of each element of the compound, present in 100 g of that compound, i.e. the mass percentage of each element present in the compound.

When the masses of compound and each element are given

$$\text{Mass percentage of an element A} = \frac{\text{Mass of element in the given mass of the compound}}{\text{Total mass of the compound}} \times 100$$

When the formula of the compound and the atomic masses of the elements are given

The mass percentage of each element can be calculated using the following formula:

$$\text{Mass percentage of an element} = \frac{\text{Total mass of the element in one molecule of the compound}}{\text{Molecular mass of the compound}} \times 100$$

SUMMARY...

1. Symbols of elements are derived from English, Latin and German names.

2. The number of hydrogen atoms that combine with one atom of an element to form a compound is called valency of that element.

3. A radical may be defined as an atom or group of atoms of the same or different elements which carries charge and behaves as a single unit.

4. The chemical formula of a compound is a symbolic representation of a molecule of the compound.

5. The names of binary acids or hydra acids are given by adding the prefix hydro– and the suffix –ic to the name of the second elements.

6. The names of acids containing polyatomic groups or radicals are given on the basis of the second element but the prefix hydro– is not used. These acids are called oxy acids.

7. Bases containing OH radical are named as hydroxides.

8. A chemical equation is a symbolic representation of a chemical reaction using symbols and chemical formulae of the substances involved in the reaction.

9. An equation that has the same number of atoms of each kind on either side of the arrow is called a balanced chemical equation.

10. The mass equal to 1/ 12^{th} of the mass of a ^{12}C atom is called one atomic mass unit.

11. The atomic mass (*A*) of an element is defined as the average mass of an atom of an element in atomic mass unit.

12. The relative atomic mass (A_r) of an element is the average mass of an atom of an element as compared to 1/12^{th} the mass of one carbon-12 atom.

13. The relative molecular mass (M_r) of a compound is the average mass of its one molecule as compared to 1/12^{th} the mass of one carbon-12 atom.

14. The average mass of one molecule of a compound in atomic mass unit is called molecular mass (*M*).

15. The percentage composition of a compound is the mass of each element of the compound, present in 100 g of that compound, i.e. the mass percentage of each element present in the compound.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