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CLASS : 8th

CHAPTER 5

CHEMISTRY

LANGUAGE OF CHEMISTRY

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INTRODUCTION

During every moment of our existence we depend upon chemistry directly or indirectly.
Chemical sciences include the study of substances or chemicals (the chemical elements), what they are made of, and how they differ from each other in their many properties and features. Another very important area of chemistry is how substances or chemicals change when they combine or react together.

We know that chemistry is a branch of science which deals with study of matter and various changes it undergoes. It deals with the preparation, properties, reactions and structures of chemical elements and compounds.

For convenience the study of chemistry is sub-divided into various branches such as:

(i) **Inorganic chemistry :** It is the branch of chemistry that deals with the study of the compounds (generally excluding carbon compounds) obtained from mineral or inanimate sources.

(ii) **Organic chemistry :** It is the branch of chemistry that deals with the compounds of carbon and hydrogen obtained from animal and plant sources. In it we study about carbohydrates, fats, proteins, vitamins etc.

(iii) **Physical chemistry :** It is the branch of chemistry that deals with the physical principles and conditions that govern the chemical processes.

(iv) **Analytical chemistry :** It is the branch of chemistry that deals with the study of the methods of detection and determination of elements and compounds.

(v) **Industrial chemistry :** It is the branch of chemistry that deals with the study of chemical processes involved in the manufacture of industrial products.

(vi) **Bio-chemistry :** It is the branch of chemistry that deals with the study of chemical processes taking place in living organism.

(vii) **Nuclear chemistry :** It is the branch of chemistry that deals with the study of the chemistry of radio-active substances and the energy changes taking place in the nucleus of the atom.

(ix) **Pharmaceutical chemistry :** Chemistry dealing with pharmaceutical preparations and drug study.

(x) **Medicinal chemistry :** Study of structure-activity relationship, pharmacological activities.

(xi) **Material chemistry :** Covers solid state chemistry, both inorganic and organic, and polymer chemistry, especially as directed to the development of materials with novel and/or useful optical, electrical, magnetic, catalytic, and mechanical properties.

CHEMISTRY AND ITS LANGUAGE

We know that every science has its own technical terms which is frequently used and which is considered as its language. In chemistry we find that in addition to technical terms it also uses certain expression like H_2, O_2, N_2, H_2O, H_2SO_4, NaOH, NaCl, KCl etc. which in the language of chemistry stand for names of certain definite chemical compounds. To have a better understanding of the language of chemistry it is essential to know some of the chemical terms which are very frequently used. Here we give a few terms commonly used in chemistry.

Atomic weights of some common elements

Element	Atomic mass	Element	Atomic mass
Hydrogen	1	Fluorine	19
Lithium	7	Sodium	23
Boron	11	Magnesium	24
Carbon	12	Aluminium	27
Nitrogen	14	Chlorine	35.5
Oxygen	16	Calcium	40
Chromium	52	Bromine	80
Manganese	55	Silver	108
Iron	56	Tin	119
Copper	63.5	Iodine	127
Zinc	65	Sulphur	32
Phosphorus	31	Potassium	39
Barium	137	Platinum	197
Mercury	200	Lead	207

(iv) **Gram atomic mass or gram atomic weight :** The atomic mass of an element when expressed in grams is known as **gram atomic mass** or simply as **gram atom (g-atom)**. Thus one g-atom of carbon (C-12) weighs 12.0 g.

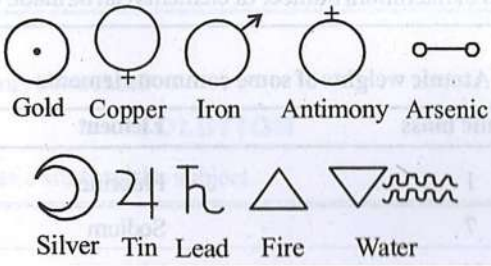
(v) **Molecular mass or molecular weight :** Molecular weight is calculated by adding the atomic weights of all the constituent atoms present in a molecule. For example.
Molecular weight of a molecule of hydrogen (H_2)
$= 2 \times$ atomic weight of hydrogen $= 2 \times 1 = 2$ amu

(vi) **Gram molecular mass:** The molecular mass of a substance when expressed in grams is known as **gram-molecular mass** or simply **gram-mole** (**g-mole**) for the sake of convenience it is expressed simply as **mole**. Thus one **mole** (or **g-mole**) of water weighs 18g (molecular weight of water = 18)

SYMBOLS

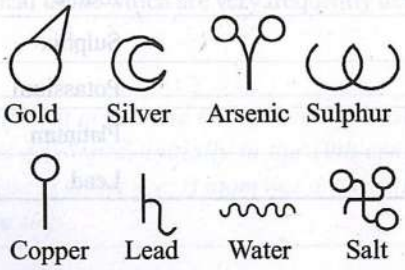
We use many symbols in mathematics simply to avoid writing full and lengthy terms so as to save time and to be precise. e.g. to write Angle A = Angle B, we write $\angle A = \angle B$.
Similarly, if we have to write "triangle", "Parallel", "Since", then we denote these term by symbols, Δ, $\|$, $\because$ respectively.
A stenographer uses shorthand to save time in taking down notes but symbols of stenographer are totally different from symbols we use in mathematics.
The need for symbols was also felt by chemists as the science of chemistry advanced. The larger number of elements and compounds needed a language which could represent the full meaning in short space and short time.
Many of the early symbols for the elements, such as those used by alchemists prior to seventeenth century, were rather puzzling. The alchemists who were interested in transforming base metals like lead into gold, used symbols that could not be easily interpreted by others. Some of the symbols used in alchemy are given below.

Symbols used in Alchemy



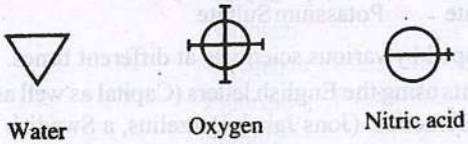
The idea of using symbols in chemistry was originated by Greeks. The symbols for some metals used by ancient Greeks are shown below.

Ancient Greek



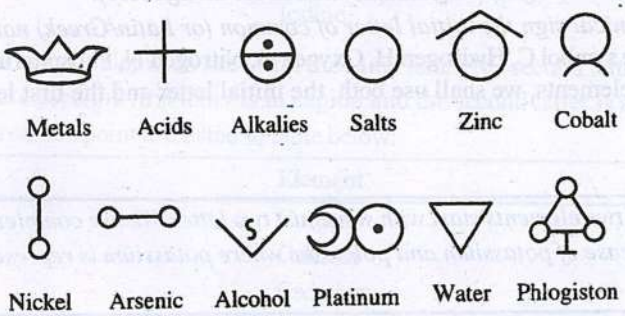
The Alchemists used strange symbols and puzzling signs to record their findings. They adopted the ancient Hindu and Greek astrologers symbols to represent some metals and other elements.
The symbols showed resemblance between metals and some heavenly bodies like Sun, Moon, Mars, Venus, Saturn etc.
Various other systems used to write symbols are shown below :

1782 Antoine Lavoisier




Antonine Lavoisier

1793 Torben Olof Bergman



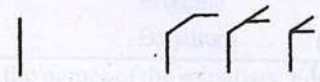
Metals Acids Alkalies Salts Zinc Cobalt

Nickel Arsenic Alcohol Platinum Water Phlogiston

Torben Olof Bergman

1787 J. H. Hassenfratz and Adet

Liquid Liquid oxides of nitrogen



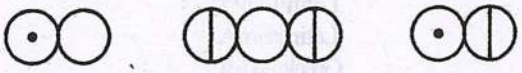
Gas Gaseous oxides of nitrogen

J. H. Hassenfratz

1808 John Dalton

Hydrogen Nitrogen Carbon Oxygen Phosphorous

Sulfur Copper Lead Gold



Water Nitrous oxide Ammonia

John Dalton

1814 J. J. Berzelius

Cu + O	S + 3O
Copper Oxide	Sulfur trioxide

Berzelius

Modern

CuO	SO_3
Copper oxide	Sulfur trioxide

$CuSO_4$	K_2SO_4
Copper Sulfate	Potassium Sulfate

However it was found difficult to use these symbols developed by various scientists at different times.

The scientist who suggested a method of representing elements using the English letters (Capital as well as small) is J.J. Berzelius. The system that we use today is very close to that proposed by Berzelius. (Jons Jakob Berzelius, a Swedish scientist).

In the system used at present, the symbol for an element consists of first one or two letters of the name of the element (e.g. H for hydrogen, He for helium, Li for lithium). When names of two elements start with the same first two letters (e.g. magnesium and manganese), the symbol used first letter and a later letter (Mg for magnesium and Mn for manganese).

Berzelius said, "*I shall, therefore, take for the chemical sign the initial letter of common (or Latin/Greek) name of each chemical element.*" Thus the element carbon was assigned the symbol C, Hydrogen H, Oxygen O, Nitrogen N, Phosphorus P, Sulphur S and so on..... If the first letter is common to two or more elements, we shall use both, the initial letter and the first letter they have not in common.

For example

Element	Symbol
Carbon	C
Copper	Cu (Latin, *Cuprum*)
Cobalt	Co (Latin, *Cobaltum*)
Calcium	Ca (Latin *Calx*)
Chromium	Cr (Greek, *chrom*)
Potassium	K (Greek, *Kalium*)
Krypton	Kr (Greek, *Kryptos*)
Antimony	Sb (Latin, *Stibium*)
Tin	Sn (Latin, *Stannum*)
Silicon	Si (Latin, *Silex*)

To represent a compound, Berzelius just joined the symbols of these elements contained in one molecule of that compound. The method used at present to write symbols for elements is illustrated in the following tables:

(i) Elements with symbols based on non-english names

English Name	Symbol	Non-English Name	Language
Antimony	Sb	Stibium	Latin
Copper	Cu	Cuprum	Latin
Gold	Au	Aurum	Latin
Iron	Fe	Ferrum	Latin
Lead	Pb	Plumbum	Latin
Mercury	Hg	Hydrargyrum	Greek
Potassium	K	Kalium	Latin
Silver	Ag	Argentum	Latin
Sodium	Na	Natrium	Latin
Tin	Sn	Stannum	Latin
Tungsten	W	Wolfram	German

(ii) For some of the elements the first letter of its English name is used as symbol to represent that element in short form. Only capital letters are used.

Some examples to illustrate the point are listed in table below:

S. No.	Name	Symbol
1.	Hydrogen	H
2.	Carbon	C
3.	Nitrogen	N
4.	Oxygen	O
5.	Fluorine	F
6.	Sulphur	S
7.	Boron	B
8.	Phosphorus	P
9.	Iodine	I

(iii) When the names of the two elements start with the same letter, the second letter or a prominent letter is added to the first letter. When two letters are used the first letter is in capital and the second letter is always a small one.

Some examples to illustrate the point are listed in table below:

S. No.	Element	Symbol
1.	Carbon	C
2.	Calcium	Ca
3.	Cadmium	Cd
4.	Chlorine	Cl
5.	Phosphorus	P
6.	Platinum	Pt
7.	Palladium	Pd
8.	Boron	B
9.	Barium	Ba
10.	Bromine	Br

11.		Beryllium	Be

(iv) Some elements are named after the names of the scientists. For example.

	Element	Name of the Scientists	Symbol
1.	Curium	Madam curie	Cm
2.	Einsteinium	Albert Einstein	Es
3.	Fermium	Enrico Fermi	Fm
4.	Nobelium	Alfred nobel	No
5.	Mandelevium	Mendeleev	Md

(v) Some elements are named after the names of the countries and laboratories. For example:

	Element	Name of the Countries Laboratories	Symbol
1.	Berkelium	City of Berkley	Bk
2.	Californium	University of California	Cf
3.	Polonium	Poland	Po
4.	Americium	America	Am
5.	Ruthenium	Russia	Ru
6.	Germanium	Germany	Ge

(vi) Some elements are named after the names of the planets. For example:

	Element	Name of the planet	Symbol
1.	Uranium	Uranus	U
2.	Neptunium	Neptune	Np
3.	Plutonium	Pluto	Pu

SIGNIFICANCE OF A SYMBOL

It has both quantitative and qualitative significance.

Quantitative significance

The *symbol* of an element denotes *one atom* of the element as well as its *gram atomic weight*. e.g. The symbol N denotes

(i) 1 atom of nitrogen.

(ii) 14 parts by weight of nitrogen because 1 atom of nitrogen is 14 times heavier than $\frac{1}{12}th$ of the weight of an atom of carbon (C-12)

(iii) *One gram-atom* of nitrogen (i.e. 14 g of nitrogen)

Qualitative significance

Qualitatively the symbol represents the name of the element. e.g. **N** represents nitrogen.

(For writing the chemical formula the knowledge of valency is essential. So we will first learn about valency)

VALENCY

During the formation of molecules of compounds, atoms combine in certain fixed proportions. This is because of the fact that different atoms have different combining capacities.

The combining capacity of an atom or radical is known as its **valency.**

The valency is measured in terms of hydrogen atoms or oxygen atoms. The valency of hydrogen is taken as one and is selected as the standard of valency.

Valency of an element can be defined as the number of hydrogen atoms which combine with an atom of element.

Following table illustrates the point:

Molecule	*Description*	*Valency of element*
Water (H_2O)	It contain two atoms of hydrogen in combination with one atom of oxygen.	Valency of oxygen is **2** (one atom of oxygen combines with the 2 atoms of hydrogen)
Methane (CH_4)	Four atoms of hydrogen combine with one atom of carbon to form CH_4	Valency of carbon is **4**
Ammonia (NH_3)	Three atoms of hydrogen with one atom of nitrogen to form NH_3	Valency of nitrogen is **3.**

Since all atoms do not combine with hydrogen so the valency of the element is also defined in term of other elements like chlorine or oxygen.

Valency with respect to chlorine

Since the valency of chlorine is 1 (as in HCl) the number of chlorine atoms with which one atom of an element can combine is called its **valency**. e.g. In sodium chloride (NaCl), one atom of sodium (Na) combines with 1 atom of chlorine (Cl), therefore the valency of sodium is **1**.

Valency with respect to oxygen

Valency can also be defined as double the number of oxygen atoms with which one atom of an element can combine because the valency of oxygen is 2 (as evident from H_2O). e.g., In calcium oxide (CaO), one atom of calcium combines with one atom of oxygen so the valency of calcium is **2** ($2 \times 1 = 2$).

IONS OR RADICALS

In addition to atoms and molecules, a third type of particles occurs in substances. These particles, called ions, are atoms or group of atoms that carry an electrical charge.

An **ion** is formed when electrons are removed from or added to an atom or group of atoms (see below).

$$\underset{\text{(Chlorine atom)}}{Cl} \xrightarrow{\text{Add 1 electron}} \underset{\text{(Chloride ion)}}{Cl^-}$$

$$\underset{\text{(Chlorine atom)}}{Na} \xrightarrow{\text{Remove 1 electron}} \underset{\text{(Sodium ion)}}{Na^+}$$

$$\underset{\text{(Oxygen molecule)}}{O_2} \xrightarrow{\text{add 2 electrons}} \underset{\text{(Peroxide ion)}}{O_2^{2-}}$$

When electrons is/are removed the resulting ion is called a **cation or basic radical.** A cation is positively charged ion. (e.g. Na^+)

When electron is/are added the resulting ion is called an **anion or acidic radicals.** An anion is negatively charged ion (e.g. , Cl^-, O_2^{2-})

An ion or radical is classified as monovalent, divalent, trivalent or tetravalent when the number of charge over it is 1, 2, 3 or 4 respectively.

The ionic charge represents the number of electrons lost (if positive ion) or number of electron gained (if negative ion). The charge on ion is indicated in the symbol or formula by a superscript number followed by the + or – sign. Removing one electron from sodium atoms (Na) creates sodium ion (Na^+). Sodium ion (Na^+) is an example of monoatomic ion (i.e. an ion formed from one atom).

A list of ions and their charges is given below :

Positive Radicals *(Cations or Basic Radicals)*

Radical	Nature	(Cations or Basic Radicals)
Sodium (Na^+)	Monovalent,	Monoatomic
Potassium (K^+)	Monovalent,	Monoatomic
Lithium (Li^+)	Monovalent,	Monoatomic
Ammonium (NH_4^+)	Monovalent,	Polyatomic
Barium (Ba^{2+})	Divalent,	Monoatomic
Calcium (Ca^{2+})	Divalent,	Monoatomic
Zinc (Zn^{2+})	Divalent,	Monoatomic
Magnesium (Mg^{2+})	Divalent,	Monoatomic
Nickel (Ni^{2+})	Divalent,	Monoatomic
Cobalt (Co^{2+})	Divalent,	Monoatomic
Aluminium (Al^{3+})	Trivalent,	Monoatomic
Chromium (Cr^{3+})	Trivalent,	Monoatomic

Negative Radicals *(Anions or Acid Radicals)*

Radical	Nature	(Anions or Acid Radicals)
Hydride (H^-)	Monovalent,	Monoatomic
Chloride (Cl^-)	Monovalent,	Monoatomic
Bromide (Br^-)	Monovalent,	Monoatomic
Iodide (I^-)	Monovalent,	Monoatomic
Sulphide (S^{2-})	Divalent,	Monoatomic
Oxide (O^{2-})	Divalent,	Monoatomic
Nitride (N^{3-})	Trivalent,	Monoatomic
Peroxide (O_2^{2-})	Divalent,	Diatomic
Hydroxide (OH^-)	Monovalent,	Diatomic
Nitrate (NO_3^-)	Monovalent,	Tetra-atomic
Nitrite (NO_2^-)	Monovalent,	Tri-atomic
Hypochlorite $(ClO)^-$	Monovalent,	Diatomic
Sulphite (SO_3^{2-})	Divalent,	Tetra-atomic
Sulphate (SO_4^{2-})	Divalent,	Polyatomic
Phosphate (PO_4^{3-})	Trivalent,	Polyatomic

The **valencies** of some of the **elements** and **radicals** are listed in the following Tables.(Table-1 and Table-2)

Table – 1 : Cation or Basic Radicals

Name	Symbol		Valency
Aluminium	Al		3
Ammonium	NH_4^+		1
Antimony	Sb		3
Barium	Ba		2
Bismuth	Bi		3
Cadmium	Cd		2
Calcium	Ca		2
Chromium	Cr		3
Cobalt	Co		2
Copper	Cu	Cuprous or Copper (I)	1
		Cupric or Copper (II)	2
Hydrogen	H		1
Iron	Fe	Ferrous or Iron (II)	2
		Ferric or Iron (III)	3
Lead	Pb	Plumbous or Lead (II)	2
		Plumbic or Lead (IV)	4
Magnesium	Mg		2
Manganese	Mn	Managanous or Manganese (II)	2
		Managanic or Manganese (III)	3
Mercury	Hg	Mercurous or Mercury (I)	1
		Mercuric or Mercury (II)	2
Nickel	Ni		2
Potassium	K		1
Silver	Ag		1
Sodium	Na		1
Strontium	Sr		2
Tin	Sn	Stannous or Tin (II)	2
		Stannic or Tin (IV)	4
Zinc	Zn		2

Table – 2 : Anion or Acid Radicals

Name	Symbol	Valency
Fluoride	F	1
Chloride	Cl	1
Hypochlorite	ClO	1
Chlorate	ClO_3	1
Bromide	Br	1
Hypobromite	BrO	1
Iodide	I	1
Ferricyanide	$Fe(CN)_6$	3
Arsenite	AsO_3	3
Arsenate	AsO_4	3
Zincate	ZnO_2	2
Meta-Aluminate	AlO_2	1
Aluminate	AlO_3	3
Stannate	SnO_3	2
Silicate	SiO_3	2
Hypoiodite	IO	1
Iodate	IO_3	1
Sulphide	S	2
Sulphite	SO_3	2
Bisulphite	HSO_3	1
Sulphate	SO_4	2
Bisulphate	HSO_4	1
Thiosulphate	S_2O_3	2
Nitrite	NO_2	1
Nitrate	NO_3	1
Nitride	N	3
Hydroxide	OH	1
Oxide	O	2
Hydride	H	1
Peroxide	O_2	2
Carbonate	CO_3	2
Bicarbonate	HCO_3	1
Carbide	C	4
Phosphate	PO_4	3
Phosphite	HPO_3	2
Phosphide	P	3
Borate	BO_3	3
Acetate	CH_3COO	1
Cyanide	CN	1
Manganate	MnO_4	2
Permanganate	MnO_4	1
Chromate	CrO_4	2
Dichromate	Cr_2O_7	2
Ferrocyanide	$[Fe(CN)_6]$	4

ACIDS, BASES AND SALTS

As now you are familiar with terms like acidic or basic radicals. So you must aware about general concepts of acids, bases and salts.

Acids : In earlier discoveries different scientist gave different definition to explain acid but most commonly acid is a substance which donates proton (H^+) or when dissolved in water yields hydronium ions (H_3O^+) or hydrogen ions.

For example HCl is an acid which dissolves in water to give hydronium ion.

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

Other examples are HNO_3, H_2SO_4, H_2CO_3 etc.

Base : It is a substance which ionize to give OH^- ions in aqueous solution or a compound which combined with the hydronium ion (H_3O^+) of an acid to form salt and water only.

$$\underset{\text{Base}}{NaOH} \xrightarrow{\text{aqueous media}} Na^+ + OH^-$$

$$\underset{\text{Base}}{Mg(OH)_2} + \underset{\text{Acid}}{H_2SO_4} \longrightarrow \underset{\text{Salt}}{MgSO_4} + \underset{\text{Water}}{2H_2O}$$

Other examples $Al(OH)_3$, NH_4OH etc.

Salts : An ionic compound which if dissolved in water, dissociates to yield a positive ions rather than hydrogen ion (H^+ ion) and a negative ions other than hydroxyl ion (OH^- ion).

$$KCl \xrightarrow{\text{aqueous media}} K^+ + Cl^-$$

Other examples are NaCl, $MgCl_3$, $Al_2(SO_4)_3$ etc.

CHEMICAL FORMULA

Formula of elements: The molecule of an element is denoted by writing the symbol of the element and, to the right and below it, a number expressing the number of atoms in the molecule. e.g.

H_2 denotes one molecule of Hydrogen containing two atoms in combination.

P_4 denotes one molecule of phosphorus containing four atoms in combination.

S_8 denotes one molecule of sulphur containing eight atoms in combination.

The formula of those elements whose atoms are capable of independent existence is the same as the symbol of the element. e.g.

Name	Symbol	Chemical Formula
Helium	He	He
Neon	Ne	Ne
Argon	Ar	Ar
Krypton	Kr	Kr
Iron	Fe	Fe
Mercury	Hg	Hg

Thus the formula is the symbolic expression for a molecule and a molecule of an element may consist of one or more atoms e.g. He, Ne, Ar... etc (one atom), O_2, H_2, N_2, Cl_2, Br_2 .... etc (two atoms), P_4, S_8 (more than 2 atoms)

Formula of compound : A molecule of a compound may be made up of atom of different elements linked up together chemically and in definite proportion by weight. e.g. Iron sulphide is made up of Iron (Fe) and sulphur(S) in the fixed ratio of 56 : 32 i.e. 56 parts of iron combine with 32 parts of sulphur by weight. Thus iron sulphide consists of one atom of iron (atomic weight of iron = 56) and one atom of sulphur (atomic weight of sulphur = 32) and its chemical formula is FeS.

In the formula both the elements are written as their symbols which always begin with a capital letter.

We have adopted the same method to represent the formula of a compound that we had adopted to represent the formula of an element.

In a chemical compound at least two symbols must appear because at least two elements must be present in a chemical compound. In the formula of a compound, the number to the right of a symbol and below it, expresses the number of atoms of the element present, the number 1 being omitted. This is quite evident from the formula of some compounds.

Formula of some common compounds are :

Compound	Formula
Hydrochloric acid	HCl
Sulphur dioxide	SO_2
Sulphur trioxide	SO_3
Sulphuric acid	H_2SO_4
Carbon dioxide	CO_2
Nitric acid	HNO_3
Sodium carbonate	Na_2CO_3
Sodium hydroxide	$NaOH$
Ammonia	NH_3
Potassium hydroxide	KOH
Potassium nitrate	KNO_3
Calcium carbonate	$CaCO_3$

How to write the formula of compound?

Various steps to be followed in writing the formula of a compound are as follows:

(i) Write the symbols of the two radicals (positive radical and negative radical) side by side with valencies at the top. Write the positive radical to the left and the negative radical to the right hand side.

(ii) Cancel the common factor, if any, from the valencies, to get their simple whole number ratio.

(iii) Apply criss-cross rule (i.e., shift the valencies cross-wise to lower right of the radical). Always enclose the compound radical in bracket before writing any numeral at the lower right corner.

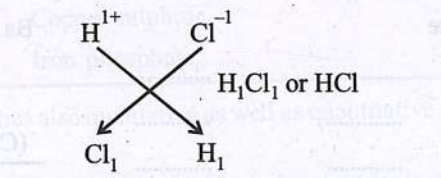
To illustrate the above rules few examples are given below :

Example 1

Hydrogen Chloride

Radical name	Hydrogen	Chloride
Radical symbol	H	Cl
Radical nature	Basic	Acidic
Valency	+1	−1

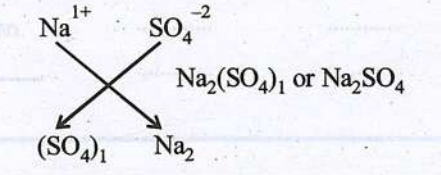
Usually subscript 1 is not written in the final formula.



Example 2

Sodium Sulphate

Radical name	Sodium	Sulphate
Radical symbol	Na	(SO_4)
Radical nature	Basic	Acidic
Valency	+1	−2

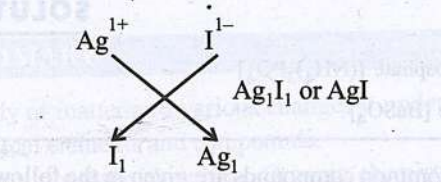


Example 3

Silver Iodide

Radical name	Silver	Iodide
Radical nature	Basic	Acidic
Valency	+1	−1

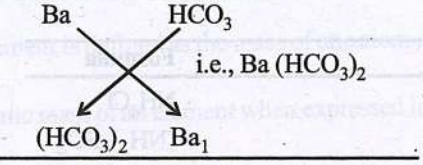
Usually subscript 1 is not written in the formula.



Based on those examples, complete the following :

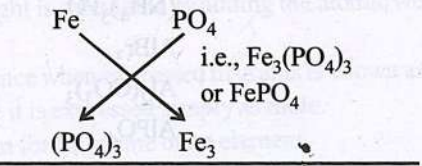
1. Barium Bicarbonate

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



2. Ferric Phosphate

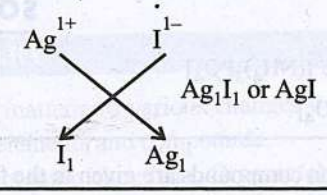
Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



Example 3

Silver Iodide

Radical name	Silver	Iodide
Radical nature	Basic	Acidic
Valency	+1	−1

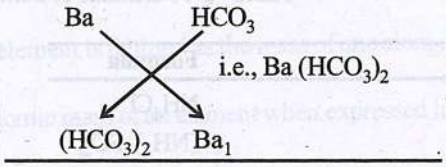


Usually subscript 1 is not written in the formula.

Based on those examples, complete the following :

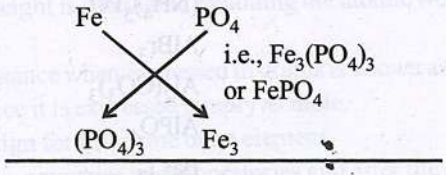
1. Barium Bicarbonate

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



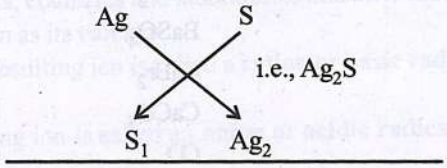
2. Ferric Phosphate

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



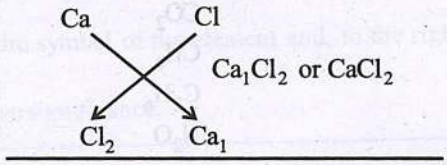
3. Silver Sulphide

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



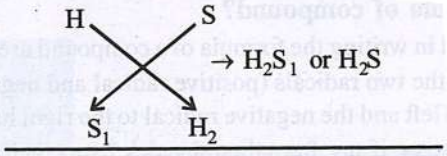
4. Calcium Chloride

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



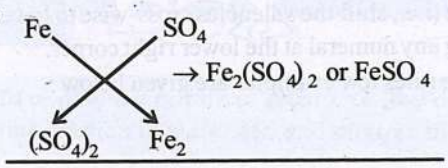
5. Hydrogen Sulphide

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



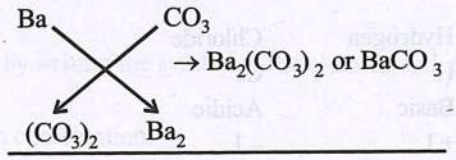
6. Ferrous Sulphate

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



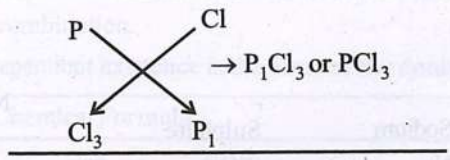
7. Barium Carbonate

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



8. Phosphorus Trichloride

Radical name	.....	.....
Radical nature	.....	.....
Valency	.....	.....



The Formulae of some common compounds are given in the following table. (Table-3)

Table – 3 : Formulae of Some Common Compounds

Compound	Formula
Ammonium chloride	NH_4Cl
Ammonium sulphate	$(NH_4)_2SO_4$
Ammonium phosphate	$(NH_4)_3PO_4$
Aluminium bromide	$AlBr_3$
Aluminium carbonate	$Al_2(CO_3)_3$
Aluminium phosphate	$AlPO_4$
Barium chloride	$BaCl_2$
Barium sulphate	$BaSO_4$
Calcium bromide	$CaBr_2$
Calcium carbonate	$CaCO_3$
Carbon monoxide	CO
Carbon dioxide	CO_2
Methane	CH_4
Ethane	C_2H_6
Nitrous oxide	N_2O

Compound	Formula
Nitric oxide	NO
Dinitrogen trioxide	N_2O_3
Nitrogen dioxide	NO_2
Dinitrogen pentoxide	N_2O_5
Ammonia	NH_3
Sulphur dioxide	SO_2
Hydrogen fluoride (Hydrofluoric acid)	HF
Hydrogen chloride (Hydrochloric acid)	HCl
Hydrogen bromide (Hydrobromic acid)	HBr
Hydrogen iodide (Hydoiodic acid)	HI
Hydrogen nitrate (Nitric acid)	HNO_3
Hydrogen nitrite (Nitrous acid)	HNO_2
Hydrogen chlorate (Chloric acid)	$HClO_3$
Hydrogen hydroxide (Water)	HOH or H_2O
Hydrogen sulphite (Sulphurous acid)	H_2SO_3

Compound	Formula
Hydrogen sulphate (Sulphuric acid)	H_2SO_4
Hydrogen carbonate (Carbonic acid)	H_2CO_3
Hydrogen sulphide	H_2S
Hydrogen phosphate (phosphoric acid)	H_3PO_4
Hydrogen borate (boric acid)	H_3BO_3
Potassium fluoride	KF
Sodium chloride	$NaCl$
Potassium bromide	KBr
Silver iodide	AgI

Compound	Formula
Potassium nitrate	KNO_3
Ammonium nitrate	NH_4NO_3
Potassium chlorate	$KClO_3$
Ammonium hydroxide	NH_4OH
Magnesium sulphite	$MgSO_3$
Barium sulphate	$BaSO_4$
Calcium carbonate	$CaCO_3$
Barium oxide	BaO
Copper sulphide	CuS
Iron phosphate	$FePO_4$

Significance of chemical formula : Like the symbols, a formula has also qualitative as well as quantitative significance.

Qualitative significance :

Qualitatively, the formula represents the name of the substance and the names of various elements present in the substance. e.g.

H_2 indicates that it consists of only hydrogen.

H_2O indicates that it consists of hydrogen and oxygen.

HNO_3 indicates that it consists of hydrogen, nitrogen and oxygen.

Quantitative significance

Quantitatively the chemical formula represent,

(i) One molecule of the substance (element or compound)

(ii) The actual number of atoms of each element present in one molecule of the substance (element or compound)

(iii) The number of parts by weight of the substance (molecular weight and number of parts by weight of each element).

1 EXERCISE

Multiple Choice Questions :

DIRECTIONS : *This section contains **18** multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.*

1. The symbols of tin and mercury are respectively
(a) Ti and Me (b) me and Ti
(c) Sn and Hg (d) Me and Sn

2. Which one of the following information is conveyed by the symbol of an element?
(a) The name of the element
(b) The atomic mass of the element
(c) The atomic number of the element
(d) All the above

3. $Na_2S_2O_3$ represent the compound
(a) sodium sulphate (b) sodium sulphite
(c) sodium thiosulphate (d) None of these

4. Which one is a bivalent ion?
(a) sodium (b) calcium
(c) sulphide (d) both (b) and (c)

5. The chromate and dichromate ions are respectively
(a) CrO_4^{2-} and $Cr_2O_7^{2-}$ (b) $Cr_2O_7^{2-}$ and CrO_4^{-}
(c) CrO_4^{-} and CrO_5^{-} (d) CrO_4^{2-} and $Cr_2O_5^{2-}$

6. The formula of sodium pyrophosphate is
(a) $Na_2P_2O_7$ (b) Na_3PO_4
(c) $Na_4P_2O_7$ (d) Na_3PO_3

7. The branch of chemistry which deals with study of physical properties and conditions is
(a) physical chemistry
(b) Analytical chemistry
(c) Nuclear chemistry
(d) Pharmaceutical chemistry

8. The branch of chemistry which deals with study of the methods of detection and determination of elements and compounds is
(a) Physical chemistry (b) Nuclear chemistry
(c) Analytical chemistry (d) Bio chemistry

9. What is the valency of sulphur in sulphur dioxide (SO_2)?
(a) 3 (b) 2
(c) 6 (d) 4

10. Molecular weight of water is
(a) 16 amu (b) 12 amu
(c) 10 amu (d) 18 amu

11. Which of the following is a symbol of palladium ?
(a) B (b) Pd
(c) Be (d) Ag

12. Hg is a symbol of
(a) Lead (b) Tin
(c) Antimony (d) Mercury

13. Valency of an atom or radicals is
(a) ionisation energy (b) electron affinity of atom
(c) its combining capacity (d) size of atom

14. When electrons are added the resulting ion is called
(a) basic radical (b) acidic radicals
(c) neutral radical (d) None of these

15. Acid turns litmus paper
(a) Blue (b) Yellow
(c) Red (d) None of these

16. Amphoprotic substances are those
(a) which can donate a proton
(b) which can accept a proton
(c) which can accept and donate proton
(d) which can donate hydroxyl ion

17. One molecule of sulphur contains
(a) Two atoms of sulphur (b) Eight atoms of sulphur
(c) Four atoms of sulphur (d) One atom of sulphur

18. Chemical formula of Aluminium sulphate is
(a) $Al_2(SO_4)_3$ (b) $AlSO_4$
(c) $Al_3(SO_4)_2$ (d) None of the above

More than One Option Correct :

DIRECTIONS : *This section contains 7 Multiple Choice Questions. Each question has 4 choices (a), (b), (c) and (d) out of which ONE OR MORE may be correct.*

1. Which of the following is / are bivalent radicals?
(a) Sulphate (b) Bisulphate
(c) Sulphite (d) Sulphide

2. Which of the following are triatomic?
(a) H_2O (b) CO_2
(c) CO_3^{2-} (d) NaCl

3. In organic chemistry we study about
(a) Carbohydrates (b) Fertilizers
(c) Proteins (d) Ceramics

4. Which of the following are acidic radicals ?
(a) PO_4^{3-} (b) Mg^{2+}
(c) CO_3^{2-} (d) NO_3^{-}

5. Acids are those substances which
   (a) Furnish H_3O^+ in aqueous solution
   (b) Lowers the pH of solution
   (c) Furnish OH^- in aqueous solution
   (d) Increase the pH of solution
6. Chemical formula gives information about
   (a) which elements are present in compound
   (b) physical properties of compound
   (c) nature of compound
   (d) total number of atoms of each element present in compounds
7. Which of the following ion is divalent ?
   (a) SO_4^{2-} (b) PO_4^{3-}
   (c) Cu^{2+} (d) Sn^{2+}

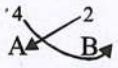
Passage Based Questions :

DIRECTIONS : *Study the given paragraph(s) and answer the following questions.*

Passage

The formula of a binary **compound**, i.e., a compound formed by two elements only, is obtained by transposing their valencies. Suppose an element. A has a valency y and element B has a valency x. Then the compound formed between A and B usually has the formula A_xB_y. The subscripts should be divided by a common factor, if any.

$\Rightarrow A_xB_y$



$\Rightarrow A_2B_4 \Rightarrow AB_2$

1. In which of the following compounds phosphorus (P) has valency 3?
   (a) PCl_5 (b) PCl_3
   (c) PCl_2 (d) None of these
2. What is the valency of the underlined elements in following compounds respectively.
   $\underline{Ag}I, \underline{Mg}_3N_2, \underline{Na}Cl, \underline{Ca}Cl_2$
   (a) 1, 2, 2, 2 (b) 1, 2, 1, 1
   (c) 1, 2, 1, 2 (d) 2, 1, 1, 2
3. How many times greater is the valency of N in NH_3 than that of Cl in HCl?
   (a) 3 (b) 2
   (c) 4 (d) 5

Assertion & Reason :

DIRECTIONS : *Each of these questions contains an assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*

(a) If both **Assertion** and **Reason** are **correct** and Reason is the **correct explanation** of Assertion.
(b) If both **Assertion** and **Reason** are correct, but Reason is **not the correct explanation** of Assertion.
(c) If **Assertion** is **correct** but **Reason** is **incorrect**.
(d) If **Assertion** is **incorrect** but **Reason** is **correct**.

1. **Assertion :** The combining capacity of an atom or radical is known as its valency.
   Reason : The valency of an element is always a whole number.
2. **Assertion :** A cation is formed after the removal of electrons.
   Reason : An element always looses one electron to form cation.
3. **Assertion :** The molecular mass of NaOH is 40.
   Reason : The molecular mass of a compound is defined as the sum of the atomic weights of all the constituent atom present in a molecule.
4. **Assertion :** One mole of any substance is equals to its molecular weight.
   Reason : Number of moles $\rightarrow \frac{\text{Mass of substance in grams}}{\text{Molecular weight}}$

Multiple Matching Questions :

DIRECTIONS : *Following question has four statements (A, B, C and D) given in Column I and four statements (p, q, r and s) in Column II. Any given statement in Column I can have correct matching with one or more statement(s) given in Column II. Match the entries in column I with entries in column II.*

1.

Column I		Column II	
A.	SO_4^{2-}	(p)	Bivalent
B.	Fe^{2+}	(q)	Monoatomic
C.	N^{3-}	(r)	Trivalent
D.	PO_4^{3-}	(s)	Polyatomic

Integer Type Questions :

DIRECTIONS : *Following are integer based questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive).*

1. Find the value of x in $NaxBO_3$.
2. What is the valency of Carbon in CH_4.
3. Calculate the sum of the valencies of Helium, Phosphorus and neon.

SOLUTIONS

Brief Explanations of Selected Questions

1 EXERCISE

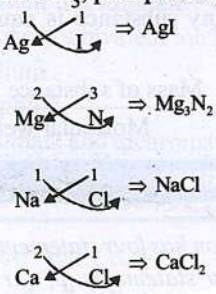
Multiple Choice Questions :

1. (c) **2.** (a) **3.** (c) **4.** (d) **5.** (a)
6. (c) **7.** (a) **8.** (c)
9. (a) Sulphur has valency 4 in sulphur dioxide (SO_2).
10. (d)
11. (b) **12.** (d) **13.** (c) **14.** (b)
15. (c) **16.** (c) **17.** (b) **18.** (a)

More Than One Option Correct :

1. (a, c, d) **2.** (a, b) **3.** (a, c)
4. (a, c, d) **5.** (a, b) **6.** (a, d)
7. (a, c, d)

Passage Based Questions :

1. (b) In PCl_3, phosphorus has valency 3.
2. (c) 

$\Rightarrow AgI$

$\Rightarrow Mg_3N_2$

$\Rightarrow NaCl$

$\Rightarrow CaCl_2$

3. (a) N in NH_3 has 3 valency and Cl in HCl has 1 valency. Thus valency of N in NH_3 is three time greater than valency of Cl in HCl.

Assertion & Reason :

1. (b)
2. (c) An element can loose one to four electron to form mono, di, tri and tetra valent cation respectively.
3. (a) **4.** (a)

Multiple Matching Questions :

1. A → (p, s), B → (p, q), C → (r, q), D → (r, s)

Integer Type Questions :

1. The formula of sodium borate is Na_3BO_3.
$\therefore x = 3$
2. 4
3. P(15) = 2, 8, 5,
Valency = 5Ne(10) = 2, 8
$\therefore$ Valency = 0,
$\therefore$ Sum of valency = 5
He(2) = 2, $\therefore$ Valency = 0