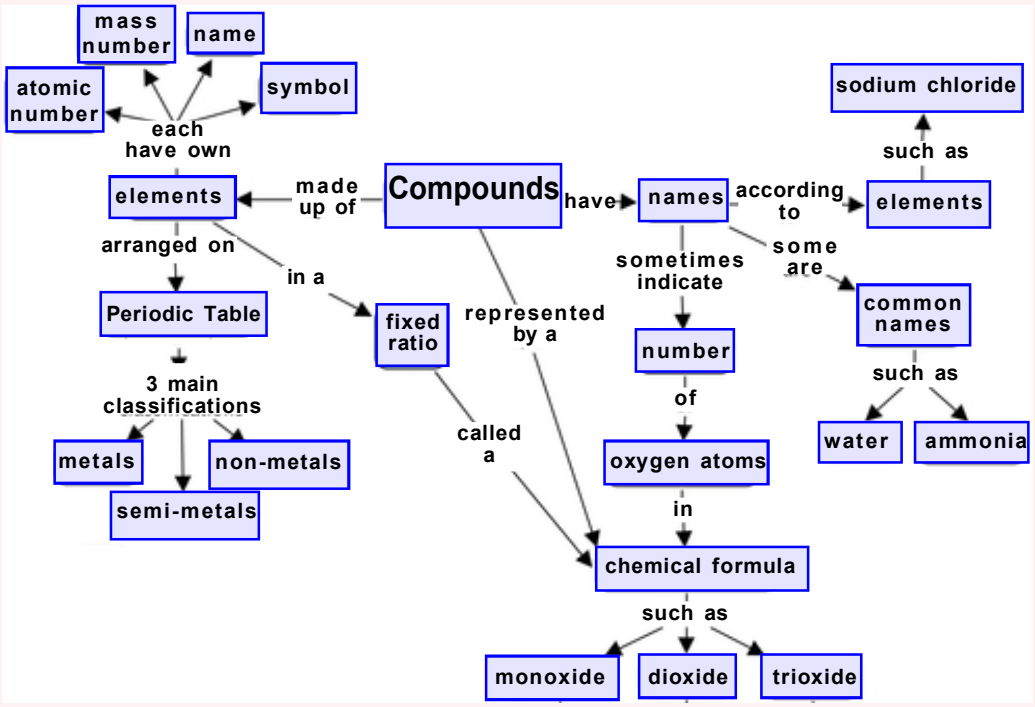
Chapter

1 LANGUAGE OF CHEMISTRY

Berzelius was a Swedish chemist. Berzelius is considered, along with Robert Boyle, John Dalton, and Antoine Lavoisier, to be one of the founders of modern chemistry.

Berzelius began his career as a physician but his research in physical chemistry were of lasting significance in the development of the subject. He is especially noted for his determination of atomic weights. He abbreviated the Latin names of the elements with one or two letters and applied superscripts to designate the number of atoms of each element present in both the acidic and basic ingredients.

CONCEPT MAP



CONCEPT 1.1

INTRODUCTION:

Chemistry is the branch of science which deals with the study of chemical substances, their composition and their properties.

To make it easy and systematic study of the subject, chemistry is sub-divided into various branches such as:

Inorganic chemistry: It is the branch of chemistry that deals with study of compounds (generally excluding carbon compounds).

Organic chemistry: It is the branch of chemistry that deals with study of carbon compounds.

Physical chemistry: It is the branch of chemistry that deals with physical principles and conditions.

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

Industrial chemistry: It is the branch of chemistry that deals with study of the process of manufacture of industrial products.

Nuclear chemistry: It is the branch of chemistry that deals with study of radioactive substances.

Biochemistry: It is the branch of chemistry that deals with study of chemical process taking place in living organism.

Nano chemistry: It is new discipline which deals with unique properties associated with assemblies of atoms and molecules.

CHEMISTRY AND ITS LANGUAGE:

When we learn a new language, we start by learning the alphabet. Then we write words and finally words form sentences. Similarly, while learning chemistry also, we start by learning symbols of the elements, formulae of the compounds and then the equations of the reactions.

Symbol: We use many symbols in mathematics to avoid writing full and lengthy terms so as to save time. 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 of symbols also felt by chemists as the science advanced. In chemistry, a symbol is defined as 'shorthand sign for the full name of an element'.

J.J. Berzelius suggested a method of representing elements using English capital letters.

- Each element has a unique symbol assigned to it.
- The symbol of an element is not used for any other element.
- We have seen that there are 118 known elements.
- Each of these elements has a symbol of its own.

Example:

1. The symbol or short form representation of the element hydrogen is "H". In chemical changes when we write "H" it means the element is hydrogen.
2. The symbol or short form representation of the element oxygen is "O". In chemical changes when we write "O" it means the element is oxygen.

- Some elements are having their symbols from their Latin names. For example, element sodium has its symbol as 'Na' (because its Latin name is natrium).

Significance of a symbol:

I **Qualitative meaning:** A symbol represents a specific element. A symbol represents one atom of an element.

Example: "O" stands for oxygen, "N" stands for nitrogen.

II **Quantitative meaning:** A symbol represents the mass of element, equal to its atomic mass of that element.

Example: Carbon atomic weight is 12, One gram atom of carbon i.e., 12 grams.

1. **Atomicity of elements:** The number of atoms present in one molecule of an element is called its atomicity. Based on the atomicity, the elements can be classified into different types.

   i. **Monoatomic elements:** The elements with only one atom in their molecules. **Example:** Cu, Ag, He, etc.

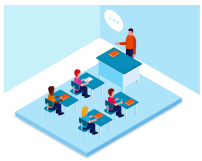
   ii. **Diatomic elements:** The elements with two atoms in their molecules. **Example:** H_2, O_2, N_2, etc.

   iii. **Triatomic elements:** The elements with three atoms in their molecules. **Example:** O_3 etc.

   iv) **Polyatomic elements:** Generally, the elements with two or more than two atoms in their molecules are called polyatomic elements.

   Example: P_4(tetra), S_8(octa), etc.

Do you know? Before the Berzelius' method, scientists proposed many systems to represent elements. But they were failed because it was found difficult to use those symbols.



CLASSROOM DISCUSSION QUESTIONS

CDQ 1.1

1. **Which branch of chemistry primarily deals with the study of carbon compounds?**
   (A) Inorganic chemistry
   (B) Physical chemistry
   (C) Analytical chemistry
   (D) Organic chemistry
2. **What is the main focus of physical chemistry?**
   (A) Study of industrial processes
   (B) Analysis of elements and compounds
   (C) Investigation of physical principles and conditions
   (D) Examination of chemical reactions in living organisms
3. **In which branch of chemistry are methods of detection and determination of elements and compounds studied?**
   (A) Industrial chemistry
   (B) Biochemistry
   (C) Analytical chemistry
   (D) Nuclear chemistry
4. **What is the significance of symbols in chemistry?**
   (A) They represent the qualitative properties of elements
   (B) They are used to indicate the atomic mass of elements
   (C) They help save time and space in representing elements
   (D) They determine the reactivity of elements in chemical reactions
5. **Which scientist suggested the method of representing elements using English capital letters?**
   (A) J.J. Berzelius
   (B) Dmitri Mendeleev
   (C) Antoine Lavoisier
   (D) Linus Pauling
6. **What does the symbol "Na" represent in chemistry?**
   (A) Nitrogen (B) Sodium
   (C) Nickel (D) Neon
7. **How many known elements are there according to the text?**
   (A) 92 (B) 100
   (C) 118 (D) 150
8. **Which type of elements have only one atom in their molecules?**
   (A) Diatomic elements
   (B) Monoatomic elements
   (C) Polyatomic elements
   (D) Triatomic elements
9. **Which type of elements have two atoms in their molecules?**
   (A) Monoatomic elements
   (B) Triatomic elements
   (C) Diatomic elements
   (D) Polyatomic elements
10. **What is the atomicity of an element if it has four atoms in its molecule?**
    (A) Diatomic
    (B) Monoatomic
    (C) Triatomic
    (D) Polyatomic

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

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6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

CONCEPT 1.2

Valency:

During the formation of molecules of compounds, atoms combine in certain fixed proportions. This is because of the fact that atoms have different combining capacities. 'The combining capacity of an element is called its **valency**'.

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.

Thus, the valency of an element can also be defined as the number of hydrogen atoms which combine with an atom of it.

Following table illustrates the point:

Molecule	Description	Valency of element
Water (H_2O)	It contains two atoms of hydrogen in combination with one atom of oxygen.	Valency of oxygen is 2 (One atom of oxygen combines with 2 atoms of hydrogen)
Ammonia (NH_3)	It contains three atoms of hydrogen in combination of one atom of nitrogen.	Valency of nitrogen is 3.
Methane (CH_4)	It contains four atoms of hydrogen in combination of one atom of carbon.	Valency of carbon is 4.

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

Valency in terms of Oxygen: Since the valency of oxygen is 2 (as in H_2O), double number of oxygen atoms with which one atom of an element can combine is called its valency.

Example: In calcium oxide (CaO), one atom of calcium combines with one atom of oxygen, so the valency of calcium is 2.

Valency in terms of Chlorine: Valency also can be defined as the number of chlorine atoms with which one atom of an element can combine, because the valency of chlorine is 1 (as in HCl).

Example: In sodium chloride (NaCl), one atom of sodium combines with one atom of chlorine, so the valency of sodium is 1.

Assumptions in finding valency of elements:

1. The valency of hydrogen and all metals is considered positive.
2. The valency of all non-metals (expect hydrogen) is considered negative.
3. As the molecule of a compound is electrically neutral, it assumed that total positive valency in its molecule is equal to total negative valency.

Variable valency:

An element with more than one valency is called variable valent element.

- It has been found that certain metals exhibit more than one valency. In such a situation, metals are said to exhibit variable valency.

Example: An atom of iron can exhibit two valencies 2 and 3. So, iron Fe is a variable valent element.

Do you know? The reason for variable valency in certain metals is that depending upon the experimental conditions, an atom of the metal loses more electrons than are present in its outermost shell (valence shell), i.e., it loses some electrons from the shell next to outermost shell. Thus, it exhibits variable valency.

How to name an element with two different valencies?

If an element exhibits two different valencies, then suffix '**-ous**' is attached at the end of the name of metal for **lower valency** and suffix '**-ic**' is attached at the end of the name of metal for **higher valency**.

Some examples:

Metal	Name and Lower Valency	Name and Higher Valency
Iron (Ferrum)	Ferrous Fe^{2+} or Fe(II)	Ferric Fe^{3+} or Fe (III)
Copper (Cuprum)	Cuprous Cu^{+} or Cu(I)	Cupric Cu^{2+} or Cu(II)
Silver (Argentum)	Argentous Ag^{+} or Ag(I)	Argentic Ag^{2+} or Ag(II)
Mecury (Hydragenium)	Mercurous Hg^{+} or Hg(I)	Mercuric Hg^{2+} or Hg(II)

IONS (or) RADICALS:

In addition to atoms and molecules, a third type of particles occur in substances. These particles are called ions. An atom or a group of atoms carrying an electrical charge (either negative or positive charge) are called **ions** (or) **radicals**.

An ion is formed when electrons are removed from or added to an atom or group of atoms.

Example:

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

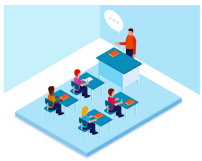
$$\underset{\text{(Chlorine atom)}}{Cl} \xrightarrow{\text{Add 1 electron}} \underset{\text{(Chloride ion)}}{Cl^{-}}$$

When electron(s) is/are removed, the resulting ion is called a **cation**.

A cation is positively charged ion. (eg. Na^{+})

When electron(s) is/are added, the resulting ion is called an **anion**.

An anion is negatively charged ion. (eg. Cl^{-})



CLASSROOM DISCUSSION QUESTIONS

CDQ 1.2

1. How is valency measured in chemistry?

(A) In terms of carbon atoms
(B) In terms of hydrogen atoms
(C) In terms of oxygen atoms
(D) In terms of nitrogen atoms

2. What is the valency of nitrogen in the molecule NH_3 (ammonia)?

(A) 1
(B) 2
(C) 3
(D) 4

3. In calcium oxide (CaO), what is the valency of calcium?

(A) 1
(B) 2
(C) 3
(D) 4

4. What is the valency of sodium in sodium chloride (NaCl)?

(A) 1
(B) 2
(C) 3
(D) 4

5. When naming an element with two different valencies, what suffix is added for the lower valency?

(A) –ate
(B) –ous
(C) –ic
(D) –ide

6. What is the name of Fe3+ in chemistry?

(A) Ferric
(B) Ferrous
(C) Cupric
(D) Cuprous

7. Which particle is formed when electrons are removed from an atom?

(A) Ion
(B) Anion
(C) Cation
(D) Radical

8. What is the charge of a cation?

(A) Neutral
(B) Positive
(C) Negative
(D) Variable

9. What type of ion is Cl- in chemistry?

(A) Cation
(B) Anion
(C) Radical
(D) Neutral

10. What happens when electrons are added to an atom?

(A) Formation of an anion
(B) Formation of a cation
(C) Formation of a radical
(D) Formation of a neutral atom

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

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6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

CONCEPT 1.3

Types of Ions:

Ions or radicals are classified as monovalent, divalent, trivalent or tetravalent when the number of charges over is 1, 2, 3 or 4 respectively.

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

I. Electro positive ion:

The metallic ion formed by the donation of one or more electrons is called electro positive ion. These electro positive ions are also called as **cations**.

Examples: H^+, Be^{+2}, Al^{+3}, Pb^{+4}, Sb^{+5}

i) Monovalent electro positive ion:

The metallic ion formed by the donation of one electron is called monovalent electro positive ion. **Examples:** H^+, Na^+, Rb^+, NH_4^+

ii) Divalent electro positive ion:

The metallic ion formed by the donation of two electrons is called divalent electro positive ion. **Examples:** Be^{+2}, Mg^{+2}, Ca^{+2}, Sr^{+2}

iii) Trivalent electro positive ion:

The metallic ion formed by the donation of three electrons is called trivalent electro positive ion. **Examples:** Al^{+3}, Fe^{+3}, Co^{+3}, Sb^{+3}

iv) Tetravalent electro positive ion:

The metallic ion formed by the donation of four electrons is called tetravalent electro positive ion. **Examples:** Pb^{+4}, Sn^{+4}

List of commonly used cations:

LIST OF CATIONS			
Name of ion	Ion	Name of ion	Ion
Hydrogen	H^+	Plumbous	Pb^{2+}
Lithium	Li^+	Radium	Ra^{2+}
Magnesium	Mg^{2+}	Sodium	Na^+
Mercuric	Hg^{2+}	Stannic	Sn^{4+}
Mercurous	Hg^{1+}	Stannous	Sn^{2+}
Platinum	Pt^{4+}	Zinc	Zn^{2+}
Plumbic	Pb^{4+}	Chromous	Cr^{+2}

LIST OF CATIONS			
Name of ion	Ion	Name of ion	Ion
Aluminium	Al^{3+}	Boron	B^{3+}
Ammonium	NH_4^+	Calcium	Ca^{2+}
Auric	Au^{3+}	Chromic	Cr^{3+}
Aurous	Au^+	Cupric	Cu^{2+}
Argentic	Ag^{2+}	Cuprous	Cu^+
Argentous	Ag^+	Ferric	Fe^{3+}
Beryllium	Be^{2+}	Ferrous	Fe^{2+}

II. Electronegative ion:

An ion (or) radical formed by the acceptance of electron is called electro negative ion. These electronegative ions are called **anions**.

Examples: Cl^-, O^{-2}, N^{-3}, C^{-4}

i) Monovalent electronegative ion:

An ion (or) radical formed by the acceptance of only one electron is called as monovalent electronegative ion

Examples: Cl^-, OH^-, NO^-

ii) Divalent electronegative ion:

An ion (or) radical formed by the acceptance of two electrons is called as divalent electronegative ion

Examples: O^{-2}, S^{-2}, SO_4^{-2}

iii) Trivalent electronegative ion:

An ion (or) radical formed by the acceptance of three electrons is called as trivalent electronegative ion

Examples: N^{-3}, B^{-3}, PO_4^{-3}

List of commonly used Anions:

LIST OF ANIONS			
Name of ion	Ion	Name of ion	Ion
Iodide	I^-	Peroxide	O_2^{2-}
Manganate	MnO_4^{2-}	Superoxide	O_2^-
Nitrate	NO_3^-	Sulphate	SO_4^{-2}
Nitrite	NO_2^-	Sulphite	SO_3^{-2}
Nitride	N^{3-}	Sulphide	S^{-2}
Oxide	O^{2-}	Silicate	SiO_3^{2-}
Permanganate	MnO_4^-	Phosphate	PO_4^{3-}

LIST OF ANIONS			
Name of ion	Ion	Name of ion	Ion
Acetate	CH_3COO^-	Cyanide	CN^-
Bicarbonate	HCO_3^-	Chromate	CrO_4^{2-}
Bisulphate	HSO_4^-	Carbide	C^{4-}
Bromide	Br^-	Dichromate	$Cr_2O_7^{2-}$
Chloride	Cl^-	Fluoride	F^-
Chlorate	ClO_3^-	Hydride	H^-
Chlorite	ClO_2^-	Hydroxide	OH^-

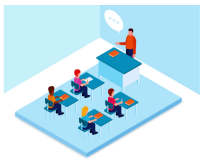
Do you know?

- The size of cation is always smaller than its corresponding atom as it lost electrons.

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

- The size of anion is always greater than its corresponding atom as it gained electrons.

$$\underset{(atom)}{Cl} \xrightarrow{\text{Addition 1 electron}} \underset{(an\ ion)}{Cl^-}$$



CLASSROOM DISCUSSION QUESTIONS CDQ 1.3

1. **What is another name for an electro-positive ion?**
   (A) Radical
   (B) Cation
   (C) Anion
   (D) Monovalent ion

2. **Which of the following is an example of a monovalent electro-positive ion?**
   (A) H+
   (B) Be+2
   (C) Al+3
   (D) Pb+4

3. **How many electrons does a trivalent electro-positive ion donate?**
   (A) 1
   (B) 2
   (C) 3
   (D) 4

4. **Which ion is formed by the acceptance of electrons?**
   (A) Cation
   (B) Radical
   (C) Anion
   (D) Monatomic ion

5. **What is the valency of the cupric ion (Cu2+)?**
   (A) 1
   (B) 2
   (C) 3
   (D) 4

6. **Which of the following is a divalent electro-negative ion?**
   (A) Cl–
   (B) O–
   (C) N–3
   (D) C–4

7. **How many electrons does a monovalent electronegative ion accept?**
   (A) 1
   (B) 2
   (C) 3
   (D) 4

8. **Which ion has the symbol OH–?**
   (A) Hydroxide
   (B) Peroxide
   (C) Oxide
   (D) Hydride

9. **What is the charge of the ion named sulphate (SO_4^{-2})?**
   (A) +1
   (B) –1
   (C) +2
   (D) –2

10. **What is the name of the ion with the symbol NO^{3-}?**
    (A) Nitrite
    (B) Nitrate
    (C) Nitride
    (D) Nitrogen

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

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6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

CONCEPT 1.4

Chemical Formula:

The short form representation of a molecular substance is known as its formula.

Formula of elements: The molecule of an element is represented by writing the symbol of the element, followed by a number written to the lower right, indicating the number of atoms in the molecule.

Example:

- 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 atoms of some elements are capable of independent existence. The formula of molecules of such elements is their symbol itself.

Example:

- Formula of sodium is Na.
- Formula of helium is He.

Thus, the formula is the symbolic expression for a molecule. A molecule of an element may consist of one or more atoms.

Formula of compound: A symbolic representation of one molecule of a compound representing the number of atoms of various elements present in it, is called formula of the compound.

Example: The formula of calcium carbonate is $CaCO_3$.

1. We know that English alphabet has 26 letters. By combining these 26 letters we can make millions of English words.
2. Much the same way by combining elements in different combinations, we can make an endless number of compounds.
3. Each compound is represented by a formula.

Following information is given by the formula of a compound:

1. It tells which elements are present in a compound.
2. It tells the number of atoms of each element present in a compound.

Note: Compound is referred to a pure substance made up of two or more elements chemically combined in a fixed ratio by weight.

How to read information in the formula of a compound?

The symbols in a formula can be prefixed or suffixed by a numeral. When the numeral is written on the lefthand side before the formula, it represents number of molecules of the compound, and hence, the number of atoms present in each molecule.

Examples:

i) When the numeral is written before the symbol, it represents the number of atoms in one molecule of a compound.
   1. When we write 2S, 3C*l* or 4A*l*, it means two atoms of sulphur, three atoms of chlorine and four atoms of aluminium respectively.
   2. When we write 2NaC*l*, 4ZnO, it means two molecules of sodium chloride (which contains two atoms of sodium and two atoms of chlorine), four molecules of zinc oxide (which contains four atoms of zinc and four atoms of oxygen) respectively.

ii) When the numeral is written on the right bottom side of the symbol, it represents the number of atoms in one molecule of a compound.
   1. When we write H_2, O_2, it means that one molecule of hydrogen has two atoms in it. Similarly, one molecule of oxygen has two atoms in it.
   2. When we write SO_2, it means one molecule of sulphur dioxide has one atom of sulphur and two atoms of oxygen.
   3. When we write $Al_2(SO_4)_3$, it means a molecule of aluminium sulphate has two atoms of aluminium, three atoms of sulphur and twelve atoms of oxygen.
   4. When we write $3KNO_3$, it means there are three molecules of potassium nitrate. Furthermore, total number of various atoms in three molecules are: three atoms of potassium, three atoms of nitrogen and nine atoms of oxygen.

How to write the formula of a compound?

One of the most important points to remember while writing the formula of a chemical compound is that it is always electrically neutral. In other words, the positive and negative valencies of the ions or radicals present in the chemical compound add up to zero. Various steps to be followed in writing a formula of a compound by using a process called **criss-cross** method are as follows:

Step I: Write the symbol of the positive ion or the radical to the left and the negative ion or the radical to the right.

Step II: Put the valency number of each of the radical or ion on its top right. Divide the valency number by the highest common factor, if any, to get simple ratio. Now ignore the (+) and (-) symbols. Interchange the valency numbers of the radicals.

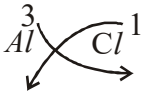
Step III: Shift the valency to the lower right of the ion or the radical. If radical receives a number more than 1, enclose it within brackets. Do not enclose single atom within brackets.

Examples:

1. Writing the formula of aluminium chloride.

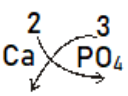
Step-1: $Al^{+3}Cl^{-1}$

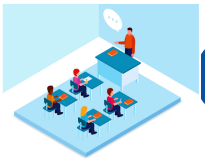
Step-2: $Al^{3}Cl^{1}$

Step-3:  $\Rightarrow AlCl_3$

Step-1: $Ca^{2+}PO_4^{3-}$

Step-2: $Ca^{2}PO_4^{3}$

Step-3:  $\Rightarrow Ca_3(PO_4)_2$



CLASSROOM DISCUSSION QUESTIONS

CDQ 1.4

1. What does the chemical formula represent?

(A) The number of compounds in a substance

(B) The structure of atoms in a compound

(C) The number of atoms of each element in a compound

(D) The mass of the compound

2. How is the number of atoms in one molecule of a compound represented when written before the symbol?

(A) On the left-hand side of the symbol

(B) On the right-hand side of the symbol

(C) Above the symbol

(D) Below the symbol

3. What does the formula "2NaCl" represent?

(A) Two atoms of sodium and two atoms of chlorine

(B) Two molecules of sodium chloride

(C) One molecule of sodium chloride

(D) One atom of sodium and one atom of chlorine

4. In the formula "SO_2", how many atoms of oxygen are present in one molecule of sulphur dioxide?

(A) 1 (B) 2

(C) 3 (D) 4

5. What does the formula "$Al2(SO_4)_3$" represent?

(A) Two atoms of aluminium, three atoms of sulphur, and twelve atoms of oxygen

(B) Two molecules of aluminium sulphate

(C) Three molecules of aluminium sulphate

(D) Three atoms of aluminium and four atoms of sulphur

6. According to the criss-cross method, what should be done after writing the symbols of ions or radicals?

(A) Assign valency numbers

(B) Switch the positions of the ions

(C) Interchange the valency numbers

(D) Ignore the valency numbers

7. Which of the following represents a monovalent electro-positive ion?

(A) O^- (B) Na^+

(C) Cl^- (D) SO_4^{-2}

8. What is the valency of magnesium in Mg^{2+}?

(A) 1 (B) 2

(C) 3 (D) 4

9. Which element has the formula He?

(A) Hydrogen (B) Helium

(C) Carbon (D) Calcium

10. What does the chemical formula H_2O represent?

(A) Two molecules of water

(B) Two atoms of hydrogen and one atom of oxygen

(C) One molecule of water

(D) One atom of hydrogen and one atom of oxygen

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 Ⓐ Ⓑ Ⓒ Ⓓ	2 Ⓐ Ⓑ Ⓒ Ⓓ	3 Ⓐ Ⓑ Ⓒ Ⓓ	4 Ⓐ Ⓑ Ⓒ Ⓓ	5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

CONCEPT 1.5

Naming of Chemical Compounds:

While there are many thousands of different chemical compounds there is a very definite system of nomenclature whereby, we can name or write chemical formulae for most of the compounds. We divide the compounds into two main types:

i) Binary compounds (compounds containing only two kinds of atoms in its molecules) and

ii) Ternary compounds (compounds containing poly atomic ions).

Naming of Binary compounds:

All binary compounds contain only two kinds of elements. The name of every binary compound ends with "**ide**". Binary compounds come in three types. They are:

Type-I..... the metal forms only one type of cation

Type-II..... the metal forms two or more types of cations

Type-III..... contains only nonmetals

Type-I Binary Compounds: The naming system for this type-I compounds are quite simple and is found below.

Rules for naming Type-I binary compounds:

1. The cation is always named first and the anion second.
2. A simple cation (obtained from a single atom) takes its name from the name of the element.
3. A simple anion (obtained from a single atom) is named by taking the first part of the element name (the root) and adding the letters "**ide**".
4. Write the name for the compound by combining the names of the ions.

Examples:

a) Name the compound CaO.

- Ca is the chemical symbol for calcium (which forms cation).
- O is the symbol for oxygen (which forms anion), whose root is "ox." Add the "ide" ending to get oxide.
- Put the pieces together to get the name 'calcium oxide'.

b) Name the compound Li_3N.

- Li is the chemical symbol for lithium.
- N is the chemical symbol for nitrogen, whose root is "nitr." Add the "ide" ending to get nitride.

- Put the pieces together to get the name 'lithium nitride'.

Type-II Binary Compounds: For Type-II binary compounds the metal present is variable valent. The naming system for this type of compound is found below.

Rules for naming Type II binary compounds:

1. The cation is always named first and the anion second.
2. A simple cation (obtained from a single atom) takes its name from the name of the element. Include a Roman numeral to indicate the valency (charge) on the metal cation.
3. A simple anion (obtained from a single atom) is named by taking the first part of the element name (the root) and adding the letters "ide."
4. Write the name for the compound by combining the names of the ions.

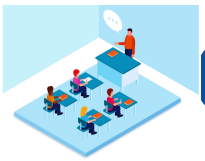
Examples:

a) Name the compound $FeCl_2$.

- Fe is the chemical symbol for iron.
- Fe is a variable valent element, therefore a Roman numeral is needed.
- Cl is the chemical symbol for chlorine, whose root is "chlor." Add the "ide" ending to get chloride.
- At this point we have iron (?) chloride. To find the Roman numeral,
- We know that Cl has a –1 charge.
- By the reverse process of criss-cross, we can find the valency of iron in this compound as 2 (as the valency of Cl is 1).
- The Roman numeral is II.
- Put the pieces together to get the name iron (II) chloride.

b) Name the compound PbS_2.

- Pb is the chemical symbol for lead.
- Pb is a variable valent element, therefore a Roman numeral is needed.
- S is sulphur, whose root is "sulph." Add the "ide" ending to get sulphide.
- At this point we have lead (?) sulphide. To find the Roman numeral,
- We know that S has a charge of -2.
- By the reverse process of criss-cross, we can find the valency of lead in this compound as 4 (as the valency of S is 2).
- The Roman numeral is IV.
- Put the pieces together to get the name lead (IV) sulphide.



CLASSROOM DISCUSSION QUESTIONS

CDQ 1.5

1. **Which of the following compounds is a Type-I binary compound?**
   (A) $FeCl_2$ (B) Li_3N
   (C) PbS_2 (D) CaO
2. **What is the naming convention for Type-I binary compounds?**
   (A) The cation is named first, followed by the anion with "ide" ending
   (B) The cation is named first, followed by the anion without any changes
   (C) The anion is named first, followed by the cation with "ide" ending
   (D) The anion is named first, followed by the cation without any changes
3. **How is the valency of the metal cation indicated in Type-II binary compounds?**
   (A) By adding a "ite" suffix to the cation
   (B) By including a Roman numeral in the cation's name
   (C) By adding a "ate" suffix to the cation
   (D) By including a numerical value in the cation's name
4. **Which compound requires a Roman numeral in its name according to the Type-II binary compound naming rules?**
   (A) CaO (B) Li_3N
   (C) $FeCl_2$ (D) PbS_2
5. **In the compound FeCl2, what Roman numeral is used to indicate the valency of iron?**
   (A) I (B) II
   (C) III (D) IV
6. **What is the name of the compound PbS_2 according to the Type-II binary compound naming rules?**
   (A) Lead Sulphate
   (B) Lead (I) Sulphide
   (C) Lead (II) Sulphide
   (D) Lead (IV) Sulphide
7. **Which part of the element's name is used to form the root of the anion in binary compounds?**
   (A) The first two letters
   (B) The first letter
   (C) The last two letters
   (D) The last letter
8. **What is the name of the compound Li_3N?**
   (A) Lithium Nitride
   (B) Lithium (I) Nitride
   (C) Lithium (II) Nitride
   (D) Lithium (III) Nitride
9. **How is the root of the anion formed in binary compounds?**
   (A) By adding "ium" to the element's name
   (B) By adding "ate" to the element's name
   (C) By adding "ide" to the element's name
   (D) By adding "ite" to the element's name
10. **Which compound exemplifies the naming rules for Type-I binary compounds?**
    (A) $FeCl_2$ (B) Li_3N
    (C) PbS_2 (D) CaO

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 Ⓐ Ⓑ Ⓒ Ⓓ	2 Ⓐ Ⓑ Ⓒ Ⓓ	3 Ⓐ Ⓑ Ⓒ Ⓓ	4 Ⓐ Ⓑ Ⓒ Ⓓ	5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

CONCEPT 1.6

Type-III Binary Compounds: Type III binary compounds contain no metal atoms.

Rules for naming Type III binary compounds:

1. The first element in the formula is named first, and the full element name is used.
2. The second element is named as an anion: root + ide.
3. Prefixes are used to denote the numbers of atoms present.
4. The prefix mono- is never used for naming the first element.

Prefixes:	1 - mono	4 - tetra	7 - hepta	10 - deca
	2 - di	5 - penta	8 - octa	
	3 - tri	6 - hexa	9 - nona	

Name the compound NO_2.

- N is the chemical symbol of nitrogen. Since there is only one nitrogen atom and it is the first element the prefix mono is not used.
- O is the chemical symbol of oxygen, whose root is ox. Add the ide ending to get oxide. There are two oxygen atoms, so we also add the prefix di to get dioxide.
- Put the pieces together to get the name nitrogen dioxide.

Write the formula for carbon tetrachloride.

- The chemical symbol of carbon is C. There is no prefix before carbon in the chemical name, therefore, there is only 1 C atom in the chemical formula.
- Tetrachloride has the prefix tetra which means there are 4 atoms present. Chloride is derived from chlorine, whose symbol is C*l*. Thus, there are 4 C*l* atoms in the chemical formula.
- Putting it all together we have CCl_4.

Naming of Ternary Compounds: (Compounds that contain polyatomic ions)

A polyatomic ion is a group of atoms with an electric charge. (Even though it is a group of atoms it acts like a single atom.)

The names of nearly all polyatomic ions end with the letters –ate or –ite. Exceptions: cyanide, hydroxide, and peroxide. These ions end with "ide" which can trick into thinking you have a binary compound when you actually have a ternary compound.

Naming ternary compounds:

Follow the naming systems for Type I and Type II binary compounds but do not change the name of polyatomic ion.

Examples:

Na_2SO_4 → Sodium sulphate $Fe(NO_3)_3$ → Iron (III) nitrate

Na_2SO_3 → Sodium sulphite $Ca(OH)_2$ → Calcium hydroxide

Na_3PO_4 → Sodium phosphate $Co(ClO_4)_2$ → Cobalt (II) perchlorate

$Cu(NO_2)_2$ → Copper (II) nitrite $(NH_4)_2Cr_2O_7$ → Ammonium dichromate

KH_2PO_4 → Potassium dihydrogen phosphate

Naming of acids:

a) The names of binary acids (acids containing hydrogen and one more element) are given by adding prefix 'hydro'- and suffix '–ic' to the name of second element.

Examples:

i) Acid of hydrogen and chlorine is (HCl) hydrochloric acid,

ii) Acid of hydrogen and fluorine is (HF) hydrofluoric acid.

b) The names of acids containing radicals or polyatomic groups are given on the basis of second element, but prefix hydro- is not used. The suffix '–ic acid' is added to the name of second element.

Examples:

i) Sulphuric acid (H_2SO_4) ii) Phosphoric acid (H_3PO_4)

iii) Carbonic acid (H_2CO_3) iv) Nitric acid (HNO_3)

Naming of bases:

Bases containing -OH radical are named as hydroxides, after the name of metal.

Examples:

i) Sodium hydroxide (NaOH) ii) Ammonium hydroxide (NH_4OH)

iii) Calcium hydroxide ($Ca(OH)_2$) iv) Potassium hydroxide (KOH)

Trival names or common names:

There are certain names of compounds which do not follow any systematic rule. Such names are called trivial names or common names. Chemists have not considered wise to replace these names by systematic names as they are widely understood by the common man.

Examples:

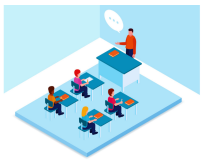
i) Common name for nitrogen hydride is **ammonia** [NH_3]

ii) Common name for sodium chloride is **table salt** [$NaCl$]

iii) Common name for hydrogen oxide is **water** [H_2O]

iv) Common name for potassium nitrate is **nitre** [KNO_3]

v) Common name for magnesium carbonate is **magnesite** [$MgCO_3$]



CLASSROOM DISCUSSION QUESTIONS CDQ 1.6

1. What prefix is used to denote the number of atoms present in Type-III binary compounds?

(A) di- (B) tri-

(C) mono- (D) tetra-

2. What is the chemical formula for nitrogen dioxide?

(A) NO (B) NO_2

(C) NO_3 (D) N_2O

3. How many chlorine atoms are present in carbon tetrachloride?

(A) 2 (B) Table salt

(C) Water (D) Nitre

4. What is the name of the compound Na_2SO_4?

(A) Sodium sulfide

(B) Sodium sulfate

(C) Sodium sulfite

(D) Sodium dioxide

5. How is the name of polyatomic ions treated in ternary compound naming?

(A) They are given a separate name without any changes.

(B) They are given a name following Type-II binary compound naming.

(C) They are given a name following Type-I binary compound naming.

(D) They are given a name with a different suffix.

6. Which acid follows the naming convention of adding 'hydro-' and '-ic' to the second element?

(A) Sulphuric acid

(B) Hydrochloric acid

(C) Phosphoric acid

(D) Carbonic acid

7. What is the name of the base $Ca(OH)_2$?

(A) Calcium hydroxide

(B) Calcium oxide

(C) Calcium chloride

(D) Calcium carbonate

8. What is the common name for the compound NaCl?

(A) Sodium chloride

(B) Sodium hydroxide

(C) Sodium nitrate

(D) Sodium sulfate

9. What is the trivial name for the compound H_2O?

(A) Nitrogen hydride

(B) Table salt

(C) Water

(D) Nitre

10. Which compound is commonly known as "Table salt"?

(A) NaOH

(B) NH_4OH

(C) NaCl

(D) KOH

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 Ⓐ Ⓑ Ⓒ Ⓓ	2 Ⓐ Ⓑ Ⓒ Ⓓ	3 Ⓐ Ⓑ Ⓒ Ⓓ	4 Ⓐ Ⓑ Ⓒ Ⓓ	5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

C.D.F. CONCEPTS, DEFINITIONS AND FORMULAE

1. **Symbol**: A symbol is a short form representation of an element.
2. J.J Berzelius suggested a method of representing elements using English capital letters.
3. **Atomicity**: The number of atoms present in one molecule is called atomicity. Example: Atomicity of ozone is 3
4. The combining capacity of an element is called **valency**.
5. When an element exhibits more than one valency, it is called variable valent element. Example: Iron (Fe) = +2, +3
6. **Formula:** The short form representation of the name of a compound is known formula. Example: The formula of calcium carbonate is $CaCO_3$.
7. If an element exhibits two different positive valencies. Then suffix 'ous' is attached at the end of the name of the metal for lower valency and suffix 'ic' is attached at the end of the name of the metal for higher valency.
8. A group of atoms having some positive or negative charge is called radical (or) ion. Example: Ammonium radical NH_4^+.
9. **Monovalent electro positive ion:** The metallic ion formed by the donation of one electron is called mono electro positive ion. Examples: H^+, Na^+, NH_4^+
10. **Divalent electro positive ion:** The metallic ion formed by the donation of two electrons is called divalent electro positive ion. Examples: Be^{+2}, Mg^{+2}
11. **Trivalent electro positive ion:** The metallic ion formed by the donation of three electrons is called trivalent electro positive ion. Examples: Al^{+3}, Fe^{+3}
12. **Monovalent electronegative ion:** An ion (or) radical formed by the acceptance of only one electron is called as monovalent electronegative ion. Examples: Cl^-, OH^-
13. **Divalent electro negative ion:** An ion (or) radical formed by the acceptance of two electrons is called as divalent electronegative ion.
    Examples: O^{-2}, S^{-2}, SO_4^{-2}
14. **Trivalent electro negative ion:** An ion (or) a radical formed by the acceptance of three electrons is called as trivalent electronegative ion.
    Examples: N^{-3}, B^{-3}, PO_4^{-3}
15. All the compounds can be divided into two main types:
    i) Binary compounds (compounds containing only two kinds of atoms in its molecules) and
    ii) Ternary compounds (compounds containing poly atomic ions).
15. Certain names of compounds do not follow any systematic rule. Such names (or) called trivial names (or) common names.
    Example: Nitrogen trihydride - NH_3 (Ammonia)
    Table salt - $NaCl$ (Sodium chloride)

ADVANCED WORKSHEET

Single Correct Answer Type (S.C.A.T)

1. The abbreviation used for the full name of an element is called its:

(A) Molecule

(B) Atom

(C) Symbol

(D) Ion

2. The symbolic representation of name of a compound known as:

(A) Valency

(B) Formula

(C) Both A & B

(D) Ion

3. The names of compounds which do not follow any systematic rule are called:

(A) Trivial names

(B) Common names

(C) Chemical names

(D) Both A & B

4. The valency of hydrogen in hydrochloric acid is:

(A) Zero

(B) One

(C) Three

(D) Two

5. An atom (or) a group of atoms which can exist independently with charge is called:

(A) Ion

(B) Molecule

(C) Compound

(D) Substance

6. The ions formed by the gain of electrons are called:

(A) Anions

(B) Cations

(C) Compounds

(D) Molecules

7. Bivalent ion among the following is:

(A) Nitride

(B) Phosphide

(C) Chloride

(D) Sulphate

8. What is the correct definition of valency?

(A) Number of outermost electrons of an atom

(B) Number of atoms gained or lost in a reaction

(C) The combining capacity of an element

(D) None of the above

9. Sodium forms _____ ion.

(A) Monovalent

(B) Bivalent

(C) Trivalent

(D) Both A & B

10. Identify phosphate ion among the following.

(A) PO_4^{3-}

(B) P^{4-}

(C) P^{3-}

(D) PO_3^{3-}

11. Which one of these is monoatomic gas?

(A) Hydrogen

(B) Helium

(C) Ozone

(D) Oxygen

12. Atomicity of ozone is:

(A) One

(B) Two

(C) Four

(D) Three

13. The formula NaCl represents:

(A) Sodium chloride

(B) Common salt

(C) Table salt

(D) All of these

14. Which of the following elements can exhibit more than one valency?

(A) Na

(B) Mg

(C) Cu

(D) Al

15. Which of the following molecules is not triatomic?

(A) NO_2

(B) CO_2

(C) MgO

(D) MnO_2

16. The valency of Mg in $MgCl_2$ is:

(A) 1

(B) 2

(C) 3

(D) 4

17. The valency of iron in ferric chloride is:

(A) +1

(B) +2

(C) +3

(D) 0

18. Which of the following elements is not tetravalent?

(A) P

(B) C

(C) Si

(D) Ge

19. What is the symbol for the element 'Lead'?

(A) L

(B) Pb

(C) Ag

(D) Au

20. Name the compound CaF_2:

(A) Calcium difluoride

(B) Calcium bifluoride

(C) Calcium fluoride

(D) Calcium fluorine

21. The compound CS_4 can be named as:

(A) Carbon sulphide

(B) Monocarbon tetrasulphide

(C) Carbon tetrasulphide

(D) Monocarbon sulphide

22. What is the correct chemical formula of the compound copper (II) oxide?

(A) CuO

(B) Cu_2O

(C) Cu_2O_2

(D) CuO_2

23. What is the correct chemical formula of the compound carbon dioxide?

(A) C_2O_2

(B) C_2O

(C) CO_2

(D) CO

24. Chemical formula of Zinc Hydroxide is:

(A) $Zn(OH)_2$

(B) ZNO_2

(C) $Zn_2(OH)_3$

(D) ZnOH

25. Valency of carbon in carbon dioxide molecule is:

(A) 1

(B) 2

(C) 3

(D) 4

Multi Correct Question (M.C.Q)

26. Which of the following elements form divalent ions?

(A) Oxygen

(B) Sodium

(C) Magnesium

(D) Calcium

27. Identify the correct statements.

(A) Atoms of different elements combine in certain fixed ratio to form a compound

(B) All chemical compounds are represented by their respective formulae

(C) The chemical formula of calcium sulphate is $CaSO_4$

(D) The chemical formula of common salt is $NaCl$

28. Which of the following molecule have same atomicity as that of chlorine?

(A) Nitrogen

(B) Hydrogen

(C) Phosphorus

(D) Oxygen

Comprehension Passage (C.P.T)

PASSAGE-I

There are certain names of compounds which do not follow any systematic rules. Such names are called trivial names (or) common names.

29. What is the trivial name of sodium chloride?

(A) Ammonia

(B) Table salt

(C) Water

(D) Baking salt

30. What is the chemical name of ammonia?

(A) Nitrogen trihydride

(B) Hydrogen nitrite

(C) Hydrogen trinitride

(D) Can not be named

31. The chemical formula of nitre is:

(A) K_2SO_4

(B) KCl

(C) K_2O

(D) KNO_3

PASSAGE-II

Binary compounds are chemical compounds composed of any two different elements.

32. Identify the binary compound.

(A) NaOH (B) H_2S

(C) HCN (D) H_2SO_4

33. What is the chemical formula for the binary compound formed between magnesium and oxygen?

(A) MgO_2 (B) Mg_2O

(C) MgO (D) Mg_3O_2

34. What is the name of binary compound with formula $FeCl_3$?

(A) Iron (II) chloride

(B) Iron (III) chloride

(C) Iron chloride

(D) Iron chlorine

Matrix Matching Type (M.M.T.)

SET-I

Column - I

35. Magnesium chloride

36. Potassium chloride

37. Calcium chloride

38. Sodium chloride

Column - II

(A) $NaCl$

(B) $CaCl_2$

(C) $MgCl_2$

(D) KCl

SET-II

Column-I (compounds)

39. $\underline{Ba}Cl_2$

40. $\underline{Fe_2}O_3$

41. $\underline{Na_2}O$

42. $\underline{S}O_2$

Column-II (valency of underlined element in a compound)

(A) 1

(B) 2

(C) 3

(D) 4

Assertion Reason Type (A.R.T.)

(A) Assertion and Reason are true and Reason is the correct explanation of Assertion

(B) Assertion and Reason are true but Reason is not the correct explanation of Assertion

(C) Assertion is true but Reason is false

(D) Assertion is false but Reason is true

43. Assertion: Some compounds have trivial names.

Reason: Trivial names for compounds non-systematic, trivial names often based on the compounds source, properties and historical usage.

44. Assertion: Atomicity of ozone is three while that oxygen is two.

Reason: Atomicity is the number of atoms constituting a molecule.

Statement Type (S.T.)

(A) Both statements are correct

(B) Both statements are incorrect

(C) Statement I is correct statement II is incorrect

(D) Statement I is incorrect Statement II is correct

45. Statement-I: Metallic ions formed by the donation of electrons.

Statement-II: The suffix 'ous' is attached at the end of the name of the metal for lower valency.

46. Statement-I: Table salt is the common name of sodium chloride.

Statement-II: Certain names do not follow any systematic rules. Such names are called common names.

Integer Type Question (I.T.Q.)

47. How many hydrogens atoms are present in hydrogen sulphide molecule?

48. How many oxygen atoms are present in magnesium sulphate molecule?

49. In CuO (Copper oxide), valency of copper is _____.

Analytical Approach Type (A.A.T.)

50. Valency of hydroxide ion (OH) is:

(A) –1 (B) –2

(C) –3 (D) –4

51. All of these radicals have a valency of 1, except:

(A) OH (B) CO_3

(C) NO_3 (D) NH_4

52. If an element A has valency Y and element B has valency X, in that case if both elements combine, the formula for the resultant compound will be:

(A) A_XB_Y (B) A_YB_X

(C) $A_{2X}B_Y$ (D) A_XB_{2Y}

53. When there are four atoms of an element in a binary compound, prefix _____ is used.

(A) Mono (B) Di

(C) Tri (D) Tetra

54. Formula of ammonium sulphate is:

(A) $NH_4(SO_4)_2$

(B) $NH_4(HSO_4)_2$

(C) $(NH_4)_2SO_4$

(D) $(NH_3)_2SO_3$

55. A simple acid will always have:

(A) Hydrogen

(B) Oxygen

(C) Chlorine

(D) Nitrogen

56. Chemical formula of aluminium oxide is:

(A) Al_2O_3 (B) AlO_4

(C) Al_2O_5 (D) Al_2O

57. The formula for Hydrogen is H_2. Then H_2 is:

(A) Molecule (B) Atom

(C) Electron (D) Ion

58. Formula of aluminium sulphate indicates that:

(A) For each ion of Al, two ions of sulphate are required

(B) For each ion of Al, three ions of sulphate are required

(C) For two ions of Al, three ions of sulphate are required

(D) For two ions of Al, four ions of sulphate are required

59. Give examples each of the following.

1) Binary compound :

_____

2) Monovalent element :

_____

3) Divalent element :

_____

4) Diatomic gas :

_____

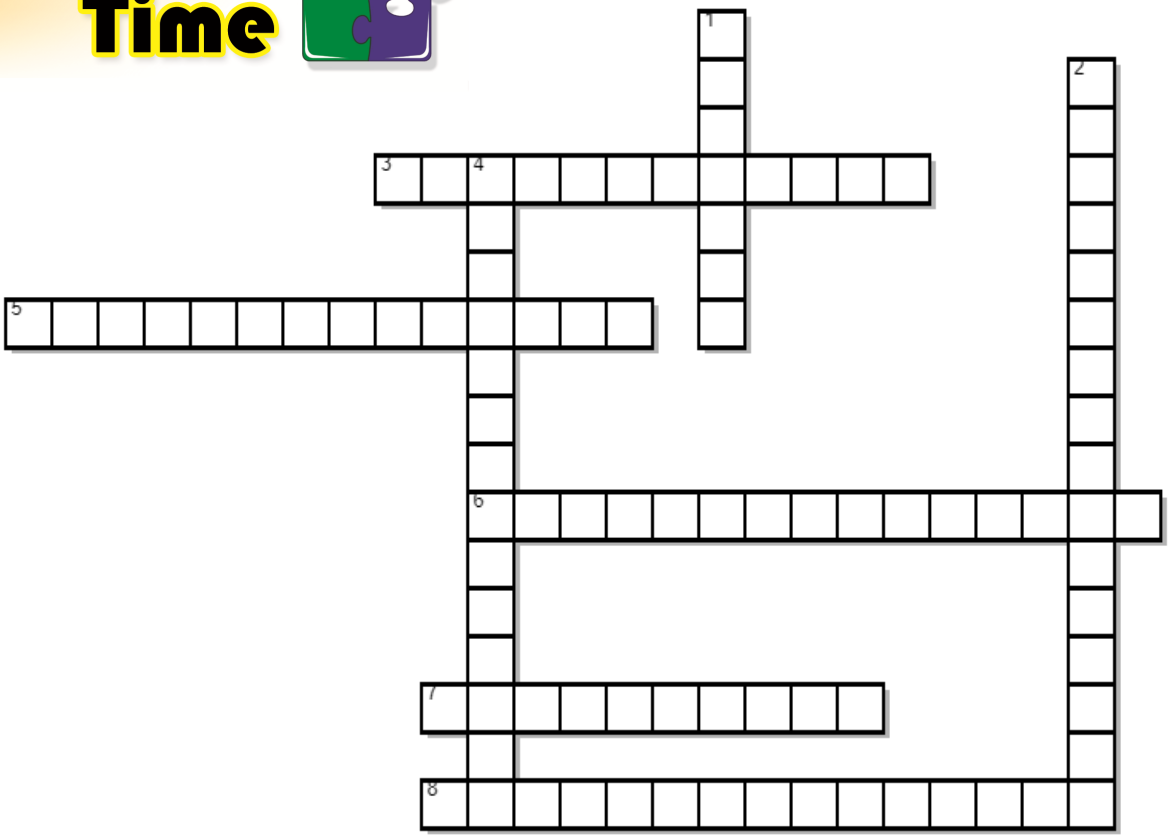
5) Trivalent element :

_____

6) Triatomic gas :

_____

Puzzle Time



***Across*: (→)**

3. CaO
5. Na_2SO_4
6. NO_2
7. HNO_3
8. $FeCl_2$

***Down*: (↓)**

1. NH_3
2. $Ca(OH)_2$
4. Li_3N

NOTES