Fundamentals of Chemistry

Long Answer Questions

Q1. Define Chemistry. Give its importance in daily life.

Ans. The branch of science which deals with the composition, structure, properties, and reactions of matter is called chemistry. It touches almost every aspect of our life.

Importance

The development of science and technology has provided us a lot of facilities in daily life. Imagine the role and importance of petrochemical products, medicines and drugs, soap and detergents, paper and plastics, paints and pigments and insecticides and pesticides which all are fruit of the efforts of chemists. The development of chemical industry has also generated toxic wastes, contaminated water and polluted air around us. On the other hand, chemistry also provides knowledge and techniques to improve our health and environment and to explore and conserve the natural resources.

Q2. Define and describe the various branches of Chemistry.

Ans. Branches of Chemistry

i. Physical Chemistry

Physical Chemistry is defined as the branch of chemistry that deals with the relationship between the composition and physical properties of matter along with the changes in them. The properties such as structure of atoms or formation of molecules, behavior of gases, liquids and solids and the study of the effect of temperature or radiation on matter, all are studied under this branch.

ii. Organic Chemistry

Organic Chemistry is the study of covalent compounds of carbon and hydrogen-hydrocarbons and their derivatives. Scope of this branch covers petroleum, petrochemicals and pharmaceutical industries.

iii. Inorganic Chemistry

Inorganic chemistry deals with the study of all elements and their compounds except hydrocarbons and their derivatives. It has applications in every aspect of the chemical industry such as glass, cement, ceramics and metallurgy.

iv. Biochemistry

It is the branch of chemistry in which we study the structure, composition, and chemical reactions of substances found in living organisms. It covers all chemical reactions

taking place in living organisms. Examples of applications of biochemistry are in the fields of medicine, food science and agriculture etc.

v. Industrial Chemistry

The branch of chemistry that deals with the manufacturing of chemical compounds on commercial scale is called industrial chemistry. It deals with the manufacturing of basic chemicals such as oxygen, chlorine, ammonia, caustic soda, nitric acid and sulphuric acid. These chemicals provide the raw materials for many other industries such as fertilizers, soap, textiles, agricultural products, paints and paper etc.

vi. Nuclear Chemistry

Nuclear Chemistry is the branch of chemistry that deals with the radioactivity, nuclear processes and properties. The main concern of this branch is with the energy of the atom and its uses in daily life. It has vast applications in medical treatment (radiotherapy), preservation of food and generation of electrical power through nuclear reactors, etc.

vii. Environmental Chemistry

It is the branch of chemistry in which we study about components of the environment and the effects of human activities on the environment. Environmental chemistry is related to other branches like biology, geology, ecology, soil and water chemistry, mathematics and engineering. The knowledge of chemical processes taking place in environment is necessary for its improvement and protection against pollution.

viii. Analytical Chemistry

Analytical chemistry is the branch of chemistry that deals with separation and analysis of a sample to identify its components. The separation is carried out prior to qualitative and quantitative analysis. Qualitative analysis provides the identity of a substance. On the other hand quantitative analysis determines the amount of each component present in the sample. Hence, in this branch different techniques and instruments used for analysis are studied. The scope of this branch covers food, water, environmental and clinical analysis.

Q3. Define Matter, Substance, Physical Properties and Chemical Properties.

Ans.

i. Matter

Matter is simply defined as anything that has mass and occupies space. Our bodies as well as all the things around us are examples of matter. In chemistry we study all types of matter that can exist in any of three physical states; solid, liquid or gas.

ii. Substance

A piece of matter in pure form is termed as substance. Every substance has a fixed composition and specific properties or characteristics.

iii. Physical Properties

The properties that are associated with the physical state of a matter are called physical properties; like colour, smell, taste, hardness, shape of crystal, solubility, melting or boiling

points etc. For example when ice is heated, it melts to form water. When water is further heated, it boils to give steam. In this entire process only the physical state of water changes where as its chemical composition remains the same.

iv. Chemical Properties

The chemical properties depend upon the composition of the substance. When a substance undergoes a chemical change, its composition changes and a new substance is formed. For example, decomposition of water is a chemical change as it produces hydrogen and oxygen gases.

Q4. **What is element? Describe its occurrence and types.**

Ans. **Element**

Element is a substance made up of same type of atoms, having same atomic number and it cannot be decomposed into simple substances by chemical means. It means that each element is made up of unique type of atoms that have very specific properties.

Explanation

In the early ages, only nine elements (carbon, gold, silver, tin, mercury, lead, copper, iron and sulphur) were known. At that time it was considered that elements were the substances that could not be broken down into simpler units by ordinary chemical process. Until the end of nineteenth century sixty-three elements had been discovered. Now 118 elements have been discovered, out of which 92 are naturally occurring elements.

Occurrence

Elements occur in nature in free or combined form. All the naturally occurring elements found in the world have different percentages in the earth's crust, oceans and atmosphere. Table shows natural occurrence in percentage by weight of some abundant elements around us.

It shows concentrations of these major elements found in the three main systems of our environment.

Natural Occurrences by Weight % of Some Major Elements

Crust of Earth		Oceans		Atmosphere	
Oxygen	47 %	Oxygen	86%	Nitrogen	78%
Silicon	28%	Hydrogen	11%	Oxygen	21%
Aluminium	7.8%	Chlorine	1.8%	Argon	0.9%

Elements may be solids, liquids or gases. Majority of the elements exist as solids e.g. sodium, copper, zinc, gold etc. There are very few elements which occur in liquid state e.g. mercury and bromine. A few elements exist as gases e.g. nitrogen, oxygen, chlorine and hydrogen.

TOPSTUDYWORLD
.COM

FOR 4 REASONS

1 NOTES

KIPS AND OTHER NOTES FOR
9TH, 10TH, 11TH AND 12TH CLASS

GREAT MARKS TIPS 2

GETTING 94 MARKS IN URDU,
AND PAPER ATTEMPTING,
ENTRY TEST, FSC EXAMS TIPS

3 BOARD NEWS AND POLICY

BOARD UPDATES, PAPER
IMPROVEMENT, CANCELLATION
POLICIES ETC IN EASY WORDS

FREE SUPPORT 4

ARE YOU BROKEN? ARE YOU
FINDING THE SOLUTION TO
YOUR PROBLEM? DO YOU WANT
TO KNOW ANYTHING RELATED
TO STUDY? WE WILL BE HAPPY
TO HELP YOU!

YOU ARE GOOD TO GO!

Stay safe

Types of Elements

On the basis of their properties, elements are divided into metals, non-metals and metalloids. About 80 percent of the elements are metals.

Q5. Define valency. Write a detailed note on concept of valency.

Ans. Valency is the unique property of an element. It is combining capacity of an element with other elements. It depends upon the number of electrons in the outermost shell.

Valency in Covalent Compound

In simple covalent compounds it is the number of hydrogen atoms which will combine with one atom of that element or a number of bonds formed by one atom of the element e.g. valency of Cl, O, N, and C is 1,2,3 and 4 respectively. Different numbers of atoms of hydrogen combine with one atom of these elements to form compounds like HCl, H_2O, NH_3 and CH_4 respectively.

Valency in Ionic Compound

In simple ionic compounds valency is the number of electrons gained or lost by an atom of an element to complete its octet. Elements having less than four electrons in the valence shell prefer to lose the electrons to complete their octet. For example atoms of Na, Mg and Al have 1,2 and 3 electrons in their valence shells respectively. They lose these electrons to have valency of 1,2 and 3 respectively. On the other hand elements having four or more than four electrons in their valence shell, gain electrons to complete their octet. For example, N, O and Cl have 5,6 and 7 electrons in their valence shells respectively. They gain 3, 2 and 1 number of electrons respectively to complete their octet. Hence they show valency of 3, 2 and 1 respectively.

Variable Valency

Some elements show more than one valency, i.e., they have variable valency. For example, in ferrous sulphate ($FeSO_4$) the valency of iron is 2. In ferric sulphate ($Fe_2(SO_4)_3$) the valency of iron is 3. Generally, the Latin or Greek name for the element (e.g., Ferrum) is modified to end in 'ous' for the lower valency (e.g., Ferrous) and to end in 'ic' for the higher valency (e.g., Ferric).

Element / Radical	Symbol	Valency	Element / Radical	Symbol	Valency
Sodium	Na	1	Hydrogen	H	1
Potassium	K	1	Chlorine	Cl	1
Silver	Ag	1	Bromine	Br	1
Magnesium	Mg	2	Iodine	I	1
Calcium	Ca	2	Oxygen	O	2
Barium	Ba	2	Sulphur	S	2

Zinc	Zn	2	Nitrogen	N	3
Copper	Cu	1,2	Phosphorus	P	3,5
Mercury	Hg	1,2	Boron	B	3
Iron	Fe	2,3	Arsenic	As	3
Aluminium	Al	3	Carbon	C	4
Chromium	Cr	3	Carbonate	CO_3^{2-}	2
Ammonium	NH_4^+	1	Sulphate	SO_4^{2-}	2
Hydronium	H_3O^+	1	Sulphite	SO_3^{2-}	2
Hydroxide	OH^-	1	Thiosulphate	$S_2O_3^{2-}$	2
Cyanide	CN^-	1	Nitride	N^{3-}	3
Bisulphate	HSO_4^-	1	Phosphate	PO_4^{3-}	3
Bicarbonate	HCO_3^-	1			

Q6. Define Compound. How is it classified?

Ans. Compound

Compound is a substance made up of two or more elements chemically combined together in a fixed ratio by mass.

Explanation

As a result of combination, elements lose their own properties and produce new substances (compounds) that have entirely different properties. Compounds cannot be broken down into its constituent elements by simple physical methods. For example, carbon dioxide is formed when elements of carbon and oxygen combine chemically in a fixed ratio of 12:32 or 3:8 by mass, Similarly water is a compound formed by a chemical combination between hydrogen and oxygen in a fixed ratio of 1:8 by mass.

Classification of Compounds

Compounds can be classified as ionic or covalent.

Ionic Compounds

Ionic compounds do not exist in independent molecular form. They form a three-dimensional crystal lattice, in which each ion is surrounded by oppositely charged ions. The oppositely charged ions attract each other very strongly; as a result ionic compounds have high melting and boiling points. These compounds are represented by formula units e.g. $NaCl$, KBr, $CuSO_4$.

Covalent Compounds

The covalent compounds mostly exist in molecular form. A molecule is a true representative of the covalent compound and its formula is called molecular formula e.g. H_2O, HCl, H_2SO_4, CH_4.

Some common Compounds with their Formulae

Compound	Chemical Formula
Water	H_2O
Sodium chloride (Common salt)	NaCl
Silicon dioxide (Sand)	SiO_2
Sodium hydroxide (Caustic Soda)	NaOH
Sodium carbonate (Washing Soda)	$Na_2CO_3.10H_2O$
Calcium oxide (Quick Lime)	CaO
Calcium carbonate (Lime Stone)	$CaCO_3$
Sugar	$C_{12}H_{22}O_{11}$
Sulphuric acid	H_2SO_4
Ammonia	NH_3

Q7. Define Mixture. How is it classified?

Ans. Mixture

When two or more elements or compounds mix-up physically without any fixed ratio, they form a mixture. On mixing up, the component substances retain their own chemical identities and properties. The mixture can be separated into parent components by physical methods such as distillation, filtration, evaporation, precipitation or magnetization.

Classification

i. Homogeneous Mixture

Mixtures that have uniform composition throughout are called homogeneous mixtures e.g. air, gasoline, ice cream.

ii. Heterogeneous Mixture

Heterogeneous mixtures are those in which composition is not uniform throughout e.g. soil, rock and wood.

Q8. What is Relative Atomic Mass and Atomic Mass Unit?

Ans. Relative Atomic Mass and Atomic Mass Unit

The relative atomic mass of an element is the average mass of atoms of that element as compared to $1/12^{th}$ (one-twelfth) the mass of one atom of carbon-12 isotope. Based on carbon-12 standard, the mass of an atom of carbon is 12 and $1/12^{th}$ of it comes to be one. When we compare atomic masses of other elements with carbon-12 atoms, they are expressed as relative atomic masses of those elements. The unit for relative atomic masses is called atomic mass unit, with symbol 'amu'. One atomic mass unit is $1/12^{th}$ the mass of one atom of carbon- 12th. When this atomic mass unit is expressed in grams, it is:

$$1 \text{ amu} = 1.66 \times 10^{-24} g$$

For example:

Mass of a proton	= 1.0073amu	or	1.672×10^{-24}g
Mass of a neutron	= 1.0087amu	or	1.674×10^{-24} g
Mass of an electron	= 5.486×10^{-4}amu.	or	9.106×10^{-28}g

Q9. **List five characteristics by which compounds can be distinguished from mixture.**

Ans. **Difference between a Compound and a Mixture**

	Compound	Mixture
i.	It is formed by a chemical combination of atoms of elements	Mixture is formed by the simple mixing up of the substances.
ii.	The constituents lose their identity and form a new substance having entirely different properties from them.	Mixture shows the properties of the constituents.
iii.	Compounds always have fixed composition by mass.	The minimum number and ratio of the components may not be fixed.
iv.	The components cannot be separated by physical means.	The components can be separated by simple physical methods.
v.	Every compound is represented by a chemical formula.	It consists of two or more components and does not have any chemical formula.
vi.	Compounds have homogeneous composition.	They may be homogeneous or heterogeneous in composition
vii.	A compound has a sharp and fixed melting point.	A mixture does not have a sharp and fixed melting point.

Q10. What do you know about Atomic Number and Mass Number? Explain them with examples.

Ans. **Atomic Number**

The atomic number of an element is equal to the number of protons present in the nucleus of its atoms. It is represented by symbol 'Z'.

Each element has a specific atomic number termed as its identification number.

Examples:

All hydrogen atoms have 1 proton, their atomic number Z=1.

All atoms in carbon have 6 protons, their atomic number Z=6.

All Oxygen atoms have 8 protons having atomic number Z=8

Sulphur having 16 protons show atomic number Z=16.

Mass Number

The mass number is the sum of number of protons and neutrons present in the nucleus of an atom. It is represented by symbol 'A'.

It is calculated as A=Z+n where n is the number of neutrons.

Examples:

Hydrogen atom has one proton and zero number of neutron in its nucleus, its mass number A=1+0 =1.

Carbon atom has 6 protons and 6 neutrons, hence its mass number A=12.

Atomic numbers and mass numbers of a few elements are given in Table

Some Elements along with their Atomic and Mass Numbers

Element	Number of Protons	Number of Neutrons	Atomic Number Z	Mass Number A
Hydrogen	1	0	1	1
Carbon	6	6	6	12
Nitrogen	7	7	7	14
Oxygen	8	8	8	16
Fluorine	9	10	9	19
Sodium	11	12	11	23
Magnesium	12	12	12	24
Potassium	19	20	19	39
Calcium	20	20	20	40

Q11. How to write a Chemical Formula?

Ans. Compounds are represented by chemical formulae as elements are represented by symbols. Chemical formulae of compounds are written keeping the following steps in consideration.

i. Symbols of two elements are written side-by-side, in the order of positive ion first and negative ion later.

ii. The valency of each ion is written on the right top corner of its symbol, e.g. Na^{+}, Ca^{2+}, Cl^{-} and O^{2-}

iii. This valency of each ion is brought to the lower right corner of other ion by cross-exchange method, e.g.
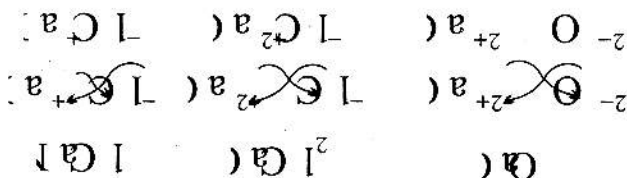
iv. If the valencies are same, they are offset and are not written in the chemical formula. But if they are different, they are indicated as such at the same position, e.g. in case of sodium chloride both the valencies are offset and formula is written as NaCl, whereas, calcium chloride is represented by formula $CaCl_2$.

v. If an ion is a combination of two or more atoms which is called radical, bearing a net charge on it, e.g. SO_4^{2-} (sulphate) and PO_4^{3-} (phosphate), then the net charge represents the valency of the radical. The chemical formula of such compounds is written as explained in (iii) and (iv) For example, chemical formula of aluminium sulphate is written as $Al_2(SO_4)_3$ and that of calcium phosphate as $Ca_3(PO_4)_2$.

Q12. Define Empirical Formula. Explain it.

Ans. Empirical formula

It is the simplest chemical formula, which shows the simplest whole number ratio of atoms present in a compound.

The empirical formula of a compound is determined by knowing the percentage composition of a compound. However, here we would explain it with simple examples.

Empirical Formula of Covalent Compounds:

The covalent compound silica (sand) has simplest ratio of 1:2 of silicon and oxygen respectively. Therefore, its empirical formula is SiO_2. Similarly, glucose has simplest ratio 1:2:1 of carbon, hydrogen and oxygen respectively. Hence its empirical formula is CH_2O.

Empirical Formula of Ionic Compound:

Ionic compounds exist in three dimensional network forms. Each ion is surrounded by oppositely charged ions in such a way to form electrically neutral compound. Therefore, the simplest unit taken as a representative of an ionic compound is called formula unit. It is defined as the simplest whole number ratio of ions, as present in the ionic compound. In other words, ionic compounds have only empirical formulae. For example, formula unit of common salt consists of one Na^+ and one Cl^- ion and its empirical formula is NaCl. Similarly, formula unit of potassium bromide is KBr, which is also its empirical formula.

Q13. Define Molecular Formula. Explain with examples.

Ans. Molecular Formula

Molecules are formed by the combination of atoms. These molecules are represented by molecular formulae that show actual number of atoms of each element present in a molecule of that compound. Molecular formula is derived from empirical formula by the following relationship:

Molecular formula = (Empirical formula)$_n$

Where n is 1,2,3 and so on.

For example, molecular formula of benzene is C_6H_6 which is derived from Its empirical formula CH where the value of n is 6.

The molecular formula of a compound may be same or a multiple of the empirical formula. A few compounds having different empirical and molecular formulae are shown in Table.

Some Compounds with their Empirical and Molecular Formulae

Compound	Empirical formula	Molecular formula
Hydrogen peroxide	HO	H_2O_2
Benzene	CH	C_6H_6
Glucose	CH_2O	$C_6H_{12}O_6$

Some compounds may have same empirical and molecular formula e.g. water (H_2O), hydrochloric acid (HCl), etc.

Q14. Define Molecular Mass and Formula Mass. Give examples.

Ans. Molecular Mass

The sum of atomic masses of all the atoms present in one molecule of a molecular compound, is called molecular mass.

Examples

Molecular mass of water (H_2O) is 18amu.

Molecular mass of Carbon dioxide (CO_2) is 44 amu.

Formula Mass:

The sum of atomic masses of all the atoms present in one formula unit of a substance is called formula mass.

Example

Formula mass of sodium chloride is 58.5amu.

Formula mass of $CaCO_3$ is 100amu.

Q15. Write a note on Chemical Species. (i) Ions (Cations and Anions) (ii) Molecular Ions (iii) Free Radicals

Ans. Chemical Species

i. Ions

Ion is an atom or group of atoms having a charge on it. The charge may be positive or negative. There are two types of ions i.e. cations and anions.
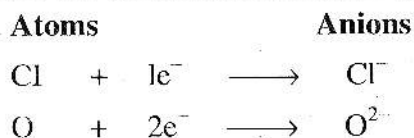
ii. Cations

An atom or group of atoms having positive charge on it is called cation. The cations are formed when an atom loses electrons from its outermost shells. For example, Na^+, K^+ are cations. The following equations show the formation of cations from atoms.

Atoms		Cations
H	$\longrightarrow$	$H^+ + 1e^-$
Na	$\longrightarrow$	$Na^+ + 1e^-$
Ca	$\longrightarrow$	$Ca^{2+} + 2e^-$
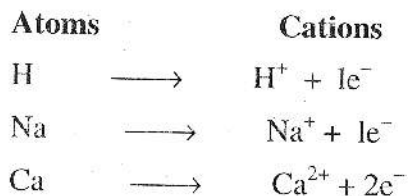
iii. Anions

An atom or a group of atoms that has a negative charge on it, is called anion. Anion is formed by the gain or addition of electrons to an atom. For example, Cl^- and O^{2-}, Following examples show the formation of an anion by addition of electrons to an atom.

| Atoms			Anions
Cl	$+$	$1e^-$ $\longrightarrow$	Cl^-
O	$+$	$2e^-$ $\longrightarrow$	O^{2-}

iv. Molecular Ion

Molecular ion or radical is a species having positive or negative charge on it. When a molecule loses or gains an electron, it forms a molecular ion. Hence, Like other ions they can be cationic molecular ions (if they carry positive charge) or anionic molecular ions (if they carry negative charge). Cationic molecular ions are more abundant than anionic molecular ions. For example CH_4^+, He^+, N_2^+.

Formation:

When gases are bombarded with high-energy electrons in a discharge tube, they ionize to give molecular ions.

v. Free Radicals

Free radicals are atoms or group of atoms possessing an odd (unpaired) electron. It is represented by putting a dot over the symbol of an element e.g. $H^{\bullet}$, $Cl^{\bullet}$, $H_3C^{\bullet}$. Free radicals are generated by the homolytic (equal) breakage of the bond between two atoms when they absorb heat or light energy. A free radical is extremely reactive species as it has the tendency to complete its octet.

Molecules		Free radicals
Cl_2	$\xrightarrow{h\nu}$	$2Cl^{\bullet}$
CH_4	$\xrightarrow{h\nu}$	$H_3C^{\bullet} + H^{\bullet}$
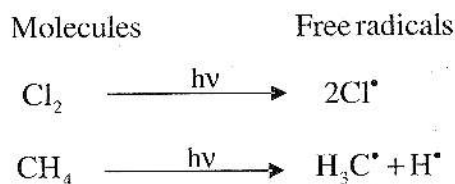
Q16. Define Molecule. Write down its types

Ans. A molecule is formed by the combination of atoms. It is the smallest unit of a substance. It shows all the properties of the substance and can exist independently.

Types of Molecules

i. Monatomic molecule

A molecule consisting of only one atom is called monatomic molecule.

Examples: The inert gases helium, neon and argon all exist independently in atomic form.

ii. Diatomic Molecule

A molecule consists of two atoms is called diatomic molecule.

Examples: Hydrogen gas(H_2) oxygen (O_2) chlorine (Cl_2) and hydrogen chloride (HCl)

iii. Triatomic molecule

A molecule consists of three atoms is called triatomic molecule.

Examples: H_2O , CO_2

iv. Polyatomic Molecule

A molecule consists of many atoms is called polyatomic molecule.

Examples: Methane (CH_4) Sulphuric Acid (H_2SO_4) and glucose ($C_6H_{12}O_6$)

v. Homoatomic Molecule

A molecule containing same type of atoms is called homoatomic molecule

Example : Hydrogen (H_2) Ozone (O_3), Sulphur (S_8)

vi. Hetroatomic Molecule

A molecule consists of different kinds of atoms is called hetroatomic molecule

Examples: CO_2 , H_2O , NH_3

Q17. Write a note on the following.

(i) Gram Atomic Mass   (ii) Gram Molecular Mass

(iii) Gram Formula Mass

Ans. Gram Atomic Mass, Gram Molecular Mass and Gram Formula Mass

i. Gram Atomic Mass

The atomic mass of an element expressed in grams is called gram atomic mass or gram atom. It is also called a mole.

I gram atom of hydrogen   =   1.008 g   =   1 mol of hydrogen

1 gram atom of carbon   =   12.0 g   =   1 mol of carbon

It means that 1 gram atom of different elements has different masses.

ii. Gram Molecular Mass

The molecular mass of a compound expressed in grams is called gram molecular mass or gram molecule. It is also called a mole.

1 gram molecule of water   =   18.0 g   =   1 mol of water

1 gram molecule of H_2SO_4 =   98.0 g   =   1 mol of sulphuric acid

iii. Gram Formula Mass

The formula mass of an ionic compound expressed in grams is called gram formula mass or gram formula. This is also called a mole. For example

1 gram formula of NaCl   =   58.5 g   =   1 mol of sodium chloride

1 gram formula of $CaCO_3$ =   100 g   =   1 mol of calcium carbonate

Q18. What is Avogadro's Number? Give examples.

Ans. Avogadro's Number

The number of particles in one mole of a substance is called Avogadro's number. The value of this number is 6.02×10^{23}. It is represented as N_A .

Explanation

In chemistry we deal with substances which are composed of atoms, molecules or formula units. The counting of these particles is not possible for the chemists. The concept of

Avogadro's number facilitated the counting of particles contained in the given mass of a substance. Avogadro's Number is a collection of 6.02×10^{23} particles. It is represented by symbol 'N_A'. Hence, the 6.02×10^{23} number of atoms, molecules or formula units are called Avogadro's number that is equivalent to one 'mole' of respective substance. In simple words 6.02×10^{23} particles are equal to one mole as twelve eggs are equal to one dozen. To understand the relationship between the Avogadro's number and the mole of a substance let us consider a few examples.

Examples:

i. 6.02×10^{23} atoms of carbon are equivalent to one mole of carbon.

ii. 6.02×10^{23} molecules of H_2O are equivalent to one mole of water.

iii. 6.02×10^{23} formula units of NaCl are equivalent to one mole of sodium chloride.

iv. Thus, 6.02×10^{23} atoms of elements or 6.02×10^{23} molecules of molecular compounds or 6.02×10^{23} formula units of ionic compounds are equivalent to 1 mole.

For further explanation about number of atoms in molecular compounds or number of ions in ionic compounds let us discuss two examples:

One molecule of water is made up of 2 atoms hydrogen and 1 atom of oxygen, hence $2 \times 6.02 \times 10^{23}$ atoms of hydrogen and 6.02×10^{23} atoms of oxygen constitute one mole of water.

One formula unit of sodium chloride consists of one ion of sodium ion and one chloride ion. So, there are 6.02×10^{23} number of Na^+ ions and 6.02×10^{23} Cl^- ions in one mole of sodium chloride.

Thus, the total number of ions in 1 mole of NaCl is 12.04×10^{23} or 1.204×10^{24}.

Q19. What is Mole? Describe the concept of mole with examples.

Ans. Mole (Chemist secret unit)

A mole is defined as the amount (mass) of a substance that contains 6.02×10^{23} number of particles (atoms, molecules or formula units). It establishes a link between mass of a substance and number of particles. It is abbreviated as mol.

You know that a substance may be an element or compound (molecular or ionic). Mass of a substance is either one of the following: atomic mass, molecular mass or formula mass. These masses are expressed in atomic mass units (amu). But when these masses are expressed in grams, they are called as molar masses.

Scientists have agreed that Avogadro's number of particles are present in one molar mass of a substance. Thus, **quantitative definition of mole** is the atomic mass, molecular mass or formula mass of a substance expressed in grams is called mole.

For example:

Atomic mass of carbon expressed as   12 g   = 1 mol of carbon

Molecular mass of H_2O expressed as   18 g   = 1 mol of water

Molecular mass of H_2SO_4 expressed as 98g = 1 mol of H_2SO_4

Formula mass of NaCl expressed as 58.5 g = 1 mol of NaCl

Thus, **the relationship between mole and mass** can be expressed as:

$$\text{Number of moles} = \frac{\text{Known mass of substance}}{\text{Molar mass of substance}}$$

Or

Mass of substance (g) = number of moles × molar mass

Solved Examples of Book

Example 1.1

How many number of protons and neutrons are there in an atom having A = 238 when it's Z = 92.

Solution:

A	=	238
Z	=	92
Number of protons	=	?
Number of neutrons	=	?
Number of protons	=	Z = 92
Number of Neutrons	=	A - Z
	=	238 - 92 = 146

Example 1.2

Calculate the molecular mass of nitric acid

Solution

Atomic mass of H	=	1amu
Atomic mass of N	=	14amu
Atomic mass of O	=	16amu
Molecular formula	=	HNO_3
Molecular mass	=	(At. mass H) + (At. mass N) + 3(At. mass O)
	=	1 + 14 + 3(16)
	=	63amu

Example 1.3

Calculate the formula mass of potassium sulphate K_2SO_4

Solution

Atomic mass of K	=	39amu
Atomic mass of S	=	32amu
Atomic mass of O	=	16amu
Formula unit	=	K_2SO_4

Formula mass of $K_2SO_4 = 2(39) + (32) + 4(16)$
$$= 78 + 32 + 64$$
$$= 174 \, amu$$

Example 1.4

Calculate the gram molecule (number of moles) in 40 g of H_3PO_4.

Solution

Given mass of H_3PO_4 = 40 g

Molecular mass of H_3PO_4 = 98 g mol^{-1}

Putting these values in equation

Number of gram molecule (mol) = $\dfrac{\text{Known mass of substance}}{\text{Molar mass of substance}}$

$$= \dfrac{40}{98} = 0.408$$

Therefore, 40 grams will contain 0.408 gram molecule of H_3PO_4.

Example 1.5

You have a piece of coal (carbon) weighing 9.0 gram. Calculate The number of moles of coal in the given mass.

Solution

Number or moles $= \dfrac{\text{Known mass of substance}}{\text{Molar mass of substance}}$

$$= \dfrac{9.0}{12}$$

$$= 0.75$$

So, 9.0 g of coal is equivalent to 0.75 mol.

Example 1.6

Calculate the number of moles, number of molecules and number of atoms present in 6 grams of water.

Solution

The known mass of water = 6 g

Molar mass of H_2O = 18 g

Number of moles of water $= \dfrac{\text{Known mass of substance}}{\text{Molar mass of substance}}$

$$= \dfrac{6}{18}$$

$$= 0.33 \text{ moles}$$

Number of molecules $= \text{Number of moles} \times N_A$

$$= 0.33 \times 6.02 \times 10^{23}$$

$$= 1.98 \times 10^{23} \text{ molecules}$$

The number of molecules contained in 6 grams of water are 1.98×10^{23}

As we know 1 molecule of water consists of 3 atoms, therefore:

Number of atoms $= 3 \times 1.98 \times 10^{23}$

$= 5.94 \times 10^{23}$ atoms

Example 1.7

There are 3.01×10^{23} molecules of CO_2 present in a container. Calculate the number of moles and its mass.

Solution

We can calculate the number of molecules of CO_2 by putting the values in equation

Number of moles of CO_2 $= \dfrac{\text{Known molecules}}{\text{Avogadro's number}}$

Number of moles of CO_2 $= \dfrac{3.01 \times 10^{23}}{6.02 \times 10^{23}}$

$= 0.5$

Then by putting this value in this equation we get

Mass of substance $=$ number of moles $\times$ molar mass (g)

Mass of CO_2 $= 0.5 \times 44$

$= 22$ g

Numericals

Q1. Sulphuric acid is the king of chemicals. If you need 5 moles of sulphuric acid for a reaction. How many grams of it will you weight?

Data:

No. of moles of H_2SO_4 $= 5$

Molar mass of H_2SO_4 $= (2 \times 1) + (32 \times 4) + (4 \times 16)$

$= 98$ g/mol

Mass of H_2SO_4 $= ?$

Solution

No. of moles $= \dfrac{\text{Mass in grams}}{\text{Mol. mass}}$

Mass in grams $=$ No. of moles $\times$ Mol. mass

$= 5 \times 98 = 490$g

Q2. Calcium carbonate is insoluble in water. If you have 40 g of it, how many Ca^{2-} and CO_3^{2-} ions are present in it?
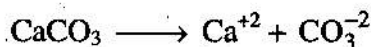
Data:

Mass of $CaCO_3$ $= 40$g

Formula mass of $CaCO_3$ $= (40 \times 1) + (12 \times 1) + (16 \times 3)$

$$= 100 \text{ g/mol}$$

No. of Ca^{+2} ions $\qquad = ?$

No. of CO_3^{-2} ions $\qquad = ?$

Solution

No. of moles $\qquad = \dfrac{\text{Known mass}}{\text{Mol. mass}}$

$$= \dfrac{40}{100} = 0.4 \text{ moles}$$

$$CaCO_3 \longrightarrow Ca^{+2} + CO_3^{-2}$$

According to balanced chemical equation no. of Ca^{+2} and CO_3^{-2} ions are equal in 1g formula of $CaCO_3$

So,

No. of Ca^{+2} ions in 40g of $CaCO_3$ $\quad = 0.4 \text{ moles} \times N_A$

$$= 0.4 \times 6.02 \times 10^{23}$$

$$= 2.40 \times 10^{23} \text{ ions}$$

We know that

No. of Ca^{+2} ions $\qquad\qquad = $ No. of CO_3^{-2} ions

So, No. of CO_3^{-2} ions $\qquad\qquad = 2.40 \times 10^{23} \text{ ions}$

Q3. If you have 6.02×10^{23} ions of aluminum, how many sulphate ions will be required to prepare $Al_2(SO_4)_3$?
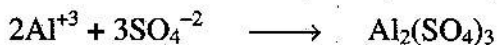
Data

No. of ions of Al^{+3} $\qquad = 6.02 \times 10^{23} \text{ ions}$

No. of SO_4^{-2} ions $\qquad = ?$

Solution

6.02×10^{23} of Al^{+3} ions $\quad = 1$ mole of Al^{+3} ions

$$2Al^{+3} + 3SO_4^{-2} \longrightarrow Al_2(SO_4)_3$$

According to balanced chemical equation

No. of moles of SO_4^{-2} ions required for 2 moles of Al^{+3} ions $\ = 3$

No. of moles of SO_4^{-2} ions for 1 mole of Al^{+3} $\qquad = \dfrac{3}{2}$

$$= 1.5 \text{ moles}$$

No. of SO_4^{-2} ions $\quad = 1.5 \times N_A = 1.5 \times 6.02 \times 10^{23}$

$$= 9.03 \times 10^{23} \text{ ions}$$

Q4. Calculate the number of molecules of the following compounds

    a. 16 g of H_2CO_3 **b.** 20g of HNO_3 **c.** 30g of $C_6H_{12}O_6$

(a) 16g of H_2CO_3

Data

    Given Mass of H_2CO_3 = 16g

    Molar mass of H_2CO_3 = $(2\times1)+(12\times1)+(16\times3)$ = 62 g/mol

    No. of molecules = ?

Solution

$$\text{No. of molecules of } H_2CO_3 = \frac{\text{Mass of } H_2CO_3}{\text{Mol. mass}} \times N_A$$

$$= \frac{16}{62} \times 6.02 \times 10^{23}$$

$$= 1.55 \times 10^{23} \text{ moles}$$

(b) 20g of HNO_3

Data:

    Mass of HNO_3 = 20g

    Molar mass of HNO_3 = $(1\times1)+(14\times1)+(16\times3)$

                           = 63 g/mol

    No. of molecules of HNO_3 = ?

Solution

$$\text{No. of molecules of } HNO_3 = \frac{\text{Mass of } HNO_3}{\text{Mol. mass}} \times N_A$$

$$= \frac{20}{63} \times 6.02 \times 10^{23}$$

$$= 1.91 \times 10^{23} \text{ molecules}$$

(c) 30g of $C_6H_{12}O_6$

Data

    Mass of $C_6H_{12}O_6$ = 30g

    Molar mass of $C_6H_{12}O_6$ = $(6\times12)+(1\times12)+(16\times6)$

                               = 180 g/mol

    No. of molecules of $C_6H_{12}O_6$ = ?

Solution

$$\text{No. of molecules of } C_6H_{12}O_6 = \frac{\text{Mass of } C_6H_{12}O_6}{\text{Molar mass}} \times N_A$$

$$= \frac{30}{180} \times 6.02 \times 10^{23}$$

No. of molecules of $C_6H_{12}O_6$ = 1×10^{23} molecules

Q5. Calculate the number of ions in the following compounds:

    a. 10g of $AlCl_3$ **b. 30g of $BaCl_2$**   **c. 58 g of H_2SO_4**

(a) <u>10g of $AlCl_3$</u>

Data

    Given Mass of $AlCl_3$ = 10 g

    Molar mass of $AlCl_3$ = $(27 \times 1) + (35.5 \times 3)$

        = 133.5 g/mol

    No. of ions of $AlCl_3$ = ?

Solution

    No. of formula units of $AlCl_3$ in 10g $= \dfrac{\text{Mass of } AlCl_3}{\text{Mol. mass}} \times N_A$

        $= \dfrac{10}{133.5} \times 6.02 \times 10^{23}$

        $= 0.451 \times 10^{23}$ formula units

        $= 4.51 \times 10^{22}$ formula units

    1 formula unit of $AlCl_3$ contains

    Total No. of ions   = 4

    4.51×10^{22} formula unit contain no. of ions = $4 \times 4.51 \times 10^{22}$

    No. of ions in 10g of $AlCl_3$ = 1.80×10^{23} ions

(b) <u>30g of $BaCl_2$</u>

Data

    Mass of $BaCl_2$ = 30 g

    Molar mass of $BaCl_2$ = $(141 \times 1) + (35.5 \times 2)$

        = 212 g/mol

    No. of ions of 30g of $BaCl_2$ = ?

Solution

    No. of formula units in 30g of $BaCl_2$ $= \dfrac{\text{Mass of } BaCl_2}{\text{Molar mass}} \times N_A$

        $= \dfrac{30}{212} \times 6.02 \times 10^{23}$

        $= 0.851 \times 10^{23}$ formula units

    No. of formula units in 30g of $BaCl_2$ $= 8.51 \times 10^{22}$

    1 Formula unit contains total no. of ions   = 3

    8.51×10^{22} formula units contains total no. of ions $= 8.51 \times 10^{22} \times 3$

        $= 2.55 \times 10^{23}$ ions

(c) 58 g of H₂SO₄

Data

No. of ions of 58g of H_2SO_4	=	?
Mass of H_2SO_4	=	58g
Molar mass of H_2SO_4	=	$(2\times1) + (32\times1) + (16\times4)$
	=	98 g/mol

Solution

No. of formula units in 58g of H_2SO_4 = $\dfrac{\text{Mass of } H_2SO_4}{\text{Mol. mass}} \times N_A$

$$= \dfrac{58}{98} \times 6.02 \times 10^{23}$$

No. of formula units in 58g of H_2SO_4 = 3.56×10^{23} formula units

1 Formula unit of H_2SO_4 contains total no. of ions = 3

3.56×10^{23} formula units of H_2SO_4 contains total no. of ions $= 3 \times 3.56 \times 10^{23}$

$= 10.692 \times 10^{23}$ ions

Q6. What will be the mass of 2.05×10^{16} molecules of H₂SO₄?

Data

Molecules of H_2SO_4	=	2.05×10^{16}
Molar mass of H_2SO_4	=	$(2\times1)+(32\times1)+(16\times4)$
	=	98 g/mol
Mass of H_2SO_4	=	?

Solution

Formula

No. of molecules $= \dfrac{\text{Mass of } H_2SO_4}{\text{Molar mass}} \times N_A$

$2.05 \times 10^{16} = \dfrac{\text{Mass}}{98} \times 6.02 \times 10^{23}$

Mass $= \dfrac{2.05 \times 10^{16} \times 98}{6.02 \times 10^{23}}$

Mass of H_2SO_4 $= 33.36 \times 10^{-7}$

$= 3.336 \times 10^{-6}$ g

Q7. How many total atoms are required to prepare 60 g of HNO₃?

Data

Mass of HNO_3	=	60g
Molar mass	=	$(1\times1) + (14\times1) + (16\times3)$
	=	63 g/mol
No. of atoms of HNO_3	=	?

Solution

$$\text{No. of molecules} = \frac{\text{Mass of } HNO_3}{\text{Molar mass}} \times N_A$$

$$= \frac{60}{63} \times 6.02 \times 10^{23}$$

$$= 0.952 \times 6.02 \times 10^{23}$$

$$\text{No. of molecules} = 5.73 \times 10^{23}$$

Hence one molecule of HNO_3 has 5 atoms so,

$$\text{No. of atoms} = 5 \times 5.73 \times 10^{23}$$

$$= 2.87 \times 10^{24} \text{ atoms}$$

Q8. How many ions of Na^+ and Cl^- will be present in 30 g of NaCl?

Data

Mass of NaCl $= 30g$

Formula mass of NaCl $= (23 \times 1) + (35.5 \times 1)$

$= 58.5$ g/mol

No. of Na^+ $= ?$

No. of Cl^- $= ?$

Solution

$$\text{No. of formula units of NaCl} = \frac{\text{Mass of NaCl}}{\text{Formula mass}} \times N_A$$

$$= \frac{30}{58.5} \times 6.02 \times 10^{23}$$

$$= 3.08 \times 10^{23} \text{ formula units}$$

1 formula unit of NaCl contains

No. of Na^+ $= 1$

3.08×10^{23} formula unit contain no. of Na^+ ions $= 3.08 \times 10^{23}$ ions

We know

No. of Na^+ $=$ No. of Cl^-

So

No. of Cl^- $= 3.08 \times 10^{23}$

Total number of Sodium ions Na^+ and Chloride ions $Cl^- = 6.16 \times 10^{23}$ ions

Q9. How many molecules of HCl will be required to make 10 grams of it?

Data

No. of molecules of HCl $= ?$

Mass of HCl $= 10g$

Molar mass of HCl $= (1 \times 1) + (35.5 \times 1)$

$= 36.5$ g/mol

Solution

$$\text{No. of HCl molecules} = \frac{\text{Mass of HCl}}{\text{Molar mass}} \times N_A$$

$$= \frac{10}{36.5} \times 6.02 \times 10^{23}$$

$$= 1.65 \times 10^{23} \text{ molecules}$$

Q10. How many grams of Mg will have the same number of atoms as 6 grams of C have?

Data

Mass of Carbon = 6 g

Atomic mass of Carbon = 12 g/mol

Mass of Mg = ?

Solution

$$\text{No. of moles of Carbon} = \frac{\text{Given Mass of Carbon}}{\text{Atomic mass of Carbon}}$$

$$= \frac{6}{12}$$

$$= 0.5 \text{ mole}$$

$$\text{Number of Carbon atoms} = 0.5 \times N_A$$

$$= 0.5 \times 6.02 \times 10^{23}$$

$$= 3.01 \times 10^{23} \text{ atoms}$$

$$\text{Number of atoms of Mg} = \frac{\text{mass}}{\text{molar mass}} \times N_A$$

$$3.01 \times 10^{23} = \frac{\text{mass}}{24} \times 6.02 \times 10^{23}$$

Mass of Mg = 12g

So, 12 g of Mg will have same No. of atoms as 6g of carbon have

Short Answer Questions

Q1. Define Science.

Ans. The knowledge that provides understanding of this world and how it works, is called science.

Q2. Define industrial chemistry and analytical chemistry.

Ans. i) Industrial Chemistry:

The branch of chemistry that deals with the manufacture of chemical compounds on commercial scale, is called industrial chemistry. It deals with the manufacturing of fertilizers, textile, soap, agricultural products paints and paper etc.

ii) Analytical Chemistry:

It is the branch of chemistry which deals with the separation and analysis of a sample to identify its components. The separation is carried out prior to qualitative and quantitative analysis. In this branch different techniques and instruments used for analysis are also studied.

Q3. How can you differentiate between organic and inorganic chemistry?

Ans.

Organic chemistry	Inorganic chemistry
Organic chemistry is the study of covalent compounds of carbon and hydrogen (hydrocarbons) and their derivatives.	Inorganic chemistry deals with the study of all elements and their compounds except those of compounds of carbon and hydrogen (hydrocarbons) and their derivatives.

Q4. Give the scope of bio chemistry.

Ans. The scope of biochemistry is very vast. Its applications are in the fields of medicines, food, science and agriculture etc.

Q5. How does homogeneous mixture differ from heterogeneous mixture?

Ans.

Homogeneous mixture	Heterogeneous mixture
Mixture that have uniform composition throughout are called homogeneous mixtures e.g. air	Heterogeneous mixture is that in which composition is not uniform throughout e.g. soil.

Q6. What is the relative atomic mass? How it is related to gram?

Ans. The relative atomic mass of an element is the average mass of atoms of that element as compared to $\frac{1}{12}$th the mass of one atom of carbon-12 isotope. Its unit is called

atomic mass unit with symbol "amu". One atomic mass unit is $\frac{1}{12}$ th the mass of one atom of carbon-12. When this atomic mass unit is expressed in grams, it is:

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{g}$$

Q7. Define empirical formula with example.

Ans. The simplest type of formula which shows the simplest whole number ratio of atoms present in a compound is called empirical formula. e.g. glucose has simplest ratio 1:2:1 of carbon, hydrogen and oxygen respectively. Hence its empirical formula is CH_2O.

Q8. State three reasons why do you think air is a mixture and water a compound.

Ans. i)   Water is a compound because it is formed by chemical combination of hydrogen and oxygen whereas air is formed by simple mixing of different gases.

ii)   Water has fixed ratio between masses of hydrogen and oxygen, whereas in air ratio between masses of component gases is not fixed.

iii)   Water has definite melting and boiling points whereas air does not have any fixed melting and boiling point.

Q9. Explain why are hydrogen and oxygen considered elements whereas water a compound.

Ans. Hydrogen and oxygen are elements because in these substances same type of atoms with same atomic number are present whereas water is made up of hydrogen and oxygen atoms having different atomic numbers.

Hydrogen and oxygen cannot be decomposed into simpler substances by chemical means whereas water can be decomposed into hydrogen and oxygen by electrolysis.

Q10. What is the significance of the symbol of an element?

Ans. Symbol is the international recognition of an element. With the help of symbol scientists form the formulae of different compounds. Symbol also helps to write and understand chemical equation for different chemical reactions. The periodic table is based on symbols of different elements. We should say without symbols Chemistry would not be easy to understandable.

Q11. State the reasons. Soft drink is a mixture and water is a compound.

Ans. Cold drink is a true solution of sugar and water in which CO_2 is dissolves through pressure. We can separate these components by physical methods. It does not has definite melting and boiling point. Therefore cold drink is a mixture. Water is formed by chemical combination of hydrogen and oxygen.

$$2H_2 + O_2 \longrightarrow 2H_2O$$
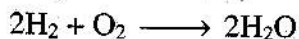
We cannot separate these two gases by physical methods. It has definite freezing and boiling points. Therefore water is a compound.

Q12. Classify the following into elements compound and mixture.

(i) He and H   (ii) CO and Co   (iii) Water and milk

(iv) Gold and brass   (v) Iron and steel

Ans.

Element	Compound	Mixture
He, H, Co, Gold and Iron	CO, Water	Milk, Brass and Steel

Q13. Define atomic mass unit. Why is it needed?

Ans. The unit for relative atomic mass is called atomic mass unit. Its symbol is "amu".

One atomic mass unit is $\frac{1}{12}$ th the mass of one atom of carbon-12th.

The mass of an atom is too small to be determined practically. So to determine the atomic mass of various elements atomic mass unit is needed.

Q14. State the nature and name of the substance formed by combining the following:

Ans.

Substance	Nature	Name
Zinc + Copper	Alloy (mixture)	Brass
Water + sugar	Solution (mixture)	Aqueous solution of sugar
Aluminium + Sulphur	Compound	Aluminium sulphide
Iron + Chromium + Nickel	Alloy (mixture)	Nichrome

Q15. Differentiate between molecular mass and formula mass. Which of the following will be molecular formula?

H_2O, NaCl, KI, H_2SO_4

Ans. The sum of atomic masses of all the atoms present in one molecule of a molecular mass e.g. molecular mass of water is 18 amu. The sum of atomic masses of all atoms present in one formula unit of a substance is called formula mass e.g. formula mass of sodium chloride is 58.5 amu. H_2O and H_2SO_4 are molecular formula of molecular compounds water and sulphuric acid respectively.

Q16. Which one has more atoms: 10g of Al or 10g of Fe?

Ans.

(i) Given mass of Al   = 10g

Molar mass of Al   = 27gmol^{-1}

No. of atoms in 10g of Al   = No. of moles $\times N_A$

$$= \frac{\text{Given mass}}{\text{Molar mass}} \times N_A$$

$$= \frac{10g}{27gmol^{-1}} \times 6.02 \times 10^{23} \text{ atoms}$$

$$= 2.23 \times 10^{23} \text{ atoms}$$

(ii) Given mass of Fe $= 10g$

Molar mass of Fe $= 56 \text{ gmol}^{-1}$

No. of atoms in 10g of Fe $= \dfrac{10}{56} \times 6.02 \times 10^{23} \text{ atoms}$

$$= 1.115 \times 10^{23} \text{ atoms}$$

Therefore 10g of Al contains more atoms as compared to 10g of Fe.

Q17. Which one has more molecules: 9g of water or 9g of sugar.

Ans.

(i) Molar mass of water (H_2O) $= 18 \text{gmol}^{-1}$

Given mass of water (H_2O) $= 9g$

No. of molecules in 9g of water $= \dfrac{\text{Mass of water}}{\text{Molar mass}} \times N_A$

$$= \dfrac{9}{18} \times 6.02 \times 10^{23} \text{ molecules}$$

$$= 3.01 \times 10^{23} \text{ molecules}$$

(ii) Molar mass of sugar ($C_{12}H_{22}O_{11}$) $= 342 \text{gmol}^{-1}$

Given mass of sugar $= 9g$

No. of molecules in 9g of sugar $= \dfrac{9}{342} \times 6.02 \times 10^{23} \text{ molecules}$

$$= 1.584 \times 10^{22} \text{ molecules}$$

Therefore 9g of water contains more molecules than 9g of sugar.

Q18. Which has more formula units: 1g of NaCl or 1g of KCl.

Ans.

(i) Formula mass of NaCl $= 58.5 \text{gmol}^{-1}$

Given mass $= 1g$

No. of formula units in 1g of NaCl $= \dfrac{\text{Given mass}}{\text{Formula mass}} \times N_A = \dfrac{1}{58.5} \times 6.02 \times 10^{23}$

$$= 1.029 \times 10^{22} \text{ formula units}$$

(ii) Formula mass of KCl $= 74.5 \text{gmol}^{-1}$

Given mass $= 1g$

No. of formula units in 1g of KCl $= \dfrac{1}{74.5} \times 6.02 \times 10^{23}$

$$= 8.080 \times 10^{21} \text{ formula units}$$

Therefore 1g of NaCl contains more formula units than 1g of KCl

Q19. Differentiate between homoatomic and heteroatomic molecules with examples.

Ans. Difference between homoatomic and heteroatomic molecules:

Homoatomic molecules	Heteroatomic molecules
A molecule containing same type of atoms is called homoatomic molecule e.g. Hydrogen (H_2), Oxygen (O_2), Ozone (O_3) and sulphur (S_8) are homoatomic molecules.	A molecule consisting of different types of atoms is called hteroatomic molecule e.g. NH_3, H_2O and CO_2 are heteroatomic molecules.

Q20. In which one of the following cases the number of hydrogen atoms is more?
2 moles of HCl or 1 mole of NH_3

Ans.

No. of moles of hydrogen in 1 mole of HCl = 1 mole

No. of moles of hydrogen in 2 moles of HCl = 2 moles

Whereas no. of moles of hydrogen in 1 mole of NH_3 = 3 moles

Hence 1 mole of NH_3 contains 3 moles of hydrogen will have more hydrogen atoms than 2 moles of hydrogen present in 2 moles of HCl.

Q21. What is Chemistry?

Ans. The branch of science which deal with the composition, structure, properties and reactions of matter is called Chemistry.

Q22. Define Physical Chemistry.

Ans. The branch of chemistry that deals with the relationship between the composition and physical properties of matter along with the change in them is called Physical Chemistry.

Q23. Define Bio Chemistry.

Ans. It is the branch of chemistry in which we study the structure, composition and chemical reactions of substances found in living organisms.

Q24. What is nuclear chemistry?

Ans. Nuclear chemistry is the branch of chemistry that deals with the reactivity, nuclear process and properties. The main concern of this branch is with the energy of atom and its uses in daily life.
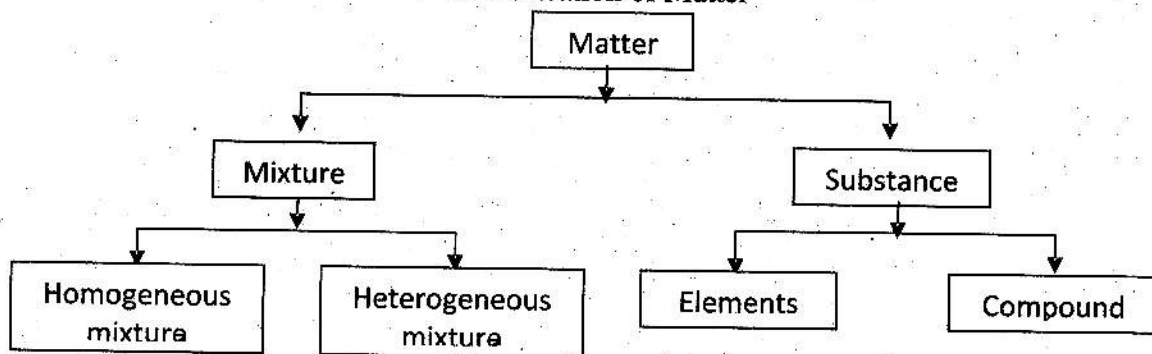
Q25. What is environmental chemistry?

Ans. The branch of chemistry that deals with the components of the environment and the effects of the human activities on the environment.

Q26. What is matter? Show classification of matter.

Ans. Anything that has mass and occupies space is called matter. Matter can exist in any of the three physical states; solid, liquid or gas.

Classification of Matter

```
                         Matter
              ┌────────────┴────────────┐
              ▼                         ▼
           Mixture                  Substance
       ┌──────┴──────┐          ┌───────┴───────┐
       ▼             ▼          ▼               ▼
  Homogeneous   Heterogeneous  Elements      Compound
    mixture       mixture
```

Q27. What is valency?

Ans. The combining capacity of an element with other elements is called valency. For example valency of carbon is 4.

Q28. What is meant by variable valency?

Ans. Some elements show more than one combining power (valency) that is called variable valency. For example, in ferrous sulphate ($FeSO_4$) the valency of iron is 2 whereas in ferric sulphate $Fe_2(SO_4)_3$ the valency of iron is 3.

Q29. What is a radical?

Ans. An atom or a group of atoms that have some charge and keeps in contact during a chemical reaction is called a radical e.g. Hydronium H_3O^+ and carbonate. CO_3^{-2}

Q30. What is atomic number and mass number?

Ans. The number of protons present in the nucleus of an atom of an element is called its atomic number. It is represented by symbol 'Z'. e.g. carbon atom has 6 protons its atomic number (Z) is 6. The sum of protons and neutrons present in the nucleus of an atom of an element is called mass number or nucleon number. It is represented by symbol 'A'. e.g. carbon atom has 6 protons and 6 neutrons, hence its mass number (A) is 12.

Q31. What is molecular formula? How molecular formula is derived from empirical formula?

Ans. The formula of molecular substances that shows actual number of atoms of each element present in a molecule of that substance is called molecular formula e.g. molecular formula of benzene is C_6H_6.

Molecular formula is derived from empirical formula by the following relationship:

Molecular formula = (Empirical formula)n

Where n is 1, 2, 3 and so on. e.g. molecular formula of benzene C_6H_6 is derived from the empirical formula CH where the value of n is 6.

Q32. What is ion? What are its types?

Ans. Ion: An atom or group of atoms having a charge on it is called ion. There are two types of ions i.e. cation an anion.

Cation: An atom or group of atoms having positive charge on it is called cation. Cation are formed when an atom loses electrons from its outermost shell. e.g.

$$\text{Atoms} \qquad \text{Cations}$$
$$Na \longrightarrow Na^+ + 1e^-$$
$$Ca \longrightarrow Ca^{+2} + e^-$$
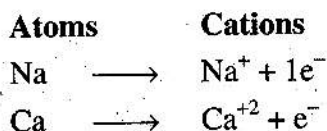
Anion: An atom or group of elements that has negative charge on it, is called anion. Anion is formed by the gain or addition of electrons to an atom. e.g. Cl^- and O^{2-}

Q33. Differentiate between atom and ion.

Ans.   **Difference between Atoms and Ions**

	Atom	Ion
i.	It is the smallest particle of an element.	It is the smallest unit of an ionic compound.
ii.	It can or cannot exist independently and can take part in a chemical reaction	It cannot exist independently and is surrounded by oppositely charged ions.
iii.	It is electrically neutral	It has a net charge (either negative or positive) on it.

Q34. Differentiate between molecule and molecular ion.

Ans.   **Difference between Molecule and Molecular Ion**

	Molecule	Molecular Ion
i.	It is the smallest particle of a compound which can exist independently and shows all the properties of that compound	It is formed by gain or loss of electrons by a molecule
ii.	It is always neutral	It can have negative or positive charge
iii.	It is formed by the combination of atoms	It is formed by the ionization of a molecule
iv.	It is a stable unit	It is a reactive specie

Q35. Define free radicals? How they are generated?

Ans. Free radicals are atoms are group of atoms possessing an odd (unpaired) electron. It is represented by putting a dot over the symbol of an element e.g. $\overset{\bullet}{H}$, $\overset{\bullet}{Cl}$, $H_3\overset{\bullet}{C}$. Free radicals are generated by the hemolytic (equal) breakage of the bond between two atoms when they absorb heat or light energy.

Q36. Differentiate between ions and free radicals.

Ans.   **Difference between Ions and Free Radicals**

	Ions	Free Radicals
i.	These are the atoms which bear some charge	These are the atoms that have odd number of electrons

ii.	They exist in solution or in crystal lattice	They can exist in solutions as well in air
iii.	Their formation is not affected by the presence of light	They may form in the presence of light

Q37. What is Avogadro's number?

Ans. Avogadro's number is a collection of 6.02×10^{23} particles. It is represented by symbol 'N_A'. Hence, the 6.02×10^{23} number of atoms, molecules or formula units are called Avogadro's number that is equivalent to one 'mole' of respective substance.

Q38. Define a mole.

Ans. A mole is defined as the amount (mass) of a substance that contains 6.02×10^{23} number of particles (atoms) molecules or formula units). It is abbreviated as 'mol' e.g. 6.02×10^{23} carbon atoms = 1 mole of carbon. It can be defined as the atomic mass, molecular mass or formula mass of a substance expressed in grams is called mole. e.g. Atomic mass of carbon expressed as 12g = 1 mole of carbon.

Q39. Write the composition of following mixtures.

(i) Air   (ii) Soil   (iii) Milk   (iv) Brass

Ans. **Air:**

Air is a mixture of nitrogen, oxygen, carbon dioxide, noble gases and moisture.

Soil:

Soil is a mixture of sand, clay, mineral salts, water and air.

Milk:

Milk is a mixture of calcium, water, sugar, fat, proteins, mineral salts and Vitamins.

Brass:

Brass is a mixture of copper and zinc metals

Q40. What is empirical formula of acetic acid (CH_3COOH)? Find its molecular mass.

Ans. Empirical formula of acetic acid is CH_2O

Molecular Mass of CH_3COOH

12 +3+12+16+16+1   = 60amu

Q41. How many atoms of sodium are present in 3 moles of sodium and what is the mass of it?

Ans. No. of atoms of sodium are present in 3 moles = $3 \times 6.02 \times 10^{23}$

= 1.806×10^{24}

The mass of 3 moles of sodium is   = 69g

Multiple Choice Questions

1. **Industrial chemistry deals with the manufacturing of compounds:**
   - (a) in the laboratory
   - (b) on micro scale
   - (c) on commercial scale
   - (d) on economic scale

2. **Which one of the following can be separated by physical means?**
   - (a) Mixture
   - (b) Element
   - (c) Compound
   - (d) Radical

3. **The most abundant element occurring in the oceans is:**
   - (a) Oxygen
   - (b) Hydrogen
   - (c) Nitrogen
   - (d) Silicon

4. **Which one of the following element is found in most abundance in the earth's crust?**
   - (a) Oxygen
   - (b) Aluminium
   - (c) Silicon
   - (d) Iron

5. **The third abundant gas found in the earth's crust is:**
   - (a) Carbon monoxide
   - (b) Oxygen
   - (c) Nitrogen
   - (d) Argon

6. **One amu (atomic mass unit) is equivalent to:**
   - (a) 1.66×10^{-24} mg
   - (b) 1.66×10^{-24} g
   - (c) 1.66×10^{-24} kg
   - (d) 1.66×10^{-23} g

7. **Which of the followings are tri-atomic molecule except:**
   - (a) H_2
   - (b) O_3
   - (c) H_2O
   - (d) CO_2

8. **The mass of one molecule of water is:**
   - (a) 18 amu
   - (b) 18 g
   - (c) 18 mg
   - (d) 18 kg

9. **The molar mass of H_2SO_4 is:**
   - (a) 98g
   - (b) 98amu
   - (c) 9.8g
   - (d) 9.8amu

10. **Molar mass is usually expressed in grams. Which one of the following is molar mass of O_2 in amu?**
    - (a) 32 amu
    - (b) 53.12×10^{-24} amu
    - (c) 1.92×10^{-25} amu
    - (d) 192.64×10^{-25} amu

11. **How many numbers of moles are equivalent to 8 grams of CO_2?**
    - (a) 0.15
    - (b) 0.18
    - (c) 0.21
    - (d) 0.24

12. **Which one of the following pair has the same number of ions?**
    - (a) 1 mole of NaCl and 1 mole of $MgCl_2$
    - (b) 1/2 mole of NaCl and 1/2 mole of $MgCl_2$
    - (c) 1/2 mole of NaCl and 1/3 mole of $MgCl_2$
    - (d) 1/3 mole of NaCl and 1/2 mole of $MgCl_2$

13. **Which one of the followings pair has the same mass?**
    - (a) 1 mole of CO and 1 mole of N_2
    - (b) 1 mole of CO and 1 mole of CO_2
    - (c) 1 mole of O_2 and 1 mole of N_2
    - (d) 1 mole of O_2 and 1 mole of CO

14. **The valency of noble gases is**
    - (a) Three
    - (b) Zero
    - (c) Two
    - (d) One

15. Structure of atom is studied in which branch of chemistry?
   (a) Organic   (b) Physical
   (c) Inorganic (d) Nuclear

16. Nuclear Chemistry has application in
   (a) Medical treatment (b) Ecology
   (c) Metallurgy (d) Agriculture

17. Which one is a physical property?
   (a) Smell   (b) Taste
   (c) Hardness (d) All of these

18. Elements may be
   (a) Solid   (b) Liquid
   (c) Gas   (d) All of these

19. Valency of carbon is
   (a) 1   (b) 2
   (c) 3   (d) 4

20. 80 percent elements are
   (a) Metals   (b) Non-metals
   (c) Metalloids (d) None

21. Valency of oxygen is
   (a) 2   (b) 3
   (c) 4   (d) 5

22. The ratio of carbon and oxygen in CO_2 is
   (a) 1:8   (b) 2:3
   (c) 3:8   (d) 1:2

23. Brass is a mixture of
   (a) Cu & Zn   (b) Cu & Sn
   (c) Cu & Al   (d) Al & Fe

24. Mixture can be separated by method
   (a) Nuclear   (b) Chemical
   (c) Physical   (d) All of these

25. Number of protons in the nucleus of an atom is called
   (a) Mass no.   (b) Atomic no.
   (c) Electron no. (d) Mass Unit

26. Empirical formula of sand is
   (a) SiO_3 (b) SiO_2
   (c) SiO_4 (d) Si_2O_3

27. Which compound has same molecular and empirical formula?
   (a) $C_6H_{12}O_6$ (b) C_6H_6
   (c) H_2O_2 (d) H_2O

28. Atom is electrically
   (a) Positive   (b) Negative
   (c) Neutral   (d) None

29. Which one is extremely reactive species?
   (a) Na   (b) H_2
   (c) N_2^+ (d) CH_3

30. Fourth state of matter is
   (a) Solid   (b) Liquid
   (c) Gas   (d) Plasma

31. Example of mono atomic molecule is
   (a) H_2 (b) O_2
   (c) CO_2 (d) He

32. Which one is polyatomic molecule?
   (a) CH_4 (b) H_2SO_4
   (c) $C_6H_2O_6$ (d) All of these

33. 1 gram formula of NaCl contains grams
   (a) 100g   (b) 32g
   (c) 58.5g   (d) 49g

34. 1 gram atom of carbon contains how many moles
   (a) 2 mole   (b) 12mole
   (c) 1 mole   (d) 6 moles

35. Value of Avogadro's number is
   (a) 6.02×10^{23} (b) 1.32×10^{23}
   (c) 6.6×10^{-20} (d) 6.00×10^{24}

36. Empirical formula of glucose is
   (a) CH_2O (b) CHO
   (c) CHO_2 (d) C_2HO

37. How many atoms are present in one gram atomic mass of a substance

    (a) 6.20×10^{24} (b) 12.04×10^{23}

    (c) 6.02×10^{23} (d) 6.2×10^{-23}

38. 40g of H_3PO_4 contains number of moles

    (a) 0.58g   (b) 0.408g

    (c) 4.8g   (d) 5.8g

39. Formation of which of the following is effected by light:

    (a) Ion   (b) Free Radical

    (c) Molecule (d) Atom

40. Which type of molecular ions are present in plasma?

    (a) Cationic   (b) Anionic

    (c) Both a & b (d) Neutral

41. Percentage of Argon in nature is

    (a) 87%   (b) 47%

    (c) 0.9%   (d) 21%

42. Formula mass of K_2SO_4 is

    (a) 174amu   (b) 180amu

    (c) 110amu   (d) 145amu

43. Empirical formula of acetic acid (CH_3COOH) is

    (a) CHO   (b) CH_2O

    (c) CH   (d) None of these

44. Mass of 3 moles of oxygen atoms is

    (a) 48g   (b) 32g

    (c) 64g   (d) 16g

45. How many molecules of water will be present in half mole of water?

    (a) 6.02×10^{23} (b) 3.01×10^{23}

    (c) 6.02×10^{24} (d) 1.66×10^{-24}

46. How many atoms are present in one gram atomic mass of a substance?

    (a) 6.02×10^{23} (b) 1.66×10^{-24}

    (c) 6.02×10^{24} (d) None of these

47. A piece of matter in pure form is termed as

    (a) Element   (b) Substance

    (c) mixture   (d) matter

48. Which one of following is an example of ionic compound?

    (a) H_2O (b) CH_4

    (c) NaCl   (d) HCl

49. Example of covalent compound is

    (a) KNO_3 (b) NaCl

    (c) KCl   (d) HCl

50. Example of heterogeneous mixture is

    (a) Air   (b) gasoline

    (c) ice cream (d) soil

Answer Key

1.	c	2.	a	3.	a	4.	a	5.	d
6.	b	7.	a	8.	a	9.	a	10.	b
11.	b	12.	c	13.	a	14.	b	15.	b
16.	a	17.	d	18.	d	19.	d	20.	a
21.	a	22.	c	23.	a	24.	c	25.	b
26.	b	27.	d	28.	c	29.	c	30.	d
31.	d	32.	d	33.	c	34.	c	35.	a
36.	a	37.	c	38.	b	39.	b	40.	c
41.	c	42.	a	43.	b	44.	a	45.	b
46.	a	47.	b	48.	c	49.	d	50.	d