Chapter Fundamentals of Chemistry

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. The branch of Chemistry that deals with hydrocarbons:
(a) Industrial Chemistry (b) Inorganic Chemistry
(c) Organic Chemistry (d) Physical Chemistry

02. The atomic mass of an element expressed in gram is:
(a) Gram molecular mass (b) Gram atomic mass
(c) Gram formula mass (d) Mole

03. Which of the following can be separated by physical means?
(a) Mixture (b) Element (c) Compound (d) Substance

04. The molar mass of H_2SO_4 is:
(a) 98 a.m.u (b) 9.8 gm (c) 98 gm (d) 9.8 a.m.u

05. The molecule consists of two atoms is:
(a) monoatomic molecule (b) polyatomic molecule
(c) heteroatomic molecule (d) diatomic molecule

06. A formula that indicates the actual number and type of atoms in a molecule is called:
(a) Chemical formula (b) Empirical formula
(c) Molecular formula (d) Formula mass

07. Ethyl alcohol was prepared by:
(a) Ibne-Sina (b) Al-Razi (c) Al-Beruni (d) Jaber bin-Hayan

08. Which of the following is a homo atomic?
(a) H_2 (b) NH_3 (c) H_2O (d) CO_2

09. The Empirical formula of hydrogen peroxide is:
(a) H_2O_2 (b) HO (c) OH (d) O_2H_2

10. A piece of matter in pure form is termed as:
(a) redical (b) mixture (c) compound (d) substance

11. The word science comes from the word "Scientia" which is:
(a) Greek word (b) Latin word (c) Persian word (d) Arabic word

12. The Latin word "Scientia" means:
(a) process (b) phenomenon (c) knowledge (d) natural

13. In universal sciences chemistry purely deals with the:
(a) matter (b) energy
(c) chemical properties (d) chemical reactions

14. *Matter has:*
(a) energy and occupy space (b) weight and occupy space
(c) valency and occupy space (d) mass and occupy space

15. *In nature, the matter changing:*
(a) sometimes (b) continuously
(c) under certain conditions (d) None of them

16. *He proposed the idea of the atom.*
(a) Aristotle (b) Plato (c) Democritus (d) Lavoisier

17. *He invented experimental methods of nitric acid, hydrochloric acid, and white lead.*
(a) Al-Razi (b) Al-Beruni (c) Ibne-Sina (d) Jabir Ibne Haiyan

18. *He found the methods of extraction of metals from their ores and dyeing clothes.*
(a) Jabir Ibne Haiyan (b) Al-Razi (c) Ibne-Sina (d) Al-Beruni

19. *Densities of different substances was determined by:*
(a) J. Priestley (b) Al-Beruni (c) Al-Razi (d) Gay Lussac

20. *This Muslim scientist contributed to medicines, philosophy, and astronomy.*
(a) Jabir Ibne Haiyan (b) Al-Razi (c) Ibne-Sina (d) Al-Beruni

21. *The gaseous law was discovered by:*
(a) Robert Boyle (b) John Dalton (c) Mendeleev (d) Eric Cornell

22. *Oxygen, Sulphur dioxide, and hydrogen chloride were discovered by:*
(a) J. Priestley (b) Cavendish (c) Lavoisier (d) Jacques Charles

23. *Chlorine was discovered by:*
(a) J. Priestley (b) Cavendish (c) Gay-Lussac (d) Scheele

24. *Hydrogen was discovered by:*
(a) J. Priestley (b) Cavendish (c) Scheele (d) J. Black

25. *A French chemist discovered that oxygen is one-fifth of air.*
(a) Arrhenius (b) De Borglie (c) Lavoisier (d) Avogadro

26. *Atomic theory of matter was proposed by the English scientist:*
(a) Jacques Charles (b) Petit (c) J.J. Berzellius (d) John Dalton

27. *He discovered that water is composed of two parts hydrogen and one part oxygen by volume.*
(a) Lavoisier (b) J.J. Berzellius (c) Scheele (d) Gay-Lussac

28. *"Equal volumes of gases under constant temperature and pressure contain the equal number of molecules", is known as:*
(a) Gas Law (b) Avogadro's Law (c) Atomic Theory (d) Acid-Base Theory

29. *Gaseous law was described by a French scientist:*
(a) Jacques Charles (b) Avogadro (c) John Dalton (d) De Broglie

30. *Symbols, formula, and chemical equation were introduced by:*
(a) Mendeleev (b) J. J. Berzellius (c) Arrhenius (d) De Broglie

31. *This Russian chemist discovered the periodic arrangement of elements.*
(a) Schrodinger (b) Eric Cornell (c) Rutherford (d) Mendeleev

32. *Acid Base Theory and ions dissociation were proposed by:*
(a) Mendeleev (b) Rutherford (c) Arrhenius (d) Petit

33. *He contributed to the study of electromagnetism and electrochemistry.*
(a) J.J. Thomson (b) Schrodinger (c) M. Faraday (d) Carl Weiman

34. *The electron was discovered by:*
(a) J.J. Thomson (b) M. Faraday (c) Rutherford (d) Elbert Einstein

35. *This British scientist proposed a theory for the hydrogen atom based on quantum theory.*
(a) Rutherford (b) Stendra Nath Bose (c) Carl Weiman (d) Neil Bohr

36. *The nuclear structure of the atom was postulated by:*
(a) Neil Bohr (b) J.J. Thomson (c) Rutherford (d) J.J. Berzellius

37. *He discovered alpha and beta rays and proposed the laws of radioactive decay.*
(a) De Broglie (b) Rutherford (c) Schrodinger (d) Carl Weiman

38. *Quantum mechanical model of the atom was proposed by:*
(a) Schrodinger (b) Rutherford (c) J.J. Thomson (d) Elbert Eienstein

39. *The hypothesis about wave-particle duality nature of electron was proposed by:*
(a) Schrodinger (b) Eric Cornell (c) De Broglie (d) Neil Bohr

40. *Fourth state of matter was proposed by:*
(a) Stendra Nath Bose (b) Elbert Eienstein (c) Both of them (d) None of them

41. *The first Bose-Einstein Condensate was synthesized by:*
(a) Be Borglie (b) Eric Cornell (c) Carl Weiman (d) Schrodinger

42. *The first Bose-Einstein Condensate was produced by:*
(a) Be Borglie (b) Eric Cornell (c) Carl Weiman (d) Schrodinger

43. *Chemistry also deals with the changes involved in the:*
(a) matter (b) mass (c) energy (d) properties

44. *The branch of chemistry which deals with the laws and principles governing the combination of atoms and molecules:*
(a) Inorganic chemistry (b) Biochemistry
(c) Physical chemistry (d) Analytical chemistry

45. *The gasoline, plastics, detergents, dyes, food additives, natural gas, and medicines are studied in the:*
(a) Industrial Chemistry (b) Physical Chemistry
(c) Inorganic Chemistry (d) Organic Chemistry

46. *The branch of Chemistry which deals with the study of all elements and their compound except hydrocarbons is:*
(a) Industrial Chemistry (b) Physical Chemistry
(c) Inorganic Chemistry (d) Organic Chemistry

47. *It is the branch of chemistry that deals with the compounds of living organisms.*
(a) Organic chemistry (b) Inorganic chemistry
(c) Physical chemistry (d) Biochemistry

48. *This branch of chemistry helps us to understand how living things obtain energy from food.*
(a) Inorganic chemistry (b) Biochemistry
(c) Organic chemistry (d) Medicinal chemistry

49. *It is used in chromatography, electrophoresis, and spectroscopy.*
(a) Analytical Chemistry (b) Quantum Chemistry
(c) Industrial Chemistry (d) Biochemistry

50. *The branch of Chemistry that deals with synthetic organic chemistry, pharmacology, and various biological specialities.*
(a) Nuclear chemistry (b) Biochemistry
(c) Analytical chemistry (d) Medicinal chemistry

51. *The branch of Chemistry that deals with the application, mechanics, and experiments of physical models in a chemical system.*
(a) Physical chemistry (b) Inorganic chemistry
(c) Quantum chemistry (d) Green chemistry

52. *The main purpose of this branch is to use waste material efficiently and improvement of energy efficiency in the chemical industry.*
(a) Analytical chemistry (b) Environmental chemistry
(c) Biochemistry (d) Green chemistry

53. *It is considered the fourth state of matter.*
(a) energy (b) plasma (c) wave (d) quanta

54. *The different states of matter are due to the:*
(a) difference of specific gravity (b) difference of mass
(c) difference of chemical properties (d) difference of energy

55. *Matter is made up of the smallest particle which is known as:*
(a) atom (b) molecule (c) radical (d) ion

56. *They are the basic units of matter and define structure of elements.*
(a) atom (b) molecule (c) radical (d) ion

57. *The smallest particle in a chemical element or compound that has the chemical properties of that element or compound is called:*
(a) atom (b) molecule (c) radical (d) ion

58. *He, Ar and Kr are the examples of:*
(a) monoatomic elements (b) diatomic molecules
(c) polyatomic molecules (d) heteroatomic molecules

59. *O_2, Cl_2, and N_2 are the examples of:*
(a) monoatomic elements (b) diatomic molecules
(c) polyatomic molecules (d) heteroatomic molecules

60. *Examples of polyatomic molecules are:*
(a) Br_2 & O_3 (b) I_2 & P_4 (c) Xe & S_8 (d) P_4 & S_8

61. *It is a substance made up of same type of atoms:*
(a) Molecule (b) Compound (c) Element (d) Radical

62. *Number of elements has been discovered so far is:*
(a) 105 (b) 108 (c) 118 (d) 120

63. *It is an abbreviation to represent the name of elements.*
(a) Symbol (b) Formula (c) Equation (d) Expression

64. *Na is the symbol of:*
(a) Nitrogen (b) Neon (c) Nickel (d) Sodium

65. *The valency depends upon the number of:*
(a) protons in the nucleus (b) neutrons in the nucleus
(c) electrons in the outermost shell (d) None of these

66. *Valency of oxygen is:*
(a) 0 (b) −1 (c) +2 (d) −2

67. ***Chemical formula of sugar is:***

(a) CaO *(b)* $C_{12}H_{22}O_{11}$ *(c)* $CaCO_3$ *(d)* $Na_2CO_3.10H_2O$

68. ***Chemical formula of sodium carbonate (washing soda) is:***

(a) CaO *(b)* $C_{12}H_{22}O_{11}$ *(c)* $CaCO_3$ *(d)* $Na_2CO_3.10H_2O$

69. ***When two or more than two elements or compounds physically combined without any fixed ratio is known as:***

(a) mixture *(b)* compound *(c)* element *(d)* mole

70. ***Salt water, air and blood are some examples of:***

(a) heterogeneous mixture *(b)* homogeneous mixture
(c) compound *(d)* mole

71. ***1 a.m.u. = :***

(a) 1.66×10^{-14} gram *(b)* 1.66×10^{-20} gram
(c) 1.66×10^{-24} gram *(d)* 1.66×10^{-27} gram

72. ***The formula showing minimum relative numbers of each type of atoms in a molecule is called:***

(a) Molecular formula *(b)* Chemical formula
(c) Empirical formula *(d)* Formula mass

73. ***Empirical formula of glucose ($C_6H_{12}O_6$) is:***

(a) CHO *(b)* CH_2O *(c)* C_2HO_2 *(d)* $C_2H_3O_2$

74. ***Molecular Formula = :***

(a) Empirical Formula *(b)* n(Empirical Formula)
(c) $(\text{Empirical Formula})^n$ *(d)* $(\text{Empirical Formula})_n$

75. ***The atomic mass is the sum of the number of:***

(a) protons and neutrons *(b)* protons and electrons
(c) electrons and neutrons *(d)* protons, neutrons and electrons

76. ***The number of atoms, molecules, or ions presents in one mole is:***
OR Avogadro's number is:

(a) 6.02×10^{23} *(b)* 6.02×10^{27} *(c)* 6.02×10^{-23} *(d)* 6.02×10^{-27}

Answers

01.	(c)	11.	(b)	21.	(a)	31.	(d)	41.	(b)	51.	(c)	61.	(c)	71.	(c)
02.	(b)	12.	(c)	22.	(a)	32.	(c)	42.	(c)	52.	(d)	62.	(c)	72.	(c)
03.	(a)	13.	(a)	23.	(d)	33.	(c)	43.	(a)	53.	(b)	63.	(a)	73.	(b)
04.	(c)	14.	(d)	24.	(b)	34.	(a)	44.	(c)	54.	(d)	64.	(d)	74.	(d)
05.	(d)	15.	(b)	25.	(c)	35.	(d)	45.	(c)	55.	(a)	65.	(c)	75.	(a)
06.	(c)	16.	(c)	26.	(d)	36.	(c)	46.	(c)	56.	(a)	66.	(d)	76.	(a)
07.	(d)	17.	(d)	27.	(d)	37.	(b)	47.	(d)	57.	(b)	67.	(b)		
08.	(a)	18.	(a)	28.	(b)	38.	(a)	48.	(b)	58.	(a)	68.	(d)		
09.	(b)	19.	(b)	29.	(a)	39.	(c)	49.	(a)	59.	(b)	69.	(a)		
10.	(d)	20.	(c)	30.	(b)	40.	(c)	50.	(d)	60.	(d)	70.	(b)		

Section B&C — Short & Detailed Answer Questions

Q.1 The word 'science' comes from which language?

Ans: ***Science:*** Word science comes from the Latin word "Scientia" which means "knowledge". This knowledge is based on hypotheses, observation, and experiments of universal science.

Q.2 What do you know about Chemistry?

Ans: ***Introduction to Chemistry:*** In the universal sciences, chemistry purely deals with the matter which has mass and occupies space. Even the table salt, we use in cooking to electrochemical interaction of our human brain shows the differences of substance because of the composition, structure, properties, and interaction of matter.

The matter is changing continuously in nature as rusting of iron, evaporation of spirit, and burning of coal are examples of reactions in which new substances are formed and energy is absorbed or released. All of these things are different due to the presence of different substances which are different employing composition, properties, interaction, and structure of matter.

The chemists use chemistry to explain the occurrence and description of things. They investigate material and their interactions and propose theories to illuminate our understanding from a particle to galaxies.

Q.3 Describe the brief history of Chemistry.

Ans: ***Historical Background of Chemistry***

Period/Timeline	Name of Scientists	Contribution/Invention	Origin of Scientists
384 - 322 B.C	Aristotle	Proposed idea of a substance as a combination of matter and form. Describes theory of the Four Elements, Fire, water, earth, air.	Greek
347 - 428 B.C	Plato	Proposed terms 'elements' as composition of organic and inorganic bodies with particular shape.	Greek
357 - 460 B.C	Democritus	Proposed the idea of atom, an indivisible particle of matter.	Greek
721 - 803 A.D	Jaber Ibne-Haiyan	Invented experimental methods of nitric acid, hydrochloric acid and white lead. Extraction of metals from their ores and dyeing clothes.	Muslim
862 - 930 A.D	Al-Razi	Prepared ethyl alcohol by fermentation process.	Muslim
973 - 1048 A.D	Al-Beruni	Determined densities of different substances.	Muslim
980 - 1037 A.D	Ibne-Sina	Contributed in medicines, philosophy and astronomy.	Muslim

1627 - 1691 A.D	Robert Boyle	Put forward idea chemistry as systematic investigation of nature. Discovered the gaseous law.	English
1728 - 1799 A.D	J.Black	Study of carbon dioxide.	Scottish
1733 - 1804 A.D	J.Priestley	Discovered oxygen, sulphur dioxide and hydrogen chloride.	English
1742 - 1786 A.D	Scheele	Discovered chlorine.	German
1731 - 1810 A.D	Cavendish	Discovered hydrogen.	British
1743 - 1794 A.D	Lavoisier	Discovered that oxygen is one fifth of air.	French
1766 - 1844 A.D	John Dalton	Proposed atomic theory of matter.	English
1778 - 1850 A.D	Gay-Lussac	Discovered that water is composed of two parts hydrogen and one part oxygen by volume. Discovered several chemical and physical properties of air and other gases.	French
1776 - 1856 A.D	Avogadro	Proposed Avogadro's law that equal volumes of gases under constant temperature and pressure contain equal number of molecules.	Italian
1746 - 1823 A.D	Jacques Charles	Described the gaseous law.	French
1741 - 1820 A.D	Petit	Determined the classical expression for the molar specific [heat capacity] of certain chemical elements.	French
1779 - 1848 A.D	J.J.Berzellius	Introduced symbols, formula and chemical equation to make study more systematic.	Swedish
1824 - 1907 A.D	Mendeleve	Discovered periodic arrangement of elements.	Russian
1859 - 1927 A.D	Arrhenius	Proposed acid base theory and ions dissociation.	Swedish
1791 - 1867 A.D	M.Faraday	Contributed to the study of electromagnetism and electrochemistry.	British
1856 - 1940 A.D	J.J.Thomson	Discovered the electron by experiments.	British
1885 - 1962 A.D	Neil Bohr	Proposed a theory for the hydrogen atom based on quantum theory.	British
1871 - 1937 A.D	Rutherford	Postulated the nuclear structure of the atom. Discovered alpha and beta rays, and proposed the laws of radioactive decay.	Scottish
1887 - 1961 A.D	Schrodinger	Proposed Quantum mechanical model of atom.	Austrian
1892 - 1987 A.D	De Broglie	Proposed hypothesis about wave particle duality nature of electron.	French
1894 - 1974 A.D	Stendra Nath Bose	Proposed fourth state of matter.	Indian
1879 - 1955 A.D	Elbert Eienstein	Proposed fourth state of matter.	German
1961 - Alive	Eric Cornell	Synthesized the first Bose Einstein Condensate.	American
1951 - Alive	Carl Weiman	Produced first Bose Einstein Condensate.	American

Q.4 Define Chemistry.

Ans: ***Chemistry:*** Chemistry is the branch of science which deals with the properties, composition, and structure of matter. Chemistry also deals with the changes involved in the matter.

Q.5 What is the importance of chemistry in daily life?
OR Write down the applications of chemistry in daily life.

Ans: ***Importance / Application of Chemistry in Daily Life:*** Our planet, earth, is the only planet in the universe that has life, due to the existence of water (H_2O). Water is a basic need of humans, animals, and plants. The chemical reactions take place in humans, animals, and plants. Disorder in these reactions may cause different diseases which may be overcome with the help of chemistry. The role of chemistry in daily life is an unavoidable fact.

(i) Cooking, eating, and digestion of food are purely chemical processes.
(ii) Construction, cleaning, and washing of our homes are dependable on chemistry.
(iii) The production of fertilizers, glass, plastic synthetic fibre, polymer, ceramics, petroleum products, soaps, and detergents are based on chemistry.
(iv) The diseases transmitted through impure drinking water as cholera, typhoid, dysentery, skin, and eye infections can be controlled with the help of chlorine treatment to kill the pathogenic organism to obtain pure water.
(v) Chlorine is the most important chemical used commercially to produce more than one thousand compounds which are used in the chemical industry as a bleaching agent, disinfectants, solvents, pesticides, refrigerates, PVC and drugs are miracles of chemistry.

Q.6 Name and define the branches of Chemistry.

Ans: ***Branches of Chemistry:*** As we know that chemistry is serving humanity everywhere in our environment. Due to its wide scope Chemistry is divided into the following main branches:

(i) **Physical Chemistry:** Physical chemistry is the branch of chemistry that deals with the relationship between composition and physical properties of matter with the changes in them. It deals with the laws and principles governing the combination of atoms and molecules in chemical reactions.
(ii) **Organic Chemistry:** Organic chemistry is the branch of chemistry that deals with hydrocarbons and their derivatives. Organic chemistry is the study of structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include hydrocarbons except for oxides, carbonates, bicarbonates, and cynites. Gasoline, plastics, detergents, dyes, food additives, natural gas, and medicines are studied in organic chemistry.
(iii) **Inorganic Chemistry:** Inorganic chemistry is the branch of chemistry which deals with the study of all elements and their compound except hydrocarbons. These compounds are generally obtained from non-living organisms. It is applicable in all areas of the chemical industry. Such as glass, cement, ceramics, and metallurgy.
(iv) **Biochemistry:** Biochemistry is the branch of chemistry that deals with the compounds of living organisms. plants and animals and their metabolism and synthesis in the living body such as carbohydrates, proteins, and fats. Biochemistry helps us to understand how living things obtain energy from food. It tells that how disorder or deficiency of these biomolecules causes diseases. This branch is useful in medicine, agriculture, and food science.
(v) **Industrial Chemistry:** The branch of chemistry which deals with the study of chemical

processes involved in the chemical industries for the manufacture of synthetic products like fertilizers, glass, cement, and medicines is called industrial chemistry.

(vi) **Nuclear Chemistry:** Nuclear chemistry is the branch of chemistry that deals with radioactivity, nuclear processes, and properties. Radioactive elements are widely used in medicine as diagnostic tools and as a means of treatment, especially for cancer, preservation of food, and generation of electric power through nuclear power reactors.

(vii) **Environmental Chemistry:** It is the branch of chemistry that deals with the study of the interaction of chemical materials and their effect on the environment of animals and plants. Personal hygiene, pollution, health hazards are the important areas of environmental chemistry.

(viii) **Analytical Chemistry:** Analytical chemistry is the branch of chemistry that deals with the separation and analysis of the kind, quality, and quantity of various components in a given substance. It is used in chromatography, electrophoresis, and spectroscopy.

(ix) **Medicinal Chemistry:** The branch of Chemistry that deals with synthetic organic chemistry, pharmacology, and various biological specialities. Medicinal chemistry is used in the synthesis of chemicals, bioactive molecules (drugs), and pharmaceutical agents.

(x) **Quantum Chemistry:** The branch of Chemistry that deals with the application, mechanics, and experiments of physical models in a chemical system. It is also called molecular quantum mechanics.

(xi) **Green Chemistry:** The branch of chemistry which deals with the study of processes and designing products, which are composed of less hazardous substances. It is also known as sustainable chemistry.

Safer chemical (polyphenyl sulfone), less hazardous chemical (poly carbons), and safer solvents are examples of green chemistry. The main purpose of this branch is to use waste material efficiently and improvement of energy efficiency in the chemical industry.

Q.7 ***In which branch of chemistry analysis of quality and quantity of compounds studied?***

Ans: Analytical chemistry is the branch of chemistry in which analysis of quality and quantity of compounds is studied.

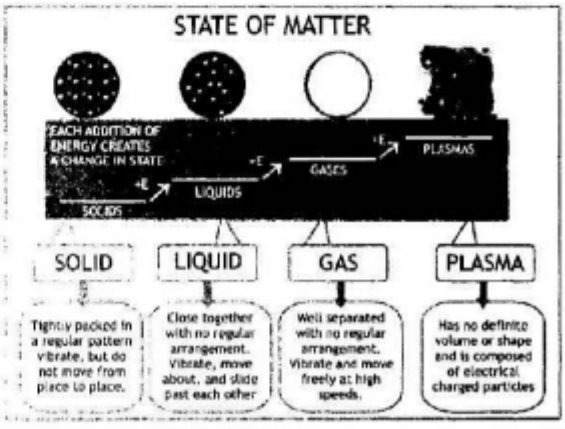
Q.8 ***What happens due to deficiency of biomolecules?***

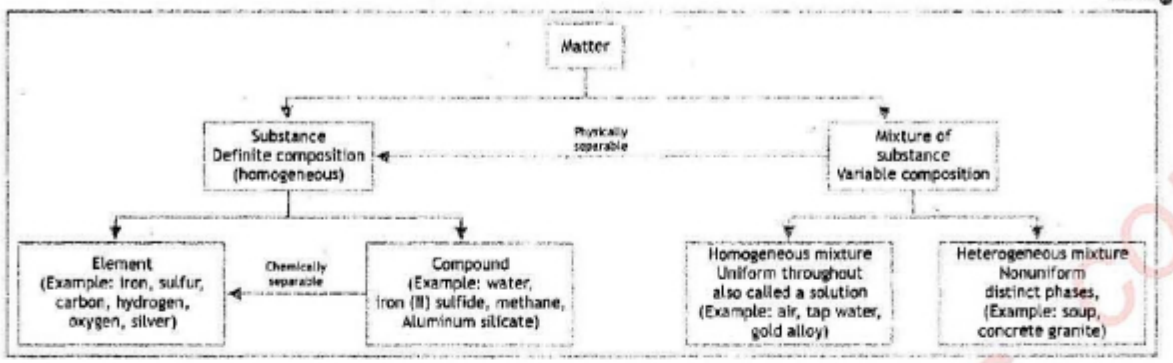
Ans: Deficiency of biomolecules causes diseases.

Q.9 ***What is matter? And in how many states is it found?***

Ans: ***Matter:*** Matter is all around us. The air we are breathing, the book we are reading, and the stuff we touch and see. Matter is simply defined as anything that has mass and occupies space.

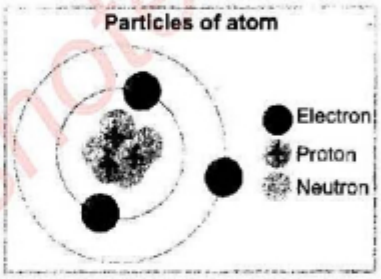
Three States of Matter: It is found in three common states solid, liquid and gas. The plasma is also considered the fourth state of matter. The different states of matter are due to differences in energy in increasing order.





Q.10 What is an atom?

Ans: ***Atom:*** Matter is made up of the smallest particles which are known as an atom. Atoms are the basic units of matter and define the structure of elements. Now it is discovered that atoms are made up of three particles: protons, neutrons, and electrons which are composed of even smaller particles as shown in the following figure where neutron and proton are situated in the nucleus and electrons are revolving around the nucleus.



Q.11 What are molecules? What are molecules made of?

Ans: ***Molecule:*** A molecule is the smallest particle in a chemical element or compound that has the chemical properties of that element or compound. Molecules are made up of atoms that are held together by chemical bonds. These bonds form as a result of the sharing or exchange of electrons among atoms.

Q.12 Write down the classification of molecules.

Ans: ***Classification of Molecules:*** Molecules are mono, di, and polyatomic molecules.

(i) **Monoatomic Molecules:** A molecule composed of just one atom, and lacking any covalent bonds. The noble gases (He, Ne, Ar, Kr, Xe, and Rn) are all monoatomic, whereas most other gases are at least diatomic.

(ii) **Diatomic Molecules:** Diatomic molecules contain two atoms that are chemically bonded. If the two atoms are identical, as in, for example, the oxygen molecule (O_2), they compose a homonuclear diatomic molecule, while if the atoms are different, as in the carbon monoxide molecule (CO), they make up a heteronuclear diatomic molecule.

(iii) **Polyatomic Molecules:** Molecules containing more than two atoms are termed polyatomic molecules, e.g., carbon dioxide (CO_2) and water (H_2O).

Examples of mono, di and polyatomic molecules are as follows.

Monatomic elements					
					
Name	helium	argon	krypton	xenon	radon
Symbol	He	Ar	Kr	Xe	Rn

Diatomic molecules					
Name	nitrogen	oxygen	chlorine	bromine	iodine
Molecular formula	N_2	O_2	Cl_2	Br_2	I_2
Polyatomic molecules					
Name	ozone		phosphorus		sulphur
Molecular formula	O_3		P_4		S_8

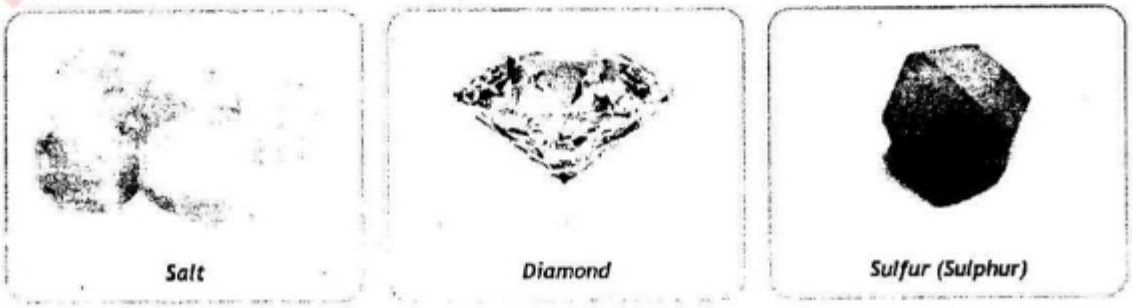
Molecule
Molecule is chemical combination of atoms.
Molecule is smallest unit of a substance.
Molecule shows properties of substance.
Molecule can exist independently.

(1) Mono atomic Molecule	(2) Di atomic Molecule	(3) Tri atomic Molecule	(4) Poly atomic Molecule	(5) Homo atomic Molecule	(6) Hetero Molecule
Molecule consist of one atom.e.g. helium (He), neon(Ne), argon(Ar)	Molecule consist of two atom.e.g Hydrogen (H_2) Oxygen (O_2) Chlorine (Cl_2)	Molecule consist of three atoms.e.g. H_2O CO_2	Molecule consist of many atoms.e.g. CH_4, H_2SO_4 $C_6H_{12}O_6$	Molecule consist of same type of atoms.e.g. H_2, O_3, P_4, S_8	Molecule consist of different type of atoms.e.g. CO_2, H_2O, NH_3

Q.13 *What do you mean by substance and elements?*

Ans: ***Substance:*** A piece of matter in pure form is termed a substance. Every substance has a fixed composition and specific properties. Every substance has physical and chemical properties.
Examples: Examples of pure substances include tin, sulfur (sulphur), diamond, water, pure sugar (sucrose), table salt (sodium chloride), and baking soda (sodium bicarbonate).
Substances are elements and compounds.

Examples of Pure Substances



Salt *Diamond* *Sulfur (Sulphur)*

Elements: An element is a substance made up of the same type of atoms. They have the same atomic number and cannot be decomposed into simple substances by ordinary chemical reactions. Elements occur in nature in free or combined form in solid, liquid, and gas states. Now 118 elements have been discovered. The majority of elements are solids as copper, gold, zinc, etc. Very few elements are liquid as mercury and bromine. Few elements are gases like hydrogen, oxygen, and nitrogen. Elements are divided into metals, nonmetals, and metalloids based on their properties.

Q.14 What do you know about metals, nonmetals, and metalloids?

Ans: **Metals:** Metal is a solid material that is typically hard, shiny, malleable, fusible, and ductile, with good electrical and thermal conductivity, e.g. iron, gold, silver, and aluminium, and alloys such as steel.

Nonmetals: Non-metal is an element that doesn't have the characteristics of metal including, the ability to conduct heat or electricity, luster, or flexibility. An example of a nonmetal element is carbon.

Metalloids: It is an element (e.g. arsenic, antimony, or tin) whose properties are intermediate between those of metals and solid non-metals semi-conductors.

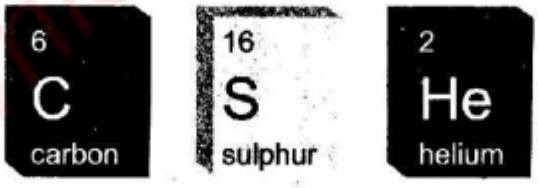
Q.15 Define symbol. How to write symbols?

Ans: **Symbols:** A symbol is an abbreviation to represent the name of elements. A symbol is taken from the name of elements from English, Latin, Greek, and German.

How to write Symbols: Symbols are usually one or two-letter long. Every symbol starts with a capital letter as carbon with C or Sulphur (sulfur) as S.

If a symbol has a second letter then start with a capital letter and the second letter will be in a small letter as He for helium, Na for sodium, Cr for chromium.

Symbols of Elements



The symbols of 30 elements in English derived from Latin, Greek, and German are given in the following.

Symbols of first 30 Elements

S.No	Names of Elements in English	Derived from Latin and Greek	Symbol
01	Hydrogen	Greek (root genes)	H
02	Helium	Greek (Helios)	He
03	Lithium	Greek (lithos)	Li
04	Beryllium	Greek (beryllos)	Be
05	Boron	Latin (Busaq)	B
06	Carbon	Latin (Carbone)	C
07	Nitrogen	Greek (nitrumgenes)	N
08	Oxygen	Greek (oxygeinomes)	O

09	Flourine	Latin (flour)	F
10	Neon	Greek (neos)	Ne
11	Sodium	Latin (Natrium)	Na
12	Magnesium	Greek (magnesium)	Mg
13	Aluminium	Latin (alumen)	Al
14	Silicon	Latin (Silen)	Si
15	Phosphorous	Greek (Phoros)	P
16	Sulphur	Latin (sulohur)	S
17	Chlorine	Greek (Chloros)	Cl
18	Argon	Greek (orgon)	Ar
19	Potassium	Latin (Potash)	K
20	Calcium	Greek (Claix)	Ca
21	Scandium	Latin (scandia)	Sc
22	Titanium	Greek (titan)	Ti
23	Vanidium	Greek (vanadis)	V
24	Chromium	Greek (Chroma)	Cr
25	Mangnese	Greek (Magnesia)	Mn
26	Iron	Latin (Ferrum)	Fe
27	Cobalt	German (Kobold)	Co
28	Nickel	German (kupanickel)	Ni
29	Copper	Latin (Cuprum)	Cu
30	Zinc	German (zink)	Zn

Q. 16 What is valency?

Ans: ***Valency:*** The combining power of an element with another element is called valency. The valency depends upon the number of electrons in the outermost shell. Valency is the number of electron of an atom of an element which can gain, lose or share.

Some elements with their symbol and common valencies are given below in the following table.

S.No	Elements	Symbol	Atomic Number	Valency
1	Hydrogen	H	1	-1 +1
2	Helium	He	2	0
3	Lithium	Li	3	+1
4	Beryllium	Be	4	+2
5	Boron	B	5	
6	Carbon	C	6	+4 +2
7	Nitrogen	N	7	

8	Oxygen	O	8	-2
9	Flourine	F	9	
10	Neon	Ne	10	0
11	Sodium	Na	11	+1
12	Magnesium	Mg	12	+2
13	Aluminium	Al	13	+3
14	Silicon	Si	14	+4
15	Phosphorous	P	15	±3
16	Sulphur	S	16	±2
17	Chlorine	Cl	17	±1
18	Argon	Ar	18	0
19	Potassium	K	19	+1
20	Calcium	Ca	20	+2
21	Scandium	Sc	21	+3
22	Titanium	Ti	22	+2 +3
23	Vanadium	V	23	+2 +3, +4
24	Chromium	Cr	24	+3
25	Manganese	Mn	25	+2 +3 +6
26	Iron	Fe	26	+2 +3
27	Cobalt	Co	27	+2 +3, +4
28	Nickel	Ni	28	+1 +2
29	Copper	Cu	29	+1 +2, +3
30	Zinc	Zn	30	+2

Q.17 What is a chemical formula?

Ans: ***Chemical Formula:*** A chemical formula represents the symbol of elements and ratios of elements to one another in a compound. The chemical formula tells us the number of atoms of each element in a compound with symbols.
For example, the chemical formula of water is H_2O which indicates that 2 atoms of hydrogen combine with 1 atom of oxygen, or the chemical formula of ammonia NH_3 shows that one nitrogen atom combines with 3 atoms of hydrogen.

Q.18 Define compounds.

Ans: ***Compounds:*** The compound is a substance formed when two or more elements are chemically bonded together in a fixed ratio by mass, as a result, a new entirely different properties

possessing substance formed. In compounds, the type of bonds holding elements may be ionic bonds or covalent bonds.

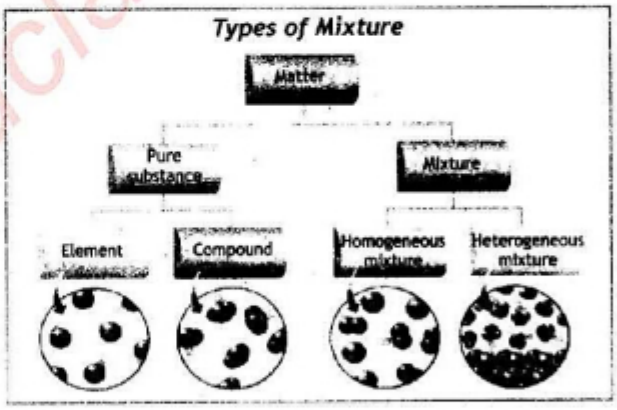
For example, NaCl, $CuSO_4$, KBr are ionic compounds, and H_2O, CH_4, H_2SO_4 are covalent compounds.

Some Common Compounds with their Formula

Compounds	Chemical Formula
Water	H_2O
Silicon dioxide(sand)	SiO_2
Sodium hydroxide (caustic soda)	NaOH
Sodium chloride (common salt)	NaCl
Sodium carbonate (washing soda)	$Na_2CO_3.10H_2O$
Calcium carbonate (limestone)	$CaCO_3$
Sugar	$C_{12}H_{22}O_{11}$
Ammonia	NH_3
Sulphuric acid	H_2SO_4
Calcium oxide	CaO

Q.19 *What is a mixture? And how many types of mixtures are there?*

Ans: ***Mixture:*** When two or more than two elements or compounds physically combined without any fixed ratio is known as a mixture. The component substances retain their chemical properties. Mixtures can be separated again by physical methods, as filtration, evaporation, distillation, and crystallization.



Types of Mixtures: There are two main types of mixtures, which are shown in the following figure, Homogeneous mixture and Heterogeneous mixture.

Homogenous Mixture: In a homogenous mixture, all the substances are evenly distributed throughout the mixture (Saltwater, air, blood).

Heterogenous Mixture: In a heterogeneous mixture, the substances are not evenly distributed (chocolate chip cookies, pizza, rocks).

Q.20 *How can you differentiate between matter and substance?*

Ans: Anything that occupies space and has mass is called matter and the matter that has a specific composition and chemical characteristics is called a substance.

Q.21 *What elements do the following compounds contain?*
Washing soda, sugar, sand, caustic soda

Ans:

Compounds	Elements in the compounds
Washing soda ($Na_2CO_3.10H_2O$)	Sodium, Carbon, Oxygen, and Hydrogen
Sugar ($C_{12}H_{22}O_{11}$)	Carbon, Hydrogen, and Oxygen
Sand (SiO_2)	Silicon and Oxygen
Caustic soda (NaOH)	Sodium, Oxygen, and Hydrogen

Q.22 ***Identify mixture, element, or compound from the following:***
Table Salt, ice cream, blood, silicon, coca-cola, tin, zinc, water, sulphur

Ans:

Element	Compound	Mixture
silicon	table salt	ice cream
tin	water	blood
zinc		coca-cola
sulphur		

Q.23 ***Define relative atomic mass and atomic mass unit.***

Ans: ***Relative Atomic Mass:*** The relative atomic mass of an atom is the average mass of naturally occurring isotopes, compared to carbon (C–12).

$$A_r = \frac{\text{average mass of one atom of the element}}{\frac{1}{12} \times \text{the mass of one atom of carbon} - 12}$$

Atomic Mass Unit: The unit of relative atomic mass is called the atomic mass unit, with the symbol a.m.u.

$$1 \text{ a.m.u} = 1.66 \times 10^{-24} \text{ gram}$$

Q.24 ***What is a chemical formula? And how many types of chemical formulas are there?***

Ans: ***Chemical Formula:*** The compounds are represented by chemical formula as elements are represented by symbols with respect to valencies. A chemical formula is of two types:

(i) Empirical Formula, and (ii) Molecular Formula.

Empirical Formula: The formula showing minimum relative numbers of each type of atoms in a molecule is called Empirical Formula.

- Empirical Formula shows the simplest ratio of each atom present in a molecule.
- Empirical Formula does not show the actual number of atoms in the molecule.
- Empirical Formula tells us the type of elements present in it.

For Example:

(1) Benzene has molecular formula C_6H_6 which has the simplest ratio of hydrogen and carbon is 1:1, so the empirical formula becomes CH.

(2) Glucose has the molecular formula $C_6H_{12}O_6$. It shows the ratio as follows:

$C_6H_{12}O_6$
6: 12: 6
1: 2: 1
C: H_2: O

So the empirical formula of glucose is CH_2O and has a simple ratio of 1:2:1 of atoms in a molecule of glucose.

Molecular Formula: The molecular formula is the formula that shows the actual number of atoms of each element present in a molecule.

- Molecular formula is derived from an empirical formula.
- Molecular formula mass calculated by adding atomic weights of its atoms.
- Molecular formula of a compound may be the same or multiple of the empirical formula.

For Example:

The molecular formula of benzene is C_6H_6, which has six carbon and six hydrogen atoms, molecular formula of benzene is an integral multiple (1,2,3, etc.) of its empirical formula.

Molecular Formula = $(\text{Empirical Formula})_n$ where n = 1,2,3,etc.

Some Compounds with their Empirical and Molecular Formula

Compound	Empirical Formula	Molecular Formula
Carbon dioxide	CO_2	CO_2
Glucose	CH_2O	$C_6H_{12}O_6$
Hydrogen peroxide	HO	H_2O_2
Benzene	CH	C_6H_6
Acetic Acid	CH_2O	CH_3COOH
Sulphuric Acid	H_2SO_4	H_2SO_4

Q.25 ***Define atomic number and atomic mass with examples.***

Ans: ***Atomic Number:*** An atomic number is the number of protons present in the nucleus of an atom of any element. It is represented by symbol Z. All atoms of an element have the same atomic number due to the presence of the same number of protons.

For example in all oxygen atoms have 8 protons due to this atomic number is 8 (Z = 8).

Atomic Mass: The atomic mass is the sum of the number of protons and neutrons present in the nucleus of an atom of any element. It is represented by symbol A and calculated by A = Z + n where n is the number of neutrons.

For example, the nitrogen atom has 7 protons and 7 electrons then the atomic mass of nitrogen is 14 (A = 7 + 7 = 14).

Q.26 ***Explain Molecular Mass and Formula Mass with examples.***

Ans: ***Molecular Mass:*** The molecular mass is the sum of atomic masses of all the atoms present in one molecule of a substance. For example, the molecular mass of CO_2 is 44 a.m.u and H_2O is 18 a.m.u.

Formula Mass: The ionic compounds which form three-dimensional solid crystals are represented by their formula units. In such cases, formula mass calculated by the sum of atomic masses of all atoms in formula unit is called formula mass of that substance. For example formula mass of sodium chloride is 58.5 a.m.u.

Q.27 ***What do you mean by chemical species? Explain ion, molecular ion, and free radical.***

Ans: ***Chemical Species:*** If one molecule is identical to another we can say they are the same chemical species. Chemical species is a chemical entity, such as a particular atom, ion, or molecule.

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, cations, and anions.

Cations: The cations are formed when an atom loses electrons from its outermost shells.

For example Na^+, K^+ are cations. The following equation shows the formation of cations.

$$Na \longrightarrow Na^+ + 1e^-$$

Anion: An atom or group of atoms that has a negative charge on it is called an anion. Anion is formed by the gain or addition of electrons to an atom. For example, Cl and O_2, the following examples show the formation of an anion by the addition of electrons to an atom.

$$Cl + 1e \longrightarrow Cl^-$$

Molecular Ions: When a molecule loses or gains electrons called molecular ions. Molecular ions also possess positive or negative charges like any ion. If it has a negative charge known as anionic molecular ions if it has a positive charge known as cationic molecular ions. For example CH_4^+.

Free Radicals: Free radicals are atoms and groups of atoms having some unpaired electrons. It is represented by putting a dot over the symbol of an element.

For example: H° , Cl° , H_3C°

Free radicals are formed when homolytic breakage of the bond between two atoms takes place by the absorption of heat or light energy. Free radical is a very reactive chemical species.

Q.28 ***Identify the cations, anions, free radicles, molecular ions, molecules from the following:***
$O_2, H^-, N_2, Cl_2, CO_3^{2-}, H_2O, Br, H_2, H_3C^\circ, Na^+$

Ans:

Cations	Anions	Free Radicles	Molecular Ions	Molecules
Na^+	H^-	H_3C°	CO_3^{2-}	O_2
				N_2
				Cl_2
				H_2O
				H_2

Q.29 ***Define and explain chemical equation.***

Ans: ***Chemical Equation:*** Chemical equation is a shorthand method of describing the chemical reaction in terms of symbols and formulae of substances.

Reactants: The starting substances are known as reactants and are always written on the left-hand of the arrow.

Products: The substances are formed due to reactions of reactants are known as products and written on the right side of the arrow.

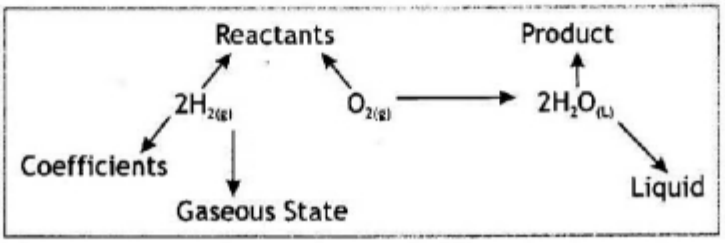
- The reactants and products are separated from one another by using (→) single arrow or (⇌) double arrow depending type of reaction.

Coefficient: The number written in front of the formula is called coefficient which shows the number of molecules of that reactant or product.

- The expression (s),(g), and (l) shows the state, solid, gaseous, and liquid of reactants and products.
- The expression (aq) expresses that substance is in the form of solution.

Similarly, if a catalyst is used this catalyst is shown over the arrow.

For example: when two molecules of hydrogen and one molecule of oxygen react two molecules of water are formed. Instead of writing the full names of reactants and products, chemists show this reaction as follows in form of an equation.



Q.30 *Explain the steps for balancing the chemical equation.*

Ans: ***Balancing of Chemical Equation:*** The chemical equation must be balanced to fulfill the law of conservation of mass. Most chemical equations can be balanced by the inspection method (trial and error method). We can balance the equation by following steps.

(i) Write the correct formula of all reactants on the left side and products on the right side of an arrow.

(ii) Balance the number of atoms on each side.

(iii) If the number of atoms may appear more or less than the other side, balance the equation by the inspection method. Multiply the coefficient with the formula to make the number of atoms same on the both (reactants and products) sides of the equation.

(iv) The covalent molecules of hydrogen, nitrogen, and chlorine exist as diatomic molecules. e.g H_2, O_2, N_2, and Cl_2. We must write them as diatomic molecules rather than isolated atoms in a chemical equation.

(v) Finally check the equation to be sure that the number and kind of atom are the same on the reactant and product side. If yes, now the equation is balanced.

For Example: Let us consider, in a laboratory, oxygen (O_2) gas is prepared by heating potassium chlorate ($KClO_3$). The products are potassium chloride (KCl) and oxygen (O_2) gas.

Now balance the equation stepwise.

Step no.1: Write the correct formula of all reactants on the left side and product on the right side of an equation.

$$KClO_{3(s)} \longrightarrow KCl_{(s)} + O_{2(g)}$$

Step no.2: Balance the number of atoms on each side.

Reactants		Products
K (1)	⟶	K (1)
Cl (1)	⟶	Cl (1)
O (3)	⟶	O (2)

We see that K and Cl elements have the same number of atoms on both sides of the equation but O is not balanced because of the three atoms on the reactant side and two atoms on the product side.

Step no.3: Now multiply the formula ($KClO_3$) with coefficient 2 on the reactant side and 3 in front of oxygen on the product side to balance the oxygen atoms.

$$2KClO_{3(s)} \longrightarrow KCl_{(s)} + 3O_{2(g)}$$

Reactants		Products
K (2)	⟶	K (1)
Cl (2)	⟶	Cl (1)
O (6)	⟶	O (6)

Step no.4: Now again check and balance the equation by placing 2 in front of KCl on the product side.

$$2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$$

Reactants		Products
K (2)	⟶	K (2)
Cl (2)	⟶	Cl (2)
O (6)	⟶	O (6)

Now this chemical equation is balanced.

Q.31 Define Gram Atomic Mass, Gram Molecular Mass, and Gram Formula Mass.

Ans: As we know that all substances are made up of atoms, molecules, or formula units. The mass of an atom is called atomic mass. The mass of a molecule is molecular mass and the mass of the formula unit is formula mass. All of these masses are expressed in a.m.u. When these masses are expressed in 'gram', they are termed as gram atomic mass, gram molecular mass, and gram formula mass.

Gram Atomic Mass: The atomic mass of an element expressed in gram is called gram atomic mass. It is also called 1 mole.

1 gram atom of oxygen	=	16.00g	=	1 mole of oxygen atom
1 gram atom of carbon	=	12.00g	=	1 mole of carbon atom
1 gram atom of nitrogen	=	14.00g	=	1 mole of nitrogen atom

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

Gram Molecular Mass: The molecular mass of an element or a compound expressed in gram is called gram molecular mass. It is also called 1 mole.

1 gram molecule of oxygen (O_2)	=	32.00g	=	1 mole of oxygen molecule
1 gram molecule of water (H_2O)	=	18.00g	=	1 mole of water
1 gram molecule of ethanol (C_2H_5OH)	=	46.00g	=	1 mole of ethanol

Gram Formula Mass: The formula mass of an ionic compound expressed in grams is called gram formula mass. It is also called 1 mole.

1 gram formula of NaCl	=	58.5g	=	1 mole of sodium chloride
1 gram formula mass of $CaCO_3$	=	100g	=	1 mole of calcium carbonate

Q.32 Define mole and give its formula.

Ans: ***Mole:*** The atomic mass, molecular mass, and formula mass of a substance expressed in grams is known as mole. A mole is defined as "an amount of substance containing equal to the Avogadro's number 6.02×10^{23}.

Gram atomic mass and a.m.u

One carbon atom	One gram atomic mass
Mass = 12 a.m.u	of carbon = 12 g (6.02×10^{23})

Thus

The atomic mass of carbon is 12gram	=	1 mole of carbon atom
The molecular mass of H_2SO_4 is 98gram	=	1 mole of H_2SO_4

The relationship between mole and mass can be expressed as

$$\text{Number of moles} = \frac{\text{known mass of a substance}}{\text{Molar mass of the substance}}$$

or Mass of substance (gm) = Number of moles × Molar mass

Q.33 Define Avogadro's Number.

Ans: ***Avogadro's Number:*** Avogadro, an Italian scientist, calculated the number of atoms, molecules, or ions present in one mole. The value is found to be 6.02×10^{23}. This value is represented by N_A and is called Avogadro's number.

For example: 1 mole of O_2 molecule = 32g

So 32gm of O_2 will contain 6.02×10^{23} molecules

Similarly 1 mole of NaCl = (23+35.5) = 58.5g of NaCl

= 6.02×10^{23} Na^+ + 6.02×10^{23} Cl^-

Q.34 What do you know about chemical calculations?

Ans: ***Chemical Calculations:*** In all types of chemical calculations, we calculate the number of moles and the number of particles of a substance. These calculations are based on the mole. In the sequence of calculation first moles are calculated then the number of particles.

(i) **Mole-Mass Calculation:** In this calculation, we calculate the number of moles of a substance with the help of the following equation.

$$\text{Number of Moles} = \frac{\text{known mass of the substance}}{\text{molar mass of the substance}}$$

We can calculate the mass of a substance with the given moles of substance with the following equation.

$$\text{Mass of substance} = \text{Number of moles} \times \text{Molar Mass}$$

(ii) **Mole-Particle Calculation:** In this calculation, we calculate the number of moles of a substance in the given number of Particles (atom, molecules, or formula unit).

$$\text{Number of Moles} = \frac{\text{Given number of particles}}{\text{Avogadro's number}} = \frac{\text{Given number of particles}}{6.02 \times 10^{23}}$$

We can calculate the number of particles as

$$\text{Number of particles} = \text{Number of moles} \times 6.02 \times 10^{23}$$

(iii) **Mole Volume Calculation:** The mole quantities of gases can be expressed in terms of volume. According to Avogadro, one gram mole of any gas at STP occupies a volume of 22.4 dm^3 (where the standard temperature is 0°C and standard pressures is 1 atom)

Q.35 Balancing Chemical Equations.

Ans: ***Solution:***

S.No.	Balancing Chemical Equations
1.	$2C + O_2 \longrightarrow 2CO$
2.	$2CO + O_2 \longrightarrow 2CO_2$
3.	$2KNO_3 \longrightarrow 2KNO_2 + O_2$
4.	$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$
5.	$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
6.	$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$
7.	$N_2 + 3H_2 \longrightarrow 2NH_3$
8.	$BaCO_3 \longrightarrow BaO + CO_2$
9.	$2C_2H_2 + 2H_2 \longrightarrow C_4H_8$
10.	$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$
11.	$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2$
12.	$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
13.	$2NO_2 \longrightarrow 2N + O_2$
14.	$4Na + O_2 \longrightarrow 2Na_2O$
15.	$2Na + 2H_2O \longrightarrow 2NaOH + H_2$
16.	$4Cu + 10HNO_3 \longrightarrow 4Cu(NO_3)_2 + NH_4NO_3 + 3H_2O$
17.	$3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$
18.	$2Ba(NO_3)_2 \longrightarrow 2BaO + 4NO_2 + O_2$
19.	$2NH_3 + CO_2 \longrightarrow (NH_2)_2CO + H_2O$

20.	$6\ PbO + O_2$	⟶	$2\ Pb_3O_4$
21.	$4\ CaCO_3 + Al_2Si_2O_7$	⟶	$2\ CaSiO_3 + Ca_2Al_2O_5 + 4\ CO_2$
22.	$PCl_3 + 3\ H_2O$	⟶	$H_3PO_3 + 3\ HCl$
23.	$2\ KI + MnO_2 + 2H_2SO_4$	⟶	$K_2SO_4 + MnSO_4 + 2\ H_2O + I_2$
24.	$2\ NaCl + MnO_2 + 2\ H_2SO_4$	⟶	$Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$
25.	$4\ Zn + 10\ HNO_3$	⟶	$4\ Zn(NO_3)_2 + 3\ H_2O + NH_4NO_3$
26.	$C_6H_{12}O_6$	⟶	$2\ C_2H_5OH + 2\ CO_2$
27.	$3\ Mg + N_2$	⟶	Mg_3N_2
28.	$2\ KClO_3$	⟶	$2\ KCl + 3\ O_2$
29.	$MnO_2 + 4\ HCl$	⟶	$MnCl_2 + 2\ H_2O + Cl_2$
30.	$Cu + 2\ H_2SO_4$	⟶	$CuSO_4 + 2\ H_2O + SO_2$
31.	$2\ H_2O_2$	⟶	$2\ H_2O + O_2$

Differences

1. *Differentiate between Element, Compound, and Mixture.*

Ans: Differentiate between Element, Compound, Mixture

Element	Compound	Mixture
Element is a substance made up of same atoms, and discovered naturally.	Compound is formed by a chemical combination of atoms of the elements.	Mixture formed by the simple mixing of the substance.
Element shows unique properties due to similarity of atoms. Elements have same atomic number.	Constituent of compound lose their identity and form a new substance with new properties. Compounds have fixed composition by mass.	Constituents of mixture retain their properties in mixture. Mixtures have no fixed composition by mass.
Element have same atomic number and cannot decompose in to simple substances by ordinary means.	Components cannot be separated by physical means.	The components can be separated by physical means.
Element represented by symbols, which are abbreviations for the names of elements.	Every compound represented by chemical formula.	It consists of two or more compounds and does not show any chemical formula.
Element are homogenous.	Compounds have homogenous composition.	Mixtures have homogenous as well as heterogeneous composition.
As the atomic number increases in elements melting points increases.	Compounds have sharp and fixed melting points.	Mixtures do not have sharp and fixed melting points.

2. *Differentiate between*
(i) physical and analytical chemistry, and (ii) medicinal chemistry and biochemistry

Ans: (i) Difference Between Physical and Analytical Chemistry

Physical Chemistry	Analytical Chemistry
Physical chemistry is the branch of chemistry that deals with the relationship between composition and physical properties of matter with the changes in them.	Analytical chemistry is the branch of chemistry that deals with the separation and analysis of the kind, quality, and quantity of various components in a given substance.

It deals with the laws and principles governing the combination of atoms and molecules in chemical reactions.	It is used in chromatography, electrophoresis, and spectroscopy.

(ii) Difference Between Medicinal Chemistry and Biochemistry

Medicinal Chemistry	*Biochemistry*
The branch of Chemistry that deals with synthetic organic chemistry, pharmacology, and various biological specialities.	Biochemistry is the branch of chemistry that deals with the compounds of living organisms, plants and animals and their metabolism and synthesis in the living body such as carbohydrates, proteins, and fats.
Medicinal chemistry is used in the synthesis of chemicals, bioactive molecules (drugs), and pharmaceutical agents.	Biochemistry helps us to understand how living things obtain energy from food. It tells that how disorder or deficiency of these biomolecules causes diseases. This branch is useful in medicine, agriculture, and food science.

3. Write four differences between Atom and Molecule.

Ans: Difference between Atom and Molecule.

Atom	*Molecule*
The smallest particle of an element which can enter into chemical reaction is called an Atom.	The smallest particle of a substance which can exist and show all properties of the substance is called Molecule.
It is represented by a symbol.	It is represented by molecular formula.
It may or may not exist independently.	It exists independently.
It is a fundamental unit of elements.	It is a fundamental unit of compound.

4. Write the main difference between Atomic Mass and Molecular Mass.

Ans: Difference between Atomic Mass and Molecular Mass.

Atomic Mass	*Molecular Mass*
The average mass of natural mixture of isotopes of an element which is compared to the mass of one atom of C-12 is called Atomic Mass.	The sum of atomic masses of all the atoms present in the molecular formula is called Molecular Mass.
It is the sum of protons and neutrons present in the nucleus of an atom.	It is the sum of masses of atoms present in one molecule.
It is the mass of one atom of an element.	It is the mass of one molecule of an element or compound.
Atomic mass gives the measurement of the mass of one atom of an element.	Molecular mass gives the measurement of one molecule of a compound.

5. Write four differences between Molecular Mass and Formula Mass.

Ans: Difference between Molecular Mass and Formula Mass.

Molecular Mass	*Formula Mass*
The sum of atomic masses of all the atoms present in the molecular formula is called Molecular Mass.	The sum of atomic masses of atoms within an empirical formula as well as molecular formula is called Formula Mass.

It is calculated on considering the molecular formula of substance.	It is calculated on considering the formula unit of substance.
It is taken for those substances which exist in a molecular form.	It is taken for those substances which exist in a network arrangement.
It represents the mass of a molecule.	It represents the mass of empirical formula as well as molecular formula.

6. Identify the differences among the following:

(i) Atom and Ion (ii) Molecule and Molecular ion

(iii) Compound and Mixture (iv) Ion and Free Radicals

Ans: (i) Difference between Atom and Ion.

Atom	*Ion*
Atom is the smallest particle of an element.	Ion is the smallest unit of ionic compound.
Atom can or can not exist independently and take part in chemical reaction.	Ion can not exist independently and surrounded by oppositely charged ions.
Atom is electrically neutral.	Ion has negative or positive charge.

(ii) Difference Between Molecule and Molecular Ion

Molecule	*Molecular Ion*
Molecule is the smallest particle in a chemical element or compound that has chemical properties of that element or compound.	Molecular ion formed by gain and lose of electrons by a molecule.
Molecule is always neutral.	Molecular ion have positive or negative charge.
Molecule is stable unit.	Molecular ion is reactive species.
Molecule is formed by the combination of atoms.	Molecular ion formed by the ionization of a molecule.

(iii) Difference Between Compound and Mixture

Compound	*Mixture*
Compound are substances which can be formed by chemically combining two or more elements.	Mixtures are substances that are formed by physically mixing two or more substances.
Compounds fall under pure substances.	Mixtures can be categorized as impure substances.
The chemical composition of compounds is always fixed.	A mixture can have a variable composition of the substances forming it.
They have a specific formula.	Mixtures do not have a certain formula.
Compounds are always homogeneous in nature.	Mixtures can either be homogeneous or heterogeneous in nature.
It is not easy to separate the elements of compounds.	The substances of the mixtures are easy to separate by different physical methods
The properties of compounds are unique to themselves and need not necessarily reflect the properties of the constituent elements.	The constituents of a mixture do not lose their properties and so, the properties of a mixture are generally the sum of the properties of its constituents.

When we do the mixing of the chemical properties of the different constituents, there is always the formation of the new substances.	No new substances form from the mixtures
Examples are water, salt, baking soda, etc.	Examples are oil and water, sand and water, smog (smoke + fog), etc.

(iv) Difference Between Ions and Free Radicals

Ion	*Free Radicals*
Ions are atoms which have positive or negative charge.	Free radicals are atoms with odd number of unpaired electrons.
Ions exist in crystals and solutions.	Free radicals exist in air and solutions.
Ions are not affected by the presence of light.	Free radicals are affected by the presence of light.

7. ***Write four differences between Empirical Formula and Molecular Formula:***

Ans: ***Difference between Empirical Formula and Molecular Formula.***

Empirical Formula	*Molecular Formula*
It shows minimum simple ratio of atoms in a molecule.	It shows actual number of each type of atoms in a molecule.
It does not show the structural formula of the compound.	It can show the structural formula of the compound.
More than one compound can have same empirical formula.	No two compounds can have same molecular formula.
The empirical formula of acetylene (C_2H_2) is CH.	Benzene has same empirical formula (CH) as acetylene. But C_6H_6 is the molecular formula of benzene only.

Reasons

1. ***Why formula mass and molecular mass calculated separately while the process of calculation is the same?***

Ans: Molecular mass is the sum of the atomic masses of the atoms in a molecule means it gives the mass of a molecule. Molecular mass is also known as molecular weight and it gives the mass of a molecule relative to that of a carbon-12 atom which has a mass of twelve units.

The formula mass of a substance is the sum of atomic masses of constituents atoms in an ionic compound or we can say that the sum of atomic masses of the ions present in the formula unit of an ionic compound. Molecular mass and formula mass are somewhat the same terms but we use them differently because molecules are covalent compounds means they have only non metals and an ionic compound cannot be a molecule therefore we just simply say formula mass when we are taking ionic compounds.

2. ***Explain why hydrogen and oxygen are considered as elements whereas water is a compound.***

Ans: Hydrogen and oxygen are made up of the same kind of atom hence these are considered elements whereas water is made by the combination of different kinds of atoms such as hydrogen and oxygen, hence it is called a compound and not an element.

Section D Numericals:

Solved Examples of the Textbook

Example 1.1: **If any element has a number of protons 11 and a number of neutrons 12, find out its atomic number and atomic mass?**

Solution: **Data:** Number of protons = 11 Number of neutrons = 12
Atomic number = Z = ? Atomic mass = A = ?
As we know atomic number Z is the number of protons due to this
Atomic number Z = 11
Atomic mass A = Z + n
A = 11 + 12
A = 23

Example 1.2: **How many protons and neutrons are there in an atom having A = 40 and Z = 20?**

Solution: **Data:** Atomic mass = A = 40 Atomic number = Z = 20
Number of protons = ? Number of neutrons = ?
As Number of protons is Z = 20
Number of neutrons = A – Z
= 40 – 20 = 20

Example 1.3: **Calculate the molecular mass of HNO_3.**

Solution: **Data:** Atomic mass of H = 1 a.m.u Atomic mass of N = 14 a.m.u
Atomic mass of O = 16 a.m.u
Molecular mass = 1 (At. Mass of H) + 1 (At.Mass of N) + 3 (At. Mass of O)
= 1 + 14 + 3(16) = 1 + 14 + 48 = 63 a.m.u

Example 1.4: **Calculate the Formula mass of $Al_2(SO_4)_3$.**

Solution: **Data:** Atomic mass of Al = 26.98 a.m.u Atomic mass of S = 32 a.m.u
Atomic mass of O = 16 a.m.u
Formula unit = $Al_2(SO_4)_3$
Formula mass of $Al_2(SO_4)_3$ = 2(26.98) + 3(32) +12(16)
= 53.96 + 69 + 192 = 342.14 a.m.u

Example 1.5: **Calculate the number of moles in 40g of Na.**

Solution: **Data:** Given mass of Na = 40g Molecular mass of Na = 23 a.m.u
Number of moles = ?

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

$$\text{Number of moles of Na} = \frac{40}{23} = 1.73 \text{ moles of Na}$$

Example 1.6: **What is the mass of 4 moles of CO_2?**

Solution: **Data:** Number of moles of CO_2 = 4 moles Formula mass of CO_2 = 44gm
mass of CO_2 = ?
Mass of CO_2 = number of moles of CO_2 × formula mass of CO_2
= 4 × 44 = 176 gm

Example 1.7: **Calculate the number of atoms present in 9.2gm of Calcium (Ca).**

Solution: **Data:** Atomic mass of Calcium (Ca) = 40
1 g atomic weight of Calcium = 40gm
40g of Calcium contains = 6.02×10^{23} atoms of calcium
By using the formula

$$\text{Number of atoms} = \frac{(N_A \times \text{Mass in g})}{40}$$

$$= \frac{6.02 \times 10^{23} \times 9.2}{40}$$

$$= \boxed{1.384 \times 10^{23} \text{ atoms of Ca}}$$

Example 1.8: **Calculate the number of moles, number of molecules present in 8g of $C_6H_{12}O_6$?**

Solution: Data: Molecular weight of glucose $(C_6H_{12}O_6) = (6 \times 12) + (12 \times 1) + (6 \times 16) = 180$

Weight of $C_6H_{12}O_6 = 8$ gm

$$\text{Number of moles} = \frac{8}{180} = 0.04 \text{ mole}$$

Number of molecules = Number of moles $\times N_A$

$= 0.04 \times 6.02 \times 10^{23} = 0.240 \times 10^{23}$

$= \boxed{2.40 \times 10^{22} \text{ molecules of glucose}}$

Example 1.9: **A coin of silver (Ag) having 8.5 gm weight. Calculate the number of moles of silver in the coin?**

Solution: The mass is converted to the number of moles by the following equation:

$$\text{Number of Moles} = \frac{\text{known mass of the substance}}{\text{Molar mass of the substance}}$$

$$= \frac{8.5}{107} = 0.07 \text{ moles of silver in 8.5 gm silver coin}$$

Example 1.10: **Calculate the number of moles, number of molecules, and number of atoms present in 10gm of H_2SO_4?**

Solution: The known mass of $H_2SO_4 = 10$gm Molar mass of $H_2SO_4 = 98.0$gm

$$\text{Number of Moles of } H_2SO_4 = \frac{\text{known mass of the substance}}{\text{Molar mass of the substance}} = \frac{10}{98} = 0.10 \text{ mole}$$

Number of molecules = Number of moles × Avogadro's number

$= 0.10 \times 6.02 \times 10^{23}$

$= 0.602 \times 10^{23} = 6.02 \times 10^{22}$

Example 1.11: **How many liters of carbon dioxide would be produced if 0.450 of a mole of carbon monoxide reacts with excess oxygen at STP.**

Solution: The equation for the reaction is

$2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)}$

$x_1 = 0.450$ moles x_2 liters = ?

2 moles of CO 2 moles of CO_2

So,

Step 1: $\frac{0.450}{2} = \frac{x_2}{2} \longrightarrow x_1 \frac{0.450 \times 2}{2} = \frac{0.450}{\text{moles}}$

1 mole of gas at STP means 0°C temperature and 1 atom pressure occupied 22.4 dm^3.

Step 2: $\frac{22.4}{1 \text{ mole}} = \frac{x^2}{0.450 \text{ moles}} \quad x_2 \frac{22.4 \text{ l} \times 0.450 \text{ moles}}{1 \text{ mole}} = 10.08 \text{ liter of } CO_2$

So 10.08 liter of CO_2 would be produced when 0.450 a mole of carbon monoxide reacts with excess oxygen at STP.

Solved Numericals

1. Calculate the number of moles in 30 gm of H_3PO_4.

Solution: **Data:** Mass of H_3PO_4 = 30 gm

Molecular mass of H_3PO_4 = 1(3) + 30.97 + 16(4) = 3 + 30.97 + 64

= 97.97 or 98

Calculation: Number of Moles = $\frac{30}{98}$ = 0.3061 moles Ans.

2. Calculate the number of moles, in 50 g of each:

(1) Na (2) H_2O

$$\text{Number of moles} = \frac{\text{Given mass of substance}}{\text{Atomic mass or Formula mass}}$$

(a) Given,

(i) Number of moles = ?

(ii) Given mass of Na = 50 g

(iii) Atomic mass of Na = 23 a.m.u.

$\Rightarrow$ No. of moles of Na = $\frac{50}{23}$ = 2.173 moles (of Na)

(b) Given,

(i) Number of moles of H_2O = ?

(ii) Formula mass of H_2O = 18 a.m.u.

(iii) Given mass of H_2O = 50 g

$\Rightarrow$ No. of moles of H_2O = $\frac{50}{18}$ = 2.777 moles (of H_2O)

3. What is the mass of 3 moles of each:

(1) Al (2) CO_2

$$\text{Number of moles} = \frac{\text{Given mass of substance}}{\text{Atomic mass or Formula mass}}$$

Mass of substance = Number of moles × Atomic mass or Formula mass

(a) Given,

(i) Number of moles of Al = 3 moles

(ii) Atomic mass of Al = 27 g

$\Rightarrow$ Mass of Al = 3 × 27 = 81 g

(b) Given,

(i) Number of moles of CO_2 = 3 moles

(ii) Formula mass of CO_2 = 44 g

$\Rightarrow$ Mass of CO_2 = 3 × 44 = 132 g

4. Calculate the number of atoms in 9g of Al.

According to Avogadro's number:

1 mole of Al = 27 g = 6.02×10^{23} atoms

This show that

27 g of Al contain = 6.02×10^{23} atoms of Al

1 g of Al will contain = $\frac{6.02 \times 10^{23}}{27g}$ atoms of Al

9 g of Al will contain $\frac{6.02 \times 10^{23} \times 9g}{27g} = 2.006 \times 10^{23}$ atoms of Al

This numerical can also be solved by using formula:

$$\text{Number of atoms} = \frac{N_A \times \text{Mass of substance}}{\text{Atomic Mass}}$$

$$\text{Number of Al atoms} = \frac{6.02 \times 10^{23} \times 9g}{27g} = 2.006 \times 10^{23} \text{ atoms of Al}$$

(5.) Calculate the number of molecules in 9g of CO_2.

According to Avogadro's number:

1 mole of CO_2 = 44 g = 6.02×10^{23} molecules

This show that

44 g of CO_2 contain = 6.02×10^{23} molecules of CO_2

1 g of CO_2 will contain = $\frac{6.02 \times 10^{23}}{44g}$ molecules of CO_2

9 g of CO_2 will contain $\frac{6.02 \times 10^{23} \times 9g}{44g} = 1.231 \times 10^{23}$ molecules of CO_2

This numerical can also be solved by using formula:

$$\text{Number of molecules} = \frac{N_A \times \text{Mass of substance}}{\text{Formula Mass}}$$

$$\text{Number of } CO_2 \text{ molecules} = \frac{6.02 \times 10^{23} \times 9g}{44g} = 1.231 \times 10^{23} \text{ molecules of } CO_2$$

(6.) Calculate the mass of one atom of carbon in grams.

According to Avogadro's number:

1 mole of C = 12 g = 6.02×10^{23} atoms

This show that

6.02×10^{23} atoms of C weigh 12 g

$$\text{1 atom of C} = \frac{12g}{6.02 \times 10^{23}} = \frac{12g \times 10^{23}}{6.02}$$

1 atom of C = 1.993×10^{23} g

This numerical can also be solved by using formula:

$$\text{Mass of one atom} = \frac{\text{Atomic mass in grams}}{N_A}$$

$$\text{Mass of one atom of C} = \frac{12g}{6.02 \times 10^{23}} = \frac{12g \times 10^{-23}}{6.02}$$

Mass of one atom of C = 1.993×10^{-23} g

(7.) Calculate the mass of one molecule of water (H_2O) in grams.

According to Avogadro's number:

1 mole of H_2O = 18 g = 6.02×10^{23} molecules

This show that

6.02×10^{23} molecules of H_2O weigh 18 g

$$\text{1 molecule of } H_2O = \frac{18g}{6.02 \times 10^{23}} = \frac{18g \times 10^{-23}}{6.02}$$

1 molecule of H_2O = 2.90×10^{-23} g

This numerical can also be solved by using formula:

$$\text{Mass of one molecule} = \frac{\text{Formula mass in grams}}{N_A}$$

Mass of one molecule of H_2O = $\frac{18g}{6.02 \times 10^{23}} = \frac{18g \times 10^{-23}}{6.02}$

Mass of one molecule of $H_2O = 2.90 \times 10^{-23}$ g

8. How many atoms are there in 5 moles of sulphur?

Data: Number of moles of S = n = 5
Avogadro's number = $N_A = 6.02 \times 10^{23}$
Number of atoms in 5 moles = ?

Solution: 1 mole of sulphur contains = 6.02×10^{23} atoms
5 mole of sulphur contains = $5 \times 6.02 \times 10^{23}$ atoms
= 3.01×10^{24} atoms

9. What number of oxygen atoms is present in 4g of oxygen?

Data: Mass of oxygen = 4g
Molecular mass of oxygen = $O_2 = 2 \times 16g = 32g$
Avogadro's number = $N_A = 6.02 \times 10^{23}$
Number of atoms in 4g of O = ?

Solution: Number of atoms = $\frac{N_A \times \text{Mass of substance}}{\text{Molecular mass}}$

Number of atoms = $\frac{6.02 \times 10^{23} \times 4}{32}$ atoms

= $\frac{24.08 \times 10^{23} \times 4}{32}$ atoms = 0.7525×10^{23} atoms

= 7.525×10^{22} atoms

10. What is mass in grams of a single atom of each of the following elements?
(a) Carbon (C) (b) Magnesium (Mg) (c) Calcium (Ca)

Data: (a) Element (C) = Carbon
Atomic mass = 12g
Avogadro's number = $N_A = 6.02 \times 10^{23}$
Mass of one atom = ?

Solution: (a) Mass of one atom = $\frac{\text{Atomic mass in grams}}{N_A}$

Mass of one atom of C = $\frac{12g}{6.02 \times 10^{23}} = \frac{12 \times 10^{-23}}{6.02}$

Mass of one atom of C = 1.993×10^{-23} g

Data: (b) Element = Magnesium (Mg)
Atomic mass = 24g
Avogadro's number = $N_A = 6.02 \times 10^{23}$
Mass of one atom = ?

Solution: (b) Mass of one atom = $\frac{\text{Atomic mass in grams}}{N_A}$

Mass of one atom of Mg = $\frac{24g}{6.02 \times 10^{23}} = \frac{24 \times 10^{-23}}{6.02}$

Mass of one atom of Mg = 3.98×10^{-23} g

Data: (c) Element = Calcium (Ca)
Atomic mass = 40g
Avogadro's number = $N_A = 6.02 \times 10^{23}$

Mass of one atom = ?

Solution: (c) Mass of one atom $= \frac{\text{Atomic mass in grams}}{N_A}$

Mass of one atom of Ca $= \frac{40g}{6.02 \times 10^{23}} = \frac{40 \times 10^{-23}}{6.02}$

Mass of one atom of Ca $= 6.64 \times 10^{-23}$ g

(11.) What is mass in grams of 1×10^{20} atoms of Na?

Data: Element = Sodium (Na)
Atomic mass = 23g
Number of atoms = 1×10^{20}
Avogadro's number = $N_A = 6.02 \times 10^{23}$
Mass of Sodium (Na) = ?

Solution: Mass of substance $= \frac{\text{Atomic mass in grams} \times \text{Number of atoms}}{N_A}$

Mass of one atom of Na $= \frac{23g \times 1 \times 10^{20}}{6.02 \times 10^{23}} = \frac{23g \times 10^{20-23}}{6.02}$

Mass of one atom of Na $= 3.82 \times 10^{-3}$ g OR 0.00382 g

(12. Calculate the molecular mass (in a.m.u.) of each of the following substances:
(a) H_2O (b) H_2O_2 (c) C_6H_6 (d) C_2H_6O

Data: (a) Substance = Water (H_2O)
Atomic mass of H = 1 a.m.u.
Atomic mass of O = 16 a.m.u.
Molecular mass of H_2O = ?

Solution: (a) Molecular Mass of H_2O = $(2 \times H) + (1 \times O)$
$= (2 \times 1) + (1 \times 16)$
$= 2 + 16$
$= 18$ a.m.u.

Data: (b) Substance = Hydrogen peroxide (H_2O_2)
Atomic mass of H = 1 a.m.u.
Atomic mass of O = 16 a.m.u.
Molecular mass of H_2O_2 = ?

Solution: (b) Molecular Mass of H_2O_2 = $(2 \times H) + (2 \times O)$
$= (2 \times 1) + (2 \times 16)$
$= 2 + 32$
$= 34$ a.m.u.

Data: (c) Substance = Benzene (C_6H_6)
Atomic mass of C = 12 a.m.u.
Atomic mass of H = 1 a.m.u.
Molecular mass of C_6H_6 = ?

Solution: (c) Molecular Mass of C_6H_6 = $(6 \times C) + (6 \times H)$
$= (6 \times 12) + (6 \times 1)$
$= 72 + 6$
$= 78$ a.m.u.

Data: (d) Substance = C_2H_6O
Atomic mass of C = 12 a.m.u.

	Atomic mass of H	= 1 a.m.u.
	Atomic mass of O	= 16 a.m.u.
	Molecular mass of C_2H_6O	= ?
Solution: (d)	Molecular Mass of C_2H_6O	= (2 × C) + (6 × H) + (1 × O)
		= (2 × 12) + (6 × 1) + (1 × 16)
		= 24 + 6 + 16
		= 46 a.m.u.

(13.) Calculate the formula mass (in a.m.u.) of each of the following:

(a) KNO_3 (b) Al_2O_3 (c) $CaCO_3$ (d) $MgCl_2$

Data: (a)	Substance (KNO_3)	= Potassium nitrate
	Atomic mass of K	= 39 a.m.u.
	Atomic mass of N	= 14 a.m.u.
	Atomic mass of O	= 16 a.m.u.
	Formula mass of KNO_3	= ?
Solution: (a)	Formula Mass of KNO_3	= (1 × K) + (1 × N) + (3 × O)
		= (1 × 39) + (1 × 14) + (3 × 16)
		= 39 + 14 + 48
		= 101 a.m.u.
Data: (b)	Substance (Al_2O_3)	= Aluminium oxide
	Atomic mass of Al	= 27 a.m.u.
	Atomic mass of O	= 16 a.m.u.
	Formula mass of Al_2O_3	= ?
Solution: (b)	Formula Mass of Al_2O_3	= (2 × Al) + (3 × O)
		= (2 × 27) + (3 × 16)
		= 54 + 48
		= 102 a.m.u.
Data: (c)	Substance ($CaCO_3$)	= Calcium carbonate
	Atomic mass of Ca	= 40 a.m.u.
	Atomic mass of C	= 12 a.m.u.
	Atomic mass of O	= 16 a.m.u.
	Formula mass of $CaCO_3$	= ?
Solution: (c)	Formula Mass of $CaCO_3$	= (1 × Ca) + (1 × C) + (3 × O)
		= (1 × 40) + (1 × 12) + (3 × 16)
		= 40 + 12 + 48
		= 100 a.m.u.
Data: (d)	Substance ($MgCl_2$)	= Magnesium chloride
	Atomic mass of Mg	= 24 a.m.u.
	Atomic mass of Cl	= 35.5 a.m.u.
	Formula mass of $MgCl_2$	= ?
Solution: (d)	Formula Mass of $MgCl_2$	= (1 × Mg) + (2 × Cl)
		= (1 × 24) + (2 × 35.5)
		= 24 + 71
		= 95 a.m.u.

(14.) Calculate the molar mass of the following substances:

(a) S_8 (b) CS_2

(c) $CHCl_3$(Chloroform) (d) CH_3COOH (Acetic Acid)

Data: (a)	Molecule (S_8)	= Sulphur
	Number of atoms	= n = 8
	Atomic mass of S	= 32g
	Molar mass of S_8	= ?
Solution: (a)	Molar mass of S_8	= n × Atomic mass
		= 8 × 32
		= 256 g
Data: (b)	Substance (CS_2)	= Carbon disulphide
	Atomic mass of C	= 12g
	Atomic mass of S	= 32g
	Molar mass of CS_2	= ?
Solution: (b)	Molar mass of CS_2	= (1 × C) + (2 × S)
		= (1 × 12) + (2 × 32)
		= 12 + 64
		= 76 g
Data: (c)	Substance ($CHCl_3$)	= Chloroform
	Atomic mass of C	= 12g
	Atomic mass of H	= 1g
	Atomic mass of Cl	= 35.5g
	Molar mass of $CHCl_3$	= ?
Solution: (c)	Molar mass of $CHCl_3$	= (1 × C) + (1 × H) + (3 × Cl)
		= (1 × 12) + (1 × 1) + (3 × 35.5)
		= 12 + 1 + 106.5
		= 119.5 g
Data: (d)	Substance ($CH_3 - COOH$)	= Acetic Acid
	Atomic mass of C	= 12g
	Atomic mass of H	= 1g
	Atomic mass of O	= 16g
	Molar mass of $CH_3 - COOH$	= ?
Solution: (d)	Molar mass of $CH_3 - COOH$	= Molar mass of $C_2H_4O_2$
		= (2 × C) + (4 × H) + (2 × O)
		= (2 × 12) + (4 × 1) + (2 × 16)
		= 24 + 4 + 32
		= 60 g

Summary

- Chemistry is the branch of science which deals with the properties, composition, and structure of matter. Chemistry also deals with the changes involved in the matter.
- Chemistry is everywhere in our environment and serving humanity day and night. Due to its wide scope Chemistry is divided into physical chemistry, organic chemistry, inorganic chemistry, biochemistry, industrial chemistry, nuclear chemistry, environmental chemistry, analytical chemistry, medicinal chemistry, quantum chemistry, green chemistry.
- Matter is simply defined as anything that has mass and occupies space. It is found in three common states solid, liquid and gas. The plasma is also considered the fourth state of matter. The different states of matter are due to differences in energy in increasing order.
- Matter is made up of the smallest particles which are known as Atom. Atoms are the basic units of matter and define the structure of elements. Now it is discovered that atoms are made up of three particles: protons, neutrons, and electrons.

- A molecule is the smallest particle in a chemical element or compound that has the chemical properties of that element or compound. Molecules are made up of atoms that are held together by chemical bonds. These bonds form as a result of the sharing or exchange of electrons among atoms. Molecules are mono, di, and polyatomic molecules.
- A piece of matter in pure form is termed a substance. Every substance has a fixed composition and specific properties. Every substance has physical and chemical properties.
- An element is a substance made up of the same type of atoms having the same atomic number and cannot be decomposed into simple substances by ordinary chemical reaction.
- Elements occur in nature in free or combined form in solid, liquid, and gaseous states. Now 118 elements have been discovered.
- A symbol is an abbreviation to represent the name of an element. A symbol is taken from the name of that element in English, Latin, and Greek. If it is one letter, it will be capital as H for Hydrogen, C for carbon, S for Sulphur, and N for Nitrogen, etc. In the case of two letters symbol, the only first letter is capital as Na for sodium, Cr for Chromium, He for Helium, and Zn for Zinc.
- When two or more than two elements or compounds physically combined without any fixed ratio is known as a mixture. The component substances retain their chemical properties. Mixtures can be separated again by physical methods, as filtration, evaporation, distillation, and crystallization.
- The Atomic Number is the number of protons present in the nucleus of an atom of any element. It is represented by symbol Z. All atoms of an element have the same atomic number due to the presence of the same number of protons.
- The Atomic Mass is the sum of the number of protons and neutrons present in the nucleus of an atom of any element. It is represented by symbol A and calculated by $A = Z + n$ where n is the number of neutrons.
- The atomic mass of an element expressed in gram is called gram atomic mass. It is also called 1 mole.
- The molecular mass of an element or a compound expressed in gram is called gram molecular mass. It is also called 1 mole.
- The formula mass of an ionic compound expressed in grams is called gram formula mass. It is also called 1 mole.
- The atomic mass, molecular mass, and formula mass of a substance expressed in grams is known as mole.
- Avogadro an Italian scientist, calculated the number of atoms, molecules, or ions present in one mole. The value is found to be 6.02×10^{23}. This value is represented by N_A and is called Avogadro's number.

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - 1 to 10

SECTION-B: SHORT QUESTIONS:

1. Differentiate between physical and analytical chemistry?

Ans: See "Differences" - Q.2

2. Write down the classification of molecules.

Ans: See "Short & Detailed Answer Questions" - Q.12

3. Identify the differences among the following:

(a) Atom and Ion (b) Molecule and Molecular ion (c) Compound and Mixture

Ans: ***(a)*** See "Differences" - Q.6 (i) ***(b)*** See "Differences" - Q.6 (ii)
(c) See "Differences" - Q.6 (iii)

4. Define the following terms:

(a) Gram atomic mass (b) Gram molecular mass (c) Gram formula mass

Ans: See "Short & Detailed Answer Questions" - Q.32

5. ***Write down the chemical, empirical and molecular formula of the following: Sulphuric acid, Carbon dioxide, Glucose, Benzene***

Ans: See "Short & Detailed Answer Questions" - Q.25

6. ***What is Free Radical?***

Ans: See "Short & Detailed Answer Questions" - Q.28

7. ***Describe the relationship between empirical and molecular formula? Explain with examples.***

Ans: See "Short & Detailed Answer Questions" - Q.25

8. ***Explain why hydrogen and oxygen are considered as elements whereas water is a compound?***

Ans: See "Reasons" - Q.2

SECTION-C: DETAILED QUESTIONS:

1. ***What do you mean by chemical species? Explain ion, molecular ion, and free radical.***

Ans: See "Short & Detailed Answer Questions" - Q.28

2. ***Write down the applications of chemistry in daily life.***

Ans: See "Short & Detailed Answer Questions" - Q.5

3. ***Explain in detail the empirical and molecular formula.***

Ans: See "Short & Detailed Answer Questions" - Q.25

4. ***Explain the steps for balancing the equation.***

Ans: See "Short & Detailed Answer Questions" - Q.31

5. ***Name the branches of chemistry and discuss any five branches.***

Ans: See "Short & Detailed Answer Questions" - Q.6

SECTION-D: Numericals

(1) ***Balance the following equations by inspection method:***

(a) $NH_3 + O_2 \longrightarrow NO + H_2O$ (b) $KNO_3 \longrightarrow KNO_2 + O_2$

(c) $Ca + H_2O \longrightarrow Ca(OH)_2 + H_2$ (d) $NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

(e) $CO + O_2 \longrightarrow CO_2$

Ans: See "Short & Detailed Answer Questions" - Q.36

(2) ***Calculate the formula mass (a.m.u) of the following?***

Solution: ***Al_2O_3, $MgCl_2$, NaCl, KNO_3***

Al_2O_3 See 'Solved Numericals' - Q.13(b)

$MgCl_2$ See 'Solved Numericals' - Q.13(d)

NaCl

Data: Substance (NaCl) = Sodium Chloride
Atomic mass of Na = 23 a.m.u.
Atomic mass of Cl = 35.5 a.m.u.
Formula mass of NaCl = ?

Calculation: Formula mass of NaCl = (1 × Na) + (1 × Cl)
= (1 × 23) + (1 × 35.5)
= 23 + 35.5 = **58.5 a.m.u.**

KNO_3 See 'Additional Solved Numericals' - Q.13(a)

(3) ***Calculate the molecular mass (a.m.u) of the following?***
C_2H_5OH, H_2O, NH_3, CO_2

Solution: C_2H_5OH

Data: Atomic mass of C = 12 a.m.u.
Atomic mass of H = 1 a.m.u.
Atomic mass of O = 16 a.m.u.
Molecular mass of C_2H_5OH = ?

Calculation: Molecular mass of C_2H_5OH = (2 × C) + (5 × H) + (1 × O) + (1 × H)
= (2 × 12) + (5 × 1) + (1 × 16) + (1 × 1)
= 24 + 5 + 16 + 1 = **46 a.m.u.**

H_2O See 'Additional Solved Numericals' - Q.12(a)

Solution: NH_3

Data: Atomic mass of N = 14 a.m.u.
Atomic mass of H = 1 a.m.u.
Molecular mass of NH_3 = ?

Calculation: Molecular mass of NH_3 $= (1 \times N) + (3 \times H)$
$= (1 \times 14) + (3 \times 1)$
$= 14 + 3 =$ **17 a.m.u.**

Solution: CO_2

Data:
Atomic mass of C = 12 a.m.u.
Atomic mass of O = 16 a.m.u.
Molecular mass of CO_2 = ?

Calculation: Molecular mass of CO_2 $= (1 \times C) + (2 \times O)$
$= (1 \times 12) + (2 \times 16)$
$= 12 + 32 =$ **44 a.m.u.**

(4) How many moles are required to prepare 40 gm of H_2SO_4?

Solution: ***Data:***
Given mass of H_2SO_4 = 40 g
Atomic mass of H = 1 a.m.u.
Atomic mass of S = 32 a.m.u.
Atomic mass of O = 16 a.m.u.
Molecular mass of H_2SO_4 $= (2 \times H) + (1 \times S) + (4 \times O)$
$= (2 \times 1) + (1 \times 32) + (4 \times 16)$
$= 2 + 32 + 64 = 98$ a.m.u.
Number of moles = ?

Calculation: Number of moles $= \dfrac{\text{known mass of a substance}}{\text{molar mass of the substance}}$

Number of moles of H_2SO_4 $= \dfrac{40}{98} =$ **0.4081 moles**

(5) Calculate the number of moles and number of molecules present in the following:
(a) 16g of H_2CO_3 (b) 20g of $C_6H_{12}O_6$

Solution: (a)

Data: Molecular mass of H_2CO_3 $= (2 \times H) + (1 \times C) + (3 \times O)$
$= (2 \times 1) + (1 \times 12) + (3 \times 16)$
$= 2 + 12 + 48 = 62$ a.m.u.
Weight of H_2CO_3 = 16 g

Calculation: Number of moles $= \dfrac{\text{known mass of a substance}}{\text{molar mass of the substance}}$

Number of moles of H_2SO_4 $= \dfrac{16}{62} =$ **0.2580 moles**

Number of molecules = number of moles $\times N_A$
$= 0.2580 \times 6.02 \times 10^{23}$
$=$ **1.55316×10^{23} molecules of H_2SO_4**

(b) ***Data:*** Molecular weight of $C_6H_{12}O_6$ $= (6 \times C) + (12 \times H) + (6 \times O)$
$= (6 \times 2) + (12 \times 1) + (6 \times 16)$
$= 72 + 12 + 96 = 180$ a.m.u.
Weight of $C_6H_{12}O_6$ = 20 g

Calculation: Number of moles $= \dfrac{\text{known mass of a substance}}{\text{molar mass of the substance}}$

Number of moles of $C_6H_{12}O_6$ $= \dfrac{20}{180} =$ **0.1111 moles**

Number of molecules = number of moles $\times N_A$
$= 0.1111 \times 6.02 \times 10^{23}$
$=$ **0.6688×10^{23} molecules of $C_6H_{12}O_6$**