CHAPTER 1

FUNDAMENTALS OF CHEMISTRY

INTRODUCTION

Q.1 What is science? *(K.B)*

Ans:

SCIENCE

Science (Latin Scientia meaning knowledge).

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

OR

"The systematic study of nature based on observation, inference, prediction and experimentation is called science".

Q.2 Define chemistry also explain its advantages and disadvantages. **(GRW 2017 G-I)(K.B)**

Ans:

CHEMISTRY

Definition:

*"The branch of science that deals with the **composition, structure, properties** and **reactions of matter** is called chemistry".*

It deals with every aspect of life.

ADVANTAGES OF CHEMISTRY

Following are advantages of chemistry:

- Petrochemical products
- Medicines and drugs
- Soap and detergents
- Paper and plastics
- Paints and pigments
- Insecticides and pesticides
- It improves our health and environment
- It helps to explore and conserve the natural resources.

DISADVANTAGES OF CHEMISTRY

Following are some major disadvantages of chemistry:

- Generation of toxic waste materials
- Contaminated water
- Polluted air and contaminated food
- Dangerous war weapons

1.1 BRANCHES OF CHEMISTRY

Q.1 Describe the various branches of chemistry. *(U.B+K.B+A.B)*

(DGK 2017, FSD 2016,17, SWL, MTN 2016, LHR 2017 G-I)

Ans:

BRANCHES OF CHEMISTRY

Chemistry is divided into following main branches:

(i) Physical Chemistry:

*"The branch of chemistry that deals with the **relationship between the composition and physical properties of matter along with the changes in them** is called physical chemistry."*

Scope:

Structure of atoms or formation of molecules, behavior of gases, liquids and solids and the study of the effects of temperature or radiations on matter.

(ii) Organic Chemistry:

*"The branch of chemistry that deals with the study of **covalent compounds of carbon and hydrogen (hydrocarbons) and their derivatives** is called organic chemistry."*

Scope:

Organic chemists determine the structure and properties of these naturally occurring as well as synthesized compounds. Scope of this branch covers petroleum, petrochemicals and pharmaceutical industries.

(iii) Inorganic Chemistry:

"The branch of chemistry that deals with the study of ***all elements and their compounds except*** *those of compounds of carbon and hydrogen* ***(hydrocarbons) and their derivatives*** *is called inorganic chemistry."*

Applications/ Scope:

It has applications in every aspect of the chemical industry such as glass, cement, eramics and metallurgy (extraction of metals from ores)

(iv) Biochemistry:

"The branch of chemistry that deals with the study of ***structure, composition,*** *and* ***chemical reactions of substances found in living organisms*** *is called biochemistry."*

Scope:

It covers all chemical processes taking place in living organisms such as synthesis and metabolism of biomolecules like carbohydrates, proteins, fats etc.

Emergence of Biochemistry as a Separate Discipline:

Biochemistry emerged as a separate discipline when scientists began to study:

- How living things obtain energy from food?
- How the fundamental biological changes occur during a disease?

Applications:

Applications of biochemistry are in the fields of medicine, food science and agriculture.

(v) Industrial Chemistry:

"The branch of chemistry that deals with the ***manufacturing of chemical compounds on commercial scale,*** *is called industrial chemistry."*

Applications/scope:

- It deals with the manufacturing of basic chemicals such as oxygen, chlorine, ammonia, caustic soda, nitric acid and sulphuric acid.
- Use of these chemicals to provide the raw materials for many other industries such as fertilizers, soap, textiles, agricultural products, paints and paper etc.

(vi) Nuclear Chemistry:

"The branch of chemistry that deals with the ***radioactivity, nuclear processes and properties*** *is called nuclear chemistry."*

Main concern:

The main concern of this branch is with the atomic energy and its uses in daily life. The chemical effects resulting from the absorption of radiation within living animals, plants, and other materials are also studied in this branch.

Applications/Scope:

It has vast applications in medical treatment (radiotherapy), preservation of food and generation of electrical power through nuclear reactors.

(vii) Environmental Chemistry:

"The branch of chemistry that deals with the study about ***components of the environment and the effects of human activities on the environment*** *is called environmental chemistry."*

Applications/Scope:

- Environmental chemistry is related to other branches like biology, geology, ecology, soil and water.
- The knowledge of chemical processes taking place in environment is necessary for its improvement and protection against pollution.

(viii) Analytical Chemistry:

"The branch of chemistry that deals with ***separation and analysis of a sample to identify its components*** *is called analytical chemistry. The separation is carried out prior to qualitative and quantitative analysis."*

Qualitative Analysis:

"*It provides the **identity of a substance (composition of chemical species)**".*

Quantitative Analysis:

"*It determines the **amount of each component** present in the sample".*

Application/Scope:

- In this branch different techniques and instruments used for analysis are studied.
- The scope of this branch covers food, water, environmental and clinical analyses.

1.1 BRANCHES OF CHEMISTRY

SHORT QUESTIONS

Q.1 Define analytical chemistry and discuss qualitative and quantitative analysis. ***(K.B)***

Ans: *Answer given on pg # 03*

Q.2 What is the scope of industrial chemistry? ***(A.B)***

Ans: *Answer given on pg # 03*

Q.3 Write the application of inorganic chemistry. ***(A.B)***

Ans: *Answer given on pg # 03*

Q.4 Define industrial chemistry. ***(K.B)***

(SGD 2017, D.G.K 2016, BWP 2016, SWL 2017, RWP 2017 G-I)

Ans: *Answer given on pg # 03*

Q.5* Define nuclear chemistry.** **(LHR 2016 G-I, MTN 2017)*(K.B)

Ans: *Answer given on pg # 03*

Q.6 Define biochemistry. **(DGK 2016, GRW 2016 G-I, LHR 2016 G-I)*(K.B)***

Ans: *Answer given on pg # 03*

Q.7 Define environmental chemistry. ***(K.B)***

Ans: *Answer given on pg # 03*

Q.8 Define physical chemistry. ***(K.B)***

Ans: *Answer given on pg # 02*

1.1 BRANCHES OF CHEMISTRY

MULTIPLE CHOICE QUESTIONS

1. The branch of science which deals with the composition, structure, properties and reactions of matter: ***(K.B)***

(A) Physics (B) Analytical chemistry

(C) Physical chemistry (D) Chemistry

2. The branch of chemistry which deals with the study of all elements and their compounds except compound of carbon and hydrogen and their derivatives: ***(K.B)***

(A) Organic chemistry (B) Physical chemistry

(C) Inorganic chemistry (D) Biochemistry

3. Which one of the following provides the identity of a substances? ***(U.B)***

(A) Qualitative analysis (B) Clinical analysis

(C) Quantitative analysis (D) Chemical analysis

4. Which one of the following is applicable in chemical industry like metallurgy, ceramics and glass? *(A.B)*

(A) Organic chemistry (B) Inorganic chemistry
(C) Industrial chemistry (D) Nuclear chemistry

5. Industrial chemistry deals with the manufacturing of compound: *(K.B)*

(A) In laboratory (B) On micro scale
(C) On commercial scale (D) On economic scale

6. Metabolism of biomolecules is studied in: *(U.B+K.B+A.B)*

(A) Environmental chemistry (B) Biochemistry
(C) Physical chemistry (D) Analytical chemistry

1.1 TEST YOURSELF

i. In which branch of chemistry behavior of gases and liquids is studied? *(A.B)*

Ans: Physical chemistry deals with the physical behavior and properties of gases and liquids.

ii. Which branch of chemistry deals with preparation of paints and papers? **(DGK 2016)** *(A.B)*

Ans: The preparation of paints and papers is studied in industrial chemistry.

iii. In which branch of chemistry are the metabolic processes of carbohydrates and proteins studied? *(A.B)*

Ans: The metabolic processes of carbohydrate and proteins are studied in biochemistry.

iv. Which branch of chemistry deals with energy of atoms and its uses in daily life? *(A.B)*

Ans: Nuclear chemistry is the branch of chemistry which deals with the atomic energy and its use in daily life.

v. Which branch of chemistry deals with the structure and properties of naturally occurring molecules? *(U.B+A.B)*

Ans: Organic chemistry is the branch of chemistry which deals with the structure and properties of naturally occurring molecules.

1.2 BASIC DEFINITIONS

Q.1 Define the following terms. *(K.B)*

(A) Matter (B) Substance (C) Mixture

Ans:

MATTER

Definition:

*"Anything that has **mass** and **occupies space** is called matter".*

Examples:

Our bodies as well as all things (air, water, chair etc.) around us are examples of matter.

Physical States of Matter:

Matters can exist in any of three physical states:

(i) Solids **(ii)** Liquids **(iii)** Gas

SUBSTANCE

Definition:

*"A piece of **matter in pure form** is called substance".*

Every substance has a fixed composition and specific properties or characteristics.

Types of Substance:

Types of substances are as follows:

Elements:

Iron, gold, silver etc.

Compounds:

Water, carbon dioxide, sulphuric acid etc.

MIXTURE

Definition:

*"A piece of **matter in impure form** is called mixture".*

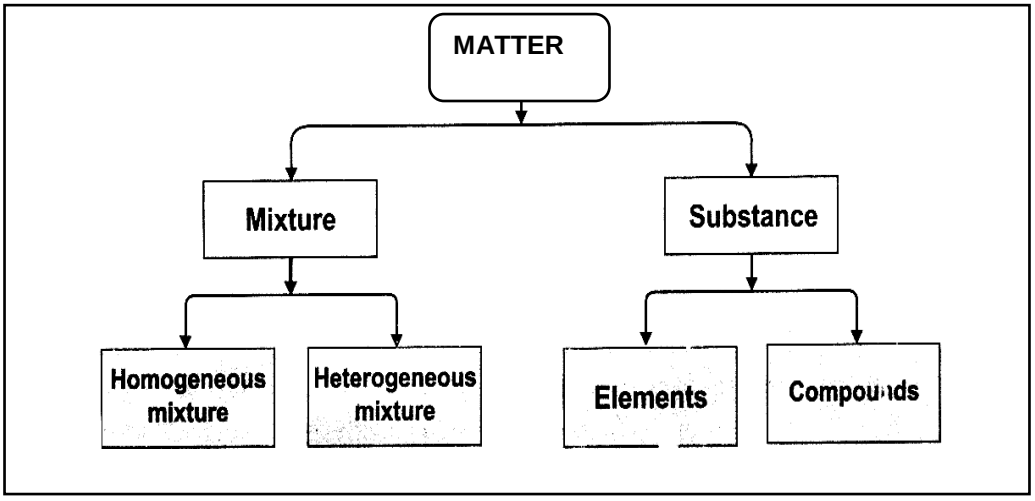
Examples:

(i) Soil **(ii)** Ice **(iii)** Cream **(iv)** Milk

Types of Mixture:

There are two types of mixture:

- Homogeneous mixture
- Heterogeneous mixture



Q.2 Write a note on physical and chemical properties. ***(U.B+K.B)***

Ans:

PHYSICAL PROPERTIES

Definition:

*"The properties that are associated with the **physical state of a matter** are called physical properties".*

Explanation:

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**.

Examples:

Colour, smell, taste, hardness, shape of crystal, solubility, melting or boiling point.

CHEMICAL PROPERTIES

Definition:

*"The properties that depend upon the **composition of the substance** are called chemical properties".*

Explanation:

When a substance undergoes a chemical change, its **composition changes** and a new substance is formed.

Examples:

- Rusting of iron
- Decomposition of water is a chemical change as it produces hydrogen and oxygen gases.

1.2 BASIC DEFINITIONS

SHORT QUESTIONS

Q.1 Define matter and give examples. ***(K.B+A.B)***

Ans: *Answer given on pg # 05*

Q.2 Define substance. ***(K.B)***

Ans: *Answer given on pg # 05*

Q.3 Define mixture and give examples. ***(K.B+A.B)***

Ans: *Answer given on pg # 06*

Q.4 Write a short note on physical property. Give examples. ***(K.B+A.B)***

Ans: *Answer given on pg # 06*

Q.5 Write a short note on chemical properties. ***(K.B)***

Ans: *Answer given on pg # 06*

1.2.1 ELEMENTS, COMPOUNDS AND MIXTURES

Q.1 Define an element and classify the elements with examples. **(Ex-Q.1)*(K.B)***

Ans:

ELEMENT

Number of Elements in Early Ages:

In the early ages, only **nine elements (carbon, gold, silver, tin, mercury, lead, copper, iron and sulphur)** were known.

Old Definition of Element:

*"The substance that could not be **broken down into simpler units by ordinary chemical processes.**"*

Number of Elements Till the End of 19th Century:

Until the end of 19th century **63 elements** had been discovered.

Present Number of Elements:

Now **118 elements** have been discovered, out of which **92 are naturally occurring** elements.

Modern Definition of Element:

*"The substance made up of **same type of atoms, having same atomic number** and it **cannot be decomposed** into simple substances by ordinary chemical means."*

Note: Each element is made up of unique atoms that have very specific properties.

Occurrence of Elements:

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.

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%

Physical States of Elements.

Elements may be:

(i) Solid (ii) Liquid (iii) Gas

Solids:

Majority of elements exist as solids **(sodium, copper, zinc and gold)**.

Liquids:

There are very few elements which occur in liquid state **(mercury and bromine)**.

Gases:

A few elements exist as gases **(nitrogen, oxygen, chlorine and hydrogen)**.

Classification of Elements:

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

Q.2 Define the symbol. How symbols can be assigned? ***(U.B+K.B)***

Ans:

SYMBOL

Definition:

*"An **abbreviation for the name of element** is called symbol."*

Examples:

Symbols for hydrogen, nitrogen and sodium are H, N and Na, respectively.

Derivation of Symbol:

A symbol is taken from the name of that element in English, Latin, Greek or German.

Methods to Write Down Symbols:

In case of **one-letter** symbol first capital letter is taken as symbol e.g. **H** for Hydrogen, **N** for Nitrogen, and **C** for Carbon only.

In case of **two letters** symbol, only first letter is capital e.g. **Ca** for Calcium, **Na** for Sodium and **C*l*** for Chlorine.

Significance of Symbol:

- It represents the name of the element.
- It indicates one atom of the element.

Q.3 Define valency. Write a detailed note on concept of valence. **(DGK 2016, MTN 2017)*(U.B+K.B)***

OR

Explain the valency of elements is simple covalent and ionic compounds.(SGD 2017 G-II)

Ans:

VALENCY

The unique property of an element is valency.

Definition:

*"The **combining capacity of an element** with other elements is called valency."*

Dependence:

It depends upon the **number of electrons in the outermost shell**.

(i) Valency of Elements in Covalent Compounds:

In simple covalent compounds it can be defined as:

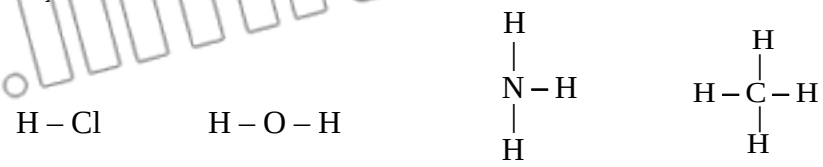
*"It is the **number of hydrogen atoms** which will combine with one atom of that element"*

OR

*"The **number of bonds formed by one atom** of that element is called valency."*

Examples:

Different Numbers of atoms of hydrogen combine with one atom of these elements to form compounds like.



The valency of **Cl, O, N** and **C** is **1, 2, 3** and **4** respectively.

(ii) Valency of Elements in Ionic Compounds:

In simple ionic compounds valency is defined as: "*The **number of electrons gained or lost by an atom** of an element to complete its octet."*

Elements Having Less Than Four Electrons in Valence Shell:

Elements having **less than four electrons in the valence shell** prefer to **lose the electrons** to complete their octet.

Examples:

Na, Mg and **Al** have valance electrons 1, 2 and 3, respectively and they lose 1, 2 and 3 electrons to have valency of **1, 2** and **3**, respectively.

Elements Having More Than Four Electrons in Valence Shell:

Elements having **four or more than four electrons in their valence shell, gain electrons** to complete their octet.

Examples:

Nitrogen, oxygen and **chorine** have 5, 6 and 7 electrons in their valence shells respectively. They gain 3, 2 and 1 electrons respectively to complete their octet. Hence they show valency of **3, 2** and **1**, respectively.

Radical:

"*A radical is a **group of atoms that has some charge.***"

Example:

- Hydroxide: OH^-
- Sulphate: SO_4^{2-}

VARIABLE VALENCY

*"Some **elements show more than one types of valency.** The valency of such elements is called variable valency"*

Examples:

- In **$FeSO_4$** the valency of iron is **2**.
- In **$Fe_2(SO_4)_3$** the valency of iron is **3**.

Note:

Generally, the Latin or Greek name for the element (e.g. Ferrum) is modified to end in 'ous' for the low 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	Bisulphite	HSO_3^{1-}	1

Table: Some Elements and Radicals with their Symbols and Common Valencies

Q.4 Describe the compound. Write its properties. ***(U.B+K.B)***

Ans:

COMPOUND

Definition:

*"Substance made up of **two or more elements chemically combined together** in a **fixed ratio by mass** is called compound."*

Examples:

- **Carbon dioxide** is a compound formed by a chemical combination between carbon **(C)** and oxygen **(O)** in a fixed ratio of **12:32** or **3:8** by mass.
- **Water** is a compound formed by a chemical combination between **hydrogen** and **oxygen** in a fixed ratio of **1:8** by mass.

PROPERTIES

The properties of compounds are as follows:

(i) In compounds, elements lose their own properties and produce new substances (compounds) that have entirely different properties.

(ii) Compounds can't be broken down into its constituent elements by simple physical methods.

(iii) Elements chemically combine together in a **fixed ratio** by mass and form compound.

(iv) All compounds are represented by a simple chemical formula.

Classification of Compounds:

Compounds can be classified as:

(i) Ionic compounds **(ii)** Covalent compounds

(i) Ionic Compounds:

*"Compounds that contain **oppositely charged ions held together by ionic bonds** are called ionic compounds."*

Properties:

The properties of ionic compounds are as follows:

(i) Ionic compound do not exist in independent molecular form.

(i) They form a **three-dimensional crystal lattice,** in which each ion is surrounded by oppositely charged ions.

(ii) They have **high melting and boiling points** due to strong attraction between oppositely charged ions.

(iii) These compounds are **represented by formula units.**

Examples:

- Sodium chloride (NaCl)
- Potassium bromide (KBr)
- Copper sulphate ($CuSO_4$)
- Ferrous sulphate ($FeSO_4$)

(iii) Covalent Compounds:

*"Compounds formed by the **sharing of electrons between different atoms** are called covalent compounds."*

Properties:

The properties of covalent compounds are as follows:

(i) The covalent compounds mostly exist in **molecular form**.

(ii) A **molecule** is a **true representative** of the **covalent compounds**.

(iii) They are **represented by molecular formulae**.

Examples:

Water (H_2O), Hydrochloric acid (HCl) , Sulphuric (H_2SO_4), Methane (CH_4)

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

Table: Some Common Compounds with their Formulae

Q.5 What is a mixture? Explain its types. **(SGD 2016,17, BWP, SWL 2017, MTN 2016)*(U.B+K.B)***

Ans:

MIXTURE

Definition:

*"A **mixture** is made up of **two or more elements or compounds (substances) mixed up physically without any fixed ratio**."*

Properties:

- 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, crystallization** or **magnetization.**

Types of Mixture:

Mixture can be classified as:

(i) Homogeneous mixture (ii) Heterogeneous mixture

(i) Homogeneous Mixture:

*"Mixture that has **uniform composition throughout** is called homogenous mixture".*

Examples:

Air, Gasoline, Ice cream

(ii) Heterogeneous Mixture:

*"Mixture that **does not have uniform composition throughout** is called heterogeneous mixture".*

Examples:

Soil, Rock, Wood

Q.6 What is the difference between compound and mixture? **(MTN 2016, SWL 2017)*(U.B)***

OR

List five characteristics by which compounds can be distinguished from mixtures.

(GRW 2017 G-I, LHR 2016 G-II, RWP 2017 G-II, FSD 2017 G-II, BWP 2017 G-I)(Ex-Q.2)*(U.B)*

Ans:

DIFFERENTIATION

The differences between compound and mixture are as follows:

Compound	Mixture
Formation	
• It is formed by a chemical combination of atoms of elements.	• Mixture is formed by the simple mixing up of the substances.
Properties	
• The constituents lose their identity and form a new substance having entirely different properties from them.	• Mixture shows the properties of the constituents.
Ratio	
• Compounds always have fixed composition by mass.	• Mixtures do not have fixed compositions.

Separation of Components	
• The components cannot be separated by physical means.	• The components can be separated by simple physical methods.
Representation	
• Every compound is represented by a chemical formula.	• It consists of two or more components and does not have any chemical formula.
Composition	
• Compounds have homogeneous composition.	• They may be homogeneous or heterogeneous in composition
Melting Point	
• A compound has a sharp and fixed melting point.	• A mixture does not have a sharp and fixed melting point.

1.2.1 ELEMENTS, COMPOUNDS AND MIXTURES

SHORT QUESTIONS

Q.1 Define an element. **(LHR 2016 G-I, BWP 2016 G-I)*(K.B)***

Ans: *Answer given on pg # 07*

Q.2 Name two elements (a metal and a non -metal) which exist in liquid state. ***(K.B)***

Ans: Mercury (a metal), Bromine (a non- metal)

Q.3 Major part of body mass is made up of which element? **(Do you know Text Book Page. # 6)*(K.B)***

Ans: Major part of the body mass is made up of water i.e. 65% to 80% by mass.

Q.4 Mention the elements which constitute about 99% of our body mass.
(Do you know Text Book Page. # 6)*(K.B)*

Ans: Six elements constitute about 99% of our body mass, namely:

(i) Oxygen 65% (ii) Carbon 18%
(iii) Hydrogen 10% (iv) Nitrogen 3%
(v) Calcium1.5% (v) Phosphorous 1.5%.

Q.5 Define the symbol. ***(K.B)***

Ans: *Answer given on pg # 08*

Q.6 Define variable valency give example. ***(K.B)***

Ans: *Answer given on pg # 09*

Q.7 What is the modern definition of element? **(BWP 2017)*(K.B)***

Ans: *Answer given on pg # 07*

Q.8 Write down the names of elements which are present in: ***(K.B)***

A. Air (B) Milk (C) Soil (D) Brass
(Do you know Text Book Page. # 9)

Ans: **Air:**

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

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

Milk:
Milk is a mixture of water, sugar, fat, proteins, mineral salts and vitamins.

Brass: Brass is a mixture of copper and zinc metals.

Q.9 Define valency in ionic compounds with an example. **(LHR 2016 G-II)** ***(K.B+U.B)***

Ans: *Answer given on pg # 09*

Q.10 Define radical. ***(K.B)***

Ans: *Answer given on pg # 09*

1.0.1 ELEMENTS, COMPOUNDS AND MIXTURES

MULTIPLE CHOICE QUESTIONS

1. Anything that has mass and occupies space is called: ***(K.B)***
(A) Substance (B) Matter (C) Element (D) Atomic mass

2. Piece of matter in pure form is called: ***(K.B)***
(A) Mixture (B) Matter (C) Substance (D) Compound

3. Which one of the following can be separated by physical mean? ***(U.B)***
(A) Mixture (B) Element (C) Compound (D) Radical

4. Impure matter is called: ***(K.B)***
(A) Atom (B) Compound (C) Substance (D) Mixture

5. Which one of the following is chemical property? ***(K.B)***
(A) Color (B) Smell (C) Taste (D) Composition

6. The number of elements known in early ages is: ***(K.B)***
(A) 118 (B) 109 (C) 63 (D) 9

7. Until the end of 19^{th} century how many elements were discovered? ***(K.B)***
(A) 9 (B) 63 (C) 92 (D) 118

8. Which one of the following element is liquid at room temperature? ***(K.B)***
(A) Bromine (B) Mercury (C) Nitrogen (D) Both A and B

9. The quantity of potassium, magnesium, sulphur and sodium in human body is: ***(K.B)***
(A) 0.2% (B) 0.6% (C) 0.8% (D) 0.4%

10. A substance whose atoms have the same atomic number is called: ***(K.B)***
(A) Element (B) Substance (C) Mixture (D) Compound

11. How many elements occur naturally? **(LHR 2016 G-II)** ***(K.B)***
(A) 92 (B) 96 (C) 98 (D) 100

12. Total number of elements which have been discovered till now are: ***(K.B)***
(A) 110 (B) 115 (C) 118 (D) 102

13. Which one of the following elements is found most abundantly in the Earth's crust? ***(K.B)***
(A) Oxygen (B) Aluminium (C) Silicon (D) Iron

14. Human body has carbon upto _____ %. ***(K.B)***
(A) 18 (B) 19 (C) 20 (D) 21

15. The most abundant element occurring in the oceans is: **(GRW 2016)(Ex-3)** ***(K.B)***
(A) Oxygen (B) Hydrogen (C) Nitrogen (D) Silicon

16. Which of the following shows variable valency? ***(K.B)***
(A) Ca (B) Fe (C) B (D) I

17. HSO_4^- is the symbol of which one of the following? ***(K.B)***
(A) Ammonium ion (B) Cyanide (C) Bisulphate (D) Bicarbonate

18. The symbol of nitride radical is: *(K.B)*

(A) CO_3^{2} (B) N^{3-} (C) PO_4^{3-} (D) $S_2O_3^{2-}$

19. After gaining one electron chlorine atom becomes: **(GRW 2015)***(K.B)*

(A) Cation (B) Anion (C) Molecular cation (D) Molecular anion

20. The mixture which has uniform composition throughout is called: *(K.B)*

(A) Simple mixture (B) Homogeneous mixture

(C) Heterogeneous mixture (D) Compound, mixture

21. Which of the following has sharp and fixed melting point? *(U.B)*

(A) Compound (B) Mixture (C) Both (D) None of these

22. Which is heterogeneous mixture? *(K.B)*

(A) Soil (B) Gasoline (C) Sugar solution (D) Salt solution

23. A good example of homogenous mixture is: *(A.B)*

(A) Rock (B) Wood (C) Soil (D) Ice cream

24. The most abundant element occurring in the ocean is *(K.B)*

(A) Nitrogen (B)Silicon (C) Hydrogen (D) Oxygen

1.2 TEST YOURSELF

i. Can you identify mixture, element or compound out of the followings? *(U.B+A.B)*
Coca cola, petroleum, sugar, table salt, blood, gun powder, urine, aluminium, silicon, tin, lime and ice cream.

Ans: Identification of mixture, element or compound is as follows:

Element	Compound	Mixture
Aluminium	Sugar	Petroleum
Silicon	Table salt	Blood
Tin	Lime	Gun powder
		Urine
		Ice cream
		Coca cola

ii. How can you justify that air is a homogeneous mixture? Identify substances present in it. *(U.B+K.B)*

Ans: **AIR IS A HOMOGENEOUS MIXTURE**

Justification:

Air is a homogeneous mixture because it has uniform composition throughout. Air consists of different gases having a uniform composition i.e. 78% nitrogen, 21% oxygen, 0.9% argon, 0.037% carbon dioxide along with other noble gases and water vapours. These gases have their identity and can be separated.

iii. Name the elements represented by the following symbols: *(K.B)*

Hg, Au, Fe, Ni, Co, W, Sn, Na, Ba, Br, Bi

Ans:

Symbol	Name	Symbol	Name
Hg	Mercury	Sn	Tin
Au	Gold	Na	Sodium
Fe	Iron	Ba	Barium
Ni	Nickel	Br	Bromine
Co	Cobalt	Bi	Bismuth
W	Tungsten		

iv. Name a solid, a liquid and a gaseous element that exits at the room temperature. ***(K.B)***

Ans: Names of elements in solid, liquid and gaseous state, at room temperature:

- Solid : Iron, gold, silver etc.
- Liquid : Mercury, bromine etc.
- Gas : Hydrogen, oxygen, nitrogen etc.

v. What elements do the following compounds contain? Sugar, common salt, lime water and chalk. ***(K.B)***

Ans:

Compound	Elements	Formula
Sugar	Carbon (C), Hydrogen (H), Oxygen (O)	$C_6H_{12}O_6$
Common Salt	Sodium (Na), Chlorine (Cl)	NaCl
Lime water	Calcium (Ca), Oxygen (O), Hydrogen (H)	$Ca(OH)_2$
Chalk	Calcium (Ca), Carbon(C), Oxygen (O)	$CaCO_3$

1.2.2 ATOMIC NUMBER AND MASS NUMBER

Q.1 Define atomic number and mass number. Explain with the help of examples. ***(U.B+K.B)***

Ans:

ATOMIC NUMBER

Definition:

"The ***number of protons present in the nucleus of an atom*** *of the element is called atomic number."*

Representation:

It is represented by symbol **'Z'**:

Explanation:

As all atoms of an element have the same number of protons in their nuclei, they have the same atomic number. Hence 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 carbon atoms have 6 protons, their atomic number, **Z = 6.**
All oxygen atoms have 8 protons, their atomic number, **Z = 8.**
All sulphur atoms have 16 protons, their atomic number, **Z = 16.**

In a **neutral atom: Atomic number = Number of protons = Number of electrons**

MASS NUMBER

Definition:

"The ***sum of number of protons and neutrons present in the nucleus of an atom*** *is called mass number."*

Representation:

It is represented by symbol **'A'**

Explanation:

Mass number = Number of protons + number of neutrons

It is calculated as: **A = Z + n** where n is the number of neutrons. Each proton and neutron has one unit of mass.

Examples:

Hydrogen atom has one proton and zero number of neutron in its nucleus, therefore mass number of hydrogen is: **A = l + 0 = 1**

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

Representation:

By convention, the mass number is written at the top left corner of the symbol of the atom and atomic number is written at the bottom left corner. ${}^{A}_{Z}X$

Examples:

${}^{12}_{6}C$, ${}^{23}_{11}Na$ etc.

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

Table: Some Elements Along With Their Atomic Numbers and Mass Numbers

Q.2 Explain the relative atomic mass and atomic mass unit. **(DGK 2016)*(U.B+K.B)***

Ans: **Relative Atomic Mass (A_r):**

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

Examples:

- A_r of carbon = 12 amu
- A_r of oxygen = 16 amu

Isotope: *"**Atoms of an element** having **different mass number** but **same atomic number**".*

Representation of atomic mass as relative atomic mass:

The mass of an atom is too small to be determined practically. However, certain instruments enable us to determine the ratio of the atomic masses of various elements to that of carbon-12 atoms. This ratio is known as the relative atomic mass of the elements. The standard of relative atomic mass is based on carbon-12 standard; the mass of an atom of carbon is 12 and 1/12th 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.

Unit of A_r (Relative Atomic Mass):

"The unit for relative atomic mass is called atomic mass unit."

Atomic Mass Unit:

*"One atomic mass unit is **1/12th the mass of one atom of carbon 12.** The atomic mass unit is abbreviated as **amu**."*

On atomic mass scale, the atomic mass of **carbon-12** is taken as **12.00 amu**.

$$1 \text{ amu} = \frac{1}{12} \times \text{mass of carbon-12 atom}$$

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

Atomic Masses of Subatomic Particles:

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

1.2.2 ATOMIC NUMBER AND MASS NUMBER

SHORT QUESTIONS

Q.1 What is the relative atomic mass? How it is related to gram? ***(U.B+K.B)***

Ans:

RELATIVE ATOMIC MASS

Definition:

"The average mass of atoms of an element as compared to 1/12th (one-twelfth) the mass of one atom of carbon-12 isotope is called relative atomic mass."

Unit of Relative Atomic Mass: Its unit is atomic mass unit, with symbol amu.

Atomic Mass Unit: *"One atomic mass unit is 1/12th the mass of one atom of carbon-12th."*

Representation in Grams: When this atomic mass unit is expressed in grams it is.

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

Q.2 Define atomic mass unit. Why is it needed? ***(U.B+K.B+A.B)***

Ans: **Definition:**

"The mass equal to one twelfth (1/12th) of the mass of a carbon -12 atom is called atomic mass unit."

The atomic mass unit is abbreviated as amu.

$$1 \text{ amu} = 1/12 \times \text{mass of C-12 atom}$$

The mass of one atom of carbon -12 is 12 amu.

Need of amu:

It is the unit used for the relative atomic mass. It is used to compare masses of atoms.

Q.3 How many neutrons are present in C–12 and C–13? **(BWP 2017 G-II)*(U.B)***

Ans:

NUMBER OF NEUTRONS IN C–12

Number of neutrons = Mass number – atomic number

= 12 – 6 = 6 neutrons

NUMBER OF NEUTRONS IN C–13

Number of neutrons = Mass number – atomic number

= 13 – 6 = 7 neutrons

Q.4 Give mass of proton and neutron in amu and grams. ***(K.B)***

Ans: *Answer given on pg # 18*

1.2.2 ATOMIC NUMBER AND MASS NUMBER

MULTIPLE CHOICE QUESTIONS

1. 1 amu (atomic mass unit) is equivalent to: ***(K.B)***

(A) 1.66×10^{-24} mg (B) 1.66×10^{-24}g (C) 1.66×10^{-21}g (D) 1.66×10^{-27}g

2. The mass of one molecule of water is: ***(K.B)***

(A) 18amu (B) 18g (C) 18mg (D) 18kg

3. Mass of an electron is: **(LHR 2014)*(K.B)***

(A) 5.486×10^{-4} amu (B) 9.106×10^{-24} amu (C) 1.67×10^{-24} g (D) 1.677×10^{-24} g

4. Mass of proton is equivalent to: ***(K.B)***

(A) 1.672×10^{-24} amu (B) 16.72×10^{-24} g (C) 1.672×10^{24} g (D) 1.672×10^{-24} g

5. Which one of the following is a molecular mass of O_2 in amu? **(LHR 2014)*(U.B+K.B)***

(A) 32 amu (B) 53.12×10^{-24} amu (C) 1.92×10^{-25} amu (D) 192.64×10^{-24} amu

6. Atomic number is represented by: **(FSD 2017 G-II)*(K.B)***

(A) Z (B) Y (C) A (D) a

7. Element with least atomic number is: ***(K.B)***

(A) Carbon (B) Sodium (C) Hydrogen (D) Helium

NUMERICAL EXAMPLE 1.1

How many number of protons and neutrons are there in an atom having A = 238 and Z = 92. *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Atomic mass A = 238
Atomic number Z = 92

To Find:

Number of neutrons = ?

Calculations:

Number of protons = Z = 92
Number of Neutrons = A – Z
= 238 - 92
= 146

Result:

The number of neutrons and protons is 146 and 92 respectively.

1.3 TEST YOURSELF

i. How many amu 1 g of a substance has? *(U.B)*

Ans: As $1amu = 1.66 \times 10^{-24}g$

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

$1\ g = \frac{1}{1.66\times10^{-24}}$ amu

$1g = 6.02\times10^{23}$ amu

ii. Is atomic mass unit a SI unit of an atomic mass? *(K.B)*

Ans: SI unit for the mass of a substance is kilogram. As an atom is too small to weigh in kg therefore, atomic mass is stated in very small unit i.e. atomic mass unit.

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

iii. What is the relationship between atomic number and atomic mass? *(U.B)*

$A = Z + n$

iv. Define relative atomic mass.

Ans:

RELATIVE ATOMIC MASS

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

Examples:

A_r of carbon = 12 amu *(K.B)*

1.2.4 HOW TO WRITE CHEMICAL FORMULA?
1.2.5 MOLECULAR MASS AND FORMULA MASS

Q.1 Define the chemical formula. Write down the steps to write chemical formula. *(DGK 2017-G-II)(U.B+K.B)*

Ans:

CHEMICAL FORMULA

Definition:

*"**Representation of an element or a compound in terms of symbols** is called chemical formula".*

Examples:

- Chemical formula of aluminium sulphate: $Al_2(SO_4)_3$
- Chemical formula of calcium phosphate: $Ca_3(PO_4)_2$
- Chemical formula of chlorine: Cl_2
- Chemical formula of water: H_2O

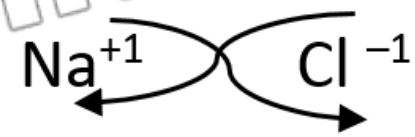
Steps to Write Down Chemical Formula:

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

(ii) **Valency of ions:** The **valency** of each ion is written on the **right top corner of its symbol,** e.g. Na^{+}, Ca^{2+},Cr^{3+} and O^{2-}.

(iii) **Cross-exchange method:** This valency of each ion is brought to the lower right corner of other ion by cross-exchange method e.g ***$Na^{+}Cl^{-}$, $Na^{+}Cl^{-}$, NaCl $Ca^{+2}Cl^{-}$, $Ca^{2+}O^{2-}$***

Na^{1+} Cl^{1-}



Na_1 Cl_1

NaCl

(iv) **Offset:** 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

Example:

- In case of **sodium chloride** both the valencies are offset and formula is written as **NaCl,**
- **Calcium chloride** is represented by formula **$CaCl_2$.**

(v) **Radical:** If an ion is a combination of two or more atoms which is called radical, bearing net charge on it. e.g. SO_4^{2-} (sulphate ion) and PO_4^{3-} (phosphate ion) then the **net charge represent the valency of the radical writing the negative radical within the parenthesis.**

Examples:

- Chemical formula of aluminum sulphate is written as $Al_2(SO_4)_3$
- Calcium phosphate as $Ca_3(PO_4)_2$

Q.2 What is the significance of chemical formula? **(SGD 2017G-I)*(U.B+K.B)***

Ans: **SIGNIFICANCE OF CHEMICAL FORMULA**

The significance of chemical formula is as follows:

- It represents the **name of the substance** e.g., H_2O (water)
- It tells the **name of the elements** as present **in the compound**.
- It indicates the **mass of an element or a compound in amu or grams**.
- It also represents **one mole of the molecule or formula unit** in the **balanced chemical equation.**
- It is in fact **one molecule or formula unit of the substance.**

Q.3 Define empirical formula. Describe the empirical formula of ionic and covalent compounds. **(BWP 2016, SWL 2016,17, DGK 2017)*(U.B+K.B)***

Ans: **EMPIRICAL FORMULA**

Definition:

*"A formula that indicates the **simplest whole number ratio of atoms of different elements present in a compound** is called an empirical formula."*

Determination of Empirical Formula:

The empirical formula of a compound is determined by knowing the percentage composition of a compound.

(i) **Empirical Formula of Covalent Compounds:**

*"It is **simplest whole number ratio of atoms of each element present in a compound**"*

Examples:

- The covalent compound **silica (sand)** has simplest ratio of **1:2** of **silicon** and **oxygen** respectively. Therefore, its empirical formula is **SiO_2**.

  Silica or sand (silicon dioxide) = Si : O
  1 : 2
  Thus empirical formula of silica = **SiO_2**

- **Glucose** has simplest ratio **1:2:1** of **carbon, hydrogen** and **oxygen** respectively. Hence its empirical formula is **CH_2O**.

  Glucose = C : H : O
  6 : 12: 6
  = 1: 2 : 1
  Thus empirical formula of glucose = **CH_2O**

(ii) Empirical Formula of Ionic Compounds:

The ionic compounds exist in **three dimensional network** forms. Each ion is surrounded by oppositely charged ion 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**.

Formula Unit:

*"The **simplest whole number ratio of ions, as present in an ionic compound** is called formula unit."*

In other words, **ionic compounds have only empirical formulae**.

Examples:

- Formula unit of **common salt** consists of one Na^+ and one Cl^- ion and its empirical formula is **NaCl**.
- Formula unit of **potassium bromide** is **KBr** which is also its empirical formula.

Q.4 What is molecular formula? Write down the relationship between molecular and empirical formula. **(MTN 2016)*(U.B+K.B)***

Ans:

MOLECULAR FORMULA

Definition:

*"A formula that indicates **actual number of atoms of each element present in a molecule of that compound** is called molecular formula."*

Examples:

Molecular formula of **water, benzene, chlorine** and **sulphur** are **H_2O, C_6H_6, Cl_2** and **S_8** respectively.

Derivation of Molecular Formula:

(Relationship between molecular formula and empirical formula)

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

Molecular formula = n × (Empirical formula)

Where

$$\mathbf{n} = \frac{\textbf{molecular formula mass}}{\textbf{empirical formula mass}}$$

Molecular formula of a compound is determined experimentally. The value of **'n'** may be **1, 2, 3, 4, 5, 6** and so on.

Examples:

Molecular formula of **benzene** is **C_6H_6** which is derived from the **empirical formula CH** where the value of **n is 6**.

Explanation:

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

Table: 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	$C_6H_{I2}O_6$

Q.5 Describe molecular mass and formula mass in detail. ***(U.B+K.B)***

Ans:

MOLECULAR MASS

Definition:

*"The **sum of atomic masses of all the atoms present in one molecule of a molecular substance** is its molecular mass."*

Examples:

- **H_2O** = 2(1 amu) +1(16 amu)

  = 2×1+16

  = 2+16

  =18 amu
- Molecular mass of **carbon oxide (CO_2)** is **44 amu.**
- Molecular mass of **chlorine (Cl_2)** is **71 amu.**

FORMULA MASS

Definition:

*"The **sum of atomic masses of all the atoms present in one formula unit of an ionic compound** is called formula mass."*

Some ionic compounds that form three-dimensional solid crystal, are represented by their formula units. Formula mass in such cases is the sum of atomic mass.

Examples:

- Formula mass of **sodium chloride** is **58.5 amu.**
- Formula mass of **calcium carbonate** is **100 amu.**

1.2.4 HOW TO WRITE CHEMICAL FORMULA?
1.2.5 MOLECULAR MASS AND FORMULA MASS

SHORT QUESTIONS

Q.1 **Write down empirical formula of silica and glucose.** **(GRW 2017 G-II)*(U.B+K.B)***

Ans: *Answer given on pg # 20*

Q.2 **What is molecular mass? Give one example** **(GRW 2016 G-I)*(K.B+A.B)***

Ans: *Answer given on pg # 22*

Q.3 **Define formula unit.** ***(K.B)***

Ans: *Answer given on pg # 21*

1.2.4 HOW TO WRITE CHEMICAL FORMULA?
1.2.5 MOLECULAR MASS AND FORMULA MASS

MULTIPLE CHOICE QUESTIONS

1. **$Al_2(SO_4)_3$ is the formula of:** ***(K.B)***

(A) Aluminium sulphate (B) Aluminium phosphate
(C) Calcium sulphate (D) Calcium phosphate

2. **The valency of ion is written on:** ***(K.B)***

(A) Top left corner (B) Top right corner
(C) Bottom right corner (D) Bottom left corner

3. **CaO is the chemical formula of:** ***(K.B)***

(A) Lime stone (B) Lime water (C) Caustic soda (D) Quick lime

4. **Which one of the following shows the simplest whole number ratio of atoms in a substance?** ***(U.B+K.B)***

(A) Molecular formula (B) Empirical formula
(C) Chemical formula (D) Covalent formula

5. **Chemical formula of washing soda is:** ***(K.B)***

(A) $Na_2CO_3.H_2O$ (B) $Na_2CO_3.10H_2O$ (C) $Na_2CO_3.7H_2O$ (D) Na_2CO_3

6. **The empirical formula of glucose is:** **(LHR 2015)*(K.B)***

(A) CH (B) CH_2O (C) OH (D) H_2O_2

7. **Which one of the following is empirical formula of benzene?** **(LHR 2016, (LHR 2016G-II, FSD 2017G-II)*(K.B)***

(A) $C_6H_6O_2$ (B) C_3H_3O (C) C_6H_6 (D) CH

8. **Silica is also known as:** ***(K.B)***

(A) Silicate (B) Clay (C) Sand (D) Sulphate

9. **In silica the ratio of silicon and oxygen atoms is:** ***(K.B)***

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

10. **Molar mass is usually expressed in grams which one of the following is molar mass of O_2 in amu?** **(Ex-10)*(U.B)***

(A) 32 amu (B) 53.2×10^{-24}amu
(C) 1.92×10^{-25} amu (D) 192.64×10^{-25} amu

11. **The molar mass of H_3PO_4 is:** **(GRW 2017G-II)*(U.B+K.B)***

(A) 58.5g (B) 98g (C) 40g (D) 98amu

12. **The formula mass of K_2SO_4 is:** ***(U.B+K.B)***

(A) 174amu (B) 174g (C) 170amu (D) 170g

13. The sum of atomic mass of all the atoms in one formula unit of a substance called: *(K.B)*

(A) Atomic mass (B) Mass number (C) Formula mass (D) Atomic mass unit

14. The formula mass of an ionic compound expressed in gram is called: *(K.B)*

(A) Gram formula mass (B) Gram molecular

(C) Mole (D) All of these

NUMERICAL EXAMPLE

NUMERICAL EXAMPLE 1.2

Calculate the molecular mass of nitric acid, HNO_3. **(FSD 2016)** *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Atomic mass of H = l amu

Atomic mass of N = 14 amu

Atomic mass of O = 16 amu

To Find:

Molecular mass of HNO_3 = ?

Calculations:

Molecular mass of HNO_3 = 1(atomic mass of H) + (atomic mass of N) + 3 (atomic mass of O)

= 1 + 14 + 3(16)

= 63 amu

Result:

The molecular mass of nitric acid is **63 amu**.

NUMERICAL EXAMPLE 1.3

Calculate the formula mass of potassium sulphate (K_2SO_4) *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Atomic mass of K = 39 amu

Atomic mass of S = 32 amu

Atomic mass of O = 16 amu

To find:

Formula mass of K_2SO_4 = ?

Calculations:

Molecular mass K_2SO_4 = 2(atomic mass of K) + 1(atomic mass of S) + 4 (atomic mass of O)

= 2(39)+1(32)+4(16)

= 78+32+64

= 174 amu

Result:

Thus formula mass of potassium sulphate is **174 amu**.

1.4 TEST YOURSELF

i. What is the relationship between empirical formula and molecular formula? **(SWL 2017)** *(U.B)*

Ans: The molecular formula is derived from empirical formula by the following relationship.

Molecular formula = n × (empirical formula)

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

ii. Differentiate between empirical formula and formula unit? *(U.B)*

Ans: The differences between empirical formula and formula units are given below:

S.No.	Empirical Formula	Formula Unit
	Definition	
	• Empirical formula is the simplest whole number ratio of atoms of different elements present in a compound.	• The simplest whole number ratio of ions as present in the ionic compound is called formula unit.

Example	
• The empirical formula of glucose ($C_6H_{12}O_6$) is CH_2O.	• The formula unit of sodium chloride is NaCl.
Type of compound	
• Both covalent and ionic compounds have empirical formula.	• Only ionic compounds have formula unit.

iii. How can you differentiate between molecular formula and empirical formula? ***(U.B)***

Ans:

DIFFERENTIATION

The differences between empirical formula and molecular formula are as follows:

Empirical Formula	Molecular Formula
• Empirical formula is the simplest whole number ratio of atoms of different elements present in a compound.	• The formula that shows actual number of atoms of each element present in a molecule of that compound is called molecular formula.
• The Empirical formula of glucose ($C_6H_{12}O_6$) is CH_2O.	• The molecular formula of glucose is $C_6H_{12}O_6$.
• It is determined on the basis of percentage composition of a compound.	• It is derived from empirical formula by the following relationship. • Molecular formula = n × empirical formula.
• It can be written both for ionic and molecular compounds.	• It can only be written for molecular substances i.e. elements and compounds

iv. Identify the following formulae as formula unit or molecular formulae: ***(U.B)***
H_2O_2, CH_4, $C_6H_{12}O_6$, $C_{12}H_{22}O_{11}$, $BaCO_3$, KBr

Ans:

IDENTIFICATION OF FORMULAS

Molecular Formula	Formula Unit	Empirical Formula
H_2O_2	$BaCO_3$	$BaCO_3$
CH_4	KBr	KBr
$C_6H_{12}O_6$		CH_4
$C_{12}H_{22}O_{11}$		

v. What is empirical formula of acetic acid (CH_3COOH)? Find out its molecular mass. ***(U.B+A.B)***

Ans:

EMPIRICAL FORMULA

Acetic acid ($C_2H_4O_2$) has simplest whole number ratio CH_2O. Thus empirical formula of acetic acid is CH_2O.

Molecular mass of acetic acid:

(CH_3COOH) = 1(12) + 3(1) +1(12) + 1(16) + 1(16) + 1(1)
= 12+3+12+16+16+1
= 60amu

vi. Calculate the formula masses of Na_2SO_4, $ZnSO_4$ and $CuCO_3$. ***(U.B+A.B)***

Ans:

FORMULA MASSES

Na_2SO_4 = 2(23) + 1(32) + 4(16)
= 46 + 32 + 64
= 142 amu

$ZnSO_4$ = 1(65) + 1(32) + 4(16)
= 65 + 32 + 64
= 161 amu

$CuCO_3$ = 1(63.5) + 1(12) + 3(16)
= 63.5 + 12 + 48
= 123.5 amu

1.3 CHEMICAL SPECIES

1.3.1 IONS (CATIONS AND ANIONS), MOLECULAR IONS AND FREE RADICALS

Q.1 Write a note on ions. Explain its types. *(U.B+U.B)*

OR

What is difference between cation and anion? **(GRW 2016 G-I)***(U.B)*

Ans:

IONS

Definition:

*"**An atom or group of atoms having a charge on it** is called ion. The charge may be **positive or negative.**"*

TYPES OF IONS

There are two types of ions:

- Cations
- Anions

Cations:

*"**An atom or group of atoms having positive charge on it** is called cation". e.g.* H^+ , Na^+ , Ca^{2+}.

Formation:

The cations are formed when an atom **loses electrons from its outermost shell**.

Examples:

The following equations show the formation of cations from atoms.

Atoms		**Cations**
H	⟶	$H^+ + 1e^-$
Na	⟶	$Na^+ + 1e^-$
Ca	⟶	$Ca^{2+} + 2e^-$

Anions:

"***An atom or a group of atoms that has a negative charge on it,*** *is called anion."e.g.* Cl^{1-}, O^{2-}, H^{1-}.

Formation:

Anion is formed by the **gain or addition of electrons** by an atom.

Examples:

Following examples show the formation of an anion by addition of electrons to an atom.

Atoms		**Anions**
$H + 1e^-$	⟶	H^-
$Cl + 1e^-$	⟶	Cl^-
$O + 2\ e^-$	⟶	O^{2-}

Q.2 What is the difference between atom and ion:

(RWP 2016, 17 G-II, MTN 2017, DCK 2017, GRW-2017 G-I)*(U.B)*

Ans:

DIFFERENTIATION

The differences between atom and ion are as follows:

Atom	Ion
Definition	
• It is smallest particle of an element.	• It is the smallest unit of an ionic compound.
Existence	
• 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.

Charge	
• It is electrically neutral.	• It has a net charge (either negative or positive) on it.
Example	
• C, Al	• Al^{3+}, O^{2-}

Q.3 Write a note on molecular ion. **(BWP 2016)*(U.B+K.B)***

Ans: **MOLECULAR ION**

Definition:

*"A **molecular ion** is a specie having **positive or negative charge on it.** When a **molecule loses or gains an electron**, it forms a molecular ion."*

Types of Molecular Ions:

Molecular ions are of two types:

(i) Cationic molecular ion

(ii) Anionic molecular ion

Note: Cationic molecular ions are more abundant than anionic molecular ions.

(i) Cationic Molecular Ion:

*"The molecular ions which **carry positive charge** are called cationic molecular ions".* They are formed by losing of electron.

Examples:

N_2^+, He^+, CH_4^+ etc.

(ii) Anionic Molecular Ion:

*"The molecular ions which **carry negative charge** are called anionic molecular ions."* They are formed by gaining of electron.

Examples:

N_2^-, O_2^{-2} etc.

Generation or Formation of Molecular Ions:

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

Q.4 Differentiate between molecule and molecule ion. **(FSD 2016, GRW 2016 G-II)*(U.B)***

DIFFERENTIATION

The differences between molecule and molecular ion are as follows:

Molecule	Molecular Ion
Definition	
• It is the smallest particle of a substance which can exist independently and show all the properties of that substance (element or compound).	• It is formed by gain or loss of electrons by a molecule.
Charge	
• It is always neutral.	• It can have negative or positive charge.
Formation	
• It is formed by the combination of atoms.	• It is formed by the ionization of a molecule.
Stability	
• It is a stable unit.	• It is a reactive specie.

Q.5 Explain free radical in detail. **(SWL 2016,17)*(U.B+K.B)***

Ans:

FREE RADICALS

Definition:

*"Atoms or group of atoms **possessing odd number of (unpaired) electrons** are called free radicals."*

Representation:

It is represented by putting a dot over the symbol of an element.

Examples:

$Cl^{\bullet}$, $H^{\bullet}$, $OH^{\bullet}$, $CH_3^{\bullet}$ etc.

Formation:

Free radicals are generated by the **homolytic (equal) breakage** of the bond between two atoms when they absorb heat or light energy.

Molecules Free radicals

$$Cl_2 \longrightarrow 2Cl^{\bullet}$$

$$CH_4 \longrightarrow H_3C^{\bullet} + H^{\bullet}$$

Reactivity:

A free radical is **extremely reactive specie** as it has the tendency to complete its octet.

$$Cl_2 \xrightarrow{\text{sun light}} 2Cl^{\bullet}$$

$$CH_4 \xrightarrow{\text{sun light}} CH_3^{\bullet} + H^{\bullet}$$

Q.6 Difference between ion and free radical. **(SGD 2016,17)*(U.B)***

Ans:

DIFFERENTIATION

The differences between ion and free radical are as follows:

Ions	Free Radicals
Definition	
• These are the atoms which bear some charge.	• These are the atoms that have odd number of electrons.
Existence	
• They exist in solution or in crystal lattice.	• They can exist in solutions as well in air.
Effect of Light on Formation	
• Their formation is not affected by the presence of light.	• They may form in the presence of light.
Example	
• Al^{3+}, O^{2-}	• $Cl^{\bullet}$, $CH_3^{\bullet}$

1.3 CHEMICAL SPECIES

1.3.1 IONS (CATIONS AND ANIONS), MOLECULAR IONS AND FREE RADICAL

SHORT QUESTIONS

Q.1 Define molecular ion and how are they generated? **(U.B+K.B)**

Ans: *Answer given on pg # 27*

Q.2 Most of the universe exists in which form of matter? **(Do you know Text Book Page. # 16)(K.B)**

Q.3 Define free radical how are they generated? **(LHR 2017 G-II)(U.B+K.B)**

Ans: *Answer given on pg # 28*

Q.4 Difference between atom and ion. **(U.B)**

Ans: *Answer given on pg # 26*

1.3 CHEMICAL SPECIES

1.3.1 IONS (CATIONS AND ANIONS), MOLECULAR IONS AND FREE RADICALS

MULTIPLE CHOICE QUESTIONS

1. An atom or group of atoms having positive charge on it is called: *(K.B)*

(A) Cation (B) Anion (C) Molecule (D) Atom

2. The symbol of nitride radical is: *(K.B)*

(A) CO_3^{2-} (B) N^{3-} (C) PO_4^{3-} (D) $S_2O_3^{2-}$

3. Which one of the following is a reactive specie? *(U.B)*

(A) Molecule (B) Molecular ion (C) Compound (D) Formula unit

4. An atom or group of atoms having odd number of electrons is called: *(K.B)*

(A) Radical (B) Ion (C) Free radical (D) Molecular ion

5. The removal of electron from an atom gives: *(U.B)*

(A) Cation (B) Anion (C) Molecular (D) Molecular anion

6. CH_4^+ is an example of: *(K.B+A.B)*

(A) Free radical (B) Molecular ion (C) Cation (D) Anion

7. Which of the following specie is generated by heat or light? *(U.B)*

(A) Ion (B) Molecular ion (C) Free radical (D) Molecule

8. Free radicals are generated by _____ breakage. *(U.B)*

(A) Homolytic (B) Heterolytic (C) Unequal (D) All of these

9. It is a stable unit: *(U.B)*

(A) Ion (B) Molecular ion (C) Molecule (D) Free radical

10. Which molecular ion is more abundant? *(U.B)*

(A) Cationic (B) Anionic (C) Both A & B (D) None

1.3.2 TYPES OF MOLECULES

Q.1 Define and explain molecule and its types.

(BWP 2016, 17, MTN 2017, FSD 2017 G-I, BWP 2017 G-II) *(U.B+K.B)*

Ans:

MOLECULE

Definition:

*"It is the **smallest particle of a substance which can exist independent** and shows all the properties of that substance (element or a compound)".*

Formation:

A molecule is formed by chemical combinations of atoms.

TYPES OF MOLECULES

On the Basis of Number of Atoms:

On the basis of number of atoms types of molecules are as follows:

(i) Monoatomic Molecule:

*"A molecule consisting of **only one atom** is called monoatomic molecule"*

Examples:

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

(ii) Diatomic Molecule:

*"A molecule consisting of **two atoms** is called diatomic molecule"*

Examples:

Hydrogen (H_2), oxygen (O_2), chlorine (Cl_2) and hydrogen chloride (HCl).

(iii)Triatomic Molecule:

*"A molecule consisting of **three atoms** is called triatomic molecule."*

Examples:

H_2O, CO_2, etc.

(iv) Polyatomic Molecule:

*"A molecule consisting of **many atoms** is called polyatomic molecule."*

Examples:

Methane (CH_4), sulphuric acid (H_2SO_4) and glucose ($C_6H_{12}O_6$).

On the Basis of Types of Atoms:

On the basis of types of atoms types of molecules are as follows:

(i) Homoatomic Molecule:

*"A molecule of **same types of atoms** is called homoatomic molecule.*

Examples: *consisting*

Hydrogen (H_2), ozone (O_3), sulphur (S_8) and phosphorus (P_4).

(ii) Heteroatomic Molecule:

*"A molecule consisting of **different kinds of atoms** is called heteroatomic molecule."*

Examples:

CO_2, H_2O and NH_3.

1.3.2 TYPES OF MOLECULES

SHORT QUESTIONS

Q.1 Differentiate between homoatomic and heteroatomic molecules. *(LE)*

Ans:

DIFFERENTIATION

The differences between homoatomic and heteroatomic molecules are as follows:

Homoatomic Molecules	Heteroatomic Molecules
Definition	
• A molecule containing **same type** of atoms is called homoatomic molecule.	• A molecule consists of **different kinds** of atoms is called a heteroatomic molecule.
Examples	
• Hydrogen (H_2), Oxygen (O_3) and sulphur (S_8) • These are molecules of elements.	• CO_2, H_2O and NH_3 • These are molecules of covalent compounds.

1.3.2 TYPES OF MOLECULES

MULTIPLE CHOICE QUESTIONS

1. Which one of the following is triatomic molecule? *(U.B)*

(A) H_2SO_4 (B) I_2
(C) CO_2 (D) HCl

2. Which one of the following is a diatomic molecule? **(GRW 2015, RWP 2017 G-II)** *(U.B)*

(A) H_2SO_4 (B) C_6H_6
(C) H_2O (D) CO

3. Which one of the following is not triatomic molecule?
(GRW 2016, LHR 2017 G-I, GRW 2016 G-II, RWP 2017 G-II) *(U.B)*

(A) H_2 (B) O_3
(C) H_2O (D) CO_2

4. P_4 is an example of: *(U.B)*

(A) Diatomic molecule (B) Homoatomic molecule
(C) Heteroatomic molecule (D) Monoatomic molecule

5. If molecule consist of two atoms is called: *(U.B+K.B)*

(A) Diatomic (B) Monoatomic
(C) Polyatomic (D) Triatomic

1.5 TEST YOURSELF

i. Identify among the following as diatomic, triatomic or polyatomic molecules: *(U.B+A.B)*
H_2SO_4, H_2, CO_2, HCl, CO, C_6H_6, H_2O

Ans: **IDENTIFICATION**

Diatomic molecules: H_2, HCl, CO
Triatomic molecules: CO_2, H_2O
Polyatomic molecules: H_2SO_4, C_6H_6

ii. Identify among the followings as cation, anion, free radical, molecular ion or molecule: *(U.B+A.B)*
Na^+, $Br^\bullet$, N_2^+, N_2, Cl_2, CO_3^{2-}, H^-, O_2, O^{2-}

Ans: **IDENTIFICATION**

Cation: Na^{1+}
Anion: H^-, O^{2-}, CO_3^{2-}
Free radical: $Br^\bullet$
Molecular ion: N_2^+
Molecule: N_2, Cl_2, O_2

1.4 GRAM ATOMIC MASS, GRAM MOLECULAR MASS AND GRAM FORMULA MASS

Q.1 Write a note on gram atomic mass, gram molecular mass and gram formula mass.
(RWP 2017 G-I) *(U.B+K.B)*

Ans: **GRAM ATOMIC MASS (GRAM ATOM OR MOLE)**

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

$$\text{Number of gram atoms of element} = \frac{\text{Mass of element}}{\text{Atomic mass of element}}$$

Examples:

- 1 gram atom of hydrogen = 1.008 g = 1 mol of hydrogen atom
- 1 gram atom of carbon = 12.0 g = 1 mol of carbon atom

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

GRAM MOLECULAR MASS

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

Examples:

- 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
- Number of gram molecules of a substance = $\frac{\text{Mass of substance}}{\text{Molecular mass of substance}}$

GRAM FORMULA MASS (GRAM FORMULA OR MOLE)

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

Examples:

- 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

1.4 GRAM ATOMIC MASS, GRAM MOLECULAR MASS AND GRAM FORMULA MASS

SHORT QUESTIONS

Q.1 Define gram atomic mass and give example. ***(K.B+A.B)***

Ans: *Answer given on pg # 31*

Q.2 Define gram molecular mass and give example. ***(K.B+A.B)***

Ans: *Answer given on pg # 32*

Q.3 Define gram formula mass and give example. ***(K.B+A.B)***

Ans: *Answer given on pg # 32*

1.4 GRAM ATOMIC MASS, GRAM MOLECULAR MASS AND GRAM FORMULA MASS

MULTIPLE CHOICE QUESTIONS

1. The molar mass of H_2SO_4 is: **(GRW 2016) (LHR 2015)*(K.B+U.B)***

(A) 98g (B) 48amu

(C) 4.8g (D) 98amu

2. The mass of one molecule of H_2O is: **(LHR 2015)*(K.B+U.B)***

(A) 18amu (B) 18gm

(C) 18g (D) 18kg

3. 36 g of water is equal to: ***(U.B)***

(A) 1 mole (B) 2 mole

(C) 3 mole (D) 1.5 mole

4. 1 mole of $CaCO_3$ is equal to: ***(U.B)***

(A) 58.5 g (B) 100 g

(C) 99 g (D) 50 g

1.5 AVOGADRO'S NUMBER AND MOLE

Q.1 Explain the Avogadro's number. **(LWP 2016)** ***(U.B+K.B)***

Ans:

AVOGADRO'S NUMBER

Amaedo Avogadro (1776-1856) was an Italian scholar. He is famous for molecular theory commonly known as Avogadro's law. In tribute to him, the number of particles (atoms, molecules, ions) in mole of a substance 6.02×10^{23} is known as the Avogadro's constant.

Introduction:

It is a huge number. It was suggested by an Italian scientist Amaedo Avagadro.

Definition:

*"The **number of particles in one mole of a substance** is called Avogadro's number."*

Representation and Numerical Value:

Avogadro's number is represented by symbol 'N_A'. Its numerical value is $\mathbf{6.02\times10^{23}}$.

Explanation:

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.

Relationship Between Avogadro's Number and Mole:

- Gram atomic mass of C = 12g = 1 mole of C = 6.02×10^{23} atoms of C
- Gram molecular mass of H_2O = 18g = 1 mole of H_2O = 6.02×10^{23} molecules of H_2O
- Gram formula mass of NaCl = 58.5g = 1mole of NaCl= 6.02×10^{23} formula units of NaCl.

Importance of Avogadro's Number:

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.

Explanation:

For further explanation about number of atoms in molecular compounds or number of ions in ionic compounds.

Examples:

- One molecule of water is made up of 2 atoms of 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 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}.

Q.2 Define mole and what is the relationship between mole and substance? ***(U.B+K.B)***

OR

Mole is SI unit for the amount of a substance. Define it with examples. **(Ex-Q.2)**

Ans:

MOLE (CHEMIST SECRET UNIT)

Definition:

*"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)** is called a mole."*

Quantitative Definition:

*"The **atomic mass, molecular mass, formula mass or ionic mass of a substance expressed in grams** is called a mole".*

Symbol:
It is abbreviated as **"mol"** when it is used as a unit.

Explanation:
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 **molar masses** or molar mass of a substance.

Examples:
- Atomic mass of carbon expressed in grams = 12g = 1mol of carbon
- Molecular mass of H_2O expressed in grams = 18g = 1mol of water
- Molecular mass of H_2SO_4 expressed in grams = 98g = 1mol of H_2SO_4
- Formula mass of NaCl expressed in grams = 58.5g = 1mol of NaCl

Relationship Between Mole and Mass:

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

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

Relation between mole and particles:

$$\text{Number of moles} = \frac{\text{Number of Particles of substance}}{\text{Avogadro's Number}}$$

Number of Particles = Number of Mole × Avogadro's Number

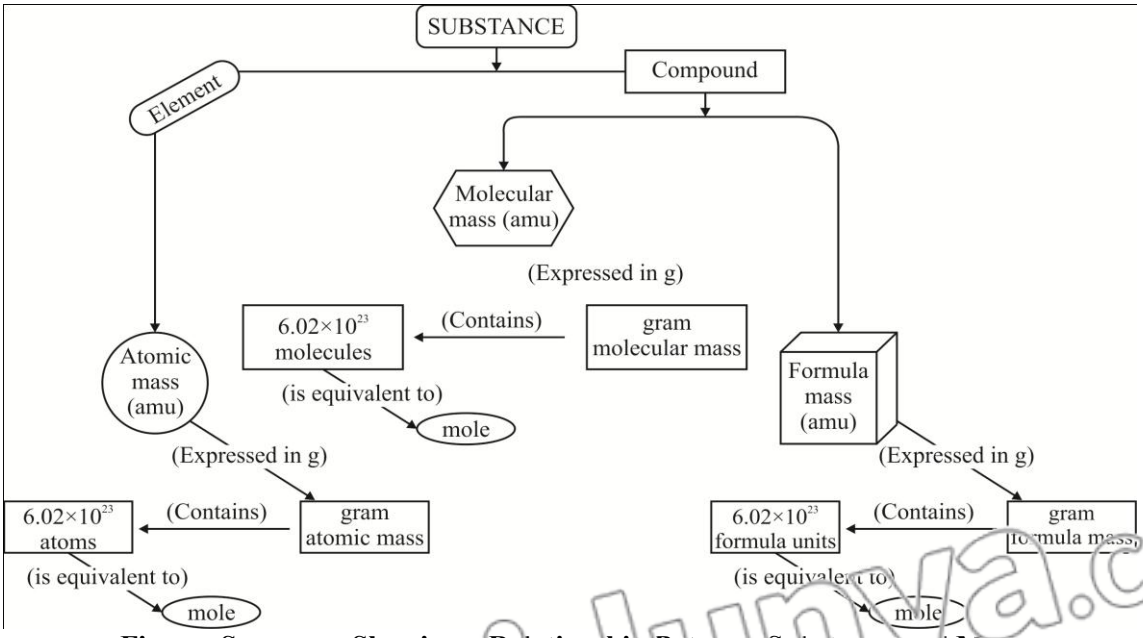


Figure: Summary Showing a Relationship Between Substance and Mole

1.5 AVOGADRO'S NUMBER AND MOLE

SHORT QUESTIONS

Q.1 What is the relationship between mole and mass? ***(U.B)***
Ans: *Answer given on pg # 34*
Q.2 Write quantitative definition of mole. **(LHR 2016 G-II)*(U.B+K.B)***
OR
What is mole? And give examples. **(LHR 2016 G-I)*(U.B+K.B)***
Ans: *Answer given on pg # 33*
Q.3 Define Avogadro's number and give examples. **(LHR 2016 G-I)*(K.B+A.B)***
Ans: *Answer given on pg # 33*

1.5 AVOGADRO'S NUMBER AND MOLE

MULTIPLE CHOICE QUESTIONS

1. The number of particles in one mole of a substance is called: *(K.B+U.B)*

(A) Atomic number (B) Particle number (C) Avogadro's number (D) Mass number

2. Total number of ions in one mole of NaCl is: *(U.B)*

(A) 12.04×10^{23} ions (B) 1.204×10^{23} ions (C) 6.04×10^{23} ions (D) 61.04×10^{23} ions

3. The symbol of Avogadro's number is: **(GRW 2017 G-I)** *(K.B)*

(A) N_A (B) A_n (C) N_x (D) N_y

1.6 TEST YOURSELF

i. Which term is used to represent the mass of 1 mole of molecules of a substance? *(U.B)*

Ans:

ONE MOLE OF MOLECULE

Gram molecular mass or gram molecule is used to represent the mass of 1 mole of molecules of a substance.

Example:

Mass of 1 mole of molecule of water is gram molecular mass i.e. 18 g.

ii. How many atoms are present in one gram atomic mass of a substance? *(U.B)*

Ans:

NUMBER OF ATOMS

One gram atomic mass of a substance is expressed in grams. It is equivalent to 1 mole of an element. Thus it consists of Avogadro's number (6.02×10^{23}) of atoms.

iii. Explain the relationship between mass and mole of a substance. *(U.B)*

Ans:

RELATIONSHIP BETWEEN MASS AND MOLE OF A SUBSTANCE

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

Mass of a substance = Number of moles x Molar mass of a substance

iv. Find out the mass of 3 moles of oxygen atoms: *(U.B+A.B)*

Ans:

NUMERICAL

Solution:

Given data:

Number of moles of O-atoms = 3mol

To Find:

Mass of 3 moles of O-atoms = ?

Calculations:

Mass of oxygen = Number of moles × molar mass of oxygen O-atom

$= 3 \text{ mole} \times 16 \text{g mol}^{-1}$

$= 48\text{g}$

Result:

Thus mass of 3 moles of oxygen is 48 g.

v. How many molecules of water will be present in half mole of water? *(U.B+A.B)*

Ans:

NUMERICAL

Solution:

Given Data:

$$\text{Number of moles of water} = \frac{1}{2} \text{ mole}$$

To Find:

Number of water molecules = ?

Calculations:

Number of water molecules = No of moles × N_A

$= \frac{1}{2}$ mole × 6.02×10^{23}

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

Result:

3.01×10^{23} molecules are present in half mole of water.

1.6 CHEMICAL CALCULATIONS

1.6.1 MOLE-MASS CALCULATIONS1.6.2 MOLE PARTICLE CALCULATIONS

Q.1 How to calculate the number of moles and number of particles from known mass of a substance. ***(U.B)***

Ans: We can calculate the number of moles from given mass by using equation.

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

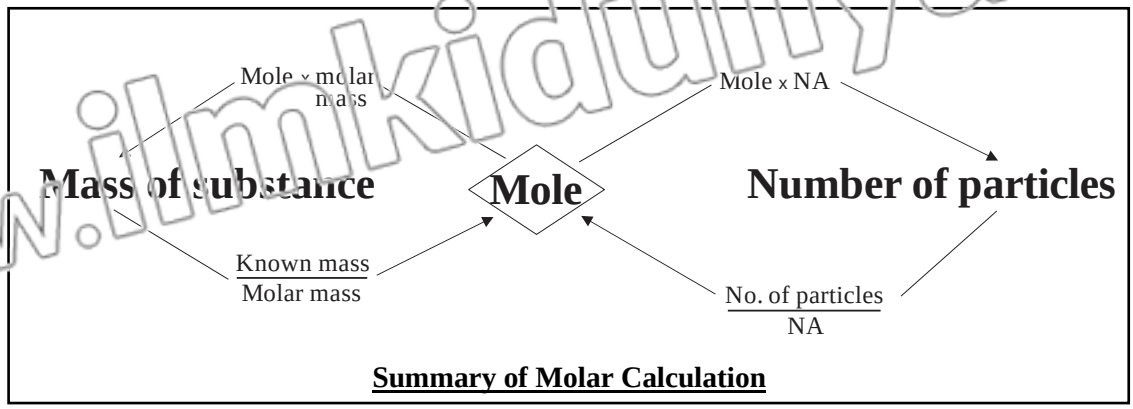
MOLE-PARTICLE CALCULATIONS

In these calculations we can calculates the number of moles of a substance from the given number of particles. (These particles are the atoms, molecules or formula unit).

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

On rearranging the above equation we get,

Number of particles = Number of moles × 6.02×10^{23}



Summary of Molar Calculation

1.6 CHEMICAL CALCULATIONS
1.6.1 MOLE-MASS CALCULATIONS1.6.2 MOLE PARTICLE CALCULATIONS

SHORT QUESTIONS

Q.1 How to calculate number of particles from mass of a substance?
(Remember pg. # 21)*(U.B)*

Ans: **NUMBER OF PARTICLES FROM MASS**

Never calculate the number of particles from mass of the substance or vice versa. Always make calculation through moles.

Q.2 How to calculate number of atoms in molecular compounds and number of ions in ionic compounds. **(Remember pg. # 21)*(U.B)***

Ans: **CALCULATION OF NUMBER OF ATOMS AND IONS**

For calculation of the number of atoms in molecular compounds and the number of ions in ionic compounds first calculate the number of molecules or formula units and then calculate the number of atoms or ions.

NUMERICAL EXAMPLES

NUMERICAL EXAMPLE 1.4

Calculate the gram molecule (number of moles) in 40 g of H_3PO_4. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Given mass of H_3PO_4 = 40g

Molecular mass of H_3PO_4 = $98 gmol^{-1}$

To Find:

Number of moles (gram molecules) = ?

Calculations:

$$\text{Number of gram molecules} = \frac{\text{Mass of substance}}{\text{Molar mass of substance}}$$

$$= \frac{40}{98}$$

$$= 0.408 \text{ mol}$$

Result:

Therefore, 40g of H_3PO_4 will contain **0.408** gram molecule of H_3PO_4.

NUMERICAL EXAMPLE 1.5

You have a piece of coal (carbon) weighing 9.0 gram. Calculate the number of mol of coal in the given mass. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Mass of coal (carbon) = 9g

To Find:

No of moles of coal = ?

Calculations:

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

$$= \frac{9}{12}$$

$$= 0.75 \text{ mol}$$

Result:

Thus, 9g of coal is equivalent to **0.75 mol.**

NUMERICAL EXAMPLE 1.6

Calculate the number of moles, number of molecules and number of atoms present in 6 grams of water. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

The known mass of water = 6g

Molar mass of Water (H_2O) = 18 g

To Find:

Number of moles of water = ?

Number of molecules of water = ?

Number of atoms of water = ?

NUMERICAL 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. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Number of molecules of CO_2 = 3.01×10^{23} molecules

To Find:

Number of moles of CO_2 =?

Mass of CO_2 =?

Calculations:

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

= 6/18

= 0.33 mol

Number of molecules of water = Number of moles x N_A

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

= 1.98×10^{23} molecules

Thus, the number of molecules contained in 6 grams of water is 1.98×10^{23}. As we know 1molecule of water consists of 3 atoms, therefore:

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

= 5.94×10^{23} atoms

Result:

Number of moles, number of molecules and number of atoms is **0.33mol, 1.98×10^{23}** and **5.94×10^{23}**, respectively, present in 6g of water.

Calculations:

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

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

Number of moles of CO_2 = $\frac{3.01\times10^{23}}{6.02\times10^{23}}$

Number of moles of CO_2 = 0.5 mol

Then by putting this value in this equation we get:

Mass of substance = number of moles x molar mass

Mass of $CO_2 = 0.5 \times 44$

Mass of CO_2 = 22g

Result:

Number of moles of carbon dioxide is **0.5 mol** and its mass is **22g**.

1.6 CHEMICAL CALCULATIONS

1.6.1 MOLE-MASS CALCULATIONS1.6.2 MOLE PARTICLE CALCULATIONS

MULTIPLE CHOICE QUESTIONS

1. The mass of 1.2 moles of H_2SO_4 is: ***(U.B)***

(A) 98g (B) 196g (C) 117.6g (D) 125g

2. Which one of the following pairs has the same mass? ***(U.B)***

(A) 1 mole of H_3PO_4 and 1 mole of H_2SO_4 (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 if CO_2

3. There are 3.01×10^{23} molecules of CO_2 present in a container. What is the number of moles in it? ***(U.B)***

(A) 22 mol (B) 0.5 mol (C) 1.7 mol (D) 2.2 mol

4. 9 g of carbon has number of moles: ***(U.B)***

(A) 0.75 mol (B) 9 mol (C) 0.5 mol (D) 3 mol

1.7 TEST YOURSELF

i. How many atoms of sodium are present in 3 moles of sodium and what is the mass of it? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Number of moles of sodium = 3 mol

To Find:

(i) Number of atoms of sodium in 3 moles = ?

(ii) Mass of 3 moles of sodium = ?

Calculations:

(i) Number of atoms present in 1 mole of sodium = 6.02×10^{23} atoms

Number of atoms present in 3 moles of sodium = $3\times6.02\times10^{23}$ atoms

= 18.06×10^{23} atoms

= 1.806×10^{24} atoms

(ii) Mass of substance = Number of moles of Na × molar mass of Na

= $3\text{mol} \times 23\text{gmol}^{-1}$

= 69 g

Result:

1.806×10^{24} atoms are present in three moles of sodium and its mass is 69g.

ii. How many atoms are in 1 amu and 1 g of hydrogen (H)? *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Atomic mass of hydrogen = 1 amu
Molar mass of hydrogen = 1g

To Find:

Number of atoms in 1 amu and 1 g of hydrogen =?

Calculations:

Atomic mass of hydrogen = Molar mass of hydrogen

Number of atoms in 1g of hydrogen $= \frac{\text{Given mass}}{\text{Molar mass}} \times N_A$

$= \frac{1g}{1g} \times 6.02\times10^{23}$

$= 6.02\times10^{23}$ atoms

Number of atoms in 1 amu of hydrogen $= 6.02\times10^{23}$ atoms

Result:

6.02×10^{23} atoms are present in 1 amu and 1g of hydrogen.

iii. How many atoms are present in 16 g of O and 8g of S? *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Mass of Oxygen atom O = 16 g
Molar mass of Oxygen O = 16 g
Given mass of sulphur S = 8g
Molar mass of sulphur S = 32g

To Find:

Number of atoms in 16g of O = ?
Number of atoms in 8g of sulphur S = ?

Calculations:

Number of atoms of Oxygen $= \frac{\text{Given mass}}{\text{Molar mass}} \times N_A$

$= \frac{16g}{16g} \times 6.02\times10^{23}$

$= 6.02\times10^{23}$ atoms

Calculations:

Number of atoms of sulphur, S $= \frac{\text{Given mass}}{\text{Molar mass}} \times N_A$

$= \frac{8g}{32gmol^{-1}} \times 6.02\times10^{23}$

$= 1.505\times10^{23}$ atoms

Result:

6.02×10^{23} atoms are present in 16g of oxygen and 1.505×10^{23} atoms are present in 8g of sulphur.

iv. Is the mass of 1 mole of O and 1 mole of S same? *(U.B)*

Ans: As Mass of 1 mole of O = 16g
Mass of 1 mole of S = 32g
Hence, the mass of 1 mole of O and 1 mole of S is not the same.

v. What do you mean by 1 atom of C and 1 gram atom of C? *(U.B)*

Ans:

ONE ATOM AND ONE GRAM ATOM OF C

1 atom of carbon means single smallest particle of carbon with mass 12 amu.
On the other hand, 1 gram atom means 12 g or 1 mole of carbon having 6.02×10^{23} carbon atoms.

vi. If 16g of oxygen contains 1 mole of oxygen atoms calculate the mass of one atom of oxygen in grams. *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

16 g of oxygen = 1 mole of oxygen atoms

To Find:

Mass of 1 atom of oxygen in grams = ?

Calculations:

16g of oxygen = 1 mole of oxygen = 6.02×10^{23} atoms
Therefore, mass of 6.02×10^{23} atoms of oxygen = 16g

$$\text{Mass of 1 atom of oxygen} = \frac{16}{6.02\times10^{23}}$$
$$= 2.65\times10^{-23}\ \text{g}$$

vii. How many times is 1 mole of oxygen atoms heavier than 1 mole of hydrogen atoms? *(U.B)*

Ans:

OXYGEN AND HYDROGEN

Mass of 1 mole of oxygen atoms = 16g
Mass of 1 mole of hydrogen atoms = 1g
Therefore, 1 mole of oxygen atoms is 16 times heavier than that of 1 mole of hydrogen atoms.

viii. Why does 10 g nitrogen gas contain the same number of molecules as 10 g of carbon monoxide? *(U.B+A.B)*

Ans:

$$\text{Number of moles of nitrogen gas} = \frac{\text{Given mass of substance}}{\text{Molar mass of substance}}$$
$$= \frac{10}{28}$$
$$= 0.35\ \text{mol}$$

Number of molecules of nitrogen gas (N_2) = number of mole $\times N_A$
$= 0.35 \times 6.02 \times 10^{23}$
$= 2.107 \times 10^{23}$ molecules

$$\text{Number of moles of carbon monoxide} = \frac{\text{Given mass of substance}}{\text{Molar mass of substance}}$$
$$= \frac{10}{28}$$
$$= 0.35\ \text{mol}$$

Number of molecules of CO = number of mole $\times N_A$
$= 0.35 \times 6.02 \times 10^{23}$
$= 2.107 \times 10^{23}$ molecules

Hence it is proved that 10g nitrogen gas contains the same number of molecules as 10g of carbon monoxide because both gases have same molar mass that is i.e. 28g.

ANSWER KEYS

1.1 BRANCHES OF CHEMISTRY

1	D	2	C	3	A	4	B	5	C	6	B

1.2.1 ELEMENTS COMPOUNDS AND MIXTURE

1	B	2	C	3	A	4	D	5	D	6	D	7	B	8	D	9	C	10	A
11	A	12	C	13	A	14	A	15	A	16	B	17	C	18	B	19	B	20	B
21	A	22	A	23	D	24	D												

1.2.2 ATOMIC NUMBER AND MASS NUMBER

1	B	2	A	3	A	4	D	5	A	6	A	7	C

1.2.4 HOW TO WRITE CHEMICAL FORMULA
1.2.5 MOLECULAR MASS AND FORMULA MASS

1	A	2	A	3	D	4	B	5	B	6	B	7	D
8	C	9	B	10	A	11	B	12	A	13	C	14	A

1.3 CHEMICAL SPECIES

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

1.3.2 TYPES OF MOLECULE

1	C	2	D	3	A	4	B	5	A

1.4 GRAM ATOMIC MASS, GRAM MOLECULAR MASS, GRAM FORMULA MASS

1	A	2	A	3	B	4	B

1.5 AVAGADRO'S NUMBER AND MOLE

1	C	2	A	3	A

1.6 CHEMICAL CALCULATIONS

1	C	2	A	3	B	4	A

EXERCISE SOLUTION

MULTIPLE CHOICE QUESTIONS

1. Industrial chemistry deals with the manufacturing of compounds: **(GRW 2016 G-I, SGD 2017 G-I, BWP 2016 G-I, II, 2017 G-II)*(U.B+K.B)***

(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? **(BWP 2016, 17 G-II, SGD 2016 G-I)*(U.B)***

(A) Mixture (B) Element (C) Compound (D) Radical

3. The most abundant element occurring in the oceans is: ***(K.B)***
(BWP 2017 G-II, MTN 2016, 17 G-I, SGD 2017 G-II, SWL 2017 G-II, RWP 2016, 17 G-II, GRW 2016 G-II, FSD 2016 G-I)

(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?** **(MTN 2016 G-II)*(K.B)

(A) Oxygen (B) Aluminum (C) Silicon (D) Iron

5. The third abundant gas found in the atmosphere is: **(DGK 2017 G-II)*(K.B)***

(A) Carbon monoxide (B) Oxygen (C) Nitrogen (D) Argon

6. One amu (atomic mass unit) is equivalent to: **(RWP 2017 G-I)*(K.B)***

(A) 1.66×10^{-24} mg (B) 1.66×10^{-24}g (C). 1.66×10^{-21}g (D) 1.66×10^{-23}g

7. All of the following are triatomic molecule except:
(GRW 2016 G-II, RWP 2017 G-I, SGD 2017 G-II, BWP 2016 G-II, FSD 2016 G-I)*(U.B)*

(A) H_2 (B) O_3 (C) H_2O (D) CO_2

8. The mass of one molecule of water is: **(LHR 2016, 17 G-I,II, DGK 2016 G-I, FSD 2016, G-II)*(K.B)***

(A) 18 amu (B) 18 g (C) 18 mg (D) 18 kg

9. The molar mass of H_2SO_4 is: **(LHR 2017 G-I, GRW 2016 G-I, MTN 2016 G-I)*(U.B+K.B)***

(A) 98 g (B) 48 amu (C) 4.8 g (D) 98 amu

10. Molar mass is usually expressed in grams, which one of the following is molar mass of O_2 in amu? ***(U.B)***

(A) 32 amu (B) 53.2×10^{-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?
(BWP 2017 G-I, DGK 2016 G-I)*(U.B)*

(A) 0.15 (B) 0.18 (C) 0.21 (D) 0.24

12. Which one of the following pairs has the same number of ions? **(LHR 2016 G-I)*(U.B)***

(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 following pairs has the same mass? **(SWL 2017 G-I)*(U.B)***

(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_2

ANSWER KEY

1	**c**	**3**	**a**	**5**	**d**	**7**	**a**	**9**	**a**	**11**	**b**	**13**	**a**
2	**a**	**4**	**a**	**6**	**b**	**8**	**a**	**10**	**a**	**12**	**c**		

EXERCISE SHORT QUESTIONS

1. Define industrial chemistry and analytical chemistry. **(RWP 2017 G-I)*(U.B)***

Ans: *Answer given on pg # 03*

2. How can you differentiate between organic and inorganic chemistry?
(RWP 2017 G-II, LSL 2017 G-II)*(U.B)*

Ans: *Answer given on pg # 02 & 03*

3. Give the scope of biochemistry. **(BWP 2017 G-II, DGK 2017 G-II)*(A.B)***

Ans:

SCOPE OF BIOCHEMISTRY

It covers all chemical processes taking place in living organisms such as synthesis and metabolism of bio-molecules like carbohydrates, proteins, fats etc.

Applications:

Applications of biochemistry are in the fields of medicine, food science and agriculture.

4. How does homogeneous mixture differ from heterogeneous mixture?
(BWP 2017, FSD 2017 G-I)*(U.B)*

Ans:

DIFFERENTIATION

The differences between homogeneous and heterogeneous mixture are as follows:

Homogeneous Mixture	Heterogeneous Mixture
Definition	
• Mixtures that have uniform composition throughout are called homogeneous mixtures. It is called solution.	• Those mixtures in which composition is not uniform throughout are called heterogeneous mixtures.
Examples	
• Air • Gasoline • Ice cream	• Soil • Rock • Wood

5. What is the relative atomic mass? How it is related to gram? ***(U.B+K.B)***

Ans:

RELATIVE ATOMIC MASS

Definition:

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

Unit of Relative Atomic Mass:

Its unit is atomic mass unit, with symbol amu.

Atomic mass unit:

"One atomic mass unit is 1/12th the mass of one atom of carbon-12th."

RELATION BETWEEN RELATIVE ATOMIC MASS AND GRAM

When this atomic mass unit is expressed in grams it is:

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

6. Define empirical formula with example. **(FSD 2016 G-II)*(A.B+K.B)***

Ans: *"A formula that indicates the* ***simplest whole number ratio of atoms of different elements present in a compound*** *is called an empirical formula."*

Example:

Glucose has simplest ratio **1:2:1** of **carbon**, **hydrogen** and **oxygen** respecuvely. Hence its empirical formula is **CH_2O**.

Glucose = C : H : O
= 6 : 12 : 6
= 1 : 2 : 1

Thus empirical formula of glucose = **CH_2O**

7. State three reasons why do you think air is a mixture and water is a compound? ***(U.B)***

Ans:

AIR IS MIXTURE AND WATER A COMPOUND

Reasons:

- 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.
- Water has fixed ratio between masses of hydrogen and oxygen, whereas in air ratio between masses of component gases is not fixed.
- Water has definite melting and boiling points whereas air does not have any fixed melting and boiling point.

8. Explain why are hydrogen and oxygen considered elements whereas water as a compound. *(U.B)*

Ans:

H AND O AS ELEMENTS AND H_2O A COMPOUND

Elements:

Hydrogen and oxygen are elements because they have same type of atoms, having same atomic number and it cannot be decompose into simple substances by chemical means.

Compound:

Water is considered as compound because it is a substance made up of two or more elements chemically combined together in a fixed ratio by mass. As a result of this combination oxygen and hydrogen lose their own properties and produce new substance (H_2O).

9. What is the significance of the symbol of an element? *(U.B)*

Ans:

SIGNIFICANCE OF SYMBOL

Symbols are used for elements instead of writing of their complete names. So, it takes less time/saves time and element can be recognized by that symbol in all over the world.

(i) Symbol represents the name of an element.

(ii) It represents one atom of the element

(iii) It helps to write and understand chemical equation for different chemical reactions.

(iv) Periodic table is based on symbols of different elements.

Examples:

- Oxygen (O)
- Sulphur (S)
- Nitrogen (N)

10. State the reasons, soft drink is a mixture and water is a compound. *(U.B)*

Ans:

DIFFERENTIATION

The reasons for soft drink is a mixture and water is a compound are as follows:

Soft Drink (Mixture)	Water (Compound)
Combination	
• Soft drink is made up of simple mixing up of substances without any fixed ratio.	• Water is formed by chemical combination of atoms of elements hydrogen and oxygen in a fixed ratio of 1:8 by mass.
Composition	
• Soft drink has heterogeneous composition.	• Water has homogeneous composition.
Separation of Components	
• Its components can be separated by physical means.	• Its components can't be separated by physical means

11. Classify the following into element, compound and mixture: *(U.B+A.B)*

- **He and H_2**
- **CO and CO_2**
- **Water and milk**
- **Gold and brass**
- **Iron and steel**

Ans:

(i) He and H_2:

He and H_2 are elements.

(ii) CO and CO_2:

CO is a compound and CO_2 is an element.

(iii) Water and Milk:

Water is a compound and milk is a mixture.

(iv) Gold and Brass:

Gold is an element and brass is a mixture.

(v) Iron and Steel:

Iron is an element and steel is a mixture.

12. Define atomic mass unit. Why is it needed? *(K.B+A.B)*

Ans:

ATOMIC MASS UNIT

Definition:

"It is one twelfth of the mass of a carbon -12 atom is called atomic mass unit."

The atomic mass unit is abbreviated as amu.

1 amu = 1/12 × mass of C-12 atom

NEED OF ATOMIC MASS UNIT

The mass of an atom is too small to be determined practically. However relative atomic mass (ratio of atomic mass of certain element to that of C-12 atom). The unit of relative atomic mass is amu.

13. State the nature and name of the substance formed by combining the following: *(U.B)*

i. Zinc + Copper ii. Water + Sugar iii. Aluminium + Sulphur

iv. Iron + Chromium + Nickel

Ans:

NATURE AND NAMES OF SUBSTANCES

(i) Zinc + Copper:

It is a mixture or alloy. The name of alloy is brass.

(ii) Water + Sugar:

It is a mixture. The name of mixture or solution is syrup.

(iii) Aluminium + Sulphur:

It forms compound. The name of compound is aluminium sulphide.

(iv) Iron + Chromium + Nickel:

It is a mixture or alloy. The name of alloy is nichrome.

14. Differentiate between molecular mass and formula mass, which of the following will be molecular formula? H_2O, NaCl, Kl, H_2SO_4 *(U.B)*

Ans:

DIFFERENTIATION

The differences between molecular mass and formula mass are as follows:

Molecular Mass	Formula Mass
Definition	
• The sum of atomic masses of all the atoms present in one molecule of a molecular substance called molecular mass.	• The sum of atomic masses of all the atoms present in one formula unit of an ionic compound is called formula mass.
Application	
• The term molecular mass is used for compounds that exist as molecules.	• The term formula mass is used for compounds that exist as formula units i.e. the compounds consist of ions.
Example	
• Molecular mass of water is 18 amu and that of carbon dioxide is 44 amu.	• Formula mass of sodium chloride is 58.5 amu and that of $CaCO_3$ is 100. amu.

Molecular Formulas:

H_2O and H_2SO_4 are the molecular formulas.

15. Which has more atoms: 10 g of A*l* or 10 g of Fe? *(U.B+A.B)*

Ans:

NUMERICAL

Given Data:

Given mass of Al = 10g

Given mass of Fe = 10g

To Find:

Which one (Al or Fe) has more atoms = ?

Calculations:

10 g of Al has more atoms than 10 g of Fe.

(i) Given mass of Al = 10g

Molar mass of Al = 27 g mol^{-1}

Number of atoms in 10g of Al = Number of moles × N_A

$$\text{Number of atoms of Al} = \frac{\text{Mass of subtance}}{\text{Molar Mass of substance}} \times N_A$$

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

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

(ii) Given mass of Fe = 10g

Molar mass of Fe = 56 g mol^{-1}

$$\text{Number of atoms of Fe} = \frac{\text{Mass of subtance}}{\text{Molar Mass of substance}} \times N_A$$

$$= \frac{10}{56} \times 6.02 \times 10^{23}$$

$$= 1.075 \times 10^{23}$$

Result:

10 g of aluminium has more number of atoms than 10g of iron.

16. Which one has more molecules: 9 g of water or 9 g of sugar ($C_{12}H_{22}O_{11}$)? *(U.B+A.B)*

Ans:

NUMERICAL

Given Data:

Given mass of water (H_2O) = 9 g

Given mass of sugar = 9 g

To Find:

Which one has more molecules = ?

Calculations:

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

Molar mass of water (H_2O) = 18 g mol^{-1}

$$\text{Number of molecules in 9g of water} = \frac{\text{Mass of subtance}}{\text{Molar Mass of substance}} \times N_A$$

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

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

(ii) Given mass of sugar ($C_{12}H_{22}O_{11}$) = 9 g

Molar mass of sugar ($C_{12}H_{22}O_{11}$) = 342 g mol^{-1}

$$\text{Number of molecules in 9g of sugar} = \frac{\text{Mass of subtance}}{\text{Molar Mass of substance}} \times N_A$$

$$= \frac{9}{342} \times 6.02 \times 10^{23}$$

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

Result:

9 g of H_2O has more molecules than 9 g of $C_{12}H_{22}O_{11}$.

17. Which one has more formula units: 1 g of NaC*l* or 1 g of KC*l*? *(U.B+A.B)*

Ans:

NUMERICAL

Given Data:

Given mass of NaCl = 1g

Given mass of KCl = 1g

To Find:

Which one has more formula units = ?

Calculations:

(i) Given mass of NaCl = 1g

Formula mass of NaCl = 58.5 g mol^{-1}

$$\text{Formula units in 1g of NaCl} = \frac{\text{Mass of subtance}}{\text{Formula mass of substance}} \times N_A$$

$$= \frac{1}{58.5} \times 6.02 \times 10^{23}$$

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

(ii) Given mass of KCl = 1g

Formula mass of KCl = 74.5 g mol^{-1}

$$\text{Formula units in 1g of KCl} = \frac{\text{Mass of subtance}}{\text{Formula mass of substance}} \times N_A$$

$$= \frac{1}{74.5} \times 6.02 \times 10^{23}$$

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

Result:

1g of NaCl has more formula units than 1g of KCl.

18. Differentiate between homoatomic and heteroatomic molecules with examples. *(U.B)*

Ans:

DIFFERENTIATION

The differences between homoatomic molecules and heteroatomic molecules are as follows:

Homoatomic Molecules	Heteroatomic Molecules
Definition	
• A molecule containing same type of atoms is called homoatomic molecule.	• A molecule consisting of different kinds of atoms is called heteroatomic molecule.
Nature	
• These are molecules of elements.	• These are molecules of compounds.
Examples	
• Hydrogen (H_2) • Oxygen (O_3) • Sulphur (S_8)	• Carbon dioxide (CO_2) • Water (H_2O) • Ammonia (NH_3)

19. In which one of the following, the number of hydrogen atoms is more? 2 moles of HCl or 1 mole of NH_3 (Hint: 1 mole of a substance contains as much number of moles of atoms as are in 1 molecule of a substance). *(U.B)*

Ans:

NUMBER OF HYDROGEN ATOMS

Number of moles of hydrogen in 1 mole of HCl = 1 mole
Number of moles of hydrogen in 2 moles of HCl = 2 moles
Whereas number of moles of hydrogen in 1 mole of NH_3 = 3 moles

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

EXERCISE LONG QUESTIONS

1. Define element and classify the elements with examples. *(U.B+K.B)*

Ans: *Answer given on pg # 07*

2. Mole is SI unit for the amount of a substance. Define it with examples? *(K.B)*

Ans: *Answer given on pg # 33*

3. List five characteristics by which compounds can be distinguished from mixtures. *(U.B)*

Ans: *Answer given on pg # 12*

4. Differentiate between the following with examples: *(U.B)*

(A) Molecule and gram molecule **(B) Atom and gram atom**
(C) Molecular mass and molar mass **(D) Chemical formula and gram formula**

Ans:

A. Molecule and gram molecule:

DIFFERENTIATION

The differences between molecule and gram molecule are as follows:

Molecule	Gram Molecule
• It is the smallest particle of substance which can exist independently and shows all the properties of that substance (element or compound).	• The molecular mass of an element or a compound expressed in grams is called gram molecule or gram molecular mass.
Examples	
One molecule of water = H_2O	Gram molecule of water = 18g

B. Atom and gram atom

DIFFERENTIATION

The differences between atom and gram atom are as follows:

Atom	Gram Atom
• The smallest particle of an element which can take part in chemical reaction and may or may not exist independently is called an atom.	• The atomic mass of an element expressed in grams is called gram atomic mass or gram atom.
Example	
• One atom of H = 1 amu	• One gram atom of H = 1g

C. Molecular mass and molar mass

DIFFERENTIATION

The differences between molecular mass and molar mass are as follows:

Molecular Mass	Molar Mass
• The sum of atomic masses of all the atoms present in one molecule of a molecule substance, is its molecular mass.	• The molar mass is a physical property defined as the mass of a given substance (chemical element or chemical compound) divided by the no. of moles of substance.
Examples	
• Molecular mass H_2O = 18amu	• Molar mass of H_2 = 2g • Molar mass of NaCl = 58.5g

D. Chemical formula and gram formula

DIFFERENTIATION

The differences between chemical formula and gram formula are as follows:

Chemical Formula	Gram Formula
• The representation of an element or a compound in terms of symbols is called chemical formula.	• The formula mass of an ionic compound expressed in grams is called gram formula mass or gram formula.
Examples	
• Chemical formula of chlorine = Cl_2 • Chemical formula of water = H_2O	• Gram formula of NaCl = 58.5g

EXERCISE SOLVED NUMERICALS

1. 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 weigh? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Number of moles of H_2SO_4 = 5 moles

Molar mass of H_2SO_4 = 2(1)+1(32)+4(16)
= 2 + 32 + 64
= 98 g/mol

To Find:

Mass of H_2SO_4 = ?

Calculations:

$$\text{Number of moles of } H_2SO_4 = \frac{\text{Mass of } H_2SO_4}{\text{Molar mass of } H_2SO_4}$$

Mass of H_2SO_4 = Number of moles × molar mass
= 5×98
= 490 g

Result:

5 moles of sulphuric acid will have mass **490 g**.

---

2. 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? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Given Mass of $CaCO_3$ = 40g

Molar mass of $CaCO_3$ = (40×1)+(12×1)+(16×3)
= 40 + 12 + 48
= 100 g/mol

To Find:

Number of Ca^{2+} ions = ?

Number of CO_3^{2-} ions = ?

Calculations:

$$\text{Number of moles of } CaCO_3 = \frac{\text{Given Mass}}{\text{Molar mass}}$$

$$= \frac{40}{100} = 0.4 \text{ mol}$$

Balanced equation for dissociation of calcium carbonate is as follows:

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

Number of moles of $CaCO_3$ = 0.4 mole

Number of moles of Ca^{2+} ions in one mole of $CaCO_3$ = 6.02×10^{23}

No. of Ca^{2+} ions in 0.4 mol of $CaCO_3$ = No. of moles × N_A
= $0.4\times6.02\times10^{23}$
= 2.408×10^{23} ions

We know that:

Number of Ca^{2+} ions = Number of CO_3^{2-} ions

Number of CO_3^{2-} = 2.40×10^{23} ions

Result:

2.408×10^{23} ions of Ca^{+2} and **2.408×10^{23}** ions of CO_3^{2-} are present in 40g of calcium carbonate.

---

3. If you have 6.02×10^{23} ions of aluminium; how many sulphate ions will be required to prepare $Al_2(SO_4)_3$? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Number of ions of Al^{3+} = 6.02×10^{23} ions

To Find:

Number of sulphate ions in $Al_2(SO_4)_3$ =?

Calculations:

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

According to balanced chemical equation:

Number of moles of SO_4^{2-} ion required for 2 moles of Al^{3+} ions = 3

Number of moles of SO_4^{2-} ions for 1 mole of Al^{3+} = 3/2 = 1.5 moles

Thus, number of SO_4^{2-} ions = Number of moles × N_A
= $1.5\times6.02\times10^{23}$
= 9.03×10^{23} ions

Results:

9.03×10^{23} ions are required to prepare $Al_2(SO_4)_3$.

4. Calculate the number of molecules of the following compounds: ***(U.B+A.B)***

a. 16 g of H_2CO_3 **b. 20 g of HNO_3**

c. 30 g of $C_6H_{12}O_6$

NUMERICAL

Solution:

Given Data:

Given mass of H_2CO_3 = 16g

Given mass of HNO_3 = 20g

Given mass of $C_6H_{12}O_6$ = 30g

To Find:

Number of molecules of H_2CO_3 = ?

Number of molecules of 20g of HNO_3 = ?

Number of molecules of 30g of $C_6H_{12}O_6$ =?

Calculations:

(a) 16g of H_2CO_3:

Guven mass of H_2CO_3= 16g

Molar mass of H_2CO_3 = 2(1)+1(12)+3(16)

= 2 + 12 + 48

= 62g / mol

$$\text{Number of molecules} = \frac{\text{Given mass of } H_2CO_3}{\text{Molar mass of } H_2CO_3} \times N_A$$

$$= \frac{16}{62} \times 6.02\times10^{23}$$

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

Result:

16g of H_3CO_3 has **1.55×10^{23} molecules**.

(b) 20g of HNO_3:

Given mass of HNO_3 = 20g

Molar mass of HNO_3 = 1(1)+1(14)+3(16)

= 1+14+48=63g/mol

Number of molecules of HNO_3 = ?

$$\text{Number of molecules of } HNO_3 = \frac{\text{Given mass of } HNO_3}{\text{Molar mass of } HNO_3} \times N_A$$

$$= \frac{20}{63} \times 6.02\times10^{23}$$

$$= 1.91\times10^{23} \text{ molecules}$$

Result:

20g of HNO_3 has **1.91×10^{23} molecules**.

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

Given mass of $C_6H_{12}O_6$ = 30g.

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

= 72 + 12 + 96

= 180g / mol

$$\text{Number of moles of } C_6H_{12}O_6 = \frac{\text{Given mass of } C_6H_{12}O_6}{\text{Molar mass of } C_6H_{12}O_6} \times N_A$$

$$= \frac{30}{180} \times 6.02\times10^{23}$$

$$= 1\times10^{23} \text{ molecules}$$

Result:

30g of $C_6H_{12}O_6$ has **1×10^{23} molecules**.

---

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

a. 10g of $AlCl_3$ **b. 30 g of $BaCl_2$**

c. 58 g of H_2SO_4

NUMERICAL

Solution:

Given Data:

Given mass of $AlCl_3$ = 10g

Given mass of $BaCl_2$ = 30g

Given mass of H_2SO_4 = 58g

To Find:

Number of ions in 10g of $AlCl_3$ = ?

Number of ions in 30g of $BaCl_2$ = ?

Number of ions in 58g of H_2SO_4 = ?

Calculations:

(a) 10g of $AlCl_3$:

Given mass of $AlCl_3$ = 10g

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

= 133.5 g / mol

Number of ions of $AlCl_3$ = ?

$$\text{Number of formula units} = \frac{\text{Given mass of } AlCl_3}{\text{Molar mass of } AlCl_3} \times N_A$$

$$= \frac{10}{133.5} \times 6.02\times10^{23}$$

$$= 0.451\times10^{23} \text{ formula units}$$

1 formula unit of $AlCl_3$ contains total number of ions = 4 ions

4.51×10^{22} formula units of $AlCl_3$ contain total number of ions = $4\times0.451\times10^{23}$

$=1.80\times10^{24}$ ions

Result:

10g of $AlCl_3$ has **1.80×10^{24}** ions.

(b) 30g of $BaCl_2$:

Given mass of $BaCl_2$ = 30g

Molar mass of $BaCl_2$ = 1(137)+2(35.5)

= 137+71=208 g/mol

Number of ions of 30g of $BaCl_2$ = ?

Number of formula units = $\frac{\text{Given mass of } BaCl_2}{\text{Molar mass of } BaCl_2} \times N_A$

$= \frac{30}{208} \times 6.02\times10^{23}$

$= 0.86\times10^{23}$ formula units

1 formula unit of $BaCl_2$ contains total number of ions = 3

0.86×10^{23} formula units of $BaCl_2$ will contain total number of ions = $3\times0.86\times10^{23}$ ions

$= 2.58\times10^{23}$ ions

Result:

20g of $BaCl_2$ has **2.58×10^{23}** ions.

(c) 58g of H_2SO_4:

Given mass of H_2SO_4 = 58g

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

=2+32+64

=98 g/mol

Number of ion of H_2SO_4 = ?

Number of formula units = $\frac{\text{Given mass of } H_2SO_4}{\text{Molar mass of } H_2SO_4} \times N_A$

$= \frac{58}{98} \times 6.02\times10^{23}$

$= 3.56\times10^{23}$ formula units

1 formula unit of H_2SO_4 contains total number of ions = 3 ions

3.56×10^{23} formula units of H_2SO_4 contain total number of ions = $3\times3.56\times10^{23}$

$= 10.682\times10^{23}$ ions

Result:

30g of H_2SO_4 has **1.068×10^{24}** ions

---

6. What will be the mass of 2.05×10^{16} molecules of H_2SO_4 *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Number of molecules of H_2SO_4 = 2.05×10^{16}

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

= 2+32+64

= 98g/mol

To Find:

Mass of H_2SO_4 = ?

Calculations:

Number of molecules of H_2SO_4 = $\frac{\text{Mass of } H_2SO_4}{\text{Molar mass of } H_2SO_4} \times N_A$

$2.05\times10^{16} = \frac{\text{Mass of } H_2SO_4}{98} \times 6.02\times10^{23}$

Mass of H_2SO_4 = $\frac{2.05\times10^{16}\times98}{6.02\times10^{23}}$

$= 3.337\times10^{-6}$g

Result:

Mass of sulphuric acid is 3.337×10^{-6}g.

---

7. How many total atoms are required to prepare 60 g of HNO_3? *(U.B+A.B)*

NUMERICAL

Solution:

Given data:

Given mass of HNO_3 = 60g

Molar mass of HNO_3 = 1(1)+1(14)+3(16)

= 1 + 14 + 48

= 63g / mol

To Find:

Number of atoms of HNO_3 = ?

Calculations:

Number of molecules of HNO_3 = $\frac{\text{Given mass of } HNO_3}{\text{Molar mass of } HNO_3} \times N_A$

$= \frac{60}{63} \times 6.02\times10^{23}$

$= 0.95\times6.02\times10^{23}$ moles

$= 5.73\times10^{23}$ molecules

As one molecule of HNO_3 contain atoms = 5 atoms

Therefore, 5.73×10^{23} molecules contain

Number of atoms = $5\times5.73\times10^{23}$

$= 28.5 \times 10^{23}$

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

Result:

2.87×10^{24} atoms are required to prepare 60g of HNO_3.

---

8. How many ions of Na^+ and Cl^- will be present in 30 g of NaCl? *(U.B+A.B)*

NUMERICAL

Solution:

Given Data:

Given mass of NaCl = 30g

Molar mass of NaCl = 1(23)+3(35.5)

= 23 + 35.5

= 58.5g / mol

To Find:

Number of Na^+ ions = ?

Number of Cl^- ions = ?

Calculations:

$$\text{Number of formula units of NaCl} = \frac{\text{Given mass of NaCl}}{\text{Molar mass of NaCl}} \times N_A$$

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

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

As,

1 formula unit of NaCl contains number of Na^+ ions = 1

3.08×10^{23} formula units of NaCl contain number of Na^+ ions $= 3.08 \times 10^{23}$ ions

We knew that in NaCl:

Number of Na^+ ions = Number of Cl^- ion

Thus number of Cl ions = 3.08×10^{23}

Result:

Total number of sodium ions (Na^+) and chloride ions (Cl^-) = 6.16×10^{23} ions

---

9. How many molecules of HCI will be required to have 10 grams of it? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Given mass of HCl = 10g

Molar mass of HCl = 1(1)+1(35.5)

=1+35.5

= 36.5g / mol

To Find:

Number of molecules of HCl = ?

Calculations:

$$\text{Number of molecules of HCl} = \frac{\text{Given mass of HCl}}{\text{Molar mass of HCl}} \times N_A$$

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

$$= 1.64 \times 10^{23} \text{ molecules}$$

Result:

10 g of HCl will have **1.64×10^{23} molecules**.

10. How many grams of Mg will have the same number of atoms as 6 grams of C have? ***(U.B+A.B)***

NUMERICAL

Solution:

Given data:

Given mass of carbon = 6g

Atomic mass of carbon = 12 g/ mol

To Find:

Mass of Mg = ?

Calculations:

$$\text{Number of moles of carbon} = \frac{\text{Given mass of carbon}}{\text{Molar mass of carbon}}$$

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

$$= 0.5 \text{ mol}$$

Number of carbon atoms = Number of moles $\times N_A$

Number of carbon atoms in 0.5 moles of carbon = $0.5 \times 6.02 \times 10^{23}$ atoms

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

As,

The number of atoms of mg and carbon are same, so their number of moles are also equal.

Thus,

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

$$3.01 \times 10^{23} = \frac{\text{Mass of Mg}}{24} \times 6.02 \times 10^{23}$$

$$\text{Mass of Mg} = \frac{3.01 \times 10^{23} \times 24}{6.02 \times 10^{23}}$$

$$= 12g$$

Result:

12g of Mg will have same no. of atoms as 6g of carbon.

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 Why melting of ice is physical property while decomposition of water is a chemical property? (U.B)

Ans: Melting of ice is physical property because in this process only the physical state of water changing whereas its chemical composition remains same.

The decomposition of a water is chemical change as it produces hydrogen and oxygen gases and its chemical composition changes.

Q.2 Why are ionic compounds not called molecules? *(U.B)*

OR

Why is NaCl not a molecule? *(U.B)*

Ans: Ionic compounds do not exist as independent molecular form, they exist in three-dimensional network form. Each ion is surrounded by the oppositely charged ion to form crystal lattice so therefore they are not molecules and are called formula units.

Q.3 Why do ionic compounds have only empirical formulas? *(U.B)*

Ans: Ionic compounds do not exist in molecular form and are not molecules so they are not represented by molecular formulas. They exist in three-dimensional network arrangement and have only empirical formulas.

Q.4 Is mass number and relative atomic mass are same? If no then Justify why? *(U.B)*

Ans: No, mass number and relative atomic mass are not same.

Justification:

- Mass number is sum of protons and neutrons present in nucleus of an atom of an element. Whereas, relative atomic is average mass of atoms of an element as compared to $\frac{1}{12}$th (one-twelfth) the mass of an atom of carbon-12 isotope.
- Relative atomic mass of an element is calculated by comparison with carbon-12 isotope whereas, mass number can be calculated by following formula A = Z+n.

Q.5 Why free radical does is extremely reactive specie? (U.B)

Ans: Free radical is extremely reactive specie as it has tendency to complete its octet due to presence of unpaired electron in valence shell.

Q.6 What is meant homolytic (equal) breakage? (U.B)

Ans: If breaking of a bond between two atoms takes place such that each atom takes its electron is called homolytic breakage.

Q.7 Which chemical specie is stable specie and why? **(U.B)**

Ans: Molecule is stable chemical specie as molecule always exist independently.

Reason:

Because molecules contain stable covalent linkages which are formed by atoms to follow octet and duplet rules.

Q.8 Among ion and free radical, which one is more reactive specie and why? **(U.B)**

Ans: Free radical is more reactive specie than ion.

Reason:

Because free radical contains unpaired electron in valence shell and it has not follow octet or duplet rule whereas, usually ion is formed when an atom lose or gain electron to complete its octet or duplet rule.

Q.9 Why do noble gases (He, Ne, Ar, Kr, Xe, Rn) are called monoatomic molecules, although they exist in atomic form? ***(U.B)***

Ans: Nobel gases exist in atomic form because they are stable and exist independently just like molecules. Due to their independent existence they are called monoatomic molecules.

Q.10 Write down type of CH_4 molecule. Also give reasons. ***(U.B+A.B)***

Ans: CH_4 is both polyatomic and heteroatomicg molecule.

Reasons:

- It is polyatomic because it contains more than 4 atoms.
- It is hetero-atomic molecule because it contains different type of atoms.

Q.11 Why one mole of a substance contains equal no of particles but different masses. Explain with an example. ***(U.B)***

Ans: one mole of any substance contains 6.02×10^{23} equal no of particles but different masses as one dozen of egg and orange contains equal no of eggs and oranges which are twelve but different masses.

TERMS TO KNOW

Terms	Definitions
Substance	"A piece of **matter in pure form** is called substance."
Physical Properties	"The properties that are associated with the **physical state of a matter** are called physical properties".
Chemical Properties	"The properties that depend upon the **composition of the substance** are called chemical properties".
Elements	"The substance made up of **same type of atoms, having same atomic number** and it **cannot be decomposed** into simple substances by ordinary chemical means."
Valency	"The **combining capacity of an element** with other elements is called valency."
Radical	"A radical is a **group of atoms that has some charge.**"
Compounds	"Substance made up of **two or more elements chemically combined together** in a **fixed ratio by mass** is called compound."
Mixtures	"A **mixture** is made up of **two or more elements or compounds (substances) mixed up physically without any fixed ratio**."
Atomic No.	"The **number of protons present in the nucleus of an atom** of the element is called atomic number."
Mass No.	"The **sum of number of protons and neutrons present in the nucleus of an atom** is called mass number."
Empirical formula	"A formula that indicates the **simplest whole number ratio of atoms of different elements present in a compound** is called an empirical formula."
Molecular formula.	"A formula that indicates **actual number of atoms of each element present in a molecule of that compound** is called molecular formula."
Atom	It is smallest particle of an element.
Molecule	"It is the **smallest particle of a substance which can exist independent** and shows all the properties of that substance (element or a compound)".
Ion	It is the smallest unit of an ionic compound.
Molecular Ion	It is formed by gain or loss of electrons by a molecule.
Molecular Mass	"The **sum of atomic masses of all the atoms present in one molecule of a molecular substance** is its molecular mass."
Formula Mass	"The **sum of atomic masses of all the atoms present in one formula unit of an ionic compound** is called formula mass."
Free Radical	"Atoms or group of atoms **possessing odd number of (unpaired) electrons** are called free radicals."
Avogadro's No.	"The **number of particles in one mole of a substance** is called Avogadro's number."
Mole	"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)** is called a mole."

SELF TEST

Time: 35 Minutes **Marks: 25**

Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. **(6×1=6)**

1. Percentage of Aluminium in earth crust:

(A) 28% (B) 18% (C) 7.8% (D) 0.9%

2. Valency of Thiosulphate is:

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

3. Formula of Quick lime is:

(A) CaO (B) $CaCO_3$ (C) NaOH (D) SiO_2

4. The element which occurs in liquid state at room temperature:

(A) Mercury (B) Bromine (C) Both a and b (D) Zinc

5. 1 gram formula of NaCl contains grams:

(A) 100g (B) 58.5g (C) 32g (D) 40g

6. Brass is a mixture of:

(A) Cu & Au (B) Cu & Zn (C) Cu & Ag (D) Al & Fe

Q.2 Give short answers to the following questions. **(5×2=10)**

(i) Define Biochemistry.

(ii) How many amu 1g of a substance has?

(iii) Differentiate between Homoatomic and Heteroatomic molecule.

(iv) Define empirical formula with an example.

(v) You have a piece of coal (Carbon) weighing 9.0g. Calculate the no of moles of Coal in the given mass.

Q.3 Answer the following questions in detail. **(5+4=9)**

(i) Give five differences between a Compound and a Mixture. (5)

(ii) What will be the mass of 2.05×10^{16} molecules of H_2SO_4. (4)

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.