UNIT – 1

FUNDAMENTALS OF CHEMISTRY

Q.1.1: What is science and chemistry and what are its significance in daily life?

Ans: Science:

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

Chemistry:

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

Significance of Chemistry:

- Chemistry facilitates us in petrochemical products.
- Chemistry helps in medicines and drugs.
- Soaps and detergents are minerals of chemistry.
- Chemistry helps in production of plastic, paints, pigments, medicines pesticides and insecticides.

Q.1.2: Explain the branches of chemistry in detail.

Ans:

1. Physical Chemistry:

Definition:

"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."

Uses:

The properties such as structures of atoms or formation of molecules, behavior of gases, liquids and solids and the study of the effect of temperature or radiation on matter, all are studied under this branch.

2. Organic Chemistry:

Definition:

"Organic chemistry is the study of covalent compounds of carbon and hydrogen (hydrocarbons) and their derivatives."

Occurrence:

Covalent compounds occur naturally and are also synthesized in laboratories.

Uses:

Scope of this branch covers petroleum, petrochemicals and pharmaceutical industries.

3. Inorganic Chemistry:

Definition:

"Inorganic chemistry deals with the study of all elements and their compound except those of compounds of carbon and hydrogen and their derivatives."

Uses:

It has applications in every aspect of chemical industry such as glass, cement, ceramics and metallurgy.

4. Biochemistry:

Definition:

"Biochemistry is the branch of chemistry in which we study the structure, composition and chemical reaction of substances found in living organisms."

Scope:

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

Biochemistry as a Separate Subject:

Biochemistry emerged as a separate discipline when scientists began to study how living things obtain energy from food.

Applications:

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

Uses:

These chemicals provide the raw materials for many other industries such as fertilizers, soap, textiles, agricultural products, paints and papers.

5. Industrial Chemistry:

"It is the branch of chemistry in which we deals with the manufacturing of chemical compounds on commercial scale is called industrial chemistry"

Application:

It deals with the manufacturing the basic chemical such as oxygen (O_2), chlorine (Cl_2), ammonia (NH_3), caustic soda (NaOH), nitric acid (HNO_3) and sulphuric (H_2SO_4).These chemical provide the raw materials for many other industries such as fertilizers, soap textiles, agricultural products, paints, etc.

6. Nuclear Chemistry:

Definition: "Nuclear chemistry is the branch of chemistry that deals with the radioactivity, nuclear process and properties".

Uses:

(i) The main concern of this branch is with the atomic energy.

(ii) It also includes the chemical effects resulting from the absorption of radiation within animal, plants and other materials.

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

7. Environmental Chemistry:

Definition:

"It is the branch of chemistry in which we study about components of the environment and the effect of human activities on the environment."

Related to Other Branches:

Environmental chemistry is related to the branches like biology, geology, ecology, soil, water.

Significance of Environmental Chemistry:

The knowledge of chemical processes taking place in environment is necessary for its improvement and protection against pollution.

8. Analytical Chemistry:

Definition:"Analytical chemistry is the branch of chemistry that deals with separation and analysis of a sample to identify its components."

The separation is carried out prior to qualitative and quantitative analysis.

Qualitative Analysis:

Qualitative analysis provides the identification of a substance.

Quantitative Analysis:

Quantitative analysis determines the amount of each component present in a sample.

Scope:

The scope of this branch covers food, water environment and clinical analysis.

Q1.3: Define matter and substances.

Ans: Matter

Matter is defined as: "Anything that has mass and occupies space."

Examples:

Our bodies, benches, walls, houses, boards etc. are examples of matter.

Substance:

"A piece of a matter in pure form is termed as substance".

Q1.4: What is Mixture? Give its types.

Ans: Mixture

Mixture is defined as:

"Impure matter is called mixture".

Types of Mixture:

A mixture is of two types.

(i) Homogeneous Mixture **(**ii) Heterogeneous Mixture

Homogeneous Mixture:

Definition:

"Mixtures that have uniform composition throughout are called homogeneous mixtures".

Examples:

Air, gasoline, ice-cream etc.

Heterogeneous Mixture:

"Heterogeneous mixtures are those in which composition is not uniform throughout."

Examples:

Soil, rock, wood.

Properties of Mixture:

(i) On mixing up, the components of substances retain their own chemical identities and properties.

(ii) The mixture can be separated into parent components by physical methods such as distillation, filtration, evaporation, precipitation and magnetization.

Physical Properties:

Definition:

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

Examples:

Color, smell, taste, solubility, melting and boiling points, hardness, shape.

Chemical Properties:

Definition:

"Chemical properties depend upon the composition of the substance."

Example:

Decomposition of water is a chemical change as it produces hydrogen and oxygen gas.

Q1.5: What are elements? Explain with examples.

Ans: Definition:

"It is a substance made up of same type of atoms having same atomic number and it cannot be decomposed into simpler substances by ordinary chemical means:"

(i) Solids:

Elements may be solids. Majority of elements exist in solid form.

Example:

Zn, Cu, Ag, Na

(ii) Liquids:

Some elements exist in liquid form.

Example:

Mercury, Bromine

(iii) Gases:

A few elements exist as gas.

Example:

N, O, Cl, H.

Types of Elements on basis of properties:

On the basis of properties elements are divided into

(i) Metals:

About 80% of elements are metals.

(i) Non Metals:

(ii) Metalloids:

Occurrence:

Elements occur in nature in free or combined form. They exist in earth crust, ocean and atmosphere with different ratios.

Natural occurrence by weight % of some major elements

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

Q1.6: How to write the symbol?

Ans: Representation: Elements are represented by symbols.

Symbols:

Definition:

"Abbreviations for the name of elements are called symbol."

Examples:

Hydrogen is abbreviated as H. Chlorine as Cl. Sodium as Na.

Rules to write symbols:

(i) A symbol is taken from the name of that element in English, Latin, Greek, and German.

(ii) If it is one letter, it will be capital as H and N

(iii) In case of two letters symbol, only first letter is capital and the 2nd one is small as: Ca, Na and Cl.

Interesting information.

Following six elements constitute 99% of body mass.	
Oxygen	65%
Hydrogen	10%
Calcium	1.5%
Carbon	18%
Nitrogen	3%
Phosphorus	1.5%

Q1.7: What is valency? Explain with example.

Ans: Valency:

"It is combining capacity of an element with other elements.**"**

It depends upon the number of electrons in the outer most shell.

Valency in Ionic Compounds:

In simple ionic compounds, valency is the number of electrons gained or lost by an atom of an element to complete its octet or duplet.

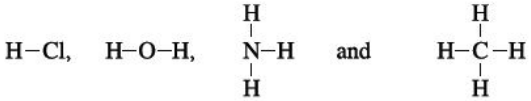
Examples:

1. Atoms of Na, Mg and Al have 1, 2, 3 electrons in their outermost shells respectively. They lose their electrons to gain valency 1, 2, 3 respectively.
2. Elements having five or more than five electrons in their valence shells, gain electrons to complete their octet. N, O and Cl have 5, 6 and 7 electrons in their valence shells. They gain 3, 2 and 1 electrons to complete their octet. Hence, they show valency of 3, 2 and 1, respectively. A radical is a group of atoms that have some charge.

Valency of Covalent Compounds:

In simple covalent compounds valency is the number of hydrogen atoms which combine with one atom of that element or number of bonds formed by that element.

Example:



In CH_4, Carbon has four valency, in NH_3, N has three valency, in H_2O, O has two valency, In HCl, Cl has one valency. The valency of chlorine, oxygen, nitrogen and carbon is 1, 2, 3 and 4, respectively.

Variable valency:

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

Table 1.2 Some Elements and Radicals with their Symbols and Common valencies.

Elements / Radical	Symbol	Valency	Elements/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 (Cuprum)	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			

Q.1.8 Define compound. Give the types of compounds.
Ans: Compounds

Definition:

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

Examples:

Carbon dioxide (CO_2) is formed by combining carbon and oxygen chemically in a fixed ratio of 12:32 or 3:8 by mass. Similarly, water is a compound formed by a chemical combination between hydrogen and oxygen in a fixed ratio of 1:8 by mass.

Classification of Compounds:

Compounds can be classified as:
(i) Ionic compounds **(ii)** Covalent compounds

(i) Independent molecular form:
Ionic compounds do not exist in independent molecular form.

(ii) Three dimensional crystals:
Ionic compounds form three-dimensional crystal lattice, in which each ion is surrounded by oppositely charged ions.

(iii) Melting and boiling points
They have high melting and boiling points.

(iv) Representation:
These compounds are represented by "formula unit".

Examples:
NaCl, KBr, $CuSO_4$.

Covalent Compounds:
The covalent compounds mostly exist in molecular form.

Example:
H_2O, HCl, H_2SO_4, CH_4

Q1.9: Define molecular formula and give some examples?
Ans: Definition:
"A molecule is a true representative of the covalent compound and its formula called molecular formula."

Some Compounds with their formula:

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

Q1.10: Differentiate between compound and mixture.

Ans:

Compound	Mixture
Formation: It is formed by a chemical combination of atoms of the elements.	It is formed by the simple mixing up of the substance.
Identity of constituent: The constituents lose their identity and form a new substance having different properties from them.	Mixture shows the properties of constituents.
Composition: Compounds always have fixed of composition by mass.	Mixture doesn't have fixed composition.
Separation: The components of compounds can't be separated by physical means:	The components of mixture can be separated by physical means:
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: Compounds have sharp and fixed melting points.	Mixture don't have sharp and fixed melting point.

Q.1.11:Write a note on atomic number and atomic mass?

Ans: Atomic Number:

"The atomic number of an element is equal to the number of protons present in the nucleus of its atoms."

Representation:

It is represented by symbol "Z"

Note:

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

Examples:

Hydrogen Z = 1, Oxygen Z = 8, Carbon Z = 6, Sulphur Z 16

Mass Number:

Definition:

"Mass number is the sum of number of protons and neutrons present in the nucleus of an atom."

Representation:

Mass number is represented by "A".

Formula:

It is calculated as:

$A = Z + n$

Where n is the number of neutrons. Each proton and neutron has "1 amu" mass.

Example:

Hydrogen has 1 proton, no neutron $A = 1 + 0 = 1$

Carbon has 6 proton, 6 neutron $A = 6 + 6 = 12$

Table 1.5 Some Elements along with their Atomic and Mass Numbers

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

Q.1.12 Explain in detail, How to write chemical formula?

Ans: Introduction:

Compounds are represented by chemical formulae as elements are represented by symbol**s.**

Rules for writing chemical formula:

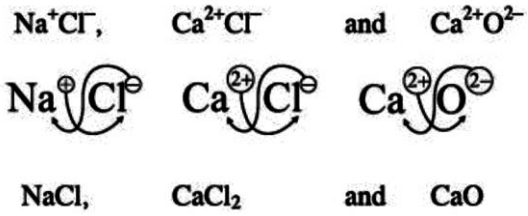
Chemical formulae of compounds are written keeping the following steps in consideratio**n.**

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

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

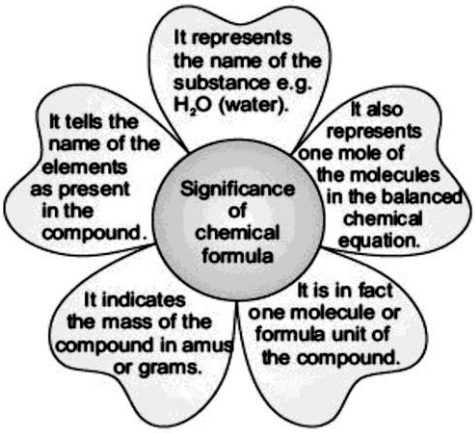
iii. This valency of each ion is brought to the lower right corner of other ion by 'cross-exchange' method, e.g.

iv. They are written as:



v. If the valencies are same, they are offset and are not written in the chemical formula. But if they are different, they are indicated as such at the same position, e.g. in case of sodium chloride both the valencies are offset and formula is written as NaCl, whereas, calcium chloride is represented by formula $CaCl_2$

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



Q1.13 Define relative atomic mass? explain it with unit.

Ans: Definition:

"Relative atomic mass of an element is the average mass of atoms of that element as compared to $1/12^{th}$ the mass of an atom of carbon – 12 isotopes."

Atomic Mass Unit: "The unit of relative atomic masses is called atomic mass unit."

Symbol:

It is represented by symbol amu.

Expression in Grams:

1 amu = 1.66×10^{-24} g

Example:

Mass of proton = 1.0073 amu or 1.672×10^{-24} g
Mass of neutrons = 1. 0087amu or 1.674×10^{-24} g
Mass of electron = 5.486×10^{-4}amu or 9.106×10^{-28} g

Q1.14: What are empirical formula, formula unit and molecular formula? Explain with examples.

Ans: Empirical Formula:

Definition:

"It is the simplest whole number ratio of atoms present in a compound."

Example:

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

Formula Unit

Definition:

"The simplest whole number ratio of ions, as present in the ionic compounds is called formula unit."

Example:

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

Molecular Formula

Definition:

"Molecular formula shows actual number of atoms of each element present in a molecule of that compound."

Formula:

Molecular formula = $(\text{Empirical Formula})_n$

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

Example:

Molecular formula of benzene is C_6H_6 as it derives from empirical formula CH where value of n is 6.

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

Table 1.6 Some Compounds with their Empirical and Molecular Formulae

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

Q1.15: Explain molecular mass and formula mass.

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:

Molecular mass of $Cl_2 = 2(35.5)$ Molecular mass of $H_2O = 2(1)+16$

$= 71.0$ amu $= 18.0$ amu

Molecular mass of $CO_2 = 12 + 2(16)$

$= 12+32$

$= 44$amu

Formula Mass

Definition:

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

Examples:

Formula mass of NaCl $= 23+35.5$ Formula mass of $CaCO_3 = 40+12+3(16)$

$= 58.5$ amu $= 100$ amu

Q1.16: What are ions, Give the types of ions.

Ans: Definition:

"Ion is an atom or group of atoms having charge on it."

Types of Ions:

Ions are of two types. (i) Anions (ii) Cations

Cation:

"An atom or group of atoms having positive charge on it is called cation."

Examples:

Na^+, K^+, Ca^{2+}, Mg^{2+}

Formation:

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

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

$$K \rightarrow K^+ + 1e^-$$

$$Ca \rightarrow Ca^{2+} + 2e^-$$

$$Mg \rightarrow Mg^{2+} + 2e^-$$

Anion

Definition:

"An atom or group of atoms having negative charge on it is called Anion."

Examples:

Cl^- , O^{2-}

Formation:

Anion is formed by addition of electrons in outermost shell of atom.

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

$O + 2e^- \rightarrow O^{2-}$

Q.1.17. What are free radicals? Explain with example.

Ans: Definition: Free redicals are atoms or group of atoms possessing odd number of (unpaired) electrons.

Representation: It is resresented by putting a dot over the symbol of an element e.g. $H^{\cdot}, Cl^{\cdot}, H_3C^{\cdot}$

Explanation: Free radicals are generated by the hemolytic (equal) breakage of the bond between two atoms when they absorb heat or light energy. A free radical is extremely reactive species as it has the tendency to complete its octet.

Molecules		Free radicals
Cl_2	$\xrightarrow{\text{sunlight}}$	$2Cl^{\bullet}$
CH_4	$\xrightarrow{\text{sunlight}}$	$H_3C^{\bullet} + H^{\bullet}$

Table: 1.9 Difference between Ions and Free Radicals.

	Ions	Free Radicals
1	These are the atoms which bear some charge.	These are the atoms that have odd number of electrons.
2.	They exist in solution or in crystal lattice.	They can exist in solutions as well in air.
3.	Their formation is not affected by the presence of light.	They may form in the presence of light.

Q1.18 What are molecules? Describe their types.

Ans: Definition of molecules:

A molecule is formed by chemical combination of atoms. "It is simplest unit of a substance which shows all the properties of the substance and can exist independently".

Types of molecules:

There are different types of molecules depending upon the number and types of atoms combining. Few types are discussed here.

i. Monoatomic Molecules:

A molecules consisting of only one atom is called monoatomic molecules.

Examples:

The inert gases all exist independently in atomic form and they are called monoatomic molecules.

ii. Diatomic Molecules :

The molecules consisting of two atoms are called diatomic molecules.

Examples:

Hydrogen (H_2), oxygen (O_2) and hydrogen chloride (HCl)

iii. Triatomic Molecules:

The molecules consisting of three atoms are called triatomic molecules.

Examples:

Water (H_2O) and carbon dioxide (CO_2).

iv. Polyatomic molecules:

The molecules consisting of many atoms are called polyatomic molecules.

Examples:

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

v. Homoatomic molecules:

The molecules consisting same types of atoms are called homoatomic molecules.

Examples:

Hydrogen (H_2), oxygen (O_2) and sulphur (S_8)

a. Heteroatomic molecules:

The molecules consisting different kinds of atoms, are called heteroatomic molecules.

Examples:

Water (H_2O) ,carbon dioxide CO_2 and ammonia (NH_3)

Q.1.19 Define and explain gram atomic mass, gram molecular mass and gram formula mass.

Ans: As we know that all substances are made up of atoms, molecules or formula units. Their masses are referred to as atomic mass, molecular mass and formula mass respectively and are expressed in amu. But these masses can also be expressed in other units as well. When masses are expressed in grams, they are termed as following:

i. Gram atomic mass ii. Gram molecular mass iii. Gram formula mass

Gram Atomic Mass

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

Examples: 1 gram atom of hydrogen = 1.008 g = 1 mole of hydrogen
1 gram atom of carbon = 12.0 g = 1mole of carbon
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 H_2 = 2.0 g = 1 mole of hydrogen
1 gram molecule of H_2O = 18.0 g = 1 mole of water
1 gram molecule of H_2SO_4 =98.0 g = 1 mole of sulphuric acid

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

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

Q1.20 What are Avogadro's Number? Explain it with examples and define mole?

Ans: Avogadro's Number

Definition: "The 6.02 x 10^{23} number of particles (atoms, molecules or ions of substance or formula unit) is called Avogadro's number."

The counting of these particles is not possible for the chemists. The concept of Avogadro's number facilitated the counting of particles mass of a substance.

Symbol: Avogadro's number is represented by "N_A"

Value: 6.02×10^{23}

Examples: Carbon:

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

Water:

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

Sodium Chlorides:

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

Avogadro's Number for molecules or ionic compounds:

Number of atoms in molecular compounds or number of ions in ionic compounds is expressed as: 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 $1 \times 6.02 \times 10^{23}$ atoms oxygen constitute 1 mole.

Mole

Definition: "The mass of a substance that contains 6.02×10^{23} number of particles is called a mole." **OR**

Quantitative definition of mole is: "The atomic mass, molecular mass, or formula mass of a substance expressed in grams is called mole."

Symbol: Mole is abbreviated as mol.

Examples:

(i) Atomic mass of carbon (C):

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

(ii) Molecular mass of H_2O (Water):

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

(iii) Molecular mass of H_2SO_4 (Sulphuric acid):

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

(iv) Formula mass of NaCl (Sodium Chloride):

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

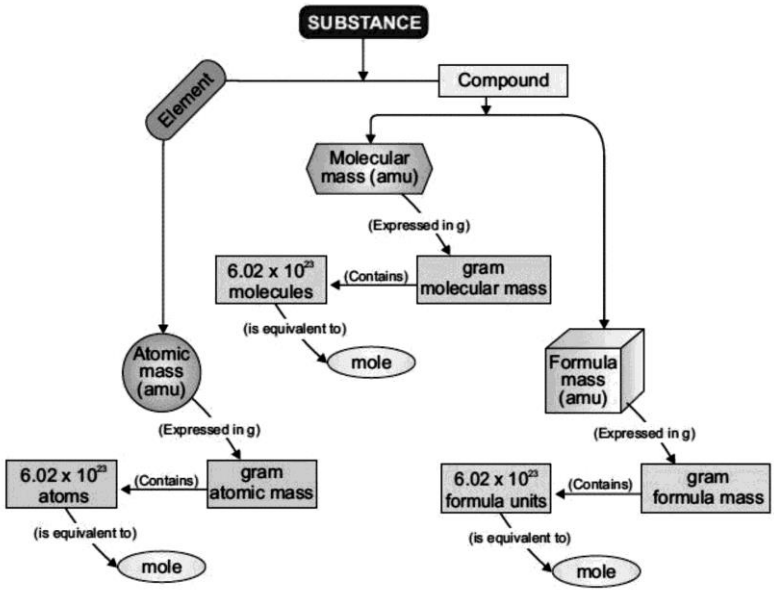
Relationship between Mole and Mass:

The relationship between mole and mass is expressed as

$$\text{Number of moles} = \frac{konwn\ mass\ of\ substasnce}{molar\ mas of\ the\ substasnce}$$

Or Mass of substance (g) = number of mole × molar mass

Relationship between mole and mass



SOLVED EXAMPLES

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

Solution:

First of all develope data from the given statement of the problem and then solve the problem with the help of data.

Data.

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

1. Calculate the molecular mass of nitric acid, HNO_3.

Solution:

Atomic mass of H =1amu
Atomic mass of N =14 amu
Atomic mass of O = 16 amu
Molecular formula $=HNO_3$
Molecular mass = (At. Mass of H) + (At. Mass of N) + 3 (At. Mass of O)
=1 + 14 + 3(16)
= $63 gmol^{-1}$

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.

2. Calculate the formula mass of potassium sulphate K_2SO_4

Solution

Atomic mass of K = 39amu
Atomic mass of S =32amu
Atomic mass of O =16amu
Formula unit $=K_2SO_4$
Formula mass of K_2SO_4 = 2(39) + 32 + 4(16)
=78 +32 +64
=174 $gmol^{-1}$

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

Solution

Given mass of H_3PO_4 =40g
Molecular mass of H_3PO_4 =98g mol^{-1}

$$\text{Number of gram molecule}(\text{mol}) = \frac{mass\ of\ subs\tan ce}{molar\ mass\ of subs\tan ce}$$

$$= \frac{40}{98} = 0.408\ gram\ molecules$$

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

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

Solution

The mass is converted to the number of moles by the equation.

$$\text{Number of moles} = \frac{knwon\ masss\ of\ subs\tan ce}{molar\ mass\ of\ subs\tan ce}$$

$$= \frac{9.0}{12} = 0.75\,mol$$

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

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

Solution

The known mass of water = 6g
Molar mass of H_2O =18g

$$\text{Number of moles of water} = \frac{masss\ of\ subs\tan ce}{molar\ mass\ of\ subs\tan ce}$$

$$= \frac{6}{8}$$

=0.33 moles
=number of moles × Avogadro's number
$=0.33\times6.02\times10^{23}$
$=1.98\times10^{23}$ molecules

The number of molecules contained in 6 grams of water are 1.98×10^{23} as we know 1 molecule of water consists of 3 atoms, therefore:

Number of atoms $=3 \times 1.98\times10^{23}$
$=5.94 \times 10^{23}$ atoms

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

Solution

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

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

$$= \frac{3.01\times10^{23}}{6.02\times10^{23}}$$

= 0.5 mol

Then by putting this value in this equation we get

Mass of substance = number of moles × molar mass (g)
Mass of CO_2 = 0.5 × 44
= 22g

NUMERICALS

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

Given Data:

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

Moles of H_2SO_4= 5 mol

Required:

Mass of H_2SO_4 = ?

Solution:

Formula:

Unknown mass = moles × molar mass
= 5 × 98g
=490g

Result:

We will weigh 490g of sulphuric acid to get 5 moles

Q2. Calcium Carbonate is insoluble in water. If you have 40g of it how many Ca^{2+} and CO<sub>3</sup>$^{2-}$ ions are present in it?

Equation:

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

Given Data

1 Molecule of $CaCO_3$ gives 1 Ca^{+2} and 1 CO_3^{-2} ions
Given Mass of $CaCO_3$ = 40g
Molar mass of $CaCO_3$ = 40+12+3(16)
=40+12+48
= 100g / mol

Required:

No. of CO_3^{2-} ions =?
No. of Ca^{2+} ions =?

Solution:

Formula

$$\text{Moles} = \frac{given\ mass}{molar\ mass}$$

$$\text{Moles} = \frac{40}{100}$$

= 0. 4 mol

Number of Ca^{2+} ions = 1 (moles × N_A)
= 1 ($0.4 \times 6.02 \times 10^{23}$)
= 2.4×10^{23} ions

Number of CO_3^{2-} ions = 1 (moles × N_A)
= 1 ($0.4 \times 6.02 \times 10^{23}$)
= 2.4×10^{23} ions

Result:

40g of Calcium Carbonate has 2.4×10^{23} Ca^{2+} ions and 2.4×10^{23} CO_3^{2-} ions.

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

Chemical Equation:

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

Given Data:

molecule of $Al_2(SO_4)_3$ gives $2Al^{3+}$ ions and $3SO_4^{2-}$ ions.
If we have 1 mole of $Al_2(SO_4)_3$ then
Number of Al^{3+} ions are = $2(6.02 \times 10^{23})$
Number of SO_4^{2-} ions are = $3\ (6.02 \times 10^{23})$

Required:

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

Solution:

If we have ½ mole of $Al_2(SO_4)_3$ then

Number of Al^{3+} ions are $= \frac{1}{2} \times 2\ (6.02 \times 10^{23})$

$= 6.02 \times 10^{23}$

Number of SO_4^{2-} ions are $= \frac{1}{2} \times 3\ (6.02 \times 10^{23})$

$= 9.03 \times 10^{23}$

Result:

So if we have 6.02×10^{23} ions of aluminium then 9.03×10^{23} sulphate ions will be required.

Q4. Calculate the number of molecules of the following compounds. A: 16g of H_2CO_3 B: 20g of HNO_3 C: 30g of $C_6H_{12}O_6$.

A) 16g of H_2CO_3

Given Data:

Given mass of H_2CO_3 = 16g
Molar mass of H_2CO_3 = 2 (1) +12+3(16)
= 2+12+48
= 62g / mol

Required:

Moles of H_2CO_3 = ?

Solution:

Formula:

$$\text{Moles} = \frac{given\ mass}{molar\ mass}$$

Putting the value of mass and molar mass in above formula you get

$$\text{Moles} = \frac{16}{62}$$

= **0.25 mol**

Formula:

Number of molecules = Moles × N_A

By putting the value
Number of molecules = $0.25 \times 6.02 \times 10^{23}$

= **1.50×10^{23}**

B) 20g of HNO_3

Given Data:

Given mass of HNO_3 = 20g

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

= 1 + 14 + 48

= 63g / mol

Required:

Number of Molecules = ?

Solution:

As we know that to find the number of molecules, number of moles should be known. So ,

Formula: Moles = $\frac{given\,mass}{molar\,mass}$

By putting the value

Moles = $\frac{20}{63}$ = 0.31mol

Formula: Number of molecules = moles × N_A

Molecules of HNO_3 = $0.31 \times 6.02 \times 10^{23}$

= 1.86×10^{23}

C) 30g of $C_6H_{12}O_6$

Given Data:

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

Required:

Number of molecules = ?

Solution

As we know that to find the number of molecules, number of moles should be know. So,

Moles = given mass/molar mass

= 30/180 = 0.166 mol

Number of molecules = moles × N_A

= $0.166 \times 6.02 \times 10^{23}$

= **1.0×10^{23} molecules**

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

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

(a) 10 g of $AlCl_3$

Given Data:

Mass of $AlCl_3$ = 10 g

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

= 133.5 g /mol

Required:

Number of Ions in $AlCl_3$**= ?**

Solution:

Number of Moles = $\frac{known\,mass}{molar\,mass}$

$= \frac{10}{133.53}$

= 0.074mol

Number of Ions = number of moles x N_A

$=0.074 \times 6.02 \times 10^{23} \times 4$

$= 4.515 \times 10^{23} \times 4$

$= 1.806 \times 10^{23}$ ions

Result: In 10 g of $AlCl_3$ 1.806 x 10^{23} ions are presents

b) 30 g of $BaCl_2$

Given Data:

Mass of $BaCl_2$ = 30 g

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

= 137+71

=208 g/mol

Required:

Number of Ions of $BaCl_2$= ?

Solution:

As we know that to find the number of Ions, number of moles should be know. So,

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

$= \frac{30}{208}$

= 0.144mol

Number of Ions = number of moles x N_A

$=0.144 \times 6.02 \times 10^{23} \times 3$

$= 2.60 \times 10^{23}$

Result:

In 30 g of $BaCl_2$ 2.60×10^{23} ions are presents

c) 58 g of H_2SO_4

Given Data:

Mass of H_2SO_4 = 58 g

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

= 98 g /mol

Required:

Number of Ions in H_2SO_4 = **?**

Solution:

As we know that to find the number of Ions, number of moles should be know. So,

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

$= \frac{58}{92}$

= 0.591 mol

Number of Particles = number of moles x N_A

Formula unit of H_2SO_4 $=0.591 \times 6.02 \times 10^{23}$

$= 3.56 \times 10^{23}$

Ions in H_2SO_4 $= 3.56 \times 10^{23}$ x 3
$= 1.068 \times 10^{24}$ ions

Result:

In 58 g of H_2SO_4 1.068×10^{24} ions are presents

Q6. What will be the mass of 2.05×10^{16}, molecules of H_2SO_4?

Given Data:

Number of molecules $=2.05 \times 10^{16}$ molecules

Molar mass of H_2SO_4 =2 (1) +32+4(16)
=2+32+48
=98g / mol

Required

Mass of sulphuric acid=?

Solution

$$Number\ of\ Molecules = Number\ of\ Moles \times N_A$$

$$Number\ of\ Molecules = \frac{\text{mass of substance}}{molar\ mass} \times N_A \qquad \therefore Number\ of\ Moles = \frac{\text{mass of substance}}{molar\ mass}$$

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

$$\frac{98 \times 2.05 \times 10^{16}}{6.02 \times 10^{23}} = \text{Mass of substance}$$

$$3.337 \times 10^{-6}\ g = \text{Mass of substance}$$

Result: The mass of 2.05 x 10^{16} molecules of H_2SO_4 will be 3.33 x 10^{-6} g

Q7. How many total atoms are required to prepare 60g of HNO_3?

Given Data:

Mass of HNO_3=60g
Molar mass of HNO_3 =1+14+3 (16)
=15+48
=63g/mol

Required:

Number of atom=?

Solution

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

$$\text{number of moles} = \frac{60}{63}$$

number of moles =0.952 mol

The number of formula units of $HNO_3 = 0.95 \times 6.02 \times 10^{23}$

The number of atoms required to prepare 0.952 moles of $HNO_3 = 5 \times 6.02 \times 10^{23} \times 0.952$
$=2.87 \times 10^{24}$ atoms.

Q. No. 8. How many ions of Na^+ and Cl^- will be present in 30g of NaCl?

Given Data:

Mass of sodium chloride = 30g
Molar mass of NaCl = NaCl
=23+35.5
=58.5g/mol

Required:

Number of ions =?

Solution:

$$\text{number of moles} = \frac{Given\ mass}{Molar\ mass}$$

$$= \frac{30}{58.5} \qquad = 0.512 \text{mol}$$

The number of ions in 1 mole of NaCl = $2 \times 6.02 \times 10^{23}$

The number of ions in 0.512 mole of NaCl = $2 \times 6.02 \times 10^{23} \times 0.512$

$= 6.17 \times 10^{23}$ ions.

Q9. How many molecules of HCl will be required to have 10g of it?

Given Data:

Mass of Hydrochloric acid = 10g

Molar mass of Hydrochloric acid= HCl

=1+35.5

=36.5g/mol

Required:

Number of molecules =?

Solution:

$$n = \frac{Given\ mass}{Molar\ mass}$$

$$n = \frac{10}{36.5}$$

n= 0.273 mol

The number of molecules = $N_A \times n$

$= 6.02 \times 10^{23} \times 0.273$

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

Result:

1.65×10^{23} molecules of HCl are required to prepare 10 g of HCl.

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

Given Data:

Mass of carbon = 6g

Molar mass carbon = 12g / mol

Molar mass of magnesium = 24g / mol

Required

Mass of Mg = ?

Solution

$$\text{Moles of carbon} = \frac{Given\ mass}{Molar\ mass}$$

$$n = \frac{6}{12} = 0.5mol$$

The number of atoms in 1 mole of C = 6.02×10^{23}

The number of atoms in 0.5 mole of C = $6.02 \times 10^{23} \times 0.5$

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

As mentioned in the question the number of atoms of "C" and "Mg" are same so their number of moles also same.

$$n = \frac{Mass\ of\ sub\tan ce}{Molar\ mass}$$

Mass of Mg = n × Molar mass of Mg

$= 0.5 \times 24$

$= 12g$

Result: 12 g of Mg have the same number of atoms as 6g of C.

SHORT QUESTION ANSWERS

Q.1 Define industrial chemistry and analytical chemistry.

Ans: Industrial Chemistry:

‘‘This branch of chemistry is related to the industrial processes.” It is associated with studies of properties uses and application of techniques for the preparation of industrial sales on large scale.

Analytical Chemistry:

It deals with the detection and estimation of elements and compounds. In this the composition of elements is primarily analyzed.”

Q.2 How can you differentiate between organic and inorganic chemistry?

Ans:

Organic Chemistry	Inorganic Chemistry
It is study of the properties and behavior of hydrocarbons (compounds of carbon "and hydrogen) and their derivatives.	It is the study of properties and behavior of all elements except the hydrocarbons and their derivatives.

Q.3 Give the scope of biochemistry.

Ans: It is the branch of chemistry in which we study the structure, composition, and chemical reaction of substance found in living organisms. It covers all chemical processes taking place in living organisms. Such as synthesis and metabolism of bio molecules like carbohydrates, proteins and fat. Biochemistry emerged as separate discipline when scientists began to study how living things obtain energy from food or how the fundamental biological changes occur during a disease. Examples of applications of biochemistry are in the fields of medicine, food science and agriculture etc.

Q.4 How does homogeneous mixture differ from heterogeneous mixture?

Ans:

Homogeneous Mixture	Heterogeneous Mixture
Mixtures that have uniform composition through are called homogeneous mixtures.	Those mixtures in which composition are not uniform throughout are called heterogeneous mixtures.

Q.5 Define relative atomic mass? How gam is related to it.

Ans: “Relative atomic mass of an element is the average masses of atoms of that element as compared to $1/12^{th}$ the mass of one atom of Carbon -12 isotope.

Example:

Mass of Na = 23 amu

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

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

Example:

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 a electron = 5.486×10^{-4} amu or 9.106×10^{-28}g

Q.6 What is relationship between empirical formula and formula unit.

Ans: Empirical formula: “It is the simplest whole number, ratio of atoms present in a compound.”

Formula Unit: “It is the simplest whole number, ratio of ions , as present in ionic compound”.

Both show simple ratios of atoms and ions.

Q.7 State three reasons why do you think air is a mixture and water a compound.

Ans:

Air (mixture)	Water (Compound)
• Mixture is formed by the simple mixing up of the substances.	• It is formed by the chemical combination of atoms of elements.
• Components of air maintain their identities	• Components of water do not maintain their identities.

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

Ans: Hydrogen and oxygen are element because;

i. Each one of it consists of same type of atoms.

ii. Each one of it has same atomic number.

Water is compound because;

i. It consists of different types of atoms combined together in a fixed proportion by mass.

ii. Properties of water are entirely different from its constituent components. For example, water exists as liquid while hydrogen and oxygen exist as gases at room temperature.

Q.9 What is the significance of writing the symbol of an element?

Ans: Significance of the symbol of an element:

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

i. Oxygen (O) ii. Sulphur (S) iii. Nitrogen (N)

Q.10 State three reasons why do you think soft drink is a mixture and water is a compound.

Ans: Soft drink is a mixture because:

i. Its components are not bounded chemically.

ii. The components do not have fix ratio.

iii. The components retain their physical and chemical properties.

Water is a compound because:

i. Its components namely hydrogen and oxygen are bounded chemically.

ii. The components have fix ratio by mass.

iii. The components lose their chemical and physical properties.

Q.11 Classify the following into element, compound and mixture?

i.He and H_2 ii. CO and Co iii. Water and milk

iv. Gold and brass v. Iron and steel

Ans:

Element	Compound	Mixture
He	CO	Milk
H_2	H_2O	Brass
Co		Steel
Gold		
Iron		

Q.12 Define atomic mass unit. Why is it needed?

Ans: Atomic mass unit

The unit for relative, atomic masses is called atomic mass unit.

Symbol

Its symbol is amu.

One atomic mass unit is $1/12^{th}$ the mass of one atom of carbon-12th the mass of one atom of carbon-12^{th}. When this atomic mass unit is expressed in grams, it is: 1 amu $=1.66 \times 10^{-24}$g

Q.13 State the nature and name of the substance formed by combining the following:
i.Zinc + Copper ii. Water + Sugar iii. Aluminum + Sulphur
iv. Iron + Chromium+ Nickel

Ans: (i) Zinc + Copper:
It will be a mixture called brass (alloy).
(ii) Water + Sugar:
It will be a solution or mixture called sugar syrup.
(iii) Aluminum + Sulphur:
It will be a compound called aluminum sulphide.
(iv) Iron + Chromium + Nickel:
It will be a mixture called nichrome (alloy).

Q.14 Differentiate between molecular mass and formula mass, which of the following will be molecular formula?

- H_2O
- NaCl
- KI
- H_2SO_4

Ans:

Molecular Mass	Formula Mass
The sum of atomic masses of all the atoms present in one molecule of a molecular compound is its molecular mass.	Formula mass is the sum of atomic masses of all the atoms present in one formula unit of a substance.
For example Molecular mass of water is 18 amu and that of carbon is 44 amu	**For example** Formula mass of sodium chloride is 58.5 amu and that of $CaCO_3$ is 100 amu.

H_2O and H_2SO_4 are the molecular formula NaCl and KI are formula units.

Q.15 Which has more atoms: 10 g of Al or 10 g of Fe?

Ans: 10 g of A1 has more atoms than 10 g of Fe.
For A1

$$\text{Number of atom} = \frac{Mass}{Molar\ Mass} \times N_A$$

$$= \frac{10}{27} \times 6.02 \times 10^{23}$$

$$= 2.22 \times 10^{23}$$

For Fe:

$$\text{Number of atom} = \frac{Mass}{Molar\ Mass} \times N_A$$

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

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

Result: Aluminium has more number of atoms than iron.

Q.16 Which one has more molecules: 9 g of water or 9 g of sugar $C_{12}H_{22}O_{11}$?

Ans: 9 g of water has more molecules than 9 g of sugar because moles of water are more than sugar.
For Water

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

$$= \frac{9}{18} \times 6.02 \times 10^{23}$$
$$= 3.01 \times 10^{23}$$

For Sugar ($C_{12}H_{22}O_{11}$)

$$\text{Number of molecules} = \frac{Mass}{Molar\ Mass} \times N_A$$
$$= \frac{9}{342} \times 6.02 \times 10^{23}$$
$$= 1.58 \times 10^{22}$$

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

Q.17 Which one has more formula units: 1 g of NaCl or 1 g KCl?

Ans: NaCl has more formula units than KCl.

For NaCl

$$\text{Formula units} = \frac{Mass}{Formula\ Mass}$$
$$= \frac{1}{58.5}$$
$$= 0.017$$
$$= 0.017 \times 6.02 \times 10^{23}$$
$$= 1.0 \times 10^{22}$$

For KCl

$$\text{Formula units} = \frac{Mass}{Formula\ Mass}$$
$$= \frac{1}{67.5}$$
$$= 0.014$$
$$= 0.014 \times 6.02 \times 10^{23}$$
$$= 8.4 \times 10^{21}$$

Result: NaCl has more formula units than KCl.

Q.18 Differentiate between homoatomic and heteroatomic molecules with examples.

Ans:

Homoatomic molecules	Heteroatomic molecules
A molecule containing same type of atoms is called homoatomic molecule.	A molecule consists of different kinds of atoms, it is called as heteroatomic molecule.
For example H_2, O_3, S_8	For example CO_2, H_2O, NH_3

Q.19 In which of the following cases 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)

Ans: 1 mole of NH_3 has more hydrogen atoms than 2 moles of HCl.

Q.20 Define Chemistry?

Ans: "The branch of science which deals with the composition, structure, properties and reactions of matter is called chemistry."

Q.21 What are applications of inorganic chemistry?

Ans: It has application in every aspect of chemical industry such as glass, cement, ceramics and

metallurgy.

Q.22 What are the uses of nuclear chemistry?

Ans: It has vast application in medical treatment, preservation of food and generation of electrical power through nuclear reactors.

Q.23 Differentiate between substance and mixture?

Ans:

Substance	Mixture
A piece of matter in pure form is termed as substance. e.g. Glucose ($C_6H_{12}O_6$), Oxygen	Impure matter is called mixture. e.g. Soil, Milk etc.

Q.24 Give the composition of earth crust with respect to three major elements.

Ans: Earth crust is formed by three major elements having following percentages.

Oxygen 47%
Silicon 28%
Aluminum 7.8%

Q.25 On the basis of properties, elements are divided into which groups?

Ans: On the basis of properties elements are divided into metals, non-metals, and metalloids

Q.26 Give the composition of milk.

Ans: Milk is a mixture of calcium, water, sugar, fat, proteins, minerals, salts and vitamins.

Q.27: Which branch of chemistry belong to structure and physical properties of metter.

Ans: Physical chemistry belongs to structure and physical properties of metters.

Q.28 Differentiate between homogeneous and heterogeneous mixture.

Homogeneous Mixture	Heterogeneous Mixture
Mixtures that have uniform composition throughout are called homogeneous mixtures. Examples: Milk, Air, Brass, Ice-cream	Mixture which does not have uniform composition throughout is called heterogeneous mixtures. Examples: Soil, Wood

Q.29 How can you justify that air is a homogeneous mixture. Identify substances present in it?

Ans: Air is a mixture formed by be the physical mixing of the substances like nitrogen, oxygen, carbon dioxide, noble gases and moisture and it has same composition throughout. So, it is homogeneous mixture.

Q.30 Name one solid, one liquid and one gaseous element present at room temperature?

Ans: Solid:
Sodium (Na), Iron (Fe)
Liquid:

Bromine (Br) and Mercury (Hg).

Gas: Oxygen (O_2), Nitrogen (N_2) and Chlorine (Cl_2).

Q.31: What elements do the following compounds contain?

Ans: Sugar, common salt, lime water and chalk.

Compounds	Elements Contain
Glucose	It contains carbon, hydrogen and oxygen. ($C_6H_{12}O_6$)
Common salt	It contains sodium and chlorine (NaCl)
Lime water	It contains calcium, oxygen and hydrogen. $Ca(OH)_2$.
Chalk	It contains calcium, carbon and oxygen. $CaCO_3$

Q.32: In one mole of water how many hydrogen atoms are present?

Ans: 1 mole of $H_2O = 6.02 \times 10^{23}$ atoms.

H atoms in 1 mole of water = $2 \times 6.02 \times 10^{23}$.

$= 12.04 \times 10^{23}$ atoms.

Q.33: Define atomic number. Is atomic mass unit a SI unit of an atomic mass?

Ans: Definition:

"The atomic number of an element is equal to the number of protons present in the nucleus of its atoms."

Representation:

It is represented by "Z".

Yes, Atomic mass unit is SI unit of atomic mass.

Q.34 Differentiate between atom and ions.

Ans:

	Atom	Ion
1.	It is the smallest particle of an element.	It is the smallest unit of an ionic compound.
2.	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.
3.	It is electrically neutral	It has a net charge (either negative or positive) on it.

Q.35 Define empirical formula and give examples.

Ans: "It is the simplest whole number, ratio of atoms present in a compound."

Example:

Empirical formula of benzene (C_6H_6) is CH.

Empirical formula of Hydrogen peroxide (H_2O_2) is HO.

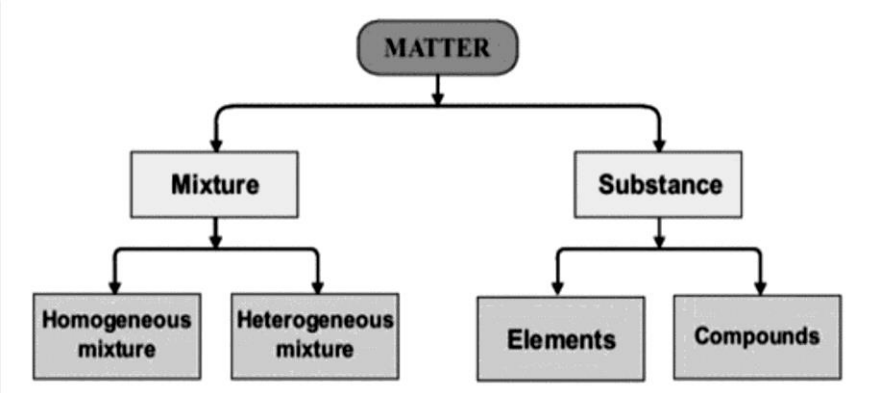
Q.36 Differentiate between empirical and molecular formula?

Ans:

Empirical Formula	Molecular Formula
It is the simplest whole number ratio of atoms present in a compound. e.g. Empirical formula of benzene is CH.	It shows the actual number of atoms of each element present in a molecule of that compound. e.g. Molecular formula of benzene is C_6H_6.

Q.37 What is matter? Give its classification diagrammatically?

Ans: Matter: "Anything which has mass and occupy space is called matter."



Q.38 What is valency?

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

Q.39 What is meant by variable valency?

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

Q.40 What is radical?

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

Q.41 What is significance of chemical formula?

Ans: i) It represents the name of the substance e.g H_2O (water).
ii) It also represents one mole of the molecules in the balance chemical equation.
iii) It tells the name of the elements as present in the compound.
iv) It indicates the mass of the compound in amu or grams.
v) It is in fact one molecule or formula unit of the compound.

Q.42 Write down the Molecular and Empirical formula of Hydrogen peroxide, benzene, Glucose?

Ans:

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

Q.43 Differentiate between molecule and molecular ion?

Ans:

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

Q.44 Differentiate between ions and free radicals?.

Ans:

Ions	Free Radicals
These are the atoms which bear some charge.	These are the atoms that have odd number of electrons.
They exist in solution or in crystal lattice.	They can exist in solutions as well as in air.
Their formation is not affected by the presence of light.	They may form in the presence of light.

Q.45 Can you identify mixture, element or compound out of the following: Coca cola, petroleum, sugar, table salt, blood, gun powder, urine, aluminium, silicon, tin, lime and ice cream.

Ans:

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

Q.46 Name the elements represented by the following symbols:
Hg, Au, Fe, Ni, Co, W, Sn, Na, Ba, Br, Bi.

Ans:

Symbols	Name the elements
Hg	Mercury
Fe	Iron
Co	Cobalt
Sn	Tin
Ba	Barium
Bi	Bismith
Au	Gold
Ni	Nickel
W	Tungsten
Na	Sodium
Br	Bromine

Q.47 How many amu 1 g of a substance has?

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

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

Q.48 What is the relationship between atomic number and atomic mass?

Ans: The relationship between atomic number and atomic mass is as following;

A= Z+n

Where A = mass number

Z = atomic number

n = no of neutrons

Q.49 Why atomic mass of an atom is defined as relative atomic mass?

Ans: Atomic mass of an atom is defined as relative atomic mass, because atomic mass of an atom is the mass which compares or relates with $\frac{1}{12}$th mass of carbon 12 isotope

Q.50 Identify the following formulae as empirical or molecular formulae:
H_2O_2 , CH_4 , $C_6H_{12}O_6$, $C_{12}H_{22}O_{11}$, $BaCO_3$, KBr.

Ans:

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

Q.51 Find out molecular mass and formula masses of the following.
Na_2SO_4 , $ZnSO_4$ and $CuCO_3$.

Ans: **Formula mass of Na_2SO_4** = 2(23)+32+4(16) = 46+32+64
= 142 amu

Formula mass of $ZnSO_4$ = 65+32+4(16) = 65+32+64
= 161 amu

Formula mass of $CuCO_3$ = 63.5+12+3(16)
= 63.5+12+48
= 123.5 amu

Q.52 Identify the followings as diatomic, triatomic or polyatomic molecules $H_2.SO_4$, H_2, CO_2, HC*l*, CO, C_6H_6, H_2O.

Ans:

Diatomic molecules	Triatomic molecules	Polyatomic molecules
H_2	CO_2	$H_2.SO_4$
HC*l*	H_2O	C_6H_6
CO		

Q.53 Identify among the followings as cation, anion, free radical, molecular ion of molecule: Na^+, $Br^\cdot$, N_2^+, N_2, Cl_2, CO_3^{2-}, H^-, O_2, O^{2-}

Ans:

Action	anion	Free radical	Molecular ion	Molecule
Na^+	H^-	$Br^\cdot$	N_2^+	N_2
	O^{2-}		CO_3^{2-}	O_2
				Cl_2

Q.54: Define Ions.

Ans: Definition: "Ion is an atom or group of atoms having charge on it."

Examples: Na^+, K^+, Cl^- , O^{2-}

Q.55 Which term is used to represent the mass of 1 mole of molecules of a substance?

Ans: Gram molecular mass

Q.56 How many atoms are present in one gram atomic mass of a substance?

Ans: One gram atomic mass of a substance is equal to Avogadro's number in which 6.02×10^{23} atoms are present .

Q.57 What is the relationship between mass and mole of a substance?

Ans: The relationship between mass and mole of a substance is given as following
Mass of substance (g) = No. of moles × molar mass of substance

Q.58 Find out the mass of 3 moles of oxygen atoms.

Ans: $3 \times 16 = 48$g of oxygen are present in 3 moles.

Q.59 How many molecules of water are present in half mole of water?

Ans: Water molecules in half mole $= \frac{1}{2} \times 6.02 \times 10^{23}$
$= 3.01 \times 10^{23}$ molecules

Q.60 How many atoms of sodium are present in 3 moles of sodium and what is the mass of it?

Ans: Number of atoms of sodium in 3 moles = $3 \times 6.02 \times 10^{23}$ atoms
$= 1.806 \times 10^{24}$
$= 3 \times 23$ So, mass of atoms = 69g

Q.61 How many atoms are in 1 amu and 1 g of hydrogen (H)?

Ans: 1amu and 1 gram of hydrogen (H) has 6.022×10^{23} atoms.

Q.62 How many atoms are present in 16 g of O and 8g of S?

Ans: 16 grams of oxygen has 6.022×10^{23} atoms and 8 grams of sulphur has 1.505×10^{23} atoms

Q.63 Is the mass of 1 mole of O and 1 mole of S same?

Ans: No, the mass of 1 mole of oxygen and 1 mole of sulphur atom is not same.

Q.64 What do you mean by 1 atom of C and 1 gram atom of C?

Ans: One atom of carbon has its atomic mass which is 12 amu. But when this mass of carbon atom is expressed in grams then it is known as gram atomic mass. As 1 gram of carbon= 12.0g

Q.65 If 16 g of oxygen contains 1 mole of oxygen atoms calculate the mass of one atom of oxygen in grams.

Ans: 16g of oxygen = 1 mol of oxygen
Mass of one atom of oxygen = 16 grams

Q.66 How many times is 1 mole of oxygen atom heavier than 1 mole of hydrogen atom?

Ans: One mole of oxygen atom is 16 times heavier than the one mole of hydrogen.

Q.67 Why does 10 g nitrogen gas contain the same number of molecules as 10 g of carbon monoxide?

Ans: Number of moles of nitrogen gas = $\frac{10}{28} = 0.35 mol$

Number of molecules of $N_2 = 0.35 \times 6.022 \times 10^{23}$

$= 2.107 \times 10^{23}$

Number of moles of carbon monoxide gas = $\frac{10}{28} = 0.35 mol$

Number of molecules of CO gas $= 0.35 \times 6.022 \times 10^{23}$

$= 2.107 \times 10^{23}$

Q.68 In which branch of chemistry behaviour of gases and liquid is studied?

Ans: The behaviour of gases and liquids is studied in the branch of chemistry called physical chemistry.

Q.69 Define Biochemistry

Ans: "It is branch of chemistry in which we study the structure, composition and chemical reactions of substances found in living organisms (i.e. humans, animals and plants).''

Q.70 Which branch of chemistry deals with preparation of paints and papers?

Ans: "Industrial chemistry deals with preparation of paints and papers."

Q.71 In which branch of chemistry are the metabolic processes of carbohydrates and proteins studied?

Ans: "In biochemistry metabolic processes carbohydrates and proteins are studied."

Q.72 Which branch of chemistry deals with energy of atoms and its uses in daily life?

Ans: "Nuclear chemistry deals with energy of atoms and its uses in daily life."

Q.73 Which branch of chemistry deals with the structure and properties of naturally occurring molecules?

Ans: "Organic chemistry deals with the structure and properties of naturally occurring molecules."

Q.74 What is the relationship between atomic number and atomic mass?

Ans: The relation between atomic number and atomic mass is as following; $A = Z + n$

Q.75 What is the relationship between empirical formula and formula unit?

Ans: All the ionic compounds are represented by formula unit. Formula unit is also and empirical formula of ionic compounds.

Q.76 What is empirical formula of acetic acid (CH_3COOH)? Also calculate the molecular mass of acetic acid.

Ans: Empirical formula of Acetic Acid is CH_2O

Molecular mass of acetic acid (CH_3COOH):

Atomic mass of C =12amu
Atomic mass of H =1 amu
Atomic mass of O = 16 amu
Molecular formula = CH_3COOH
Molecular mass = 2 (At. Mass of C) + 4(At. Mass of H) + 2 (At. Mass of O)

=2(12)	+	4(1)	+	2(16)
=24	+	4	+	32
=60amu				

Q.77 What is free radical? Give example.

Ans: Free Radicals

"Free radicals are atoms or group of atoms possessing odd number of (unpaired) electrons".

Explanation and examples:

It is represented by putting a dot over the symbol of an element e.g. $H^{\cdot}$, $Cl^{\cdot}$, $H_3C^{\cdot}$.Free radicals are generated by the homolytic (equal) breakage of the bond between 3 two atoms when they absorb heat or light energy. A free radical is extremely reactive species as it has the tendency to complete its octet.

Reactions:

Molecules		Free radicals
Cl_2	$\xrightarrow{\text{sunlight}}$	$2Cl^{\bullet}$
CH_4	$\xrightarrow{\text{sunlight}}$	$H_3C^{\bullet} + H^{\bullet}$

MULTIPLE CHOICE QUESTIONS

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

2. Which one of the following compounds can be separated by physical means?
(a) mixture (b) hydrogen (c) compound (d) radical

3. The most abundant element occurring in the oceans is:
(a) oxygen (b) hydrogen (c) nitrogen (d) silicon

4. The third abundant gas found in the Earth's atmosphere is:
(a) carbon monoxide (b) oxygen (c) nitrogen (d) argon

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

6. Which one of the following elements is found in most abundance in the Earth's crust?
(a) oxygen (b) aluminum (c) silicon (d) iron

7. Which one of the following molecule is not tri-atomic?
(a) H_2 (b) O_3 (c) H_2O (d) CO_2

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

9. The mass of one molecule H_2SO_4 is:
(a) 98 g (b) 98amu (c) 9.8 g (d) 9.8 amu

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

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

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

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

14. The knowledge that provides understanding of this world is called:
(a)Chemistry (b) Science (c) Biochemistry (d) Biology

15. The branch of chemistry deals with physical properties of matter is called:
(a) Organic chemistry (b) Physical chemistry
(c) Analytical chemistry (d) Nuclear chemistry

16. Formation of industrial products studied under:
(a) Industrial chemistry (b) Nuclear chemistry
(c) Inorganic chemistry (d) Organic chemistry

17. Hydrocarbons are studied under:
(a) Organic chemistry (b) Inorganic (c) Analytical (d) Physical

18. Identification of a substance is called:
(a) Qualitative analysis (b) Quantitative analysis (c) Both (d) None

19. A piece of matter in pure form is:
(a) Mixture (b) Compound (c) Substance (d) Molecule

20. Anything that has mass occupy space is:
(a) Mixture (b) Element (c) Matter (d) Compound

21. Colour, smell, taste are properties:
(a) Physical (b) Chemical (c) Composition (d) All

22. Chemical properties depend upon:
(a) Matter (b) Composition (c) Mixture (d) All

23. Weight of oxygen in earth is:
(a) 20% (b) 47% (c) 7.8% (d) 30%

24. Occurrence of silicon on earth is:
(a) 10% (b) 70% (c) 28% (d) 90%

25. 80% of elements on earth are:
(a) Metals (b) Non metals (c) Metalloids (d) Gases

26. The most abundant element on ocean is:
(a) Hydrogen (b) Oxygen (c) Chlorine (d) Argon

27. Majority of elements exist in…….state:
(a) Solids (b) Liquids (c) Gases (d) Plasma

28. The elements are represented by:
(a) Formula (b) Empirical Formula (c) Symbol (d) Valency

29. Symbol of silver is:
(a) Si (b) Zn (c) S (d) Ag

30. Cu is symbol of:
(a) Hydrogen (b) Chlorine (c) Sodium (d) Copper

31. The combining capacity of elements with other elements is:
(a) Bonding (b) Valency (c) Shielding effect (d) Symbol

32. Valency of N is:
(a) 3 (b) 4 (c) 5 (d) 6

33. Valency of O is:
(a) 1 (b) 2 (c) 3 (d) 6

34. A group of atom that has some charge:
(a) Compound (b) Radical (c) Ion (d) Valency

35. Radical of hydronium is:
(a) OH^{1-} (b) H_3O^+ (c) OH^+ (d) HSO_4^-

36. Compounds exist in independent molecular form:
(a) Covalent (b) Ionic (c) Metals (d) Non metals

37. Mixture that have uniform composition:
(a) Alloy (b) Homogeneous (c) Heterogeneous (d) All

38. Atomic number is represented by:
(a) N (b) Z (c) A (d) K

39. Mass number is represented by:
(a) Z (b) K c) A (d) N

40. Number of protons in the nucleus of atom:
(a) Radical number (b) Mass number (c) Atomic Number (d) All

41. Sum of number of protons and neutrons is:
(a) Mass number (b) Atomic number (c) Valency (d) Charge number

42. A = Z + n is the expression of:
(a) Symbol (b) Atomic Number (c) Mass Number (d) None of these

43. Relative atomic mass is related to mass of:
(a) Na (b) C (c) O (d) H

44. Empirical formula represents ……. of atoms present in a compound:
(a) Simplest whole number ratio of atoms (b) Actual number of atoms
(c) Simplest whole number ratio of ions (d) None

45. Empirical formula of Benzene is:
(a) C_6H_6 (b) CH (c) HC (d) C_2H_2

46. Molecular formula of Glucose …….
(a) CH_2O (b) C_6H_6 (c) $C_6H_{12}O_6$ (d) $C_{11}H_{12}O_{11}$

47. An atom or group of atoms having positive charge called ……
(a) Anion (b) Cation (c) Molecular ion (d) All

48. An atom or group of atoms having negative charge called ……
(a) Anion (b) Cation (c) Molecular ion (d) All

49. When a molecule loses or gains an electron called …….
(a) Molecular ion (b) Cation (c) Anion (d) None

50. Molecule of Hydrogen is represented by:
(a) H (b) H_2 (c) H^+ d) a & b both

51. All are diatomic molecules except:
(a) H_2 (b) CO_2 (c) N_2 (d) O_2

52. All are heteroatomic molecules except:
(a) CO_2 (b) O_2 (c) H_2O (d) $C_6H_{12}O_6$

53. Example of diatomic molecule:
(a) HCl (b) H_2O (c) O_3 (d) CO_2

54. which element is found in most abundance in atmosphere:
(a) chlorine (b) argon (c) oxygen (d) nitrogen

55. 12 gram of carbon contain atoms:
(a) 18.06×10^{23} (b) 1.672×10^{22} (c) 12.04×10^{23} (d) 6.02×10^{23}

56. Percentage by weight of hydrogen in ocean is:
(a) 14 (b) 13 (c) 12 (d) 11

57. Major part of a living body with respect to mass made up of:
(a) water (b) urea (c) ammonia (d) benzene

58. The percentage of nitrogen in air is:
(a) 70 (b) 78 (c) 21 (d)20

59. The molecular mass of nitric acid (HNO_3) is.
(a) 65 amu (b) 63 amu (c) 62 amu (d) 60 amu

60. Formula mass of sodium chloride is:
(a) 57.5 (b) 58.5 (c) 35.5 (d) 38.5

61. The empirical formula of glucose is:
(a) $C_2H_6O_3$ (b) CHO (c) CH_2O (d) $C_5H_{10}O_3$

62. Molecular formula of benzene is.
(a) C_2H_2 (b) C_6H_6 (c) C_4H_4 (d) C_2H_6

63. The molecular mass of CO_2 is:
(a) 50 amu (b) 44 amu (c) 40 amu (d) 34 amu

64. A good example of homogeneous mixture is.
(a) soil (b) rock (c) wood (d) ice cream

65. An element which occurs in gaseous state is?
(a) mercury (b) gold (c) oxygen (d) sodium

66. Gram atomic mass of hydrogen is.
(a) 1.008 g (b) 2.016 g (c) 1.008 amu (d) 1.08 g

67. Atomic number of sodiums.
(a) 13 (b) 12 (c) 10 (d) 11

MCQs Keys

1	c	**11**	b	**21**	a	**31**	b	**41**	a	**51**	b
2	a	**12**	d	**22**	b	**32**	c	**42**	c	**52**	b
3	a	**13**	a	**23**	b	**33**	b	**43**	b	**53**	a
4	d	**14**	b	**24**	c	**34**	b	**44**	a	**54**	d
5	c	**15**	b	**25**	a	**35**	b	**45**	b	**55**	c
6	a	**16**	a	**26**	b	**36**	a	**46**	c	**56**	d
7	a	**17**	a	**27**	a	**37**	b	**47**	b	**57**	a
8	a	**18**	c	**28**	c	**38**	b	**48**	a	**58**	b
9	a	**19**	c	**29**	d	**39**	c	**49**	a	**59**	b
10	a	**20**	c	**30**	d	**40**	c	**50**	b	**60**	b
										61	c
										62	b
										63	B
										64	D
										65	C
										66	D
										67	A