Unit 01

Fundamentals of Chemistry

Long Answer Questions

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

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

Importance

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

Q2. Define and describe the various branches of Chemistry.

Ans. Branches of Chemistry

i. Physical Chemistry

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

ii. Organic Chemistry

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

iii. Inorganic Chemistry

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

iv. Biochemistry

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

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

v. Industrial Chemistry

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

vi. Nuclear Chemistry

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

vii. Environmental Chemistry

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

viii. Analytical Chemistry

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

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

Ans.

i. Matter

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

ii. Substance

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

iii. Physical Properties

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

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

iv. Chemical Properties

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

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

Ans. Element

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

Explanation

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

Occurrence

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

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

Natural Occurrences by Weight % of Some Major Elements

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

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

Types of Elements

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

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

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

Valency in Covalent Compound

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

Valency in Ionic Compound

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

Variable Valency

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

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

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

Q6. Define Compound. How is it classified?

Ans. Compound

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

Explanation

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

Classification of Compounds

Compounds can be classified as ionic or covalent.

Ionic Compounds

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

Covalent Compounds

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

Some common Compounds with their Formulae

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

Q7. Define Mixture. How is it classified?

Ans. Mixture

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

Classification

i. Homogeneous Mixture

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

ii. Heterogeneous Mixture

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

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

Ans. Relative Atomic Mass and Atomic Mass Unit

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

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

For example:

Mass of a proton = 1 .0073amu or 1.672×10^{-24}g

Mass of a neutron = 1 .0087amu or 1.674×10^{-24} g

Mass of an electron = 5.486×10^{-4}amu. or 9.106×10^{-28}g

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

Ans. Difference between a Compound and a Mixture

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

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

Ans. Atomic Number

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

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

Examples:

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

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

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

Sulphur having 16 protons show atomic number Z=16.

Mass Number

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

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

Examples:

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

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

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

Some Elements along with their Atomic and Mass Numbers

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

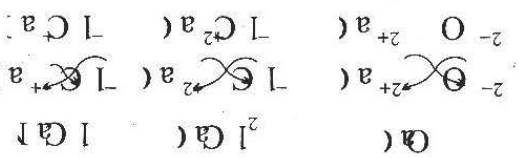
Q11. How to write a Chemical Formula?

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

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

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

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



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

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

Q12. Define Empirical Formula. Explain it.

Ans. Empirical formula

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

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

Empirical Formula of Covalent Compounds:

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

Empirical Formula of Ionic Compound:

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

Q13. Define Molecular Formula. Explain with examples.

Ans. Molecular Formula

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

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

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

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

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

Some Compounds with their Empirical and Molecular Formulae

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

Some compounds may have same empirical and molecular formula e.g. water (H_2O), hydrochloric acid (HC1), etc.

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

Ans. Molecular Mass

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

Examples

Molecular mass of water (H_2O) is 18amu.

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

Formula Mass:

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

Example

Formula mass of sodium chloride is 58.5amu.

Formula mass of $CaCO_3$ is 100amu.

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

Ans. Chemical Species

i. Ions

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

ii. Cations

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

Atoms		Cations
H	$\longrightarrow$	$H^+ + Ie^-$
Na	$\longrightarrow$	$Na^+ + Ie^-$
Ca	$\longrightarrow$	$Ca^{2+} + 2e^-$

iii. Anions

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

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

iv. Molecular Ion

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

Formation:

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

v. Free Radicals

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

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

Q16. Define Molecule. Write down its types

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

Types of Molecules

i. Monatomic molecule

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

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

ii. Diatomic Molecule

A molecule consists of two atoms is called diatomic molecule.

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

iii. Triatomic molecule

A molecule consists of three atoms is called triatomic molecule.

Examples: H_2O , CO_2

iv. Polyatomic Molecule

A molecule consists of many atoms is called polyatomic molecule.

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

v. Homoatomic Molecule

A molecule containing same type of atoms is called homoatomic molecule

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

vi. Hetroatomic Molecule

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

Examples: CO_2 , H_2O , NH_3

Q17. Write a note on the following.

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

(iii) Gram Formula Mass

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

i. Gram Atomic Mass

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

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

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

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

ii. Gram Molecular Mass

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

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

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

iii. Gram Formula Mass

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

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

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

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

Ans. Avogadro's Number

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

Explanation

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

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

Examples:

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

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

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

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

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

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

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

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

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

Ans. Mole (Chemist secret unit)

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

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

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

For example:

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

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

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

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

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

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

Or

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