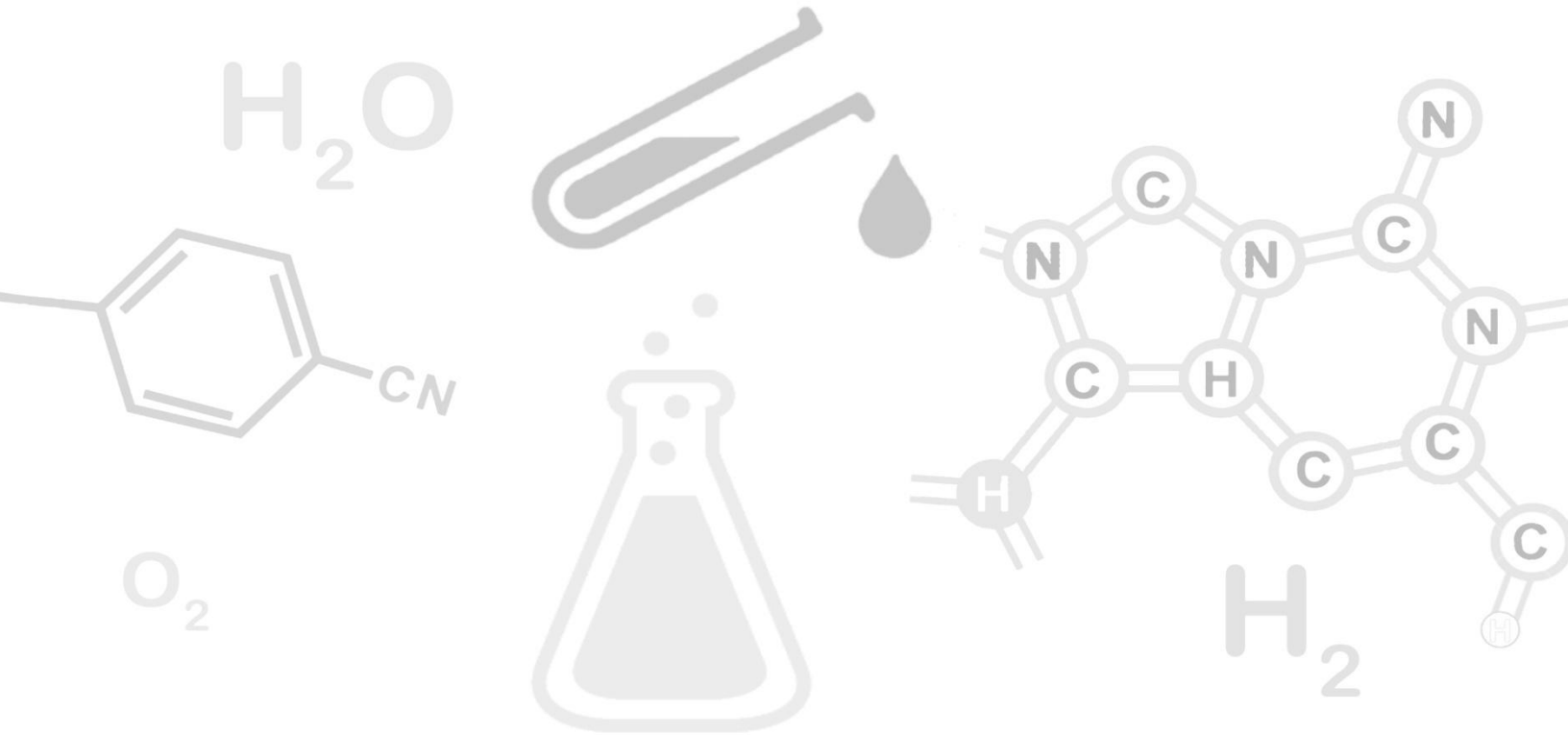
CHEMISTRY



Some Basic Concepts of Chemistry

- Chemistry is the branch of science that studies the composition, properties and interaction of matter.
- Chemistry plays an important role in science and is often intertwined with other branches of science such as physics, biology and geology.
- Chemistry plays an important role in daily life such as weather patterns, functioning of brain, health care products and other materials aimed at improving the quality of life.
- Matter is anything that occupies space and has mass.
- Matter can exist in three physical states such as solid, liquid and gas.
- Solids have definite volume and definite shape.
- Liquids have definite volume but not definite shape.
- Gases have neither definite volume nor definite shape.
- These states of matter can be interconvertible by changing the conditions of temperature and pressure.
- At the macroscopic level, matter can be classified into mixtures or pure substances.
- A mixture may be homogeneous or heterogeneous.
- Pure substances can be further classified into elements and compounds.
- An element consists of only one type of particles.
- Two or more atoms of different elements combine to form a molecule of a compound.
- The constituents of a compound can be separated only by chemical methods.
- A compound has properties different from its constituent elements.
- Isotopes are elements with same atomic number but different mass number.
- Every substance has unique properties that can be classified into two types: physical properties and chemical properties.
- The SI system (The International System of Units) has seven base units which pertain to the 7 fundamental scientific quantities:

Base Physical Quantity	Symbol for quantity	Name of SI Unit	Symbol for SI Unit
Length	L	metre	m
Mass	M	kilogram	kg
Time	T	second	s
Electric current	I	ampere	A
Thermodynamic temperature	T	Kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	I_v	candela	cd

- The unit is written on the right of the quantity with a space between them.
- The SI system allows the use of prefixes to indicate the multiples or submultiples of a unit.

Multiple	Prefix	Symbol
10^{-1}	Deci	D
10	Deca	Da
10^2	Hector	H
10^3	kilo	K
10^6	mega	M

- There are three common scales to measure temperature: ^oC (degree Celsius), ^oF (degree Fahrenheit) and K (Kelvin).
- To indicate very small numbers, we use negative exponents.
- To indicate large numbers, we use positive exponents.
- Scientific notation is a proper representation of a number in exponential form $N \times 10^n$, where n is an exponent having positive or negative values and N can vary from 1 to 10.
- Precision indicates how closely repeated measurements match each other.
- Accuracy indicates how closely a measurement matches the correct or expected value.
- A result is valid only if it is both accurate and precise.
- Significant figures are meaningful digits which are known with certainty.
- There are certain rules for determining the number of significant figures:
  - All non-zero digits are significant.
  - Zeros preceding the first non-zero digit are not significant.
  - Zeros between two non-zero digits are significant.

- Zeros at the end or right of the number are significant provided they are on the right side of the decimal point, but otherwise the zeros are not significant.

- During addition and subtraction, the result cannot have more digits to the right of the decimal point than either of the original numbers.

- In multiplication and division with significant figures, the answer cannot have more significant figures than either of the original numbers.

- There are 5 basic laws of chemical combinations that govern every reaction such as law of conservation of mass, law of definite proportions, law of multiple proportions, Gay Lussac's law of gaseous volumes and Avogadro's law.

- Law of conservation of mass: Antoine Lavoisier established the law of conservation of mass. It states that matter can neither be created nor destroyed. In other words, we can say that during any physical or chemical change, the total mass of reactants is equal to the total mass of products.

- Law of definite proportions: Joseph Proust showed that a given compound always contains exactly the same proportion of elements by weight.

- Law of multiple proportions: Dalton proposed the law of multiple proportions. According to this law, if two elements can combine to form more than one compound, the mass of one element that combines with the fixed mass of the other element is in the ratio of small whole numbers.

- Gay Lussac's law of gaseous volumes: When gases combine or are produced in a chemical reaction, they do so in a simple ratio by volume, provided all the gases have the same temperature and pressure.

- Avogadro law: At the same temperature and pressure, equal volumes of gases contain equal number of molecules.

- Dalton's atomic theory: In 1808, Dalton published 'A New System of Chemical Philosophy' in which he proposed the following:
  - Matter consists of indivisible atoms.
  - All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.
  - Compounds are formed when atoms of different elements combine in a fixed ratio.
  - Chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.

- Dalton's theory could explain the laws of chemical combination.

- The number 6.022×10^{23} is called Avogadro's constant or Avogadro's number.

- Atomic Mass: Average relative mass of an atom of an element as compared to the mass of a carbon atom is taken as 12 amu. Atomic mass expressed in grams is called gram atomic mass.

- Atomic mass is donated by '*u*', where u is the unified mass.
- Molecular mass: It is the sum of atomic masses of elements present in a molecule. Molecular mass expressed in grams is called gram molecular mass.
- Formula mass: It is the sum of atomic masses of all atoms in a formula unit of the compound.
- A mole is a collection of 6.022×10^{23} particles.
- One mole is the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 g (or 0.012 kg) of ^{12}C.
- The mass of one mole of a substance in grams is called its molar mass.
- The molar mass in grams is numerically equal to the atomic/molecular/formula mass in 'u'..
- Following relations given below can be summarized as
  - One mole of atoms = 6.022×10^{23} atoms = Gram atomic mass of an element.
  - One mole of molecules = 6.022×10^{23} molecules = Gram molecular mass of a substance.
- $$\text{Mass \% of an element} = \frac{\text{Mass of that element in the compound}}{\text{Molar mass of compound}} \times 100$$
- The concentration of a solution can be expressed in any of the following ways: Mass per cent, mole fraction, molarity and molality.
- $$\text{Mass per cent} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$
- $$\text{Mole Fraction} = \frac{\text{No. of mole of a particular component}}{\text{Total No. of moles of solution}}$$
- Molarity is the number of moles of solute in per liter of solution. Unit is moles per liter.
- $$\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$$
- Molality is the number of moles of solute present in 1 kg of solvent.
  $$\text{Molality} = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}}$$
- An empirical formula represents the simplest whole number ratio of various atoms present in a compound.

- Molecular formula shows the exact number of different types of atoms present in a molecule of a compound.

- If the mass per cent of various elements present in a compound is known, then its empirical formula can be determined.

- Molecular formula = n (Empirical formula), where n is a simple number and may have values 1, 2, 3….

- Following steps should be followed to determine empirical formula of the compound:
  - Step 1: Conversion of mass per cent of various elements into grams.
  - Step 2: Convert mass obtained in step 1 into number of moles.
  - Step 3: Divide the mole value obtained in step 2 by the smallest mole value (out of the mole value of various elements calculated).
  - Step 4: In case the ratios are not whole numbers, they may be converted into whole numbers by multiplying by a suitable coefficient.
  - Step 5: Write empirical formula by mentioning the numbers after writing the symbols of respective elements.

- Out of various reactants in a reaction, a reactant that is completely consumed in a chemical reaction is called limiting reagent.

- Stoichiometry gives a quantitative relation between reactants and products in a reaction. It also helps us in identifying limiting reagents.