Chapter 1-Some Basic concepts of Chemistry

- Matter is anything that has mass and occupies space. It exists in three states- solid, liquids and gases.

- Solids have definite shape and definite volume. Liquids have definite volume but not a definite shape. Gases neither have definite shape nor definite volume.

- Inter-convertibility-Solids on heating changes to a liquid and liquids on heating changes to gaseous state. On cooling, gases change to liquid and liquids change to solid state.

- Matter can be classified into mixtures and pure substances. Mixtures are further subdivided into heterogeneous and homogeneous and pure substances as compounds and elements.

- Mixtures-Two or more substances which have been combined such that each substance retains its own chemical identity. Can be separated by simple physical methods.

- Homogeneous refers to a substance that is consistent or uniform throughout its volume.

- Heterogeneous mixtures- Having a non-uniform composition. Examples: A mixture of sand and water is heterogeneous.

- A Pure substance is a sample of matter with both definite and constant composition with distinct chemical properties.Cannot be separated by simple physical methods.

- A chemical element is a substance that cannot be broken down by chemical means. It consists of only one type of particles.

- When two or more atoms of different elements combine, the molecule of a compound is obtained.The constituents of a compound cannot be separated into simpler substances by physical methods. They can be separated by chemical methods.

- Physical properties are those properties which can be measured or observed without changing the identity or the composition of the substance. Ex-boiling point, melting point etc.

- Chemical properties require a chemical change to occur. Ex-acidity, basicity.

- The SI system has seven base units. These units pertain to the seven fundamental scientific quantities .The other physical quantities such as speed, volume, density etc. can be derived from these quantities.

- Basic Physical Quantities and their Units.

Basic 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
TEMPERATURE	*T*	kelvin	kg
AMOUNT OF SUBSTANCE	*N*	mole	mol
LUMINOUS INTENSITY	I_v	candela	cd

- Mass of a substance is the amount of matter present in it while weight is the force exerted by gravity on an object. The mass of a substance is constant whereas its weight may vary from one place to another due to change in gravity.

- Density is defined as mass per unit volume.

- There are three common scales to measure temperature — °C (degree celsius), °F (degree fahrenheit) and K (kelvin). Here, K is the SI unit.

- F = (9 / 5) * C + 3.
- K = C + 273.1
- Precision refers to the closeness of variousmeasurements for the same quantity. However,accuracy is the agreement of a particular valueto the true value of the result.
- Significantfigures are meaningful digits which are knownwith certainty. The uncertainty is indicated bywriting the certain digits and the last uncertaindigit.
- There are certain rules for determining the number of significant figures-

➢ All non-zero digits are significant. For example in 285 cm, there are three significant figures and in 0.25 mL, there are two significant figures.

➢ Zeros preceding to first non-zero digit are not significant. Such zero indicates the position of decimal point. Thus, 0.03 has one significant figure and 0.0052 has two significant figures.

➢ Zeros between two non-zero digits are significant. Thus, 2.005 has four significant figures.

- Zeros at the end or right of a number are significant provided they are on the right side of the decimal point. For example,0.200 g has three significant figures.

- Exact numbers have an infinite zeros at the end or right of a number are significant provided they are on the right side of the number of significant figures.

- Often while calculating, there is a need to convert units from one system to other. The method used to accomplish this is called factor label method or unit factor method or dimensional analysis.

- Law of Conservationof Mass-It states that matter canneither be created nordestroyed.This law was put forth by Antoine Lavoisierin 1789.

- Law of Definite Proportions-This law was given by, aFrench chemist, JosephProust. He stated that a given compound alwayscontains exactly the sameproportion of elements by weight.

- Law of Multiple Proportions-This law was proposed by Dalton in 1803.According to this law, if two elements can combine to form more than one compound, themasses of one element that combine with afixed mass of the other element, are in theratio of small whole numbers.

- Gay Lussac's Law of GaseousVolumes-This law was given by GayLussac in 1808. He observedthat when gases combine orare produced in a chemicalreaction they do so in asimple ratio by volumeprovided all gases are atsame temperature andpressure.

- Avogadro Law-In 1811, Avogadro proposedthat equal volumes of gases at the same temperature and pressure should containequal number of molecules.

- Dalton's Atomic Theory-Matter consists of indivisible atoms.All the atoms of a given element haveidentical properties including identicalmass. Atoms of different elements differ in mass. Compounds are formed when atoms of different elements combine in a fixed ratio. Chemical reactions involve reorganization of atoms. These are neither created nor destroyed in a chemical reaction. Dalton's theory could explain the laws of chemical combination.

- One atomic massunit (amu) is defined as a mass exactly equal to onetwelfththe mass of one carbon-12 atom.
  And 1 amu = 1.66056×10^{-24} g.

- Molecular mass is the sum of atomic massesof the elements present in a molecule. It is obtained by multiplying the atomic mass ofeach element by the number of its atoms andadding them together.

- One mole is the amount of a substancethat contains as many particles or entitiesas there are atoms in exactly 12 g (or 0.012kg) of the 12C isotope.

- The mass of one moleof a substance in grams is called itsmolar mass. The molar mass in grams isnumerically equal to atomic/molecular/formula mass in u.

- An empirical formula represents the simplestwhole number ratio of various atoms presentin a compound whereas the molecularformula shows the exact number of differenttypes of atoms present in a molecule of acompound.

- Stoichiometry is the study of the relationships or ratios between two or more substances undergoing a physical or chemical change

- According to the law of conservation of mass, a balanced chemical equation has the same number of atoms of each element on both sides of the equation.

- Thereactant which gets consumed, limits theamount of product formed is called the limiting reagent.

- Mole fraction-It is the ratio of number of moles of a particularcomponent to the total number of moles of thesolution. If a substance ‘A’ dissolves insubstance ‘B’ and their number of moles are n_a and n_b respectively; then the mole fractionsof A and B are given as n_a/n_a+n_b.

- Molarity=No of moles/Volume of Solution.

- Molality-It is defined as the number of moles of solute present in 1 kg of solvent. It is denoted by m.

Sample Examples

- Calculate molecular mass of glucose ($C_6H_{12}O_6$) molecule.

  Molecular mass of glucose ($C_6H_{12}O_6$) = 6(12.011 u) + 12(1.008 u) + 6(16.00 u)

  = (72.066 u) + (12.096 u) + (96.00 u)

  = 180.162 u

- The density of 3 M solution of NaCl is1.25 g mL–1. Calculate molality of thesolution.

  Solution

  M = 3 mol L–1

  Mass of NaClin 1 L solution = 3 × 58.5 = 175.5 g

  Mass of1L solution = 1000 × 1.25 = 1250 g(since density = 1.25 g mL–1)

  Mass of water in solution = 1250 –175.5 = 1074.5 g

  Molality is defined as the number of moles of solute present in 1 kg of solvent.

  Molality = 3 mol / 1.0745 kg = 2.79 m

- Determine the empirical formula of a compound with the followingcomposition by mass : 8.04 percent lithium, 91.96 percent bromide.

  Solution-

$$\text{moles Li} = \frac{8.04\text{g}}{7\text{g/mole}} = 1.15\,\text{moles}$$

$$\text{moles Br} = \frac{91.96\text{g}}{80\text{g/mole}} = 1.15\,\text{moles}$$

$$\frac{\text{moles Br}}{\text{moles Li}} = \frac{1.15}{1.15} = 1$$

$\therefore$ LiBr

- Determine the empirical formula of a compound with the following composition by mass : 29.4 percent calcium, 23.5 percent sulfur, 47.1 percent oxygen.

  Solution-

$$\text{moles Ca} = \frac{29.4\text{g}}{40\text{g/mole}} = .735 \text{ moles}$$

$$\text{moles S} = \frac{23.5\text{g}}{32\text{g/mole}} = .735 \text{ moles}$$

$$\text{moles O} = \frac{47.1}{16\text{g/mole}} = 2.94 \text{ moles}$$

$$\frac{\text{moles O}}{\text{moles Ca}} = \frac{2.94}{.735} = 4$$

$$\frac{\text{moles S}}{\text{moles Ca}} = \frac{.735}{.735} = 1$$

$$\frac{\text{moles Ca}}{\text{moles Ca}} = \frac{.735}{.735} = 1$$

$\therefore CaSO_4$