Some Basic Concepts of Chemistry
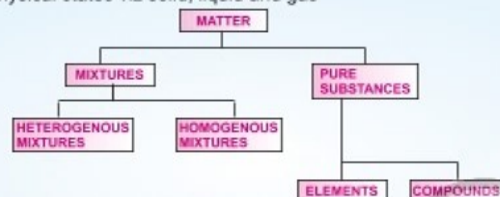
① CLASSIFICATION OF MATTER

- Matter can exist in three physical states viz solid, liquid and gas

- A **mixture** contains particles of two or more pure substances in any ratio.
- **Movement of air follow pressure gradient.**
- In **Homogeneous mixture**, components completely mix with each other.
- In **Heterogeneous mixture**, composition is not uniform.
- Constituent particles of **pure substance** have fixed composition.
- **Compound** is formed when two ore more atoms of different elements combine together in definite ratio.

② PROPERTIES OF MATTER AND THEIR MEASUREMENT

- Properties are of two types viz. physical and chemical properties.
- **Physical properties** can be measured or observed without changing the identity or the composition of the substance.
- **Chemical properties** requires a chemical change to occur.
- Colour, odour, melting point, density etc are some physical properties.
- Composition, combustibility, reactivity with acids and bases are examples of chemical properties.
- Quantitative measurement of physical properties represented by a number followed by **units**.
- SI system has seven base units.
- Base physical quantities and their units.

Length (m)	Mass (kg)
Time (s)	Electric current (A)
Thermodynamic	Amount of substance (mol)
Temperature (K)	Luminous intensity (cd)

SOME PREFIX USED IN SI SYSTEMS ARE

10^{-12} (pico), 10^{-9} (nano), 10^{-6} (micro) 10^{-3} (milli), 10^{-2} (centi),

10^{3} (kilo), 10^{6} (mega) 10^{9} (giga)

SOME COMMON UNITS

- $1\ L = 1000\ mL = 1000\ cm^3 = 1\ dm^3$, °F = 9/5 (°C) + 32, K = °C + 273.15

③ UNCERTAINTY IN MEASUREMENT

- **Scientific notation** is exponential notation in which any number represented in $N \times 10^n$, where n is exponent having positive or negative values and N is number between 1.000 ... and 9.999 .....
- **Significant figures** are meaningful digits which are known with certainity plus one which is estimated or uncertain.
- **Rules for determining the number of significant figures.**
- All non zero digits are significant.
- Zeros preceding to first non-zero digit are non significant.
- Zeroes between two non-zero digits are significant.
- Zeroes at the end or right of a number are significant provided they are on the right side of decimal point.
- Counting numbers have infinite significant figures.
- In a number written in scientific notation, all digits are significant.
- **Precision** refers to the closeness of various measurements for the same quantity.
- **Accuracy** is the agreement of a particular value to the true value of the result.
- In **addition** and **subtraction** of significant figures the result cannot have more digits to the right of the decimal point than either of the original numbers.
- In multiplication and division of significant figures the result must be reported with no more significant figures as are there in the measurement with the fewer significant figures.

- **Important points for rounding off the numbers.**
  - If the rightmost digit to be removed is more than 5, the preceding number is increased by one.
  - If the rightmost digit is less than 5, the preceding number is not changed.
  - If the rightmost digit is 5 then preceding number increased by 1 only if it is an odd number.
- Method used to interconversion of unit is known as **dimensional analysis, unit factor method.**

④ LAWS OF CHEMICAL COMBINATION

- **Law of conservation of mass** conclude that in all physical and chemical changes, there is no net change in mass during the **change**.
- **Law of definite proportions/composition** stated that a given compound always contains exactly the same proportion of elements by weight.
- **Law of multiple proportions** stated that, if two elements can combine to form more than one compound, the masses of one element that combine with a fixed mass of other element are in the ratio of small whole number.
- **Gay Lussac's law of gaseous volume** : When gases combine or are produced in a chemical reaction they do so in a simple ratio by volume, provided all gases are at same temperature and pressure.
- **Avogadro's law** proposed that equal volumes of all gases at same temperature and pressure should contain equal number of molecules.
- **Dalton's Atomic Theory** proposed to following points
  - Matter consists of indivisible atoms.
  - All atoms of a given element have indentical 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.

⑤ ATOMIC AND MOLECULAR MASS

- One **atomic mass unit (amu)** is defined as a mass exactly equal to one-twelfth of the mass of one C-12 atom, **1 amu = 1.66056×10^{-24} g.**
- At present amu has been replaced by **unified mass (u)**
- **Average atomic mass** can be computed when we take into account the existence of isotopes and their relative abundance.
- **Molecular mass** is the sum of atomic masses of the elements present in a molecule.
- **Formula mass** is used instead of molecular mass for ionic solids as in solid state they do not exist as a single entity.

⑥ MOLE CONCEPT AND MOLAR MASSES

- Mole (Symbol, mol) is seventh base quantity for amount of a substance.
- One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the **Avogadro's constant (N_A)**.
- The mass of one mole of a substance in grams is called its **molar mass**.
- **Mass% of an element** = Mass of that element in the compound × 100 / Molar mass of the compound.

- **Empirical formula** represents the simplest whole number ratio of various atoms present in a compound, whereas, the **molecular** formula shows exact number of different types of atoms present in a molecule of a compound.

⑦ STOICHIOMETRY AND STOICHIOMETRIC CALCULATIONS

- Stoichiometry deals with calculation of masses (sometime volume) of the reactants and products involved in a chemical reaction.
- Reactant, which gets consumed first, limits the amount of product formed is called limiting reagent.
- A majority of reactions are carried out in solutions. The **concentration** of a solution can be expressed in following ways.
- **Mass percent** = Mass of solute × 100 / (Mass of solution)
- **Mole fraction** of solute = No. of moles of solute/No. of moles of solution
- **Molarity** (M) = No. of moles of solute / Volume of solution in litres
  - For dilution of solutions, $M_1V_1 = M_2V_2$
- **Molality** (m) = No. of moles of solute/Mass of solvent in kg.

Sharpen Your Understanding

NCERT Based MCQs

1. Incorrect boiling point of water is

   [NCERT Pg. 10]

   (1) 373 K   (2) 100°C

   (3) 212°F   (4) 98.6°F

2. Number of significant digits in 0.200 g is

   [NCERT Pg. 12]

   (1) 1   (2) 2

   (3) 3   (4) 4

3. Law of multiple proportions is not valid for the pair of   [NCERT Pg. 15]

   (1) H_2O and H_2O_2

   (2) CO and CO_2

   (3) CH_4 and CO_2

   (4) CH_4 and C_2H_6

4. Select the incorrect statement regarding Dalton's atomic theory   [NCERT Pg. 16]

   (1) Matter consists of indivisible atoms

   (2) Atoms of given element have identical properties

   (3) Compounds are formed when atoms of different elements combined in a fixed ratio

   (4) Atoms are created or destroyed in a chemical reactions

5. An element has two isotopes having atomic mass 10 and 15 u respectively. If the % abundance of lighter isotope is 80% then the average atomic mass of the element is

   [NCERT Pg. 17]

   (1) 9 u   (2) 11 u

   (3) 12 u   (4) 14 u

6. Formula mass is used instead of molecular mass in the case of   [NCERT Pg. 17]

   (1) H_2O (2) NaCl

   (3) He   (4) H_2

7. 88 g of CO_2 contains (N_A = Avogadro's No.)

   [NCERT Pg. 18]

   (1) N_A molecules   (2) $2N_A$ molecules

   (3) $0.5 N_A$ molecules   (4) $4N_A$ molecules

8. In which molecule, mass % of both elements in the molecule are equal? [NCERT Pg. 19]

   (1) CO   (2) SO_2

   (3) NH_3 (4) H_2O_2

9. A hydrocarbon contains 80% carbon by mass. The empirical formula of the hydrocarbon is   [NCERT Pg. 19]

   (1) CH   (2) CH_2

   (3) CH_3 (4) CH_4

10. Mole(s) of CO_2 gas obtained at STP, when 32g CH_4 reacted with 32 g of oxygen is

    [NCERT Pg. 20]

    (1) 0.5   (2) 1

    (3) 2   (4) 3

11. Mass of one CO molecule in gram is

    [NCERT Pg. 18]

    (1) 4.65×10^{-23} (2) 1.66×10^{-24}

    (3) 3×10^{-24} (4) 6.22×10^{-23}

12. If 2 mol of N_2 and 3 mol of H_2 mixed together to produce NH_3 then select the correct option.   [NCERT Pg. 22]

    (1) N_2 is limiting reagent

    (2) 1 mole of NH_3 will be formed

    (3) H_2 is limiting reagent

    (4) N_2 and H_2 both are limiting reagents

13. The aqueous solution contains 2g of solute in 18 g solution. The mass% of solute is

    [NCERT Pg. 23]

    (1) 11.1%   (2) 10%

    (3) 12.5%   (4) 80%

14. A gaseous mixture of CH_4 and O_2 contains equal masses of both. The mole fraction of CH_4 in the mixture is   [NCERT Pg. 23]

    (1) $\dfrac{1}{2}$ (2) $\dfrac{1}{3}$

    (3) $\dfrac{2}{3}$ (4) $\dfrac{1}{4}$

15. In order to prepare 500 mL, 0.2 M NaOH solution, the mole(s) of NaOH required is

    [NCERT Pg. 23]

    (1) 0.1   (2) 0.2

    (3) 1   (4) 2

16. 2M, 2L aqueous HCl solution is mixed with 3L H_2O, the molarity of resultant solution is [NCERT Pg. 23]
    (1) 1.34 M
    (2) 0.4 M
    (3) 0.8 M
    (4) 1 M

17. 58.5 g of NaCl is added in 2500 g of water. The molality of the solution formed is [NCERT Pg. 23]
    (1) 0.2 m
    (2) 0.4 m
    (3) 0.8 m
    (4) 1 m

18. The density of 1 M solution of compound A is 1.12 g mL^{-1}. The molality of the solution is (Molar mass of A = 120 g mol^{-1}) [NCERT Pg. 23]
    (1) 0.55 m
    (2) 0.75 m
    (3) 1 m
    (4) 1.2 m

19. Mole fraction of solute in 1 molal aqueous NaOH solution is [NCERT Pg. 28]
    (1) 1
    (2) 0.5
    (3) $\dfrac{1}{55.55}$
    (4) $\dfrac{1}{56.55}$

20. 0.0014 can be written in scientific notation as [NCERT Pg. 11]
    (1) 0.14×10^{-2}
    (2) 1.4×10^{-3}
    (3) 14×10^{-4}
    (4) 140×10^{-3}

? Thinking in Context

1. _____ refers to the closeness of various measurements for the same quantity. [NCERT Pg. 13]

2. According to law of definite proportions, a given compound always contains same elements combined together in the same proportion by _____ [NCERT Pg. 16]

3. ^{12}C and ^{14}C are _____ of carbon. [NCERT Pg. 16]

4. 1 amu is defined as mass exactly equal to _____ of the mass of one carbon-12 atom. [NCERT Pg. 17]

5. 6.022×10^{23} is known as _____ [NCERT Pg. 18]

6. 5 moles of H_2SO_4 contains_____ moles of atoms. [NCERT Pg. 18]

7. Empirical formula of CH_3COOH is _____ [NCERT Pg. 19]

8. The reactant, which gets consumed first, limits the amount of product formed is known as _____ [NCERT Pg. 21]

9. Number of moles of _____ after and before dilution remained the same. [NCERT Pg. 24]

10. 15 ppm means 15 g of solute in _____ g of solution. [NCERT Pg. 26]

11. 12.7106 can be rounded up in three significant figures as _____ [NCERT Pg. 27]

12. 1 dm^3 is equal _____ L. [NCERT Pg. 27]

13. 1 micro is equal to _____ [NCERT Pg. 9]

14. Counting the number of object has _____ significant figures. [NCERT Pg. 13]

15. Volume of 56 g CO gas at STP is _____ [NCERT Pg. 28]

16. For a binary solution, mole fraction of solute is 0.2 then mole fraction of solvent is_____ [NCERT Pg. 23]

17. Concentration term which changes with temperature is _____ [NCERT Pg. 23]

18. 1 mol of C_3H_8 for complete combustion requires _____ mol of O_2 [NCERT Pg. 21]

19. Two volumes of hydrogen react with one volume of oxygen to give _____ of water vapours. [NCERT Pg. 16]

20. For the multiplication of 3.7 and 1.384, the result should not have more than _____ significant figures. [NCERT Pg. 13]

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