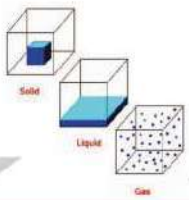


Chapter - 1

Some Basic Concepts of Chemistry

FAST TRACK : QUICK REVISION

- **Matter :** Anything that has mass and occupies space.
- **Precision :** It refers to the closeness of various measurements for the same quantity.
- **Accuracy :** It refers to the agreement of a particular value to the true value of the result.
- **Mass and weight :** Mass of a substance is the amount of matter present in body, 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.
- **Volume :** 1 L = 1 dm^3 = $10^3 cm^3$ = 10^{-3} m^3
- **Temperature :** K = °C + 273.15; $\frac{°F - 32}{9} = \frac{°C}{5}$
- **Standard Temperature Pressure (STP) :** 0°C (273.15 K) temperature and 1 atm pressure.
- **Normal Temperature Pressure (NTP) :** 20°C (293.15 K) temperature and 1 atm pressure.
- **Standard Ambient Temperature Pressure (SATP) :** 25°C (298.15 K) temperature and 1 atm pressure
- **Scientific Notation :** Expressing a number in the form N × 10^n, and N can vary between 1 to 9.99.
- **Significant figures :** These are meaningful digits which are known with certainty.
- **Laws of Chemical Combination :**
  - **Law of Conservation of Mass (Antonie Lavoisier) :** Mass can neither be created nor be destroyed.
  - **Law of Definite Proportions (Joseph Proust) :** A given compound always contains the same elements in the same proportion by mass.

- **Law of Multiple Proportions (John Dalton) :** When two elements combine to form two or more compounds, then the different masses of one element, which combine with a fixed mass of the other, bear a simple ratio to one another.
- **Gay Lussac's Law :** When gases combine or are produced in a chemical reaction, they do so in a simple ratio of their volume provided all gases are under the same temperature and pressure.

e.g., $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

2 Vol 1 Vol 2 Vol

(at same T, P)

- **Atomic Mass :** It is defined as the average relative mass of an atom of an element as compared to the mass of an atom of carbon – 12 taken as 12.

  Atomic mass is represented by '*u*' (unified mass).

  $1u = 1.66056 \times 10^{-24}$ g
- **Molecular mass :** It is algebraic the sum of the atomic mass of the elements present in the molecule.

  For example : Molecular mass of $CH_4 = (1 \times 12) + (4 \times 1) = 16$ u
- **Avogadro Number :** It is the amount of atoms or molecules present in one mole of a substance.

  Avogadro number $(N_A) = 6.022 \times 10^{23}$ mol^{-1}
- **Molar Mass :** The mass of one mole of a substance in grams is called its molar mass.

  For example : Molar mass of $CH_4 = (1 \times 12) + (4 \times 1) = 16$g mol^{-1}
- **Mole (*n*) :** It is amount of a substance that contains as many particles or entities as the number of atoms in exactly 12 grams of pure C-12.

  1 mole of a substance = Molar mass of substance = Avogadro's Number of chemical units = 22.4L volume at STP of gaseous substance

  e.g., 1 mole of CH_4 = 16g of CH_4 = 6.022×10^{23} molecules of CH_4 = 22.4L at STP

$$n = \frac{w\,g}{M_m} = \frac{VL\ (at\ STP)}{22.4L} = \frac{x\ particles}{N_A} = \frac{MV}{1000}$$

- **Molar Volume (V_m) :** It is volume occupied by one mole of gas at STP.

  Molar volume of a gas = 22.4L at STP (273 K, 1atm) or 22.7L at STP (273 K, 1 bar)

Calculating Molar Volume: PV = nRT

$$\therefore V = \frac{nRT}{P} = \frac{1\text{mol} \times 0.082\text{L atm K}^{-1}\text{mol}^{-1} \times 273\text{K}}{1\text{ atm}} = 22.4\text{L}$$

Or

$$V = \frac{nRT}{P} = \frac{1\,\text{mol} \times 0.083\,\text{L bar K}^{-1}\,\text{mol}^{-1} \times 273\,\text{K}}{1\text{ bar}} = 22.7\,\text{L}$$

- **Percentage Composition :** Mass % of the element

$$= \frac{\text{Mass of element in a molecule of the compound} \times 100}{\text{Molecular mass of the compound}}$$

- **Empirical Formula :** It represents the simplest whole number ratio of various atoms present in a compound. For *e.g.*, CH is the empirical formula of benzene.
- **Molecular Formula** : It shows the exact number of different of atoms present in a molecule of a compound. For *e.g.*, C_6H_6 is the molecular formula of benzene.
- **Relationship between empirical and molecular formulae :**
  Molecular formula = n × Empirical formula

  Where; $$n = \frac{\text{Molar mass}}{\text{Empirical formula mass}}$$

- **Information Conveyed by a chemical equation :**

	$N_2(g)$	+	$3H_2(g)$	→	$2NH_3(g)$
(i)	1 molecule of N_2	+	3 molecules of H_2	→	2 molecules of NH_3
(ii)	1 mole of N_2	+	3 mole of H_2	→	2 mole of NH_3
(iii)	1 × 28g of N_2	+	3 × 2 g of H_2	→	2 × 17 g of NH_3
(iv)	1 × 22.4L of N_2 at STP	+	3 × 22.4L of H_2 at STP	→	2 × 22.4L of NH_3 at STP

- **Limiting Reagent** : It is the reactant which gets consumed first or limits the amount of product formed.
- **Mass Percent** : It is the mass of the solute in grams per 100 grams of the solution.

$$\text{Mass percent} = \frac{\text{Mass of solute in } g \times 100}{\text{Mass of solution in } g}$$

- **Parts per million (ppm) :** It is part of solute per million part of solution by mass.

$$\text{ppm} = \frac{\text{Parts of solute (by mass)} \times 10^6}{\text{Parts of solution (by mass)}}$$

- **Molarity (M)** : It is number of moles of solute dissolved per litre (dm^3) of the solution.

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in L}}$$

Molarity equation : $M_1V_1 = M_2V_2$

(Before dilution) (After Dilution)

Molarity of a solution decreases on increasing temperature.

Molarity of pure water is 55.56 mol L^{-1}

- **Molality (*m*)**—It is number of moles of solute dissolved per 1000g (1kg) of solvent.

$$\text{Molality} = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}}$$

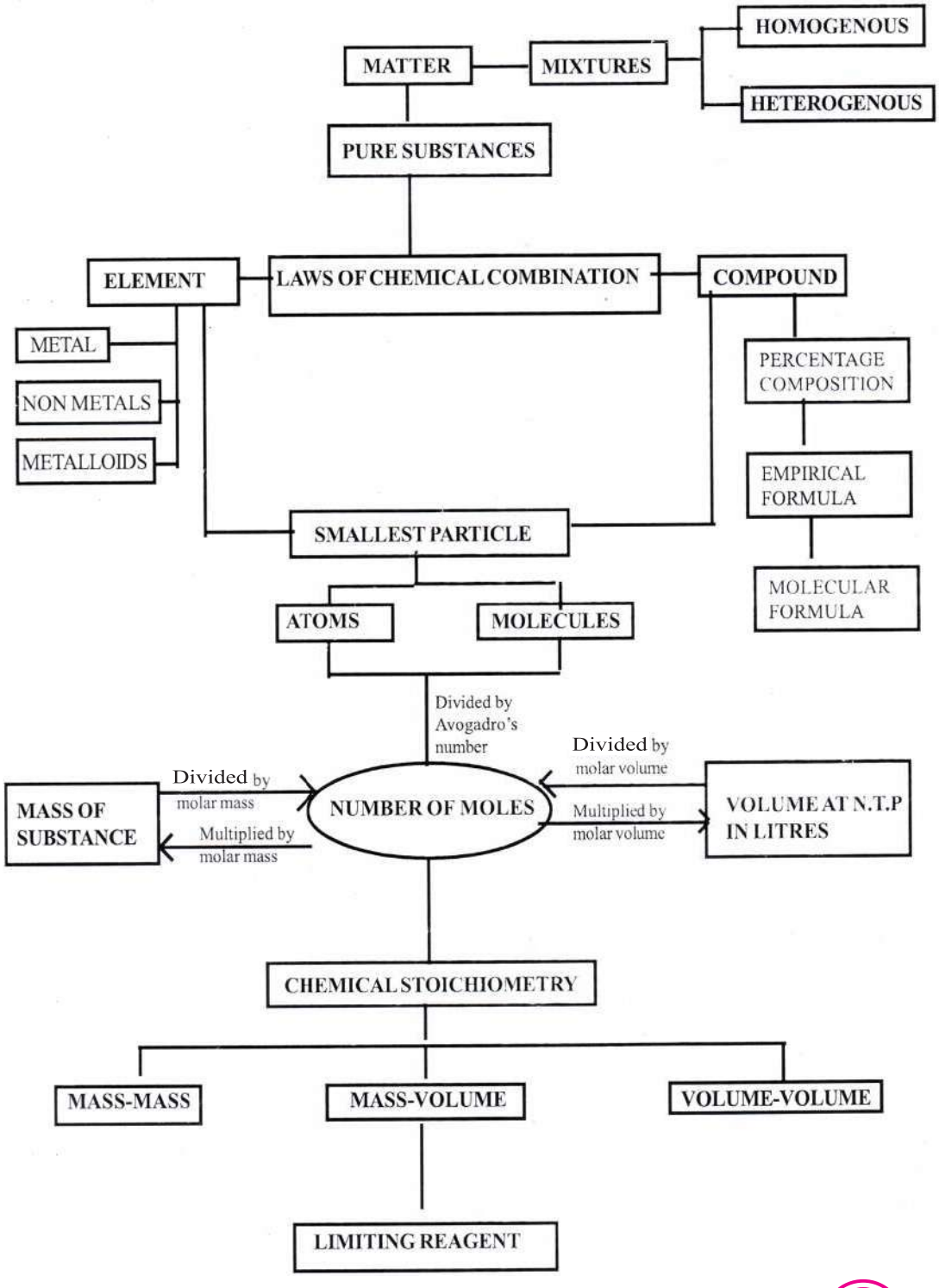
Molality is independent of temperature.

- **Mole Fraction(*x*)** is the ratio of number of moles of one component to the total number of moles (solute and solvents) present in the solution.

$$x_1 = \frac{n_1}{n_1 + n_2} \quad \text{and} \quad x_2 = \frac{n_2}{n_1 + n_2}$$

The sum of all the mole fractions in a solution is equal to one. *i.e.*, $x_1 + x_2 = 1$

MIND MAP
SOME BASIC OF CONCEPTS OF CHEMISTRY



CASE BASE : QUESTIONS

1. Read the passage given below and answer the following questions:

The ideas underlying our modern understanding of thermodynamics and kinetic theory were developed during the nineteenth century. Central to these developments was the discovery that matter reacting chemically does not do so simply between equal masses of the samples involved. We now call the study of this phenomenon 'stoichiometry', defined as: 'the relationship between the amounts of substance that react together, and the products that are formed'.

Another development during the nineteenth century that was central to our modern understanding of the chemical nature of matter was the observation by Avogadro that 'equal volumes of ideal or perfect gases, at the same temperature and pressure, contain the same number of particles, or molecules'. This is now known as Avogadro's law. It provides the motivation to formulate expressions for the quantity of a sample that reacts with another sample. The most notable example of such a formulation is the gram-molecule, which has been used to refer to both a unit and a quantity.

(Reference: Milton Martin J. T. 2011A new definition for the mole based on the Avogadro constant: a journey from physics to chemistry *Phil. Trans. R. Soc.* A.3693993–4003)

The following questions are multiple choice questions. Choose the most appropriate answer:

I. The concept of stoichiometry mentioned in the study is based on the

a. formation of chemical bonds.

b. amount of reactant and product involved in a chemical reaction.

c. idea of temperature and pressure required for the reaction to occur.

d. oxidation states of reactant and product involved.

II. How much gram-molecules of H_2O are produced on combustion of 32 g of methane in excess oxygen?

a. 72 b. 4

c. 2 d. 36

III. When an antacid tablet is used, $Ca(OH)_2$ reacts with HCl in the stomach to form inert $CaCl_2$ and H_2O. If the molar mass of $Ca(OH)_2$ is 75 g/mol, how many moles of HCl are required to fully react with 150 g of $Ca(OH)_2$?

a. 4 b. 1

c. 8 d. 2

IV. What must be held constant when applying Avogadro's law?

a. pressure and temperature

b. volume and temperature

c. moles and temperature

d. pressure and volume

ANS:- I-B, II-B, III-A, IV-A

2. Read the passage given below and answer the following questions:

The goal of this study was to examine the means used by textbook authors to introduce, define, and explain the mole concept in high school and introductory college chemistry textbooks. The analysis was framed by four questions:

1. How is the mole defined?
2. What concepts about the atom are introduced prior to the mole?
3. Is Avogadro's constant presented as an experimentally determined value?
4. What is the context for introducing the mole?

Twenty nine high school and introductory college level chemistry texts were examined. After independent reading of appropriate sections of each text, discussion of differences, second or third readings of texts, and subsequent discussions, both authors reach 100% agreement concerning the results. Major conclusions were

1. Two ways of defining the mole dominate the texts. One way defines the mole as Avogadro's number (6.02×10^{23}) particles; the other method defines the mole in terms of carbon 12.
2. All texts that present a definition in terms of C-12 introduce and define concepts about the atom prior to introducing the mole.
3. Most texts at all levels point out that the value 6.02×10^{23} is an experimentally determined quantity.

4. Nearly all texts discuss the mole in relation to die problem of finding a way to count particles that are too small to be directly weighed. Most texts also use a familiar counting unit, such as the dozen, to introduce the mole by analogy.

(Reference: John R. Staver, Andrew T. Lumpe, A content analysis of the presentation of the mole concept in chemistry textbooks, Journal of Research in Science Teaching).

In these questions (Q. No. (i) to (iv) , a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement

i. ASSERTION: Equal moles of different substances contain same number of constituent particles.

REASON: Equal weights of different substances contain the same number of constituent particles.

ii. ASSERTION: Both 106g of sodium carbonate and 12g of carbon have same number of carbon atoms.

REASON: Both contain 1 g-atom of carbon which contains 6.02×10^{23} carbon atoms

iii. ASSERTION: Both 32g SO_2 and 8g CH_4 have same number of molecules.

REASON: Equal moles of substances have equal number of molecules.

iv. ASSERTION: Average atomic mass of an element depends mainly on the heavier isotope.

REASON: The average atomic mass of an element is the sum of the masses of its isotopes, each multiplied by its natural abundance

ANS:- I-C, II-A, III-A, IV-D

MULTIPLE CHOICE QUESTIONS (MCQ)

1. Which of the following is dependent of temperature ?

   (a) Molarity (b) Molality

   (c) Mole fration (d) Mass percentage

2. 4 g of NaOH dissolved in 100 ml solution. Molarity of the solution is

   (a) 1 M (b) 10 M

   (c) 0.1 M (d) 4 M

3. Which has the maximum number of molecules among the following ?

   (a) 44g of CO_2 (b) 44g of O_2

   (c) 8g of H_2 (d) 64g of SO_2

4. 10 mol of Zn react with 10 mol of HCl. Calculate the number of moles of H_2 produced.

   (a) 5 mol (b) 10 mol

   (c) 20 mol (d) 2.5 mol

5. The number of oxygen atoms in 4.4g of CO_2 is approximately

   (a) 1.2×10^{23} (b) 6×10^{22}

   (c) 6×10^{23} (d) 12×10^{23}

6. The molarity of a solution obtained by mixing 750 mL of 0.5 M HCl with 250 ml of 2 M HCl will be

   (a) 0.975 M (b) 0.875 M

   (c) 1.00 M (d) 1.175 M

7. Number of atoms of He in 100 u of He (Atomic mass of He is 4 u)

   (a) 25 (b) 50

   (c) 100 (d) 400

8. 6.02×10^{20} molecules of urea are present in 100 mL of its solution. The concentration of the solution is

   (a) 0.02 M (b) 0.01 M

   (c) 0.001 M (d) 0.1 M

9. A gaseous hydrocarbons gives upon combustion, 0.72 g of water and 3.08 g of CO_2. The empirical formula of the hydrocarbon is :

(a) C_6H_5 (b) C_7H_8

(c) C_2H_4 (d) C_3H_4

10. The density of solution prepared by dissolving 120 g of urea (Mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of the solution is

(a) 0.50 M (b) 1.78 M

(c) 1.02 M (d) 2.05 M

Ans: 1. (a), 2. (a), 3. (b), 4. (a), 5. (a), 6. (b), 7. (a), 8. (b), 9. (b), 10. (d)

FILL IN THE BLANKS

1. 17 g of NH_3 gas will occupy a volume of _____ cm^3 at NTP.
2. The number of Li atoms in _____ g. is 6.022×10^{24} atoms.
3. (1/12)th of the mass of carbon atom is _____
4. Number of atoms of oxygen in 24 g of O_3 is _____
5. The number of moles of barium carbonate which contains 1.5 moles of oxygen atoms is _____
6. A mixture having 2 g of H_2 and 32 g of oxygen occupies a volume of _____ at NTP.
7. If the phosphate of a metal has the formula MPO_4 the formula of the metallic sulphate is _____
8. At NTP, the mass of 1 litre of gas is 3 g. Molecular mass of the gas is _____
9. The percentage mass of magnesium in chlorophyll is 2.68% The number of magnesium atoms in 2 g of chlorophyll is _____
10. The mass of one molecule of carbon dioxide is _____
11. Percentage of nitrogen in urea is _____
12. Number of carbon atoms present in 18 g of glucose ($C_6H_{12}O_6$)

13. 0.5 mole of triatomic gas contains _____atoms.

14. A binary compound contains 50% A (at. mass = 16) and 50% B (at. mass 32). The empirical formula of the compound is _____.

15. The number of hydrogen atoms in 60 u of ethane is_____

Ans:

1.	22400	2.	70 g	3.	1 u
4.	9.033×10^{23}	5.	0.5	6.	44.8 litre
7.	$M_2(SO_4)_3$	8	67.2	9.	1.34×10^{21}
10.	7.3×10^{-23}	11.	46.67	12.	3.61×10^{23}
13.	9.033×10^{23}	14.	A_2B	15.	7.226×10^{24}

TRUE AND FALSE TYPE QUESTIONS

Write true or false for the following statements

1. Equal volumes of different gases under similar conditions of temperature and pressure contain equal number of molecules.

2. 1 mole of $C_{12}H_{22}O_{11}$ contain 22 hydrogen atoms.

3. Nitrogen forms five oxides. It proves the law of multiple proportions.

4. The atomicity of phosphorus is four.

5 Molarity change with change in temp.

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

7. Gram-atomic mass of an element may be defnined as the mass of Avogadro's number of atoms.

8. Gay-Lussac's law of chemical combination is valid for all substances.

9. Avogadro's number varies with temperature and pressure.

10. 18 g of water vapour and 18 g of ice will contain the same number of molecules.

Ans:

1. (T)	2. (F)	3. (T)	4. (T)	5. (T)
6. (F)	7. (T)	8. (F)	9. (F)	10. (T)

MATCH THE COLUMNS

1.

Column X	Column Y	Column Z
a. 8 g CH_4	i. 0.1 mol	p. Emp. formulation $\rightarrow$ CH_2O
b. 1.7 g NH_3	ii. 0.5 mol	q. 50% oxygen
c. CH_3OH	iii. 40% carbon	r. 1.806×10^{23} atoms of hydrogen
d. $C_6H_{12}O_6$	iv. Vapour density = 16	s. 25% hydrogen

2.

Column X	Column Y
a. Molarity	i. For very dilute solution
b. Molality	ii. No units
c. mole fraction	iii. Mol L^{-1}
d. ppm	iv. independent of temperature

3.

Column X	Column Y	Column Z
a. 40 g of He	i. 3.011×10^{23} atoms	p. 0.5 moles
b. 35 g of Li	ii. 10 atoms	q. 1.67×10^{-23}
c. 40 u of He	iii. 6.022×10^{24} atoms	r. 10 moles
d. 16 g of O_2	iv. 3.011×10^{24} atoms	s. 5 moles

4.

Column X	Column Y
a. Petrol	i. Heterogenous mixture
b. Graphite	ii. Compound
c. Sucrose	iii. Element
d. Milk	iv. Homogeneous mixture

Ans: 1. a.(ii). (s), b.(i). (r), c.(iv). (q), d.(iii). (p)

2. a.(iii), b.(iv), c.(ii), d.(i)

3. a.(iii). (r), b.(iv). (s), c.(ii). (q), d.(i). (p)

4. a.(iv), b.(iii), c.(ii), d.(i)

ASSERTION AND REASON TYPE QUESTIONS

Directions for Q. No.1-10

A Both Assertion & Reason are true and the reason is the correct explanation of the assertion.

B Both Assertion & Reason are true but the reason is not the correct explanation of the assertion.

C Assertion is true statement but Reason is false.

D Assertion is false but Reason is true.

1. Assertion : A solution of table salt in a glass of water is homogeneous
   Reason : A solution having same composition throughout is heterogeneous
2. Assertion : The molecular weight of oxygen is 32 amu.
   Reason : The atomic weight of oxygen is 16 amu
3. Assertion : No of moles of H_2 in 0.224 L of hydrogen is 0.01 mole.
   Reason : 22.4 L of H_2 at STP contain 6.023×10^{23} moles.
4. Assertion : Atomic mass of Na is 23.
   Reason : An atom of sodium is 23 times heavier than 1/12th mass of C-12 isotope.
5. Assertion : Number of atoms of He in 60 u of He is 15.
   Reason : Atomic weight of He is 4 u.
6. Assertion : In a gaseous reaction, the ratio of volumes of reactants and products is in agreement with their molar ratio.
   Reason : Volume of gas is inversely proportional to its moles at particular temperature and pressure.
7. Assertion : The Empirical mass of ethane is half of its molecular mass.
   Reason : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.
8. Assertion : Significant figures for 0.200 is 3 whereas for 200 is 1
   Reason : Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.
9. Assertion : One molar aqueous solution has always higher concentration than One molal aqueous solution
   Reason : The molality of solution depends upon the density of solution whereas molarity does not.

10. Assertion : In a combustion reaction in the air, oxygen is the limiting reagent

Reason : Limiting reagent is the reactant in a chemical reaction that limits the amount of product that can be formed.

Ans: 1.C 2.A 3.C 4.A 5.A 6. C 7.A 8.C 9.B 10.D

ONE WORD ANSWER TYPE QUESTIONS

1. What is the SI unit of density?
2. What is the SI unit of molarity?
3. Calculate the number of atoms in 32 u of He. [**Ans.** : 8]
4. What is the volume of 17 g of NH_3 gas at STP? [**Ans.** : 223.4 L]
5. How many molecules of SO_2 are present in 11.2 L at STP?

[**Ans.** : 3.011×10^{23}]

6. Which has more number of atoms ? 1.0 g Na or 1.0 g Mg

[**Ans.** : 1.0 g Na]

7. How many oxygen atoms are present in 16 g of ozone (O_3)?

[**Ans.** : 2.007×10^{23}]

8. Calculate the number of molecules present in 22.0 g of CO_2.

[**Ans.** : 3.011×10^{23}]

9. A substance has molecular formula $C_6H_{12}O_6$. What is its empirical formula.
10. Empirical formula of a compound X (Molar mass = 78 mol^{-1}) is CH. Write its molecular formula.

1-MARK QUESTIONS

1. Classify following as pure substances and mixtures : air, glucose, gold, sodium and milk.
2. Which measurement is more precise 4.0g or 4.00g ? [**Ans.** 4.00 g]

3. How many significant figures are there in (i) 3.070 and (ii) 0.0025 ?

[**Ans.** (i) 4 (ii) 2]

4. Express the following in the scientific notation : (i) 0.0048 (ii) 234,000

5. If ten volumes of dihydrogen gas react with five volumes of dioxygen gas, how much volume of water vapour would be produced ?

[**Ans.** 10 volumes]

6. At STP, what will be the volume of 6.022×10^{23} molecules of H_2 ?

[**Ans.** 22.4L]

7. 1L of a gas at STP weighs 1.97g. What is molecular mass ?

[**Ans.** 44.128 g mol^{-1}]

8. Write the relationship between empirical formula and molecular formula.

9. Which is more informative ? Empirical formula or Molecular formula.

10. How are 0.5 mol Na_2CO_3 and 0.5 M Na_2CO_3 different from each other ?

11. Why molality is preferred over molarity of a solution ?

12. Define molarity of a solution.

13. What is the effect of temperature on molarity of solution ?

14. What is limiting reactant in a reaction ?

2-MARKS QUESTIONS

1. Classify following substances as element, compounds and mixtures : water, tea, silver, steel, carbon dioxide and platinum.

2. The body temperature of a normal healthy person is 37°C. Calculate its value in°F.

3. Convert 5L into m^3.

4. What does the following prefixes stand for :
   (a) pico (b) nano (c) micro (d) deci

5. How many significant figures are present in the following :
   (i) 4.00005
   (ii) 0.004

6. Convert '450 pm' into SI unit and write the answer in scientific notation upto 2 significant figures.
   [**Ans.** 4.5×10^{-10} m]

7. Hydrogen peroxide and water contain 5.93% and 11.2 % of hydrogen respectively. Show that the data illustrate law of multiple proportions.

8. The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% H_2SO_4 (Molar mass = 98 g mol^{-1}) by mass will be .....
   [**Ans.** 1.21 g/mL]

9 The cost of table salt (NaCl) is Rs. 10 per Kg. calculate its cost per mole. (Molar mass of NaCl is 58.5 $gmol^{-1}$) [**Ans.** 0.58 Rs]

10 Calculate the mole fraction of the solute in a 1.00 molal aqueous solution. [**Ans.** 0.0177]

11 Dissolving 120 g of urea (Molar mass of urea = 60 g mol^{-1}) in 1000 of water gave a solution of density 1.15 g/mL. Calculate the molarity of the solution. [**Ans.** 2.05 M]

12 Calculate the percentage of N in urea. (Molar mass of urea = 60 g mol^{-1}) [**Ans.** 46.66]

13 25 ml of 3.0 M HCl are mixed with 75 mL 0f 4.0 M HCl. If the volumes are additive, the molarity of the final mixture will be. [**Ans.** 3.75 M]

14 How many atoms and molecules are present in 124 gm of phosphorus (P_4) [**Ans.** Atoms = 4 N_A & Molecules = N_A]

15 45.4 L of dinitrogen reacted with 22.7 L of dioxygen and 45.4 L of nitrous oxide was formed.
   The reaction is given below : $2N_2\,(g) + O_2\,(g) \longrightarrow 2N_2O\,(g)$
   Which law is being obeyed in this experiment? Write the statement of the law.

16 Give one example each of a molecule in which empirical formula and molecular formula is

(i) Same (ii) Different.

17 Calculate the number of moles in the following masses :

(i) 7.85g of Fe;
(ii) 7.9mg of Ca

18 Calculate the percent of carbon, hydrogen and oxygen in ethanol (C_2H_5OH) [**Ans.** 52.14%, 13.13%, 34.73%]

19 How much copper can be obtained from 100 g of $CuSO_4$? [**Ans.** 39.8g]

20 Calculate the amount of water (g) produced by the combustion of 16 g of methane. [**Ans.** 36g]

21 How many moles of methane are required to produce 22 g CO_2 (g) after combustion? [**Ans.** 0.5 mol]

22 A solution is prepared by adding 2 g of a substance A to 18 g of water. Calculate the mass per cent of the solute. [Ans. 10%]

23 Calculate molarity of water if its density is 1.00 g mL^{-1}.

[**Ans.** 55.56 M]

24 Calculate the molarity of NaOH in the solution prepared by dissolving its 4 g in enough water to form 250 mL of the solution. [**Ans.** 0.4 M]

25 The density of 3 M solution of NaCl is 1.25 g mL^{-1}. Calculate molality of the solution. [**Ans.** 2.8m]

26 NH_3 gas can be prepared by Haber's process as, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$. At a particular moment concentration of all the species is 2 moles; calculate the concentration of N_2 and H_2 taken initially.

[**Ans.** 3 mole, 5 moles]

3-MARKS QUESTIONS

1. Calculate the average atomic mass of Mg using the following data:

	% Natural Abudance	Molar mass
^{24}Mg	80	24
^{25}Mg	10	25
^{26}Mg	10	26

2. The following data are obtained when dinitrogen and dioxygen react together to form different compounds :

	(i)	(ii)	(iii)	(iv)
Mass of dinitrogen	14	14	28	28
Mass of dioxygen	16	32	32	80

Which law of chemical combination is obeyed by the above experimental data ? Give its statement.

3. Calculate :

(i) Mass in gram of 5.8 mol N_2O

(ii) Number of moles in 8.0 g of O_2

(iii) Molar mass if 11.2 L at STP weigh 8.5 g.

[**Ans.** (i) 255.2 g (ii) 0.25 mol (iii) 17 g mol^{-1}]

4. In three moles of ethane (C_2H_6), calculate the following :

(i) Number of moles of carbon atom,

(ii) Number of moles of hydrogen atoms,

(iii) Number of molecules of ethane.

[**Ans.** (i) 6 moles, (ii) 18 moles, (iii) 1.81×10^{24}]

5. 16 g of an ideal gas SO_x occupies 5.6 L at STP. What is its molecular mass ? What is the value of X ? [**Ans.** 64u, x = 2]

6. Calculate the number of moles :

(i) 5.0 L of 0.75 M Na_2CO_3

(ii) 7.85 g of Fe

(iii) 34.2 g of sucrose ($C_{12}H_{22}O_{11}$)

[**Ans.** (i) 3.75, (ii) 0.14, (iii) 0.1]

7. Calculate the number of atoms in each of the following :

(i) 52 moles of Ar. (ii) 52u of He (iii) 52g of He.

[**Ans.** (i) 3.13 × 1025 (ii) 13 (iii) 7.83 × 1024]

8. Vitamin C is essential for the prevention of scurvy. Combustion of 0.2000g of vitamin C gives 0.2998g of CO_2 and 0.819g of H_2O. What is the empirical formula of vitamin C ? [**Ans.** $C_3H_4O_3$]

9. A compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas? [**Ans.** CH_2C1, $C_2H_4Cl_2$]

10. A compound made up of two elements A and B has A = 70%, B = 30%. Their relative number of moles in the compound is 1.25 and 1.88, calculate :

(i) Atomic masses of the elements A and B

(ii) Molecular formula of the compound , if its molecular mass is found to be 160. [**Ans.** (i) 56 and 16, (ii) A_2B_3]

11. The reaction $2C + O_2 \longrightarrow 2CO$ is carried out by taking 24.0 g of carbon and 96.0 g of O_2. Find out.

(i) Which reactant is left in excess ?

(ii) How much of it is left ?

(iii) How many grams of the other reactant should be taken so that nothing is left at the end of the reaction ? [**Ans.** (i) O_2, (ii) 64 g, (iii) 72]

12. A 10 g sample of a mixture of calcium chloride and sodium chloride is treated with Na_2CO_3 to precipitate calcium as calcium carbonate. This $CaCO_3$ is heated to convert all the calcium to CaO and the final mass of CaO is 1.62 g. Calculate % by mass of NaCl in original solution.

[**Ans.** 67.9%]

13. 3.0 g of H_2 react with 29.0 g of O_2 yield H_2O.

(i) Which is the limiting reagent.

(ii) Calculate the maximum amount of H_2O that can be formed

(iii) Calculate the amount of reactant left unreacted

[**Ans.** H_2 , 26.8g H_2O & 5.2 g O_2]

14 Zinc and hydrochloric acid react according to the reaction:

$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

If 0.30 mol Zn are added to hydrochloric acid containing 0.52 mol of HCl, How many moles of H_2 are produced ?

[HCl is limiting reagent; H_2 formed = 0.36 mol]

15 How many moles of Lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl ? [Atomic mass of Pb = 207 U]

[**Ans.** 0.029 mole]

16 What volume of oxygen at N.T.P is needed to cause the complete combustion of 200 ml of acetylene ?Also calculate the volume of carbon dioxide formed. [**Ans.** 500 mL of O_2 & 400 mL of CO_2]

5-MARKS QUESTIONS

1 (i) A black dot used as a full stop at the end of a sentence has a mass of about one attogram. Assuming that the dot is made up of carbon, calculate the approximate number of carbon atoms present in the dot. [Hint : 1 attogram = 10^{-18}g] [**Ans.** 5.02×10^4]

(ii) Which one of the following will have largest number of atoms ?

(a) 1g Au (s) (b) 1g Na (s) (c) 1g Li (s) (d) 1g of $Cl_2(g)$

[**Ans.**. (i) 39.81 g (ii) 1 g of Li]

2. (i) What is the difference between empirical formula and molecular formula ?

(ii) A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gas 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calcuate

(i) Empirical formula, (ii) molar mass of the gas, and (iii) Molecular formula. [**Ans.** (i) CH, (ii) 26 g mol^{-1}, (iii) C_2H_2]

3. (i) What is the difference between Molarity and Molality.

   (ii) The Molarity of a solution of sulphuric acid is 1.35 M. Calculate its molality. (The density of acid solution is 1.02 g cm^{-3}).

   [**Ans.**. 1.52 m]

4. (i) Define : (a) Mole fraction (b) Mass percentage.

   (ii) If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution ? [**Ans.** 0.0025 L]

HOTS QUESTIONS

1 In a compound $C_xH_yO_z$, the mass % of C and H is 6:1 and the amount of oxygen present is equal to the half of the oxygen required to react completely C_xH_y. Find the empirical formula of the compound.

[**Ans.** $C_2H_4O_3$]

2 A crystalline salt when heated becomes anhydrous and loses 51.2 % of its weight. The anhydrous salt on analysis gave the following percentage composition

Mg = 20.0% , S = 26.6 % , O = 53.33 %

Calculate the molecular formula of the anhydrous salt and the crystalline salt. Molecular weight of the anhydrous salt is 120.

[**Ans.** $MgSO_4.7H_2O$]

3 An LPG cylinder weighs 14.8 kg when empty. When full, it weighs 29.0 kg and shows a pressure of 2.5 atm. In the course of use at 27°C, the weight of cylinder is reduced to 23.2 kg. Find the volume of n-butane in cubic meters used up at 27°C and 1 atm (Molecular weight of n-butane = 58). [**Ans.** 2.463 m^3]

4 2.5 g of $CaCO_3$ was placed in 50 ml of a solution of HCl.1.05 g of $CaCO_3$ was left after the reaction. Calculate:

(a) the weight of HCl per litre

(b) the Molarity of HCl [**Ans.** (a) 21.17 g, (b) 0.58 M]

UNIT TEST-I

Time allowed : 1 hour **Maximum Marks : 20**

General instructions :

(i) All questions are compulsory.

(ii) Maximum marks carried by each question are indicated against it.

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1. If 30 mL of H_2 and 20 mL of O_2 react to form water, what is left at the end of the reaction ? (1)

   (a) 10 mL of H_2 (b) 5 mL of H_2

   (c) 10 mL of O_2 (d) 5 mL of O_2

2. 7.5 grams of a gas occupy 5.6 litres of volume at STP the gas is (1)

   (a) NO (b) N_2O (c) CO (d) CO_2

3. Write the relationship between empirical formula and molecular formula. (1)

4. Why molarity is preferred over molarity in expressing the concentration of solution ? (1)

5. Which has more number of atoms ? 1.0 g Na or 1.0g Mg? (1)

6. How many atoms and molecules are present in 124 g of phosphorus (P_4)? (2)

7. (a) How many significant figures are present in 0.0102. (2)

   (b) Write the number in scientific notation 1013.6.

8. A sample of drinking water was found to be severely contaminated with chloroform $CHCl_3$. The level of contamination was 15 ppm (by mass).

   (a) Express this in percent by mass.

   (b) Determine the molarity of chloroform in the water sample. (3)

9. A compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formula ? (3)

10. (a) Explain the following terms:

    (i) Gay Lussac's law (ii) Limiting reagent

    (b) 3.0 g of H_2 react with 30.0 g of O_2 yield H_2O.

    (i) Which is the limiting reagent?

    (ii) Calculate the maximum amount of H_2O that can be formed.

    (iii) Calculate the amount of reactant left unreacted. (5)

UNIT TEST-II

Time allowed : 1 hour **Maximum Marks : 20**

General instructions :

(i) All questions are compulsory.

(ii) Maximum marks carried by each question are indicated against it.

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1. One mole of oxygen gas at STP is equal to ---------- (1)

   (a) 6.022×10^{23} molecules of oxygen

   (b) 6.022×10^{23} atoms of oxygen

   (c) 16 g of oxygen

   (d) 32 g of oxygen

2. 1g of M_2CO_3 on treatment with excess HCl produces 0.01186 moles of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is ? (1)

   (a) 1186 (b) 84.3 (c) 118.6 (d) 11.86

3. How many atoms are present in 16 g of ozone? (1)

In following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and Reason are true and Reason is the correct explanation of Assertion

(b) Assertion and Reason are true but Reason is not the correct explanation of Assertion

(c) Assertion is true but Reason is false

(d) Both Assertion and Reason are false

4. **Assertion** : The empirical mass of ethene is half of its molecular mass. (1)

   Reason : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

5. **Assertion** : Combustion of 16 g of methane gives 18 g water. (1)

   Reason : In the combustion of methane, water is one of the products.

6. If 2 litres of N_2 is mixed with 2 litres of H_2 at a constant temperature and pressure, then what will be the volume of NH_3 formed? (2)

7. Calculate the percentage of Copper in a sample of $CuCl_2$ (2)

   (Atomic mass of Cu = 63.5u, Cl = 35.5u)

8. In an experiment, when HCl was reacted with $CaCO_3$ at STP, 48 Cm^3 of CO_2 was formed. Calculate the number of mole of CO_2 and number of molecules. (3)

9. In the reaction $2A + 4B \rightarrow 3C + 4D$, when 5 moles of A react with 6 moles of B, then (3)

   (i) Which is the limiting reagent

   (ii) Calculate the amount of C formed

   (iii) Calculate the amount of excess reagent left after reaction

10. (a) How many grams atoms are there in 8.0 g of S? (5)

    (b) The molarity of solution of H_2SO_4 is 1.35 M. Calculate its molality.

    (The density of solution is 1.02 g cm^{-3})

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