Chapter 1

Some Basic Concepts of Chemistry

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NATURE OF MATTER

Anything which has mass and occupies space is called matter.
Matter can exist in three physical states: solid, liquid and gas. These three states are interconvertible by changing the conditions of temperature and pressure.

$$\text{Solid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Liquid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Gas}$$

At macroscopic level, matter is classified as

Matter

Mixtures
They contains two or more substances in any ratio. Their components can be separated by simple physical methods. They are further classified as

- **Homogeneous**
  Their components mix completely and they have uniform composition throughout.
  Example : sugar solution, air, etc.
- **Heterogeneous**
  Components of the mixture remain separate. The composition is not uniform throughout.
  Example : mixture of salt and sugar

Pure substances
They contains two or more substances in a fixed ratio. Their the components cannot be separated by physical methods. They are further classified as

- **Elements**
  It consists of only one type of particles, which may be atoms or molecules
- **Compounds**
  It is formed by the combination of 2 or more elements in a fixed ratio.

PROPERTIES OF MATTER AND THEIR MEASUREMENT

Every substance has characteristic properties which can be classified as physical properties and chemical properties.
Physical properties are those which can be measured or observed without changing the identity or composition of the substance. Ex: colour, odour, m.pt, b.pt, etc.
Chemical properties are those which require a chemical change for their measurement.
Many properties of matter are quantitative in nature which can be measured under the following system of units.

The International System of Units (SI)

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

Physical Quantity	Symbol	SI unit	Symbol
Length	l	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric current	I	ampere	A
Temperature	T	kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	I_v	candela	cd

UNCERTAINTY IN MEASUREMENT AND SIGNIFICANT FIGURES

Precision and Accuracy

Very large or very small numbers, having many zeros can be expressed by using scientific notation for such numbers i.e., exponential notation in which any number can be represented in the form $N \times 10^n$ where n is an exponent having +ve or –ve value and N can vary between 1 to 10.

Every experimental measurement has some amount of uncertainty associated with it. However, one would always like the results to be precise and accurate. Precision refers to the closeness of various measurements for the same quantity while accuracy is the agreement of particular value to the true value of the result.

Significant Figures

The uncertainty in experimental or calculated values is indicated by mentioning the number of significant figures. Significant figures are meaningful digits which are known with certainty. The uncertainty is indicated by writing the certain digits and the last imcertain digit.

The rules for determining the number of significant figures are:

(i) All non-zero digits are significant. For ex: in 285 cm, there are 3 significant figures.

(ii) Zeros preceding to first non-zero digit are not significant. Such zero indicates the position of decimal point. For ex: 0.03 has one significant figure.

(iii) Zeros between two non-zero digits are significant. For ex: 2.005 has four significant figures.

(iv) Zeros at the end or right are significant provided they are on the right side of the decimal point. For ex: 0.200 g has 3 significant figure.

(v) If a number ends in zeros that are not to right of a decimal the zeros may or may not be significant. For e.g., 3500 may have two, three or five significant figures.

(vi) Counting no. of objects have infinite significant figures.

(vii) In numbers written in scientific notation, all digits are significant.

LAWS OF CHEMICAL COMBINATION

The combination of elements to form compounds is governed by following five basic laws :

(i) Laws of Conservation of Mass

It states that matter can neither be created nor destroyed,

(ii) Law of Definite Proportion/Composition

It states that a given compound always contains exactly the same proportion of elements by weight.

(iii) Law of Multiple Proportions

It states that if two elements can combine to form more than one compound, the masses of one element that combine with a fixed mass of the other element, are in the ratio of small whole numbers.

For ex :

$$\underset{2g}{H_2} + \underset{16g}{\tfrac{1}{2}O_2} \longrightarrow \underset{18g}{H_2O} \qquad \underset{2g}{H_2} + \underset{32g}{O_2} \longrightarrow \underset{34g}{H_2O_2}$$

Here, masses of oxygen (i.e., 16 g and 32 g) which combine with a fixed mass of H (2g) bear a simple ratio, 16 : 32 i.e. 1:2.

(iv) Gay Lussac's law of Gaseous Volumes

According to this law, 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.

(v) Avogadro Law

It states that equal volumes of gases at same temperature and pressure should 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 :

(i) Matter consists of indivisible atoms.

(ii) All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.

(iii) Compounds are formed when atoms of different elements combine in a fixed ratio.

(iv) Atoms are neither created nor destroyed in a chemical reaction. **Dalton's theory** could explain the laws of chemical combination.

ATOMIC AND MOLECULAR WEIGHT

Atomic Mass :

Atomic mass is the number of times an atom of an element is heavier than 1/12 th of an atom of C–12.

$$\text{Atomic weight of an element} = \frac{\text{Weight of 1 atom of element}}{1/12 \times \text{weight of 1 atom of C-12}}$$

Determination of atomic weight :

Atomic weight × specific heat = 6.4 (app.)

Molecular weight : It is the number of times a molecule of any compound is heavier than 1/12 th of an atom of C–12

$$\text{Molecular weight} = \frac{\text{Weight of one molecule}}{1/12 \times \text{weight of one C-12 atom}}$$

Determination of molecular weight :

(i) Vapour density method :

$$\text{Vapour density} = \frac{\text{Wt. of a certain vol. of a gas or vapour under certain temperature and pressure}}{\text{Wt. of the same volume of } H_2 \text{ under same temperature and pressure}}$$

Molecular weight = 2 × vapour density

(ii) Diffusion method :

(a) It is based on **Graham's law** of diffusion.

(b) **Graham's law** states that : *The rate of diffusion of different gases, under similar conditions of temperature and pressure are inversely proportional to the square roots of their density* (or molecular weights).

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

MOLE CONCEPT

Mole : Mole is a unit which represents 6.023×10^{23} particles of same nature.

22.4 L at NTP/STP

$$\text{Mole} = \frac{\text{Volume (L)}}{22.4\ \text{L}}$$

$N_A = 6.023 \times 10^{23}$ Particles

$$\text{Mole} = \frac{\text{No. of particles}}{N_A}$$

1 Mole

One gram mole of a compound

$$\text{Mole} = \frac{\text{Weight of compound (gm)}}{\text{GMM}}$$

One gram atom of an element

$$\text{Mole} = \frac{\text{Weight of element}}{\text{GAM}}$$

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1 Mole = 6.023×10^{23} particles.

1 Mole of atoms = 6.023×10^{23} Atoms.

1 Mole of molecules = 6.023×10^{23} molecules

1 Mole of electrons = 6.023×10^{23} electrons.

The number 6.023×10^{23} is called *Avogadro number* (N_A)

EQUIVALENT WEIGHT

Equivalent weight of a substance (element or compound) is defined as *"The number of parts by weight of it, that will combine with or displace directly or indirectly 1.008 parts by weight of hydrogen, 8 parts by weight of oxygen, 35.5 parts by weight of chlorine or the equivalent parts by weight of another element".*

$$\text{Eq. wt of elements} = \frac{\text{Molecular mass}}{\text{Basicity of acid}}$$

$$\text{Eq. wt of an acid} = \frac{\text{Molecular mass}}{\text{Basicity of acid}}$$

$$\text{Eq. wt of a base} = \frac{\text{Molecular mass}}{\text{Acidity of base}}$$

Equivalent mass for salts

$$= \frac{\text{Formula mass}}{\text{(Valency of cation) (No. of cations)}}$$

Equivalent mass for oxidising agents

$$= \frac{\text{Formula mass}}{\text{No. of electrons gained per molecule}}$$

Equivalent mass for reducing agents

$$= \frac{\text{Formula mass}}{\text{No. of electrons lost per molecule}}$$

PERCENTAGE COMPOSITION AND CHEMICAL FORMULAE

Percentage Composition

The percentage composition of an element in a compound is given by:

Mass % of an element

$$= \frac{\text{mass of the element in compound}}{\text{molar mass of compound}} \times 100$$

For ex: Percentage composition of water is:

Molar mass of water = 18.02 g

$$\text{Mass \% of H} = \frac{2 \times 1.008}{18.02} \times 100 = 11.18\%$$

$$\text{Mass \% of O} = \frac{16.00}{18.02} \times 100 = 88.79\%$$

Chemical Formulae

It is of two types :

(i) Molecular formulae : Chemical formulae that indicate the actual number and type of atoms in a molecule are called *molecular formulae*.

Example : Molecular formula of benzene is C_6H_6.

(ii) Empirical formulae : Chemical formulae that indicate only the relative number of atoms of each type in a molecule are called *empirical formulae*.

Example : Empirical formula of benzene is "CH".

Determination of Chemical Formulae :

(a) Determination of empirical formulae :

Step (I) : Determination of percentage of each element

Step (II) : Determination of mole ratio

Step (III) : Making it whole number ratio

Step (IV) : Simplest whole ratio

(b) Determination of molecular formulae

Step (I) : First of all find empirical formulae

Step (II) : Calculate the empirical weight

Step (III) : Molecular formulae = *n* (Empirical formulae)

$$n = \frac{\text{Molecular weight}}{\text{Empirical weight}}$$

STOICHIOMETRY

It deals with the calculation of masses of reactant and products involved in a chemical reaction.

For ex: the balanced equation for combustion of CH_4 is:

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$$

The coefficients of 2 for O_2 and H_2O are called stoichiometric coefficients. The coefficient for CH_4 and CO_2 is one in each case. According to the above chemical reaction,

(i) One mole of CH_4 (g) reacts with 2 moles of O_2(g) to give 1 mole of CO_2(g) and 2 moles of H_2O (g).

(ii) One molecule of CH_4 (g) reacts with 2 molecules of O_2(g) to give 1 molecule of CO_2(g) and 2 molecules of H_2O (g).

(iii) 22.4 L of CH_4(g) reacts with 44.8 L of O_2(g) to give 22.4 L of CO_2(g) and 44.8 L of H_2O(g)

(iv) 16 g of CH_4(g) reacts with 2×32 g of O_2(g) to give 44 g of CO_2(g) and 2×18g of H_2O(g)

The given data can be interconverted as:

$$\text{Mass} \rightleftharpoons \text{Moles} \rightleftharpoons \text{No. of molecules}$$

The calculations based on the knowledge of chemical equations are also called **stoichiometry calculations.** The following steps are generally followed for carrying out such calculations :

(i) Write the balanced chemical equation.

(ii) Write the molar relationship from the equation between the given and the required species.

(iii) Convert these moles into the desired parameters such as mass, volume, etc.

(iv) Apply unitary method to calculate the result.

Limiting Reagent

The reactant which gets consumed and limits the amount of product formed is called limiting reagent. The moles of product are always determined by the starting moles of limiting reactant.

EXPRESSION OF STRENGTH/CONCENTRATION OF SOLUTION

The concentration of the solution or the amount of substance present in its given volume can be expressed in any of the following ways:

1. Mass Percent or Weight Percent (w/W%)

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

(i) Weight-weight percent (w/W) :

$$\text{Weight percent} = \frac{\text{Weight of solute (gm)}}{\text{Weight of solution (gm)}} \times 100$$

(ii) Volume-volume percent (v/V) :

Volume – volume percentage

$$= \frac{\text{Volume of solute (ml.)}}{\text{Volume of solution (ml.)}} \times 100$$

(iii) Weight – volume percentage (w/V) :

Weight – volume percentage

$$= \frac{\text{Weight of solute (gm)}}{\text{Volume of solution (ml)}} \times 100$$

2. Normality :

The number of gram equivalents of the solute dissolved per litre of the solution. It is denoted by 'N' :

$$\text{Normality} = \frac{\text{Number of gram equivalents of solute}}{\text{Volume of solution (lit.)}}$$

$\because$ Gram equivalents of solute

$$= \frac{\text{Weight of solute (gm)}}{\text{Equivalent weight of solute}}$$

3. Mole Fraction :

If a substance A dissolves in substance B and their number of moles are n_A and n_B, then their mole fractions (x) are given by

$$x_A = \frac{n_A}{n_A + n_B} \quad \text{and} \quad x_B = \frac{n_B}{n_A + n_B}$$

Also, $x_A + x_B = 1$

4. Molarity :

It is defined as the number of moles of solute in 1 litre of solution. Thus,

$$\text{Molarity}(M) = \frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$$

5. Molality :

It is defined as the number of moles of solute present in 1 kg of solvent. Thus,

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

6. ppm. (Parts per million) :

The parts of the component per million parts (10^6) of the solution.

$$\text{ppm} = \frac{w}{w+W} \times 10^6$$

where, w = weight of solute, W = weight of solvent

CONCEPT MAP

SOME BASIC CONCEPTS OF CHEMISTRY

Laws of Chemical Combination

Law of multiple proportion: Two elements combine to form more than one compound. The mass of one element; Which combine with a fixed mass of other element will always be in ratio of small whole number.

Avogadro's law: Equal volume of gases at the same temp and pressure should contain equal number of gases.

Gas lussac's law: When gases combine or are produce in a chemical reaction. They do so in simple ratio by volume provided all gases are at same temperature and pressure.

Law of definite proportion : A given compound contain exactly the same proportion of element by weight

Law of conservation : mass can neither be created nor be distorted

Concentration terms

- Mass percent = $\dfrac{\text{mass of solute}}{\text{mass of solution}} \times 100$
- Mole fraction = $\dfrac{\text{No of moles of one component}}{\text{Total moles}}$
- Molarity = $\dfrac{\text{No. of moles}}{\text{volume of solution (lit)}}$
- Molality = $\dfrac{\text{No. of moles}}{\text{mass of solvent (kg)}}$
- Normality = $\dfrac{\text{No of gram equivalent}}{\text{vol. of solution}}$

Stoichiometry and its calculation: Stoichiometry is the calculation of Quantitative relationships of the reactants & products in a balanced chemical reaction.
Limiting reagent: The reactant which react completely in a reaction is called limiting reagent.

Mole concept: Number of atom or molecule in a definite amount of substances is equal to Avogadro's No. $N_A = 6.022 \times 10^{23}$.

- 1 Mole of any substance $= 6.022 \times 10^{23}$ Particles

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Uncertainty in measurement

Scientific notation: number can be represented as $N \times 10^n$.

Significant figures (All certaint digit plus one doubtfull digit).
Rules:
- All non-zero digit as well as zero between the non-zero digit are significant.
- Zero at left of first non-zero digit are not significant.
- A number end with zero and it is right of decimal Then the zero is significant.

Precision: Closeness of measured values.
Accuracy Agreement of measured value to true value

Matter, Anything which has mass and Occupies Space

At microscopic level
- **Solid:** definite shape and volume
- **Liquid:** definite volume but not-definite shape
- **Gas:** neither definite volume nor definite shape

At macroscopic level
- Mixture
  - **Homogeneous** uniform composion
  - **Heterogeneous** Non-uniform composion
- Pure substance
  - **Element** only one type of particles
  - **Compounds** (Two or more atom of different element).

Properties of Matters

Physical properties measure without changing the identify and composition

Chemical properties Chemical change in substance

Unit to measure the properties
Standard of reference to measure the physical quantities is called units.
Basic SI units are : length -meter (m)
time - second(s), amount of substance-mole (n)
mass-kilogram (kg), temperature-kelvin (k)
Electric current- Ampere (A), Luminous intensity candela (cd)

EXERCISE - 1
Conceptual Questions

1. The oxide of an element contains 67.67% oxygen and the vapour density of its volatile chloride is 79. Equivalent weight of the element is:
(a) 2.46 (b) 3.82 (c) 4.36 (d) 4.96

2. The empirical formula of a compound is CH_2O. Its molecular weight is 180. The molecular formula of compound is :
(a) C_4HO_4 (b) $C_3H_6O_3$
(c) $C_6H_{12}O_6$ (d) $C_5H_{10}O_5$

3. 0.4 moles of HCl and 0.2 moles of $CaCl_2$ were dissolved in water to have 500 mL of solution, the molarity of Cl^- ion is:
(a) 0.8 M (b) 1.6 M (c) 1.2 M (d) 10.0 M

4. 10^{21} molecules are removed from 200 mg of CO_2. The moles of CO_2 left are :
(a) 2.88×10^{-3} (b) 28.8×10^{-3}
(c) 288×10^{-3} (d) 28.8×10^{3}

5. The weight of NaCl decomposed by 4.9g of H_2SO_4, if 6 g of sodium hydrogen sulphate and 1.825 g of HCl, were produced in the reaction is:
(a) 6.921 g (b) 4.65 g (c) 2.925 g (d) 1.4 g

6. Which one of the following pairs of compounds illustrate the law of multiple proportions ?
(a) H_2O and Na_2O (b) MgO and Na_2O
(c) Na_2O and BaO (d) $SnCl_2$ and $SnCl_4$

7. The molecular weight of O_2 and SO_2 are 32 and 64 respectively. At 15°C and 150 mm Hg pressure, one litre of O_2 contains 'N' molecules. The number of molecules in two litres of SO_2 under the same conditions of temperature and pressure will be :
(a) N/2 (b) 1N (c) 2N (d) 4N

8. In the final answer of the expression

$$\frac{(29.2-20.2)(1.79\times10^{5})}{1.37}$$

the number of significant figures is :
(a) 1 (b) 2 (c) 3 (d) 4

9. The number of significant figures for the three numbers 161 cm, 0.161 cm, 0.0161 cm are
(a) 3,4 and 5 respectively (b) 3,4 and 4 respectively
(c) 3,3 and 4 respectively (d) 3,3 and 3 respectively

10. A gas occupies a volume of 300 cc at 27°C and 620 mm pressure. The volume of gas at 47°C and 640 mm pressure is:
(a) 260 cc (b) 310 cc (c) 390 cc (d) 450 cc

11. The prefix 10^{18} is
(a) giga (b) kilo (c) exa (d) nano

12. A sample was weighted using two different balances. The results were
(i) 3.929 g (ii) 4.0 g
How would the weight of the sample be reported?
(a) 3.93 g (b) 3g (c) 3.9 g (d) 3.929 g

13. The weight of one molecule of a compound of molecular formula $C_{60}H_{122}$ is
(a) 1.2×10^{-20} g (b) 5.025×10^{23} g
(c) 1.4×10^{-21} g (d) 6.023×10^{-20} g

14. Among the following pairs of compounds, the one that illustrates the law of multiple proportions is
(a) NH_3 and NCl_3 (b) H_2S and SO_2
(c) CS_2 and $FeSO_4$ (d) CuO and Cu_2O

15. Irrespective of the source, pure sample, of water always yields 88.89% mass of oxygen and 11.11% mass of hydrogen. This is explained by the law of
(a) conservation of mass (b) multiple proportions
(c) constant composition (d) constant volume

16. The volume of 20 volume H_2O_2 required to get 5 litres of O_2 at STP is
(a) 250 ml (b) 125 ml (c) 100 ml (d) 50 ml.

17. Given P = 0.0030m, Q = 2.40m, R = 3000m, Significant figures in P, Q and R are respectively
(a) 2, 2, 1 (b) 2, 3, 4 (c) 4, 2, 1 (d) 4, 2, 3

18. The prefix zepto stands for (in m)
(a) 10^{9} (b) 10^{-12}
(c) 10^{-15} (d) 10^{-21}

19. Two samples of lead oxide were separately reduced to metallic lead by heating in a current of hydrogen. The weight of lead from one oxide was half the weight of lead obtained from the other oxide. The data illustrates
(a) law of reciprocal proportions
(b) law of constant proportions
(c) law of multiple proportions
(d) law of equivalent proportions

20. Number of valency electrons in 4.2 gram of N_3^- ion is
(a) $4.2\,N_A$ (b) $0.1\,N_A$ (c) $1.6\,N_A$ (d) $3.2\,N_A$

21. 100 ml of solution of H_2O_2 on decomposition gives 1500 ml of O_2 at N.T.P. The H_2O_2 has the volume strength
(a) 8.6 volume (b) 10 volume
(c) 15 volume (d) 25 volume

22. Which of the following is the best example of law of conservation of mass?
(a) 12 g of carbon combines with 32 g of oxygen to form 44 g of CO_2
(b) When 12 g of carbon is heated in a vacuum there is no change in mass
(c) A sample of air increases in volume when heated at constant pressure but its mass remains unaltered
(d) The weight of a piece of platinum is the same before and after heating in air

23. With increase of temperature, which of these changes?
(a) Molality (b) Weight fraction of solute
(c) Molarity (d) Mole fraction

24. A gas is found to have formula $(CO)_n$. If its vapour density is 56, the value of n will be:
(a) 7 (b) 5 (c) 4 (d) 3

25. The least count of an instrument is 0.01 cm. Taking all precautions, the most possible error in the measurement can be :
(a) 0.005 cm (b) 0.01 cm (c) 0.0001 cm (d) 0.1 cm

26. A metallic chloride contain 47.22% metal. Calculate the equivalent weight of metal.
(a) 39.68 (b) 31.76 (c) 36.35 (d) 33.46

27. One litre hard water contains 12.00 mg Mg^{2+}. Milli-equivalents of washing soda required to remove its hardness is :
(a) 1 (b) 12.16
(c) 1×10^{-3} (d) 12.16×10^{-3}

28. The percentage weight of Zn in white vitriol $[ZnSO_4.7H_2O]$ is approximately equal to $(Zn = 65, S = 32, O = 16 \text{ and } H = 1)$
(a) 33.65 % (b) 32.56 % (c) 23.65 % (d) 22.65 %

29. 25ml of a solution of barium hydroxide on titration with a 0.1 molar solution of hydrochloric acid gave a litre value of 35ml. The molarity of barium hydroxide solution was
(a) 0.14 (b) 0.28 (c) 0.35 (d) 0.07

30. 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is
(a) 0.02 M (b) 0.01 M (c) 0.001 M (d) 0.1 M
(Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1})

31. Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 ml of 1.2 M second solution. What is the molarity of the final mixture?
(a) 2.70 M (b) 1.344 M (c) 1.50 M (d) 1.20 M

32. What volume of hydrogen will be liberated at NTP by the reaction of Zn on 50 ml dilute H_2SO_4 of specific gravity 1.3 and having purity 40%?
(a) 3.5 litre (b) 8.25 litre (c) 6.74 litre (d) 5.94 litre

33. Following is the composition of a washing soda sample :

Substance	Molecular Wt.	Mass percent
Na_2CO_3	106.0	84.8
$NaHCO_3$	84.0	8.4
NaCl	58.5	6.8

On complete reaction with excess HCl, one kilogram of the washing soda will evolve:
(a) 9 mol of CO_2 (b) 16 mol of CO_2
(c) 17 mol of CO_2 (d) 18 mol of CO_2

34. To neutralise completely 20 mL of 0.1 M aqueous solution of phosphorous acid (H_3PO_3), the value of 0.1 M aqueous KOH solution required is
(a) 40 mL (b) 20 mL (c) 10 mL (d) 60 mL

35. Density of a 2.05M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is
(a) 2.28 mol kg^{-1} (b) 0.44 mol kg^{-1}
(c) 1.14 mol kg^{-1} (d) 3.28 mol kg^{-1}

36. The equivalent weight of $MnSO_4$ is half of its molecular weight when it is converted to :
(a) Mn_2O_3 (b) MnO_2 (c) MnO_4^- (d) MnO_4^{2-}

37. What is the molarity of 0.2N Na_2CO_3 solution?
(a) 0.1 M (b) 0 M (c) 0.4 M (d) 0.2 M

38. The molar solution of H_2SO_4 is equal to :
(a) N/2 solution (b) N solution
(c) 2N solution (d) 3N solution

39. The equivalent weight of a solid element is found to be 9. If the specific heat of this element is 1.05 Jg^{-1} K^{-1}, then its atomic weight is :
(a) 17 (b) 21 (c) 25 (d) 27

40. The maximum number of molecules are present in
(a) 15 L of H_2 gas at STP
(b) 5 L of N_2 gas at STP
(c) 0.5 g of H_2 gas
(d) 10 g of O_2 gas

41. The vapour density of a gas is 11.2, then 11.2 g of this gas at N.T.P. will occupy a volume-
(a) 11.2 L (b) 22.4 L (c) 11.2 mL (d) 22.4 mL

42. What is the mass of 1 molecule of CO.
(a) 2.325×10^{-23} (b) 4.65×10^{-23}
(c) 3.732×10^{-23} (d) 2.895×10^{-23}

43. Calculate the volume at STP occupied by 240 gm of SO_2.
(a) 64 (b) 84 (c) 59 (d) 73

44. The number of gram molecules of oxygen in 6.02×10^{24} CO molecules is
(a) 10 gm molecules (b) 5 gm molecules
(c) 1 gm molecules (d) 0.5 gm molelcules

45. Which has maximum number of molecules?
(a) 7 gm N_2 (b) 2 gm H_2
(c) 16 gm NO_2 (d) 16 gm O_2

46. Number of atoms in 558.5 gram Fe (at. wt. of Fe = 55.85 g mol^{-1}) is
(a) twice that in 60 g carbon (b) 6.023×10^{22}
(c) half that in 8 g He (d) $558.5 \times 6.023 \times 10^{23}$

47. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?
(a) 1.25×10^{-2} (b) 2.5×10^{-2}
(c) 0.02 (d) 3.125×10^{-2}

48. 7.5 grams of a gas occupy 5.6 litres of volume at STP. The gas is
(a) N_2O (b) NO (c) CO (d) CO_2

49. 3 g of an oxide of a metal is converted to chloride completely and it yielded 5 g of chloride. The equivalent weight of the metal is
(a) 3.325 (b) 33.25 (c) 12 (d) 20

50. The number of molecules in 16 g of methane is
(a) 3.0×10^{23} (b) $\frac{16}{6.02} \times 10^{23}$
(c) 6.023×10^{23} (d) $\frac{16}{3.0} \times 10^{23}$

51. Number of g of oxygen in 32.2 g $Na_2SO_4.10\,H_2O$ is
(a) 20.8 (b) 2.24
(c) 22.4 (d) 2.08

52. The number of water molecules present in a drop of water (volume 0.0018 ml) at room temperature is
(a) 1.084×10^{18} (b) 6.023×10^{19}
(c) 4.84×10^{17} (d) 6.023×10^{23}

53. The number of moles of oxygen in one litre of air containing 21% oxygen by volume, under standard conditions are
(a) 0.0093 mole (b) 0.21 mole
(c) 2.10 mole (d) 0.186 mole

54. The number of molecules in 8.96 litre of a gas at 0ºC and 1 atm. pressure is approximately
(a) 6.023×10^{23} (b) 12.04×10^{23}
(c) 18.06×10^{23} (d) 24.08×10^{22}

55. The mass of a molecule of water is
(a) 3×10^{-25} kg (b) 3×10^{-26} kg
(c) 1.5×10^{-26} kg (d) 2.5×10^{-26} kg

56. How many atoms are contained in one mole of sucrose ($C_{12}H_{22}O_{11}$)?
(a) $20 \times 6.02 \times 10^{23}$ atoms/mol
(b) $45 \times 6.02 \times 10^{23}$ atoms/mol
(c) $5 \times 6.02 \times 10^{23}$ atoms/mol
(d) None of these

57. How many moles of helium gas occupy 22.4 litre at 0°C and 1 atm pressure ?
(a) 0.11 (b) 1.11 (c) 0.90 (d) 1.0

58. Number of moles of NaOH present in 2 litre of 0.5 M NaOH is :
(a) 1.5 (b) 2.0 (c) 1.0 (d) 2.5

59. O_2, N_2 are present in the ratio of 1 : 4 by weight. The ratio of number of molecules is :
(a) 7 : 32 (b) 1 : 4 (c) 2 : 1 (d) 4 : 1

60. The hydrogen phosphate of certain metal has formula $MHPO_4$. The formula of metal chloride would be
(a) MCl (b) M_2Cl_2 (c) MCl_2 (d) MCl_3

61. Number of moles of $KMnO_4$ required to oxidize one mole of $Fe(C_2O_4)$ in acidic medium is
(a) 0.167 (b) 0.6 (c) 0.2 (d) 0.4

62. 10 g $CaCO_3$ gives on strong heating CO_2. It gives quicklime (in grams)
(a) 5g (b) 4.4 g (c) 5.6 g (d) 4 g

63. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene ?
(a) 2.8 kg (b) 6.4 kg (c) 9.6 kg (d) 96 kg

64. In the reaction

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

When 1 mole of ammonia and 1 mole of O_2 are made to react to completion,
(a) 1.0 mole of H_2O is produced
(b) 1.0 mole of NO will be produced
(c) all the oxygen will be consumed
(d) all the ammonia will be consumed

65. Assuming fully decomposed, the volume of CO_2 released at STP on heating 9.85 g of $BaCO_3$ (Atomic mass, Ba = 137) will be
(a) 2.24 L (b) 4.96 L (c) 1.12 L (d) 0.84 L

66. In a compound C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular weight of compound is 108. Molecular formula of compound is
(a) $C_2H_6N_2$ (b) C_3H_4N
(c) $C_6H_8N_2$ (d) $C_9H_{12}N_3$.

67. The simplest formula of a compound containing 50% of element X (atomic mass 10) and 50% of element Y (atomic mass 20) is
(a) XY (b) XY_3 (c) X_2Y (d) X_2Y_3

68. The empirical formula of an acid is CH_2O_2, the probable molecular formula of acid may be :
(a) $C_3H_6O_4$ (b) CH_2O (c) CH_2O_2 (d) $C_2H_4O_2$

69. An organic compound contains 49.3% carbon, 6.84% hydrogen and its vapour density is 73. Molecular formula of the compound is :
(a) $C_3H_5O_2$ (b) $C_4H_{10}O_2$
(c) $C_6H_{10}O_4$ (d) $C_3H_{10}O_2$

70. The number of atoms in 4.25 g of NH_3 is approximately
(a) 6×10^{23} (b) 2×10^{23} (c) 4×10^{23} (d) 1×10^{23}

71. 30 g of magnesium and 30 g of oxygen are reacted, then the residual mixture contains
(a) 50 g of Magnesium oxide and 10 g of oxygen
(b) 40 g of Magnesium oxide and 20 g of oxygen
(c) 45 g of Magnesium oxide and 15 g of oxygen
(d) 60 g of Magnesium oxide only

72. The mass of $BaCO_3$ produced when excess CO_2 is bubbled through a solution of 0.205 mol $Ba(OH)_2$ is :
(a) 81 g (b) 40.5 g (c) 20.25 g (d) 162 g

73. A compound contains 54.55 % carbon, 9.09% hydrogen , 36.36% oxygen. The empirical formula of this compound is :
(a) C_3H_5O (b) $C_4H_8O_2$
(c) $C_2H_4O_2$ (d) C_2H_4O

74. In the reaction

$4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(l)$,when 1 mole of ammonia and 1 mole of O_2 are made to react to completion
(a) 1.0 mole of H_2O is produced
(b) 1.0 mole of NO will be produced
(c) all the ammonia will be consumed
(d) all the oxygen will be consumed

75. A gas is found to have a formula $[CO]_x$. If its vapour density is 70, the value of x is :
(a) 2.5 (b) 3.0 (c) 5.0 (d) 6.0

EXERCISE - 2
Applied Questions

1. 0.5400 g of a metal X yields 1.020 g of its oxide X_2O_3. The number of moles of X is :
(a) 0.01 (b) 0.02 (c) 0.04 (d) 0.05

2. 12 L of H_2 and 11.2 L of Cl_2 are mixed and exploded. Find the composition by volume of mixture.
(a) 11.2, 11.2, 22.4 (b) 0.8, 0, 22.4
(c) 0.8, 0.8, 22.4 (d) 0.8, 11.2, 22.4

3. The hydrated salt $Na_2CO_3.xH_2O$ undergoes 63% loss in mass on heating and becomes anhydrous. The value of x is
(a) 3 (b) 5 (c) 7 (d) 10

4. On adding excess of $CaCl_2$ to a solution containing Na_2CO_3 and $NaHCO_3$, x g of precipitate was obtained. On adding in drops to the filtrate, a further y g of precipitate was obtained. In another experiment to the same amount of solution excess of $CaCl_2$ was added, boiled and filtered. The amount of the precipitate in the second experiment would be
(a) $x+y$ (b) $x+\frac{y}{2}$
(c) $\frac{x+y}{2}$ (d) none of these

5. 10 moles SO_2 and 15 moles O_2 were allowed to react over a suitable catalyst. 8 moles of SO_3 were formed. The remaining moles of SO_2 and O_2 respectively are -
(a) 2 moles, 11 moles (b) 2 moles, 8 moles
(c) 4 moles, 5 moles (d) 8 moles, 2 moles

6. If 0.5 mol of $BaCl_2$ is mixed with 0.2 mole of Na_3PO_4, find the maximum amount of $Ba_3(PO_4)_2$ that can be formed.
(a) 1 mole (b) 0.5 mole
(c) 0.1 mole (d) 0.01 mole

7. On reduction 1.644 gm of hot iron oxide give 1.15 gm of iron. Evaluate the equivalent weight of iron.
(a) 18.62 (b) 19.13
(c) 18.95 (d) 12.95

8. The volume of chlorine at STP required to liberate all the bromine and iodine in 100 ml of 0.1 M each of KI and MBr_2 will be:
(a) 0.224 L (b) 0.336 L (c) 0.448 L (d) 0.560 L

9. 6.8 gm H_2O_2 present in 100 ml of its solution. What is the molarity of solution?
(a) 1 M (b) 2 M (c) 3 M (d) 0.5 M

10. 1 c.c. N_2O at NTP contains :
(a) $\frac{1.8}{224}\times10^{22}$ atoms (b) $\frac{6.02}{22400}\times10^{23}$ molecules
(c) $\frac{1.32}{224}\times10^{23}$ electrons (d) All of these

11. The specific heat of a metal is 0.16 cal g^{-1}. The equivalent mass of the metal is 20.04, the correct atomic mass of the metal is :
(a) 40 (b) 20.04 (c) 40.08 g (d) 80.16 g

12. A metal oxide has the formula Z_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of the metal oxide requires 6 mg of hydrogen for complete reduction. The atomic weight of the metal is
(a) 27.9 (b) 159.6 (c) 79.8 (d) 55.8

13. Ratio of C_p and C_v of a gas 'X' is 1.4. The number of atoms of the gas 'X' present in 11.2 litres of it at NTP will be
(a) 6.02×10^{23} (b) 1.2×10^{23}
(c) 3.01×10^{23} (d) 2.01×10^{23}

14. Percent by mass of a solute (molar mass = 28 g) in its aqueous solution is 28. Calculate the mole fraction (X) and molality (m) of the solute in the solution.
(a) $X=0.2, m=10$ (b) $X=0.2, m=125/9$
(c) $X=0.8, m=125/9$ (d) $X=0.8, m=10$

15. The density of 0.5 M glucose solution is 1.0900g ml^{-1}. The molality of the solution is
(a) 0.1000 (b) 0.2000 (c) 0.2500 (d) 0.5000

16. Haemoglobin contains 0.334% of iron by weight. The molecular weight of haemoglobin is approximately 67200. The number of iron atoms (at. wt. of Fe is 56) present in one molecule of haemoglobin are
(a) 1 (b) 6
(c) 4 (d) 2

17. Specific volume of cylindrical virus particle is 6.02×10^{-2} cc/gm. whose radius and length 7 Å & 10 Å respectively.
If $N_A = 6.02\times10^{23}$, find molecular weight of virus
(a) 3.08×10^3 kg/mol (b) 3.08×10^4 kg/mol
(c) 1.54×10^4 kg/mol (d) 15.4 kg/mol

18. Percentage of Se in peroxidase anhydrase enzyme is 0.5% by weight (at. wt. of Se = 78.4) then minimum molecular weight of peroxidase anhydrase enzyme is
(a) 1.568×10^3 (b) 15.68
(c) 2.136×10^4 (d) 1.568×10^4

19. In Haber process 30 litres of dihydrogen and 30 litres of dinitrogen were taken for reaction which yielded only 50% of the expected product. What will be the composition of gaseous mixture under the aforesaid condition in the end?
(a) 20 litres ammonia, 25 litres nitrogen, 15 litres hydrogen
(b) 20 litres ammonia, 20 litres nitrogen, 20 litres hydrogen
(c) 10 litres ammonia, 25 litres nitrogen, 15 litres hydrogen
(d) 20 litres ammonia, 10 litres nitrogen, 30 litres hydrogen

20. Malachite has the formula $Cu_2CO_3(OH)_2$. What percentage by mass of malachite is copper?
(a) 25% (b) 50.9% (c) 57.5% (d) 63.5%

21. What volume of hydrogen gas, at 273 K and 1 atm. pressure will be consumed in obtaining 21.6 g of elemental boron (atomic mass = 10.8) from the reduction of boron trichloride by hydrogen ?
(a) 67.2 L (b) 44.8 L (c) 22.4 L (d) 89.6 L

22. The number of atoms of Cr and O are 4.8×10^{10} and 9.6×10^{10} respectively. Its empirical formula is
(a) Cr_2O_3 (b) CrO_2
(c) Cr_2O_4 (d) None of these

23. The unit J Pa^{-1} is equivalent to
(a) m^3 (b) cm^3
(c) dm^3 (d) None of these

24. Sulphur forms the chlorides S_2Cl_2 and SCl_2. The equivalent mass of sulphur in SCl_2 is
(a) 8 g/mol (b) 16 g/mol
(c) 64.8 g/mol (d) 32 g/mol

25. How many moles of KI are required to produce 0.4 moles of K_2HgI_4 ?
(a) 0.4 (b) 0.8
(c) 3.2 (d) 1.6

26. 100 ml O_2 and H_2 kept at same temperature and pressure. What is true about their number of molecules
(a) $N_{O_2} > N_{H_2}$ (b) $N_{O_2} < N_{H_2}$
(c) $N_{O_2} = N_{H_2}$ (d) $N_{O_2} + N_{H_2} = 1$ mole

27. The percentage of P_2O_5 in diammonium hydrogen phosphate $(NH_4)_2HPO_4$ is
(a) 23.48 (b) 46.96 (c) 53.78 (d) 71.00

28. Under similar conditions of pressure and temperature, 40 ml of slightly moist hydrogen chloride gas is mixed with 20 ml of ammonia gas, the final volume of gas at the same temperature and pressure will be
(a) 100 ml (b) 20 ml
(c) 40 ml (d) 60 ml

29. How many gram of sulphur can be obtained by the reaction of 1 mol of SO_2 with 22.4 L of H_2S at STP?
(a) 96 g (b) 48 g
(c) 32 g (d) None of these

30. 3 g of Mg is burnt in a closed vessel containing 3 g of oxygen. The weight of excess reactant left is
(a) 0.5 g of oxygen (b) 1.0 g of oxygen
(c) 1.0 g of Mg (d) 0.5 g of Mg

31. The mass of carbon anode consumed (giving only carbondioxide) in the production of 270 kg of aluminium metal from bauxite by the Hall process is (Atomic mass: Al = 27)
(a) 270 kg (b) 540 kg (c) 90 kg (d) 180 kg

32. Volume occupied by one molecule of water (density = 1 g cm^{-3}) is :
(a) 9.0×10^{-23} cm^3 (b) 6.023×10^{-23} cm^3
(c) 3.0×10^{-23} cm^3 (d) 5.5×10^{-23} cm^3

33. 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 ?
(a) 0.044 (b) 0.333 (c) 0.011 (d) 0.029

34. Which has the maximum number of molecules among the following ?
(a) 44 g CO_2 (b) 48 g O_3
(c) 8 g H_2 (d) 64 g SO_2

35. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will
(a) decrease twice
(b) increase two fold
(c) remain unchanged
(d) be a function of the molecular mass of the substance

36. 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
(a) 1.45 (b) 1.64 (c) 1.88 (d) 1.22

37. The molality of a urea solution in which 0.0100 g of urea, $[(NH_2)_2CO]$ is added to 0.3000 dm^3 of water at STP is :
(a) 5.55×10^{-4} m (b) 33.3 m
(c) 3.33×10^{-2} m (d) 0.555 m

38. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is
(a) 3 (b) 4 (c) 5 (d) 6

39. A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g. of CO_2. The empirical formula of the hydrocarbon is :
(a) C_2H_4 (b) C_3H_4 (c) C_6H_5 (d) C_7H_8

40. Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M, present as M^{2+} and M^{3+} in its oxide. Fraction of the metal which exists as M^{3+} would be :
(a) 7.01% (b) 4.08% (c) 6.05% (d) 5.08%

41. Liquid benzene (C_6H_6) burns in oxygen according to the equation $2C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(g)$
How many litres of O_2 at STP are needed to complete the combustion of 39 g of liquid benzene?(Mol. wt. of O_2 = 32, C_6H_6 = 78)
(a) 74 L (b) 11.2 L (c) 22.4 L (d) 84 L

42. An organic compound whose empirical and molecular formula are same, contains 20% carbon, 6.7% hydrogen, 46.7% nitrogen and the rest oxygen. On heating it yields ammonia, leaving a solid residue. The solid residue gives a violet colour with dilute solution of alkaline copper sulphate. The organic compound is
(a) NH_2COONH_4 (b) $HCOONH_4$
(c) NH_2NHCHO (d) NH_2CONH_2

43. In order to prepare one litre normal solution of $KMnO_4$, how many grams of $KMnO_4$ are required if the solution is to be used in acid medium for oxidation?
(a) 158 g (b) 62.0 g (c) 31.6 g (d) 790 g

44. If $1\frac{1}{2}$ moles of oxygen combine with Al to form Al_2O_3 the weight of Al used in the reaction is (Al = 27)
(a) 27 g (b) 54 g (c) 49.5 g (d) 31 g

45. Number of moles of MnO_4^- required to oxidize one mole of ferrous oxalate completely in acidic medium will be :
(a) 0.6 moles (b) 0.4 moles
(c) 7.5 moles (d) 0.2 moles

46. 10 g of hydrogen and 64 g of oxygen were filled in a steel vessel and exploded. Amount of water produced in this reaction will be:
(a) 3 mol (b) 4 mol (c) 1 mol (d) 2 mol

47. In the reaction,

$$2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^{-}(aq) + 3H_2(g)$$

(a) 11.2 L $H_2(g)$ at STP is produced for every mole $HCl(aq)$ consumed
(b) 6 L $HCl(aq)$ is consumed for every 3 L $H_2(g)$ produced
(c) 33.6 L $H_2(g)$ is produced regardless of temperature and pressure for every mole Al that reacts
(d) 67.2 $H_2(g)$ at STP is produced for every mole Al that reacts.

DIRECTIONS for Qs. 48 to 50 : These are Assertion-Reason type questions. Each of these question contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Answer these questions from the following four options.

(a) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(b) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(c) Statement - 1 is True, Statement- 2 is False
(d) Statement -1 is False, Statement -2 is True

48. **Statement-1 :** Volume of a gas is inversely proportional to the number of moles of gas.
Statement-2 : The ratio by volume of gaseous reactants and products is in agreement with their mole ratio.

49. **Statement-1 :** One mole of SO_2 contains double the number of molecules present in one mole of O_2.
Statement-2 : Molecular weight of SO_2 is double to that of O_2.

50. **Statement-1 :** 1.231 has three significant figures.
Statement-2 : All numbers right to the decimal point are significant.

EXERCISE - 3
Exemplar & Past Years NEET/AIPMT Questions

Exemplar Questions

1. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

Students	Readings	
	(i)	(ii)
A	3.01	2.99
B	3.05	2.95

(a) Results of both the students are neither accurate nor precise.
(b) Results of student A are both precise and accurate.
(c) Results of student B are neither precise nor accurate.
(d) Results of student B are both precise and accurate.

2. A measured temperature on Fahrenheit scale is 200°F. What will this reading be on celsius scale?
(a) 40 °C (b) 94 °C
(d) 93.3 °C (d) 30 °C

3. What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?
(a) 4 mol L^{-1} (b) 20 mol L^{-1}
(c) 0.2 mol L^{-1} (d) 2 mol L^{-1}

4. If 500 mL of a 5 M solution is diluted to 1500 mL, what will be the molarity of the solution obtained?
(a) 1.5 M (b) 1.66 M
(c) 0.017 M (d) 1.59 M

5. The number of atoms present in one mole of an element is equal to Avogadro number. Which of the following element contains the greatest number of atoms?
(a) 4 g He (b) 46 g Na
(c) 0.40 g Ca (d) 12 g He

6. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?
(a) 5 M (b) 50 M
(c) 0.005 M (d) 0.5 M

7. What will be the molality of the solution containing 18.25 g of HCl gas in 500 g of water?
(a) 0.1 m (b) 1 M
(c) 0.5 m (d) 1 m

8. One mole of any substance contains 6.022×10^{23} atoms/molecules. Number of molecules of H_2SO_4 present in 100 mL of 0.02 M H_2SO_4 solution is........
(a) 12.044×10^{20} molecules (b) 6.022×10^{23} molecules
(c) 1×10^{23} molecules (d) 12.044×10^{23} molecules

9. What is the mass percent of carbon in carbon dioxide?
(a) 0.034% (b) 27.27%
(c) 3.4% (d) 28.7%

10. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively .What will be the molecular formula of the compound?
(a) $C_9H_{18}O_9$ (b) CH_2O
(c) $C_6H_{12}O_6$ (d) $C_2H_4O_2$

11. If the density of a solution is 3.12 g mL^{-1}, the mass of 1.5 mL solution in significant figures is......
(a) 4.7 g (b) 4680×10^{-3} g
(c) 4.680 g (d) 46.80 g

12. Which of the following statements about a compound is incorrect?
(a) A molecule of a compound has atoms of different elements.
(b) A compound cannot be separated into its constituent elements by physical methods of separation.
(c) A compound retains the physical properties of its constituent elements.
(d) The ratio of atoms of different elements in a compound is fixed.

13. Which of the following statements is correct about the reaction given below?

$$4Fe\,(s) + 3O_2\,(g) \longrightarrow 2Fe_2O_3\,(g)$$

(a) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product therefore it follows law of conservation of mass.
(b) Total mass of reactants = total mass of product, therefore, law of multiple proportions is followed.
(c) Amount of Fe_2O_3 can be increased by taking any one of the reactants (iron or oxygen) in excess.
(d) Amount of Fe_2O_3 produced will decrease if the amount of any one of the reactants (iron or oxygen) is taken in excess.

14. Which of the following reactions is not correct according to the law of conservation of mass?
(a) $2Mg\,(s) + O_2\,(g) \longrightarrow 2MgO\,(s)$
(b) $C_3H_8\,(g) + O_2\,(g) \longrightarrow CO_2\,(g) + H_2O\,(g)$
(c) $P_4\,(s) + 5O_2\,(g) \longrightarrow P_4O_{10}\,(s)$
(d) $CH_4\,(g) + 2O_2\,(g) \longrightarrow CO_2\,(g) + 2H_2O\,(g)$

15. Which of the following statements indicates that law of multiple proportion is being followed?
(a) Sample of carbon dioxide taken from any source will always have carbon and oxygen in the ratio 1 : 2.
(b) Carbon forms two oxides namely CO_2 and CO, where masses of oxygen which combine with fixed mass of carbon are in the simple ratio 2 : 1.
(c) When magnesium burns in oxygen, the amount of magnesium taken for the reaction is equal to the amount of magnesium in magnesium oxide formed.
(d) At constant temperature and pressure 200 mL of hydrogen will combine with 100 mL oxygen to produce 200 mL of water vapour.

NEET/AIPMT (2013-2017) Questions

16. In an experiment it showed that 10 mL of 0.05 M solution of chloride required 10 mL of 0.1 M solution of $AgNO_3$, which of the following will be the formula of the chloride (X stands for the symbol of the element other than chlorine): ***[NEET Kar. 2013]***
(a) X_2Cl (b) X_2Cl_2
(c) XCl_2 (d) XCl_4

17. 6.02×10^{20} molecules of urea are present in 100 mL of its solution. The concentration of solution is : ***[2013]***
(a) 0.01 M (b) 0.001 M
(c) 0.1 M (d) 0.02 M

18. When 22.4 litres of $H_2(g)$ is mixed with 11.2 litres of $Cl_2(g)$, each at S.T.P., the moles of HCl(g) formed is equal to : ***[2014]***
(a) 1 mole of HCl(g) (b) 2 moles of HCl(g)
(c) 0.5 moles of HCl(g) (d) 1.5 moles of HCl(g)

19. 1.0 g of magnesium is burnt with 0.56 g O_2 in a closed vessel. Which reactant is left in excess and how much ? ***[2014]***
(At. wt. Mg = 24 ; O = 16)
(a) Mg, 0.16 g (b) O_2, 0.16 g
(c) Mg, 0.44 g (d) O_2, 0.28 g

20. If Avogadro number N_A, is changed from 6.022×10^{23} mol^{-1} to 6.022×10^{20} mol^{-1} this would change : ***[2015 RS]***
(a) the definition of mass in units of grams
(b) the mass of one mole of carbon
(c) the ratio of chemical species to each other in a balanced equation.
(d) the ratio of elements to each other in a compound

21. What is the mass of precipitate formed when 50 mL of 16.9% solution of $AgNO_3$ is mixed with 50 mL of 5.8% NaCl solution ? ***[2015 RS]***
(Ag = 107.8, N = 14, O = 16, Na = 23, Cl = 35.5)
(a) 28 g (b) 3.5 g
(c) 7 g (d) 14 g

22. A mixture of gases contains H_2 and O_2 gases in the ratio of 1 : 4 (w/w). What is the molar ratio of the two gases in the mixture? ***[2015]***
(a) 4 : 1 (b) 16 : 1
(c) 2 : 1 (d) 1 : 4

23. 20.0 g of a magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.0 g magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample ? ***[2015 RS]***
(a) 75 (b) 96
(c) 60 (d) 84

24. The number of water molecules is maximum in : ***[2015 RS]***
(a) 18 molecules of water
(b) 1.8 gram of water
(c) 18 gram of water
(d) 18 moles of water

Hints & Solutions

EXERCISE - 1

1. (b) Equivalent weight of an element is its weight which reacts with 8 gm of oxygen to form oxide.
Thus eq. weight of the given element
$$=\frac{32.33}{67.67}\times 8=3.82$$

2. (c) Empirical formula weight $=12+2+16=30$
$$n=\frac{180}{30}=6$$
Molecular formula $=(CH_2O)_6=C_6H_{12}O_6$.

3. (b) $$\underset{0.4\,\text{moles}}{HCl}\rightleftharpoons H^+ + \underset{0.4\,\text{moles}}{Cl^-}$$
$$\underset{0.2\,\text{moles}}{CaCl_2}\rightleftharpoons Ca^{2+} + \underset{2\times0.2=0.4\,\text{moles}}{2Cl^-}$$
Total Cl^- moles $=0.4+0.4=0.8$ moles
$$\text{Molarity}=\frac{\text{Moles}}{\text{Vol.in L}}$$
$$\therefore \text{Molarity of } Cl^- = \frac{0.8}{0.5}=1.6\text{ M.}$$

4. (a) $$\text{No. of moles}=\frac{\text{Wt. in g}}{\text{Mol. wt}}$$
$$\text{No. of moles in 200 mg}=\frac{200}{1000\times 44}$$
$=4.5\times10^{-3}$ moles
No. of moles in 10^{21} molecules
$$=\frac{10^{21}}{6.02\times10^{23}}=1.67\times10^{-3}\text{ moles}$$
No. of moles left $=(4.5-1.67)\times10^{-3}=2.88\times10^{-3}$

5. (c) $$\underset{x\,g}{NaCl}+\underset{4.9\,g}{H_2SO_4}\longrightarrow \underset{6\,g}{NaHSO_4}+\underset{1.825\,g}{HCl}$$
According to law of conservation of mass "*mass is neither created nor destroyed during a chemical change*"
$\therefore$ Mass of the reactants = Mass of products
$x + 4.9 = 6 + 1.825$
or $x = 2.925$ g

6. (d) $SnCl_2$ $SnCl_4$
$119:2\times35.5$ $119:4\times35.5$
Chlorine ratio in both compounds is
$=2\times35.5:4\times35.5=1:2$

7. (c) According to Avogadro's law "equal volumes of all gases contain equal number of molecules under similar conditions of temperature and pressure". Thus if 1 L of one gas contains N molecules, 2 L of any other gas under the same conditions of temperature and pressure will contain 2N molecules.

8. (c) On calculation we find
$$\frac{(29.2-20.2)(1.79\times10^5)}{1.37}=1.17\times10^6$$
As the least precise number contains 3 significant figures therefore, answers should also contains 3 significant figures.

9. (d) We know that all non-zero digits are significant and the zeros at the beginning of a number are not significant. Therefore number 161 cm, 0.161 cm and 0.0161cm have 3, 3 and 3 significant figures respectively.

10. (b) From $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$
$$\frac{V_1\times640}{(273+47)}=\frac{620\times300}{(273+27)}$$
$$V_1=\frac{620\times300\times320}{640\times300}=310\text{ cc}$$

11. (c) Exa $=10^{18}$

12. (a) Out of two 3.929 g is more accurate and will be reported as 3.93 after rounding off.

13. (c) M.W. $=60\times12+122=842$
$$\text{Weight of one molecule}=\frac{842}{6.02\times10^{23}}\text{ gm}$$
$=140\times10^{-23}$ gm $=1.4\times10^{-21}$ gm

14. (d) In CuO and Cu_2O the O : Cu is 1 : 1 and 1 : 2 respectively. This is law of multiple proportion.

15. (c) The H : O ratio in water is fixed, irrespective of its source. Hence it is law of constant composition.

16. (a) 20 volume H_2O_2 means that 1mL of this H_2O_2 solutions produces 20 mL of O_2 at N.T.P. on decomposition by heat.
$\therefore$ For 20 mL of O_2, the volume of 20 volume H_2O_2 required = 1mL
For 1 mL of O_2, the volume of 20 volume
$$H_2O_2\text{ required}=\frac{1}{20}\text{ mL}$$
For 5000 mL or 5L of O_2, the volume of 20
$$\text{volume }H_2O_2\text{ required}=\frac{1}{20}\times5000\text{ mL}=250\text{ mL}$$

17. (b) Given P = 0.0030m, Q = 2.40m & R = 3000m. In P(0.0030) initial zeros after the decimal point are not significant. Therefore, significant figures in P(0.0030) are 2. Similarly in Q (2.40) significant figures are 3 as in this case final zero is significant. In R = (3000) all the zeros are significant hence, in R significant figures are 4 because they come from a measurement.

18. (d) 1 zepto $=10^{-21}$

19. (c)

20. (b) Number of valence electrons in a N_3^- ion = 1

Now, 1 mol or 42 g of N_3^- has $= 6.023 \times 10^{23}$ ions

So, 42 g of N_3^- has $6.023 \times 4 \times 10^{23}$ valency e^-

1 g of N_3^- has $\frac{6.023 \times 1 \times 10^{23}}{42}$ valency e^-

4.2 g of N_3^- has $\frac{4.2 \times 6.023 \times 1 \times 10^{23}}{42}$ valency e^- i.e., 0.1 N_A valency e^-.

21. (c) Given 100 mL of H_2O_2 gives 1500 mL of O_2 at NTP.
$\Rightarrow$ 1 mL of H_2O_2 gives 15 mL of O_2 at NTP.
As we know that when 1 mL of H_2O_2 gives 10 mL of O_2 at N.T.P., the solution is called 10 volume H_2O_2 i.e., the volume strength of H_2O_2 is 10 volume.
So, when 1 mL of H_2O_2 gives 15 mL of O_2 at N.T.P., the volume strength of H_2O_2 is 15 voume.

22. (a)

23. (c) Among all the given options molarity is correct because the term molarity involve volume which increases on increasing temperature.

24. (c) As we know that,
Molecular mass = 2 × Vapour density

$\Rightarrow (12+16)n = 2 \times 56 \Rightarrow n = \frac{112}{28} = 4$

25. (a) In case of instrumental error, most possible error is equal to the least count of the instrument. So, most possible instrumental error can be 0.01 cm for the instrument which has a least count 0.01 cm.

26. (b) Suppose weight of metallic chloride = 100 gm
Then weight of metal = 47.22 gm
Weight of chlorine = 100 – 47.22 = 52.78 gm

$\therefore$ Equivalent weight of metal $= \frac{47.22}{52.78} \times 35.5 = 31.76$

27. (a) $Mg^{++} + Na_2CO_3 \longrightarrow MgCO_3 + 2Na^+$
1 g eq.   1g eq.
1 g eq. of Mg^{2+} = 12 g of Mg^{2+} = 12000 mg
= 1000 milli eq. of Na_2CO_3
$\therefore$ 12 mg Mg^{++} = 1 milli eq. Na_2CO_3

28. (d) Molecular weight of $ZnSO_4.7H_2O$
$= 65 + 32 + (4 \times 16) + 7(2 \times 1 + 16) = 287.$

$\therefore$ percentage mass of zinc (Zn) $= \frac{65}{287} \times 100 = 22.65\%$

29. (d) $25 \times N = 0.1 \times 35$; $N = 0.14$
$Ba(OH)_2$ is diacid base
hence $N = M \times 2$ or $M = \frac{N}{2}$
$M = 0.07$ M

30. (b) Moles of urea present in 100 ml of sol. $= \frac{6.02 \times 10^{20}}{6.02 \times 10^{23}}$

$\therefore M = \frac{6.02 \times 10^{20} \times 1000}{6.02 \times 10^{23} \times 100} = 0.01M$
[$\because$ M = Moles of solute present in 1L of solution]

31. (b) From the molarity equation.
$M_1V_1 + M_2V_2 = MV$
Let M be the molarity of final mixture,

$M = \frac{M_1V_1 + M_2V_2}{V}$ where $V = V_1 + V_2$

$M = \frac{480 \times 1.5 + 520 \times 1.2}{480 + 520} = 1.344$ M

32. (d) $\underset{(50\ mL)}{Zn + H_2SO_4} \longrightarrow ZnSO_4 + H_2$
Normality of H_2SO_4,

$N = \frac{\text{purity \%} \times \text{sp.gravity} \times 10}{\text{equ wt of } H_2SO_4}$

$= \frac{40 \times 1.3 \times 10}{98} = 10.61$ N

i.e. 1 L of H_2SO_4 contains = 10.61 gm H_2SO_4

50 mL of H_2SO_4 contains $= \frac{10.61}{1000} \times 50$ g H_2SO_4
= 0.5305 g H_2SO_4
According to the reaction,
1 gm equivalent of H_2SO_4 will liberate
= 1 gm equivalent of H_2
So, 0.5305 of H_2SO_4 will liberate
= 0.5305 gm equivalent of H_2

$= \frac{0.5305}{2} \times 22.4$ L at NTP = 5.9416 L of H_2 at NTP

33. (a) $\underset{1\,mol}{Na_2CO_3} + 2HCl \longrightarrow 2NaCl + H_2O + \underset{1\,mol}{CO_2}$

$\underset{1\,mol}{NaHCO_3} + HCl \longrightarrow NaCl + H_2O + \underset{1\,mol}{CO_2}$

$Na_2CO_3 + NaHCO_3 + NaCl + HCl \longrightarrow$

$\underbrace{\underset{8\,mol}{848g} \quad \underset{1mol}{84g}}_{1\,kg\ washing\ soda}$ 68g (excess)

$\longrightarrow \underset{from\,Na_2CO_3}{8CO_2} + \underset{from\,NaHCO_3}{CO_2}$

Thus, on complete reaction with HCl, 1kg of washing soda will evolve 9 mol of CO_2.

34. (a) $N_1V_1 = N_2V_2$ (Note : H_3PO_3 is dibasic $\therefore M = 2N$)
$20 \times 0.2 = 0.1 \times V$ (Thus. 0.1 M = 0.2 N)
$\therefore V = 40$ ml

35. (a) Apply the formula $d = M\left(\frac{1}{m} + \frac{M_2}{1000}\right)$
where M = molarity, M_2 = molecular weight of CH_3COOH
d = density, m = molality.

$\therefore 1.02 = 2.05\left(\frac{1}{m} + \frac{60}{1000}\right)$
On solving we get, $m = 2.28$ mol/kg

36. (b) For equivalent weight of $MnSO_4$ to be half of its molecular weight, change in oxidation state must be equal to 2. It is possible only when oxidation state of Mn in product is + 4. Since oxidation state of Mn in $MnSO_4$ is + 2. So, MnO_2 is correct answer.
In MnO_2, O.S. of Mn = +4
$\therefore$ Change in O.S. of Mn = +4 – (+2) = +2

37. (a) $\text{Molarity} = \text{Normality} \times \frac{\text{Equivalent mass}}{\text{Molecular mass}}$

$$= 0.2 \times \frac{M}{2 \times M} = 0.1\ M$$

38. (a) $\text{Molarity} = \frac{\text{Normality}}{\text{Replaceable hydrogen atom}}$

$\because$ H_2SO_4 is dibasic acid.
$\therefore$ Molar solution of $H_2SO_4 = N/2\ H_2SO_4$

39. (d) Using Dulong and Petit's law,
At. weight $\times$ Specific heat = 6.4 approx

$$\text{Approx . Atomic weight} = \frac{6.4}{\text{Specific heat}}$$

$$= \frac{6.4}{(1/4.18) \times 1.05 Jg^{-1}} = 25.4780$$

$$\text{Valency} = \frac{\text{App. weight}}{\text{Equ. weight}} = \frac{25.4780}{9} = 2.83 \approx 3$$

$\therefore$ Atomic weight = valency $\times$ Equ. wt.
$= 3 \times 9 = 27$

40. (a) No. of molecules in different cases
(a) $\because$ 22.4 litre at STP contains
$= 6.023 \times 10^{23}$ molecules of H_2

$\therefore$ 15 litre at STP contains $= \frac{15}{22.4} \times 6.023 \times 10^{23}$
$= 4.03 \times 10^{23}$ molecules of H_2

(b) $\because$ 22.4 litre at STP contains
$= 6.023 \times 10^{23}$ molecules of N_2

$\because$ 5 litre at STP contains $= \frac{5}{22.4} \times 6.023 \times 10^{23}$
$= 1.344 \times 10^{23}$ molecules of N_2

(c) $\because$ 2 gm of $H_2 = 6.023 \times 10^{23}$ molecules of H_2

$\because$ 0.5 gm of $H_2 = \frac{0.5}{2} \times 6.023 \times 10^{23}$
$= 1.505 \times 10^{23}$ molecules of H_2

(d) Similarly 10 g of O_2 gas

$= \frac{10}{32} \times 6.023 \times 10^{23}$ molecules of O_2
$= 1.88 \times 10^{23}$ molecules of O_2

Thus (a) will have maximum number of molecules

41. (a) Molecular mass of any gas occupies 22.4 L at N.T.P.

$$\text{Vapour density} = \frac{\text{Molecular mass}}{2}$$

Vapour density of any gas occupies a volume of 11.2 litres at N.T.P.

42. (b) Gram molecular weight of CO = 12 + 16 = 28 g
6.023×10^{23} molecules of CO weight 28 g

1 molecule of CO weighs $= \frac{28}{6.02 \times 10^{23}} = 4.65 \times 10^{-23}$ g

43. (b) Molecular weight of $SO_2 = 32 + 2 \times 16 = 64$
64 g of SO_2 occupies 22.4 litre at STP

240 g of SO_2 occupies $= \frac{22.4}{64} \times 240 = 84$ litre at STP

44. (b) 6.02×10^{23} molecules of CO = 1 mole of CO
6.02×10^{24} CO molecules = 10 moles CO
= 10 g atoms of O = 5 g molecules of O_2

45. (b) 2g of H_2 means one mole of H_2, hence contains 6.023×10^{23} molecules. Others have less than one mole, so have less no. of molecules.

46. (a) Fe (no. of moles) $= \frac{558.5}{55.85} = 10$ moles $= 10N_A$ atoms.
No. of moles in 60 g of C = 60/12 = 5 moles = $5N_A$ atoms.

47. (d) 1 Mole of $Mg_3(PO_4)_2$ contains 8 mole of oxygen atoms
$\therefore$ 8 mole of oxygen atoms $\equiv$ 1 mole of $Mg_3(PO_4)_2$

0.25 mole of oxygen atom $\equiv \frac{1}{8} \times 0.25$ mole of $Mg_3(PO_4)_2$

$= 3.125 \times 10^{-2}$ mole of $Mg_3(PO_4)_2$

48. (b) PV = nRT $\quad \therefore 5.6 \times 1 = \frac{7.5}{\text{M. Wt.}} \times 0.0821 \times 273$

M. Wt = 30.12 Hence gas NO.

49. (b) $\frac{\text{Wt. of metal oxide}}{\text{Wt. of metal chloride}}$

$$= \frac{\text{Eq. wt of metal} + \text{Eq. wt of oxygen}}{\text{Eq. wt of metal} + \text{Eq. wt of chlorine}}$$

$$\frac{3}{5} = \frac{E + 8}{E + 35.5} \qquad \therefore E = 33.25$$

50. (c) 16 g CH_4 is 1 mol. Hence number of molecules = Avogadro number = 6.023×10^{23}.

51. (c) M. Wt of $Na_2SO_4.10H_2O$ is 322 g which contains 224 g oxygen.
$\therefore$ 32.2 g will contain 22.4 g oxygen.

52. (b) 0.0018 ml = 0.0018 g = 0.0001 mole of water $= 10^{-4}$ mole

$\therefore$ number of water molecules $= 6.023 \times 10^{23} \times 10^{-4}$
$= 6.023 \times 10^{19}$

53. (a) 21% of 1 litre is 0.21 litre.
22.4 litres = 1 mole at STP

$\therefore$ 0.21 litre $= \frac{0.21}{22.4} = 0.0093$ mol

54. (d) At S.T.P. 22.4 litre of gas contains 6.023×10^{23} molecules
$\therefore$ molecules in 8.96 litre of gas

$$= \frac{6.023 \times 10^{23} \times 8.96}{22.4} = 24.08 \times 10^{22}$$

55 (b) Mass of one molecule of Water

$$= \frac{18}{6.023 \times 10^{23}} = 3 \times 10^{-23} g = 3 \times 10^{-26} Kg$$

56. (b) Total atoms in 1 molecule of $C_{12}H_{22}O_{11}$
= 12 + 22 + 11 = 45
$\therefore$ Total atoms in 1 mole of $C_{12}H_{22}O_{11}$
$= 45 \times 6.02 \times 10^{23}$ atoms/mol.

57. (d) 22.4 L of He at STP = 1 mole.

58. (c) Given $V = 2$ L, Molarity = 0.5M, Moles = ?

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{V \text{ of solution in L}} \text{ or } 0.5 = \frac{\text{Moles}}{2}$$

$\therefore$ Moles = $2 \times 0.5 = 1.0$

59. (a) Let mass of O_2 = 1 g

$\therefore$ Mass of $N_2 = 4g$

No. of molecules of $O_2 = \frac{1}{32}$

No. of molecules of $N_2 = \frac{4}{28}$

Ratio of no. of molecules $= \frac{1}{32} : \frac{4}{28} = \frac{1}{32} : \frac{1}{7} = 7 : 32$

60. (c) Formula of metal phosphate is $M^{++}H^{+}PO_4^{---}$.
Valency of metal + 2. Hence metal chloride is MCl_2.

61. (b) The required equation is

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + \underset{\text{nascent oxygen}}{5[O]}$$

$$2Fe(C_2O_4) + 3H_2SO_4 + 3[O] \longrightarrow Fe_2(SO_4)_3 + 2CO_2 + 3H_2O$$

O required for 1 mol. of $Fe(C_2O_4)$ is 1.5, 5O are obtained from 2 moles of $KMnO_4$

$\therefore$ 1.5 [O] will be obtained from $= \frac{2}{5} \times 1.5 = 0.6$ moles of $KMnO_4$.

62. (c) $CaCO_3 \rightleftharpoons CaO + CO_2$
100 g 56 g
10 g $CaCo_3$ will give 5.6 gCaO

63. (c) $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$
28 g 96 g
$\because$ 28 g of C_2H_4 undergo complete combustion by $= 96$ g of O_2
$\therefore$ 2.8 kg of C_2H_4 undergo complete combustion by $= 9.6$ kg of O_2.

64. (c) According to Stoichiometry they should react as follow
$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$
4 mole of NH_3 requires 5 mole of O_2.

1 mole of NH_3 requires $= \frac{5}{4} = 1.25$ mole of O_2.

Hence O_2 is consumed completely.

65. (c) $\underset{197\text{ gm}}{BaCO_3} \rightarrow BaO + CO_2$
$\because$ 197 gm of $BaCO_3$ released carbon dioxide $= 22.4$ litre at STP

$\therefore$ 1 gm of $BaCO_3$ released carbon dioxide $= \frac{22.4}{197}$ litre

$\therefore$ 9.85 gm of $BaCO_3$ released carbon dioxide

$= \frac{22.4}{197} \times 9.85 = 1.12$ litre

66. (c)

	Percentage	R.N.A	Simplest ratio
C	9	$\frac{9}{12} = \frac{3}{4}$	3
H	1	$\frac{1}{1} = 1$	4
N	3.5	$\frac{3.5}{14} = \frac{1}{4}$	1

Empirical formula $= C_3H_4N$
$(C_3H_4N)_n = 108$
$(12 \times 3 + 4 \times 1 + 14)_n = 108$
$(54)_n = 108$

$n = \frac{108}{54} = 2$

$\therefore$ molecular formula $= C_6H_8N_2$

67. (c) 50% of X (Atomic mass 10), 50% of Y (Atomic mass 20).

Relative number of atoms of X $= \frac{50}{10} = 5$ and than Y $= \frac{50}{20} = 2.5$

Simple Ratio 2 : 1. Formula X_2Y

68. (c) The acid with empirical formula CH_2O_2 is formic acid, H—COOH.

69. (c)

Element	%	Relative no. of atoms	Simplest ratio of atoms
C	49.3	49.3/12 = 4.1	4.1/2.74 = 1.5 1.5 × 2 = 3
H	6.84	6.84/1 = 6.84	6.84/2.74 = 2.5 = 2.5 × 2 = 5
O	43.86	43.86/16 = 2.74	2.74/2.74 = 1 1 × 2 = 2

$\therefore$ Empirical formula $= C_3H_5O_2$
Empirical formula mass
$= (3 \times 12) + (5 \times 1) + (2 \times 16) = 36 + 5 + 32 = 73$
Molecular mass $= 2 \times$ Vapour density
$= 2 \times 73 = 146$

$n = \frac{\text{molecular mass}}{\text{empirical formula mass}} = 146/73 = 2$

Molecular formula = Empirical formula × 2
$= (C_3H_5O_2) \times 2 = C_6H_{10}O_4$

70. (a) Number of atoms $= \frac{4.25 \times 6.023 \times 10^{23} \times 4}{17} = 6 \times 10^{23}$

(One molecule of NH_3 contains 4 atoms 1 N and 3H)

71. (a)

	2Mg	+ O_2 ⟶	2MgO
	2 × 24	2×16	2 × 40
	48 g	32 g	80 g
given	30 g	30 g	
Actually Reacting	30 g	20 g	50g (formed)

O_2 left $(30 - 20) = 10$ g MgO formed 50 g.

72. (b) $\underset{n\text{ mol}}{Ba(OH)_2} + CO_2 \longrightarrow \underset{n\text{ mol}}{BaCO_3} + H_2O$
n mol $Ba(OH)_2 = n$ mol $BaCO_3$
$\therefore$ 0.205 mol $Ba(OH)_2 \equiv$ 0.205 mol $BaCO_3$
Wt. of substance = No. of moles × Molecular mass
$= 0.205 \times 197.3 = 40.5$ g

73. (d)

C	54.55	54.55/12 = 4.5	4.5/2.27 = 2
H	9.09	9.09/1 = 9.09	9.09/2.27 = 4
O	36.36	36.36/16 = 2.27	2.27/2.27 = 1

Hence empirical formula of the compound $= C_2H_4O$

74. (d) $4NH_3(g)+5O_2(g) \longrightarrow 4NO(g)+6H_2O(l)$

	$4NH_3$	$5O_2$		$4NO$	$6H_2O$
	4 moles	5 moles		4 moles	6 moles
given	1 Mole	1 Mole			
Reacting	0.8	1	$\rightarrow$	0.8	1.2 (formed)

All, O_2 consumed being limiting.

75. (c) As we know that,
Molecular mass of $[CO]_x = 2 \times$ V.D.
$\Rightarrow (12+16)x = 2\times 70 \Rightarrow 28x = 140 \Rightarrow x = 5$

EXERCISE - 2

1. (b) Mass of oxygen combined with 0.5400 g of X = 1.0200 – 0.5400 = 0.4800 g

Mol of $X = \dfrac{2\times 0.48}{48} = 0.02$

2. (b)

H_2	+	$Cl_2 \rightarrow$	$2HCl$
1L		1L	2L
11.2 L		11.2 L	22.4L

Volume of $H_2 = [12-11.2] = 0.8$ L,
Volume of Cl_2 = Zero, Volume of HCl = 22.4 L

3. (d) The loss in mass is due to elimination of water of crystallisation of $Na_2CO_3.xH_2O$.

Hence , $\dfrac{18x\times 100}{106+18x} = 63 \Rightarrow x = 10$

4. (b) On adding $CaCl_2$, only $CaCO_3$ will be precipitated whereas $Ca(HCO_3)_2$ is soluble.

$Na_2CO_{3(aq)} + CaCl_{2(aq)} \rightarrow Na_2CO_3 + H_2O$

On boiling, $Ca(HCO_3)_2$ changes into sparingly soluble $CaCO_3$ as :

$Ca(HCO_3)_{2(aq)} \rightarrow CaCO_{3(s)} + CO_{2(g)} + H_2O_{(\ell)}$

Hence, total mass of precipitate in second case $= x + \dfrac{y}{2}$

5. (a)

$2SO_2$	+	O_2	$\longrightarrow$	$2SO_3$
10		15		0
$10-2x$		$15-x$		$2x$
$\because 2x = 8$		$x = 4$		

Hence, remaining, $SO_2 = 10-8 = 2$ moles,
$O_2 = 15-4 = 11$ moles

6. (c)

	$3\,BaCl_2$	+ $2\,Na_3PO_4 \rightarrow$	$6\,NaCl$	$+\,Ba_3(PO_4)_2$
Molar ratio	3	2	6	1
Initial moles	0.5	0.2	0	0

Limiting reagent is Na_3PO_4 hence it would be consumed, and the yield would be decided by it inital moles.
2 moles of Na_3PO_4 give 1 mole of $Ba_3(PO_4)_2$,
$\therefore$ 0.2 moles of Na_3PO_4 would give 0.1 mole of $Ba_3(PO_4)_2$

7. (a) Weight of iron oxide = 1.644 gm
Weight of iron after reduction = 1.15 gm
weight of displaced oxygen = 1.644 – 1.15 = 0.494 gm

$\therefore$ Equivalent weight of iron $= \dfrac{1.15}{0.494}\times 8 = 18.62$
Thus equivalent weight of metal is = 18.62.

8. (b) $2KI_{(aq)} + Cl_{2(g)} \rightarrow 2KCl_{(aq)} + I_2$;

$MBr_{2(aq)} + Cl_{2(g)} \rightarrow MCl_{2(aq)} + Br_2$

Mol of Cl_2 required for liberating iodine from KI

$= \dfrac{1}{2}\times$ mol of KI $= \dfrac{1}{2}\times 100\times 10^{-3}\times 0.1 = 0.005$

Mol of Cl_2 required for liberating bromine from MBr_2 = mol of $MBr_2 = 0.1\times 100\times 10^{-3} = 0.01$
Hence, volume of Cl_2 (STP) required = (0.005 + 0.01) × 22.4 = 0.336 L

9. (b) $\because$ Weight of H_2O_2 in 100 ml of H_2O_2 solution = 6.8 gm
$\because$ Weight of H_2O_2 in 1000 ml of its solution = 6.8 × 10 = 68g
Molecular weight of $H_2O_2 = 34$

Then, Molarity $= \dfrac{68}{34} = 2M$

10. (d) At NTP 22400 cc of $N_2O = 6.02\times 10^{23}$ molecules

$\therefore$ 1 cc $N_2O = \dfrac{6.02\times 10^{23}}{22400}$ molecules

$= \dfrac{3\times 6.02\times 10^{23}}{22400}$ atoms $= \dfrac{1.8}{224}\times 10^{22}$ atoms

No. of electrons in a molecule of $N_2O = 7+7+8 = 22$
Hence no. of electrons

$= \dfrac{6.02\times 10^{23}}{22400}\times 22$ electrons $= \dfrac{1.32\times 10^{23}}{224}$

11. (c) Following Dulong-Pettit law, approx. atomic mass

$= \dfrac{6.4}{\text{Specific heat}} = \dfrac{6.4}{0.16} = 40$

Valency of the metal $= \dfrac{40}{\text{Equiv.mass}} = \dfrac{40}{20.04} = 2$

Correct atomic mass = valency × eq.mass = 2 × 20.04 = 40.08

12. (d) The reaction may given as
$Z_2O_3 + 3H_2 \longrightarrow 2Z + 3H_2O$
0.1596 g of Z_2O_3 react with H_2 = 6 mg = 0.006 g

$\therefore$ 1 g of H_2 react with $= \dfrac{0.1596}{0.006} = 26.6$ g of Z_2O_3

$\therefore$ Eq. wt. of $Z_2O_3 = 26.6$ (from the definition of eq. wt.)
Eq. wt. of Z + Eq. wt. of O = E + 8 = 26.6
$\Rightarrow$ Eq. wt. of Z = 26.6 – 8 = 18.6
Valency of metal in $Z_2O_3 = 3$

Eq. wt.of metal $= \dfrac{\text{Atomic wt.}}{\text{valency}}$

$\therefore$ At. wt. of Z = 18.6 × 3 = 55.8

13. (a) $C_p / C_v = 1.4$ shows that the gas is diatomic.
22.4 litre at NTP $\equiv 6.02\times 10^{23}$ molecules
11.2 L at NTP $= 3.01\times 10^{23}$ molecules

$= 3.01 \times 10^{23} \times 2$ atoms $= 6.02 \times 10^{23}$ atoms

14. (b) Mol. of solute in 100 g solution $= \frac{28}{28} = 1$

Mol. of water in 100 g solution $= \frac{100-28}{18} = 4$

Mol. fraction of solute $= \frac{1}{1+4} = 0.2$;

Molality $= \frac{1 \times 1000}{72} = \frac{125}{9}$

15. (d) Mass of 1 L (= 1000 ml) solution = 1000 × 1.090 = 1090g
Mass of glucose in 1L = 0.5 × 180 = 90 g.
Mass of water = 1090.0 g – 90.0 g = 1000 g

Hence, molality $= \frac{0.5 \times 1000}{1000} = 0.5$

16. (c) Mass of iron in 100 g haemoglobin = 0.334 g
∴ In 67200 g haemoglobin, mass of iron

$= \frac{67200 \times 0.334}{100} = 672 \times 0.33\,g$

∴ The number of Fe atoms in one molecule of haemoglobin

$= \frac{672 \times 0.334}{56} = 4$

17. (d) Specific volume (volume of 1 gm) of cylindrical virus particle $= 6.02 \times 10^{-2}$ cc/gm
Radius of virus (r) = 7 Å $= 7 \times 10^{-8}$ cm
Length of virus $= 10 \times 10^{-8}$ cm
Volume of virus

$\pi r^2 l = \frac{22}{7} \times (7 \times 10^{-8})^2 \times 10 \times 10^{-8} = 154 \times 10^{-23}$ cc

Wt. of one virus particle $= \frac{\text{volume}}{\text{specific volume}}$

∴ Mol. wt. of virus = Wt. of N_A particle

$= \frac{154 \times 10^{-23}}{6.02 \times 10^{-2}} \times 6.02 \times 10^{23} = 15400$ g/mol = 15.4 kg/mole

18. (d) 0.5 g of Se = 100 g enzyme

78.4 g of Se $= \frac{100}{0.5} \times 78.4 = 1.568 \times 10^4$ g enzyme

19. (c)

N_2	+ $3H_2$	$\rightarrow 2NH_3$
1 vol.	3 vol.	2 vol.
10 litre	30 litre	20 litre

It is given that only 50% of the expected product is formed hence only 10 litre of NH_3 is formed
N_2 used = 5 litres, left = 30 – 5 = 25 litres
H_2 used = 15 litres, left = 30 – 15 = 15 litres

20. (c) Percentage by mass of copper in malachite

$= \frac{2 \times 63.5}{221} = 57.5\%$

21. (a) $2BCl_3 + 3H_2 \rightarrow 2B + 6HCl$

or $BCl_3 + \frac{3}{2}H_2 \rightarrow B + 3HCl$

Now, since 10.8 gm boron requires hydrogen

$= \frac{3}{2} \times 22.4$L at N.T.P

hence 21.6 gm boron requires hydrogen

$\frac{3}{2} \times \frac{22.4}{10.8} \times 21.6 = 67.2$L at N.T. P.

22. (b) Ratio of atoms of Cr and O $= 4.8 \times 10^{10} : 9.6 \times 10^{10} = 1 : 2$
Hence, empirical formula $= CrO_2$

23. (a) Joule is the unit of work and Pascal is unit of pressure.

$JPa^{-1} = \frac{J}{Pa} = \frac{\text{Work}}{\text{Pressure}} = \frac{Nm}{Nm^{-2}} = m^3$

24. (b) The atomic weight of sulphur =32
In SCl_2 valency of sulphur = 2

So equivalent mass of sulphur $= \frac{32}{2} = 16$

25. (b) $2KI + HgI_2 \longrightarrow K_2HgI_4$
Moles of KI required to produce 0.4 moles of K_2HgI_4
$= 2 \times 0.4 = 0.8$

26. (c) This is Avogadro's hypothesis.
According to this, equal volume of all gases contain equal no. of molecules under similar condition of temperature and pressure.

27. (c) 1 mole of $(NH_4)_2HPO_4$ would give $\frac{1}{2}$ mole of P_2O_5

$\underset{2(36+1+31+64)=264}{2(NH_4)_2HPO_4} \equiv \underset{62+80=142}{P_2O_5}$

% of $P_2O_5 = \frac{\text{wt. of } P_2O_5}{\text{wt. of salt}} \times 100$

$= \frac{142}{264} \times 100 = 53.78\%$

28. (b)

	$NH_3(g)$ +	$HCl(g) \rightarrow$	$NH_4Cl(g)$
t=0	20ml	40ml	0
t=t	0	20ml	solid

Final volume = 20 ml

29. (b) $SO_2 + 2H_2S \longrightarrow 2H_2O + 3S$

22.4 L (STP) of H_2S = 1 mol

Mass of S produced $= \frac{3 \times 32}{2}$ g = 48 g

30. (b) $Mg + \frac{1}{2}O_2 \longrightarrow MgO$

Mass of oxygen required for 3 g of Mg $= \frac{16 \times 3}{24} = 2g$

Hence, excess reactant = 3 – 2 = 1g oxygen

31. (c) $2Al_2O_3 + 3C \longrightarrow Al + 3CO_2$
Gram equivalent of $Al_2O_3 \equiv$ gm equivalent of C

Now equivalent weight of Al $= \frac{27}{3} = 9$

Equivalent weight of C $= \frac{12}{4} = 3 \quad (\overset{0}{C} \rightarrow \overset{+4}{C}O_2)$

No. of gram equivalent of Al $= \frac{270 \times 10^3}{9}$

$= 30 \times 10^3$

Hence,

No. of gram equivalent of C $= 30 \times 10^3$

Again,

No. of gram equivalent of C

$= \frac{\text{mass in gram}}{\text{gram equivalent weight}}$

$\Rightarrow 30 \times 10^3 = \frac{\text{mass}}{3}$

$\Rightarrow$ mass $= 90 \times 10^3$ g $= 90$ kg

32. (c) Density $= \frac{\text{Mass}}{\text{Volume}}$

1 gram cm$^{-3} = \frac{1\text{ gram}}{\text{cm}^3}$

Volume $= \frac{\text{Mass}}{\text{Density}} = \frac{1\text{ gram}}{1\text{ gram cm}^{-3}} = 1\text{cm}^3$

$\therefore$ Volume occupied by 1 gram water = 1 cm^3

or Volume occupied by

$\frac{6.023 \times 10^{23}}{18}$ molecules of water = 1 cm^3

[$\therefore$ 1g water $= \frac{1}{18}$ moles of water]

Thus volume occupied by 1 molecule of water

$= \frac{1 \times 18}{6.023 \times 10^{23}} \text{cm}^3 = 3.0 \times 10^{-23} \text{ cm}^3$.

i.e. the correct answer is option (c).

33. (d) Writing the equation for the reaction, we get

PbO	+	$2HCl$	$\longrightarrow$	$PbCl_2$	+	H_2O
207 + 16		2 × 36.5		207 + 71		
= 223 g		= 73g		= 278g		

No. of moles of PbO $= \frac{6.5}{223} = 0.029$

No. of moles of HCl $= \frac{3.2}{36.5} = 0.0877$

Thus PbO is the limiting reactant 1 mole of PbO produce 1 mole $PbCl_2$.

0.029 mole PbO produces 0.029 mole $PbCl_2$.

34. (c)

	No. of molecules
Moles of $CO_2 = \frac{44}{44} = 1$	N_A
Moles of $O_3 = \frac{48}{48} = 1$	N_A
Moles of $H_2 = \frac{8}{2} = 4$	$4N_A$
Moles of $SO_2 = \frac{64}{64} = 1$	N_A

35. (a) Relative atomic mass

$= \frac{\text{Mass of one atom of the element}}{1/12^{\text{th}} \text{ part of the mass of one atom of Carbon} - 12}$

or $\frac{\text{Mass of one atom of the element}}{\text{mass of one atom of the C} - 12} \times 12$

Now if we use $^1/_6$ in place of $^1/_{12}$ the formula becomes

Relative atomic mass $= \frac{\text{Mass of one atom of element}}{\text{Mass of one atom of carbon}} \times 6$

$\therefore$ Relative atomic mass decrease twice

36. (d) Since molarity of solution is 3.60 M. It means 3.6 moles of H_2SO_4 is present in its 1 litre solution.

Mass of 3.6 moles of H_2SO_4

= Moles × Molecular mass

$= 3.6 \times 98$ g $= 352.8$ g

$\therefore$ 1000 ml solution has 352.8 g of H_2SO_4

29% H_2SO_4 by mass means 29 g of H_2SO_4 is present in 100 g of solution

$\therefore$ 352.8 g of H_2SO_4 is present in

$= \frac{100}{29} \times 352.8$ g of solution = 1216 g of solution

Density $= \frac{\text{Mass}}{\text{Volume}} = \frac{1216}{1000} = 1.216$ g/ml $= 1.22$ g/ml

37. (a) Molality = Moles of solute / Mass of solvent in kg

Molality $= \frac{0.01/60}{0.3} = \frac{0.01}{60 \times 0.3}$;

$d = 1$ g/ml $= 5.55 \times 10^{-4}$ m

38. (d) The following reaction occurs:

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

From the above equation, we find that Mohr's salt ($FeSO_4.(NH_4)_2SO_4.6H_2O$) and dichromate reacts in 6 : 1 molar ratio.

39. (d) $\because$ 18 gm, H_2O contains = 2 gm H

$\therefore$ 0.72 gm H_2O contains $= \frac{2}{18} \times 0.72$ gm $= 0.08$ gm H

$\because$ 44 gm CO_2 contains = 12 gm C

$\therefore$ 3.08 gm CO_2 contains $= \frac{12}{44} \times 3.08 = 0.84$ gm C

$\therefore C : H = \frac{0.84}{12} : \frac{0.08}{1} = 0.07 : 0.08 = 7 : 8$

$\therefore$ Empirical formula $= C_7H_8$

40. (b) For one mole of the oxide

Moles of M = 0.98

Moles of $O^{2-} = 1$

Let moles of $M^{3+} = x$

$\therefore$ Moles of $M^{2+} = 0.98 - x$

On balancing charge

$(0.98 - x) \times 2 + 3x - 2 = 0$

$x = 0.04$

$\therefore$ % of $M^{3+} = \frac{0.04}{0.98} \times 100 = 4.08\%$

41. (d) $\underset{2(78)}{2C_6H_6} + \underset{15(32)}{15O_2(g)} \rightarrow 12CO_2(g) + 6H_2O(g)$

$\because$ 156 gm of benzene required oxygen = 15 × 22.4 litre

$\therefore$ 1 gm of benzene required oxygen $= \frac{15 \times 22.4}{156}$ litre

$\therefore$ 39 gm of Benzene required oxygen

$= \frac{15 \times 22.4 \times 39}{156} = 84.0$ litre

42. (d)

Element	Percentage	Atomic mass	Relative no. of atoms	Simplest ratio
C	20%	12	1.66	1
H	6.7%	1	6.7	4
N	46.7%	14	3.33	2
O	26.6%	16	1.66	1

Empirical formula = Molecular formula

= CH_4N_2O or NH_2CONH_2

$$H_2NCONH_2 + H_2NCONH_2 \xrightarrow{\Delta} \underset{\text{biuret,}}{H_2NCONHCONH_2} + NH_3$$

When an aqueous solution of biuret is treated with dilute sodium hydroxide and a drop of copper sulphate, a violet colour is produced. This test is known as biuret test, is characteristic of compounds having the group –CONH.

43. (c) Eq. wt of $KMnO_4$ in acid medium is 31.6 g. Hence this much amount must be dissolved in 1 litre to prepare normal solution.

44. (b) $2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3$

According to equation $\frac{3}{2}$ mole of O_2 combines with 2 mole Al.

2 mole Al = 54 gm

45. (a)

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)] \times 3$$

$$2\begin{matrix}COO\\|\\COO\end{matrix}\!\!>Fe + 3(O) \longrightarrow Fe_2O_3 + 2CO_2 \quad] \times 5$$

$$\underset{(6\text{ moles})}{6KMnO_4} + 9H_2SO_4 + 10\underset{(10\text{ moles})}{\begin{matrix}COO\\|\\COO\end{matrix}\!\!>Fe} \longrightarrow 3K_2SO_4 + 6MnSO_4 + 9H_2O + 5Fe_2O_3 + 10CO_2$$

From above equation 6 moles MnO_4^- required to oxidise 10 moles of oxalate.

Thus number of moles of MnO_4^- required to oxidise one mole of oxalate $= \frac{6}{10} = 0.6$ moles

46. (b) $\underset{10g}{H_2} + \underset{64g}{\frac{1}{2}O_2} \longrightarrow H_2O$

$\left(\frac{10}{2} = 5 \text{ mol}\right) \left(\frac{64}{32} = 2 \text{ mol}\right)$

In this reaction oxygen is the limiting agent. Hence amount of H_2O produced depends on the amount of O_2 taken

$\because$ 0.5 mole of O_2 gives H_2O = 1 mol

$\therefore$ 2 mole of O_2 gives H_2O = 4 mol

47. (a) $2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^-(aq) + 3H_2(g)$

$\because$ 6 moles of HCl produces = 3 moles of H_2

= 3 × 22.4 L of H_2 at S.T.P

$\therefore$ 1 mole of HCl produces $= \frac{3 \times 22.4}{6}$ L of H_2 at S.T.P

= 11.2 L of H_2 at STP

48. (d) We know that from the reaction $H_2 + Cl_2 \rightarrow 2HCl$ that the ratio of the volume of gaseous reactants and products is in agreement with their molar ratio. The ratio of $H_2 : Cl_2 :$ HCl volume is 1: 1: 2 which is the same as their molar ratio. Thus volume of gas is directly related to the number of moles. Therefore, the assertion is false but reason is true.

49. (d) One mole of any substance corresponding to 6.023×10^{23} entities in respective of its weight.

Molecular weight of $SO_2 = 32 + 2 \times 16 = 64$gm.

Molecular weight of $O_2 = 16 \times 2 = 32$gm.

$\therefore$ Molecular weight of SO_2 is double to that of O_2

50. (d) 1.231 has four significant figures all no. from left to right are counted, starting with the first digit that is not zero for calculating the no. of significant figure.

EXERCISE - 3

AAJ KA TOPPER

Exemplar Questions

1. (b) Average of readings of student A

$= \frac{3.01 + 2.99}{2} = 3.00$

Average of readings of student B

$= \frac{3.05 + 2.95}{2} = 3.00$

Correct reading = 3.00

Since, average value in both the cases is close to the correct value. Hence, readings of both are accurate. Readings of student A differ only by 0.02 and also close to the correct reading hence, readings are precise too. But readings of student B differ by 0.1 and hence are not precise.

2. (c) The relation between the temperatures on two scales is given by the following relationship :

$°F = \frac{9}{5}T\,°C + 32$

$\therefore \quad T\,°C = (°F - 32) \times \frac{5}{9} = \frac{200 - 32}{9} \times 5$

$\Rightarrow \quad T°C = \frac{168 \times 5}{9} = 93.3\,°C$

3. (c) Molarity $= \frac{\text{weight} \times 1000}{\text{molecular weight} \times \text{volume (mL)}}$

$= \frac{5.85 \times 1000}{58.5 \times 500} = 0.2 \text{ mol L}^{-1}$

4. (b) For dilution, a general formula is

$$\underset{\text{(Before dilution)}}{M_1 V_1} = \underset{\text{(After dilution)}}{M_2 V_2}$$

$500 \times 5M = 1500 \times M_2$

$$M_2 = \frac{5}{3} = 1.66 \text{ M}$$

5. (d) number of atoms = No. of moles × N_A

Moles of 4 g He $= \frac{4}{4} = 1$ mol $\Rightarrow$ N_A atoms

46 g Na $= \frac{46}{23} = 2$ mol $\Rightarrow$ 2 N_A atoms

0.40 g Ca $= \frac{0.40}{40} = 0.1$ mol $\Rightarrow$ 0.1 N_A atoms

12 g He $= \frac{12}{4} = 3$ mol $\Rightarrow$ 3 N_A atoms

i.e.12 g He contains greatest number of atoms.

6. (c) In the given question, 0.9 g L^{-1} means that 1000 mL (or 1L) solution contains 0.9 g of glucose.
Molecular mass of glucose ($C_6H_{12}O_6$) = 180 u

$\therefore$ Number of moles of glucose $= \frac{0.9}{180} = 0.005$ M

$= 5 \times 10^{-3}$ mol glucose

Hence, 1000 mL or 1L solution contains 0.005 mole glucose or the molarity of glucose is 0.005 M.

7. (d) $$\text{Molality (m)} = \frac{\text{Moles of solute}}{\text{Mass of solvent (in kg)}}$$

$\because$ Molecular weight of HCl = 36.5 g

$\therefore$ Moles of HCl $= \frac{18.25}{36.5} = 0.5$

$$m = \frac{0.5 \times 1000}{500} = 1 \text{ m}$$

8. (a) Number of millimoles of H_2SO_4.
= molarity × volume in mL
= 0.02 × 100 = 2 millimoles
= 2 × 10^{-3} mol
Number of molecules = Number of moles × N_A.
= 2 × 10^{-3} × 6.022 × 10^{23}
= 12.044 × 10^{20} molecules

9. (b) Molecular mass of CO_2 = 44 g
$\because$ 44 g of CO_2 contain C = 12 g atoms of carbon

$\therefore$ % of C in $CO_2 = \frac{12}{44} \times 100 = 27.27\%$

i.e. mass percent of carbon in CO_2 is 27.27%.

10. (c) Empirical formula mass of CH_2O = 30
Molecular mass = 180 (Given)

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{180}{30} = 6$$

$\therefore$ Molecular formula = n × empirical formula
= 6 × CH_2O
= $C_6H_{12}O_6$

11. (a) For a solution, Mass = volume × density
= 1.5 mL × 3.12 g mL^{-1} = 4.68 g
The digit 1.5 has only two significant figures, so the answer must also be limited to two significant figure. So it is rounded off to 4.7 g.

12. (c) The properties of a compound are quite different from the properties of constituent elements. e.g., ammonia is a compound containing hydrogen and nitrogen combined together in a fixed proportion. But the properties of ammonia are completely different from its constituents, hydrogen and nitrogen.

13. (a) According to the law of conservation of mass,
Total mass of reactants = Total mass of products

14. (b) In this equation

$$\underset{44g}{C_3H_8(g)} + \underset{32g}{O_2(g)} \longrightarrow \underset{44g}{CO_2(g)} + \underset{18g}{H_2O(g)}$$

i.e. mass of reactants ≠ mass of products
Hence, law of conservation of mass is not obeyed.

15. (b) In CO_2, 12 parts by mass of carbon combine with 32 parts by mass of oxygen while in CO, 12 parts by mass of carbon combine with 16 parts by mass of oxygen. Therefore, the masses of oxygen combine with a fixed mass of carbon (12 parts) in CO_2 and CO are 32 and 16 respectively. These masses of oxygen bear a simple ratio of 32 : 16 or 2 : 1 to each other.
This is an example of law of multiple proportion.

NEET/AIPMT (2013-2017) Questions

16. (c) Millimoles of solution of chloride
= 0.05 × 10 = 0.5
Millimoles of $AgNO_3$ solution = 10 × 0.1 = 1
So, the millimoles of $AgNO_3$ are double than the chloride solution.

$$\therefore\ XCl_2 + 2AgNO_3 \longrightarrow 2AgCl + X(NO_3)_2$$

17. (a) $$M = \frac{6.02 \times 10^{20} \times 1000}{100 \times 6.02 \times 10^{23}} = \frac{6.02 \times 10^{21}}{6.02 \times 10^{23}}$$

= 0.01 M

18. (a)

	H_2	+	$Cl_2 \longrightarrow$	2HCl
t = 0	22.4 lit		11.2 lit	0
t = 0 or	1 mole		0.5 mole	0
at time t			(1 − 0.5)	

0.5 × 2 = 0.5 = 1 mole

19. (a) Initially $\underset{1g}{Mg} + \underset{0.56}{\frac{1}{2}O_2} \longrightarrow MgO$

or $\frac{1}{24}$ mole $\qquad \frac{0.56}{32}$ mole

0.0416 mole $\qquad$ 0.0175 mole

(0.0416 − 2 × 0.0175) $\qquad$ (2 × 0.0175) mole

= 0.0066 mole

$\therefore$ Mass of Mg $= 0.0066 \times 24$

$= 0.158 \approx 0.16\text{g}$

20. (b) If 6.022×10^{23} changes to 6.022×10^{20}/mol than this would change mass of one mole of carbon.

21. (c) 50 ml of 16.9% solution of $AgNO_3$

$\left(\frac{16.9}{100} \times 50\right) = 8.45$ g of $AgNO_3$

$$n_{mole} = \frac{8.45\text{g}}{(107.8 + 14 + 16 \times 3)\ \text{g/mol}}$$

$$= \left(\frac{8.45\ \text{g}}{169.8\text{g/mol}}\right) = 0.0497 \text{ moles}$$

50 ml of 5.8% solution of NaCl contain

$$NaCl = \left(\frac{5.8}{100} \times 50\right) = 2.9\ \text{g}$$

$$n_{NaCl} = \frac{2.9\text{g}}{(23 + 35.5)\ \text{g/mol}} = 0.0495 \text{ moles}$$

$$AgNO_3 + NaCl \rightarrow AgCl \downarrow + Na^{\oplus} + Cl^{\ominus}$$

1 mole 1 mole 1 mole

$\therefore$ 0.049 mole 0.049 mole 0.049 mole of AgCl

$$n = \frac{w}{M} \rightarrow w = (n_{AgCl}) \times \text{Molecular Mass}$$

$= (0.049) \times (107.8 + 35.5)$

$= 7.02$ g

22. (a) Ratio of weight of gases $= w_{H_2} : w_{O_2} = 1 : 4$

Ratio of moles of gases $= n_{H_2} : n_{O_2} = \frac{1}{2} : \frac{4}{32}$

$\therefore$ Molar Ratio $= \frac{1}{2} \times \frac{32}{4} = 4 : 1$

23. (d) $MgCO_3 \longrightarrow MgO + CO_2$

84 g of $MgCO_3$ form 40 g of MgO

$\therefore$ 20g of $MgCO_3$ form $\frac{40 \times 20}{84}$ g of MgO

$= 9.52$ g of MgO

Since 8.0 g of MgO is formed

Purity of sample $= \frac{8}{9.52} \times 100 = 84.0\%$

24. (d) No. of moles of water

In 1.8 g of $H_2O = 0.1$ moles

In 18 g of $H_2O = 1$ moles

1 mole contain 6.022×10^{23} molecules of water

therefore maximum number of molecules is in 18 moles of water.