

## Some Basic Concepts of Chemistry

Topic-1: Measurement, Mole Concept and Percentage Composition

## 1 MCQs with One Correct Answer

1. The number of molecules and moles in 2.8375 litres of $\mathrm{O}_{2}$ at STP are respectively
[Main April 10, 2023 (I)]
(a) $7.527 \times 10^{22}$ and 0.250 mol
(b) $1.505 \times 10^{23}$ and 0.250 mol
(c) $7.527 \times 10^{23}$ and 0.125 mol
(d) $7.527 \times 10^{22}$ and 0.125 mol
2. Which of the following have same number of significant figures?
[Main April 08, 2023(II)]
(A) 0.00253
(B) 1.0003
(C) 15.0
(D) 163

Choose the correct answer from the options given below
(a) A, B and C only
(b) C and D only
(c) A, C and D only
(d) B and C only
3. A metal chloride contains $55.0 \%$ of chlorine by weight. 100 mL vapours of the metal chloride at STP weight 0.57 g . The molecular formula of the metal chloride is (Given : Atomic mass of chlorine is 35.5 u )
[Main April 12, 2023 (I)]
(a) $\mathrm{MCl}_{2}$
(b) $\mathrm{MCl}_{4}$
(c) $\mathrm{MCl}_{3}$
(d) MCl
4. Hemoglobin contains $0.34 \%$ of iron by mass. The number of Fe atoms in 3.3 g of hemoglobin is : (Given : Atomic mass of Fe is $56 \mathrm{u}, \mathrm{N}_{\mathrm{A}}$ in $6.022 \times 10^{23} \mathrm{~mol}^{-1}$ )
[Main July 26, 2022 (III)]
(a) $1.21 \times 10^{5}$
(b) $12.0 \times 10^{16}$
(c) $1.21 \times 10^{20}$
(d) $3.4 \times 10^{22}$
5. Using the rules for significant figures, the correct answer for the expression $\frac{0.02858 \times 0.112}{0.5702}$ will be :
[Main June 29, 2022 (III)]
(a) 0.005613
(b) 0.00561
(c) 0.0056
(d) 0.006
6. Compound A contains $8.7 \%$ Hydrogen, $74 \%$ Carbon and $17.3 \%$ Nitrogen. The molecular formula of the compound is, Given : Atomic masses of C, H and N are 12, 1 and 14 amu respectively.
[Main June 28, 2022 (III)] The molar mass of the compound A is $162 \mathrm{~g} \mathrm{~mol}^{-1}$.
(a) $\mathrm{C}_{4} \mathrm{H}_{6} \mathrm{~N}_{2}$
(b) $\mathrm{C}_{2} \mathrm{H}_{3} \mathrm{~N}$
(c) $\mathrm{C}_{5} \mathrm{H}_{7} \mathrm{~N}$
(d) $\mathrm{C}_{10} \mathrm{H}_{14} \mathrm{~N}_{2}$
7. Amongst the following statements, that which was not proposed by Dalton was:
[Main Jan. 07, 2020 (I)]
(a) Chemical reactions involve reorganization of atoms. These are neither created nor destroyed in a chemical reaction.
(b) All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.
(c) When gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume, provided all gases are at the same $T \& P$.
(d) Matter consists of indivisible atoms.
8. The percentage composition of carbon by mole in methane is:
[Main April 8, 2019 (II)]
(a) $75 \%$
(b) $80 \%$
(c) $25 \%$
(d) $20 \%$
9. An unknown chlorohydrocarbon has $3.55 \%$ of chlorine. If each molecule of the hydrocarbon has one chlorine atom only, chlorine atoms present in 1 g of chlorohydrocarbon are: (Atomic wt. of $\mathrm{Cl}=35.5 \mathrm{u}$; Avogadro constant $=6.023 \times$ $10^{23} \mathrm{~mol}^{-1}$ )
[Main Online April 16, 2018]
(a) $6.023 \times 10^{9}$
(b) $6.023 \times 10^{23}$
(c) $6.023 \times 10^{21}$
(d) $6.023 \times 10^{20}$
10. 5 moles of $\mathrm{AB}_{2}$ weigh $125 \times 10^{-3} \mathrm{~kg}$ and 10 moles of $\mathrm{A}_{2} \mathrm{~B}_{2}$ weigh $300 \times 10^{-3} \mathrm{~kg}$. The molar mass of $\mathrm{A}\left(\mathrm{M}_{\mathrm{A}}\right)$ and molar mass of $B\left(M_{B}\right)$ in $\mathrm{kg} \mathrm{mol}^{-1}$ are: [Main April 12, 2019 (I)]
(a) $\mathrm{M}_{\mathrm{A}}=10 \times 10^{-3}$ and $\mathrm{M}_{\mathrm{B}}=5 \times 10^{-3}$
(b) $\mathrm{M}_{\mathrm{A}}=50 \times 10^{-3}$ and $\mathrm{M}_{\mathrm{B}}=25 \times 10^{-3}$
(c) $\mathrm{M}_{\mathrm{A}}=25 \times 10^{-3}$ and $\mathrm{M}_{\mathrm{B}}=50 \times 10^{-3}$
(d) $\mathrm{M}_{\mathrm{A}}=5 \times 10^{-3}$ and $\mathrm{M}_{\mathrm{B}}=10 \times 10^{-3}$
11. Which has maximum number of atoms?
[2003S]
(a) 24 g of $\mathrm{C}(12)$
(b) 56 g of Fe (56)
(c) 27 g of $\mathrm{Al}(27)$
(d) 108 g of $\mathrm{Ag}(108)$
12. How many moles of electron weigh one kilogram?
[Main 2002S]
(a) $6.023 \times 10^{23}$
(b) $\frac{1}{9.108} \times 10^{31}$
(c) $\frac{6.023}{9.108} \times 10^{54}$
(d) $\frac{1}{9.108 \times 6.023} \times 10^{8}$
13. If two compounds have the same empirical formula but different molecular fomulae they must have
(a) different percentage composition [1987-1 Mark]
(b) different molecular weight
(c) same viscosity
(d) same vapour density
14. The largest number of molecules is in
[1979]
(a) 36 g of water
(b) 28 g of carbon monoxide
(c) 46 g of ethyl alcohol
(d) 54 g of nitrogen pentoxide
15. The total number of electrons in one molecule of carbon dioxide is
[1979]
(a) 22
(b) 44
(c) 66
(d) 88
16. A gaseous mixture contains oxygen and nitrogen in the ratio of $1: 4$ by weight. Therefore, the ratio of their number of molecules is
[1979]
(a) $1: 4$
(b) $1: 8$
(c) $7: 32$
(d) $3: 16$
17. A compound was found to contain nitrogen and oxygen in the ratio 28 g and 80 g respectively. The formula of compound is
[1978]
(a) NO
(b) $\mathrm{N}_{2} \mathrm{O}_{3}$
(c) $\mathrm{N}_{2} \mathrm{O}_{5}$
(d) $\mathrm{N}_{2} \mathrm{O}_{4}$

## 3 Numeric / New Stem Based Questions

18. An organic compound gives 0.220 g of $\mathrm{CO}_{2}$ and 0.126 g of $\mathrm{H}_{2} \mathrm{O}$ on complete combustion If the $\%$ of carbon is 24 then the $\%$ hydrogen is $\qquad$ $\times 10^{-1}$. (Nearest integer) [Main April 13, 2023 (I)]
19. A sample of a metal oxide has formula $\mathrm{M}_{0.83} \mathrm{O}_{1.00}$. The metal M can exist in two oxidation states +2 and +3 . In the sample of $\mathrm{M}_{0.83} \mathrm{O}_{1.00}$, the percentage of metal ions existing in +2 oxidation state is $\qquad$ \% (nearest integer)
[Main Jan. 31, 2023 (II)]
20. Number of hydrogen atoms per molecule of a hydrocarbon A having $85.8 \%$ carbon is $\qquad$ (Given : Molar mass of $\mathrm{A}=84 \mathrm{~g} \mathrm{~mol}^{-1}$ ) [Main Jan. 25, 2023 (III)]
21. Chlorophyll extracted from the crushed green leaves was dissolved in water to make 2 L solution of Mg of concentration 48 ppm . The number of atoms of Mg in this solution is $x \times 10^{20}$ atoms. The value of $x$ is $\qquad$ (Nearest Integer)
(Given: Atomic mass of Mg is $24 \mathrm{~g} \mathrm{~mol}^{-1}$;
$\mathrm{N}_{\mathrm{A}}=6.02 \times 10^{23} \mathrm{~mol}^{-1}$ ) [Main July 26, 2022 (I)]
22. A protein ' A ' contains $0.30 \%$ of glycine (molecular weight 75). The minimum molar mass of the protein ' $A$ ' is
$\qquad$ $\times 10^{3} \mathrm{~g} \mathrm{~mol}^{-1}$ [nearest integer]
[Main June 25, 2022 (II)]
23. Complete combustion of 750 g of an organic compound provides 420 g of $\mathrm{CO}_{2}$ and 210 g of $\mathrm{H}_{2} \mathrm{O}$. The percentage composition of carbon and hydrogen in organic compound is 15.3 and $\qquad$ respectively. (Round off to the Nearest Integer).
[Main March 16, 2021 (I)]
24. The complete combustion of 0.492 g of an organic compound containing ' C ', ' H ' and ' O ' gives 0.793 g of $\mathrm{CO}_{2}$ and 0.442 g of $\mathrm{H}_{2} \mathrm{O}$. The percentage of oxygen composition in the organic compound is $\qquad$ . (nearest integer) [Main June 28, 2022 (II)]
25. Two elements A and B which form 0.15 moles of $\mathrm{A}_{2} \mathrm{~B}$ and $A B_{3}$ type compounds. If both $A_{2} B$ and $A B_{3}$ weigh equally, then the atomic weight of A is $\qquad$ times of atomic weight of $B$.
[Main June 27, 2022 (I)]
26. On complete combustion 0.30 g of an organic compound gave 0.20 g of carbon dioxide and 0.10 g of water. The
percentage of carbon in the given organic compound is (Nearest Integer) [Main June 26, 2022 (I)]
27. The number of N atoms is 681 g of $\mathrm{C}_{7} \mathrm{H}_{5} \mathrm{~N}_{3} \mathrm{O}_{6}$ is $x \times 10^{21}$. The value of $x$ is $\qquad$ $\left(\mathrm{N}_{\mathrm{A}}=6.02 \times 10^{23} \mathrm{~mol}^{-1}\right)$ (Nearest Integer)
[Main June 25, 2022 (I)]
28. The number of atoms in 8 g of sodium is $x \times 10^{23}$.

The value of $x$ is $\qquad$ . (Nearest integer)
[Given : $N_{\mathrm{A}}=6.0 \overline{2 \times 10^{23} \mathrm{~mol}^{-1}}$
Atomic mass of $\mathrm{Na}=23.0 \mathrm{u}$ ] [Main Sep. 1, 2021 (III)]
29. The number of significant figures in 0.00340 is $\qquad$ .
[Main July 25, 2021 (II)]
30. The number of significant figures in $50000.020 \times 10^{-3}$ is
$\qquad$ -
[Main Feb. 26, 2021 (I)]
31. The ratio of the mass percentages of ' $\mathrm{C} \& \mathrm{H}$ ' and ' $\mathrm{C} \& \mathrm{O}$ ' of a saturated acyclic organic compound ' X ' are $4: 1$ and $3: 4$ respectively. Then, the moles of oxygen gas required for complete combustion of two moles of organic compound ' X ' is $\qquad$ . [Main Sep. 02, 2020 (III)]
32. If the value of Avogadro number is $6.023 \times 10^{23} \mathrm{~mol}^{-1}$ and the value of Boltzmann constant is $1.380 \times 10^{-23} \mathrm{~J} \mathrm{~K}^{-1}$, then the number of significant digits in the calculated value of the universal gas constant is
[Adv. 2014]
33. The composition of a sample of Wurtzite is $\mathrm{Fe}_{0.93} \mathrm{O}_{1.00}$. What percentage of the iron is present in the form of Fe (III)?
[1994-2 Marks]
34. A compound contains 28 percent of nitrogen and 72 percent of metal by weight. 3 atoms of metal combine with 2 atoms of N. Find the atomic weight of metal.
[1980]

## 4 Fill in the Blanks

35. The weight of $1 \times 10^{22}$ molecules of $\mathrm{CuSO}_{4} \cdot 5 \mathrm{H}_{2} \mathrm{O}$ is $\qquad$
[1991-1 Mark]
36. The modern atomic mass unit is based on
..........................
[1980]
37. The total number of electrons present in 18 mL of water is
$\qquad$ [1980]

## $6 \quad$ MCQs with One or More than One Correct Answer

38. To check the principle of multiple proportions, a series of pure binary compounds ( $\mathrm{P}_{\mathrm{m}} \mathrm{Q}_{\mathrm{n}}$ ) were analyzed and their composition is tabulated below. The correct option(s) is (are)
[Adv. 2022]

| Compound | Weight \% of $\mathbf{P}$ | Weight \% of Q |
| :---: | :---: | :---: |
| 1 | 50 | 50 |
| 2 | 44.4 | 55.6 |
| 3 | 40 | 60 |

(a) If empirical formula of compound $\mathbf{3}$ is $P_{3} Q_{4}$, then the empirical formula of compound $\mathbf{2}$ is $\mathrm{P}_{3} \mathrm{Q}_{5}$.
(b) If empirical formula of compound $\mathbf{3}$ is $\mathrm{P}_{3} \mathrm{Q}_{2}$ and atomic weight of element $P$ is 20 , then the atomic weight of $Q$ is 45 .
(c) If empirical formula of compound $\mathbf{2}$ is PQ , then the empirical formula of the compound $\mathbf{1}$ is $\mathrm{P}_{5} \mathrm{Q}_{4}$.
(d) If atomic weight of P and Q are 70 and 35 , respectively, then the empirical formula of compound $\mathbf{1}$ is $\mathrm{P}_{2} \mathrm{Q}$.

## 7 Match the Following

39. Match List I with List II List I
(A) 16 g of $\mathrm{CH}_{4}(\mathrm{~g})$
(B) 1 g of $\mathrm{H}_{2}(\mathrm{~g})$
(C) 1 mole of $\mathrm{N}_{2}(\mathrm{~g})$
(D) 0.5 mol of $\mathrm{SO}_{2}(\mathrm{~g})$
[Main April 10, 2023 (II)]
List II
(I) Weighs 28 g
(II) $60.2 \times 10^{23}$ electrons
(III) Weighs 32 g
(IV) Occupies 11.4 L volume at STP

Choose the correct answer from the options given below:
(a) A-I, B-III, C-II, D-IV
(b) A-II, B-III, C-IV, D-I
(c) A-II, B-IV, C-III, D-I
(d) A-II, B-IV, C-I, D-III

10 Subjective Problems
40. A plant virus is found to consist of uniform cylindrical particles of $150 \AA$ in diameter and $5000 \AA$ long. The specific volume of the virus is $0.75 \mathrm{~cm}^{3} / \mathrm{g}$. If the virus is considered to be a single particle, find its molar mass. [1999-3 Marks]
41. Find
[1980]
(i) The total number of neutrons and
(ii) The total mass of neutron in 7 mg of ${ }^{14} \mathrm{C}$.
(Assume that mass of neutron $=$ mass of hydrogen atom)

## Topic-2: Stoichiometry, Equivalent Concept, Neutralization and Redox Titration

## 1 MCQs with One Correct Answer

1. What is the mass ratio of ethylene glycol $\left(\mathrm{C}_{2} \mathrm{H}_{6} \mathrm{O}_{2}\right.$, molar mass $=62 \mathrm{~g} / \mathrm{mol}$ ) required for making 500 g of 0.25 molal aqueous solution and 250 mL of 0.25 molar aqueous solution?
[Main Jan. 25, 2023 (II)]
(a) $1: 1$
(b) $3: 1$
(c) $2: 1$
(d) $1: 2$
2. $\mathrm{C}(\mathrm{s})+\mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{CO}_{2}(\mathrm{~g})+400 \mathrm{~kJ}$
$\mathrm{C}(\mathrm{s})+\frac{1}{2} \mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{CO}(\mathrm{g})+100 \mathrm{~kJ}$
[Main July 29, 2022 (II)]
When coal of purity $60 \%$ is allowed to burn in presence of insufficient oxygen, $60 \%$ of carbon is converted into ' CO ' and the remaining is converted into ' $\mathrm{CO}_{2}$ '.
The heat generated when 0.6 kg of coal is burnt is
(a) 1600 kJ
(b) 3200 kJ
(c) 4400 kJ
(d) 6600 kJ

$\qquad$ $\square$.
3. 250 g solution of D-glucose in water contains $10.8 \%$ of carbon by weight. The molality of the solution is nearest to
(Given: Atomic Weights are $\mathrm{H}, 1 \mathrm{u} ; \mathrm{C}, 12 \mathrm{u} ; \mathrm{O}, 16 \mathrm{u}$ )
[Main July 27, 2022 (I)]
(a) 1.03
(b) 2.06
(c) 3.09
(d) 5.40
4. $\mathrm{SO}_{2} \mathrm{Cl}_{2}$ on reaction with excess of water results into acidic mixture
$\mathrm{SO}_{2} \mathrm{Cl}_{2}+2 \mathrm{H}_{2} \mathrm{O} \rightarrow \mathrm{H}_{2} \mathrm{SO}_{4}+2 \mathrm{HCl}$
16 moles of NaOH is required for the complete neutralisation of the resultant acidic mixture.
The number of moles of $\mathrm{SO}_{2} \mathrm{Cl}_{2}$ used is:
[Main July 25, 2022 (I)]
(a) 16
(b) 8
(c) 4
(d) 2
5. Production of iron in blast furnace follows the following equation
[Main June 29, 2022 (I)]
$\mathrm{Fe}_{3} \mathrm{O}_{4}(\mathrm{~s})+4 \mathrm{CO}(\mathrm{g}) \rightarrow 3 \mathrm{Fe}(\mathrm{l})+4 \mathrm{CO}_{2}(\mathrm{~g})$
when 4.640 kg of $\mathrm{Fe}_{3} \mathrm{O}_{4}$ and 2.520 kg of CO are allowed to react then the amount of iron (ing) produced is :
[Given : Molar Atomic mass $\left(\mathrm{g} \mathrm{mol}^{-1}\right)$ : $\mathrm{Fe}=56$

Molar Atomic mass $\left(\mathrm{g} \mathrm{mol}^{-1}\right): 0=16$
Molar Atomic mass ( $\mathrm{g} \mathrm{mol}^{-1}$ ): $\mathrm{C}=12$
(a) 1400
(b) 2200
(c) 3360
(d) 4200
6. A commercially sold conc. HCl is $35 \% \mathrm{HCl}$ by mass. If the density of this commercial acid is $1.46 \mathrm{~g} / \mathrm{mL}$, the molarity of this solution is :
[Main June 26, 2022 (I)]
(Atomic mass : $\mathrm{Cl}=35.5 \mathrm{amu}, \mathrm{H}=1 \mathrm{amu}$ )
(a) 10.2 M
(b) 12.5 M
(c) 14.0 M
(d) 18.2 M
7. If a rocket runs on a fuel $\left(\mathrm{C}_{15} \mathrm{H}_{30}\right)$ and liquid oxygen, the weight of oxygen required and $\mathrm{CO}_{2}$ released for every litre of fuel respectively are:
[Main June 24, 2022 (I)]
(Given: density of the fuel is $0.756 \mathrm{~g} / \mathrm{mL}$ )
(a) 1188 g and 1296 g
(b) 2376 g and 2592 g
(c) 2592 g and 2376 g
(d) 3429 g and 3142 g
8. Complete combustion of 1.80 g of an oxygen containing compound $\left(\mathrm{C}_{\mathrm{x}} \mathrm{H}_{\mathrm{y}} \mathrm{O}_{\mathrm{z}}\right)$ gave 2.64 g of $\mathrm{CO}_{2}$ and 1.08 g of $\mathrm{H}_{2} \mathrm{O}$. The percentage of oxygen in the organic compound is:
[Main Feb. 25, 2021 (I)]
(a) 50.33
(b) 53.33
(c) 51.63
(d) 63.53
9. The ammonia $\left(\mathrm{NH}_{3}\right)$ released on quantitative reaction of 0.6 g urea $\left(\mathrm{NH}_{2} \mathrm{CONH}_{2}\right)$ with sodium hydroxide $(\mathrm{NaOH})$ can be neutralized by:
[Main Jan. 07, 2020 (II)]
(a) 200 mL of 0.4 N HCl
(b) 200 mL of 0.2 N HCl
(c) 100 mL of 0.2 N HCl
(d) 100 mL of 0.1 N HCl
10. The minimum amount of $\mathrm{O}_{2}(\mathrm{~g})$ consumed per gram of reactant is for the reaction : (Given atomic mass : $\mathrm{Fe}=56$, $\mathrm{O}=16, \mathrm{Mg}=24, \mathrm{P}=31, \mathrm{C}=12, \mathrm{H}=1$ )
[Main April 10, 2019 (II)]
(a) 4 Fe (s) $+3 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{Fe}_{2} \mathrm{O}_{3}$ (s)
(b) $\mathrm{P}_{4}(\mathrm{~s})+5 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{P}_{4} \mathrm{O}_{10}(\mathrm{~s})$
(c) $\mathrm{C}_{3} \mathrm{H}_{8}(\mathrm{~g})+5 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow 3 \mathrm{CO}_{2}(\mathrm{~g})+4 \mathrm{H}_{2} \mathrm{O}(l)$
(d) $2 \mathrm{Mg}(\mathrm{s})+\mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{MgO}(\mathrm{s})$
11. A sample of $\mathrm{NaClO}_{3}$ is converted by heat to NaCl with a loss of 0.16 g of oxygen. The residue is dissolved in water and precipitated as AgCl . The mass of AgCl (in g) obtained will be: (Given: Molar mass of $\mathrm{AgCl}=143.5 \mathrm{~g} \mathrm{~mol}^{-1}$ )
[Main Online April 15, 2018 (I)]
(a) 0.35
(b) 0.54
(c) 0.41
(d) 0.48
12. 1 gram of a carbonate $\left(\mathrm{M}_{2} \mathrm{CO}_{3}\right)$ on treatment with excess HCl produces 0.01186 mole of $\mathrm{CO}_{2}$. The molar mass of $\mathrm{M}_{2} \mathrm{CO}_{3}$ in $\mathrm{g} \mathrm{mol}^{-1}$ is :
[Main 2017]
(a) 1186
(b) 84.3
(c) 118.6
(d) 11.86
13. Excess of $\mathrm{NaOH}(\mathrm{aq})$ was added to 100 mL of $\mathrm{FeCl}_{3}(\mathrm{aq})$ resulting into 2.14 g of $\mathrm{Fe}(\mathrm{OH})_{3}$. The molarity of $\mathrm{FeCl}_{3}(\mathrm{aq})$ is:
[Main Online April 8, 2017]
(Given molar mass of $\mathrm{Fe}=56 \mathrm{~g} \mathrm{~mol}^{-1}$ and molar mass of $\mathrm{Cl}=35.5 \mathrm{~g} \mathrm{~mol}^{-1}$ )
(a) 0.2 M
(b) 0.3 M
(c) 0.6 M
(d) 1.8 M
14. The volume of 0.1 N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of $\mathrm{OH}^{-}$in aqueous solution is :
[Main Online April 10, 2016]
(a) 400 mL
(b) 600 mL
(c) 200 mL
(d) 800 mL
15. 5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is :
[Main Online April 9, 2016; Similar Online April 25, 2013]
(a) Isobutane
(b) Ethane
(c) Butane
(d) Propane
16. At 300 K and $1 \mathrm{~atm}, 15 \mathrm{~mL}$ of a gaseous hydrocarbon requires 375 mL air containing $20 \% \mathrm{O}_{2}$ by volume for complete combustion. After combustion the gases occupy 330 mL . Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is:
[Main 2016]
(a) $\mathrm{C}_{4} \mathrm{H}_{8}$
(b) $\mathrm{C}_{4} \mathrm{H}_{10}$
(c) $\mathrm{C}_{3} \mathrm{H}_{6}$
(d) $\mathrm{C}_{3} \mathrm{H}_{8}$
17. The molecular formula of a commercial resin used for exchanging ions in water softening is $\mathrm{C}_{8} \mathrm{H}_{7} \mathrm{SO}_{3}{ }^{-} \mathrm{Na}^{+}$(Mol. wt. 206. What would be the maximum uptake of $\mathrm{Ca}^{2+}$ ions by the resin when expressed in mole per gram resin?
[Main 2015]
(a) $\frac{2}{309}$
(b) $\frac{1}{412}$
(c) $\frac{1}{103}$
(d) $\frac{1}{206}$
18. A sample of a hydrate of barium chloride weighing 61 g was heated until all the water of hydration is removed. The dried sample weighed 52 g . The formula of the hydrated salt is : (atomic mass, $\mathrm{Ba}=137 \mathrm{amu}, \mathrm{Cl}=35.5$ amu)
[Main Online April 10, 2015]
(a) $\mathrm{BaCl}_{2} \cdot 4 \mathrm{H}_{2} \mathrm{O}$
(b) $\mathrm{BaCl}_{2} \cdot 3 \mathrm{H}_{2} \mathrm{O}$
(c) $\mathrm{BaCl}_{2} \cdot \mathrm{H}_{2} \mathrm{O}$
(d) $\mathrm{BaCl}_{2} \cdot 2 \mathrm{H}_{2} \mathrm{O}$
19. $\mathrm{A}+2 \mathrm{~B}+3 \mathrm{C} \rightleftharpoons \mathrm{AB}_{2} \mathrm{C}_{3}$

Reaction of 6.0 g of $\mathrm{A}, 6.0 \times 10^{23}$ atoms of B , and 0.036 mol of C yields 4.8 g of compound $\mathrm{AB}_{2} \mathrm{C}_{3}$. If the atomic
mass of A and C are 60 and 80 amu , respectively, the atomic mass of B is (Avogadro no. $=6 \times 10^{23}$ ):
[Main Online April 11, 2015]
(a) 50 amu
(b) 60 amu
(c) 70 amu
(d) 40 amu
20. Dissolving 120 g of a compound of mol. wt. 60 in 1000 g of water gave a solution of density $1.12 \mathrm{~g} / \mathrm{mL}$. The molarity of the solution is:
[Main Online April 9, 2014]
(a) 1.00 M
(b) 2.00 M
(c) 2.50 M
(d) 4.00 M
21. The amount of $\mathrm{BaSO}_{4}$ formed upon mixing 100 mL of $20.8 \%$ $\mathrm{BaCl}_{2}$ solution with 50 mL of $9.8 \% \mathrm{H}_{2} \mathrm{SO}_{4}$ solution will be:
[Main Online April 12, 2014]
( $\mathrm{Ba}=137, \mathrm{Cl}=35.5, \mathrm{~S}=32, \mathrm{H}=1$ and $\mathrm{O}=16$ )
(a) 23.3 g
(b) 11.65 g
(c) 30.6 g
(d) 33.2 g
22. A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g of $\mathrm{CO}_{2}$. The empirical formula of the hydrocarbon is :
[Main 2013]
(a) $\mathrm{C}_{2} \mathrm{H}_{4}$
(b) $\mathrm{C}_{3} \mathrm{H}_{4}$
(c) $\mathrm{C}_{6} \mathrm{H}_{5}$
(d) $\mathrm{C}_{7} \mathrm{H}_{8}$
23. Mixture $X=0.02 \mathrm{~mol}$ of $\left[\mathrm{Co}\left(\mathrm{NH}_{3}\right)_{5} \mathrm{SO}_{4}\right] \mathrm{Br}$ and 0.02 mol of $\left[\mathrm{Co}\left(\mathrm{NH}_{3}\right)_{5} \mathrm{Br}\right] \mathrm{SO}_{4}$ was prepared in 2 litre of solution.
[2003S]
1 litre of mixture $X+$ excess $\mathrm{AgNO}_{3} \longrightarrow Y$.
1 litre of mixture $X+$ excess $\mathrm{BaCl}_{2} \longrightarrow Z$
No. of moles of $Y$ and $Z$ are
(a) $0.01,0.01$
(b) $0.02,0.01$
(c) $0.01,0.02$
(d) $0.02,0.02$
24. An aqueous solution of 6.3 g oxalic acid dihydrate is made up to 250 mL . The volume of 0.1 N NaOH required to completely neutralize 10 mL of this solution is [2001S]
(a) 40 mL
(b) 20 mL
(c) 10 mL
(d) 4 mL
25. In the standardization of $\mathrm{Na}_{2} \mathrm{~S}_{2} \mathrm{O}_{3}$ using $\mathrm{K}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$ by iodometry, the equivalent weight of $\mathrm{K}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$ is [2001S]
(a) (molecular weight) $/ 2$
(b) (molecular weight) $/ 6$
(c) (molecular weight) $/ 3$
(d) same as molecular weight
26. The normality of 0.3 M phosphorous acid $\left(\mathrm{H}_{3} \mathrm{PO}_{3}\right)$ is,
[1999-2 Marks]
(a) 0.1
(b) 0.9
(c) 0.3
(d) 0.6
27. The equivalent weight of $\mathrm{MnSO}_{4}$ is half of its molecular weight when it is converted to :
[1988-1 Mark]
(a) $\mathrm{Mn}_{2} \mathrm{O}_{3}$
(b) $\mathrm{MnO}_{2}$
(c) $\mathrm{MnO}_{4}^{-}$
(d) $\mathrm{MnO}_{4}^{2-}$
28. In which mode of expression, the concentration of a solution remains independent of temperature?
[1988-1 Mark]
(a) Molarity
(b) Normality
(c) Formality
(d) Molality
29. A molal solution is one that contains one mole of a solute in:
(a) 1000 g of the solvent
[1986-1 Mark]
(b) one litre of the solvent
(c) one litre of the solution
(d) 22.4 litres of the solution
30. If 0.50 mole of $\mathrm{BaCl}_{2}$ is mixed with 0.20 mol of $\mathrm{Na}_{3} \mathrm{PO}_{4}$, the maximum number of moles of $\mathrm{Ba}_{3}\left(\mathrm{PO}_{4}\right)_{2}$ that can be formed is
[1981-1 Mark]
(a) 0.70
(b) 0.50
(c) 0.20
(d) 0.10
31. $M$ is molecular weight of $\mathrm{KMnO}_{4}$. The equivalent weight of $\mathrm{KMnO}_{4}$ when it is converted into $\mathrm{K}_{2} \mathrm{MnO}_{4}$ is [1980]
(a) $M$
(b) $M / 3$
(c) $M / 5$
(d) $M / 7$
32. 2.76 g of silver carbonate on being strongly heated yields a residue weighing
[1979]
(a) 2.16 g
(b) 2.48 g
(c) 2.32 g
(d) 2.64 g
33. 27 g of Al will react completely with how many grams of oxygen?
[1978]
(a) 8 g
(b) 16 g
(c) 32 g
(d) 24 g

## 2 Integer Value Answer

34. The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product X in $75 \%$ yield. The weight (in g ) of X obtained is $\qquad$ .
[Adv. 2023]
[Use, molar mass ( $\mathrm{g} \mathrm{mol}^{-1}$ ): $\mathrm{H}=1, \mathrm{C}=12, \mathrm{O}=16, \mathrm{Si}=28$, $\mathrm{Cl}=35.5$ ]
35. $\mathrm{H}_{2} \mathrm{~S}$ ( 5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is $x$, and the number of moles of electrons involved is $y$. The value of $(x+y)$ is
$\qquad$ -.
[Adv. 2023]

## 3 Numeric / New Stem Based Questions

36. 1 g of a carbonate $\left(\mathrm{M}_{2} \mathrm{CO}_{3}\right)$ on treatment with excess HCl produces 0.01 mol of $\mathrm{CO}_{2}$. The molar mass of $\mathrm{M}_{2} \mathrm{CO}_{3}$ is
$\qquad$ $\mathrm{g} \mathrm{mol}^{-1}$. (Nearest integer) [Main April 13, 2023 (II)]
37. The volume of hydrogen liberated at STP by treating 2.4 g magnesium with excess of hydrochloric acid is $\times 10^{-2} \mathrm{~L}$. Given: Molar volume of gas is 22.4 Lat STP.
Molarmass ofmagnesium is $24 \mathrm{~g} \mathrm{~mol}^{-1}$. [Main April 11, 2023(III]]
38. A solution of sugar is obtained by mixing 200 g of its $25 \%$ solution and 500 g of its $40 \%$ solution (both by mass). The mass percentage of the resulting sugar solution is $\qquad$ .
(Nearest integer)
[Main April 11, 2023 (I)]
39. 0.5 g of an organic compound $(\mathrm{X})$ with $60 \%$ carbon will produce $\qquad$ $\times 10^{-1} \mathrm{~g}$ of $\mathrm{CO}_{2}$ on complete combustion.
[Main April 08, 2023 (I)]
40. If 5 moles of $\mathrm{BaCl}_{2}$ is mixed with 2 moles of $\mathrm{Na}_{3} \mathrm{PO}_{4}$, the maximum number of moles of $\mathrm{Ba}_{3}\left(\mathrm{PO}_{4}\right)_{2}$ formed is. $\qquad$ (Nearest integer)
[Main April 06, 2023 (I)]
41. On complete combustion, 0.492 g of an organic compound gave 0.792 g of $\mathrm{CO}_{2}$. The $\%$ of carbon in the organic compound is $\qquad$ (Nearest integer)
[Main Jan. 31, 2023 (I)]
42. Zinc reacts with hydrochloric acid to give hydrogen and zinc chloride. The volume of hydrogen gas produced at STP from the
reaction of 11.5 g ofzinc with excess HCl is $\qquad$ L(Nearestinteger) (Given : Molar mass of Zn is $65.4 \mathrm{~g} \mathrm{~mol}^{-1}$ and Molar volume of $\mathrm{H}_{2}$ at $\mathrm{STP}=22.7 \mathrm{~L}$ )
[Main Jan. 31, 2023 (I)]
43. Assume carbon burns according to following equation : $2 \mathrm{C}(\mathrm{s})+\mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{CO}(\mathrm{g})$
When 12 g carbon is burnt in 48 g of oxygen, the volume of carbon monoxide produced is $\qquad$ $\times 10^{-1} \mathrm{~L}$ at STP [nearest integer]
[Given : Assume CO as ideal gas, Mass of C is $12 \mathrm{~g} \mathrm{~mol}^{-1}$, Mass of O is $16 \mathrm{~g} \mathrm{~mol}^{-1}$ and molar volume of an ideal gas at STP is $22.7 \mathrm{~L} \mathrm{~mol}^{-1}$ ] [Main Jan. 31, 2023 (II)]
44. A 300 mL bottle of soft drink has $0.2 \mathrm{MCO}_{2}$ dissolved in it. Assuming $\mathrm{CO}_{2}$ behaves as an ideal gas, the volume of the dissolved $\mathrm{CO}_{2}$ at STP is $\qquad$ mL . (Nearest integer)
Given: At STP, molar volume of an ideal gas is $22.7 \mathrm{Lmo}^{-1}$.
[Main Jan. 30, 2023 (I)]
45. The strength of 50 volume solution of hydrogen peroxide is $\qquad$ $\mathrm{g} / \mathrm{L}$ (Nearest integer).
Given: Molar mass of $\mathrm{H}_{2} \mathrm{O}_{2}$ is $34 \mathrm{~g} \mathrm{~mol}^{-1}$
Molar volume of gas at $\mathrm{STP}=22.7 \mathrm{~L}$. [Main Jan. 30, 2023 (III)]
46. When 0.01 mol of an organic compound containing $60 \%$ carbon was burnt completely, 4.4 g of $\mathrm{CO}_{2}$ was produced. The molar mass of compound is $\qquad$ $\mathrm{g} \mathrm{mol}^{-1}$ (Nearest integer)
[Main Jan. 29, 2023 (II)]
47. The volume of HCl , containing $73 \mathrm{~g} \mathrm{~L}^{-1}$, required to completely neutralise NaOH obtained by reacting 0.69 g of metallic sodium with water, is $\qquad$ mL . (Nearest Integer) (Given : molar Masses of $\mathrm{Na}, \overline{\mathrm{Cl}, \mathrm{O}, \mathrm{H}}$ are 23, 35.5, 16 and $1 \mathrm{~g} \mathrm{~mol}^{-1}$ respectively) [Main Jan. 29, 2023 (II)]
48. When $\mathrm{Fe}_{0.93} \mathrm{O}$ is heated in presence of oxygen, it converts to $\mathrm{Fe}_{2} \mathrm{O}_{3}$. The number of correct statement/s from the following is $\qquad$ -
[Main Jan. 24, 2023 (I)]
A. The equivalent weight of $\mathrm{Fe}_{0.93} \mathrm{O}$ is $\frac{\text { Molecular weight }}{0.79}$
B. The number of moles of $\mathrm{Fe}^{2+}$ and $\mathrm{Fe}^{3+}$ in 1 mole of $\mathrm{Fe}_{0.93} \mathrm{O}$ is 0.79 and 0.14 respectively.
C. $\mathrm{Fe}_{0.93} \mathrm{O}$ is metal deficient with lattice comprising of cubic closed packed arrangement of $\mathrm{O}^{2-}$ ions.
D. The \% composition of $\mathrm{Fe}^{2+}$ and $\mathrm{Fe}^{3+}$ in $\mathrm{Fe}_{0.93} \mathrm{O}$ is $85 \%$ and $15 \%$ respectively.
49. On complete combustion of 0.492 g of an organic compound containing $\mathrm{C}, \mathrm{H}$ and $\mathrm{O}, 0.7938 \mathrm{~g}$ of $\mathrm{CO}_{2}$ and 0.4428 g of $\mathrm{H}_{2} \mathrm{O}$ was produced. The $\%$ composition of oxygen in the compound is $\qquad$ -.
[Main July 28, 2022 (I)]
50. In the given reaction,
$\mathrm{X}+\mathrm{Y}+3 \mathrm{Z} \rightleftarrows \mathrm{XYZ}_{3}$
if one mole of each of $X$ and $Y$ with 0.05 mol of $Z$ gives compound $\mathrm{XYZ}_{3}$. (Given : Atomic masses of $\mathrm{X}, \mathrm{Y}$ and Z are 10, 20 and 30 amu , respectively). The yield of $\mathrm{XYZ}_{3}$ is
$\qquad$ g. (Nearest integer) [Main July 28, 2022 (I)]
51. 56.0 L of nitrogen gas is mixed with excess of hydrogen gas and it is found that 20 L of ammonia gas is produced. The volume of unused nitrogen gas is found to be $\qquad$ L.
[Main July 25, 2022 (II)]
52. Blister copper is produced by reaction of copper oxide with copper sulphide.
$2 \mathrm{Cu}_{2} \mathrm{O}+\mathrm{Cu}_{2} \mathrm{~S} \rightarrow 6 \mathrm{Cu}+\mathrm{SO}_{2}$
When $2.86 \times 10^{3} \mathrm{~g}$ of $\mathrm{Cu}_{2} \mathrm{O}$ and $4.77 \times 10^{3} \mathrm{~g}$ of $\mathrm{Cu}_{2} \mathrm{~S}$ are used for reaction, the mass of copper produced is $\quad \mathrm{g}$. (nearest integer)
[Main June 30, 2022 (l)]
(Atomic mass of $\mathrm{Cu}=63.5 \mathrm{a} . \mathrm{m} . \mathrm{u}$ )
$\mathrm{S}=32.0 \mathrm{a} . \mathrm{m} . \mathrm{u}$
$\mathrm{O}=16.0$ a.m. u)
53. The neutralization occurs when 10 mL of 0.1 M acid ' $A$ ' is allowed to react with 30 mL of 0.05 M base $\mathrm{M}(\mathrm{OH})_{2}$. The basicity of the acid ' $A$ ' is $\qquad$ . [ M is a metal]
[Main June 25, 2022 (II)]
54. Number of grams of bromine that will completely react with 5.0 g of pent-1-ene is $\qquad$ $\times 10^{-2} \mathrm{~g}$.
(Atomic mass of $\mathrm{Br}=80 \mathrm{~g} / \mathrm{mol}$ ) (Nearest Integer)
[Main June 25, 2022 (I)]
55. 1 L aqueous solution of $\mathrm{H}_{2} \mathrm{SO}_{4}$ contains 0.02 m mol $\mathrm{H}_{2} \mathrm{SO}_{4} .50 \%$ of this solution is diluted with deionized water to give 1 L solution (A). In solution (A), 0.01 m mol of $\mathrm{H}_{2} \mathrm{SO}_{4}$ are added. Total m mols of $\mathrm{H}_{2} \mathrm{SO}_{4}$ in the final solution is $\qquad$ $\times 10^{3} \mathrm{~m}$ mols.
[Main June 25, 2022 (I)]
56. Sodium oxide reacts with water to produce sodium hydroxide. 20.0 g of sodium oxide is dissolved in 500 mL of water. Neglecting the change in volume, the concentration of the resulting NaOH solution is $\times 10^{-1} \mathrm{M}$. (Nearest integer)
$\overline{\text { [Atomic mass : }} \mathrm{Na}=23.0, \mathrm{O}=16.0, \mathrm{H}=1.0$ ]
[Main Aug. 31, 2021 (II)]
57. When 10 mL of an aqueous solution of $\mathrm{Fe}^{2+}$ ions was titrated in the presence of dil $\mathrm{H}_{2} \mathrm{SO}_{4}$ using diphenylamine indicator, 15 mL of 0.02 M solution of $\mathrm{K}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$ was required to get the end point. The molarity of the solution containing $\mathrm{Fe}^{2+}$ ions is $x \times 10^{-2} \mathrm{M}$. The value of $x$ is $\qquad$ . (Nearest integer)
[Main July 25, 2021 (I); Similar March 17, 2021 (I)]
58. If the concentration of glucose $\left(\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}\right)$ in blood is $0.72 \mathrm{~g} \mathrm{~L}^{-1}$, the molarity of glucose in blood is $\times 10^{-3} \mathrm{M}$. (Nearest integer)
[Given : Atomic mass of $\mathrm{C}=12, \mathrm{H}=1, \mathrm{O}=16 \mathrm{u}$ ]
[Main July 22, 2021 (II)]
59. When 35 mL of 0.15 M lead nitrate solution is mixed with 20 mL of 0.12 M chromic sulphate solution, $\qquad$ $\times$ $10^{-5}$ moles of lead sulphate precipitate out. (Round off to the Nearest Integer).
[Main March 16, 2021 (II)]
60. The $\mathrm{NaNO}_{3}$ weighed out to make 50 mL of an aqueous solution containing $70.0 \mathrm{mg} \mathrm{Na}^{+}$per mL is $\qquad$ g. (Rounded off to the nearest integer)
[Main Feb. 26, 2021 (III)] [Given : Atomic weight in $\mathrm{g} \mathrm{mol}^{-1}-\mathrm{Na}: 23 ; \mathrm{N}: 14 ; \mathrm{O}: 16$ ]
61. 4.5 g of compound $\mathrm{A}(\mathrm{MW}=90)$ was used to make 250 mL of its aqueous solution. The molarity of the solution is $x \times 10^{-1}$. The value of $x$ is $\qquad$ (Rounded off to the nearest integer)
[Main Feb. 24, 2021 (I)]
62. The volume, in mL , of $0.02 \mathrm{M} \mathrm{K}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is
$\qquad$ . (Molar mass of $\left.\mathrm{Fe}=56 \mathrm{~g} \mathrm{~mol}^{-1}\right)$
[Main Sep. 05, 2020 (II)]
63. The mass of ammonia in grams produced when 2.8 kg of dinitrogen quantitatively reacts with 1 kg of dihydrogen is
[Main Sep. 04, 2020 (I)]
64. The mole fraction of glucose $\left(\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}\right)$ in an aqueous binary solution is 0.1 . The mass percentage of water in it, to the nearest integer, is $\qquad$ . [Main Sep. 03, 2020 (I)]
65. 10.30 mg of $\mathrm{O}_{2}$ is dissolved into a liter of sea water of density $1.03 \mathrm{~g} / \mathrm{mL}$. The concentration of $\mathrm{O}_{2}$ in ppm is [- [Main Jan. 09, 2020 (III)]
66. $\mathrm{NaClO}_{3}$ is used, even in spacecrafts, to produce $\mathrm{O}_{2}$. The daily consumption of pure $\mathrm{O}_{2}$ by a person is 492 L at 1 atm, 300 K . How much amount of $\mathrm{NaClO}_{3}$, in grams, is required to produce $\mathrm{O}_{2}$ for the daily consumption of a person at $1 \mathrm{~atm}, 300 \mathrm{~K}$ ? $\qquad$ $\rightarrow$.
$\mathrm{NaClO}_{3}(\mathrm{~s})+\mathrm{Fe}(\mathrm{s}) \rightarrow \mathrm{O}_{2}(\mathrm{~g})+\mathrm{NaCl}(\mathrm{s})+\mathrm{FeO}(\mathrm{s})$
$R=0.082 \mathrm{~L} \mathrm{~atm} \mathrm{~mol}^{-1} \mathrm{~K}^{-1} \quad$ [Main Jan. 08, 2020 (III)]
67. The molarity of $\mathrm{HNO}_{3}$ in a sample which has density 1.4 $\mathrm{g} / \mathrm{mL}$ and mass percentage of $63 \%$ is $\qquad$ . (Molecular Weight of $\mathrm{HNO}_{3}=63$ ) [Main Jan. 09, 2020 (I)] Question Stem for Question Nos. 68 and 69
A sample ( 5.6 g ) containing iron is completely dissolved in cold dilute HCl to prepare a 250 mL of solution. Titration of 25.0 mL of this solution requires 12.5 mL of $0.03 \mathrm{M} \mathrm{KMnO}_{4}$ solution to reach the end point. Number of moles of $\mathrm{Fe}^{2+}$ present in 250 mL solution is $x \times 10^{-2}$ (consider complete dissolution of $\mathrm{FeCl}_{2}$ ). The amount of iron present in the sample of $y \%$ by weight.
(Assume : $\mathrm{KMnO}_{4}$ reacts only with $\mathrm{Fe}^{2+}$ in the solution
Use : Molar mass of iron as $56 \mathrm{~g} \mathrm{~mol}^{-1}$ )
68. The value of $x$ is $\qquad$ .
[Adv. 2021]
69. The value of $y$ is $\qquad$ .
[Adv. 2021]
70. The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $\mathrm{NiCl}_{2} \cdot 6 \mathrm{H}_{2} \mathrm{O}$ to form a stable coordination compound. Assume that both the reactions are $100 \%$ complete. If 1584 g of ammonium sulphate and 952 g of $\mathrm{NiCl}_{2} \cdot 6 \mathrm{H}_{2} \mathrm{O}$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is $\qquad$ .
(Atomic weights in $\mathrm{g} \mathrm{mol}^{-1}: \mathrm{H}=1, \mathrm{~N}=14, \mathrm{O}=16, \mathrm{~S}=32$, $\mathrm{Cl}=35.5, \mathrm{Ca}=40, \mathrm{Ni}=59$ )
[Adv. 2018]
71. Galena (an ore) is partially oxidized by passing air through it at high temperature. After some time, the passage of air is stopped, but the heating is continued in a closed furnace such that the contents undergo self-reduction. The weight (in kg ) of Pb produced per kg of $\mathrm{O}_{2}$ consumed is
(Atomic weights in $\mathrm{g} \mathrm{mol}^{-1}: \mathrm{O}=16, \mathrm{~S}=32, \mathrm{~Pb}=207$ )
[Adv. 2018]
72. How many millilitres of $0.5 \mathrm{MH}_{2} \mathrm{SO}_{4}$ are needed to dissolve 0.5 g of copper(II) carbonate? [1999-3 Marks]
73. One gram of commercial $\mathrm{AgNO}_{3}$ is dissolved in 50 mL . of water. It is treated with 50 mL . of a KI solution. The silver iodide thus precipitated is filtered off. Excess of KI in the filterate is titrated with $(\mathrm{M} / 10) \mathrm{KIO}_{3}$ solution in presence of 6 M HCl till all $\mathrm{I}^{-}$ions are converted into ICl . It requires 50 mL . of $(\mathrm{M} / 10) \mathrm{KIO}_{3}$ solution. 20 mL . of the same stock solution of KI requires 30 mL . of $(\mathrm{M} / 10) \mathrm{KIO}_{3}$ under similar conditions. Calculate the percentage of $\mathrm{AgNO}_{3}$ in the sample. (Reaction : $\mathrm{KIO}_{3}+2 \mathrm{KI}+6 \mathrm{HCl} \rightarrow 3 \mathrm{ICl}+3 \mathrm{KCl}+3 \mathrm{H}_{2} \mathrm{O}$ )
[1992-4 Marks]
74. A 1.0 g sample of $\mathrm{Fe}_{2} \mathrm{O}_{3}$ solid of $55.2 \%$ purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100.0 mL . An aliquot of 25.0 mL of this solution requires 17.0 mL of 0.0167 M solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration.
[1991-4 Marks]
75. Calculate the molality of 1 litre solution of $93 \% \mathrm{H}_{2} \mathrm{SO}_{4}$ (weight/volume). The density of the solution is $1.84 \mathrm{~g} / \mathrm{mL}$.
[1990-1 Marks]
76. A sample of hydrazine sulphate $\left(\mathrm{N}_{2} \mathrm{H}_{6} \mathrm{SO}_{4}\right)$ was dissolved in 100 mL of water, 10 mL of this solution was reacted with excess of ferric chloride solution and warmed to complete the reaction. Ferrous ion formed was estimated and it required 20 mL of $\mathrm{M} / 50$ potassium permanganate solution. Estimate the amount of hydrazine sulphate in one litre of the solution.
[1988-3 Marks]
Reaction :
$4 \mathrm{Fe}^{3+}+\mathrm{N}_{2} \mathrm{H}_{4} \rightarrow \mathrm{~N}_{2}+4 \mathrm{Fe}^{2+}+4 \mathrm{H}^{+}$
$\mathrm{MnO}_{4}^{-}+5 \mathrm{Fe}^{2+}+8 \mathrm{H}^{+} \rightarrow \mathrm{Mn}^{2+}+5 \mathrm{Fe}^{3+}+4 \mathrm{H}_{2} \mathrm{O}$.
77. Hydroxylamine reduces iron (III) according to the equation: $2 \mathrm{NH}_{2} \mathrm{OH}+4 \mathrm{Fe}^{3+} \rightarrow \mathrm{N}_{2} \mathrm{O}(\mathrm{g}) \uparrow+\mathrm{H}_{2} \mathrm{O}+4 \mathrm{Fe}^{2+}+4 \mathrm{H}^{+}$ Iron (II) thus produced is estimated by titration with a standard permanganate solution. The reaction is :
$\mathrm{MnO}_{4}^{-}+5 \mathrm{Fe}^{2+}+8 \mathrm{H}^{+} \rightarrow \mathrm{Mn}^{2+}+5 \mathrm{Fe}^{3+}+4 \mathrm{H}_{2} \mathrm{O}$
A 10 mL . sample of hydroxylamine solution was diluted to 1 litre. 50 mL . of this diluted solution was boiled with an excess of iron (III) solution. The resulting solution required 12 mL . of $0.02 \mathrm{M} \mathrm{KMnO}_{4}$ solution for complete oxidation of iron (II). Calculate the weight of hydroxylamine in one litre of the original solution. $(\mathrm{H}=1, \mathrm{~N}=14, \mathrm{O}=16, \mathrm{~K}=39$, $\mathrm{Mn}=55, \mathrm{Fe}=56$ )
[1982-4 Marks]
78. A 1.00 g sample of $\mathrm{H}_{2} \mathrm{O}_{2}$ solution containing $X$ per cent $\mathrm{H}_{2} \mathrm{O}_{2}$ by weight requires $X \mathrm{~mL}$ of a $\mathrm{KMnO}_{4}$ solution for complete oxidation under acidic conditions. Calculate the normality of the $\mathrm{KMnO}_{4}$ solution. [1981-3 Marks]
79. 4.215 g of a metallic carbonate was heated in a hard glass tube and the $\mathrm{CO}_{2}$ evolved was found to measure 1336 mL at $27^{\circ} \mathrm{C}$ and 700 mm pressure. What is the equivalent weight of the metal?
[1979]
80. What weight of AgCl will be precipitated when a solution containing 4.77 g of NaCl is added to a solution of 5.77 g of $\mathrm{AgNO}_{3}$ ?
[1978]
81. Igniting $\mathrm{MnO}_{2}$ converts it quantitatively to $\mathrm{Mn}_{3} \mathrm{O}_{4}$. A sample of pyrolusite is of the following composition : $\mathrm{MnO}_{2}$ $80 \%, \mathrm{SiO}_{2}$ and other inert constituents $15 \%$, rest being water. The sample is ignited in air to constant weight. What is the percentage of Mn in the ignited sample? [1978] $[\mathrm{O}=16, \mathrm{Mn}=54.9]$

## $9 \quad$ Assertion and Reason / Statement Type Questions

Each Question contains Assertion and Reason statements. In the light of the given statements in the question choose the correct answer from the options given below.
(a) If both Assetion and Reason are correct and Reason is the correct explanation of the Assertion
(b) If both Assertion and Reason are correct but Reaon is not the correct explanation of the Assertion.
(c) If the Assertion is correct but the Reason is incorrect
(d) If the Assertion is incorrect but the Reason is correct
82. Assertion : In the titration of $\mathrm{Na}_{2} \mathrm{CO}_{3}$ with HCl using methyl orange indicator, the volume required at the equivalence point is twice that of the acid required using phenolphthalein indicator.
Reason : Two moles of HCl are required for the complete neutralization of one mole of $\mathrm{Na}_{2} \mathrm{CO}_{3}$. [1991-2 Marks]

## 10 Subjective Problems

83. Calculate the molarity of water if its density is $1000 \mathrm{~kg} / \mathrm{m}^{3}$.
[2003-2 Marks]
84. Hydrogen peroxide solution ( 20 mL ) reacts quantitatively with a solution of $\mathrm{KMnO}_{4}(20 \mathrm{~mL})$ acidified with dilute $\mathrm{H}_{2} \mathrm{SO}_{4}$. The same volume of the $\mathrm{KMnO}_{4}$ solution is just decolourised by 10 mL of $\mathrm{MnSO}_{4}$ in neutral medium simultaneously forming a dark brown precipitate of hydrated $\mathrm{MnO}_{2}$. The brown precipitate is dissolved in 10 mL of 0.2 M sodium oxalate under boiling condition in the presence of dilute $\mathrm{H}_{2} \mathrm{SO}_{4}$. Write the balanced equations involved in the reactions and calculate the molarity of $\mathrm{H}_{2} \mathrm{O}_{2}$.
[2001-5 Marks]
85. An aqueous solution containing $0.10 \mathrm{~g} \mathrm{KIO}_{3}$ (formula weight $=214.0$ ) was treated with an excess of KI solution. The solution was acidified with HCl . The liberated $\mathrm{I}_{2}$ consumed 45.0 mL of thiosulphate solution to decolourise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution. [1998-5 Marks]
86. A 3.00 g sample containing $\mathrm{Fe}_{3} \mathrm{O}_{4}, \mathrm{Fe}_{2} \mathrm{O}_{3}$ and an inert impure substance, is treated with excess of KI solution in presence of dilute $\mathrm{H}_{2} \mathrm{SO}_{4}$. The entire iron is converted into $\mathrm{Fe}^{2+}$ along with the liberation of iodine. The resulting solution is diluted to 100 mL . A 20 mL of the diluted solution requires 11.0 mL of $0.5 \mathrm{M} \mathrm{Na}_{2} \mathrm{~S}_{2} \mathrm{O}_{3}$ solution to reduce the iodine present. A 50 mL of the diluted solution, after complete extraction of the iodine requires 12.80 mL of 0.25 M $\mathrm{KMnO}_{4}$ solution in dilute $\mathrm{H}_{2} \mathrm{SO}_{4}$ medium for the oxidation of $\mathrm{Fe}^{2+}$. Calculate the percentages of $\mathrm{Fe}_{2} \mathrm{O}_{3}$ and $\mathrm{Fe}_{3} \mathrm{O}_{4}$ in the original sample. [1996-5 Marks]
87. $8.0575 \times 10^{-2} \mathrm{~kg}$ of Glauber's salt is dissolved in water to obtain $1 \mathrm{dm}^{3}$ of a solution of density $1077.2 \mathrm{~kg} \mathrm{~m}^{-3}$. Calculate the molarity, molality and mole fraction of $\mathrm{Na}_{2} \mathrm{SO}_{4}$ in the solution.
[1994-3 Marks]
88. Upon mixing 45.0 mL . of 0.25 M lead nitrate solution with 25.0 mL of 0.10 M chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentrations of the species left behind in the final solution. Assume that lead sulphate is completely insoluble.
[1993-3 Marks]
89. A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is gently heated till the evolution of $\mathrm{CO}_{2}$ ceases. The volume of $\mathrm{CO}_{2}$ at 750 mm Hg pressure and at 298 K is measured to be 123.9 mL . A 1.5 g of the same sample requires 150 mL . of $(\mathrm{M} / 10) \mathrm{HCl}$ for complete neutralisation. Calculate the $\%$ composition of the components of the mixture. [1992-5 Marks]
90. A solution of 0.2 g of a compound containing $\mathrm{Cu}^{2+}$ and
$\mathrm{C}_{2} \mathrm{O}_{4}^{2-}$ ions on titration with $0.02 \mathrm{M} \mathrm{KMnO}_{4}$ in presence of $\mathrm{H}_{2} \mathrm{SO}_{4}$ consumes 22.6 mL . of the oxidant. The resultant solution is neutralized with $\mathrm{Na}_{2} \mathrm{CO}_{3}$, acidified with dil. acetic acid and treated with excess KI. The liberated iodine requires 11.3 mL of $0.05 \mathrm{M} \mathrm{Na}_{2} \mathrm{~S}_{2} \mathrm{O}_{3}$ solution for complete reduction. Find out the molar ratio of $\mathrm{Cu}^{2+}$ to $\mathrm{C}_{2} \mathrm{O}_{4}^{2-}$ in the compound. Write down the balanced redox reactions involved in the above titrations.
[1991-5 Marks]
91. A mixture of $\mathrm{H}_{2} \mathrm{C}_{2} \mathrm{O}_{4}$ (oxalic acid) and $\mathrm{NaHC}_{2} \mathrm{O}_{4}$ weighing 2.02 g was dissolved in water and solution made upto one litre. Ten millilitres of the solution required 3.0 mL . of 0.1 N sodium hydroxide solution for complete neutralization. In another experiment, 10.0 mL . of the same solution, in hot dilute sulphuric acid medium. require 4.0 mL . of 0.1 N potassium permanganate solution for complete reaction. Calculate the amount of $\mathrm{H}_{2} \mathrm{C}_{2} \mathrm{O}_{4}$ and $\mathrm{NaHC}_{2} \mathrm{O}_{4}$ in the mixture.
[1990-5 Marks]
92. A solid mixture $(5.0 \mathrm{~g})$ consisting of lead nitrate and sodium nitrate was heated below $600^{\circ} \mathrm{C}$ until the weight of the residue was constant. If the loss in weight is 28.0 per cent, find the amount of lead nitrate and sodium nitrate in the mixture.
[1990-4 Marks]
93. An equal volume of a reducing agent is titrated separately with $1 \mathrm{M} \mathrm{KMnO}_{4}$ in acid neutral and alkaline media. The volumes of $\mathrm{KMnO}_{4}$ required are 20 mL . in acid, 33.4 mL in neutral and 100 mL . in alkaline media. Find out the oxidation state of manganese in each reduction product. Give the balanced equations for all the three half reactions. Find out the volume of $1 \mathrm{M}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$ consumed; if the same volume of the reducing agent is titrated in acid medium.
[1989-5 Marks]
94. A sugar syrup of weight 214.2 g contains 34.2 g of sugar $\left(\mathrm{C}_{12} \mathrm{H}_{22} \mathrm{O}_{11}\right)$. Calculate : (i) molal concentration and (ii) mole fraction of sugar in the syrup.
[1988-2 Marks]
95. (i) What is the weight of sodium bromate and molarity of solution necessary to prepare 85.5 mL of 0.672 N solution when the half-cell reaction is

$$
\mathrm{BrO}_{3}^{-}+6 \mathrm{H}^{+}+6 \mathrm{e}^{-} \rightarrow \mathrm{Br}^{-}+3 \mathrm{H}_{2} \mathrm{O}
$$

(ii) What would be the weight as well as molarity if the half-cell reaction is :

$$
2 \mathrm{BrO}_{3}^{-}+12 \mathrm{H}^{+}+10 \mathrm{e}^{-} \rightarrow \mathrm{Br}_{2}+6 \mathrm{H}_{2} \mathrm{O}
$$

[1987-5 Marks]
96. Five mL of 8 N nitric acid, 4.8 mL of 5 N hydrochloric acid and a certain volume of 17 M sulphuric acid are mixed together and made upto 2 litre. Thirty mL of this acid mixture exactly neutralise 42.9 mL of sodium carbonate solution containing one gram of $\mathrm{Na}_{2} \mathrm{CO}_{3} \cdot 10 \mathrm{H}_{2} \mathrm{O}$ in 100 mL of water. Calculate the amount in gram of the sulphate ions in solution.
[1985-4 Marks]
97. $2.68 \times 10^{-3}$ moles of a solution containing an ion $A^{n+}$ require $1.61 \times 10^{-3}$ moles of $\mathrm{MnO}_{4}^{-}$for the oxidation of $A^{n+}$ to $A \mathrm{O}_{3}^{-}$in acid medium. What is the value of $n$ ?
[1984-2 Marks]
98. The density of a 3 M sodium thiosulphate solution $\left(\mathrm{Na}_{2} \mathrm{~S}_{2} \mathrm{O}_{3}\right)$ is 1.25 g per mL . Calculate (i) the percentage by weight of sodium thiosulphate, (ii) the mole fraction of sodium thiosulphate and (iii) the molalities of $\mathrm{Na}^{+}$and $\mathrm{S}_{2} \mathrm{O}_{3}{ }^{2-}$ ions.
[1983-5 Marks]
99. 4.08 g of a mixture of BaO and an unknown carbonate $\mathrm{MCO}_{3}$ was heated strongly. The residue weighed 3.64 g . This was dissolved in 100 mL of 1 N HCl . The excess acid required 16 mL of 2.5 N NaOH solution for complete neutralization. Identify the metal $M$. [1983-4 Marks] (At. wt. $\mathrm{H}=1, \mathrm{C}=12, \mathrm{O}=16, \mathrm{Cl}=35.5, \mathrm{Ba}=138$ )
100. 3 g of a salt of molecular weight 30 is dissolved in 250 g of water. The molality of the solution is ..... . [1983-1 Mark]
101. (i) A sample of $\mathrm{MnSO}_{4} \cdot 4 \mathrm{H}_{2} \mathrm{O}$ is strongly heated in air. The residue is $\mathrm{Mn}_{3} \mathrm{O}_{4}$.
(ii) The residue is dissolved in 100 mL of $0.1 \mathrm{~N} \mathrm{FeSO}_{4}$ containing dilute $\mathrm{H}_{2} \mathrm{SO}_{4}$.
(iii) The solution reacts completely with 50 mL of $\mathrm{KMnO}_{4}$ solution.
(iv) 25 mL of the $\mathrm{KMnO}_{4}$ solution used in step (iii) requires 30 mL of $0.1 \mathrm{~N} \mathrm{FeSO}_{4}$ solution for complete reaction. Find the amount of $\mathrm{MnSO}_{4} \cdot 4 \mathrm{H}_{2} \mathrm{O}$ present in the sample.
[1980]
102. (a) One litre of a sample of hard water contains 1 mg of $\mathrm{CaCl}_{2}$ and 1 mg of $\mathrm{MgCl}_{2}$. Find the total hardness in terms of parts of $\mathrm{CaCO}_{3}$ per $10^{6}$ parts of water by weight.
(b) A sample of hard water contains 20 mg of $\mathrm{Ca}^{++}$ions per litre. How many milli-equivalent of $\mathrm{Na}_{2} \mathrm{CO}_{3}$ would be required to soften 1 litre of the sample?
(c) 1 g of Mg is burnt in a closed vessel which contains $0.5 \mathrm{~g}^{\text {of }}{ }_{2}$.
(i) Which reactant is left in excess?
(ii) Find the weight of the excess reactants?
(iii) How may milliliters of $0.5 \mathrm{NH}_{2} \mathrm{SO}_{4}$ will dissolve the residue in the vessel.
[1980]
103. A hydrocarbon contains 10.5 g of carbon per gram of hydrogen. 1 litre of the vapour of the hydrocarbon at 127 ${ }^{\circ} \mathrm{C}$ and 1 atmosphere pressure weighs 2.8 g . Find the molecular formula.
[1980]
104. A mixture contains NaCl and unknown chloride MCl .
(i) 1 g of this is dissolved in water. Excess of acidified $\mathrm{AgNO}_{3}$ solution is added to it. 2.567 g of white ppt. is formed.
(ii) 1 g of original mixture is heated to $300^{\circ} \mathrm{C}$. Some vapours come out which are absorbed in acidified $\mathrm{AgNO}_{3}$ solution, 1.341 g of white precipitate was obtained.
Find the molecular weight of unknown chloride. [1980]
105. 5 mL of a gas containing only carbon and hydrogen were mixed with an excess of oxygen $(30 \mathrm{~mL})$ and the mixture exploded by means of an electric spark. After the explosion, the volume of the mixed gases remaining was 25 mL . On
adding a concentrated solution of potassium hydroxide, the volume further diminished to 15 mL of the residual gas being pure oxygen. All volumes have been reduced to N.T.P. Calculate the molecular formula of the hydrocarbon gas.
[1979]
106. A solution contains $\mathrm{Na}_{2} \mathrm{CO}_{3}$ and $\mathrm{NaHCO}_{3} .10 \mathrm{~mL}$ of solution requires 2.5 mL of $0.1 \mathrm{M} \mathrm{H}_{2} \mathrm{SO}_{4}$ for neutralisation using phenolphthalein as an indicator. Methyl orange is then added when a further 2.5 mL of $0.2 \mathrm{M}_{2} \mathrm{SO}_{4}$ was required. Calculate the amount of $\mathrm{Na}_{2} \mathrm{CO}_{3}$ and $\mathrm{NaHCO}_{3}$ in one litre of the solution.
[1979]
107. One gram of an alloy of aluminium and magnesium when treated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen, collected over mercury at $0^{\circ} \mathrm{C}$ has a volume of 1.20 litres at 0.92 atm . pressure. Calculate the composition of the alloy. $[\mathrm{H}=1, \mathrm{Mg}=24, \mathrm{Al}=27]$
[1978]


## Answer Key

## Topic-1 : Measurement, Mole Concept and Percentage Composition

1. (d)
2. (c)
3. (a)
4. (c)
5. (b)
6. (d)
7. (c)
8. (d)
9. (d)
10. (d)
11. (a)
12. (d)
13. (b)
14. (a)
15. (a)
16. (c)
17. (c)
18. (56)
19. (59)
20. (12)
21. (25)
22. (25)
23. (3)
24. (46)
25. (2)
26. (18)
27. (5418)
28. (2)
29. (3)
30. (8)
31. (5)
32. (4)
33. (15.05)
34. (24)
35. $(4.14 \mathrm{~g})$
36. (Carbon $(\mathrm{C}-12))$
37. $\left(6.02 \times 10^{24}\right)$
38. (b,c)
39. (d)

Topic-2 : Stoichiometry, Equivalent Concept, Neutralization and Redox Titration

1. (c)
2. (d)
3. (b)
4. (c)
5. (c)
6. (c)
7. (c)
8. (b)
9. (c)
10. (a)
11. (d)
12. (b)
13. (a)
14. (a)
15. (d)
16. (N)
17. (b)
18. (d)
19. (a)
20. (b)
21. (b)
22. (d)
23. (a)
24. (a)
25. (b)
26. (d)
27. (b)
28. (d)
29. (a)
30. (d)
31. (a)
32. (a)
33. (d)
34. (222)
35. (18)
36. (100)
37. (224)
38. (36)
39. (11)
40. (1)
41. (44)
42. (4)
43. (227)
44. (1362)
45. (150)
46. (200)
47. (15)
48. (4)
49. (46)
50. (2)
51. (46)
52. (3810)
53. (3)
54. (1143)
55. ( 0 )
56. (13)
57. (18)
58. (4)
59. (525)
60. (13)
61. (2)
62. (50)
63. (3400)
64. (47)
65. (10.00) 66. (2130)
66. (14.00)
67. (1.875)
68. (18.75)
69. (2992)
70. (6.47)
71. (8.09)
72. (85)
73. (6.0)
74. (10.43)76. (6.5)
75. (39.6)
76. (0.58)
77. (12.15)8
78. (4.87)
79. (59.33)
80. (b)
81. (55.55)
