1

Some Basic Concepts of Chemistry

TOPIC 1 Significant Figures, Laws of Chemical Combinations and Mole Concept

1. A solution of two components containing n_1 moles of the 1st component and n_2 moles of the 2nd component is prepared. M_1 and M_2 are the molecular weights of component 1 and 2 respectively. If d is the density of the solution in g mL^{-1}, C_2 is the molarity and x_2 is the mole fraction of the 2nd component, then C_2 can be expressed as: **[Sep. 06, 2020 (I)]**

(a) $C_2 = \dfrac{1000\, x_2}{M_1 + x_2(M_2 - M_1)}$

(b) $C_2 = \dfrac{d\, x_2}{M_2 + x_2(M_2 - M_1)}$

(c) $C_2 = \dfrac{1000\, d\, x_2}{M_1 + x_2(M_2 - M_1)}$

(d) $C_2 = \dfrac{d\, x_1}{M_2 + x_2(M_2 - M_1)}$

2. The molarity of HNO_3 in a sample which has density 1.4 g/mL and mass percentage of 63% is ______. (Molecular Weight of HNO_3 = 63) **[NV, Jan. 09, 2020 (I)]**

3. Amongst the following statements, that which was not proposed by Dalton was: **[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.

4. The percentage composition of carbon by mole in methane is : **[April 8, 2019 (II)]**

(a) 75% (b) 80% (c) 25% (d) 20%

5. 8 g of NaOH is dissolved in 18 g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solution respectively are : **[Jan. 12, 2019 (II)]**

(a) 0.2, 22.20 (b) 0.2, 11.11
(c) 0.167, 11.11 (d) 0.167, 22.20

6. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is: **[Jan. 10, 2019 (II)]**

(a) 136.8 g (b) 17.1 g (c) 68.4 g (d) 34.2 g

7. An unknown chlorohydrocarbon has 3.55% of chlorine. If each molecule of the hydrocarbon has one chlorine atom only, chlorine atoms present in 1g of chlorohydrocarbon are:
(Atomic wt. of Cl = 35.5u; Avogadro constant = 6.023×10^{23} mol^{-1}) **[Online April 16, 2018]**

(a) 6.023×10^{9} (b) 6.023×10^{23}
(c) 6.023×10^{21} (d) 6.023×10^{20}

8. Excess of NaOH (aq) was added to 100 mL of $FeCl_3$ (aq) resulting into 2.14 g of $Fe(OH)_3$. The molarity of $FeCl_3$ (aq) is : **[Online April 8, 2017]**
(Given molar mass of Fe=56 g mol^{-1} and molar mass of Cl=35.5 g mol^{-1})

(a) 0.2 M (b) 0.3 M (c) 0.6 M (d) 1.8 M

9. 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 : **[Online April 9, 2016]**

(a) Isobutane (b) Ethane
(c) Butane (d) Propane

10. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3^-\,Na^+$ (Mol. wt. 206. What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ? **[2015]**

(a) $\dfrac{2}{309}$ (b) $\dfrac{1}{412}$ (c) $\dfrac{1}{103}$ (d) $\dfrac{1}{206}$

11. Dissolving 120 g of a compound of (mol. wt. 60) in 1000 g of water gave a solution of density 1.12 g/mL. The molarity of the solution is: **[Online April 9, 2014]**

(a) 1.00 M (b) 2.00 M (c) 2.50 M (d) 4.00 M

12. The amount of oxygen in 3.6 moles of water is: **[Online April 9, 2014]**
(a) 115.2 g (b) 57.6 g (c) 28.8 g (d) 18.4 g

13. The density of 3M solution of sodium chloride is 1.252 g mL^{-1}. The molality of the solution will be :
(molar mass, NaCl = 58.5 g mol^{-1}) **[Online April 22, 2013]**
(a) 260 m (b) 2.18 m (c) 2.79 m (d) 3.00 m

14. Number of atoms in the following samples of substances is the largest in : **[Online April 23, 2013]**
(a) 4.0 g of hydrogen (b) 71.0 g of chlorine
(c) 127.0 g of iodine (d) 48.0 g of magnesium

15. 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration ? **[Online April 25, 2013]**
(a) 0.57 (M) (b) 5.7 (M) (c) 11.4 (M) (d) 1.14 (M)

16. 6 litres of an alkene require 27 litres of oxygen at constant temperature and pressure for complete combustion. The alkene is : **[Online April 25, 2013]**
(a) Ethene (b) Propene (c) 1-Butene (d) 2 -Butene

17. The concentrated sulphuric acid that is peddled commercial is 95% H_2SO_4 by weight. If the density of this commercial acid is 1.834 g cm^{-3}, the molarity of this solution is **[Online May 7, 2012]**
(a) 17.8 M (b) 12.0 M (c) 10.5 M (d) 15.7 M

18. The ratio of number of oxygen atoms (O) in 16.0 g ozone (O_3), 28.0 g carbon monoxide (CO) and 16.0 oxygen (O_2) is
(Atomic mass : C = 12, O = 16 and Avogadro's constant $N_A = 6.0 \times 10^{23}\ mol^{-1}$) **[Online May 7, 2012]**
(a) 3 : 1 : 2 (b) 1 : 1 : 2 (c) 3 : 1 : 1 (d) 1 : 1 : 1

19. The ppm level of F^- in a 500 g sample of a tooth paste containing 0.2 g F^- is **[Online May 12, 2012]**
(a) 400 (b) 1000 (c) 250 (d) 200

20. 5 g of benzene on nitration gave 6.6 g of nitrobenzene. The theoretical yield of the nitrobenzene will be **[Online May 12, 2012]**
(a) 4.5 g (b) 5.6 g (c) 8.09 g (d) 6.6 g

21. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms? **[2006]**
(a) 1.25×10^{-2} (b) 2.5×10^{-2}
(c) 0.02 (d) 3.125×10^{-2}

22. Density of a 2.05M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is **[2006]**
(a) 2.28 mol kg^{-1} (b) 0.44 mol kg^{-1}
(c) 1.14 mol kg^{-1} (d) 3.28 mol kg^{-1}

23. 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 ? **[2005]**
(a) 2.70 M (b) 1.344 M (c) 1.50 M (d) 1.20 M

24. If we consider that 1/6, in place of 1/12, mass of carbon atom as the relative atomic mass unit, the mass of one mole of the substance will **[2005]**
(a) be a function of the molecular mass of the substance
(b) remain unchanged
(c) increase two fold
(d) decrease twice

25. 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is **[2004]**
(a) 0.02 M (b) 0.01 M (c) 0.001 M (d) 0.1 M
(Avogadro constant, $N_A = 6.02 \times 10^{23}\ mol^{-1}$)

26. 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 **[2003]**
(a) 0.14 (b) 0.28 (c) 0.35 (d) 0.07

27. With increase of temperature, which of these changes? **[2002]**
(a) molality (b) weight fraction of solute
(c) molarity (d) mole fraction.

28. Number of atoms in 558.5 gram Fe (at. wt. of Fe = 55.85 g mol^{-1}) is **[2002]**
(a) twice that in 60 g carbon
(b) 6.023×10^{22}
(c) half that in 8 g He
(d) $558.5 \times 6.023 \times 10^{23}$

TOPIC 2 Percent Composition and Empirical Formula

29. The average molar mass of chlorine is 35.5 g mol^{-1}. The ratio of ^{35}Cl to ^{37}Cl in naturally occrring chlorine is close to: **[Sep. 06, 2020 (II)]**
(a) 4 : 1 (b) 3 : 1 (c) 2 : 1 (d) 1 : 1

30. The ratio of the mass percentages of 'C & H' and 'C & 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 ________. **[NV, Sep. 02, 2020 (II)]**

31. The ratio of mass percent of C and H of an organic compound ($C_XH_YO_Z$) is 6 : 1. If one molecule of the above compound ($C_XH_YO_Z$) contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_XH_YO_Z$ is : **[2018]**
(a) $C_3H_6O_3$ (b) C_2H_4O (c) $C_3H_4O_2$ (d) $C_2H_4O_3$

32. The most abundant elements by mass in the body of a healthy human adult are : **[2017]**
Oxygen (61.4%) ; Carbon (22.9%), Hydrogen (10.0%) ; and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is
(a) 15 kg (b) 37.5 kg (c) 7.5 kg (d) 10 kg

33. What quantity (in mL) of a 45% acid solution of a mono-protic strong acid must be mixed with a 20% solution of the same acid to produce 800 mL of a 29.875% acid solution? **[Online April 9, 2017]**
(a) 320 (b) 325 (c) 316 (d) 330

34. At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% 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: **[2016]**
(a) C_4H_8 (b) C_4H_{10} (c) C_3H_6 (d) C_3H_8

35. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is : **[2015]**
(at. mass Ag = 108; Br = 80)
(a) 48 (b) 60 (c) 24 (d) 36

36. Choose the incorrect formula out of the four compounds for an element X below : **[Online April 11, 2015]**
(a) X_2O_3 (b) X_2Cl_3 (c) $X_2(SO_4)_3$ (d) XPO_4

37. A gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of hydrogen. The density of the compound relative to hydrogen is 16. The molecular formula of the compound is: **[Online April 11, 2014]**
(a) NH_2 (b) N_3H (c) NH_3 (d) N_2H_4

38. The amount of $BaSO_4$ formed upon mixing 100 mL of 20.8% $BaCl_2$ solution with 50 mL of 9.8% H_2SO_4 solution will be: **[Online April 12, 2014]**
(Ba = 137, Cl = 35.5, S = 32, H = 1 and O = 16)
(a) 23.3 g (b) 11.65 g (c) 30.6 g (d) 33.2 g

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 : **[2013]**
(a) C_2H_4 (b) C_3H_4 (c) C_6H_5 (d) C_7H_8

40. A transition metal *M* forms a volatile chloride which has a vapour density of 94.8. If it contains 74.75% of chlorine the formula of the metal chloride will be **[Online May 26, 2012]**
(a) MCl_3 (b) MCl_2 (c) MCl_4 (d) MCl_5

41. 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 **[2002]**
(a) $C_2H_6N_2$ (b) C_3H_4N (c) $C_6H_8N_2$ (d) $C_9H_{12}N_3$.

TOPIC 3 Stoichiometric Calculations

42. The minimum number of moles of O_2 required for complete combustion of 1 mole of propane and 2 moles of butane is ______. **[NV, Sep. 05, 2020 (I)]**

43. The volume, in mL, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is _________. (Molar mass of Fe = 56 g mol^{-1}) **[NV, Sep. 05, 2020 (II)]**

44. A 20.0 mL solution containing 0.2 g impure H_2O_2 reacts completely with 0.316 g of $KMnO_4$ in acid solution. The purity of H_2O_2 (in %) is _________ (mol. wt. of H_2O_2 = 34; mol. wt. of $KMnO_4$ = 158) **[NV, Sep. 04, 2020 (I)]**

45. The mass of ammonia in grams produced when 2.8 kg of dinitrogen quantitatively reacts with 1 kg of dihydrogen is __________. **[NV, Sep. 04, 2020 (I)]**

46. A 100 mL solution was made by adding 1.43 g of $Na_2CO_3 \cdot xH_2O$. The normality of the solution is 0.1 N. The value of *x* is ____________. **[NV, Sep. 04, 2020 (II)]**
(The atomic mass of Na is 23 g/ mol)

47. The mole fraction of glucose ($C_6H_{12}O_6$) in an aqueous binary solution is 0.1. The mass percentage of water in it, to the nearest integer, is ________. **[NV, Sep. 03, 2020 (I)]**

48. 6.023×10^{22} molecules are present in 10 g of a substance '*x*'. The molarity of a solution containing 5 g of substance '*x*' in 2 L solution is __________ $\times 10^{-3}$. **[NV, Sep. 03, 2020 (II)]**

49. The volume (in mL) of 0.1 N NaOH required to neutralise 10 mL of 0.1 N phosphinic acid is _________. **[NV, Sep. 03, 2020 (II)]**

50. 10.30 mg of O_2 is dissolved into a liter of sea water of density 1.03 g/mL. The concentration of O_2 in ppm is _____. **[NV, Jan. 09, 2020 (II)]**

51. Ferrous sulphate heptahydrate is used to fortify foods with iron. The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat is ______. Atomic weight: Fe = 55.85; S = 32.00; O = 16.00 **[NV, Jan. 08, 2020 (I)]**

52. $NaClO_3$ is used, even in spacecrafts, to produce O_2. The daily consumption of pure O_2 by a person is 492 L at 1 atm, 300 K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K? ________.
$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaCl(s) + FeO(s)$ R = 0.082 L atm $mol^{-1} K^{-1}$ **[NV, Jan. 08, 2020 (II)]**

53. The ammonia (NH_3) released on quantitative reaction of 0.6 g urea (NH_2CONH_2) with sodium hydroxide (NaOH) can be neutralized by: **[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

54. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of A (M_A) and molar mass of B (M_B) in kg mol^{-1} are: **[April 12, 2019 (I)]**
(a) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$
(b) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$
(c) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$
(d) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$

55. The minimum amount of $O_2(g)$ consumed per gram of reactant is for the reaction : (Given atomic mass : Fe = 56, O = 16, Mg = 24, P = 31, C = 12, H = 1) **[April 10, 2019 (II)]**
(a) $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$
(b) $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$
(c) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
(d) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

56. For a reaction,
$N_2(g) + 3H_2(g) \rightarrow 2\,NH_3(g)$; identify dihydrogen ($H_2$) as a limiting reagent in the following reaction mixtures. **[April 9, 2019 (I)]**
(a) 56 g of N_2 + 10 g of H_2 (b) 35 g of N_2 + 8 g of H_2
(c) 28 g of N_2 + 6 g of H_2 (d) 14 g of N_2 + 4 g of H_2

57. 0.27 g of a long chain fatty acid was dissolved in 100 cm^3 of hexane. 10 mL of this solution was added dropwise to the surface of water in a round watch glass. Hexane evaporates and a monolayer is formed. The distance from edge to centre of the watch glass is 10 cm. What is the height of the monolayer?
[Density of fatty acid = 0.9 g cm^{-3} ; $\pi = 3$] **[April 8, 2019 (II)]**
(a) 10^{-6} m (b) 10^{-8} m (c) 10^{-2} m (d) 10^{-4} m

58. 50 mL of 0.5 M oxalic acid is needed to neutralize 25 mL of sodium hydroxide solution. The amount of NaOH in 50 mL of the given sodium hydroxide solution is: **[Jan. 12, 2019 (I)]**
(a) 40 g (b) 10 g (c) 20 g (d) 80 g

59. A 10 mg effervescent tablet containing sodium bicarbonate and oxalic acid releases 0.25 mL of CO_2 at T = 298.15K and P = 1 bar. If molar volume of CO_2 is 25.0 L under such condition, what is the percentage of sodium bicarbonate in each tablet ?
[Molar mass of $NaHCO_3$ = 84 g mol^{-1}] **[Jan. 11, 2019 (I)]**
(a) 0.84 (b) 33.6 (c) 16.8 (d) 8.4

60. 25 mL of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqueous NaOH solution? **[Jan. 11, 2019 (II)]**
(a) 25 mL (b) 75 mL (c) 50 mL (d) 12.5 mL

61. For the following reaction the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is: **[Jan. 9, 2019 (II)]**
$2C_{57}H_{110}O_6(s) + 163\,O_2(g) \rightarrow 114CO_2(g) + 110\,H_2O(l)$
(a) 490 g (b) 445 g (c) 495 g (d) 890 g

62. A sample of $NaClO_3$ 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 AgCl = 143.5 g mol^{-1}) **[Online April 15, 2018 (I)]**
(a) 0.35 (b) 0.54 (c) 0.41 (d) 0.48

63. 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is : **[2017]**
(a) 1186 (b) 84.3 (c) 118.6 (d) 11.86

64. The amount of arsenic pentasulphide that can be obtained when 35.5 g arsenic acid is treated with excess H_2S in the presence of conc. HCl (assuming 100% conversion) is : **[Online April 9, 2016]**
(a) 0.25 mol (b) 0.50 mol (c) 0.333 mol (d) 0.125 mol

65. The volume of 0.1 N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of OH^- in aqueous solution is : **[Online April 10, 2016]**
(a) 400 mL (b) 600 mL (c) 200 mL (d) 800 mL

66. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is: **[2015]**
(a) 42 mg (b) 54 mg (c) 18 mg (d) 36 mg

67. 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, Ba = 137 amu, Cl = 35.5 amu) **[Online April 10, 2015]**
(a) $BaCl_2.4H_2O$ (b) $BaCl_2.3H_2O$
(c) $BaCl_2.H_2O$ (d) $BaCl_2.2H_2O$

68. $A + 2B + 3C \rightleftharpoons AB_2C_3$
Reaction of 6.0 g of A, 6.0×10^{23} atoms of B, and 0.036 mol of C yields 4.8 g of compound AB_2C_3. If the atomic mass of A and C are 60 and 80 amu, respectively, the atomic mass of B is (Avogadro no. = 6×10^{23}): **[Online April 11, 2015]**
(a) 50 amu (b) 60 amu (c) 70 amu (d) 40 amu

69. An aqueous solution of oxalic acid dihydrate contains its 6.3 g in 250 mL. The volume of 0.1 N NaOH required to completely neutralize 10 mL of this solution **[Online May 12, 2012]**
(a) 4 mL (b) 20 mL (c) 2 mL (d) 40 mL

70. 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 : **[2011RS]**
(a) 5.55×10^{-4} m (b) 33.3 m
(c) 3.33×10^{-2} m (d) 0.555 m

71. 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 **[2007]**
(a) 1.45 (b) 1.64 (c) 1.88 (d) 1.22

72. In the reaction, **[2007]**
$2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^-(aq) + 3H_2(g)$
(a) 11.2 L $H_2(g)$ at STP is produced for every mole of HCl(aq) consumed
(b) 6 L HCl(aq) is consumed for every 3 L of $H_2(g)$ produced
(c) 33.6 L $H_2(g)$ is produced regardless of temperature and pressure for every mole of Al that reacts
(d) 67.2 $H_2(g)$ at STP is produced for every mole of Al that reacts.

73. 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 **[2004]**
(a) 40 mL (b) 20 mL (c) 10 mL (d) 60 mL

74. 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 ? **[2003]**
(a) 67.2 L (b) 44.8 L (c) 22.4 L (d) 89.6 L

Hints & Solutions

1. (c)

	1st component	2nd component
mole	n_1	n_2
m.w	M_1	M_2
mass	n_1M_1	n_2M_2

[$\because$ mass = mole × m.w.]

Mass of solution $= n_1M_1 + n_2M_2$

Mole fraction of the 2nd component $(x_2) = \dfrac{n_2}{n_1+n_2}$

$$\Rightarrow n_1 = \frac{n_2(1-x_2)}{x_2}$$

Mass of solution $= n_1M_1 + n_2M_2$

$$= \frac{n_2M_1(1-x_2)}{x_2} + n_2M_2$$

$$= \frac{n_2}{x_2}[M_2x_2 - x_2M_1 + M_1]$$

Volume of solution $= \dfrac{n_2[M_2x_2 - x_2M_1 + M_1]}{1000dx_2}$

$$C_2 = \frac{1000n_2dx_2}{n_2[M_2x_2 - x_2M_1 + M_1]}$$

$$\Rightarrow C_2 = \frac{1000dx_2}{M_1 + x_2(M_2 - M_1)}$$

2. (14.00)

Mass percent of HNO_3 = 63

Thus, 100 g of nitric acid solution contains 63 g of nitric acid by mass.

No. of moles $= \dfrac{63\,g}{63\,g\,mol^{-1}} = 1$

Volume of 100 g of nitric acid solution

$$= \frac{Mass}{Density} = \frac{100\ g}{1.4\ g/mL} = 71.4\ mL$$

$$Molarity = \frac{No.\ of\ moles}{volume\ (mL)} \times 1000$$

$$= \frac{1}{71.4} \times 1000 = 14\ M$$

3. (c) Except (3) all postulates was given by the Dalton.

4. (d) CH_4 has one atom of carbon among 5 atoms (1C + 4H)

$\therefore$ Mole % of C $= \dfrac{1}{5} \times 100 = 20\%$

5. (c) No. of moles of H_2O $(n_1) = \dfrac{18}{18} = 1$

No. of moles of NaOH $(n_2) = \dfrac{8}{40} = \dfrac{1}{5}$

Mole fraction of NaOH $= \dfrac{n_2}{n_2+n_1} = \dfrac{\frac{1}{5}}{\frac{1}{5}+1} = 0.167$

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

$$= = \frac{1}{5} \times \frac{1000}{18} = 11.11\ m$$

6. (c) As we know,

$$Molarity = \frac{No. of\ moles\ of\ sugar}{Volume\ of\ solution\ (in\ L)}$$

$$\Rightarrow 0.1 = \frac{No. of\ moles\ of\ sugar}{2L}$$

So, no. of moles of sugar = 0.2 mole

$\therefore$ Mass of sugar = No. of moles of sugar × Molar mass of sugar

$= 0.2 \times 342 = 68.4$ g

7. (d) Given percentage of chlorine in an hydrocarbon = 3.55%

i.e.,

100 g of chlorohydrocarbon has 3.55 g of chlorine.

1 g of chlorohydrocarbon will have $\dfrac{3.55}{100} = 0.0355$ g of chlorine.

Atomic wt. of Cl = 35.5 g/mol

Number of moles of Cl $= \dfrac{0.0355\ g}{35.5\ g/mol} = 0.001$ mol

Number of atoms of Cl $= 0.001\ mol \times 6.023 \times 10^{23}\ mol^{-1}$
$= 6.023 \times 10^{20}$

8. (a) $FeCl_3$ (aq.) + 3NaOH (aq.) $\longrightarrow$ $Fe(OH)_3$ (s) + 3NaCl (aq.)

($FeCl_3$: limiting reagent; NaOH: (Excess amount) Not behave as limiting reagent)

$$Moles\ of\ Fe(OH)_3 = \frac{weight\ in\ g}{Mol.\ mass\ of\ Fe(OH)_3}$$

$$= \frac{2.14\ g}{107\ g/mol} = 0.02\ mol.$$

1.0 mole of $Fe(OH)_3$ is obtained from = 1.0 mole of $FeCl_3$

0.02 mole of $Fe(OH)_3$ will be obtained from = 0.02 mole $FeCl_3$

$$\text{Molarity} = \frac{\text{No. of moles}}{\text{Volume in L}} = \frac{0.02 \text{ mole}}{0.1 \text{ L}} = 0.2 \text{ M}$$

9. **(d)** Since the compound undergoing combustion is an alkane. Hence the combustion reaction can be written as

$$\underset{5L}{C_nH_{2n+2}} + \underset{25L}{\left(\frac{3n+1}{2}\right)O_2} \longrightarrow nCO_2 + (n+1)H_2O$$

Since volumes are measured at constant T & P, hence according to Avogadro's law

Volume $\propto$ mole

1 L alkane requires $\frac{3n+1}{2}$ L of O_2

5 L alkane requires 25 L of O_2

$$\frac{1}{5} = \frac{\frac{3n+1}{2}}{25}$$

$\therefore n = 3$

Hence alkane is propane (C_3H_8).

10. **(b)** 2 mole of water softner require 1 mole of Ca^{2+} ion

So, 1 mole of water softner require $\frac{1}{2}$ mole of Ca^{2+} ion

Thus, $\frac{1}{2 \times 206} = \frac{1}{412}$ mol/g will be maximum uptake.

11. **(b)** Given

mass of solute $(w) = 120$ g

mass of solvent $(w) = 1000$ g

Mol. mass of solute = 60 g

density of solution = 1.12 g/ mL

From the given data,

Mass of solution = 1000 + 120 = 1120 g

$\because \quad d = \frac{\text{Mol. mass}}{V}$ or $V = \frac{\text{Mol. mass}}{d}$

Volume of solution $V = \frac{1120}{1.12} = 1000$ mL or = 1 litre

$$\text{Now molarity (M)} = \frac{w}{\text{Mol. mass} \times V(L)} = \frac{120}{60 \times 1} = 2M$$

12. **(b)** 1 mole of water contains = 16 g of oxygen

$\therefore$ 3.6 mole of water contains

$= 16 \times 3.6 = 57.6$ g

13. **(c)** The relation between molarity (M) and molality (m) is

$d = M\left(\frac{1}{m} + \frac{M_2}{1000}\right)$, M_2 = Mol. mass of solute

On putting value

$$1.252 = 3\left(\frac{1}{m} + \frac{58.5}{1000}\right)$$

On solving m = 2.79

14. **(a)** 4g of hydrogen = 4 mole of hydrogen

$= 4 \times 6.023 \times 10^{23}$ atoms

$$71.0 \text{ g of chlorine} = \frac{71.0}{71.0} = 1 \text{ moles of chlorine}$$

$= 6.023 \times 10^{23}$ atoms

$$127 \text{ g of iodine} = \frac{127}{254} \text{ mol}$$

$$= 6.023 \times 10^{23} \times \frac{1}{2} \text{ atoms}$$

$$48.0 \text{ g of magnesium} = \frac{48.0}{24.0} \text{ mol}$$

$= 2 \times 6.023 \times 10^{23}$ atoms

$\therefore$ 4.0 g H_2 has largest number of atoms.

15. **(a)** From molarity equation

$$M_1V_1 + M_2V_2 = MV_{(total)}$$

$$M = \frac{M_1V_1 + M_2V_2}{\text{Total}} = \frac{2 \times 10 + 0.5 \times 200}{210}$$

$$M = \frac{120}{210} = 0.57 \text{ M}$$

16. **(b)** General combustion reaction for hydrocarbons is

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

For alkane, x = n and y = 2n

$$C_nH_{2n} + \left(n + \frac{2n}{4}\right)O_2 \longrightarrow nCO_2 + \frac{2n}{2}H_2O$$

$$C_nH_{2n} + \frac{3n}{2}O_2 \longrightarrow nCO_2 + nH_2O$$

$\therefore$ 1 mole alkene reacts with $\frac{3n}{2}$ mole of O_2

moles $\propto$ volume (at constant temp & spress.)

1 L alkene requires $\frac{3n}{2}$ L of O_2

6 L alkene requires 27 L of O_2

$$\frac{1}{6} = \frac{\frac{3n}{2}}{27}$$

$$3n = \frac{54}{6}$$

$n = 3$

Hence alkene is propene (C_3H_6)

17. **(a)** 95% H_2SO_4 by weight means 100 g H_2SO_4 solution contains 95 g H_2SO_4 by mass.

Molar mass of H_2SO_4 = 98 g mol^{-1}

$$\text{Moles in 95 g } H_2SO_4 = \frac{95}{98} = 0.969 \text{ mol}$$

Volume of 100 g H_2SO_4 solution

$$= \frac{\text{mass}}{\text{density}} = \frac{100 \text{ g}}{1.834 \text{ g cm}^{-3}}$$

$= 54.52$ cm^3 = 54.52×10^{-3} L

$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution in L}}$$

$$= \frac{0.969}{54.52 \times 10^{-3}} = 17.8\text{ M}$$

18. **(d)** $16.0\text{g } O_3 = \frac{16}{48}\text{mol}$

$$= \frac{16}{48} \times 6.023 \times 10^{23} \text{ molecules}$$

$$= 3 \times \frac{16}{48} \times 6.023 \times 10^{23} \text{ atoms}$$

$$= 6.023 \times 10^{23} \text{ atoms}$$

$$28.0 \text{ g } CO = \frac{28}{28} \text{ mol} = 1 \text{ mol}$$

$= 1 \times 6.023 \times 10^{23}$ molecules
$= 1 \times 6.023 \times 10^{23}$ atoms
$= 6.023 \times 10^{23}$ atoms

$$16.0 \text{ g } O_2 = \frac{16}{32} \text{ mol}$$

$$= \frac{16}{32} \times 6.023 \times 10^{23} \text{ molecules}$$

$$= 2 \times \frac{16}{32} \times 6.023 \times 10^{23} \text{ atoms}$$

$= 6.023 \times 10^{23}$ atoms

Therefore, the ratio is
$6.023 \times 10^{23} : 6.023 \times 10^{23} : 6.023 \times 10^{23}$
i.e. 1 : 1 : 1

19. **(a)** $\text{ppm} = \frac{\text{mass of solute (g)}}{\text{mass of solution (g)}} \times 10^6$

$$= \frac{0.2}{500} \times 10^6 = 400 \text{ ppm}$$

20. **(c)** $\underset{78g}{C_6H_6} + HNO_3 \longrightarrow \underset{123g}{C_6H_5NO_2} + H_2O$

Now since 78g of benzene on nitration give = 123g nitrobenzene

hence 5g of benzene on nitration give

$$= \frac{123}{78} \times 5 = 7.88g$$

The nearest answer is (c) i.e. theoritical yield = 7.88g

21. **(d)** 1 Mole of $Mg_3(PO_4)_2$ contains 8 moles 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 $Mg_3(PO_4)_2$

22. **(a)** Apply the formula $d = M\left(\frac{1}{m} + \frac{M_2}{1000}\right)$

$$\therefore 1.02 = 2.05\left(\frac{1}{m} + \frac{60}{1000}\right)$$

On solving we get, m = 2.288 mol/kg

23. **(b)** From the molarity equation

$$M_1V_1 + M_2V_2 = MV$$

Let M be the molarity of final mixture,

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

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

24. **(d)** 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 $\frac{1}{6}$ in place of $\frac{1}{12}$ 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.

25. **(b)** Moles of urea present in 100 mL of sol.

$$= \frac{6.02 \times 10^{20}}{6.02 \times 10^{23}} \text{ mol}$$

$$\therefore M = \frac{6.02 \times 10^{20} \times 1000}{6.02 \times 10^{23} \times 100} = 0.01M$$

[$\because$ M = Moles of solute present in 1L of solution]

26. **(d)**

$Ba(OH)_2$	HCl
N_1V_1	$= N_2V_2$
$N_1 \times 25$	$= 0.1 \times 35$
N_1	$= 0.14$

Since, $Ba(OH)_2$ is diacid base

Hence $N = M \times 2$ or $M = \frac{N}{2}$

M = 0.07 M

27. **(c)** Among all the given options, molarity changes with temperature because the term molarity involves volume which increases on increasing temperature.

28. **(a)** Fe (No. of moles) $= \frac{558.5}{55.85} = 10$ mol

C (No. of moles) in 60 g of C = 60/12 = 5 mol.

29. **(b)**

	^{35}Cl	^{37}Cl
Molar ratio	x	$(1-x)$

$M_{avg.} = 35 \times x + 37(1-x) = 35.5$
$= 35x + 37(1-x) = 35.5$

$\Rightarrow 2x = 1.5$

$$x = \frac{3}{4}$$

So, ratio of $^{35}Cl : {}^{37}Cl = \frac{3}{4} \Big/ \frac{1}{4} = 3:1$.

30. (5)

Mass ratio of C : H is $4:1 \Rightarrow 12:3$ and

C : O is $3:4 \Rightarrow 12:16$

So,

	mass	mole	mole ratio
C	12	1	1
H	3	3	3
O	16	1	1

Empirical formula $\Rightarrow CH_3O$

As compound is saturated acyclic, so molecular formula is $C_2H_6O_2$.

$$\underset{2\text{ mole}}{C_2H_6O_2} + \underset{5\text{ mole}}{\frac{5}{2}O_2(g)} \longrightarrow 2CO_2\ (g) + 3H_2O\ (g)$$

$\therefore$ Number of moles of O_2 required to oxidise 2 moles of (X) = 5.

31. (d)

Element	Relative mass	Relative mole	Simplest whole number ratio
C	6	$\frac{6}{12}=0.5$	1
H	1	$\frac{1}{1}=1$	2

So, x = 1, y = 2

Equation for combustion of C_xH_y

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

Oxygen atoms required $= 2\left(x+\frac{y}{4}\right)$

As mentioned,

$$2\left(x+\frac{y}{4}\right) = 2z;\ \left(x+\frac{y}{4}\right) = z$$

Now putting the values of x and y

$$\Rightarrow \left(1+\frac{2}{4}\right) = z \quad \Rightarrow z = 1.5$$

$\therefore$ Molecule $(C_xH_yO_z)$ can be written as

$C_1H_2O_{3/2}$

$\Rightarrow C_2H_4O_3$

32. (c) Percentage (by mass) of elements given in the body of a healthy human adult is :-

Oxygen = 61.4%, Carbon = 22.9%,

Hydrogen = 10.0% and Nitrogen = 2.6%

$\because$ Total weight of person = 75 kg

$\therefore$ Mass due to ^1H is $= 75 \times \frac{10}{100} = 7.5\,kg$

If ^1H atoms are replaced by ^2H atoms.

Mass gain by person would be = 7.5 kg

33. (c) $\frac{V \times 45}{100} + \frac{(800-V)\times 20}{100} = \frac{800 \times 29.875}{100}$

$$\Rightarrow \frac{9V}{20} + 160 - \frac{V}{5} = 239 \Rightarrow V = 316$$

34. (N) $C_xH_y(g) + \left(\frac{4x+y}{4}\right)O_2(g) \longrightarrow xCO_2(g) + \frac{y}{2}H_2O(l)$

Volume of O_2 used $= \frac{20}{100} \times 375 = 75$ mL

Volume of air = 375 – 75 = 300 mL

Total volume of gases after combustion

= vol. of CO_2 + vol. of air = 330 mL

Volume of CO_2 = 330 – 300 = 30 mL

15 mL C_xH_y gives = 30 mL CO_2

1 mL C_xH_y gives $= \frac{30}{15} = 2$ mL CO_2

At constant T and P; Volume $\propto$ mole

$\therefore$ 1 mol C_xH_y = 2 mol CO_2

$x = 2$

$$\left(\frac{4x+y}{4}\right) = \frac{75}{15}$$

$4x + y = 20$

$y = 20 - 4 \times 2 = 12$

Hence, formula of the hydrocarbon is C_2H_{12}.

35. (c) Mass of substance = 250 mg = 0.250 g

Mass of AgBr = 141 mg = 0.141 g

1 mole of AgBr = 1 g atom of Br

188 g of AgBr = 80 g of Br

$\therefore$ 188 g of AgBr contain bromine = 80 g

0.141 g of AgBr contain bromine

$$= \frac{80}{188} \times 0.141 = 0.06\,g$$

0.06 g of bromine is present in 0.250 g of organic compound

$\therefore$ % of bromine $= \frac{0.06}{0.250} \times 100 = 24\%$

36. (b) $X_2O_3 \Rightarrow X^{3+}O^{2-}$

$X_2Cl_3 \Rightarrow X^{3+}Cl^{2-}$

$X_2(SO_4)_3 \Rightarrow X^{3+}SO_4^{\ 2-}$

$XPO_4 \Rightarrow X^{3+}PO_4^{\ 3-}$

Since Cl^{2-} does not exist. So, X_2Cl_3 is incorrect. The correct formula should be XCl_3.

37. **(d)** In an unknown compounds containing N and H given % of H = 12.5%

$\therefore$ % of N = 100 – 12.5 = 87.5%

Element	Percentage	Atomic ratio	Simple ratio
H	12.5%	$\frac{12.5}{1}=12.5$	$\frac{12.5}{6.25}=2$
N	87.5	$\frac{87.5}{14}=6.25$	$\frac{6.25}{6.25}=1$

Empirical formula = NH_2

Mol. wt = 2 × vapour density = 16 × 2 = 32.

Molecular formula = n × empirical formula mass

$$n=\frac{32}{16}=2$$

$\therefore$ Molecular formula of the compound will be $=(NH_2)_2$
$=N_2H_4$

38. **(b)** $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$

208 g 98 g 233 g 73 g

Mass of $BaCl_2$ in solution $=100\times\frac{20.8}{100}=20.8$ g

Mass of H_2SO_4 in solution $=50\times\frac{9.8}{100}\times4.9=4.9$ g

98 g of H_2SO_4 reacts with 208g $BaCl_2$

4.9 g H_2SO_4 will react with $\frac{208}{98}\times4.9=10.4$ g $BaCl_2$

H_2SO_4 reacts as a limiting reagent because $BaCl_2$ is given in excess

98 g H_2SO_4 produces 233 g $BaSO_4$

4.9 g H_2SO_4 will produce $\frac{233}{98}\times4.9=11.65$ g $BaSO_4$

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

$\therefore$ 0.72 g H_2O contains

$=\frac{2}{18}\times0.72\text{ g}=0.08\text{ g H}$

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

$\therefore$ 3.08 g CO_2 contains $=\frac{12}{44}\times3.08=0.84$ g 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. **(c)** 74.75% of chlorine means 74.75 g chlorine is present in 100 g of metal chloride.

Weight of metal = 100 – 74.75
= 25.25 g

$$\text{Equivalent weight}=\frac{\text{weight of metal}}{\text{weight of chlorine}}\times35.5$$

$$=\frac{25.25}{74.75}\times35.5=12$$

Valency of metal

$$=\frac{2\times\text{V.D.}}{\text{Equivalent wt. of metal}+35.5}$$

$$=\frac{2\times94.8}{12+35.5}=4$$

$\therefore$ Formula of metal chloride is MCl_4

Alternate method:

Mol. wt = 2 × vapour density
= 2 × 98.4 = 189.6 g

Since 74.75% is chlorine

therefore, 189.6 metal chloride contains

$=\frac{74.75}{100}\times189.6=141.72$ g chloride

Number of atoms of chloride $=\frac{141.72}{35.5}=3.99\approx4$

Hence, formula of metal chloride is MCl_4

41. **(c)**

Element	%	Relative no. of atoms	Simplest ratio of atoms
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

$(C_3H_4N)_n=108$

$(12\times3+4\times1+14)_n=108$

$(54)_n=108$

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

$\therefore$ Molecular formula = $C_6H_8N_2$

42. **(18)** Complete combustion of hydrocarbons can be represented by the following reaction.

$$C_xH_y+\left(x+\frac{y}{4}\right)O_2\longrightarrow xCO_2+\frac{y}{2}H_2O$$

For propane combustion reaction is

$$C_3H_8+\left(3+\frac{8}{4}\right)O_2\longrightarrow3CO_2+\frac{8}{2}H_2O$$

$$\therefore C_3H_8+5O_2\longrightarrow3CO_2+4H_2O$$

Similarly, for butane is

$$C_4H_{10}+\left(4+\frac{10}{4}\right)O_2\longrightarrow4CO_2+\frac{10}{2}H_2O$$

$$\therefore C_4H_{10}+\frac{13}{2},O_2\longrightarrow4CO_2+5\,^2H_2O$$

$\because$ For 1 mol of C_4H_{10} required $O_2 = \frac{13}{2}$ mol

$\therefore$ For 2 mol of C_4H_{10} required $O_2 = \frac{13}{2} \times 2 = 13$ mol

43. (50)

M. eq. of $K_2Cr_2O_7$ = M. eq. of FeC_2O_4

$$FeC_2O_4 + Cr_2O_7^{2-} \longrightarrow Fe^{3+} + CO_2 + Cr^{3+}$$

$$V \times 0.02 \times 6 = \frac{0.288}{144} \times 3 \times 1000$$

V = 50 mL

44. (85)

$$5H_2O_2 + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$$

Moles of $KMnO_4 = \frac{0.316}{158} = 2 \times 10^{-3}$

Equivalents of H_2O_2 = Equivalents of $KMnO_4$

Equivalents of $KMnO_4 = 2 \times 10^{-3} \times 5 = 0.01$

Moles of $H_2O_2 = \frac{0.01}{2} = 0.005$

Mass of pere $H_2O_2 = 0.005 \times 34 = 0.170$ g

Percentage purity $= \frac{0.17}{0.2} \times 100 = 85\%$.

45. (3400)

Mole of $N_2 = \frac{2800}{28} = 100$ and Mole of $H_2 = \frac{1000}{2} = 500$

	$N_2(g)$ +	$3H_2(g)$ →	$2NH_3$ (g)
Initial mole	100	500	
Final mole	0	300	200
	Limiting reagent		

Mass of NH_3 formed $= 200 \times 17 = 3400$ g

46. (10)

$$\text{Normality} = \frac{\text{No. of equivalents of solute}}{\text{Volume of solution (in L)}}$$

$$0.1 = \frac{1.43}{\frac{(106+18x)}{2} \times 0.1} \Rightarrow \frac{106+18x}{2} = 143$$

$\Rightarrow 18x = 286 - 106 = 180 \Rightarrow x = 10.$

47. (47)

Let total mole of solution = 1

So, mole of glucose = 0.1

Mole of H_2O = 0.9

$$\% \text{ (w/w) of } H_2O = \left[\frac{0.9 \times 18}{0.9 \times 18 + 0.1 \times 180}\right] \times 100$$

$= 47.368 = 47.37.$

48. (25)

$$\text{Number of mole of } x = \frac{6.022 \times 10^{22}}{6.022 \times 10^{23}} = \frac{10}{\text{Molar mass of } x}$$

So molar mass of x = 100 g

Molarity $= \frac{5}{100 \times 2} = 0.025$ M.

49. (10)

Phosphinic acid is hypophosphorous acid (H_3PO_2).

$$NaOH + H_3PO_2 \longrightarrow NaH_2PO_2 + H_2O$$

For neutrization,

$(N_1V_1)_{acid} = (N_2V_2)_{base}$

$0.1 \times 10 = 0.1 \times (V_{mL})_{NaOH}$

$V_{NaOH} = 10$ mL

50. (10.00)

$$ppm = \frac{10.3 \times 10^{-3}}{1.03 \times 1000} \times 10^6 = 10$$

51. (4.96)

$$10 \text{ ppm} = \frac{\text{Mass of Fe (in g)}}{100 \times 1000} \times 10^6$$

$\Rightarrow$ Mass of Fe = 1 g

Molar mass of $FeSO_4.7H_2O$ = 278

56 g of iron present in 1 mole of $FeSO_4.7H_2O$

1 g of Fe present $\frac{278}{56}$ g in of salt = 4.96 g

52. (2130)

$$NaClO_3(s) + Fe(s) \longrightarrow NaCl(s) + FeO(s) + O_2(g)$$

Moles of $NaClO_3$ = Moles of O_2

Moles of $O_2 = \frac{PV}{RT} = \frac{1 \times 492}{0.082 \times 300} = 20$ mol

Mass of $NaClO_3 = 20 \times 106.5 = 2130$ g

53. (c) 1 mol of urea = 2 mol of NH_3

60 g of urea = 2 mol of NH_3

0.6 g of urea $= \frac{2}{60} \times 0.6$ mol $= 0.02$ mol of NH_3

mol of NH_3 = mol of HCl

$\therefore$ mol of HCl = 0.02 mol

$\Rightarrow$ Normality of HCl = 0.2 N

Volume of HCl = 100 mL

54. (d) 5 mol AB_2 weighs 125 g

$\therefore AB_2$ = 25 g/mol

10 mol A_2B_2 weighs 300 g

$\therefore A_2B_2$ = 30 g/mol

$\therefore$ Molar mass of A(M_A) = 5 g or 5×10^{-3} kg

Molar mass of B (M_B) = 10 g or 10×10^{-3} kg

55. (a) (a) $4Fe + 3O_2 \longrightarrow 2Fe_2O_3$

1 g Fe requries $= \frac{3 \times 32}{4 \times 56} = 0.43$ g of oxygen

(b) $P_4 + 5O_2 \longrightarrow P_4O_{10}$

1 g of P requries $= \frac{5 \times 32}{31 \times 4} = 1.3$ g of oxygen

(c) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

1 g of C_3H_8 requires $= \frac{5\times32}{44} = 3.6$ g of O_2

(d) $2Mg + O_2 \longrightarrow 2MgO$

1 g Mg requires $= \frac{32}{2\times24}$ g $= 0.66$ g of O_2

56. **(a)** According to the stoichiometry of balanced equation, 28 g N_2 reacts with 6 g H_2

$$\underset{\substack{1\text{ mole}\\28\text{ g}}}{N_2} + \underset{\substack{3\text{ mole}\\6\text{ g}}}{3H_2} \longrightarrow 2NH_3$$

∴ For 56 g of N_2, 12 g of H_2 is required.

57. **(a)** Given: 0.27 g is present in 100 cm^3 of hexane

∴ 10 mL of aqueous solution contains only 0.027 g acid.

Volume of 0.027 g acid $= \frac{0.027}{0.9}$ mL

∴ $\pi r^2 h = \frac{0.027}{0.9}$ (given $r = 10$ cm, $\pi = 3$)

∴ $h = 10^{-4}$ cm $= 10^{-6}$ m

58. **(N)** **Oxalic acid** **Sodium hydroxide**

$$N_1V_1 = N_2V_2$$
$$(2\times M_1)V_1 = M_2V_2$$
$$2\times0.5\times50 = M_2\times25$$
$$M_2 = 2$$
$$\text{Molarity} = \frac{\text{No. of moles}}{\text{Vol.(L)}}$$
$$2 = \frac{\text{No. of moles}}{50/1000}$$
$$\text{No. of moles} = \frac{1}{10} = 0.1$$
$$\text{No. of moles} = \frac{W}{\text{Molar mass}}$$
$$W = 0.1\times40 = 4\text{ g}$$

No option is correct.

59. **(d)**

$2NaHCO_3 + H_2C_2O_4 \longrightarrow Na_2C_2O_4 + 2CO_2 + 2H_2O$

Moles of CO_2 evolved $= \frac{0.25}{25\times10^3} = 10^{-5}$

∴ Moles of $NaHCO_3 = 10^{-5}$

∴ Mass of $NaHCO_3 = 84\times10^{-5}$ g

$= 0.84\times10^{-3}$ g $= 0.84$ mg

∴ % by weight $= \times 100 = 8.4\%$

60. **(a)** 25 mL of HCl solution requires 30 mL of 0.1 M Na_2CO_3 solution.

∵ $N_1V_1 = N_2V_2$

∴ $25\times N_1 = 30\times0.2$ (0.1 M Na_2CO_3 = 0.2N Na_2CO_3)

$N_1 = \frac{6}{25} = 0.24$N

Now, HCl solution is titrated with NaOH solution.

$M_1V_1 = M_2V_2$; 0.24 N HCl = 0.24 M HCl

∴ $V\times0.24\times1 = 30\times0.2\times1 \Rightarrow V = 25$ mL

61. **(c)** For the given reaction:

$2C_{57}H_{110}O_6(s) + 163\,O_2(g) \rightarrow 114\,CO_2(g) + 110\,H_2O(l)$

Moles of $C_{57}H_{110}O_6 = \frac{445}{890} = 0.5$

Now, moles of water $= \frac{100}{2}\times0.5 = 27.5$

∴ Mass of water $= 27.5\times18 = 495$ g

62. **(d)** No. of moles of oxygen in 0.16 g of oxygen molecule

$= \frac{0.16\text{ g}}{32\text{ g/mol}} = 0.005$ mol

$2NaClO_3 \xrightarrow{\Delta} 2NaCl + 3O_2$

According to the reaction,

3 moles of O_2 = 2 moles of NaCl = 2 moles of AgCl

Molar mass of AgCl = 143.5 g/mol

0.005 moles of O_2 will ppt. $= 0.005\times\frac{2}{3}$ moles AgCl

$= 0.0033$ moles of AgCl

∴ Mass of AgCl (in g) obtained will be

= 143.5 g/mol × 0.0033 moles = 0.48 g.

63. **(b)** Given chemical eq^n

$$\underset{1\text{g}}{M_2CO_3} + 2HCl \rightarrow 2MCl + H_2O + \underset{0.01186\text{ mol}}{CO_2}$$

From the above chemical eq^n.

$nM_2CO_3 = nCO_2$

$\frac{1}{\text{Molar mass of }M_2CO_3} = 0.01186$

∴ Molar mass of $M_2CO_3 = \frac{1}{0.01186}$

Molar mass = 84.3 g/mol

64. **(d)**
$$\underset{\substack{2\text{ mol}\\1\text{ mol}}}{2H_3AsO_4} + 5H_2S \xrightarrow{\text{Conc. HCl}} \underset{\substack{1\text{ mol}\\½\text{ mol}}}{As_2S_5} + 8H_2O$$

∵ The molar mass of H_3AsO_4 is 3 × 1 + 79 + 4 × 16 = 142g/mol

∴ Number of moles of $H_3AsO_4 = \frac{35.5}{142} = 0.25$ mol.

∴ Number of moles of $As_2S_5 = \frac{0.25}{2} = 0.125$ mol.

65. **(a)** Applying law of equivalence

Equivalence of acid = Equivalence of base

Equivalent of acid = Normality × volume = 0.1 × V

Another formula of equivalence = n factor × number of moles

∴ Equivalent of base = n factor of OH^- × moles of OH^-

= 1 × 0.04

0.1 × V = 1 × 0.04

V = 0.4 L = 0.4 × 1000 = 400 mL.

66. **(c)** Let the weight of acetic acid initially be w_1 in 50 mL of 0.060 N solution.

$N = \frac{w_1 \times 1000}{M.wt. \times 50}$ (Normality = 0.06 N)

$0.06 = \frac{w_1 \times 1000}{60 \times 50}$

$\Rightarrow w_1 = \frac{0.06 \times 60 \times 50}{1000} = 0.18\ g = 180\ mg.$

After an hour, the strength of acetic acid = 0.042 N

so, let the weight of acetic acid be w_2

$N = \frac{w_2 \times 1000}{60 \times 50}$

$0.042 = \frac{w_2 \times 1000}{3000}$

$\Rightarrow w_2 = 0.126\ g = 126\ mg$

So amount of acetic acid adsorbed per 3g

$= 180 - 126\ mg = 54\ mg$

$\therefore$ amount of acetic acid absorbed per g = 54/3 = 18 mg

67. **(d)** Weight of hydrated $BaCl_2 = 61$ g

Weight of anhydrous $BaCl_2 = 52$ g

Loss in mass = 9 g

Assuming $BaCl_2.xH_2O$ as hydrate

Mass of $H_2O = 9$ g

Moles of $H_2O = \frac{9}{18} = 0.5$ mol

Grass molecular wt. of $BaCl_2 = 208$ g/mol.

% of H_2O in this hydrated $BaCl_2 = \frac{9}{61} \times 100 = 14.75\%$

% of H_2O in $BaCl_2.xH_2O = \frac{18x}{208+18x} \times 100$

Thus, $\frac{18x}{208+18x} \times 100 = 14.75$

On solving $x = 2$

Hence, the formula of hydrated salt is $BaCl_2.2H_2O$

68. **(a)** $A + 3B + 3C \rightleftharpoons AB_2C_3$ .... (i)

No. of moles of A $= \frac{6.0\ g}{60\ g/mol} = 0.1$ mol

No. of moles of B $= \frac{6.00 \times 10^{23}}{6.000 \times 10^{23}} = 1$ mol

No. of moles of C = 0.036

Therefore, C is the limiting reagent,

The number of moles of product formed

$= \frac{0.036}{3} = 0.012$ mol

The expression for the molar mass is

$\text{Molar mass} = \frac{\text{Given mass}}{\text{mole of product}}$

$60 + (2 \times x) + (3 \times 80) = \frac{4.8}{0.012}$

x = 50 amu

Hence, atomic mass of B is 50 amu

69. **(d)** Normality of oxalic acid solution

$= \frac{6.3 \times 1000}{63 \times 250} = 0.4$ N

Now from

$N_1V_1 = N_2V_2$

$0.4 \times 10 = 0.1 \times V_2$

$V_2 = 40$ mL

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

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

$= 5.55 \times 10^{-4}$ m

71. **(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

Given that 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

$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{1216}{1000}$

= 1.216 g/mL = 1.22 g/mL

72. **(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

$= 3 \times 22.4$ 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

73. **(a)** H_3PO_3 KOH

$N_1V_1 = N_2V_2$

Note: H_3PO_3 is dibasic, $\therefore$ M = 2N

$20 \times 0.2 = 0.1 \times V_2$ (Thus. 0.1 M = 0.2 N)

$\therefore V_2 = 40$ mL

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

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

Now, since 10.8 g boron requires hydrogen

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

Hence 21.6 boron requires hydrogen

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