1 Some Basic Concepts of Chemistry

Trend Analysis with Important Topics & Sub-Topics

		2020		2019		2018		2017		2016	
Topic Name	**Sub-Topic**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**
Significant figures,law of chemical combinations and mole concept	mole concept	1	E	1	E	1	E				
Stoichiometric calculations	stoichiometric calculations					1	A				

LOD - Level of Difficulty | E - Easy | A - Average | D - Difficult | Qns - No. of Questions

Topic 1 : Significant Figures, Laws of Chemical Combinations and Mole Concept

1. Which one of the followings has maximum number of atoms ? ***[2020]***
   (a) 1 g of Mg(s) [Atomic mass of Mg = 24]
   (b) 1 g of O_2(g) [Atomic mass of O = 16]
   (c) 1 g of Li(s) [Atomic mass of Li = 7]
   (d) 1 g of Ag(s) [Atomic mass of Ag = 108]

2. The number of moles of hydrogen molecule required to produce 20 moles of ammonia through Haber' s process is: ***[2019]***
   (a) 10 (b) 20
   (c) 30 (d) 40

3. In which case is number of molecules of water maximum? ***[2018]***
   (a) 18 mL of water
   (b) 0.18 g of water
   (c) 10^{-3} mol of water
   (d) 0.00224 L of water vapours at 1 atm and 273 K

4. A mixture of gases contains H_2 and O_2 gases in the ratio of 1 : 4 (w/w). What is the molar ratio of the two gases in the mixture ? ***[2015]***
   (a) 4 : 1 (b) 16 : 1
   (c) 2 : 1 (d) 1 : 4 5. The

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

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

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

8. 1.0 g of magnesium is burnt with 0.56 g O_2 in a closed vessel. Which reactant is left in excess and how much ? ***[2014]***
(At. wt. Mg = 24 ; O = 16)
(a) Mg, 0.16 g (b) O_2, 0.16 g
(c) Mg, 0.44 g (d) O_2, 0.28 g

9. Which has the maximum number of molecules among the following ? ***[2011 M]***
(a) 44 g CO_2 (b) 48 g O_3
(c) 8 g H_2 (d) 64 g SO_2

10. The number of atoms in 0.1 mol of a triatomic gas is : ***[2010]***
($N_A = 6.02 \times 10^{23}\ mol^{-1}$)
(a) 6.026×10^{22} (b) 1.806×10^{23}
(c) 3.600×10^{23} (d) 1.800×10^{22}

11. What volume of oxygen gas (O_2) measured at 0°C and 1 atm, is needed to burn completely 1L of propane gas (C_3H_8) measured under the same conditions ? ***[2008]***
(a) 7 L (b) 6 L
(c) 5 L (d) 10 L

12. Number of moles of MnO_4^- required to oxidize one mole of ferrous oxalate completely in acidic medium will be : ***[2008]***
(a) 0.6 moles (b) 0.4 moles
(c) 7.5 moles (d) 0.2 moles

13. Volume occupied by one molecule of water (density = 1 g cm^{-3}) is : ***[2008]***
(a) $9.0 \times 10^{-23}\ cm^3$ (b) $6.023 \times 10^{-23}\ cm^3$
(c) $3.0 \times 10^{-23}\ cm^3$ (d) $5.5 \times 10^{-23}\ cm^3$

14. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphite ion in acidic solution is ***[2007]***
(a) 4/5 (b) 2/5
(c) 1 (d) 3/5

15. An element, X has the following isotopic composition : ***[2007]***
$^{200}X : 90\%$ $^{199}X : 8.0\,\%$ $^{202}X : 2.0\%$
The weighted average atomic mass of the naturally occuring element X is closest to
(a) 201 amu (b) 202 amu
(c) 199 amu (d) 200 amu

16. The number of moles of $KMnO_4$ reduced by one mole of KI in alkaline medium is: ***[2005]***
(a) one (b) two
(c) five (d) one fifth

17. The maximum number of molecules is present in
(a) 15 L of H_2 gas at STP ***[2004]***
(b) 5 L of N_2 gas at STP
(c) 0.5 g of H_2 gas
(d) 10 g of O_2 gas

18. Which has maximum number of molecules?
(a) 7 g N_2 (b) 2 g H_2 ***[2002]***
(c) 16 g NO_2 (d) 16 g O_2

19. Specific volume of cylindrical virus particle is 6.02×10^{-2} cc/g whose radius and length are 7 Å & 10 Å respectively. If $N_A = 6.02 \times 10^{23}$, find molecular weight of virus ***[2001]***
(a) 3.08×10^3 kg/mol (b) 3.08×10^4 kg/mol
(c) 1.54×10^4 kg/mol (d) 15.4 kg/mol

20. Assuming fully decomposed, the volume of CO_2 released at STP on heating 9.85 g of $BaCO_3$ (Atomic mass, Ba = 137) will be ***[2000]***
(a) 2.24 L (b) 4.96 L
(c) 1.12 L (d) 0.84 L

21. Haemoglobin contains 0.334% of iron by weight. The molecular weight of haemoglobin is approximately 67200. The number of iron atoms (at. wt. of Fe is 56) present in one molecule of haemoglobin are ***[1998]***
(a) 1 (b) 6
(c) 4 (d) 2

22. The number of significant figures for the three numbers 161 cm, 0.161 cm, 0.0161 cm are
(a) 3, 4 and 5 respectively ***[1998]***
(b) 3, 4 and 4 respectively
(c) 3, 3 and 4 respectively
(d) 3, 3 and 3 respectively

23. The weight of one molecule of a compound $C_{60}H_{122}$ is ***[1995]***
(a) 1.2×10^{-20} gram (b) 1.4×10^{-21} gram
(c) 5.025×10^{23} gram (d) 6.023×10^{23} gram

24. In the final answer of the expression

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

the number of significant figures is : ***[1994]***
(a) 1 (b) 2
(c) 3 (d) 4

25. If N_A is Avogadro's number then number of valence electrons in 4.2g of nitride ions (N^{3-}) is
(a) $2.4\,N_A$ (b) $4.2\,N_A$ ***[1994]***
(c) $1.6\,N_A$ (d) $3.2\,N_A$

26. The molecular weight of O_2 and SO_2 are 32 and 64 respectively. At 15°C and 150 mm Hg pressure, one litre of O_2 contains 'N' molecules. The number of molecules in two litres of SO_2 under the same conditions of temperature and pressure will be : ***[1990]***

(a) N/2 (b) N
(c) 2N (d) 4N

27. Boron has two stable isotopes, ^{10}B (19%) and ^{11}B (81%). Average atomic weight for boron in the periodic table is ***[1990]***
(a) 10.8 (b) 10.2
(c) 11.2 (d) 10.0

28. The number of oxygen atoms in 4.4 g of CO_2 is ***[1990]***
(a) 1.2×10^{23} (b) 6×10^{22}
(c) 6×10^{23} (d) 12×10^{23}

29. The number of gram molecules of oxygen in 6.02×10^{24} CO molecules is ***[1990]***
(a) 10 g molecules (b) 5 g molecules
(c) 1 g molecules (d) 0.5 g molecules

30. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene ?
(a) 2.8 kg (b) 6.4 kg ***[1989]***
(c) 9.6 kg (d) 96 kg

31. Ratio of C_p and C_v of a gas 'X' is 1.4. The number of atoms of the gas 'X' present in 11.2 litres of it at NTP will be ***[1989]***
(a) 6.02×10^{23} (b) 1.2×10^{23}
(c) 3.01×10^{23} (d) 2.01×10^{23}

32. 1 c.c. N_2O at NTP contains : ***[1988]***
(a) $\frac{1.8}{224} \times 10^{22}$ atoms
(b) $\frac{6.02}{22400} \times 10^{23}$ molecules
(c) $\frac{1.32}{224} \times 10^{23}$ electrons
(d) all the above

33. At S.T.P. the density of CCl_4 vapours in g/L will be nearest to : ***[1988]***
(a) 6.87 (b) 3.42
(c) 10.26 (d) 4.57

Topic 2: Percent Composition and Empirical Formula

34. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave C, 38.71% and H, 9.67%. The empirical formula of the compound would be : ***[2008]***
(a) CH_3O (b) CH_2O
(c) CHO (d) CH_4O

35. Percentage of Se in peroxidase anhydrase enzyme is 0.5% by weight (at. wt. = 78.4) then minimum molecular weight of peroxidase anhydrase enzyme is ***[2001]***
(a) 1.568×10^3 (b) 15.68
(c) 2.136×10^4 (d) 1.568×10^4

36. An organic compound containing C, H and O gave on analysis C – 40% and H – 6.66%. Its empirical formula would be ***[1999, 94]***
(a) C_3H_6O (b) CHO
(c) CH_2O (d) CH_4O

37. An organic compound containing C, H and N gave the following analysis :
C = 40% ; H = 13.33% ; N = 46.67%
Its empirical formula would be ***[1998]***
(a) $C_2H_7N_2$ (b) CH_5N
(c) CH_4N (d) C_2H_7N

38. The percentage weight of Zn in white vitriol $[ZnSO_4.7H_2O]$ is approximately equal to $(Zn = 65, S = 32, O = 16 \text{ and } H = 1)$ ***[1995]***
(a) 33.65 % (b) 32.56 %
(c) 23.65 % (d) 22.65 %

39. A metal oxide has the formula Z_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of the metal oxide requires 6 mg of hydrogen for complete reduction. The atomic weight of the metal is ***[1989]***
(a) 27.9 (b) 159.6
(c) 79.8 (d) 55.8

Topic 3: Stoichiometric Calculations

40. A mixture of 2.3 g formic acid and 4.5 g oxalic acid is treated with conc. H_2SO_4. The evolved gaseous mixture is passed through KOH pellets. Weight (in g) of the remaining product at STP will be ***[2018]***
(a) 1.4 (b) 3.0
(c) 4.4 (d) 2.8

41. 20.0 g of a magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.0 g magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample ? ***[2015 RS]***
(a) 75 (b) 96
(c) 60 (d) 84

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

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

44. 6.02×10^{20} molecules of urea are present in 100 mL of its solution. The concentration of solution is : ***[NEET 2013]***
(a) 0.01 M (b) 0.001 M
(c) 0.1 M (d) 0.02 M

45. What is the $[\overline{OH}]$ in the final solution prepared by mixing 20.0 mL of 0.050 M HCl with 30.0 mL of 0.10 M $Ba(OH)_2$? ***[2009]***
(a) 0.40 M (b) 0.0050 M
(c) 0.12 M (d) 0.10 M

46. 10 g of hydrogen and 64 g of oxygen were filled in a steel vessel and exploded. Amount of water produced in this reaction will be: ***[2009]***
(a) 3 mol (b) 4 mol
(c) 1 mol (d) 2 mol

47. How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl ? ***[2008]***
(a) 0.044 (b) 0.333
(c) 0.011 (d) 0.029

48. Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.80 g mL^{-1}. Volume of acid required to make one litre of 0.1M H_2SO_4 solution is ***[2007]***
(a) 16.65 mL (b) 22.20 mL
(c) 5.55 mL (d) 11.10 mL

49. The mass of carbon anode consumed (giving only carbon dioxide) in the production of 270 kg of aluminium metal from bauxite by the Hall process is (Atomic mass: Al = 27) ***[2005]***
(a) 270 kg (b) 540 kg
(c) 90 kg (d) 180 kg

50. In Haber process 30 litres of dihydrogen and 30 litres of dinitrogen were taken for reaction which yielded only 50% of the expected product. What will be the composition of gaseous mixture under the aforesaid condition in the end? ***[2003]***
(a) 20 litres ammonia, 25 litres nitrogen, 15 litres hydrogen
(b) 20 litres ammonia, 20 litres nitrogen, 20 litres hydrogen
(c) 10 litres ammonia, 25 litres nitrogen, 15 litres hydrogen
(d) 20 litres ammonia, 10 litres nitrogen, 30 litres hydrogen

51. In the reaction
$4\,NH_3\,(g) + 5\,O_2\,(g) \rightarrow 4\,NO(g) + 6\,H_2O(l)$
When 1 mole of ammonia and 1 mole of O_2 are made to react to completion, ***[1998]***
(a) 1.0 mole of H_2O is produced (b) 1.0 mole of NO will be produced
(c) all the oxygen will be consumed
(d) all the ammonia will be consumed

52. Liquid benzene (C_6H_6) burns in oxygen according to the equation
$2C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(g)$
How many litres of O_2 at STP are needed to complete the combustion of 39 g of liquid benzene? (Mol. wt. of $O_2 = 32, C_6H_6 = 78$) ***[1996]***
(a) 74 L (b) 11.2 L
(c) 22.4 L (d) 84 L

53. A 5 molar solution of H_2SO_4 is diluted from 1 litre to a volume of 10 litres, the normality of the solution will be : ***[1991]***
(a) 1 N (b) 0.1 N
(c) 5 N (d) 0.5 N

54. One litre hard water contains 12.00 mg Mg^{2+}. Mili-equivalents of washing soda required to remove its hardness is : ***[1988]***
(a) 1 (b) 12.16
(c) 1×10^{-3} (d) 12.16×10^{-3}

ANSWER KEY

1	(c)	**7**	(a)	**13**	(c)	**19**	(d)	**25**	(a)	**31**	(a)	**37**	(c)	**43**	(c)	**49**	(c)		
2	(c)	**8**	(a)	**14**	(b)	**20**	(c)	**26**	(c)	**32**	(d)	**38**	(d)	**44**	(a)	**50**	(c)		
3	(a)	**9**	(c)	**15**	(d)	**21**	(c)	**27**	(a)	**33**	(a)	**39**	(d)	**45**	(d)	**51**	(c)		
4	(a)	**10**	(b)	**16**	(b)	**22**	(d)	**28**	(a)	**34**	(a)	**40**	(d)	**46**	(b)	**52**	(d)		
5	(d)	**11**	(c)	**17**	(a)	**23**	(b)	**29**	(b)	**35**	(d)	**41**	(d)	**47**	(d)	**53**	(a)		
6	(b)	**12**	(b)	**18**	(b)	**24**	(c)	**30**	(c)	**36**	(c)	**42**	(c)	**48**	(c)	**54**	(a)		

Hints & Solutions

1. (c) Number of atoms

$$= \frac{W}{\text{Molar mass}} \times N_A \times \text{atomicity}$$

(a) Number of Mg atoms $= \frac{1}{24} \times N_A \times 1$

(b) Number of O atoms $= \frac{1}{32} \times N_A \times 2$

(c) Number of Li atoms $= \frac{1}{7} \times N_A \times 1$

(d) Number of Ag atoms $= \frac{1}{108} \times N_A \times 1$

2. (c) $N_2 + 3H_2 \longrightarrow 2NH_3$

$1 \text{ Mol } NH_3 = \frac{3}{2} \text{ mol } H_2$

$20 \text{ mol } NH_3 = \frac{3}{2} \times 20 \text{ mol } H_2 = 30 \text{ mol } H_2$

$\therefore$ 30 moles of H_2 are required.

3. (a)

(1) Mass of water = 18 × 1 = 18 g
Molecules of water = mole × N_A

$= \frac{18}{18} N_A = N_A$

(2) Molecules of water = mole × N_A

$= \frac{0.18}{18} N_A = 10^{-2} N_A$

(3) Molecules of water = mole × $N_A = 10^{-3} N_A$

(4) Moles of water $= \frac{0.00224}{22.4} = 10^{-4}$
Molecules of water = mole × $N_A = 10^{-4} N_A$

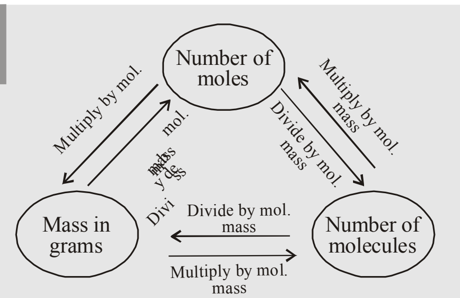
4. (a) Ratio of weight of gases = $w_{H_2} : w_{O_2} = 1 : 4$

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

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

5. (d) No. of moles of water
In 1.8 g of H_2O = 0.1 moles
In 18 g of H_2O = 1 moles
1 mole contains 6.022×10^{23} molecules of water therefore maximum number of molecules is in 18 moles of water.

NOTES



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

NOTES

Mass of $_{12}C$ carbon is used to define the atomic mass unit. In this system, 12C is assigned a mass of exactly 12 a.m.u.
Earlier one mole was defined as the amount of substance that contains as many particles as there are atoms in exactly 12 g of the $_{12}C$ isotope. From November 2018, one mole is defined as exactly $6.02214076 \times 10^{23}$ constitutive particles, which may be atoms, molecules, ions or electrons.
Hence, if we change the value of NA from 6.022×10^{23} mol^{-1} to 6.022×10^{20} mol^{-1} then mass of one mole of carbon will also change.
The definition of mass is independent of Avogadro number N_A.

7. (a)

	$H_2(g)$	+ $Cl_2(g)$	$\longrightarrow 2HCl(g)$	
	22.4 L = 1 mole	11.2 L = 0.5 mole	0	initial
	1 − 0.5	0.5 − 0.5	2 × 0.5	final

Moles of HCl formed = 2 × 0.5 = 1

8. (a) Initially Mg $\quad \frac{1}{2} O_2 \longrightarrow$ MgO
1g $\quad$ 0.56

or $\frac{1}{24}$ mole $\quad \frac{0.56}{32}$ mole
0.0417 mole $\quad$ 0.0175 mole
(0.0417 − 2 × 0.0175) = 0.0067 mole $\quad$ 0 mole

$\therefore$ Mass of Mg = 0.0067 × 24 = 0.16g

9. (c) **No. of molecules**

Moles of $CO_2 = \frac{44}{44} \quad 1, N_A$

Moles of $O_3 = \frac{48}{48}$ 1 , N_A

Moles of $H_2 = \frac{8}{2}$ 4 , $4N_A$

Moles of $SO_2 = \frac{64}{64}$ 1 , N_A

10. (b) The number of atoms in 0.1 mol of a triatomic gas $= 0.1 \times 3 \times 6.023 \times 10^{23}$.
$= 1.806 \times 10^{23}$

11. (c) Writing the equation of combustion of propane (C_3H_8), we get

$$\underset{\substack{1\,vol\\1L}}{C_3H_8} + \underset{\substack{5\,vol\\5L}}{5O_2} \rightarrow 3CO_2 + 4H_2O$$

From the above equation we find that we need 5 L of oxygen at **N.T.P.** to completely burn 1 L of propane at N.T.P.
If we change the conditions for both the gases from N.T.P. to same conditions of temperature and pressure. The same results are obtained. *i.e.* 5 L is the correct answer.

12. (b) $$5\begin{matrix}COO^-\\ | \\ COO^-\end{matrix} + 2\,MnO_4^- + 16\,H^+ \longrightarrow$$
oxalate ion

$$2\,Mn^{2+} + 10CO_2 + 8H_2O$$

From above equation 2 moles of MnO_4 required to oxidise 5 moles of oxalate.

Thus number of moles of MnO_4^- required to oxidise one mole of oxalate $= 2 \times 2/5 = 0.4$ moles

NOTES

In $KMnO_4$ the oxidation state of Mn is +7. In acidic medium Mn takes up five electrons and making it an oxidizing agent. In strongly alkaline solution it takes up only 1 electrons and making it much weaker oxidising agent. In neutral medium it gives up 3 electrons to form MnO_2.
Acidic medium:
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
Alkaline medium: $MnO_4^- + e^- \rightarrow MnO_4^{2-}$
Neutral medium:
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$

13. (c) $\therefore$ Volume occupied by 1 gram water = 1 cm^3
or Volume occupied by

$$\frac{6.023\times10^{23}}{18} \text{ molecules of water} = 1\ cm^3$$

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

Thus, volume occupied by 1 molecule of water

$$= \frac{1\times18}{6.023\times10^{23}}\,cm^3 = 3.0\times10^{-23}\,cm^3.$$

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

14. (b) The balance chemical equation is :

$$2MnO_4^- \quad 6H^+ \quad 5SO_3^{2-} \longrightarrow$$
$$2Mn^{2+} \quad 5SO_4^{2-} \quad 3H_2O$$

From the equation it is clear that
Moles of MnO_4^- require to oxidise 5 moles of SO_3^{2-} are 2
Moles of MnO_4^- require to oxidise 1 mole of SO_3^{2-} are 2/5.

15. (d) Average isotopic mass of

$$X \quad \frac{200\times90+199\times8+202\times2}{90 \quad 8 \quad 2}$$

$$\frac{18000 \quad 1592 \quad 404}{100}$$

$$\frac{19996}{100} \quad 199.96 \simeq 200\,\text{amu}$$

NOTES

Average atomic mass
= (Mass of isotope A × % natural abundance) + (Mass of isotope B × % natural abundance) +

(% Natural abundance of A + % natural abundance of B) + .

16. (b) In weak alkaline medium, the equation is:
$$2Mn\,SO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + IO_4^- + 2OH^-$$
Hence, one mole of KI reduce, 2 moles of $KMnO_4$.

17. (a) No. of molecules in different cases
(a) $\because$ 22.4 litre at STP contains
$= 6.023\times10^{23}$ molecule of H_2

$$\therefore 15\ \text{litre at STP contains} = \frac{15}{22.4}\times6.023\times10^{23}$$

(b) $\because$ 22.4 litre at STP contains
$= 6.023\times10^{23}$ molecule of N_2

$$\therefore\ 5\ \text{litre at STP contians} = \frac{5}{22.4}\times6.023\times10^{23}$$

(c) $\because$ 2 g of $H_2 = 6.023\times10^{23}$ molecules of H_2

$$\therefore\ 0.5\ g\ of\ H_2 = \frac{0.5}{2}\times6.023\times10^{23}$$

(d) Similarly 10 g of O_2 gas

$$= \frac{10}{32}\times6.023\times10^{23}\ \text{molecules}$$

Thus (a) will have maximum number of molecules

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

19. (d) Specific volume (volume of 1 g) of cylindrical virus particle $= 6.02 \times 10^{-2}$ cc/g Radius of virus (r) = 7 Å $= 7 \times 10^{-8}$ cm
Length of virus $= 10 \times 10^{-8}$ cm
Volume of virus $= \pi r^2 l = \frac{22}{7} \times (7 \times 10^{-8})^2 \times 10 \times 10^{-8}$
$= 154 \times 10^{-23}$ cc

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

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

$$= \frac{154 \times 10^{-23}}{6.02 \times 10^{-2}} \times 6.02 \times 10^{23}$$

= 15400 g/mol = 15.4 kg/mol

20. (c) $\underset{197\,g}{BaCO_3} \rightarrow BaO \quad CO_2$
As 197 g of $BaCO_3$ will release 22.4 litre of CO_2 at STP
$\therefore$ 1 g of $BaCO_3$ will release
$= \frac{22.4}{197}$ litre of CO_2
And 9.85 g of $BaCO_3$ will release carbon dioxide
$= \frac{22.4}{197} \times 9.85 = 1.12$ litre of CO_2

21. (c) Given : Percentage of the iron = 0.334%; Molecular weight of the haemoglobin = 67200 and atomic weight of iron = 56. We know that the number of iron atoms

$$\frac{\text{Molecular wt. of haemoglobin} \times \%\text{ of iron}}{100 \times \text{Atomic weight of iron}}$$

$$= \frac{67200 \times 0.334}{100 \times 56} = 4$$

22. (d) Number 161 cm, 0.161 cm and 0.0161cm have 3, 3 and 3 significant figures respectively.

> **NOTES** All non-zero digits are significant and the zeros at the beginning of a number are not significant.

23. (b) Molecular weight of $C_{60}H_{122}$ $= (12 \times 60) + 122 = 842$.
Therefore, weight of one molecule

$$= \frac{\text{Molecular weight of } C_{60}H_{122}}{\text{Avogadro's number}}$$

$$\frac{842}{6.023 \times 10^{23}} \quad 1.36 \times 10^{-21}\,g \simeq 1.4 \times 10^{-21}\,g$$

24. (c) $\frac{(29.2 - 20.2)(1.79 \times 10^5)}{1.37}$
As the least precise number contains 3 significant figures therefore, answers should also contains 3 significant figures.

25. (a) No of moles of nitride ion
$= \frac{4.2}{14} \quad 0.3$ mol $\quad 0.3 \times N_A$ nitride ions.
Valence electrons $= 8 \times 0.3\, N_A = 2.4\, N_A$

> **NOTES** Nitride ion has seven protons in the nucleus and ten electrons surrounding the nucleus. Therefore total no. of electrons is 10. Number of valence electrons is (5 + 3) = 8.

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

27. (a) Average atomic mass $= \frac{19 \times 10 + 81 \times 11}{100}$
$= 10.81$

28. (a) 1 mol of CO_2 = 44 g of CO_2
4.4 g $CO_2 = \frac{4.4}{44} = 0.1$ mol CO_2
$= 6 \times 10^{22}$ molecules
$= 2 \times 6 \times 10^{22}$ atoms or 1.2×10^{23} atoms of oxygen.

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

30. (c) $\underset{28\,kg}{C_2H_4} + \underset{96\,kg}{3O_2} \rightarrow 2CO_2 + 2H_2O$
As 28 kg of C_2H_4 undergo complete combustion by 96 kg of O_2
$\therefore$ 2.8 kg of C_2H_4 undergo complete combustion by 9.6 kg of O_2.

31. (a) $C_p / C_v = 1.4$ shows that the gas is diatomic.
22.4 litre at NTP $\equiv 6.02 \times 10^{23}$ molecules
11.2 L at NTP $= 3.01 \times 10^{23}$ molecules
No. of atoms in gas $= 3.01 \times 10^{23} \times 2$ atoms
$= 6.02 \times 10^{23}$ atoms

> **NOTES** $r \quad \frac{C_p}{C_v} \quad 1 \quad \frac{2}{F}$, where F = degree of freedom of the gas molecules
> For mono atomic gas, F = 3
> $\therefore \quad \gamma \quad \frac{C_p}{C_v} \quad 1 \quad \frac{2}{3} \quad \frac{5}{3} \quad 1.67$

For diatomic gas, F = 5

$$\therefore \quad \gamma \quad \frac{C_p}{C_v} \quad 1 \quad \frac{2}{5} \quad \frac{7}{5} \quad 1.40$$

For triatomic gas, F = 6 or 7 (depending upon the nature of the gas)

$$\therefore \quad \gamma \quad \frac{C_p}{C_v} \quad 1 \quad \frac{2}{6} \quad 1.33$$

$$\gamma \quad \frac{C_p}{C_v} \quad 1 \quad \frac{2}{7} \quad 1.29$$

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

$\therefore$ 1 cc of N_2O contain

$$= \frac{6.02 \times 10^{23}}{22400} \text{ molecules}$$

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

($\because$ N_2O molecule has 3 atoms)

No. of electrons in a molecule of N_2O

$= 7 + 7 + 8 = 22$

Hence, no. of electrons

$$= \frac{6.02 \times 10^{23}}{22400} \times 22 \quad \frac{1.32 \times 10^{23}}{224} \text{ electrons}$$

33. (a) 1 mol CCl_4 vapour $= 12 + 4 \times 35.5$ $= 154\text{ g} \equiv 22.4\text{ L}$ at STP

$$\therefore \text{Density} = \frac{154}{22.4}\text{ gL}^{-1} = 6.875\text{ gL}^{-1}$$

34. (a)

Element	%	Atomic weight	Atomic ratio	Simple ratio
C	38.71	12	$\frac{38.71}{12} = 3.23$	$\frac{3.23}{3.23} = 1$
H	9.67	1	$\frac{9.67}{1} = 9.67$	$\frac{9.67}{3.23} = 3$
O	100 – (38.71 + 9.67) = 51.62	16	$\frac{51.62}{16} = 3.23$	$\frac{3.23}{3.23} = 1$

Thus, empirical formula is CH_3O.

35. (d) Suppose the mol. wt. of enzyme = x

Given 100 g of enzyme wt of Se = 0.5 g

$$\therefore \text{In } x \text{ g of enzyme wt. of Se} = \frac{0.5}{100} \times x$$

$$\text{Hence } 78.4 \quad \frac{0.5 \times x}{100}$$

$\therefore x = 15680 = 1.568 \times 10^4$

36. (c) **Table for empirical formula :**

Element	%	At. wt	Relative number	Ratio
C	40	12	$\frac{40}{12} = 3.33$	$\frac{3.33}{3.33} = 1$
H	6.66	1	$\frac{6.66}{1} = 6.66$	$\frac{6.66}{3.33} = 2$
O	53.34	16	$\frac{53.34}{16} = 3.33$	$\frac{3.33}{3.33} = 1$

(% of O in organic compound $= 100 - (40 + 6.66) = 53.34\%$)

$\therefore$ Empirical formula of organic compound $= CH_2O$.

37. (c) As the sum of the percentage of C, H & N is 100. Thus, it does not contains O atom.

Table for empirical formula

Element	%	At. wt.	Relative Number	Ratio
C	40.00	12	$\frac{40}{12}$ 3.33	$\frac{3.33}{3.33}$ 1
H	13.33	1	$\frac{13.33}{1} = 13.33$	$\frac{13.33}{3.33} = 4$
N	46.67	14	$\frac{46.67}{14} = 3.33$	$\frac{3.33}{3.33} = 1$

Hence, empirical formula $= CH_4N$

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

$\therefore$ percentage mass of zinc (Zn)

$$= \frac{65}{287} \times 100 = 22.65\%$$

39. (d) The reaction can be given as

$$Z_2O_3 + 3H_2 \longrightarrow 2Z + 3H_2O$$

0.1596 g of Z_2O_3 react with H_2 = 6 mg = 0.006 g

$\therefore$ 1 g of H_2 react with

$$= \frac{0.1596}{0.006} = 26.6\text{ g of } Z_2O_3$$

$\therefore$ Eq. wt. of $Z_2O_3 = 26.6$

(from the definition of eq. wt.)

Eq. wt. of Z + Eq. wt. of O (8) = 26.6

$\Rightarrow$ Eq. wt. of $Z = 26.6 - 8 = 18.6$

Valency of metal in $Z_2O_3 = 3$

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

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

40. (d) $HCOOH \xrightarrow[\text{Dehydrating agent}]{H_2SO_4} CO + H_2O$

[H_2O absorbed by H_2SO_4]

At start (moles) $= \frac{2.3}{46} \frac{1}{20}$ 0   0

Final moles   0 $\frac{1}{20}$ $\frac{1}{20}$

$H_2C_2O_4 \xrightarrow{H_2SO_4} CO + CO_2 + H_2O$

[H_2O absorbed by H_2SO_4]

At start (moles) $= \frac{4.5}{90} \frac{1}{20}$ 0   0   0

Final moles   0 $\frac{1}{20}$ $\frac{1}{20}$ $\frac{1}{20}$

CO_2 is absorbed by KOH.
So, the remaning product is only CO.
Moles of CO formed from both reactions

$$\frac{1}{20} \quad \frac{1}{20} \quad \frac{1}{10}$$

Left mass of CO = moles × molar mass

$$= \frac{1}{10} \times 28 \quad 2.8\text{ g}$$

41. (d) $MgCO_3 \longrightarrow MgO \quad CO_2$

84 g of $MgCO_3$ form 40 g of MgO

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

$= 9.52$ g of MgO

Since 8.0 g of MgO is formed

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

42. (c) 50 mL of 16.9% solution of $AgNO_3$

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

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

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

50 mL of 5.8% solution of NaCl contain

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

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

$$AgNO_3 + NaCl \rightarrow AgCl\downarrow + Na^+ + NO_3^-$$

1 mole   1 mole   1 mole

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

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

$$= (0.049) \times (107.8 + 35.5) = 7.02\text{ g}$$

43. (c) Millimoles of solution of chloride
$= 0.05 \times 10 = 0.5$

Millimoles of $AgNO_3$ solution $= 10 \times 0.1 = 1$

So, the millimoles of $AgNO_3$ are double than the chloride solution.

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

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

$= 0.01$ M

45. (d) No. of milli equivalent of HCl
$= 20 \times 0.05 = 1.0$

No. of milli equivalent of Ba $(OH)_2$
$= 30 \times 0.1 \times 2 = 6.0$

After neutralization, no. of milli equivalents in 50 mL. of solution $= (6 - 1) = 5$

Total volume of the solution $= 20 + 30 = 50$ mL

$\therefore$ No. of equivalent of OH^- in 50 mL is

$$[OH^-] = \frac{5 \times 1000}{50} \times 10^{-3} = 0.1 \text{ M}$$

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

10g (5 mol)   64g (2 mol)

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

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

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

NOTES

When there is not enough of one reactant in a chemical reaction, the reaction stops. To find the amount of product produced, we must determine reactant that will limit the chemical reaction (the limiting reagent) we can find the limiting reagent by calculating the amount of product that can be formed by each reactant, the one that produces less product is the limiting reagent.

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

$$\underset{\substack{207+16\\=223\text{ g}}}{PbO} + \underset{\substack{2\times 36.5\\=73\text{g}}}{2HCl} \longrightarrow \underset{\substack{207+71\\=278\text{g}}}{PbCl_2} + H_2O$$

From this equation we find 223 g of PbO reacts with 73 g of HCl to form 278 g of $PbCl_2$.

If we carry out the reaction between 3.2 g HCl and 6.5 g PbO.

Amount of PbO that reacts with 3.2 g HCl

$= \frac{223}{73} \times 3.2 = 9.77$ g.

Since amount of PbO present is only 6.5 g so PbO is the limiting reagent.

Amount of $PbCl_2$ formed by 6.5 g of PbO

$= \frac{278}{223} \times 6.5$ g

Number of moles of $PbCl_2$ formed

$= \frac{278}{223} \times \frac{6.5}{278}$ moles $= 0.029$ moles.

48. (c) Molarity of H_2SO_4 solution

$= \frac{98 \times 1000}{98 \times 100} \times 1.80 \quad 18.0$

Suppose V mL of this H_2SO_4 is used to prepare 1 lit. of 0.1M H_2SO_4

$\therefore V \times 18.0 = 1000 \times 0.1$

or $V \quad \frac{1000 \times 0.1}{18.0} \quad 5.55$ mL.

49. (c) $2Al_2O_3 + 3C \longrightarrow Al \quad 3CO_2$

Gram equivalent of $Al_2O_3 \equiv$ g equivalent of C

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

Equivalent weight of C

$= \frac{12}{4} = 3 \; (\overset{0}{C} \rightarrow \overset{+4}{C}O_2)$

No. of gram equivalent of Al $= \frac{270 \times 10^3}{9} = 30 \times 10^3$

Hence,

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

Again,

No. of gram equivalent of C

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

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

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

50. (c) $\underset{\substack{1\text{ vol.}\\10\text{ litre}}}{N_2} + \underset{\substack{3\text{ vol.}\\30\text{ litre}}}{3H_2} \rightarrow \underset{\substack{2\text{ vol.}\\20\text{ litre}}}{2NH_3}$

It is given that only 50% of the expected product is formed hence, only 10 litre of NH_3 is formed.

N_2 used = 5 litres, left = 30 – 5 = 25 litres

H_2 used = 15 litres, left = 30 – 15 = 15 litres

51. (c) According to Stoichiometry, they should react as follow:

$$\underset{\substack{4\text{ moles}\\0.8\text{ moles}}}{4NH_3} + \underset{\substack{5\text{ moles}\\1\text{ mole}}}{5O_2} \longrightarrow \underset{\substack{4\text{ moles}\\0.8\text{ moles}}}{4NO} + \underset{\substack{6\text{ moles}\\1.2\text{ moles}}}{6H_2O}$$

Thus, for 1 mole of O_2 only 0.8 moles of NH_3 is consumed. Hence O_2 is consumed completely.

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

$\because$ 156 g of benzene, required oxygen $= 15 \times 22.4$ litre

$\therefore$ 1g of benzene, required oxygen

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

$\therefore$ 39 g of benzene, required oxygen

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

53. (a) 5 M H_2SO_4 = 10 N H_2SO_4,

($\because$ Basicity of $H_2SO_4 = 2$)

$N_1V_1 = N_2V_2$,

$10 \times 1 = N_2 \times 10$ or $N_2 = 1$ N

54. (a) $\underset{1\text{ g eq.}}{Mg^2} + \underset{1\text{g eq.}}{Na_2CO_3} \longrightarrow MgCO_3 \quad 2Na$

1 g eq. of Mg^{2+} = 12 g of Mg^{2+} = 12000 mg

= 1000 milli eq. of Na_2CO_3

$\therefore$ 12 mg Mg^{2+} = 1 milli eq. Na_2CO_3