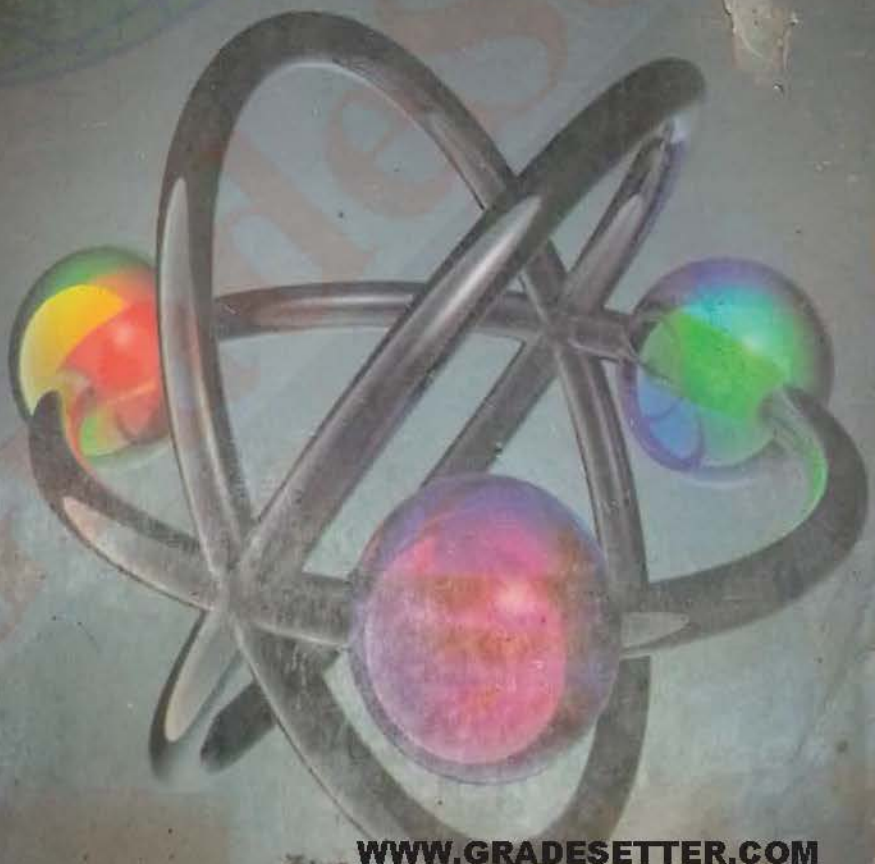
श्री BalaJi

N.Avasthi • V.K.Jaiswal

IIT-JEE Problems in Physical & Inorganic Chemistry



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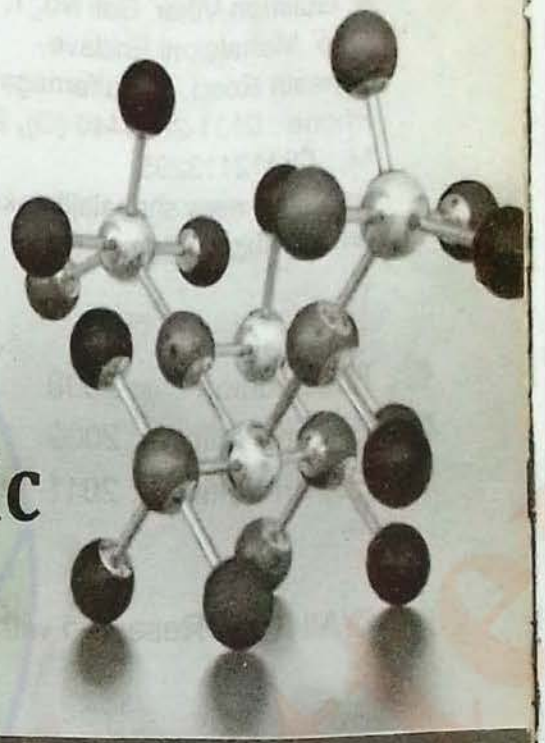

by:

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Dedicated

to

our

Beloved Parents

for

their blessings and support

GROW GREEN

Save Nature

Preface

It is a matter of great pleasure for us to present the first edition of "IIT-JEE Problems in Physical & Inorganic Chemistry" for IIT-JEE aspirants. This book brings out the experience gained during many years of teaching to the IIT-JEE aspirants. The objective of this book is to provide proper guidance and relevant material, which is really needed for the preparation of IIT-JEE.

In the book, each chapter consists of three levels of problems to cover the wide subject of chemistry in a nut shell. The level of problems given in this book is essentially required for IIT-JEE aspirants.

LEVEL-1: Problems based on basic concepts and are useful just to begin the topic.

LEVEL-2: Challenging problems based on twists and wide applications of facts.

LEVEL-3: Problems based on Comprehensions, Problems with One or More than one Correct Option, Matching Type Problems, Assertion – Reason Type Problems and Subjective Problems (Integer Type Problems) to make the students familiar with current IIT-JEE Pattern.

The problems are completely supported by answers. In the last, hints and solution have also been provided wherever necessary, to save precious time of students.

We hope that this effort will cater to the needs of IIT-JEE aspirants and as a matter of facts they will really enjoy the subjects with the problems given. We would feel rewarded if you achieve your goal with the help of the present venture.

All attempts have been made to make it free from errors. In the t constructive criticism and valuable suggestion from the readers most welcome to make this effort more useful.

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Finally, this part of book will remain incomplete without thanking to Mrs. Priti Avasthi, Mrs. Anjali Jaiswal, whose time was spent during this job. We admire for their patience, understanding and support.

I also pay my sincere thanks to all the esteemed members of M/s Shri Balaji Publications in bringing out this book in such a nice form.

There are undoubtedly many other who are learning their indelible mark on this book. Thanks to every one for their assistance.

Authors

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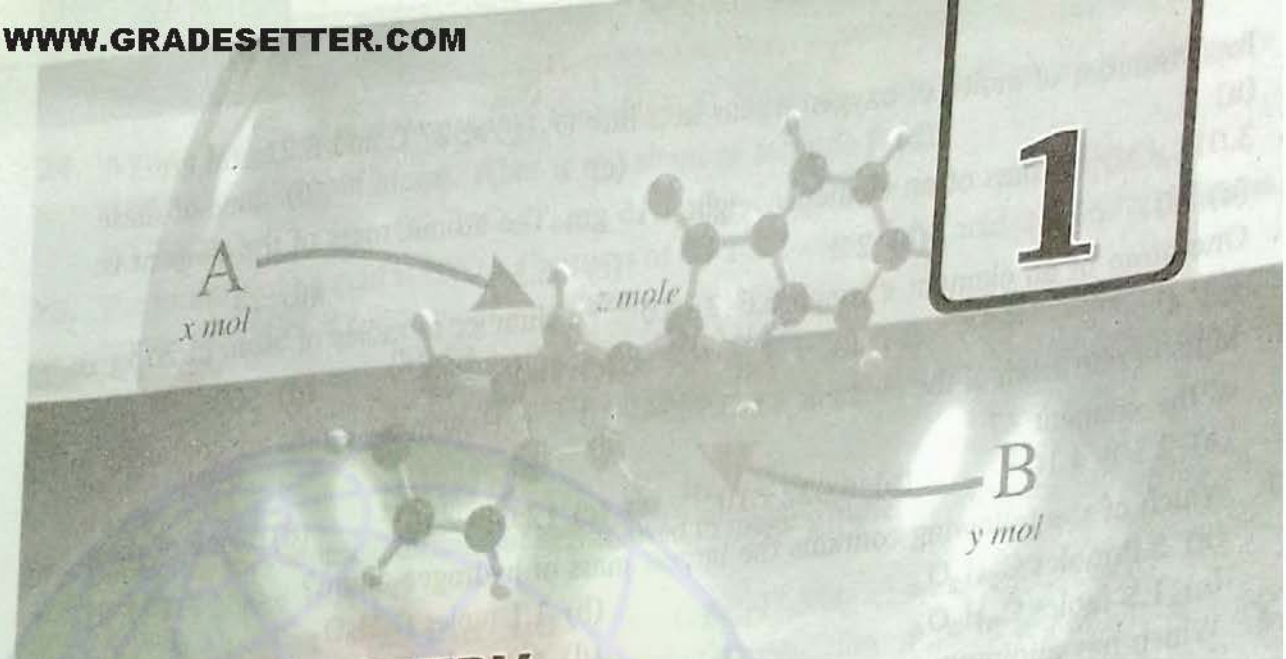


1

STOICHIOMETRY

Level 1

4/4/2012

1. If water sample are taken from sea, rivers or lake, they will be found to contain hydrogen and oxygen in the approximate ratio of 1 : 8. This indicates the law of:
   (a) Multiple proportion (b) Definite proportion
   (c) Reciprocal proportions (d) None of these
2. Hydrogen and oxygen combine to form H_2O_2 and H_2O containing 5.93% and 11.2% hydrogen respectively. The data illustrates :
   (a) law of conservation of mass (b) law of constant proportion
   (c) law of reciprocal proportion (d) law of multiple proportion
3. One of the following combinations illustrate law of reciprocal proportions :
   (a) N_2O_3, N_2O_4, N_2O_5 (b) NaCl, NaBr, NaI
   (c) CS_2, CO_2, SO_2 (d) PH_3, P_2O_3, P_2O_5
4. All the substances listed below are fertilizers that contribute nitrogen to the soil. Which of these is the richest source of nitrogen on a mass percentage basis ?
   (a) Urea, $(NH_2)_2CO$ (b) Ammonium nitrate, NH_4NO_3
   (c) Nitric oxide, NO (d) Ammonia, NH_3
5. Cisplatin, an anticancer drug, has the molecular formula $Pt(NH_3)_2Cl_2$. What is the mass (in gram) of one molecule ? (Atomic weights : Pt = 195, H = 1.0, N = 14, Cl = 35.5)
   (a) 4.98×10^{-21} (b) 4.98×10^{-22} (c) 6.55×10^{-21} (d) 3.85×10^{-22}
6. Aspirin has the formula $C_9H_8O_4$. How many atoms of oxygen are there in a tablet weighing 360 mg?
   (a) 1.204×10^{23} (b) 1.08×10^{22} (c) 1.204×10^{24} (d) 4.81×10^{21}
7. 20 g of an ideal gas contains only atoms of S and O occupies 5.6 L at NTP. What is the mol. wt. of gas ?
   (a) 64 (b) 80 (c) 96 (d) None of these
8. A sample of ammonium phosphate, $(NH_4)_3PO_4$, contains 6 moles of hydrogen atoms. The number of moles of oxygen atoms in the sample is:
   (a) 1 (b) 2 (c) 4 (d) 6

9. Total number of moles of oxygen atoms in 3 litre $O_3(g)$ at 27°C and 8.21 atm are:
(a) 3 (b) 1 (c) 1 (d) none of these

10. 3.011×10^{22} atoms of an element weight 1.15 gm. The atomic mass of the element is:
(a) 10 (b) 2.3 (c) 35.5 (d) 23

11. One atom of an element x weigh 6.643×10^{-23} g. Number of moles of atom in 20 kg is:
(a) 4 (b) 40 (c) 100 (d) 500

12. Mass of one atom of the element A is 3.9854×10^{-23} g. How many atoms are contained in 1 g of the element A?
(a) 2.509×10^{23} (b) 6.022×10^{23} (c) 12.044×10^{23} (d) None of these

13. Which of the following contains the largest mass of hydrogen atoms?
(a) 5.0 moles $C_2H_2O_4$ (b) 1.1 moles $C_3H_8O_3$
(c) 1.5 moles $C_6H_8O_6$ (d) 4.0 moles $C_2H_4O_2$

14. Which has minimum number of atoms of oxygen ?
(a) 10 mL H_2O (l) (b) 0.1 mole of V_2O_5
(c) 12 gm $O_3(g)$ (d) 12.044×10^{22} molecules of CO_2

15. Rearrange the following (I to IV) in the order of increasing masses:
(I) 0.5 mole of O_3 (II) 0.5 gm atom of oxygen
(III) 3.011×10^{23} molecules of O_2 (IV) 5.6 litre of CO_2 at STP
(a) II < IV < III < I (b) II < I < IV < III (c) IV < II < III < I (d) I < II < III < IV

16. The total no. of neutrons present in 54 mL H_2O (l) are:
(a) $3N_A$ (b) $30N_A$ (c) $24N_A$ (d) none of these

17. Total no. of electrons present in 48 g Mg^{2+} are:
(a) $24N_A$ (b) $2N_A$ (c) $20N_A$ (d) none of these

18. The number of neutron in 5 g of D_2O (D is ^2_1H) are:
(a) $0.25N_A$ (b) $2 \cdot 5N_A$ (c) $1 \cdot 1N_A$ (d) none of these

19. *It is known that atom contain protons, neutrons and electrons. If the mass of neutron is assumed to half of its original value whereas that of proton is assumed to be twice of its original value then the atomic mass of* $^{14}_6C$ will be :
(a) same (b) 14.28% less (c) 14.28% more (d) 28.56% less

20. *The hydrated salt* $Na_2CO_3 \cdot xH_2O$ undergoes 63% loss in mass on heating and becomes anhydrous. The value of x is:
(a) 10 (b) 12 (c) 8 (d) 18

21. *A 6.85 g sample of the hydrate* $Sr(OH)_2 \cdot xH_2O$ is dried in an oven to give 3.13 g of anhydrous $Sr(OH)_2$. What is the value of x ? (Atomic weights : Sr = 87.60, O = 16.0, H = 1.0)
(a) 8 (b) 12 (c) 10 (d) 6

22. What percentage of oxygen is present in the compound $CaCO_3 \cdot 3Ca_3(PO_4)_2$?
(a) 23.3% (b) 45.36% (c) 41.94% (d) 17.08%

23. *One mole of element X has 0.444 times the mass of one mole of element Y. One average atom of element X has 2.96 times the mass of one atom of* ^{12}C. What is the atomic weight of Y ?
(a) 80 (b) 15.77 (c) 46.67 (d) 40.0

24. A given sample of pure compound contains 9.81 gm of Zn, 1.8×10^{23} atoms of chromium and 0.60 mole of oxygen atoms. What is the simplest formula ?
(a) $ZnCr_2O_7$ (b) $ZnCr_2O_4$ (c) $ZnCrO_4$ (d) $ZnCrO_6$

25. The formula of an acid is HXO_2. The mass of 0.0242 moles of the acid is 1.657 g. What is the atomic weight of X ?
(a) 35.5 (b) 28.1 (c) 128 (d) 19.0

26. What is the empirical formula of vanadium oxide, if 2.74 g of the metal oxide contains 1.53 g of metal ?
(a) V_2O_3 (b) VO (c) V_2O_5 (d) V_2O_7

27. Determine the empirical formula of Kelvar, used in making bullet proof vests, is 70.6% C, 4.2% H, 11.8% N and 13.4% O :
(a) $C_7H_5NO_2$ (b) $C_7H_5N_2O$ (c) C_7H_9NO (d) C_7H_5NO

28. Dieldrin, an insecticide, contains C, H, Cl and O. Combustion of 29.72 mg of Dieldrin gave 41.21 mg CO_2 and 5.63 mg of H_2O. In a separate analysis 25.31 mg of Dieldrin was converted into 57.13 mg AgCl. What is the empirical formula of Dieldrin ?
(a) $C_6H_4Cl_3O$ (b) C_8H_8ClO (c) $C_{12}H_8Cl_6O$ (d) $C_6H_4Cl_3O_2$

29. A gaseous compound is composed of 85.7% by mass carbon and 14.3% by mass hydrogen. It's density is 2.28 g/litre at 300 K and 1.0 atm pressure. Determine the molecular formula of the compound :
(a) C_2H_2 (b) C_2H_4 (c) C_4H_8 (d) C_4H_{10}

30. If average molecular wt. of air is 29, then assuming N_2 and O_2 gases are there which options are correct regarding composition of air:
(i) 75% by mass of N_2 (ii) 75% by moles N_2 (iii) 72.41% by mass of N_2
(a) only (i) is correct (b) only (ii) is correct
(c) both (ii) and (iii) are correct (d) both (i) and (ii) are correct

31. Density of dry air containing only N_2 and O_2 is 1.15 g/L at 740 mm and 300 K. What is % composition of N_2 by weight in the air ?
(a) 78% (b) 75.5% (c) 70.02% (d) 72.75%

32. A gaseous mixture of H_2 and CO_2 gas contains 66 mass % of CO_2. The vapour density of the mixture is:
(a) 6.1 (b) 5.4 (c) 2.7 (d) 10.8

33. The vapour density of a mixture containing NO_2 and N_2O_4 is 27.6. The mole fraction of N_2O_4 in the mixture is:
(a) 0.1 (b) 0.2 (c) 0.5 (d) 0.8

34. A compound used in making nylon, is 43.8% oxygen. There are four oxygen atoms per molecule. What is the molecular weight of compound?
(a) 36 (b) 116 (c) 292 (d) 146

35. Average atomic mass of magnesium is 24.31 a.m.u. This magnesium is composed of 79 mole % of ^{24}Mg and remaining 21 mole % of ^{25}Mg and ^{26}Mg. Calculate mole % of ^{26}Mg.
(a) 10 (b) 11 (c) 15 (d) 16

36. Indium (atomic weight = 114.82) has two naturally occurring isotopes, the predominant one form has isotopic weight 114.9041 and abundance of 95.72%. Which of the following isotopic weights is the most likely for the other isotope ?
(a) 112.94 (b) 115.90 (c) 113.90 (d) 114.90

37. Suppose two elements X and Y combine to form two compounds XY_2 and X_2Y_3 when 0.05 mole of XY_2 weighs 5 g while 3.011×10^{23} molecules of X_2Y_3 weighs 85 g. The atomic masses of X and Y are respectively :
(a) 20, 30 (b) 30, 40 (c) 40, 30 (d) 80, 60

38. 44 g of a sample on complete combustion gives 88 gm CO_2 and 36 gm of H_2O. The molecular formula of the compound may be:
(a) C_4H_6 (b) C_2H_6O (c) C_2H_4O (d) C_3H_6O

39. 40 milligram diatomic volatile substance (X_2) is converted to vapour that displaced 4.92 mL of air at 1 atm and 300 K. Atomic weight of element X is nearly:
(a) 400 (b) 240 (c) 200 (d) 100

40. A mixture of O_2 and gas "Y" (mol. wt. 80) in the mole ratio $a : b$ has a mean molecular weight 40. What would be mean molecular weight, if the gases are mixed in the ratio $b : a$ under identical conditions ? (gases are non-reacting):
(a) 40 (b) 48 (c) 62 (d) 72

41. Two element X (at. mass = 75) and Y (at. mass = 16) combine to give a compound having 75.8% of X. The formula of the compound is:
(a) XY (b) X_2Y (c) X_2Y_2 (d) X_2Y_3

42. A sample of phosphorus that weighs 12.4 g exerts a pressure 8 atm in a 0.821 litre closed vesel at 527°C. The molecular formula of the phosphorus vapour is:
(a) P_2 (b) P_4 (c) P_6 (d) P_8

43. Manganese forms non-stoichiometric oxides having the general formula MnO_x. The value of x for the compound that analyzed 64% Mn:
(a) 1.16 (b) 1.83 (c) 2 (d) 1.93

44. 1.44 gram of titanium (Ti) reacted with excess of O_2 and produce x gram of non-stoichiometric compound $Ti_{1.44}O$. The value of x is:
(a) 2 (b) 1.77 (c) 1.44 (d) none of these

45. A 25.0 mm × 40.0 mm piece of gold foil is 0.25 mm thick. The density of gold is 19.32 g/cm^3. How many gold atoms are in the sheet ? (Atomic weight : Au = 197.0)
(a) 7.7×10^{23} (b) 1.5×10^{23} (c) 4.3×10^{21} (d) 1.47×10^{22}

46. Balance the following equation and choose the quantity which is the sum of the coefficients of the products :

$$\ldots\ldots CS_2 + \ldots\ldots Cl_2 \longrightarrow CCl_4 + \ldots\ldots S_2Cl_2$$

(a) 5 (b) 3 (c) 6 (d) 2

47. Balance the following equation and choose the quantity which is the sum of the coefficients of reactants and products:

$$\ldots PtCl_4 + \ldots XeF_2 \longrightarrow PtF_6 + \ldots ClF + \ldots Xe$$

(a) 16 (b) 13 (c) 18 (d) 12

48. Which statement is false for the balanced equation given below ?

$$CS_2 + 3O_2 \longrightarrow 2SO_2 + CO_2$$

(a) One mole of CS_2 will produce one mole of CO_2
(b) The reaction of 16 g of oxygen produces 7.33 g of CO_2

(c) The reaction of one mole of O_2 will produce 2/3 mole of SO_2
(d) Six molecules of oxygen requires three molecules of CS_2

49. Which of the following setups is correct to calculate the weight (in g) of $KClO_3$ produced from the reaction of 0.150 moles of Cl_2?

$$3Cl_2 + 6KOH \longrightarrow 5KCl + KClO_3 + 3H_2O$$

(a) 0.150 moles $Cl_2 \times 1$ mole $KClO_3/3$ moles $Cl_2 \times 122.5$ g/1 mole $KClO_3$
(b) 0.150 moles $Cl_2 \times 1$ mole $KClO_3/3$ moles $Cl_2 \times 1$ mole $KClO_3/122.5$ g
(c) 0.150 moles $Cl_2 \times 3$ moles $Cl_2/1$ mole $KClO_3 \times 122.5$ g/1 mole $KClO_3$
(d) 0.150 moles $Cl_2 \times 3$ moles $Cl_2/1$ mole $KClO_3 \times 1$ mole $KClO_3/122.5$ g

50. 2.0 g sample contain mixture of SiO_2 and Fe_2O_3, on very strong heating leave a residue weighing 1.96 g. The reaction responsible for loss of weight is

$$Fe_2O_3\ (s) \longrightarrow Fe_3O_4\ (s) + O_2(g),\ \text{(unbalance equation)}$$

What is the percentage by mass of SiO_2 in original sample ?
(a) 10% (b) 20% (c) 40% (d) 60%

51. What volume of air at STP containing 21% of oxygen by volume is required to completely burn sulphur (S_8) present in 200 g of sample, which contains 20% inert material which does not burn. Sulphur burns according to the reaction

$$\frac{1}{8}S_8(s) + O_2(g) \longrightarrow SO_2(g)$$

(a) 23.52 litre (b) 320 litre (c) 112 litre (d) 533.33 litre

52. For the reaction, $2Fe(NO_3)_3 + 3Na_2CO_3 \longrightarrow Fe_2(CO_3)_3 + 6NaNO_3$
Initially if 2.5 mole of $Fe(NO_3)_2$ and 3.6 mole of Na_2CO_3 is taken. If 6.3 mole of $NaNO_3$ is obtained then % yield of given reaction is:
(a) 50% (b) 84 (c) 87.5 (d) 100

53. How many moles of P_4 can be produced by reaction of 0.10 moles $Ca_5(PO_4)_3F$, 0.36 moles SiO_2 and 0.90 moles C according to the following reaction ?

$$4\,Ca_5(PO_4)_3F + 18\,SiO_2 + 30\,C \longrightarrow 3P_4 + 2CaF_2 + 18CaSiO_3 + 30\,CO$$

(a) 0.060 (b) 0.030 (c) 0.045 (d) 0.075

54. Some older emergency oxygen masks containing potassium superoxide, KO_2 which reacts with CO_2 and water in exhaled air to produce oxygen according to the given equation. If a person exhales 0.667 g of CO_2 per minute, how many grams of KO_2 are consumed in 5.0 minutes?

$$4KO_2 + 2H_2O + 4CO_2 \longrightarrow 4KHCO_3 + 3O_2$$

(a) 10.7 (b) 0.0757 (c) 1.07 (d) 5.38

55. The mass of N_2F_4 produced by the reaction of 2.0 g of NH_3 and 8.0 g of F_2 is 3.56 g. What is the per cent yield?

$$2NH_3 + 5F_2 \longrightarrow N_2F_4 + 6HF$$

(a) 79.0 (b) 71.2 (c) 84.6 (d) None of these

56. Phosphoric acid (H_3PO_4) prepared in a two step process.
(1) $P_4 + 5O_2 \longrightarrow P_4O_{10}$ (2) $P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$

We allow 62 g of phosphorus to react with excess oxygen which form P_4O_{10} in 85% yield. In the step (2) reaction 90% yield of H_3PO_4 is obtained. Produced mass of H_3PO_4 is:
(a) 37.485 g (b) 149.949 g (c) 125.47 g (d) 564.48 g

57. 0.8 mole of a mixture of CO and CO_2 requires exactly 40 gram of NaOH in solution for complete conversion of all the CO_2 into Na_2CO_3. How many moles more of NaOH would it require for conversion into Na_2CO_3, if the mixture (0.8 mole) is completely oxidised to CO_2?
(a) 0.2 (b) 0.6 (c) 1 (d) 1.5

58. Silver oxide (Ag_2O) decomposes at temperature 300°C yielding metallic silver and oxygen gas. A 1.60 g sample of impure silver oxide yields 0.104 g of oxygen gas. What is the per cent by mass of the silver oxide in the sample ?
(a) 5.9 (b) 47.125 (c) 94.25 (d) 88.2

59. What is the molar mass of diacidic organic Lewis base, if 12 g of chloroplatinate salt on ignition produced 5 gm residue?
(a) 52 (b) 58 (c) 88 (d) None of these

60. One gram of the silver salt of an organic dibasic acid yields, on strong heating, 0.5934 g of silver. If the weight percentage of carbon in it 8 times the weight percentage of hydrogen and one-half the weight percentage of oxygen, determine the molecular formula of the acid.
(a) $C_4H_6O_4$ (b) $C_4H_6O_6$ (c) $C_2H_6O_2$ (d) $C_5H_{10}O_5$

61. 0.607 g of a silver salt of tribasic organic acid was quantitatively reduced to 0.37 g of pure Ag. What is the mol. wt. of the acid?
(a) 207 (b) 210 (c) 531 (d) 324

62. An ideal gaseous mixture of ethane (C_2H_6) and ethene (C_2H_4) occupies 28 litre at STP. The mixture reacts completely with 128 g O_2 to produce CO_2 and H_2O. Mole fraction at C_2H_6 in the mixture is:
(a) 0.6 (b) 0.4 (c) 0.5 (d) 0.8

63. 20 mL of a mixture of CO and H_2 were mixed with excess of O_2 and exploded and cooled. There was a volume contraction of 18 mL. All volume measurements corresponds to room temperature (27°C) and one atmospheric pressure. Determine the volume ratio $V_1 : V_2$ of CO and H_2 in the original mixture.
(a) 1 : 2 (b) 3 : 2 (c) 2 : 3 (d) 4 : 1

64. The percentage by volume of C_3H_8 in a gaseous mixture of C_3H_8, CH_4 and CO is 20. When 100 mL of the mixture is burnt in excess of O_2, the volume of CO_2 produced is:
(a) 90 mL (b) 160 mL (c) 140 mL (d) none of these

65. 40 mL gaseous mixture of CO, CH_4 and Ne was exploded with 10 mL of oxygen. On cooling, the gases occupied 36.5 mL. After treatment with KOH the volume reduced by 9 mL and again on treatment with alkaline pyrogallol, the volume further reduced.
Percentage of CH_4 in the original mixture is:
(a) 22.5 (b) 77.5 (c) 7.5 (d) 15

66. A gaseous mixture of propane and butane of volume 3 litre on complete combustion produces 11.0 litre CO_2 under standard conditions of temperature and pressure.
The ratio of volume of butane to propane is:
(a) 1 : 2 (b) 2 : 1 (c) 3 : 2 (d) 3 : 1

67. Fluoxymesterone, $C_{20}H_{29}FO_3$, is an anabolic steroid. A solution is prepared by dissolving 10.0 mg of the steroid in 500 mL of water, 1.0 mL portion of this solution is diluted to a final volume of 1.00 L. What is the resulting molarity ?
(a) 1.19×10^{-10} (b) 1.19×10^{-7} (c) 5.95×10^{-8} (d) 2.38×10^{-11}

68. The lead nitrate, $Pb(NO_3)_2$, in 25 mL of a 0.15 *M* solution reacts with all of the aluminium sulphate, $Al_2(SO_4)_3$, in 20 mL of solution. What is the molar concentration of the $Al_2(SO_4)_3$?

$$3Pb(NO_3)_2(aq) + Al_2(SO_4)_3(aq) \longrightarrow 3PbSO_4(s) + 2Al(NO_3)_3(aq)$$

(a) 6.25×10^{-2} *M* (b) 2.421×10^{-2} *M* (c) 0.1875 *M* (d) None of these

69. Concentrated HNO_3 is 63% HNO_3 by mass and has a density of 1.4 g/mL. How many millilitres of this solution are required to prepare 250 mL of a 1.20 M HNO_3 solution?

(a) 18.0 (b) 21.42 (c) 20.0 (d) 14.21

70. Wood's metal contains 50.0% bismuth, 25.0% lead, 12.5% tin and 12.5% cadmium by weight. What is the mole fraction of tin ?

(Atomic weights : Bi = 209, Pb = 207, Sn = 119, Cd = 112)

(a) 0.202 (b) 0.158 (c) 0.176 (d) 0.221

71. The density of a 56.0% by weight aqueous solution of 1-propanol ($CH_3CH_2CH_2OH$) is 0.8975 g/cm^3. What is the mole fraction of the compound ?

(a) 0.292 (b) 0.227 (c) 0.241 (d) 0.276

72. Three solutions *X*, *Y*, *Z* of HCl are mixed to produce 100 mL of 0.1 *M* solution. The molarities of *X*, *Y* and *Z* are 0.07 *M*, 0.12 *M* and 0.15 *M* respectively. What respective volumes of *X*, *Y* and *Z* should be mixed ?

(a) 50 mL, 25 mL, 25 mL (b) 20 mL, 60 mL, 20 mL

(c) 40 mL, 30 mL, 30 mL (d) 55 mL, 20 mL, 25 mL

73. What is the molartiy of SO_4^{2-} ion in aqueous solution that contain 34.2 ppm of $Al_2(SO_4)_3$? (Assume complete dissociation and density of solution 1 g/mL)

(a) 3×10^{-4} *M* (b) 2×10^{-4} *M* (c) 10^{-4} *M* (d) None of these

74. 50 mL of 20.8% (*w*/*V*) $BaCl_2$ (*aq*) and 100 mL of 9.8% (*w*/*V*) H_2SO_4 (*aq*) solutions are mixed. Molarity of Cl^- ions in the resulting solution is: (At. wt. of Ba = 137)

(a) 0.333 *M* (b) 0.666 *M* (c) 0.1 *M* (d) 1.33 M

75. The relation between molarity (*M*) and molality (*m*) is given by :

(ρ = density of solution, M_1 = molecular weight of solute)

(a) $m = \dfrac{1000\,M}{1000\,\rho - M_1}$ (b) $m = \dfrac{1000\,\rho M}{1000\,\rho - MM_1}$

(c) $m = \dfrac{1000\,MM}{1000\,\rho - MM_1}$ (d) $m = \dfrac{1000\,M}{1000\,\rho - MM_1}$

76. Molarity and molality of a solution of an liquid (mol. wt. = 50) in aquous solution is 9 and 10 respectively. What is the density of solution?

(a) 1 g/cc (b) 0.95 g/cc (c) 1.05 g/cc (d) 1.35 g/cc

77. An aqueous solution of ethanol has density 1.025 g/mL and it is 2 M. What is the molality of this solution ?

(a) 1.79 (b) 2.143 (c) 1.951 (d) None of these

78. 0.2 mole of HCl and 0.2 mole of barium chloride were dissolved in water to produce a 500 mL solution. The molarity of the Cl^- ions is :

(a) 0.06 *M* (b) 0.09 *M* (c) 1.2 M (d) 0.80 M

79. Calculate the mass of anhydrous HCl in 10 mL of concentrated HCl (density = 1.2 g / mL) solution having 37% HCl by weight.

(a) 4.44 g (b) 4.44 mg (c) 4.44×10^{-3} g (d) 0.444 µg

80. 100 mL of 10% NaOH (*w/V*) is added to 100 mL of 10% HCl (*w/V*). The resultant solution becomes:
(a) alkaline (b) strongly alkaline (c) acidic (d) neutral

81. Calculate the molality of 1 L solution of 80% H_2SO_4 (*w/V*), given that the density of the solution is 1.80 g mL^{-1}.
(a) 8.16 (b) 8.6 (c) 1.02 (d) 10.8

82. How many millilitres of 0.1 *M* H_2SO_4 must be added to 50 mL of 0.1 *M* NaOH to give a solution that has a concentration of 0.05 *M* in H_2SO_4 ?
(a) 400 mL (b) 200 mL (c) 100 mL (d) None of these

83. 1 *M* HCl and 2 *M* HCl are mixed in volume ratio of 4 : 1. What is the final molarity of HCl solution?
(a) 1.5 (b) 1 (c) 1.2 (d) 1.8

84. 342 gm of 20% by mass of $Ba(OH)_2$ solution (sp. gr. 0.57) is reacted with 1200 mL of 2*M* HNO_3. If the final density is same as pure water then molarity of the ion in resulting solution by nature of the above solution is identified, is:
(a) 0.25 (b) 0.5 *M* (c) 0.888 *M* (d) None of these

85. 100 mL of H_2SO_4 solution having molarity 1 *M* and density 1.5 g/mL is mixed with 400 mL of water. Calculate final molarity of H_2SO_4 solution, if final density is 1.25 g/mL :
(a) 4.4 *M* (b) 0.145 *M* (c) 0.52 *M* (d) 0.227 M

86. What volume of HCl solution of density 1.2 g/cm^3 and containing 36.5% by weight HCl, must be allowed to react wtih zinc (Zn) in order to liberate 4.0 g of hydrogen ?
(a) 333.33 mL (b) 500 mL (c) 614.66 mL (d) None of these

87. A bottle of an aqueous H_2O_2 solution is labelled as '28 *V*' H_2O_2 and the density of the solution in g/mL is 1.25. Choose the correct option:
(a) Molality of H_2O_2 solution is 2 (b) Molarity of H_2O_2 solution is 5
(c) Molality of H_2O_2 solution is 2.15 (d) None of these

88. The impure 6 g of NaCl is dissolved in water and then treated with excess of silver nitrate solution. The weight of precipitate of silver chloride is found to be 14 g. The % purity of NaCl solution would be:
(a) 95% (b) 85% (c) 75% (d) 65%

89. 10 L of hard water required 5.6 g of lime for removing hardness. Hence temporary hardness in ppm of $CaCO_3$ is:
(a) 1000 (b) 2000 (c) 100 (d) 1

90. A sample of peanut oil weighing 2 g is added to 25 mL of 0.40 *M* KOH. After saponification is complete, 8.5 mL of 0.28 *M* H_2SO_4 is needed to neutralize excess of KOH. The saponification number of peanut oil is :
(saponification number is defined as the milligrams of KOH consumed by 1 g of oil)
(a) 146.72 (b) 223.44 (c) 98.9 (d) None of these

91. $Al_2(SO_4)_3$ solution of 1 molal concentration is present in 1 litre solution of 2.684 g/cc. How many moles of $BaSO_4$ would be precipitated on adding $BaCl_2$ in excess ?
(a) 2 moles (b) 3 moles (c) 6 moles (d) 12 moles

92. A certain public water supply contains 0.10 ppb (part per billion) of chloroform ($CHCl_3$). How many molecules of $CHCl_3$ would be obtained in 0.478 mL drop of this water ?
(assumed $d = 1$ g/mL)
(a) $4 \times 10^{-3} \times N_A$ (b) $10^{-3} \times N_A$ (c) $4 \times 10^{-10} \times N_A$ (d) None of these

93. 1 L of pond water contains 20 mg of Ca^{2+} and 12 mg of Mg^{2+} ions. What is the volume of a 2 *N* Na_2CO_3 solution required to soften 5000 L of pond water?
(a) 500 L (b) 50 L (c) 5 L (d) None of these

94. One litre of a sample of hard water contain 4.44 mg $CaCl_2$ and 1.9 mg of $MgCl_2$. What is the total hardness in terms of ppm of $CaCO_3$?
(a) 2 ppm (b) 3 ppm (c) 4 ppm (d) 6 ppm

95. Phosphorous has the oxidation state of + 1 in:
(a) Orthophosphoric acid (b) Phosphorous acid
(c) Hypophosphorous acid (d) Metaphosphoric acid

96. The oxidation state(s) of Cl in $CaOCl_2$ (bleaching powder) is/are:
(a) +1 only (b) − 1 only (c) + 1 and − 1 (d) none of these

97. The oxidation number of sulphur in S_8, S_2F_2 and H_2S H_2SO_4 and respectively are:
(a) 0, + 1, − 2 and 6 (b) + 2, 0, + 2 and 6 (c) 0, + 1, + 2 and 4 (d) − 2, 0, + 2 and 6

98. Fe shows an oxidation state of + 1 in:
(a) $Fe(CO)_5$ (b) $[Fe(H_2O)_5NO]SO_4$
(c) $Fe_4[Fe(CN)_6]_3$ (d) $FeCl_4^-$

99. When SO_2 is passed into an acidified potassium dichromate solution, the oxidation numbers of sulphur and chromium in the final products respectively are:
(a) +6, +6 (b) +6, +3 (c) 0, +3 (d) +2, +3

100. The oxidation number of nitrogen atoms in NH_4NO_3 are:
(a) +3, +3 (b) +3, − 3 (c) − 3, + 5 (d) −5, + 3

101. The oxidation states of S-atoms in Caro's and Marshell's acids are:
(a) + 6, + 6 (b) + 6, + 4 (c) + 6, − 6 (d) + 4, + 6

102. In Fe(II)–MnO_4^- titration, HNO_3, is not used because:
(a) it oxidises Mn^{2+} (b) it reduces MnO_4^-
(c) it oxidises Fe^{2+} (d) it reduces Fe^{3+} formed

103. 0.1 mole H_3PO_x is completely neutralised by 5.6 g KOH then the true statement is:
(a) $x = 3$ and given acid is dibasic
(b) $x = 4$ and given acid has no P–H linkage
(c) $x = 2$ and given acid does not form acid salt
(d) all of these

104. When potassium permanganate is titrated against ferrous ammonium sulphate in acidic medium, the equivalent weight of potassium permanganate is:
(a) $\frac{\text{molecular weight}}{3}$ (b) $\frac{\text{molecular weight}}{5}$
(c) $\frac{\text{molecular weight}}{2}$ (d) $\frac{\text{molecular weight}}{10}$

105. 2 mole of N_2H_4 loses 16 mole of electron is being converted to a new compound X. Assuming that all of the N appears in the new compound. What is the oxidation state of 'N' in X ?
(a) − 1 (b) − 2 (c) + 2 (d) + 4

106. Equivalent weight of FeS_2 in the half reaction, $FeS_2 \longrightarrow Fe_2O_3 + SO_2$ is :
(a) *M*/10 (b) *M*/11 (c) *M*/6 (d) *M*/1

107. The equivalent weight of HCl in the given reaction is:

$K_2Cr_2O_7 + 14HCl \longrightarrow 2KCl + 2CrCl_3 + 3Cl_2 + H_2O$

(a) 16.25 (b) 36.5 (c) 73 (d) 85.1

108. Equivalent weight of H_3PO_2 when it disproportionate into PH_3 and H_3PO_3 is:

(a) M (b) $M/2$ (c) $M/4$ (d) $3M/4$

109. In the following reaction, $As_2S_3 + H^+ + NO_3^- \longrightarrow NO + H_2O + AsO_4^{3-} + SO_4^{2-}$

the equivalent weight of As_2S_3 is related to its molecular weight by :

(a) $M/2$ (b) $M/4$ (c) $M/24$ (d) $M/28$

110. 6×10^{-3} mole $K_2Cr_2O_7$ reacts completely with 9×10^{-3} mole X^{n+} to give XO_3^- and Cr^{3+}. The value of n is :

(a) 1 (b) 2 (c) 3 (d) None of these

111. When BrO_3^- ion reacts with Br^- in acid medium, Br_2 is liberated. The equivalent weight of Br_2 in this reaction is:

(a) $\frac{5M}{8}$ (b) $\frac{5M}{3}$ (c) $\frac{3M}{5}$ (d) $\frac{4M}{6}$

112. Decreasing order (first having highest and then others following it) of mass of pure NaOH in each of the aqueous solution:

(i) 50 g of 40% (*w/W*) NaOH

(ii) 50 mL of 50% (*w/V*) NaOH [$d_{soln.} = 1.2$ g / mL]

(iii) 50 g of 15 *M* NaOH [$d_{soln.} = 1$ g / mL]

(a) i, ii, iii (b) iii, ii, i (c) ii, iii, i (d) ii, i, iii

113. If m_A gram of a metal *A* displaces m_B gram of another metal *B* from its salt solution and if the equivalent weights are E_A and E_B respectively then equivalent weight of *A* can be expressed as:

(a) $E_A = \frac{m_A}{m_B} \times E_B$ (b) $E_A = \frac{m_A \times m_B}{E_B}$ (c) $E_A = \frac{m_B}{m_A} \times E_B$ (d) $E_A = \sqrt{\frac{m_A}{m_B} \times E_B}$

114. For the redox reaction, $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

the correct coefficients of the reactants for the balanced reaction are respectively MnO_4^-, $C_2O_4^-$, H^+:

(a) 2, 5, 16 (b) 16, 3, 12 (c) 15, 16, 12 (d) 2, 16, 5

115. In a chemical reaction, $K_2Cr_2O_7 + xH_2SO_4 + ySO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + zH_2O$; the value of x, y and z respectively are :

(a) $x = 1, y = 3, z = 1$ (b) $x = 4, y = 1, z = 4$

(c) $x = 3, y = 2, z = 1$ (d) $x = 2, y = 2, z = 1$

116. Hydrazine reacts with KIO_3 in presence of HCl as

$N_2H_4 + IO_3^- + 2H^+ + Cl^- \longrightarrow ICl + N_2 + 3H_2O$

The equivalent masses of N_2H_4 and KIO_3 respectively are:

(a) 8 and 53.5 (b) 16 and 53.5 (c) 8 and 35.6 (d) 8 and 87

117. What will be the normality of a solution obtained by mixing 0.45 *N* and 0.60 *N* NaOH in the ratio 2 : 1 by volume ?

(a) 0.4 *N* (b) 0.5 *N* (c) 1.05 *N* (d) 0.15 *N*

118. A 3.4 g sample of H_2O_2 solution containing x% H_2O_2 by mass requires x mL of a $KMnO_4$ solution for complete oxidation under acidic condition. The molarity of $KMnO_4$ solution is :
(a) 1 (b) 0.5 (c) 0.4 (d) 0.2

119. What volume of $O_2(g)$ measured at STP will be formed by action of 100 mL of 0.5 *N* $KMnO_4$ on hydrogen peroxide in an acid solution ? The skeleton equation for the reaction is

$$KMnO_4 + H_2SO_4 + H_2O_2 \longrightarrow K_2SO_4 + MnSO_4 + O_2 + H_2O$$

(a) 0.12 litre (b) 0.028 litre (c) 0.56 litre (d) 1.12 litre

120. A sample of 1.0 g of solid Fe_2O_3 of 80% purity is dissolved in a moderately concentrated HCl solution which is reduced by zinc dust. The resulting solution required 16.7 mL of a 0.1 M solution of the oxidant. Calculate the number of electrons taken up by the oxidant.
(a) 2 (b) 4 (c) 6 (d) 5

121. $KMnO_4$ reacts with oxalic acid according to the equation

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Here, 20 mL of 0.1 *M* $KMnO_4$ is equivalent to :
(a) 120 mL of 0.25 *M* $H_2C_2O_4$ (b) 150 mL of 0.10 *M* $H_2C_2O_4$
(c) 25 mL of 0.20 *M* $H_2C_2O_4$ (d) 50 mL of 0.20 *M* $H_2C_2O_4$

122. Ratio of moles of Fe (II) oxidised by equal volumes of equimolar $KMnO_4$ and $K_2Cr_2O_7$ solutions in acidic medium will be:
(a) 5 : 3 (b) 1 : 1 (c) 1 : 2 (d) 5 : 6

123. The weight of a mixture contining HCl and H_2SO_4 is 0.1 g. On treatment with an excess of an $AgNO_3$ solution, reacted with this acid mixture gives 0.1435 g of AgCl. Weight % of the H_2SO_4 is mixture is :
(a) 36.5 (b) 63.5 (c) 50 (d) None of these

124. A solution of $Na_2S_2O_3$ is standardized iodometrically against 0.167 g of $KBrO_3$. This process requires 50 mL of the $Na_2S_2O_3$ solution. What is the normality of the $Na_2S_2O_3$?
(a) 0.2 *N* (b) 0.12 *N* (c) 0.72 *N* (d) 0.02 *N*

125. 0.80 g of impure $(NH_4)_2SO_4$ was boiled with 100 mL of a 0.2 *N* NaOH solution till all the $NH_3(g)$ evolved. The remaining solution was diluted to 250 mL. 25 mL of this solution was neutralized using 5 mL of a 0.2 *N* H_2SO_4 solution. The percentage purity of the $(NH_4)_2SO_4$ sample is:
(a) 82.5 (b) 72.5 (c) 62.5 (d) 17.5

126. The NH_3 evolved due to complete conversion of N from 1.12 g sample of protein was absorbed in 45 mL of 0.4 *N* HNO_3. The excess acid required 20 mL of 0.1 *N* NaOH. The % N in the sample is:
(a) 8 (b) 16 (c) 20 (d) 25

127. Find out % of oxalate ion in a given sample of an alkali metal oxalate salt, 0.30 g of it is dissolved in 100 mL water required 90 mL of centimolar $KMnO_4$ solution in acidic medium.
(a) 66% (b) 55% (c) 44% (d) 6.6%

128. 320 mg of a sample of magnesium having a coating of its oxide required 20 mL of 0.1 M hydrochloric acid for the complete neutralisation of the latter. The composition of the sample is:
(a) 87.5% Mg and 12.5% MgO (b) 12.5% Mg and 87.5% MgO
(c) 80% Mg and 20% MgO (d) 20% Mg and 80% MgO

129. The concentration of bivalent lead ions in a sample of polluted water that also contains nitrate ions is determined by adding solid sodium sulphate (M = 142) to exactly 500 mL water.

Calculate the molarity of lead ions if 0.355 g of sodium sulphate was needed for complete precipitation of lead ions as sulphate.
(a) 1.25×10^{-3} *M* (b) 2.5×10^{-3} *M* (c) 5×10^{-3} *M* (d) None of these

130. What volume of HNO_3 (sp. gravity 1.05 g mL^{-1} containing 12.6 (*w/W*) of HNO_3) that reduce into NO is required to oxidise iron 1 g $FeSO_4 \cdot 7H_2O$ in acid medium is?
(a) 70 mL (b) 0.57 mL (c) 80 mL (d) 0.65 mL

131. The total volume of 0.1 *M* $KMnO_4$ solution that are needed to oxidize 100 mg each of ferrous oxalate and ferrous sulphate in a mixture in acidic medium is:
(a) 1.096 mL (b) 1.32 mL (c) 5.48 mL (d) none of these

132. When 2.5 g of a sample of Mohr's salt reacts completely with 50 mL of $\frac{N}{10}$ $KMnO_4$ solution. The % purity of the sample of Mohr's salt is :
(a) 78.4 (b) 70 (c) 37 (d) 40

133. 4 mole of a mixture of Mohr's salt and $Fe_2(SO_4)_3$ requires 500 mL of 1 *M* $K_2Cr_2O_7$ for complete oxidation in acidic medium. The mole % of the Mohr's salt in the mixture is:
(a) 25 (b) 50 (c) 60 (d) 75

134. The equivalent weight of a metal is double than of oxygen. How many times is the weight of it's oxide greater than the weight of the metal ?
(a) 1.5 (b) 2 (c) 3 (d) 4

135. A metal oxide has the formula X_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of metal oxide requires 6 mg of hydrogen for complete reduction. The atomic weight of the metal (in amu) is:
(a) 15.58 (b) 155.8 (c) 5.58 (d) 55.8

136. In the mixture of ($NaHCO_3 + Na_2CO_3$), volume of HCl required is *x* mL with phenolphthalein indicator and *y* mL with methyl orange indicator in the same titration. Hence, volume of HCl for complete reaction of Na_2CO_3 is:
(a) $2x$ (b) y (c) $x/2$ (d) $(y - x)$

137. 0.1 g of a solution containing Na_2CO_3 and $NaHCO_3$ requires 10 mL of 0.01 *N* HCl for neutralization using phenolphthalein as an indicator. wt. % of Na_2CO_3 is:
(a) 25 (b) 32 (c) 50 (d) None of these

138. A mixture of NaOH and Na_2CO_3 required 25 mL of 0.1 *M* HCl using phenolphthalein as the indicator. However, the same amount of the mixture required 30 mL of 0.1 *M* HCl when methyl orange was used as the indicator. The molar ratio of NaOH and Na_2CO_3 in the mixture was:
(a) 2 : 1 (b) 1 : 2 (c) 4 : 1 (d) 1 : 4

139. 100 mL solution of NaOH and Na_2CO_3 was first titrated with *N*/10 HCl in presence of HPh, 17.5 mL is required to end point. After this MeOH was added and 2.5 mL of same HCl is required. The amount of NaOH in mixture is :
(a) 0.06 g per 100 mL (b) 0.06 g per 200 mL
(c) 0.05 g per 100 mL (d) 0.012 g per 200 mL

140. 1 gram of a sample of $CaCO_3$ was strongly heated and the CO_2 liberated was absorbed in 100 mL of 0.5 *M* NaOH. Assuming 90% purity for the sample. How much mL of 0.5 M HCl

would be required to react with the solution of the alkali and Na_2CO_3 to reach the phenolphthalein end point ?
(a) 73 mL (b) 41 mL (c) 82 mL (d) 100 mL

141. A sample of pure sodium carbonate 0.318 g is dissolved in water and titrated with HCl solution. A volume of 60 mL is required to reach the methyl orange end point. Calculate the molarity of the acid.
(a) 0.1 *M* (b) 0.2 *M* (c) 0.4 *M* (d) None of these

142. Calculate the mass of anhydrous oxalic acid, which can be oxidised to $CO_2(g)$ by 100 mL of an MnO_4^- solution, 10 mL of which is capable of oxidising 50 mL of 1*N* I^- to I_2.
(a) 45 g (b) 22.5 g (c) 30 g (d) 12.25 g

143. A mixture of $NaHC_2O_4$ and $KHC_2O_4 \cdot H_2C_2O_4$ required equal volumes of 0.2 *N* $KMnO_4$ and 0.12 *N* NaOH separately. What is the molar ratio of $NaHC_2O_4$ and $KHC_2O_4 \cdot H_2C_2O_4$ in the mixture ?
(a) 6 : 1 (b) 1 : 6 (c) 1 : 3 (d) 3 : 1

144. If *a* g is the mass of $NaHC_2O_4$ required to neutralize 100 mL of 0.2 *M* NaOH and *b* g that required to reduce 100 mL of 0.02 *M* $KMnO_4$ in acidic medium, then:
(a) $a = b$ (b) $2a = b$ (c) $a = 2b$ (d) None of these

145. 2 mole, equimolar mixture of $Na_2C_2O_4$ and $H_2C_2O_4$ required V_1 L of 0.1 *M* $KMnO_4$ in acidic medium for complete oxidation. The same amount of the mixture required V_2 L of 0.2 *M* NaOH for neutralization. The ratio of V_1 to V_2 is:
(a) 1 : 2 (b) 2 : 1 (c) 4 : 5 (d) 5 : 4

146. A mixture containing 0.05 mole of $K_2Cr_2O_7$ and 0.02 mole of $KMnO_4$ was treated with excess of KI in acidic medium. The liberated iodine required 1.0 L of $Na_2S_2O_3$ solution for titration. Concentration of $Na_2S_2O_3$ solution was:
(a) 0.40 mol L^{-1} (b) 0.20 mol L^{-1} (c) 0.25 mol L^{-1} (d) 0.30 mol L^{-1}

147. 25 mL of 2 *N* HCl, 50 mL of 4 *N* HNO_3 and *x* mL of 2 *M* H_2SO_4 are mixed together and the total volume is made up to 1 L after dilution. 50 mL of this acid mixture completely reacted with 25 mL of a 1 *N* Na_2CO_3 solution. The value of *x* is:
(a) 250 mL (b) 62.5 mL (c) 100 mL (d) None of these

148. In an iodometric estimation, the following reactions occur

$$2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2; \quad I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$$

0.12 mole of $CuSO_4$ was added to excess of KI solution and the liberated iodine required 120 mL of hypo. The molarity of hypo solution was:
(a) 2 (b) 0.20 (c) 0.1 (d) 1.0

149. 1 g mixture of equal number of mole of Li_2CO_3 and other metal carbonate required 10.99 mL of 0.5 *N* HCl for complete neutralisation reaction. What is the approximate atomic weight of the other metal ?
(a) 25 (b) 23 (c) 24 (d) 39

150. 32 g of a sample of $FeSO_4 \cdot 7H_2O$ were dissolved in dilute sulphuric acid and water and it's volume was made up to 1 litre, 25 mL of this solution required 20 mL of 0.02 M $KMnO_4$ solution for complete oxidation. Calculate the weight % of $FeSO_4 \cdot 7H_2O$ in the sample.
(a) 34.75 (b) 69.5 (c) 89.5 (d) None of these

Level 2

1. A mixture of NH_4NO_3 and $(NH_4)_2HPO_4$ contain 30.40% mass per cent of nitrogen. What is the mass ratio of the two components in the mixture ?
(a) 2 : 1 (b) 1 : 2 (c) 3 : 4 (d) 4 : 1

2. What value of 75% alcohol by weight ($d = 0.80\ g/cm^3$) must be used to prepare 150 cm^3 of 30% alcohol by weight ($d = 0.90\ g/cm^3$)?
(a) 67.5 mL (b) 56.25 mL (c) 44.44 mL (d) None of these

3. Calculate the number of millilitres of NH_3 (*aq*) solution ($d = 0.986\ g/mL$) contain 2.5% by weight NH_3, which will be required to precipitate iron as $Fe(OH)_3$ in a 0.8 g sample that contains 50% Fe_2O_3.
(a) 0.344 mL (b) 3.44 mL (c) 17.24 mL (d) 10.34 mL

4. In the preparation of iron from haematite (Fe_2O_3) by the reaction with carbon

$$Fe_2O_3 + C \longrightarrow Fe + CO_2$$

How much 80% pure iron could be produced from 120 kg of 90% pure Fe_2O_3 ?
(a) 94.5 kg (b) 60.48 kg (c) 116.66 kg (d) 120 kg

5. A mineral consists of an equimolar mixture of the carbonates of two bivalent metals. One metal is present to the extent of 12.5% by weight. 2.8 g of the mineral on heating lost 1.32 g of CO_2. What is the % by weight of the other metal ?
(a) 87.5 (b) 35.71 (c) 65.11 (d) 23.21

6. 6.2 g of a sample containing Na_2CO_3, $NaHCO_3$ and non-volatile inert impurity on gentle heating loses 5% of its weight due to reaction $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$. Residue is dissolved in water an formed 100 mL solution and its 10 mL portion requires 7.5 mL of 0.2 *M* aqueous solution of $BaCl_2$ for complete precipitation of carbonates.
Determine weight (in gram) of Na_2CO_3 in the original sample.
(a) 1.59 (b) 1.06 (c) 0.53 (d) None of these

7. Nitric acid can be produced NH_3 in three steps process

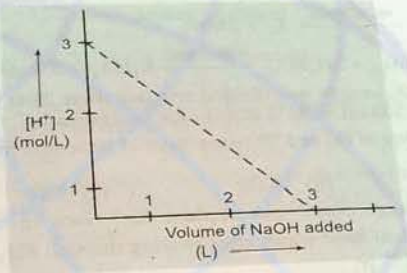
(I) $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$

(II) $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

(III) $3NO_2(g) + H_2O(l) \longrightarrow 2HNO_3(aq) + NO(g)$

% yield of I^{st}, II^{nd} and III^{rd} are respectively 50%, 60% and 80% respectively then what volume of $NH_3(g)$ at 1 atm and 0°C required to produced 1575 g of HNO_3.
(a) 156.25 (b) 350 L (c) 3500 L (d) None of these

8. 1 *M* NaOH solution was slowly added into 1000 mL of 183.75 g impure H_2SO_4 solution and the following plot was obtained. The percentage purity of H_2SO_4 sample and slope of the curve respectively are:



(a) 75%, $-\frac{1}{3}$ (b) 80%, $-\frac{1}{2}$ (c) 80%, -1 (d) None of these

9. MnO_2 on ignition converts into Mn_3O_4. A sample of pyrolusite having 75% MnO_2, 20% inert impurities and rest water is ignited in air to constant weight. What is the percentage of Mn in the ignited sample ?

(a) 24.6% (b) 37% (c) 55.24% (d) 74.05%

10. A 1.0 g sample of a pure organic compound containing chlorine is fused with Na_2O_2 to convert chlorine to NaCl. The sample is then dissolved in water, and the chloride precipitated with $AgNO_3$, giving 1.96 g of AgCl. If the molecular weight of organic compound is 147, how many chlorine atoms does each molecule contain ?

(a) 1 (b) 2 (c) 3 (d) 4

11. A 0.60 g sample consisting of only CaC_2O_4 and MgC_2O_4 is heated at 500°C, converting the two salts of $CaCO_3$ and $MgCO_3$. The sample then weighs 0.465 g. If the sample had been heated to 900°C, where the products are CaO and MgO, what would the mixtures of oxides have weighed ?

(a) 0.12 g (b) 0.21 g (c) 0.252 g (d) 0.3 g

12. A metal M forms the sulphate $M_2(SO_4)_3$. A 0.596 gram sample of the sulphate reacts with excess $BaCl_2$ to give 1.220 g $BaSO_4$. What is the atomic weight of M ?

(Atomic weights : S = 32, Ba = 137.3)

(a) 26.9 (b) 69.7 (c) 55.8 (d) 23

13. Urea (H_2NCONH_2) is manufactured by passing $CO_2(g)$ through ammonia solution followed by crystallization. CO_2 for the above reaction is prepared by combustion of hydrocarbon. If combustion of 236 kg of a saturated hydrocarbon (C_nH_{2n+2}) produces as much CO_2 as required for production of 999.6 kg urea then molecular formula of hydrocarbon is:

(a) $C_{10}H_{22}$ (b) $C_{12}H_{26}$ (c) $C_{13}H_{28}$ (d) C_8H_{18}

14. 11.6 g of an organic compound having formula C_nH_{2n+2} is burnt in excess of $O_2(g)$ initially taken in a 22.41 litre steel vessel. Before reaction the gaseous mixture was at 273 K with pressure reading 2 atm. After complete combustion and loss of considerable amount of heat, the mixture of product and excess of O_2 had a temperature of 546 K and 4.6 atm pressure. The formula of organic compound is:

(a) C_2H_6 (b) C_3H_8 (c) C_5H_{12} (d) C_4H_{10}

15. $H_2O_2 + 2KI \xrightarrow{40\% \text{ yield}} I_2 + 2KOH$

$H_2O_2 + 2KMnO_4 + 3H_2SO_4 \xrightarrow{50\% \text{ yield}} K_2SO_4 + 2MnSO_4 + 3O_2 + 4H_2O$

150 mL of H_2O_2 sample was divided into two parts. First part was treated with KI and formed KOH required 200 mL of $M/2$ H_2SO_4 for neutralisation. Other part was treated with $KMnO_4$ yielding 6.74 litre of O_2 at STP. Using % yield indicated find volume strength of H_2O_2 sample used.

(a) 5.04 (b) 10.08 (c) 3.36 (d) 33.6

16. RH_2 (ion exchange resin) can replace Ca^{2+} ions in hard water as $RH_2 + Ca^{2+} \longrightarrow RCa + 2H^+$. If 1 L of hard water after passing through RH_2 has pH = 3 then hardness in parts per million of Ca^{2+} is:

(a) 20 (b) 10 (c) 40 (d) 100

17. 100 cm^3 of a solution of an acid (Molar mass = 98) containing 29.4 g of the acid per litre were completely neutralized by 90.0 cm^3 of aq. NaOH containing 20 g of NaOH per 500 cm^3. The basicity of the acid is:

(a) 3 (b) 2 (c) 1 (d) data insufficient

18. 20 mL of 0.1 *M* solution of compound $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$ is titrated against 0.05 *M* HCl, x mL of HCl is used when phenolphthalein is used as an indicator and y mL of HCl is used when methyl orange is the indicator in two separate titrations. Hence $(y - x)$ is:

(a) 40 mL (b) 80 mL (c) 120 mL (d) None of these

19. SO_2Cl_2 (sulphuryl chloride) reacts with water to given a mixture of H_2SO_4 and HCl. What volume of 0.2 *M* $Ba(OH)_2$ is needed to completely neutralize 25 mL of 0.2 *M* SO_2Cl_2 solution:

(a) 25 mL (b) 50 mL (c) 100 mL (d) 200 mL

20. A sample containing $HAsO_2$ (mol. wt. = 108) and weighing 3.78 g is dissolved and diluted to 250 mL in a volumetric flask. A 50 mL sample (aliquot) is withdrawn with a pipet and titrated with 35 mL of 0.05 *M* solution of I_2. Calculate the percentage $HAsO_2$ in the sample:

(a) 25% (b) 20% (c) 10% (d) none of these

21. A mixture of FeO and Fe_2O_3 is completely reacted with 100 mL of 0.25 M acidified $KMnO_4$ solution. The resultant solution was then titrated with Zn dust which converted Fe^{3+} of the solution to Fe^{2+}. The Fe^{2+} required 1000 mL of 0.10 M $K_2Cr_2O_7$ solution. Find out the weight % Fe_2O_3 in the mixture.

(a) 80.85 (b) 19.15 (c) 50 (d) 89.41

22. To a 10 mL, 1 *M* aqueous solution of Br_2, excess of NaOH is added so that all Br_2 is disproportional to Br^- and BrO_3^-. The resulting solution is free from Br^-, by extraction and excess of OH^- neutralised by acidifying the solution. The resulting solution is sufficient to react with 2 g of impure CaC_2O_4 (M = 128 g/mol) sample. The % purity of oxalate sample is:

(a) 85.3% (b) 12.5% (c) 90% (d) 64%

23. 0.10 g of a sample containing $CuCO_3$ and some inert impurity was dissolved in dilute sulphuric acid and volume made up to 50 mL. This solution was added into 50 mL of 0.04 M KI solution where copper precipitates as CuI and I^- is oxidized into I_3^-. A 10 mL portion of this solution is taken for analysis, filtered and made up free I_3^- and then treated with excess

acidic permanganate solution. Liberated iodine required 20 mL of 2.5 *mM* sodium thiosulphate solution to reach the end point.
Determine weight percentage of $CuCO_3$ in the original sample.
(a) 7.41 (b) 74.1 (c) 61.75 (d) None of these

24. 1 mole of equimolar mixture of ferric oxalate and ferrous oxalate will require *x* mole of $KMnO_4$ in acidic medium for complete oxidation, *x* is:
(a) 0.5 mole (b) 0.9 mole (c) 1.2 mole (d) 4.5 mole

25. 5 *g* sample contain only Na_2CO_3 and Na_2SO_4. This sample is dissolved and the volume made up to 250 mL, 25 mL of this solution neutralizes 20 mL of 0.1 *M* H_2SO_4.
Calculate the % of Na_2SO_4 in the sample:
(a) 42.4 (b) 57.6 (c) 36.2 (d) none of these

26. An impure sample of sodium oxalate ($Na_2C_2O_4$) weighing 0.20 g is dissolved in aqueous solution of H_2SO_4 and solution is titrated at 70°C, requiring 45 mL of 0.02 M $KMnO_4$ solution. The end point is overrun, and back titration in carried out with 10 mL of 0.1 M oxalic acid solution. Find the % purity of $Na_2C_2O_4$ in sample:
(a) 75 (b) 83.75 (c) 90.25 (d) None of these

27. 0.5 *g* mixture of $K_2Cr_2O_7$ and $KMnO_4$ was treated with excess of KI in acidic medium. Iodine liberated required 150 cm^3 of 0.10 *N* solution of thiosulphate solution for titration.
Find the percentage of $K_2Cr_2O_7$ in the mixture:
(a) 14.64 (b) 34.2 (c) 65.69 (d) 50

28. A 150 mL of solution of I_2 is divided into two unequal parts. I part reacts with hypo solution in acidic medium. 15 mL of 0.4 *M* hypo was consumed. II part was added with 100 mL of 0.3 M *NaOH* solution. Residual base required 10 mL of 0.3 *M* H_2SO_4 solution for complete neutralization. What was the initial concentration of I_2 ?
(a) 0.08 *M* (b) 0.1 *M* (c) 0.2 *M* (d) None of these

29. A mixture of H_2SO_4 and $H_2C_2O_4$ (oxalic acid) and some inert impurity weighing 3.185 g was dissolved in water and the solution made up to 1 litre, 10 mL of this solution required 3 mL of 0.1 *N* NaOH for complete neutralization. In another experiment 100 mL of the same solution in hot condition required 4 mL of 0.02 *M* $KMnO_4$ solution for complete reaction.
The wt. % of H_2SO_4 in the mixture was:
(a) 40 (b) 50 (c) 60 (d) 80

30. 0.80 *g* of sample of impure potassium dichromate was dissolved in water and made upto 500 mL solution. 25 mL of this solution treated with excess of KI in acidic medium and I_2 liberated required 24 mL of a sodium thiosulphate solution. 30 mL of this sodium thiosulphate solution required 15 mL of *N*/20 solution of pure potassium dichromate.
What was the percentage of $K_2Cr_2O_7$ in given sample ?
(a) 73.5% (b) 75.3% (c) 36.75% (d) None of these

Level 3

PASSAGE 1

Oleum is considered as a solution of SO_3 in H_2SO_4, which is obtained by passing SO_3 in solution of H_2SO_4. When 100 g sample of oleum is diluted with desired weight of H_2O then the total mass of H_2SO_4 obtained after dilution is known as % labelling in oleum. For example, a oleum bottle labelled as '109% H_2SO_4' means the 109 g total mass of pure H_2SO_4 will be formed when 100 g of oleum is diluted by 9 g of H_2O which combines with all the free SO_3 present in oleum to form H_2SO_4 as $SO_3 + H_2O \longrightarrow H_2SO_4$.

1. What is the % of free SO_3 in an oleum that is labelled as '104.5% H_2SO_4' ?
(a) 10 (b) 20 (c) 40 (d) None of these

2. 9.0 g water is added into oleum sample labelled as "112%" H_2SO_4 then the amount of free SO_3 remaining in the solution is :
(a) 14.93 L at STP (b) 7.46 L at STP (c) 3.73 L at STP (d) 11.2 L at STP

3. If excess water is added into a bottle sample labelled as "112% H_2SO_4" and is reacted with 5 g Na_2CO_3, then find the volume of CO_2 evolved at 1 atm pressure and 300 K temperature after the completion of the reaction :
(a) 2.46 L (b) 24.6 L (c) 1.23 L (d) 12.3 L

4. 1 g of oleum sample is diluted with water. The solution required 54 mL of 0.4 N NaOH for complete neutralization. The % of free SO_3 in the sample is :
(a) 74 (b) 26 (c) 20 (d) None of these

PASSAGE 2

The strength of H_2O_2 is expressed in several ways like molarity, normality, % (w/V), volume strength, etc. The strength of "10 V" means 1 volume of H_2O_2 on decomposition gives 10 volumes of oxygen at STP or 1 litre of H_2O_2 gives 10 litre of O_2 at STP. The decomposition of H_2O_2 is shown as under :

$$H_2O_2(aq) \longrightarrow H_2O(l) + \frac{1}{2}O_2(g)$$

H_2O_2 can acts as oxidising as well as reducing agent, as oxidizing agent H_2O_2 converted into H_2O and as reducing agent H_2O_2 converted into O_2, both cases it's n-factor is 2.

$\therefore$ Normality of H_2O_2 solution = 2 × Molarity of H_2O_2 solution

What is the molarity of "11.2 V" of H_2O_2?
(a) 1 M (b) 2 M (c) 5.6 M (d) 11.2 M

What is the percentage strength (% w/V) of "11.2 V" H_2O_2?
(a) 1.7 (b) 3.4 (c) 34 (d) None of th

3. 20 mL of H_2O_2 solution is reacted with 80 mL of 0.05 *M* $KMnO_4$ in acidic medium then what is the volume strength of H_2O_2?
(a) 2.8 (b) 5.6 (c) 11.2 (d) None of these

4. 40 g $Ba(MnO_4)_2$ (mol. wt. = 375) sample containing some inert impurities in acidic medium is completely reacted with 125 mL of "33.6 *V*" of H_2O_2. What is the percentage purity of the sample?
(a) 28.12% (b) 70.31% (c) 85% (d) None of these

PASSAGE 3

A water is said to be a soft water if it produces sufficient foam with the soap and water that does not produce foam with soap is known as hard water. Hardness has been classified into two types (i) Temporary hardness (ii) Permanent hardness.

Temporary hardness is due to presence of calcium and magnesium bicarbonate. It is simply removed by boiling as

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + CO_2\uparrow + H_2O$$

$$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3\downarrow + CO_2\uparrow + H_2O$$

Temporary hardness can also be removed by addition of slaked lime, $Ca(OH)_2$

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + 2H_2O$$

Permanent hardness is due to presence of sulphate and chlorides of Ca, Mg, etc. It is removed by washing soda as

$$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaCl$$

$$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + Na_2SO_4$$

Permanent hardness also removed by ion exchange resin process as

$$2RH + Ca^{2+} \longrightarrow R_2Ca + 2H^+$$

$$2ROH + SO_4^{2-} \longrightarrow R_2SO_4 + 2OH^-$$

The degree of hardness of water is measured in terms of ppm of $CaCO_3$. 100 ppm means 100 g of $CaCO_3$ is present in 10^6 g of H_2O. If any water contain 120 ppm of $MgSO_4$, its hardness in terms of $CaCO_3$ = 100 ppm.

1. One litre of a sample of hard water (d = 1 g/mL) contains 136 mg of $CaSO_4$ and 190 mg of $MgCl_2$. What is the total hardness of water in terms of $CaCO_3$?
(a) 100 ppm (b) 200 ppm (c) 300 ppm (d) None of these

2. What is the weight of $Ca(OH)_2$ required for 10 litre of water remove temporary hardness of 100 ppm due to $Ca(HCO_3)_2$?
(a) 1.62 g (b) 0.74 g (c) 7.4 g (d) None of these

3. A 200 g sample of hard water is passed through the column of cation exchange resin, in which H^+ is exchanged by Ca^{2+}. The outlet water of column required 50 mL of 0.1 M NaOH for complete neutralization. What is the hardness of Ca^{2+} ion in ppm?
(a) 250 ppm (b) 500 ppm (c) 750 ppm (d) 1000 ppm

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