SECOND EDITION

Problems and Solutions in Physical Chemistry for JEE (Main and Advance)

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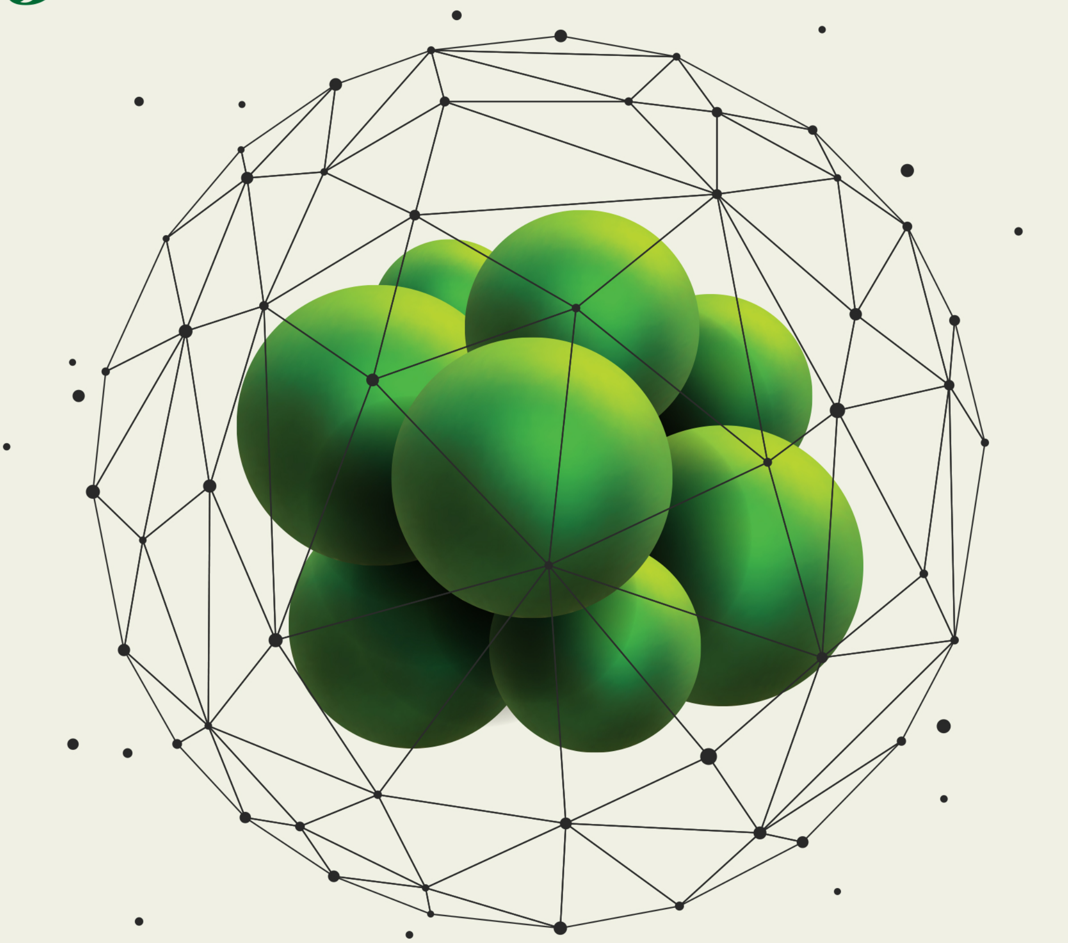

Focused on JEE Main and Advance

Questions graded as per level - Mains and Advance with detailed solution

Pearson

Neeraj Kumar

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for JEE (Main and Advanced)

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Second Edition

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Pearson

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Preface

Problems and Solutions in Physical Chemistry for JEE (Main and Advanced), 2nd edition has been conceived to meet the specific requirements of the students preparing for engineering entrance examination. The best way to ensure that students understand the concepts of physical chemistry is to solve as many problems on each concept. It aims to impart the wide range of questions with exhaustive solutions from different concepts to practice while preparing for examination. Students should attempt range of questions, rather than spending too much time with the same problems again and again. Students should also ensure to read each problem carefully, since a small variation in the problem can make huge difference in its solution.

This enhanced second edition written in lucid and structured manner to help students prepare and practice the ample number of problems in minimum possible time and develop effective techniques to attempt the examination. Questions are arranged into two sections—JEE Main and JEE Advanced followed by topic-wise practice exercises. These include – single and multiple correct choice, comprehension-based, assertion-reason, matrix match and integer answer type. Exhaustive solutions to these practice questions both (Main and Advanced) incorporated to achieve target with good score.

Practicing these questions, aspirants will come to know about the pattern and toughness of the examination in both Main and Advanced. The soul of the title is to make the aspirants competent enough to crack the uncertainty of success in the entrance examination.

In the last, I wish to emphasize that though I made every sincere effort to make this book error-free, but I do not claim to be infallible. I hope the students will be greatly benefited with this edition. Suggestions are welcome.

Acknowledgement

I am grateful to Pearson Education for keeping faith in me. I would like to thank Jitendra Kumar, from the editorial division, for regularly motivating me. Without his kind support, bringing out this book would not have been possible.

I would like to thank all of my friends—Akhilesh Kanthed, Amit Kumar Gupta, Ankit Sharma, Deepak Arora, Dilip Sharma, Faheem Naik, Gautam Bothra, Girish Kumar Gupta, Jitendra Hirwani, Krishnavtar Gaur, Manoj Agarwal, Mithilesh Thakur, P. C. Reddy, Puneet Hakoo, Rahul Kaushik, Rahul Mishra, Rajesh Kumar, Samvit Bissa, Vijay Jain, Vijay Kumar Tripathy, Vijit Jain—for their constructive criticism and suggestions that added value to this book.

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My special thanks goes to my wife Sweta, and daughter Shrija, for their encouragement, patience, sacrifice and constant support.

A very special thanks to my son Mihir Suman (Mihu) who delighted our life for a very small time (only three months) but I have written the solutions of 3–4 chapters during hospitalisation. It's great memory for me.

I am also thankful to all of my students, who made me, who am I now.

As an author, I have tried to touch the goodness of my father, Suresh Prasad. Without his blessings and motivation, it would not have been possible.

I heartily welcome suggestions from the readers for further improvement of this book. Please feel free to contact me at neerajnca@gmail.com

About the Author

Neeraj Kumar is a civil engineer from Bihar College of Engineering, Patna (now NIT, Patna). He has been teaching IIT-JEE aspirants since 1992. He established Neeru's Chemistry Arena at Musallahpur Hat, Patna. He worked for Career Point, Kota (2002–04), Sri Chaitanya IIT Academy, Kota (2004–07), AMBITION (own institute at Kota) (2007–09) and Bansal Classes, Kota. Presently, he is working as Senior Lecturer in the department of Physical Chemistry (IIT Division), Allen Career Institute, Kota.

The author strongly believes that cracking any competitive examination demands theoretical knowledge. Even the current trends of IIT-JEE support the theoretical and analytical approach.

Neeraj Kumar has written a good number of books for IIT-JEE as well as for schools. He has co-authored several books and contributed papers in reputed educational magazines such as *Chemistry Patron and Junior Science Refresher.*

CHAPTER 1

Mole Concept

EXERCISE I (JEE MAIN)

Laws of Chemical Combinations

1. A quantity of 10 g of a hydrocarbon exactly requires 40 g oxygen for complete combustion. The products formed are CO_2 and water. When CO_2 gas formed is absorbed completely in lime water, the mass of solution increases by 27.5 g. What is the mass of water formed simultaneously in the combustion?

(a) 22.5 g (b) 27.5 g
(c) 50 g (d) 10 g

2. Zinc ore (zinc sulphide) is treated with sulphuric acid, leaving a solution with some undissolved bits of material and releasing hydrogen sulphide gas. If 10.8 g of zinc ore is treated with 50.0 ml of sulphuric acid (density 1.2 g/ml), 65.2 g of solution and undissolved material remains. In addition, hydrogen sulphide (density 1.4 g/L) is evolved. What is the volume (in litres) of this gas?

(a) 4.0 (b) 5.6
(c) 7.84 (d) 4.4

3. When a mixture of aluminium powder and iron (III) oxide is ignited, it produces molten iron and aluminium oxide. In an experiment, 5.4 g of aluminium was mixed with 18.5 g of iron (III) oxide. At the end of the reaction, the mixture contained 11.2 g of iron, 10.2 g of aluminium oxide, and an undetermined amount of unreacted iron (III) oxide. No aluminium was left. What is the mass of the iron (III) oxide left?

(a) 2.5 g (b) 7.3 g
(c) 8.3 g (d) 2.9 g

4. Some bottles of colourless liquids were being labelled when the technicians accidentally mixed them up and lost track of their contents. A 15.0 ml sample withdrawn from one bottle weighed 22.3 g. The technicians knew that the liquid was either acetone, benzene, chloroform or carbon tetrachloride (which have densities of 0.792 g/cm^3, 0.899 g/cm^3, 1.489 g/cm^3, and 1.595 g/cm^3, respectively). What was the identity of the liquid?

(a) Carbon tetrachloride
(b) Acetone
(c) Chloroform
(d) Benzene

5. A sample of an ethanol–water solution has a volume of 55.0 cm^3 and a mass of 50.0 g. What is the percentage of ethanol (by mass) in the solution? Assume that there is no change in volume when the pure compounds are mixed. The density of ethanol is 0.80 g/cm^3 and that of water is 1.00 g/cm^3.

(a) 20% (b) 40%
(c) 60% (d) 45.45%

6. In a textile mill, a double-effect evaporator system concentrates weak liquor containing 4% (by mass) caustic soda to produce a lye containing 25% solids (by mass). What is the weight of water evaporated per 100 g feed in the evaporator?

(a) 125.0 g (b) 50.0 g
(c) 84.0 g (d) 16.0 g

7. At 373 K and 1 atm, if the density of liquid water is 1.0 g/ml and that of water vapour is 0.0006 g/ml, then the volume occupied by water molecules in 1 litre of steam at that temperature is

(a) 6 ml (b) 60 ml
(c) 0.6 ml (d) 0.06 ml

8. A person needs an average of 2.0 mg of riboflavin (vitamin B_2) per day. How many grams of butter should be taken by the person per day if it is the only source of riboflavin? Butter contains 5.5 μg riboflavin per g.

(a) 363.6 g (b) 2.75 mg
(c) 11 g (d) 19.8 g

9. Law of multiple proportions is not applicable for the oxide(s) of

(a) carbon (b) iron
(c) nitrogen (d) aluminium

10. Two elements A and B combine to form compound X and Y. For the fixed mass of A, masses of B combined for the compounds X and Y are in 3:7 ratio. If in compound X, 4 g of A combines with 12 g B, then in compound Y, 8 g of A will combine with …… g of B.

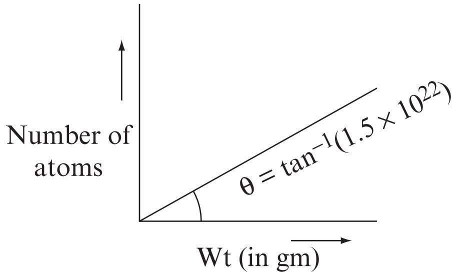
(a) 24 (b) 56
(c) 28 (d) 8

Atomic Mass

11. The mass of 3.2×10^5 atoms of an element is 8.0×10^{-18} g. The atomic mass of the element is about ($N_A = 6 \times 10^{23}$)

(a) 2.5×10^{-22} (b) 15
(c) 8.0×10^{-18} (d) 30

12. A graph is plotted for an element by putting its mass on *X*-axis and the corresponding number of atoms on *Y*-axis. What is the atomic mass of the element for which the graph is plotted? ($N_A = 6.0 \times 10^{23}$)



(a) 80 (b) 40
(c) 0.025 (d) 20

13. If **'NEERAJ KUMAR'** is written by a graphite pencil, it weighs 3.0×10^{-10} g. How many carbon atoms are present in it? ($N_A = 6 \times 10^{23}$)

(a) 1.5×10^{13} (b) 5×10^{12}
(c) 2×10^{33} (d) 1.5×10^{10}

14. The atomic masses of two elements P and Q are 20 and 40, respectively. If '*a*' g of P contains '*b*' atoms, then how many atoms are present in '2*a*' g of Q?

(a) *a* (b) *b*
(c) 2*a* (d) 2*b*

15. The molecular formula of a compound is X_4O_9. If the compound contains 40% X by mass, then what is the atomic mass of X?

(a) 24 (b) 12
(c) 26 (d) 13

16. A quantity of 1 g of metallic carbonate XCO_3 is completely converted into a chloride XCl_2 weighing 1.11 g. The atomic mass of the element 'X' is

(a) 10 (b) 20
(c) 30 (d) 40

17. An element X has three isotopes X^{20}, X^{21} and X^{22}. The percentage abundance of X^{20} is 90% and average atomic mass of the element is 20.18. The percentage abundance of X^{21} should be

(a) 2% (b) 8%
(c) 10% (d) 0%

18. A sample of hydrogen gas is collected and it is observed that it contains only hydrogen and deuterium atoms in the atomic ratio 6000 : 1. The number of neutrons in 3.0 g of such a sample should be nearly

(a) 0.0005 (b) 3.01×10^{20}
(c) 1.80×10^{24} (d) 1.0

19. If isotopic distribution of C^{12} and C^{14} is 98.0% and 2.0%, respectively, then the number of C^{14} atoms in 12 g of carbon is

(a) 1.032×10^{22} (b) 1.20×10^{22}
(c) 5.88×10^{23} (d) 6.02×10^{23}

20. The fractional abundance of Cl^{35} in a sample of chlorine containing only Cl^{35} (atomic weight = 34.9) and Cl^{37} (atomic weight = 36.9) isotopes, is 0.6. The average mass number of chlorine is

(a) 35.7 (b) 35.8
(c) 18.8 (d) 35.77

Molecular Mass

21. Twenty molecules of SO_3 will weigh as much as ….. molecules of oxygen.

(a) 100 (b) 50
(c) 15 (d) 8

22. The mass of CO_2 that must be mixed with 20 g of oxygen such that 27 ml of a sample of the resulting mixture would contain equal number of molecules of each gas, is

(a) 13.75 g (b) 27.50 g
(c) 41.25 g (d) 55 g

23. A mixture of 2×10^{21} molecules of P and 3×10^{21} molecules of Q weighs 0.60 g. If the molecular mass of P is 45, then the molecular mass of Q will be ($N_A = 6 \times 10^{23}$)

(a) 45 (b) 180
(c) 90 (d) 270

24. The shape of tobacco mosaic virus (TMV) is cylindrical, having length 3000 Å and diameter 170 Å. If the specific volume of virus is 12.5 ml/g, then the molecular mass of TMV is ($N_A = 6 \times 10^{23}$)

(a) 3.28 (b) 5.44×10^{-24}
(c) 5.44×10^{-18} (d) 3.27×10^{6}

25. The density of a DNA sample is 1.1g/ml and its molar mass determined by cryoscopic method was found to be 6×10^8 g/mole. What is the volume occupied by one DNA molecule? ($N_A = 6 \times 10^{23}$)

(a) 5.45×10^{8} ml (b) 1.83×10^{-9} ml
(c) 9.09×10^{-16} ml (d) 1.09×10^{-13} ml

26. How many atoms do mercury vapour molecules consist of if the density of mercury vapour relative to air is 6.92? The average mass of air is 29 g per mole (Hg = 200).

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

27. Vapour density of a volatile substance is 1.2 ($C_2H_6 = 1$). Its molecular mass would be

(a) 1.2 (b) 2.4
(c) 36 (d) 72

28. A compound contains 7 carbon atoms, 2 oxygen atoms and 9.96×10^{-24} g of other elements. The molecular mass of compound is ($N_A = 6 \times 10^{23}$)

(a) 122 (b) 116
(c) 148 (d) 154

29. If the mass of neutron is doubled and that of proton is halved, the molecular mass of H_2O containing only H^1 and O^{16} atoms will

(a) increase by about 25%.
(b) decrease by about 25%.
(c) increase by about 16.67%.
(d) decrease by about 16.67%.

30. Out of 1.0 g dioxygen, 1.0 g atomic oxygen and 1.0 g ozone, the maximum number of oxygen atoms are contained in

(a) 1.0 g of atomic oxygen.
(b) 1.0 g of ozone.
(c) 1.0 g of oxygen gas.
(d) All contain the same number of atoms.

31. Total number of electrons present in 4.4 g oxalate ion ($C_2O_4^{2-}$) is

(a) $0.05N_A$ (b) $2.3N_A$
(c) $2.2N_A$ (d) $2.1N_A$

32. Total number of valence electrons present in 6.4 g peroxides ion (O_2^{2-}) is

(a) $0.2N_A$ (b) $3.2N_A$
(c) $3.6N_A$ (d) $2.8N_A$

33. The number of F^- ions in 4.2 g AlF_3 is (Al = 27, F = 19)

(a) 0.05 (b) 9.03×10^{22}
(c) 3.01×10^{22} (d) 0.15

34. A quantity of 13.5 g of aluminium when changes to Al^{3+} ion in solution will lose (Al = 27)

(a) 18.0×10^{23} electrons
(b) 6.02×10^{23} electrons
(c) 3.01×10^{23} electrons
(d) 9.03×10^{23} electrons

35. If an iodized salt contains 1% of KI and a person takes 2 g of the salt every day, the iodine ions going into his body everyday would be approximately (K = 39, I = 127)

(a) 7.2×10^{21} (b) 7.2×10^{19}
(c) 3.6×10^{21} (d) 9.5×10^{19}

Calculation of Mole

36. Dopamine is a neurotransmitter, a molecule that serves to transmit message in the brain. The chemical formula of dopamine is $C_8H_{11}O_2N$. How many moles are there in 1 g of dopamine?

(a) 0.00654 (b) 153
(c) 0.0654 (d) None of these

37. Ethanol is a substance, which is commonly called alcohol. The density of liquid alcohol is 0.8 g/ml at 293 K. If 1.2 moles of ethanol is needed for a particular experiment, then what volume of ethanol should be measured out?

(a) 55.2 ml (b) 57.5 ml
(c) 69 ml (d) 47.9 ml

38. The volume of one mole of water at 277 K is 18 ml. One ml of water contains 20 drops. The number of molecules in one drop of water will be ($N_A = 6 \times 10^{23}$)

(a) 1.07×10^{21} (b) 1.67×10^{21}
(c) 2.67×10^{21} (d) 1.67×10^{20}

39. A given mixture consists only of pure substance X and pure substance Y. The total mass of the mixture is 3.72 g. The total number of moles is 0.06. If the mass of one mole of Y is 48 g and there is 0.02 mole of X in the mixture, then what is the mass of one mole of X?

(a) 90 g (b) 75 g
(c) 45 g (d) 180 g

40. Number of gas molecules present in 1 ml of gas at 0°C and 1 atm is called Loschmidt number. Its value is about

(a) 2.7×10^{19} (b) 6×10^{23}
(c) 2.7×10^{22} (d) 1.3×10^{28}

41. A quantity of 0.25 g of a substance when vaporized displaced 50 cm^3 of air at 0°C and 1 atm. The gram molecular mass of the substance will be

(a) 50 g (b) 100 g
(c) 112 g (d) 127.5 g

42. An amount of 6 moles of Cl atoms at STP occupies a volume of

(a) 134.4 L (b) 67.2 L
(c) 68.1 L (d) 136.2 L

43. While resting, an average 70 kg human male consumes 16.628 L of oxygen per hour at 27ºC and 100 kPa. How many moles of oxygen are consumed by the 70 kg man while resting for 1 hour?

(a) 0.67 (b) 66.7
(c) 666.7 (d) 67.5

44. One molecule of haemoglobin will combine with four molecules of oxygen. If 1.0 g of haemoglobin combines with 1.642 ml of oxygen at body temperature (27ºC) and a pressure of 760 torr, then what is the molar mass of haemoglobin?

(a) 6,00,000 (b) 1,50,000
(c) 15,000 (d) 60,000

45. A quantity of 2.0 g of a triatomic gaseous element was found to occupy a volume of 448 ml at 76 cm of Hg and 273 K. The mass of its each atom is

(a) 100 amu (b) 5.53×10^{-23} g
(c) 33.3 g (d) 5.53 amu

46. The most abundant element dissolved in sea water is chlorine at a concentration of 19 g/kg of sea water. The volume of earth's ocean is 1.4×10^{21} L. How many g-atoms of chlorine are potentially available from the oceans? The density of sea water is 1 g/ml ($N_A = 6 \times 10^{23}$).

(a) 7.5×10^{20} (b) 27×10^{21}
(c) 27×10^{24} (d) 7.5×10^{19}

47. From 2 mg calcium, 1.2×10^{19} atoms are removed. The number of g-atoms of calcium left is (Ca = 40)

(a) 5×10^{-5} (b) 2×10^{-5}
(c) 3×10^{-5} (d) 5×10^{-6}

48. The number of g-molecules of oxygen in 6.023×10^{24} CO molecules is

(a) 1 g-molecule (b) 0.5 g-molecule
(c) 5 g-molecules (d) 10 g-molecules

EXERCISE I

49. Equal masses of oxygen, hydrogen and methane are taken in identical conditions. What is the ratio of the volumes of the gases under identical conditions?

(a) 16 : 1 : 8 (b) 1 : 16 : 2
(c) 1 : 16 : 8 (d) 2 : 16 : 1

50. A pre-weighed vessel was filled with oxygen at NTP and weighed. It was then evacuated, filled with SO_2 at the same temperature and pressure, and again weighed. The weight of oxygen is

(a) the same as that of SO_2.
(b) $\frac{1}{2}$ that of SO_2.
(c) twice that of SO_2.
(d) $\frac{1}{4}$ that of SO_2.

Average Molecular Mass

51. Molecular mass of dry air is

(a) less than moist air.
(b) greater than moist air.
(c) equal to moist air.
(d) may be greater or less than moist air.

52. At room temperature, the molar volume of hydrogen fluoride gas has a mass of about 50 g. The formula weight of hydrogen fluoride is 20. Therefore, gaseous hydrogen fluoride at room temperature is probably a mixture of

(a) H_2 and F_2 (b) HF and H_2F_2
(c) HF and $H_{2.5}F_{2.5}$ (d) H_2F_2 and H_3F_3

53. A gaseous mixture contains 70% N_2 and 30% unknown gas by volume. If the average molecular mass of gaseous mixture is 37.60, then the molecular mass of unknown gas is

(a) 42.2 (b) 60
(c) 40 (d) 50

54. The mass composition of universe may be given as 90% H_2 and 10% He. The average molecular mass of universe should be

(a) 2.20 (b) 2.10
(c) 3.80 (d) 3.64

55. A quantity of 10 g of a mixture of C_2H_6 and C_5H_{10} occupy 4480 ml at 1 atm and 273 K. The percentage of C_2H_6 by mass in the mixture is

(a) 30% (b) 70%
(c) 50% (d) 60%

56. The density (in g/L) of an equimolar mixture of methane and ethane at 1 atm and 0°C is

(a) 1.03 (b) 2.05
(c) 0.94 (d) 1.25

57. 'n' mol of N_2 and 0.05 mol of Ar is enclosed in a vessel of capacity 6 L at 1 atm and 27°C. The value of 'n' is ($R = 0.08$ L atm mol^{-1} K^{-1})

(a) 0.25 (b) 0.20
(c) 0.05 (d) 0.4

58. A gaseous mixture contains 40% H_2 and 60% He by volume. What is the total number of moles of gases present in 10 g of such mixture?

(a) 5 (b) 2.5
(c) 3.33 (d) 3.125

59. A sample of ozone gas is found to be 40% dissociated into oxygen. The average molecular mass of sample should be

(a) 41.60 (b) 40
(c) 42.35 (d) 38.40

60. The vapour density of a sample of SO_3 gas is 28. Its degree of dissociation into SO_2 and O_2 is

(a) 1/7 (b) 1/6
(c) 6/7 (d) 2/5

Percentage Composition

61. The commonly used pain reliever, aspirin, has the molecular formula $C_9H_8O_4$. If a sample of aspirin contains 0.968 g of carbon, then what is the mass of hydrogen in the sample?

(a) 0.717 g (b) 0.0717 g
(c) 8.000 g (d) 0.645 g

62. For $CuSO_4 \cdot 5H_2O$, which is the correct mole relationship?

(a) 9 × Mole of Cu = Mole of O
(b) 5 × Mole of Cu = Mole of O
(c) 9 × Mole of Cu = Mole of O_2
(d) Mole of Cu = 5 × Mole of O

63. The percentage of Fe(III) present in iron ore $Fe_{0.93}O_{1.00}$ is (Fe = 56)

(a) 94 (b) 6
(c) 21.5 (d) 15

64. A quantity of 5 g of a crystalline salt when rendered anhydrous lost 1.8 g of water. The formula mass of the anhydrous salt is 160. The number of molecules of water of crystallization in the salt is

(a) 3 (b) 5
(c) 2 (d) 1

65. Cortisone is a molecular substance containing 21 atoms of carbon per molecule. The mass percentage of carbon in cortisone is 69.98%. What is the molecular mass of cortisone?

(a) 180.05 (b) 360.1
(c) 312.8 (d) 205.8

66. A polystyrene of formula $Br_3C_6H_2(C_8H_8)_n$ was prepared by heating styrene with tribromobenzyl peroxide in the absence of air. It was found to contain 10.46% bromine by mass. The value of n is (Br = 80)

(a) 20 (b) 21
(c) 19 (d) 22

67. A compound contains 36% carbon by mass. If each molecule contains two carbon atoms, the number of moles of compound in its 10 g is

(a) 66.67 (b) 0.15
(c) 0.30 (d) 1.5

68. The percentage of oxygen in a compound is 4%. Its minimum molecular mass will be

(a) 100 (b) 400
(c) 200 (d) 32

69. In Dumas method, 0.2 g of an organic nitrogenous compound gave 28 ml of N_2 (volume reduced to 0°C and 1 atm). What is the percentage of nitrogen by mass in the compound?

(a) 17.5 (b) 8.75
(c) 35.0 (d) 14.0

70. A quantity of 0.2 g of an organic compound containing C, H and O on combustion yielded 0.147 g CO_2 and 0.12 g water. The percentage of oxygen in it is

(a) 73.29% (b) 78.45%
(c) 83.23% (d) 89.50%

Empirical and Molecular Formula

71. The empirical formula of an organic gaseous compound containing carbon and hydrogen is CH_2. The volume occupied by certain mass of this gas is exactly half of the volume occupied by the same mass of nitrogen gas under identical conditions. The molecular formula of the organic gas is

(a) C_2H_4 (b) CH_2
(c) C_6H_{12} (d) C_4H_8

72. A compound has carbon, hydrogen and oxygen in 3 : 3 : 1 atomic ratio. If the number of moles in 1 g of the compound is 6.06×10^{-3}, then the molecular formula of the compound will be

(a) C_3H_3O
(b) $C_6H_6O_2$
(c) $C_9H_9O_3$
(d) $C_{12}H_{12}O_4$

73. A compound having the empirical formula, C_3H_4O has a molecular weight of 170 ± 5. The molecular formula of the compound is

(a) C_3H_4O (b) $C_6H_8O_2$
(c) $C_6H_{12}O_3$ (d) $C_9H_{12}O_3$

74. It was found from the chemical analysis of a gas that it has two hydrogen atoms for each carbon atom. At 0°C and 1 atm, its density is 1.25 g per litre. The formula of the gas would be

(a) CH_2 (b) C_2H_4
(c) C_2H_6 (d) C_4H_8

75. A quantity of 1.4 g of a hydrocarbon gives 1.8 g water on complete combustion. The empirical formula of hydrocarbon is

(a) CH (b) CH_2
(c) CH_3 (d) CH_4

76. An organic compound contains 40% carbon and 6.67% hydrogen by mass. Which of the following represents the empirical formula of the compound?
(a) CH_2 (b) CH_2O
(c) C_2H_4O (d) CH_3O

77. A compound contains elements X and Y in 1 : 4 mass ratio. If the atomic masses of X and Y are in 1 : 2 ratio, the empirical formula of the compound should be
(a) XY_2 (b) X_2Y
(c) XY_4 (d) X_4Y

78. A compound contains equal masses of the elements A, B and C. If the atomic masses of A, B and C are 20, 40 and 60, respectively, then the empirical formula of the compound is
(a) A_3B_2C (b) AB_2C_3
(c) ABC (d) $A_6B_3C_2$

79. A gaseous oxide contains 30.4% of nitrogen, one molecule of which contains one nitrogen atom. The density of the oxide relative to oxygen under identical conditions is about
(a) 0.69 (b) 1.44
(c) 0.35 (d) 2.88

80. Iron forms two oxides. If for the same mass of iron, the mass of oxygen combined in the first oxide is two-third of the mass of oxygen combined in the second oxide, then the ratio of valency of iron in first and second oxide is
(a) 1:1 (b) 2:3
(c) 3:2 (d) 2:5

Stoichiometry

81. When a certain amount of octane, C_8H_{18}, is burnt completely, 7.04 g CO_2 is formed. What is the mass of H_2O formed simultaneously?
(a) 1.62 g (c) 6.48 g
(c) 3.24 g (d) 2.28 g

82. If a rocket was fuelled with kerosene and liquid oxygen, then what mass of oxygen would be required for every litre of kerosene? Assume kerosene to have the average composition $C_{14}H_{30}$ and density 0.792 g/ml.
(a) 5.504 kg (b) 2.752 kg
(c) 1.376 kg (d) 3.475 kg

83. Air contains 20% O_2 by volume. What volume of air is needed at 0°C and 1 atm for complete combustion of 80 g methane?
(a) 10 L (b) 50 L
(c) 224 L (d) 1120 L

84. Acrylonitrile C_3H_3N is the starting material for the production of a kind of synthetic fibre (acrylics). It can be made from propylene C_3H_6 by reaction with nitric oxide (NO).

$C_3H_6(g) + NO(g) \rightarrow C_3H_3N(g) + H_2O(g) + N_2(g)$ (Unbalanced)

How many grams of acrylonitrile may be obtained from 420 kg of propylene and excess NO?
(a) 265 kg (b) 530 kg
(c) 1060 kg (d) 795 kg

85. A quantity of 2.76 g of silver carbonate on being strongly heated yields a residue weighing (Ag = 108)
(a) 2.16 g (b) 2.48 g
(c) 2.32 g (d) 2.64 g

86. How many litres of detonating gas may be produced at 0°C and 1 atm from the decomposition of 0.1 mole of water by an electric current?
(a) 2.24 L (b) 1.12 L
(c) 3.36 L (d) 4.48 L

87. What mass of solid ammonium carbonate $H_2NCOONH_4$ when vaporized at 273°C will have a volume of 8.96 L at 760 mm of pressure. Assume that the solid completely decomposes as

$H_2NCOONH_4(s) \rightarrow CO_2(g) + 2NH_3(g)$

(a) 15.6 g (b) 5.2 g
(c) 46.8 g (d) 7.8 g

88. The minimum mass of sulphuric acid needed for dissolving 3 g of magnesium carbonate is
(a) 3.5 g (b) 7.0 g
(c) 1.7 g (d) 17.0 g

89. Samples of 1.0 g of Al are treated separately with an excess of sulphuric acid and an excess of sodium hydroxide. The ratio of the number of moles of the hydrogen gas evolved is
(a) 1 : 1 (b) 3 : 2
(c) 2 : 1 (d) 9 : 4

90. The minimum mass of water needed to slake 1 kg of quicklime, assuming no loss by evaporation, is

(a) 243.2 g (b) 642.8 g
(c) 160.7 g (d) 321.4 g

91. When 20 g Fe_2O_3 is reacted with 50 g of HCl, $FeCl_3$ and H_2O are formed. The amount of unreacted HCl is (Fe = 56)

(a) 27.375 g (b) 22.625 g
(c) 30 g (d) 4.75 g

92. SO_2 gas is slowly passed through an aqueous suspension containing 12 g of $CaSO_3$ till the milkiness just disappears. What amount of SO_2 would be required?

(a) 6.4 mole (b) 0.3 mole
(c) 0.1 mole (d) 0.2 mole

93. A mixture of N_2 and H_2 is caused to react in a closed container to form NH_3. The reaction ceases before either reactant has been totally consumed. At this stage, 2.0 moles each of N_2, H_2 and NH_3 are present. The moles of N_2 and H_2 present originally were, respectively,

(a) 4 and 4 moles (b) 3 and 5 moles
(c) 3 and 4 moles (d) 4 and 5 moles

94. An ore contains 2.296% of the mineral argentite, Ag_2S, by mass. How many grams of this ore would have to be processed in order to obtain 1.00 g of pure solid silver? (Ag = 108)

(a) 1.148 g (b) 0.026 g
(c) 50 g (d) 2.296 g

95. A power company burns approximately 500 tons of coal per day to produce electricity. If the sulphur content of the coal is 1.5% by mass, then how many tons of SO_2 are dumped into the atmosphere every day?

(a) 15.0 (b) 7.5
(c) 30.0 (d) 18.75

Limiting Reagent Based

96. An amount of 1.0×10^{-3} moles of Ag^+ and 1.0×10^{-3} moles of CrO_4^{2-} reacts together to form solid Ag_2CrO_4. What is the amount of Ag_2CrO_4 formed? (Ag = 108, Cr = 52)

(a) 0.332 g (b) 0.166 g
(c) 332 g (d) 166 g

97. An amount of 0.3 mole of $SrCl_2$ is mixed with 0.2 mole of K_3PO_4. The maximum moles of KCl which may form is

(a) 0.6 (b) 0.5
(c) 0.3 (d) 0.1

98. Large quantities of ammonia are burned in the presence of a platinum catalyst to give nitric oxide, as the first step in the preparation of nitric acid.

$NH_3(g) + O_2(g) \xrightarrow{Pt} NO(g) + H_2O(g)$ (Unbalanced)

Suppose a vessel contains 0.12 moles of NH_3 and 0.14 of moles O_2. How many moles of NO may be obtained?

(a) 0.120 (b) 0.112
(c) 0.140 (d) 0.070

99. Equal masses of iron and sulphur are heated together to form FeS. What fraction of the original mass of excess reactant is left unreacted? (Fe = 56, S = 32)

(a) 0.22 (b) 0.43
(c) 0.86 (d) 0.57

100. Hydrogen cyanide, HCN, is prepared from ammonia, air and natural gas (CH_4) by the following process.

$2NH_3(g) + 3O_2(g) + 2CH_4(g) \xrightarrow{Pt} 2HCN(g) + 6H_2O(g)$

If a reaction vessel contains 11.5 g NH_3, 10.0 g O_2, and 10.5 g CH_4, then what is the maximum mass, in grams, of hydrogen cyanide that could be made, assuming the reaction goes to completion?

(a) 18.26 g (b) 5.625 g
(c) 17.72 g (d) 16.875 g

Sequential and Parallel Reactions

101. What mass of carbon disulphide CS_2 can be completely oxidized to SO_2 and CO_2 by the oxygen liberated when 325 g of Na_2O_2 reacts with water?

(a) 316.67 g (b) 52.78 g
(c) 633.33 g (d) 211.11 g

102. An amount of 2 moles of $KClO_3$ is decomposed completely to produce O_2 gas. How many moles of butene C_4H_8 can be burnt completely by the O_2 gas produced?

(a) 0.5 (b) 1.0
(c) 2.0 (d) 3.0

103. On heating $KClO_3$ at a certain temperature, it is observed that one mole of $KClO_3$ yields one mole of O_2. What is the mole fraction of $KClO_4$ in the final solid mixture containing only KCl and $KClO_4$, the latter being formed by parallel reaction?

(a) 0.50 (b) 0.25
(c) 0.33 (d) 0.67

104. When 12 g graphite is burnt in sufficient oxygen, CO as well as CO_2 is formed. If the product contains 40% CO and 60% CO_2 by mass and none of the reactant is left, then what is the mass of oxygen gas used in combustion?

(a) 24.0 g (b) 21.33 g
(c) 23.8 g (d) 15.6 g

105. A mixture of 254 g of iodine and 142 g of chlorine is made to react completely to give a mixture of ICl and ICl_3. How many moles of each product are formed? (I = 127, Cl = 35.5)

(a) 0.1 mol of ICl and 0.1 mol of ICl_3.
(b) 1.0 mol of ICl and 1.0 mol of ICl_3.
(c) 0.5 mol of ICl and 0.1 mol of ICl_3.
(d) 0.5 mol of ICl and 1.0 mol of ICl_3.

Percentage Based

106. A quantity of 4.35 g of a sample of pyrolusite ore, when heated with conc. HCl gave chlorine. The chlorine, when passed through potassium iodide solution liberated 6.35 g of iodine. The percentage of pure MnO_2 in the pyrolusite ore is (Mn = 55, I = 127)

(a) 40 (b) 50
(c) 60 (d) 70

107. How many grams of 90% pure Na_2SO_4 can be produced from 250 g of 95% pure NaCl?

(a) 640.6 g (b) 288.2 g
(c) 259.4 g (d) 320.3 g

108. A quantity of 10 g of a piece of marble was put into excess of dilute HCl acid. When the reaction was complete, 1120 cm^3 of CO_2 was obtained at 0^oC and 1 atm. The percentage of $CaCO_3$ in the marble is

(a) 5% (b) 25%
(c) 50% (d) 2.5%

109. A 1.50 g sample of potassium bicarbonate having 80% purity is strongly heated. Assuming the impurity to be thermally stable, the loss in weight of the sample on heating is

(a) 3.72 g (b) 0.72 g
(c) 0.372 g (d) 0.186 g

110. Hydrazine N_2H_4 (used as a fuel in rocket system) can be produced according to the following reaction.

$$ClNH_2 + 2NH_3 \rightarrow N_2H_4 + NH_4Cl$$

When 1.0 kg $ClNH_2$ is reacted with excess of NH_3, 473 g of N_2H_4 is produced. What is the percentage yield?

(a) 76.12 (b) 67.21
(c) 26.17 (d) 16.72

111. Two successive reactions, $A \rightarrow B$ and $B \rightarrow C$, have yields of 90% and 80%, respectively. What is the overall percentage yield for conversion of A to C?

(a) 90% (b) 80%
(c) 72% (d) 85%

112. Iodobenzene is prepared from aniline ($C_6H_5NH_2$) in a two-step process as shown here.

$$C_6H_5NH_2 + HNO_2 + HCl \longrightarrow$$
$$C_6H_5N_2^+Cl^- + 2H_2O$$

$$C_6H_5N_2^+Cl^- + KI \rightarrow C_6H_5I + N_2 + KCl$$

In an actual preparation, 9.30 g of aniline was converted to 16.32 g of iodobenzene. The percentage yield of iodobenzene is (I = 127)

(a) 8% (b) 50%
(c) 75% (d) 80%

113. One mole of a mixture of CO and CO_2 requires exactly 20 g of NaOH in solution for complete conversion of all the CO_2 into Na_2CO_3. How many grams more of NaOH would it require for conversion into Na_2CO_3 if the mixture (one mole) is completely oxidized to CO_2?

(a) 60 g (b) 80 g
(c) 40 g (d) 20 g

114. When burnt in air, 14.0 g mixture of carbon and sulphur gives a mixture of CO_2 and SO_2 in the volume ratio of 2 : 1, the volume being measured at the same conditions of temperature and pressure. Moles of carbon in the mixture is

(a) 0.25 (b) 0.40
(c) 0.5 (d) 0.75

115. A mixture of NaI and NaCl on reaction with H_2SO_4 gave Na_2SO_4 equal to the weight of original mixture taken. The percentage of NaI in the mixture is (I = 127)

(a) 82.86 (b) 26.38
(c) 62.38 (d) 28.86

Eudiometry

116. When 0.03 L of a mixture of hydrogen and oxygen was exploded, 0.003 L of oxygen remained. The initial mixture contains (by volume)

(a) 60% O_2 (b) 40% O_2
(c) 50% O_2 (d) 30% O_2

117. A volume of 100 ml of air containing only oxygen and nitrogen is a taken in a jar over water. NO is slowly passed till no more brown fumes appear in the gas jar. It is found that 42 ml of NO is required. The percentage of nitrogen in the air would be

(a) 42% (b) 79%
(c) 21% (d) 39.5%

118. A mixture of methane and ethylene in the ratio of a : b by volume occupies 30 ml. On complete combustion, the mixture yields 40 ml of CO_2. What volume of CO_2 would have been obtained if the ratio would have been b : a?

(a) 50 ml (b) 30 ml
(c) 40 ml (d) 60 ml

119. A volume of 200 ml of oxygen is added to 100 ml of a mixture containing CS_2 vapour and CO, and the total mixture is burnt. After combustion, the volume of the entire mixture is 245 ml. Calculate the volume of the oxygen that remains

(a) 67.5 ml (b) 125.0 ml
(c) 200.0 ml (d) 100.0 ml

120. A volume of 10 ml hydrogen requires 25 ml air for complete combustion. The volume per cent of N_2 in air is

(a) 20% (b) 80%
(c) 79% (d) 5%

121. A volume of 10 ml of gaseous C_4H_x exactly requires 55 ml O_2 for complete combustion. The value of 'x' is

(a) 4 (b) 6
(c) 8 (d) 10

122. When 500 ml CO_2 gas is passed through red hot charcoal, the volume becomes 700 ml. The volume of CO_2 converted into CO is

(a) 200 ml (b) 300 ml
(c) 350 ml (d) 500 ml

123. The percentage by volume of C_3H_8 in a mixture of C_3H_8, CH_4 and CO is 36.5. The volume of CO_2 produced when 100 ml of the mixture is burnt in excess of O_2 is

(a) 153 ml (b) 173 ml
(c) 193 ml (d) 213 ml

124. A volume of 1 ml of a gaseous aliphatic compound $C_nH_{3n}O_m$ is completely burnt in an excess of oxygen. The contraction in volume (in ml) is

(a) $\left(1+\frac{1}{2}n-\frac{3}{4}m\right)$ (b) $\left(1+\frac{3}{4}n-\frac{1}{4}m\right)$
(c) $\left(1-\frac{1}{2}n-\frac{3}{4}m\right)$ (d) $\left(1+\frac{3}{4}n-\frac{1}{2}m\right)$

125. The explosion of a mixture consisting of one volume of a gas being studied and one volume of H_2 yielded one volume water vapour and one volume of N_2. The formula of gas being studied, is

(a) NO (b) NO_2
(c) N_2O (d) N_2O_3

126. A gaseous alkane is exploded with oxygen. The volume of O_2 for complete combustion to the volume of CO_2 formed is in 7:4 ratio. The molecular formula of alkane is

(a) CH_4 (b) C_3H_8
(c) C_2H_6 (d) C_4H_{10}

127. A volume V of a gaseous hydrocarbon was exploded with an excess of oxygen. The observed contraction was $2.5V$, and on treatment with potash, there was a further contraction of $2V$. What is the molecular formula of the hydrocarbon?

(a) C_2H_6 (b) C_3H_6
(c) C_4H_{12} (d) C_2H_4

128. A volume of 10 ml chlorine gas combines with 25 ml of oxygen gas to form 10 ml of a gaseous compound. If all the volumes are measured at the same pressure and temperature, then what is the molecular formula of compound formed?

(a) Cl_2O (b) Cl_2O_7
(c) ClO_2 (d) Cl_2O_5

129. A volume of 10 ml of an oxide of nitrogen was taken in a eudiometer tube and mixed with hydrogen until the volume was 28 ml. On sparking, the resulting mixture occupied 18 ml. To this mixture, oxygen was added when the volume came to 27 ml and on explosion again, the volume fall to 15 ml. Find the molecular weight of the oxide of nitrogen originally taken in eudiometer tube. All measurements were made at STP.

(a) 22 (b) 44
(c) 88 (d) 176

130. V_1 ml of unknown gas (A) + V_2 ml of $O_2 \rightarrow (V_1 + V_2)$ ml of CO_2.
Gas 'A' may be

(a) CO
(b) $(CO + CO_2)$ in equal proportion
(c) $C_{12}O_9$
(d) C_3O_2

Concentration Terms

131. How many grams of solute should be added in 100 g water to get a solution of density 1.2 g/ml and strength 5% (w/v)?

(a) 5 g (b) 6 g
(c) 4.17 g (d) 4.35 g

132. An aqueous solution of glucose is 10% (w/v). The volume in which 1 mole of glucose is dissolved will be

(a) 18 L (b) 9 L
(c) 0.9 L (d) 1.8 L

133. A quantity of 50 g of water is saturated with HCl gas to get 75 ml of solution containing 40% HCl by mass. The density of solution formed is

(a) 1.11 g/ml (b) 0.4 g/ml
(c) 0.9 g/ml (d) 0.99 g/ml

134. The concentration of same aqueous solution of glucose is determined by two students—Sawan and Gautam. Sawan reported the concentration as 20% (w/w) and Gautam reported the concentration as 25% (w/v). If both the concentrations are correct, then the density of solution is

(a) 0.8 g/ml (b) 1.0 g/ml
(c) 1.25 g/ml (d) 1.33 g/ml

135. How much $Ca(NO_3)_2$, in mg, must be present in 50 ml of a solution with 2.35 ppm of Ca?

(a) 0.1175 (b) 770.8
(c) 4.7 (d) 0.48

136. The legal limit for human exposure to CO in the work place is 35 ppm. Assuming that the density of air is 1.3 g/L, how many grams of CO are in 1.0 L of air at the maximum allowable concentration?

(a) 4.55×10^{-5} g (b) 3.5×10^{-5} g
(c) 2.69×10^{-5} g (d) 7.2×10^{-5} g

137. What volume of 0.8 M-$AlCl_3$ solution should be mixed with 50 ml of 0.2 M-$CaCl_2$ solution to get a solution of chloride ion concentration equal to 0.6 M?

(a) 5.56 ml (b) 100 ml
(c) 50 ml (d) 4.89 ml

138. D5W refers to one of the solutions used as an intravenous fluid. It is 5% by mass solution of dextrose, $C_6H_{12}O_6$ in water. The density of D5W is 1.08 g/ml. The molarity of the solution is

(a) 0.3 M (b) 0.6 M
(c) 0.28 M (d) 0.26 M

139. How much $BaCl_2$ would be needed to make 250 ml of a solution having the same concentration of Cl^- as one containing 3.78 g NaCl per 100 ml? (Ba = 137)

(a) 16.8 g (b) 67.2 g
(c) 33.6 g (d) 22.4 g

140. Upon heating a litre of semimolar HCl solution, 2.675 g of hydrogen chloride is lost and the volume of the solution shrinks to 750 ml. The molarity of the resultant solution is

(a) 0.569 M (b) 0.5 M
(c) 0.42 M (d) 1.707 M

141. A volume of 500 ml of a 0.1 M solution of $AgNO_3$ is added to 500 ml of 0.1 M solution of KCl. The concentration of nitrate ion in the resulting solution is

(a) 0.05 M (b) 0.1 M
(c) 0.2 M (d) Reduced to zero

142. In 1200 g solution, 12 g urea is present. If density of the solution is 1.2 g/ml, then the molarity of the solution is

(a) 0.2 M (b) 10 M
(c) 0.167 M (d) 12 M

143. Mole fraction of solute in an aqueous solution of NaOH is 0.1. If the specific gravity of the solution is 1.4, then the molarity of the solution is

(a) 6.93 (b) 0.1
(c) 71.4 (d) 0.14

144. What should be the density of an aqueous solution of urea (molar mass = 60 g/mol) such that the molality as well as molarity of the solution becomes equal to 1.0 unit ?

(a) 1.0 g/ml (b) 1.6 g/ml
(c) 1.06 g/ml (d) 1.16 g/ml

145. A quantity of 10 g of acetic acid is dissolved in 100 g of each of the following solvents. In which solvent, the molality of solution is maximum? Assume no any dissociation or association of acetic acid in the solvent.

(a) Water (b) Ethanol
(c) Benzene (d) Same in all solvents

146. A quantity of 10 g of acetic acid is dissolved in 100 g of each of the following solvents. In which solvent, the mole fraction of solute is maximum? Assume no any dissociation or association of acetic acid in the solvent.

(a) Water
(b) Ethanol
(c) Benzene
(d) Same in all solvents

147. An aqueous solution has urea and glucose in mass ratio 3 : 1. If the mass ratio of water and glucose in the solution is 10 : 1, then the mole fraction of glucose in the solution is

(a) $\frac{1}{110}$ (b) $\frac{9}{110}$
(c) $\frac{3}{110}$ (d) $\frac{100}{110}$

148. The volume strength of a sample of H_2O_2 is '9.08 vol'. The mass of H_2O_2 present in 250 ml of this solution is

(a) 0.4 g (b) 27.2 g
(c) 6.8 g (d) 108.8 g

149. What is the percentage of 'free SO_3' in a sample of oleum labelled as '104.5%'?

(a) 20% (b) 40%
(c) 60% (d) 80%

150. Which of the following percentage strength is not possible for a sample of oleum?

(a) 104% (b) 109%
(c) 118% (d) 127%

EXERCISE II (JEE ADVANCED)

Section A (Only one Correct)

1. A sample of clay contains 50% silica and 10% water. The sample is partially dried by which it loses 8 g water. If the percentage of silica in the partially dried clay is 52, then what is the percentage of water in the partially dried clay?
   (a) 2.0% (b) 6.4%
   (c) 10.4% (d) 2.4%

2. In the atomic weight determination, Dalton suggested the formula of water as HO and the composition of water as hydrogen = 12.5% and oxygen = 87.5% by weight. What should be the atomic weight of oxygen on H-scale, on the basis of this information?
   (a) 16 (b) 8
   (c) 14 (d) 7

3. The mercury content of a stream was believed to be above the minimum considered safe limit (1 part per billion, by mass). An analysis indicated that the concentration was 1.68 parts per billion. How many Hg atoms are present in 15 L of water, the density of which is 0.998 g/ml. (Hg = 200)
   (a) 7.57×10^{13} (b) 7.57×10^{19}
   (c) 7.57×10^{16} (d) 5.37×10^{16}

4. Assume that sodium atoms are spheres of radius 0.2 nm and that they are lined up side by side. How many miles, in length, is the line of atoms present in a 1.15 mg sample of sodium? ($N_A = 6 \times 10^{23}$)
   (a) 1.2×10^{10} (b) 1.2×10^{8}
   (c) 7.5×10^{8} (d) 7.5×10^{6}

5. The density of gold is 19.7 g/cm^3. The radius of gold atom is [Au = 197, $N_A = 6 \times 10^{23}$, $(10\pi)^{1/3} = 3.15$]
   (a) 1.587×10^{-8} m (b) 1.587×10^{-9} m
   (c) 1.587×10^{-10} m (d) 1.587×10^{-12} m

6. The average density of the universe as a whole is estimated as 3×10^{-29} g/ml. If we assume that the entire mass is only H atoms, then what is the average volume of space that contains one H atom?
   (a) 111.11 L (b) 1.8×10^{-5} L
   (c) 55.56 L (d) 3.6×10^{-5} L

7. The waste of nuclear power plant contains C^{12} and C^{14} in the ratio of 4 : 1 by moles. What is the molecular mass of methane gas produced from this disposed waste? Given that the natural abundance of C^{12} and C^{14} are 98% and 2%, respectively.
   (a) 15.998 (b) 16.0053
   (c) 16 (d) 16.4

8. Two isotopes of an element Q are Q^{97} (23.4% abundance) and Q^{94} (76.6% abundance). Q^{97} is 8.082 times heavier than C^{12} and Q^{94} is 7.833 times heavier than C^{12}. What is the average atomic weight of the element Q?
   (a) 94.702 (b) 78.913
   (c) 96.298 (d) 94.695

9. The O^{18}/O^{16} ratio in some meteorites is greater than that used to calculate the average atomic mass of oxygen on earth. The average mass of an atom of oxygen in these meteorites is ______ that of a terrestrial oxygen atom?
   (a) equal to (b) greater than
   (c) less than (d) None of these

10. If the atomic mass were given by as 1/6th part and molecular mass as 1/12th part by mass of one atom of C^{12} isotope, then what would be the molecular mass of water? Suppose atomic masses of hydrogen and oxygen on new scale are 1 and 16, respectively,
    (a) 18 (b) 9
    (c) 36 (d) Unpredictable

11. Assuming that 1,3,5-hexatriene has only pure double bonds and pure single bonds, how many grams of it contain one mole of double bonds?
    (a) 13.3 g (b) 26.7 g
    (c) 40 g (d) 80 g

12. In an experiment, it is found that 2.0769 g of pure X produces 3.6769 g of pure X_2O_5. The number of moles of X is
    (a) 0.04 (b) 0.06
    (c) 0.40 (d) 0.02

13. The volume occupied by 20 g water at 1.2 atm and 4°C is about

(a) 20 ml (b) $\frac{20\times0.082\times227}{18\times1.2}$ L

(c) $\frac{20\times0.082\times4}{18\times1.2}$ L (d) 20 L

14. A quantity of 2.3 g of a mixture of NO_2 and N_2O_4 has a pressure of 0.82 atm, at temperature TK in a container of volume V litres such that the ratio, $T:V$ is 300 : 1 in magnitude. What is the degree of dissociation of N_2O_4?

(a) 0.17 (b) 0.33

(c) 0.67 (d) 0.70

15. When acetylene is passed through red hot metal tubes, some molecules trimerize to form benzene. The molecular mass of the gaseous mixture, when acetylene is passed through the tube is 60. The degree of trimerization of acetylene is

(a) 0.85 (b) 0.60

(c) 0.15 (d) 0.283

16. When a sample of hydrogen fluoride is cooled to 303 K, most of the molecules undergo dimerization. If the vapour density of such a sample is 18, then what per cent of total molecules in the sample are in dimer form? (F = 19)

(a) 88.89 (b) 80.0

(c) 20.0 (d) 11.11

17. Nitrogen (N), phosphorus (P) and potassium (K) are the main nutrients in plant fertilizers. According to an industry convention, the numbers on the label refer to the mass percent of N, P_2O_5 and K_2O in that order. What is N : P : K ratio of a 30 : 10 : 10 fertilizer in terms of moles of each element expressed as x : y : 1.0? (N = 14, P = 31, K = 39)

(a) 10 : 0.66 : 1.0 (b) 20 : 0.66 : 1.0

(c) 8.4 : 1.3 : 1.0 (d) 16.8 : 1.3 : 1.0

18. A certain mixture of MnO and MnO_2 contains 66.67 mol percent of MnO. What is the approximate mass percent of Mn in it? (Mn = 55)

(a) 66.67 (b) 24.02

(c) 72.05 (d) 69.62

19. A sample of impure cuprous oxide contains 66.67% copper by mass. What is the percentage of pure Cu_2O in the sample? (Cu = 63.5)

(a) 66.67 (b) 75

(c) 70 (d) 80

20. Sodium bicarbonate $NaHCO_3$ can be purified by dissolving it in hot water (60°C), filtering to remove insoluble impurities, cooling to 0°C to precipitate solid $NaHCO_3$, and then filtering to remove the solid, leaving soluble impurities in solution. Any $NaHCO_3$ that remains in the solution is not recovered. The solubility of $NaHCO_3$ in hot water at 60°C is 164 g/litre and is 69 g/litre in cold water at 0°C. What is the percentage yield of $NaHCO_3$, when it is purified by this method?

(a) 57.93% (b) 42.07%

(c) 69% (d) 100%

21. The mineral haematite is Fe_2O_3. Haematite ore contains unwanted material called gangue in addition to Fe_2O_3. If 5 kg of ore contains 2.78 kg of Fe, then what percentage of ore is gangue? (Fe = 56)

(a) 55.6% (b) 44.4%

(c) 20.6% (d) 79.4%

22. A sample of iron ore weighing 0.700 g is dissolved in nitric acid. The solution is then diluted with water, following with sufficient concentrated aqueous ammonia, to quantitative precipitation the iron as $Fe(OH)_3$. The precipitate is filtered, ignited and weighed as Fe_2O_3. If the mass of the ignited and dried precipitate is 0.541 g, then what is the mass percent of iron in the original iron ore sample? (Fe = 56)

(a) 27.0% (b) 48.1%

(c) 54.1% (d) 81.1%

23. The empirical formula of a compound is CH_2O. If 0.0833 moles of the compound contains 1.0 g of hydrogen, then its molecular formula should be

(a) $C_6H_{12}O_6$ (b) $C_5H_{10}O_5$

(c) $C_4H_8O_4$ (d) $C_3H_6O_3$

24. A hydrocarbon C_nH_{2n} yields C_nH_{2n+2} by reduction. In this process, the molar mass of the compound is raised by 2.38%. The value of n is

(a) 8 (b) 4

(c) 6 (d) 5

25. A certain vitamin extracted from plant sources has carbon and hydrogen in 8 : 1 mass ratio. The percentage of oxygen is nearly 7.3. The compound gave no test for nitrogen or sulphur or any other element. What should be the empirical formula of the compound?

(a) $C_{30}H_{45}O_2$ (b) $C_{15}H_{23}O$

(c) $C_{29}H_{45}O_3$ (d) $C_{10}H_{15}O$

26. An unknown oxide of manganese is reacted with carbon to form manganese metal and CO_2. Exactly 31.6 g of the oxide, Mn_xO_y, yielded 13.2 g of CO_2. The simplest formula of the oxide is (Mn = 55)

(a) MnO (b) MnO_2
(c) Mn_2O_3 (d) Mn_4O_6

27. Assume that the atomic mass of oxygen is 7. A sample of 11 g of an oxide of uranium contains 10 g of uranium. Which of the following formula for the oxide is compatible with the data?

(a) Uranium oxide is UO and the atomic mass of U is 70.
(b) Uranium oxide is U_3O_8 and the atomic mass of U is 240.
(c) Uranium oxide is UO_2 and the atomic mass of U is 105.
(d) Uranium oxide is U_3O_2 and the atomic mass of U is 105.

28. A sample of protein was analysed for metal content and analysis revealed that it contained magnesium and titanium in equal amounts, by mass. If these are the only metallic species present in the protein and it contains 0.016% metal, by mass, the minimum possible molar mass of the protein is (Mg = 24, Ti = 48)

(a) 6,00,000 (b) 1,50,000
(c) 3,00,000 (d) 12,00,000

29. One mole of mixture of N_2, NO_2 and N_2O_4 has a mean molar mass of 55.4 g. On heating to a temperature, at which all the N_2O_4 is dissociated into NO_2, the mean molar mass tends to a lower value of 39.6 g. What is the mole ratio of N_2, NO_2 and N_2O_4 in the original mixture?

(a) 5:1:4 (b) 1:1:1
(c) 1:4:5 (d) 1:5:4

30. A protein isolated from a bovine preparation, was subjected to amino acid analysis. The amino acid present in the smallest amount was lysine, $C_6H_{14}N_2O_2$ and the amount of lysine was found to be 365 mg per 100 g protein. What is the minimum molecular mass of the protein?

(a) 40,000,000 (b) 40,000
(c) 40 (d) 4,00,000

31. Cupric ammonium sulphate was found to contain 27.03% water of crystallization by mass. Upon strongly heating, it gave cupric oxide corresponding to 19.89% of starting mass. Find the empirical formula of cupric ammonium sulphate. (Cu = 63.5)

(a) $CuSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$
(b) $CuSO_4 \cdot (NH_4)_2SO_4 \cdot 5H_2O$
(c) $CuSO_4 \cdot 2(NH_4)_2SO_4 \cdot 6H_2O$
(d) $CuSO_4 \cdot (NH_4)_2SO_4 \cdot 8H_2O$

32. A drug, marijuana, owes its activity to tetrahydrocannabinol, which contains 70 per cent as many carbon atoms as hydrogen atoms and 15 times as many hydrogen atoms as oxygen atoms. The number of moles in a gram of tetrahydrocannabinol is 0.00318. Determine its molecular formula.

(a) CH_3O_2 (b) $C_{21}H_{30}O_2$
(c) $C_{15}H_{30}O_2$ (d) $C_{70}H_{15}O$

33. How many millilitres (at 0°C and 1 atm) of hydrogen sulphide are needed to precipitate cupric sulphide completely from 100 ml of a solution containing 2.69 g of $CuCl_2$ in a 1 L solution? (Cu = 63.5)

(a) 448 (b) 4.48
(c) 22.4 (d) 44.8

34. When the hydrocarbon propane is burned in air, carbon dioxide and water are formed. If 0.15 mol of CO_2 is produced, then how many drops of water will be formed, assuming one drop is 0.05 cm^3 and contains 1.70×10^{21} water molecules?

(a) 1.2×10^{23} (b) 4
(c) 53 (d) 70

35. When a hydrocarbon is burnt completely, the ratio of masses of CO_2 and H_2O formed is 44 : 27. The hydrocarbon is

(a) CH_4 (b) C_2H_6
(c) C_2H_4 (d) C_2H_2

36. An aqueous ammonium sulphate solution containing 50 moles of solute reacts with excess of calcium hydroxide. How many litres of a solution (specific gravity 0.85) containing 20% by mass of ammonia can be prepared using this reaction?

(a) 10.0 L (b) 8.5 L
(c) 20.0 L (d) 17.0 L

37. Specialized cells in the stomach release HCl to aid digestion. If they release too much, the excess can be neutralized by antacid tablets. Which of the following should be the more effective active ingredient of antacid tablets?

(a) $Mg(OH)_2$ (b) $Al(OH)_3$
(c) $Ca(OH)_2$ (d) H_2SO_4

38. A metal oxide has the formula M_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of the metal oxide required 6 mg of hydrogen for complete reduction. The atomic mass of the metal is

(a) 111.60 (b) 159.60
(c) 79.80 (d) 55.80

39. If 0.250 g of an element M reacts with excess fluorine to produce 0.547 g of the hexafluoride, MF_6, the element should be (Cr = 52, Mo = 95.94, S = 32, Te = 127.6, F = 19)

(a) Cr (b) Mo
(c) S (d) Te

40. Fluorine reacts with uranium hexafluoride UF_6 as represented by the following equation.

$U(s) + 3F_2(g) \rightarrow UF_6(g)$

How many fluorine molecules are required to produce 2.0 mg of uranium hexafluoride UF_6 from an excess of uranium? The molar mass of UF_6 is 352.0 g mol^{-1}.

(a) 5.13×10^{18} (b) 1.026×10^{19}
(c) 2.052×10^{19} (d) 1.026×10^{20}

41. What is the total mass of the products formed, when 51 g of H_2S is oxidized by oxygen to produce water and sulphur dioxide?

(a) 72 g (b) 27 g
(c) 123 g (d) 96 g

42. A quantity of 1.08 g of $Cr_2O_7^{2-}$ is reduced in an acidic solution by an excess of SO_2 to form HSO_4^- and Cr^{3+}. What is the minimum number of moles of H^+ that must be present for this reaction to occur? (Cr = 52)

(a) 0.025 (b) 0.020
(c) 0.005 (d) 0.070

43. Diborane tetrachloride was treated with NaOH and the following reaction occurred.

$B_2Cl_4 + NaOH \rightarrow NaBO_2 + H_2O + H_2 + NaCl$

If 1362 ml of hydrogen gas is formed at STP, then how much B_2Cl_4 was consumed? (B = 11)

(a) 9.97 g (b) 9.84 g
(c) 0.0968 g (d) 23.57 g

44. What total volume, in litre at 727ºC and 1 atm, could be formed by the decomposition of 16 g of NH_4NO_3?
Reaction: $2NH_4NO_3 \rightarrow 2N_2 + O_2 + 4H_2O(g)$.

(a) 57.47 L (b) 114.94 ml
(c) 41.78 L (d) 24.63 L

45. A compound of iron and chlorine is soluble in water. An excess of silver nitrate was added to precipitate all chloride ions as silver chloride. If a 127 mg sample of the compound gave 287 mg AgCl, then what is the formula of the compound? (Fe = 56, Ag = 108)

(a) $FeCl_2$ (b) $FeCl_3$
(c) FeCl (d) $FeCl_6$

46. From the following reactions,

$2CoF_2 + F_2 \rightarrow 2CoF_3$
$(CH_2)_n + 4n\ CoF_3 \rightarrow (CF_2)_n + 2n\ HF + 4n\ CoF_2$

calculate how much F_2 will be consumed to produce 1 kg of $(CF_2)_n$. (F = 19)?

(a) 1.52 kg (b) 2.04 kg
(c) 0.76 kg (d) 4.56 kg

47. An element 'A' reacts with the compound BO_3 to produce A_3O_4 and B_2O_3. The number of moles of A_3O_4 produced if 1 mole each of A and BO_3 are allowed to react is

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

48. A 1.50 g sample of type metal (an alloy of Sn, Pb, Cu and Sb) is dissolved in nitric acid, and metastannic acid, H_2SnO_3, precipitates. This is dehydrated by heating to tin (IV) oxide, which is found to weigh 0.50 g. What percentage of tin was in the original type metal sample? (Sn = 119)

(a) 33.33% (b) 26.27%
(c) 29.38% (d) 52.54%

49. An amount of 5 moles of A, 6 moles of B and excess amount of C are mixed to produce a final product D, according to the following reactions.

$A + 2B \rightarrow I$

$I + C \rightarrow B + D$

What is the maximum moles of D, which can be produced assuming that the products formed can also be reused in the reactions?

(a) 3 moles (b) 4.5 moles
(c) 5 moles (d) 6 moles

50. Hydrogen cyanide, HCN, can be made by a two-step process. First, ammonia is reacted with O_2 to give nitric oxide, NO.

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

Then nitric oxide is reacted with methane, CH_4.

$2NO(g) + 2CH_4(g) \rightarrow 2HCN(g) + 2H_2O(g) + H_2(g)$

When 25.5 g of ammonia and 32.0 g of methane are used, how many grams of hydrogen cyanide can be produced?

(a) 1.5 (b) 2.0
(c) 40.5 (d) 54.0

51. To determine soluble (free) SiO_2 in a rock, an alkaline extraction was carried out, as a result of which there was found 1.52% of SiO_2 in the extract and also 1.02% of Al_2O_3. Considering that, apart from the free SiO_2, the extract also contained the SiO_2 that had passed into it from Kaolin ($2SiO_2 \cdot Al_2O_3$), the percentage of free SiO_2 in the rock being analysed is (Si = 28, Al = 27)

(a) 1.20 (b) 0.32
(c) 0.50 (d) 1.52

52. A sample of iron oxide has FeO and Fe_2O_3 in the mole ratio 2 : 1. It is partially oxidized to change this ratio to 1 : 2. The number of moles of FeO oxidized per mole of initial mixture is

(a) 0.2 (b) 0.333
(c) 0.4 (d) 0.5

53. When x g carbon is burnt with y g oxygen in a closed vessel, no residue is left behind. Which of the following statement is correct regarding the relative amounts of oxygen and carbon?

(a) y/x must be less than 1.33.
(b) y/x must be greater than 1.33.
(c) y/x must be greater than 2.67.
(d) y/x must lie between 1.33 and 2.67.

54. An amount of 1 mole of calcium cyanamide and 1 mole of water are allowed to react. The number of moles of ammonia produced is

(a) 3.0 (b) 2.0
(c) 1.0 (d) 0.67

55. An amount of 1 mole of N_2 and 4 moles of H_2 are allowed to react in a vessel and after reaction, water is added. Aqueous solution required 1 mole of HCl for complete reaction. Mole fraction of H_2 in the gas mixture after reaction is

(a) 1/6 (b) 5/6
(c) 1/3 (d) 2/3

56. A quantity of 5.08 g of iodine held in suspension in water is slowly acted upon by 460 ml of H_2S measured at 0°C and 1 atm. What weight of sulphur will be liberated? (I = 127)

(a) 0.64 g (b) 0.657 g
(c) 1.297 g (d) 0.017 g

57. A quantity of 27.6 g of K_2CO_3 was treated by a series of reagent so as to convert all of its carbon to $K_2Zn_3[Fe(CN)_6]_2$. The mass of the product formed is (K = 39, Zn = 65.4, Fe = 56)

(a) 139.2 g (b) 11.6 g
(c) 69.6 g (d) 23.2 g

58. What is the volume required of a 20.0% HCl solution of density 1.20 g/ml to prepare 363.0 g of $AsCl_3$ according to the equations? (As = 75, Cl = 35.5)

$2KMnO_4 + 16\ HCl \rightarrow 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

$2As + 3Cl_2 \rightarrow 2AsCl_3$

(a) 2.56 l (b) 0.73 l
(c) 1.46 l (d) 2.92 l

59. Cyclohexanol is dehydrated to cyclohexene on heating with conc. H_2SO_4. If the yield of this reaction is 75%, then how much cyclohexene will be obtained from 100 g of cyclohexanol?

(a) 61.5 g (b) 82 g
(c) 109.3 g (d) 75 g

60. A sample of pure Cu (4.00 g) heated in a stream of oxygen for some time, gains in weight with the formation of black oxide of copper (CuO). The final mass is 4.90 g. What percent of copper remains unoxidized? (Cu = 64)

(a) 90% (b) 10%
(c) 20% (d) 80%

61. If the yield of chloroform obtainable from acetone and bleaching powder is 75%, then what mass of acetone is required for producing 30 g of chloroform?

(a) 40 g (b) 19.4 g
(c) 10.92 g (d) 14.56 g

62. Pure FeS_2 is burnt with 60% excess air. What is the percentage of N_2, by volume, in the gaseous mixture after the reaction? Air contains 20% O_2 and 80% N_2 by volume.

(a) 81.94 (b) 82.8
(c) 70.4 (d) 89.3

63. A 12 g sample of CH_4 and C_2H_4 yielded 35.2 g of CO_2 on complete oxidation. What was the mean molar mass of the original sample?

(a) 20.0 (b) 22.0
(c) 14.7 (d) 23.0

64. For a hydrocarbon, the ratio of volume O_2 used for complete combustion and the volume of CO_2 formed is independent to the number of carbon atoms present in the hydrocarbon. The hydrocarbon may be

(a) Alkane (b) Alkene
(c) Alkyne (d) Arene

65. A volume of 60 ml of a mixture of nitrous oxide and nitric oxide was exploded with excess hydrogen. If 38 ml of N_2 was formed, the volume of nitrous oxide in the original mixture is

(a) 16 ml (b) 44 ml
(c) 27 ml (d) 33 ml

66. A mixture is made equal volume of CO and air. A spark passed through so that all the oxygen is converted to carbon dioxide. What will be fractional decrease in the total volume of system assuming pressure and temperature remain constant? Air contains 20% oxygen by volume.

(a) 0.1 (b) 0.2
(c) 0.15 (d) 0.3

67. A mixture of formic acid and oxalic acid is heated with conc. H_2SO_4. The gaseous product is passed into KOH solution where the volume decreased by 1/6th. What was the molecular proportion of the organic acids, formic and oxalic acid in the mixture?

(a) 1 : 4 (b) 4 : 1
(c) 1 : 5 (d) 5 : 1

68. A volume of 50 ml of a gas mixed with 70 ml of oxygen gave after explosion 50 ml of CO_2 and after absorption by KOH, 45 ml of oxygen are left. What is the molecular formula of the gas?

(a) CH_4 (b) C_2H_4
(c) CO (d) C_2H_2

69. A human patient suffering from a duodenal ulcer may show a concentration of HCl of 80×10^{-3} molar in gastric juice. If his stomach receives 3 L of gastric juice per day, how much medicine (antacid syrup) containing 2.6 g of $Al(OH)_3$ per 100 ml must he consumes per day to neutralize the acid?

(a) 27 ml (b) 80 ml
(c) 240 ml (d) 120 ml

70. When V ml of 2.2 M – H_2SO_4 solution is mixed with $10V$ ml of water, the volume contraction of 2% takes place. The molarity of diluted solution is

(a) 0.2 M (b) 0.204 M
(c) 0.196 M (d) 0.224 M

71. A quantity of 23.6 g of succinic acid is dissolved in 500 ml of 0.1 M acetic acid solution. Assuming that neither acid is dissociated in solution, calculate the molarity of '–COOH' in the solution.

(a) 0.3 M (b) 0.5 M
(c) 0.9 M (d) 0.8 M

72. Chlorofluorocarbons such as CCl_3F (M = 137.5) and CCl_2F_2 (M = 121) have been linked to ozone depletion in Antarctica. As of 2004, these gases were found in 275 and 605 parts per trillion (10^{12}), by volume. What are the concentrations of these gases under conditions typical of Antarctica stratosphere (200 K and 0.08 atm)? (R = 0.08 l-atm/K-mol)

(a) $[CCl_3F] = 1.375 \times 10^{-12}$ mol l^{-1}, $[CCl_2F_2] = 3.025 \times 10^{-12}$ mol l^{-1}
(b) $[CCl_3F] = 2.75 \times 10^{-14}$ mol l^{-1}, $[CCl_2F_2] = 6.05 \times 10^{-14}$ mol l^{-1}
(c) $[CCl_3F] = 2.75 \times 10^{-10}$ mol l^{-1}, $[CCl_2F_2] = 6.05 \times 10^{-10}$ mol l^{-1}
(d) $[CCl_3F] = 1.375 \times 10^{-13}$ mol l^{-1}, $[CCl_2F_2] = 3.025 \times 10^{-12}$ mol l^{-1}

73. A quantity of 1 kg of 2 m urea solution is mixed with 2 kg of 4 m urea solution. The molality of the resulting solution is

(a) 3.33 m (b) 10 m
(c) 3.29 m (d) 5 m

74. A quantity of 1 kg of 1 m glucose solution is diluted to 5 kg. The molality of the diluted solution should be

(a) 0.2 m (b) 0.02 m
(c) 0.207 m (d) 0.175 m

75. A quantity of 500 g of an aq. urea solution having mole fraction of solute, 0.2 is diluted to 1500 g. The mole fraction of solute in the diluted solution is

(a) 0.05 (b) 0.067
(c) 0.6 (d) 0.1

76. A volume of 20 ml of 8.5% (w/v) H_2O_2 solution is diluted to 50 ml. A volume of 10 ml of the diluted solution is reacted with excess of an oxidant. It will cause liberation of ___ ml of ___ gas at 0°C and 1 atm.

(a) 56, O_2 (b) 112, O_2
(c) 224, H_2 (d) 224, H_2

77. A volume of 50 ml of '20 vol' H_2O_2 solution is mixed with 50 ml of '10 vol' H_2O_2 solution. The volume strength of the resulting solution is (assume neither expansion nor contraction in volume of solution, on mixing)

(a) '30 vol' (b) '10 vol'
(c) '15 vol' (d) '22.5 vol'

78. In 200 g of a sample of oleum labelled as 109.0%, 12 g water is added. The new labelling of the oleum sample is

(a) 106.0% (b) 103.0%
(c) 102.8% (d) 105.6%

79. When 200 g of an oleum sample labelled as 109% is mixed with 300 g of another oleum sample labelled as 118%, the new labelling of resulting oleum sample becomes

(a) 114.4% (b) 112.6%
(c) 113.5% (d) 127%

80. A sample of oleum is labelled as 112%. In 200 g of this sample, 18 g water is added. The resulting solution will contain

(a) 218 g pure H_2SO_4.
(b) 218 g H_2SO_4 and 6 g free SO_3.
(c) 212 g H_2SO_4 and 6 g free SO_3.
(d) 191.33 g H_2SO_4 and 26.67 g free SO_3.

Section B (One or More than one Correct)

1. A quantity of 0.22 g of a gas occupies a volume of 112 ml at pressure of 1 atm and temperature of 273 K. The gas may be

(a) nitrogen dioxide
(b) nitrous oxide
(c) carbon dioxide
(d) propane

2. The number of hydrogen atoms in 0.9 g glucose, $C_6H_{12}O_6$, is same as

(a) 0.48 g hydrazine, N_2H_4
(b) 0.17 g ammonia, NH_3
(c) 0.30 g ethane, C_2H_6
(d) 0.03 g hydrogen, H_2

3. The composition of universe is approximately 90% hydrogen and 10% helium, by mass. It represents that

(a) there are 18 hydrogen atoms in the universe per atom of helium.
(b) there are 9 hydrogen atoms in the universe per atom of helium.
(c) there are 36 hydrogen atoms in the universe per atom of helium.
(d) the average molar mass of universe is 2.105 g per mole.

4. The vapour density of a sample of hydrogen fluoride gas is measured by an experiment as 20. It may represent that (F = 19)

(a) some molecules of hydrogen fluoride are dissociated.
(b) some molecules of hydrogen fluoride are in dimer form.
(c) all hydrogen fluoride molecules are in dimer form.
(d) some hydrogen fluoride molecules are in trimer form.

5. Which of the following statement(s) is/are correct for water?

(a) H and O are in 2 : 1 atomic ratio.
(b) H and O are in 2 : 1 mass ratio.
(c) H and O are in 1 : 8 mass ratio.
(d) Hydrogen and oxygen gases are combined in 2:1 volume ratio.