

- 1) Calculate the strength of the following solutions in kg/dm^3
 - a) $0.4\text{N H}_2\text{SO}_4$
 - b) 0.125N NaOH
 - c) 0.12M HClO_4
 - d) 1.25N KMnO_4
- 2) 2.8 gms of KOH was dissolved in water to give a solution with a volume of exactly 0.5 dm^3 . Calculate the normality and molarity of the solution.
- 3) A solution contains 28 gms of phosphoric acid, H_3PO_4 (mol.wt.98) in 1 dm^3 of aqueous solution. Assuming that the acid is 36% ionised, calculate the molar concentration of the constituent.
- 4) 2.5 gms of ammonium sulphate $(\text{NH}_4)_2\text{SO}_4$ (Mol.wt. 142) was dissolved in water and diluted to 300 cm^3 . What is the formality of the solution and formal concentration of NH_4^+ ions.? The density of NaCl solution is 1.002 gms/cm^3 .
- 5) 250 cm^3 of a solution of common salt, NaCl (mol. wt. 58.5) contains 0.523 gms of the salt. Express the concentration of the solution in terms of a) normality b) molarity c) mole fraction of two components d) molality .
- 6) Density of H_2SO_4 in an almost completely storage battery is 1.25 gms/ cm^3 .This solution contains 33.3% by weight of the acid. Calculate
 - a) weight of H_2SO_4 per dm^3 of the solution.
 - b) molarity of the solution.
 - c) molality of the solution.
- 7) Calculate the volume of 98% H_2SO_4 solution of density 1.829 gms/cm^3 required to prepare 10 dm^3 of $0.5\text{M H}_2\text{SO}_4$ solution.
- 8) Commercially available HNO_3 has a specific gravity of 1.42 and contains 69% acid on wt/wt basis. What mass of HNO_3 is contained in 500 cm^3 of the solution? What volume of this acid be diluted to obtain 800 cm^3 of 0.2M HNO_3 ?
- 9) How many millidm³ of conc. HCl of 38% wt/wt of specific gravity 1.19 gms/cm^3 are required to prepare 1 dm^3 of 0.1M solution?
- 10)A chemical storeroom has the following stock solutions: 0.5M HCl , 10% HBr (wt/vol.), 15% K_2CO_3 (wt/ vol.) and 0.02M KOH .Calculate the volumes of these solutions required to prepare
 - a) 2 dm^3 of 0.5M HCl
 - b) 5 dm^3 0.02M KOH
 - c) 4 gms of HBr
 - d) 10 gms of K_2CO_3
- 11)Commercial acetic acid has a molarity of 17.4 M . How much of this solution will be required to prepare 25 dm^3 of 2.5M acid.?
- 12) 7.8 gms of benzene are dissolved in 100 gms of toluene(C_7H_8).Calculate the molality of the solution.
- 13)A solution containing 13 gms of NaOH and 87 gms of water has a density of 1.142 gms/cm^3 .Calculate a) molality b) mole fraction c) molarity of the solution.
- 14)Calculate the quantity of cane sugar, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (mol. wt. 342) required to be dissolved in 0.5 kg of water so that the resulting solution is 0.25 molal.

- 15) A solution is 25 % water, 25 % ethanol and 50 % acetic acid by mass. Calculate the mole fraction of each component.
- 16) 100 cm^3 of ethanol (density 0.78 gms/mole) are mixed with 100 cm^3 of water (density 0.9987 gms/cm^3). Calculate the mole fraction of each component in the mixture. (Assume that there is no change in the volume.)
- 17) $5 \times 10^{-3} \text{ kg}$ of A (Mol.wt. 0.2 kg) and $5 \times 10^{-2} \text{ kg}$ of B are mixed together. The mole fraction of A in the mixture is 0.714 . Calculate the mol. wt. of B.
- 18) Calculate the molarity and molality of the solution containing 10.1 gms of KCl dissolved in 0.5 dm^3 of the solution. Density of the solution is 1.0 gms/cm^3 .
- 19) What volume of 1.0 M HCl must be added to 50 cm^3 of 0.5 M HCl to give a solution whose concentration is 0.6 M ?
- 20) How many millidm³ of water must be added to 300 cm^3 of 5 N NaOH solution in order to prepare 2 N solution?
- 21) What volumes of 12 M HCl and 3 M HCl must be mixed to give 1 dm^3 of 6 M HCl ?
- 22) In the extraction of iron(III) into diethylether, it is desired that the final acid concentration should be 7.0 M . To 25 cm^3 of the iron solution prepared in 1 M HCl , what volume of 12 M HCl should be added so that the final strength becomes 7.0 M ?
- 23) It is desired to prepare 6 M HNO_3 nitric acid from available acid solution of strength 2.8 M and 7.2 M respectively. If the total volume of 6 M HNO_3 required to be prepared is 8 dm^3 , calculate the volumes of the two acid solutions mixed.
- 24) An effluent from an industrial plant contains residues of acetic acid, HCl and H_2SO_4 with 1.6% , 0.8% and 2.1% (w/v) respectively. Calculate the volume of standard 10 N NaOH required for complete neutralisation of 1 dm^3 of the effluent.
- 25) 2.6 dm^3 of 0.2 M HCl is mixed with 1.2 dm^3 of 1.5 M HCl solution. Assuming that there is no change in volume, calculate the strength of HCl in kg/dm^3 .
- 27) 6 g of urea was dissolved in 500 g of water. Calculate the percentage by mass of urea in solution. (Ans: **1.186%**)
- 28) 58 cm^3 of alcohol was dissolved in 400 cm^3 of water to form 454 cm^3 of solution of ethyl alcohol. Calculate the percentage by volume of ethyl alcohol in water. (Ans: **12.78% by volume**)
- 29) 23 g of ethyl alcohol (Molar mass 46 g mol^{-1}) is dissolved in 54 g of water (molar mass 18 g mol^{-1}) Calculate the mole fraction of ethyl alcohol and water in solution. (Ans: **0.1429, 0.8571**)
- 30) A solution of NaOH (molar mass 40 g mol^{-1}) was prepared by dissolving 1.6 g of NaOH in 500 cm^3 of water. Calculate the molarity of NaOH solution. (Ans: **0.08 M**)

- 31) 11.11 g of urea was dissolved in 100g of water . calculate the molality of solution (N = 14, H = 1, C =12 and O = 16). (Ans:1.852mol kg⁻¹)
- 32) 34.2g of sugar was dissolved in water to produce 214.2g of sugar syrup. Calculate the molality and mole fraction of sugar in the syrup. (C=12, H =1 and O=16)(Ans:**0.556 molkg⁻¹,0.0099**)
- 33) Calculate the molality and molarity of sulphuric acid solution of density 1.198g cm⁻³ containing 27% by mass of sulphuric acid (molar mass of H₂SO₄ = 98g mol⁻¹)(Ans:**3.77molkg⁻¹,3.301moldm⁻³**)
- 34) Commercially available concentrated hydrochloric acid is an aqueous solution containing 38% HCl gas by mass. If its density is 1.1 g cm⁻³, calculate the molarity of HCl solution and also calculate mole fraction of HCl and H₂O.(Ans:**11.45moldm⁻³,0.232,0.768**)
- 35) 34.2g of glucose is dissolved in 400g of water. Calculate the percentage by mass of glucose solution,(Ans:**7.87w/W**)
- 36) A solution is prepared by dissolving certain amount of solute in 500g of water. The percentage by mass of a solute in solution is 2.38. calculate mass of solute.(Ans:**12.19g**)
- 37) 4.6cm³ of methyl alcohol is dissolved in 25.2g of water. Calculate i)% by mass of methyl alcohol ii) mole fraction of methyl alcohol and water. (Given density of methyl alcohol = 0.7952gcm³ and C=12 , H=1, O=16)(Ans:i)**12.68** ii)**0.0755,0.9245**)
- 38) 12.8cm³ of benzene is dissolved in 16.8cm³ of xylene. Calculate % by volume of benzene.(Ans:**43.24**)
- 39) Calculate mole fraction of HCl in solution of HCl containing 24.8% of HCl by mass.(H=1, Cl=25.5)(Ans:**0.1398**)
- 40) Calculate mole fraction of solute in its 2 molal aqueous solution.(Ans:**0.0347**)
- 41) Calculate the mole fractions, molality and molarity of HNO₃ in a solution containing 12.2% HNO₃. Given density of HNO₃ = 1.038 g cm⁻³, H = 1 , N = 14 , O =16)(Ans:**0.0396m,2.205molkg⁻¹,M=2.01moldm⁻³**)
- 42) Sulphuric acid is 95.8% by mass. Calculate mole fraction and molarity of H₂SO₄ of density 1.91g cm⁻³ (H = 1 , S = 32 O =16)(Ans:**0.80730,17.98M**)
- 43) Aqueous solution of NaOH is marked 10% (w/w). The density of the solution is 1.070g cm⁻³. Calculate i)molarity ii) molality and iii) mole fraction of NaOH and water. (Na=23 H = 1 , O = 16)(Ans:M=**2.675**,m=**2.77**, **0.0476,0.9523**)

- 44) Battery acid is 4.22M aqueous H_2SO_4 solution and has density 1.21g cm^{-3} . What is the molality of H_2SO_4 ? (H = 1, S = 32, O = 16)($m=5.298\text{mol kg}^{-1}$)
- 45) Calculate the strength of the following solutions in kg/dm^3
 a) **0.4F** H_2SO_4 b) **0.125N** NaOH c) **0.12M** HClO_4 d) **1.25N** KMnO_4
- 46) **2.8 gms** of KOH was dissolved in water to give a solution with a volume of exactly **0.5 dm³**. Calculate the normality and molarity of the solution.
- 47) A solution contains **28 gms** of phosphoric acid, H_3PO_4 (mol.wt. **98**) in **1 dm³** of aqueous solution. Assuming that the acid is **36 %** ionised, calculate the formal and molar concentration of the constituent.
- 48) **250 cm³** of a solution of common salt, NaCl (Mol. wt. 58.5) contains **0.523 gms** of the salt. Express the concentration of the solution in terms of a) normality b) molarity c) mole fraction of two components d) molality .
- 49) Density of H_2SO_4 in an almost completely storage battery is **1.25 gms/ cm³**. This solution contains **33.3%** by weight of the acid. Calculate
 d) weight of H_2SO_4 per dm^3 of the solution.
 e) molarity of the solution.
 f) molality of the solution.
- 50) Calculate the volume of **98 %** H_2SO_4 solution of density **1.829 gms/cm³** required to prepare **10 dm³** of **0.5M** H_2SO_4 solution.
- 51) Commercially available HNO_3 has a specific gravity of **1.42** and contains **69%** acid on wt/wt basis. What mass of HNO_3 is contained in **500 cm³** of the solution? What volume of this acid be diluted to obtain **800 cm³** of **0.2M** HNO_3 ?
- 52) Calculate the i) normality ii) molarity iii) molality iv) mole fraction of **8%** solution of **KOH** (At.wt. of K=39, O=16, H=1; Density of water =1 gm/cc)
- 53) A chemical storeroom has the following stock solutions: 0.5M HCl, 10% HBr(wt/vol.), 15 % K_2CO_3 (wt/ vol.) and 0.02M KOH. Calculate the volumes of these solutions required to prepare
 a) **2 dm³** of **0.5M** HCl
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- 59) **100 cm³** of ethanol(density **0.78 gms/mole**) are mixed with **100 cm³** of water(density **0.9987gms/cm³**). Calculate the mole fraction of each component in the mixture.(Assume that there is no change in the volume.)
- 60) **5 X 10⁻³ kg** of A (Mol.wt. 0.2 kg) and **5 X 10⁻² kg** of B are mixed together.The mole fraction of A in the mixture is **0.714**. Calculate the mol. wt. of B.
- 61) Calculate the molarity and molality of the solution containing 10.1 gms of KCl dissolved in 0.5 dm³ of the solution. Density of the solution is 1.0 gms/ cm³
- 62) Calculate the concentration in ppm if **8 grams** of CaCl₂ is dissolved in **250 ml** of water.
- 63) What is the concentration in ppm of selenium if **1.3 milligrams** is found in **2500 kg** of soil?

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F.Y.B.Sc

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Questionnaire on Introduction to Molecular spectroscopy

Q.1) Define the following terms:

- i) Electromagnetic radiations ii) Wavelength iii) Frequency
iv) Wavenumber

Q.2) Give the characteristics of electromagnetic radiations.

Q.3) Give the relation between the following:

- a) Wavelength and Frequency b) Nanometer and Angstrom c) Megahertz and Hertz
d) Energy and frequency.

Q.4) Draw the spectrum of electromagnetic spectrum mentioning the various regions in it.

Q.5) Arrange the different types of radiations in increasing order of wavelength.

Q.6) Give a brief account of the following regions:

- a) Infra red region b) Visible and ultraviolet region c) Microwave region

Q.7) Explain the different ways in which matter interacts with electromagnetic radiations.

Q.8) Explain in brief the various types of energies associated with a molecule.

Q.9) What are molecular energy levels? Give a neat representation of molecular energy level.

Q.10) Explain the following energy levels possess by the molecules:

- i) Vibrational energy level
- ii) Electronic energy level
- iii) Rotational energy level

Q.11) Explain the terms i) Emission spectra ii) Absorption spectra

Q.12) Distinguish between atomic spectroscopy and molecular spectroscopy.

Q.13) Give a brief account of the following molecular spectra:

- i) IR spectra
- ii) Electronic spectra
- iii) NMR spectra
- iv) ESR spectra

Q.14) What type of information is obtained when the molecule of a substance absorbs in the following region?

- i) Infrared region
- ii) uv-visible region
- iii) Radiofrequency region

Q.15) What type of changes are expected in the molecule of a substance when the molecule absorbs in the following region?

- i) Infra red region
- ii) Visible region
- iii) Microwave

Q.16) What is the selection rule?

Q.17) Explain the principle of NMR and ESR spectra.

Q.18) Why rotational spectra is obtained in the microwave region?

Problems:

- 1) The frequency of a strong yellow line in the spectrum of sodium is $5.09 \times 10^{14} \text{sec}^{-1}$. Calculate the wavelength in Angstroms and its energy ($h = 6.625 \times 10^{-34} \text{J.s}$)
- 2) The wavelength of a light is 500nm. calculate its frequency and wave number.
- 3) Calculate i) wave number ii) frequency iii) energy of one quantum of radiation of wavelength 10^4 nm in joules and eV.