

KATHMANDU UNIVERSITY  
End Semester Examination[C]  
January/February 2024

Level : B.E./B. Pharm./B.Tech.  
Year : III  
Time : 2 hrs. 30mins.

23 JAN 2024

Course : INAN 301  
Semester : I  
F. M. : 55

SECTION "B"

[5Q × 3 = 15 marks]

Attempt *ANY FIVE* questions

1. Explain, how is the  $\pi \rightarrow \pi^*$  molecular absorption in UV and visible region affected by (i) nature of solvent, (ii) presence of conjugation within the molecule. [1.5×2=3]
2. List out basic components of gas chromatography, systematically assemble them into a suitable figure. [3]
3. Write the different types of flame on the basis of fuel and oxidant. Briefly explain the flame structure. [1+2=3]
4. Among triatomic molecule CO<sub>2</sub> and H<sub>2</sub>O; CO<sub>2</sub> gives two IR absorptions at 2330 cm<sup>-1</sup> and 667 cm<sup>-1</sup> whereas H<sub>2</sub>O gives three IR absorptions at 3760 cm<sup>-1</sup>, 3650 cm<sup>-1</sup> and 1595 cm<sup>-1</sup>. Explain. [3]
5. Discuss on the "*effect of magnetic field strength on population of excited nuclei*" in proton NMR. Calculate the excess number of protons in the ground state, when the sample is placed in a magnetic field of 4.69 Tesla, at 20°C. [1+2=3]  
[ $h = 6.63 \times 10^{-34}$  Js,  $\gamma = 2.68 \times 10^8$  T<sup>-1</sup>s<sup>-1</sup>,  $k = 1.38 \times 10^{-23}$  J K<sup>-1</sup>]
6. Give reason. [1.5+1.5=3]
  - a. It is necessary to use deuterated solvents for NMR experiments.
  - b. A measurement process can be represented as a series of interdomain conversions.
7. Discuss briefly on [1.5+1.5=3]
  - a. Packing material
  - b. Stationary phase that are used in HPLC.

SECTION "C"

[5Q × 5 = 25 marks]

Attempt *ANY FIVE* questions.

8.
  - a. Write and elaborate Beer's law. How do polychromatic radiation affects the Beer's law? Explain. [1+2=3]
  - b. What do you know about radiation buffer? Explain how does it eliminate spectral interferences in AAS. [2]
9. Define the following terms: [2.5×2=5]
  - a. Hydride generation for atomization in AAS
  - b. Solvent selection in IR spectroscopy
10.
  - a. What is the factor that is responsible for splitting of HNMR peaks? Explain the nature of splitting using a simple example. [3]

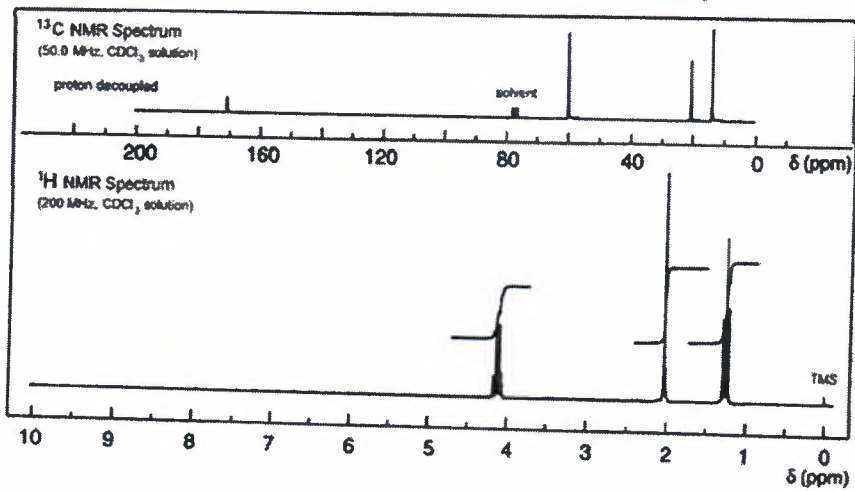
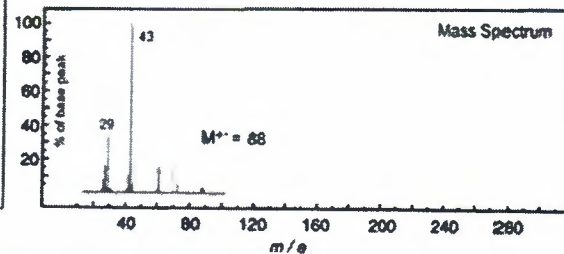
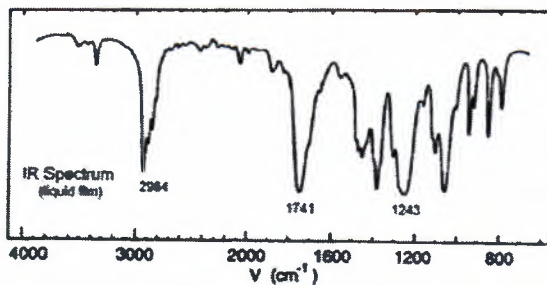
11. a. Describe magnetic sector mass analyzer system. What are the beauty of double focusing over single focusing analyzer? [2+1=3]
- b. What do you understand by an isotopic peak? Calculate the isotopic peak ratio  $(M+2)^+/M^+$ , in  $C_3H_7ClBr$  [1+1=2]
12. a. What are different sample injection systems in HPLC? Explain. [2]
- b. Substance A and B were found to have retention time of 16.40 and 17.63 minutes respectively on a 30.0 cm column. An unretained species passes through the column in 1.30 min. The peak width (at base) for A and B were 1.11 and 1.21 min, respectively. Calculate [3]
- (i) Column resolution
- (ii) Average number of plates in the column and
- (iii) Length of column required to achieve resolution of 1.5.
13. How are the performance characteristics like, retardation factor ( $R_f$ ), capacity factor ( $k'$ ) and plate height ( $H$ ), determined in planar chromatography? Explain. [5]
14. a. Differentiate between isocratic and gradient elution. [2]
- b. Write about capillary columns used in GC. [3]

SECTION "D"  
[2Q × 7.5 = 15 marks]

Attempt ANY TWO questions.

15. a. Discuss different components under van Deemter equation which affects the efficiency of the column. (use figure and formula where they fit appropriately) [5]
- b. Discuss on the principal and application regarding suppressor column most commonly used in ion exchange chromatography. [2.5]
16. a. Define detection limit. How is the detection limit of an analytical instrument determined? Explain. [1+2=3]
- b. Explain in brief: [1.5×3=4.5]
- i) Deshielding effect of aromatic protons
- ii) Hydrogen deficiency index
- iii) Reverse phase chromatography
17. From the combined IR, mass,  $^{13}C$ -NMR &  $^1H$ -NMR spectra given below for an unknown compound  $C_4H_8O_2$ , elucidate the correct structure with detailed description analyzing each of the given spectrum. Also show the possible mass fragmentation pattern. [7.5]

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Time: 30 mins.


F. M. : 20

Registration No.:

Date :

SECTION "A"  
[20Q. × 1 = 20 marks]

Encircle the most appropriate answer.

- The minimum resolution of mass spectrometer, required to distinguish the cations:  $N_2^+$  ( $m = 28.0061$ ) and  $CO^+$  ( $m = 27.9949$ ) is.....  
a. 1000                      b. 1500                      c. 2000                      d. 2500
- Usually wavelength range of vacuum UV, in molecular absorption falls in the region.  
a. 180-780 nm              b. 10-180 nm              c. 0.75-3.75 mm              d. 0.6-10 m
- Strong absorption by IR in frequency  $3300\text{ cm}^{-1}$  will probably indicate the presence of ..... in the compound.  
a.  $-C\equiv C-H$               b.  $-C=C-H$               c.  $=C-O-H$               d.  $-CO-H$
- How many  $^{13}C$  NMR signals would be obtained in *1,4-dimethylbenzene* ?  
a. 2                      b. 3                      c. 4                      d. 5  

- To improve resolution and reduce elution time in gas chromatography, most commonly  
a. Different types of injectors are used for different sample  
b. Hydrogen carrier gas is replaced with inert helium gas  
c. The length of capillary column is changes by hit and trial method  
d. Temperature is varied at different stage of elution
- There are a number of specific reagents to locate solute front in thin layer chromatography. Most common such reagent for detecting amino acid molecules is.....  
a. Iodine vapour                      b. Rhodamine B  
c. Ninhydrin                      d. Aniline phthalate
- In mass spectroscopy, the molecular ion will be fragmented inside  
a. Inlet chamber                      b. Ionization chamber  
c. Analyzer chamber                      d. Detector chamber
- Which of the following quantity lies under analog domain?  
a. Scale position              b. Serial count              c. Frequency              d. Current
- When the sample is atomized in flame "*the solvent is evaporated there by producing finely divided molecular aerosole*", this process is called as.....  
a. Volatilization              b. Dissociation              c. Desolvation              d. Nebulization

10. The volume inside UV visible absorption cell, used in HPLC is often kept small, since .
  - a. It is a bulk property detector
  - b. UV light is passed through narrow slit
  - c. It helps to reduce extra column band broadening
  - d. The solute components are very small in size

**Fill in the blank by most appropriate VALUE or WORD**

11. In order for a vibration mode to be observable in the IR, the vibration must change the ..... of the molecule.
12. In HNMR, a resonance peak is displaced at ..... Hz from TMS, at a magnetic field strength of 7.05 T. (give,  $\gamma = 2.68 \times 10^8 \text{ T}^{-1}\text{s}^{-1}$ )
13. .... interference arises when the absorbance or emission of interfering species lies close to absorption or emission from analyte.
14. One of commonly used device for the generation of IR radiation in analytical laboratory is .....
15. In size exclusion chromatography, the total volume of the column is written as:  $V_t = V_g + V_i + V_0$ . The elution volume ( $V_e$ ) for unretained species will be equal to .....
16. In chromatographic separation with 30 cm column; solute species is eluted after 16.4 minutes, with base peak width of 1.11 minutes. Then theoretical plate height (HETP) for the column will be .....
17. Ion exchange resins are functionalized co-polymer materials. The most common active functional group in anion exchange resin is .....
18. When the monochromatic UV radiation impinges on ....., material will eject electrons inside a vacuum photo tube device.
19. The removal of dissolved gases in HPLC solvent by passing inert gases like He and N<sub>2</sub> is called .....
20. Analytical sensitivity of an instrument is obtained by dividing calibration sensitivity with ..... of the measured parameters.