

KATHMANDU UNIVERSITY  
End Semester Examination  
14 January 2024

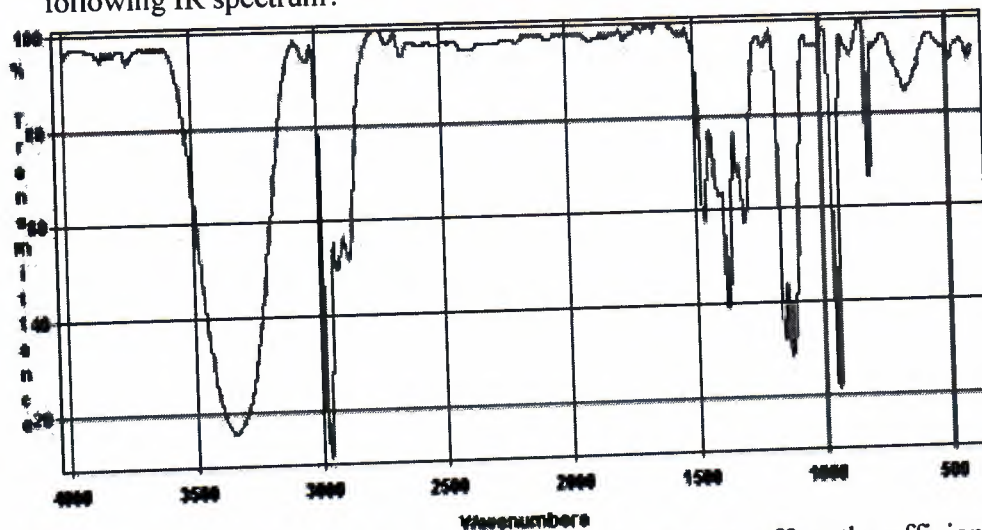
Level : B.Tech.  
Year : III  
Time : 2 hrs. 30mins.

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

SECTION "B"  
[5Q × 3 = 15 marks]

Attempt *ANY FIVE* questions.

1. a. What are the differences between calibration sensitivity and analytical sensitivity? [1.5]  
b. What is the splitting pattern of the methylene protons in propane? [1.5]
2. The selectivity coefficient for an ion selective electrode for  $K^+$  with respect to  $Na^+$  is reported to be 0.052. Calculate the relative error in the determination of  $K^+$  in a solution that has a  $K^+$  concentration of 0.004 M if the  $Na^+$  concentration is 0.001 M. Assume that  $S_{bl}$  for a series of blanks was approximately zero.
3. a. Show the basic design of an instrument used for a chemical measurement. [1.5]  
b. Giving suitable reasons, figure out the functional group of the compound that gives following IR spectrum? [1.5]



4. Particle size, particle loading speed and solvent viscosity affect the efficiency of HPLC column. Elaborate the statement.
5. In the room temperature, no spin spin coupling is observed for  $^1H$  spectra of methanol. When methanol sample is cooled to  $-40^\circ C$ , the exchange rate of the hydroxyl proton slows sufficiently so that splitting is observed. Sketch spectra for methanol at the two temperatures.
6. Calculate the energy of a 580nm photon of a visible radiation in KJ/mol unit. ( $h=6.63 \times 10^{-34} JS$ , Avogadro's no= $6.02 \times 10^{23}$ ).
7. Is  $CO_2$  molecule IR active? Justify.

SECTION "C"  
[5Q × 5 = 25 marks]

Attempt *ANY FIVE* questions.

8. Explain (with well-labelled diagram) about the most common radiation source used for atomic absorption measurements. Why an electrothermal atomizer more sensitive than flame atomizer? [3.5+1.5]
9. a. In a hydrogen-oxygen flame, the atomic absorption signal for calcium was found to decrease in the presence of large concentration of sulphate ions. Suggest an explanation for this observation. [2.5]  
b. What is Beer's law? Why Beer's law is called a limiting law? [2.5]
10. a. Explain about absorption by inorganic species in UV Visible region. [3]  
b. In NMR spectroscopy, what are the advantages of using a magnet having highest possible field strength? [2]
11. a. In chromatography, what are the variables that lead to zone broadening? [3]  
b. What is an isocratic elution? [2]
12. a. How do soft and hard ion sources differ? What are the advantages of each? [3]  
b. What is column resolution? What type of chemical species can be separated by HPLC but not by GC? [2]
13. What are the different processes that occur during flame atomization? Write the principle of flame photometry. [3+2]
14. Draw block diagram of HPLC. Write about injectors used in GC. [2+3]

SECTION "D"  
[2Q × 7.5 = 15 marks]

Attempt *ANY TWO* questions.

15. a. Differentiate between normal phase and reversed phase chromatography. Also write about common visualization methods in Thin Layer Chromatography. [4]  
b. Write short note on Electron Capture Detector. [3.5]
16. a. Write the role of NMR and MS in structure elucidation. [5]  
b. What is charge transfer absorption? Why it is important for quantitative purpose? [2.5]
17. a. Differentiate:  
i. Deuterium Lamp and Tungsten lamp [4]  
ii. Finger print region and group frequency region  
b. Explain sample preparation techniques of IR. [3]

KATHMANDU UNIVERSITY  
End Semester Examination  
14 January 2024

Marks Scored:

Level : B.Tech.

Year : III

Exam Roll No. :

Time: 30 mins.

Course : INAN 301

Semester : I

F. M. : 20

Registration No.:

Date :

SECTION "A"

[20Q.  $\times$  1 = 20 marks]

- Which of these statements is **TRUE**?
  - Precision provides a measure of systematic error.
  - The time between successive LO to HI transition is called the pulse width
  - Detector converts electrical signal to non electrical signal and vice versa.
  - Sensors are the devices that are capable of monitoring specific chemical species continuously and reversibly
- In UV absorption spectroscopy, which of the following statements is **NOT TRUE**?
  - $n \rightarrow \pi^*$  and  $\pi \rightarrow \pi^*$  transitions require the presence of an unsaturated group
  - The molar absorptivity for  $\pi \rightarrow \pi^*$  transitions are generally high
  - $n \rightarrow \pi^*$  transitions are higher in energy than  $\pi \rightarrow \pi^*$  transitions
  - $\sigma \rightarrow \sigma^*$  transitions are lower in energy than  $\pi \rightarrow \pi^*$  transitions
- The sample container used in the UV Visible Spectrophotometer in the region below 350nm wave length are made up of the material \_\_\_\_\_ [A]Glass [B]Quartz [C] Fused Silica [D] Plastic
  - [AB]
  - [BC]
  - [AC]
  - [AD]
- Rank the following bonds in order of decreasing stretching frequency ( $\text{cm}^{-1}$ ) in IR spectrum.  
[A]O-H (alcohols) [B] C=O (ketones) [C] C-N (amines) [D] C-H (alkanes)
  - A<D<B<C
  - C<B<A<D
  - B<A<C<D
  - D<C<B<A
- How many peaks are present in the NMR signal for the indicated proton in  $\text{CH}_3\text{CH}_2\text{OH}$ ?
  - 3
  - 4
  - 9
  - 2
- Which of the following is an example of gas phase source?
  - Electrospray ionization
  - Field desorption
  - Fast atom bombardment
  - Chemical ionization
- In proton NMR instrument where magnet provides field strength of 9.38 T, at what frequency would the hydrogen nucleus absorbs? [ $\gamma = 2.6752 \times 10^8 \text{ T}^{-1} \text{ S}^{-1}$ ]
  - 100MHz
  - 200 MHz
  - 300MHz
  - 400MHz
- The purpose of flame in flame atomic-absorption spectroscopy is to
  - Purify the sample
  - Desolvate and atomize the analyte atoms in a sample
  - Prepare the sample solution
  - Solidify the analyte atoms

9. What is the order in which following compounds would be eluted from an HPLC column containing a reversed phase packing? [A] Alcohol [B] Amide [C] Acetone [D] Benzene  
a. B,A,C,D                      b. C,B,A,D                      c. D,C,B,A                      d. A,B,C,D
10. \_\_\_\_\_ Column has highest sample holding capacity.  
a. Wall Coated Open Tubular                      b. Surface Coated Open Tubular column  
c. Packed column                      d. Fused Silica Wall Coated Open Tubular

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

11. Which region of the electromagnetic spectrum, Radiofrequency or Visible is characterized by waves of shorter wave length? \_\_\_\_\_
12. An IR wavelength of  $5.88\mu\text{m}$  is equivalent to a wave number of \_\_\_\_\_  $\text{cm}^{-1}$ .
13. A nucleus has a spin quantum number of  $1/2$ . How many magnetic energy states does this nucleus have? \_\_\_\_\_
14. A weak absorption band in the region of  $280\text{nm} - 290\text{nm}$ , which is displaced towards shorter wavelengths with increased solvent polarity, strongly indicated the presence of a carbonyl group. Such a shift is termed as \_\_\_\_\_.
15. In Infra-Red Spectroscopy, the number of vibrational modes for  $\text{SO}_2$  molecule is \_\_\_\_\_.
16. In thin layer chromatography, after TLC development the solvent front has moved  $8.0\text{ cm}$ , component 1 has moved  $5.6\text{ cm}$  and component 2 has moved  $3.2\text{ cm}$  from the original sample spot. The  $R_f$  value for each component is \_\_\_\_\_ and \_\_\_\_\_ respectively.
17. In mass spectrometry, the resolution needed to separate the ions  $\text{M}^+$  and  $\text{N}^+$  with masses  $18.856$  and  $18.869$ , respectively is \_\_\_\_\_.
18. The \_\_\_\_\_ is an atomization technique mostly applicable for the determination of Arsenic.
19. We have  $86.1\%$  transmittance value. Conversion of this percent transmittance data into absorbance will give the value \_\_\_\_\_.
20. Among  $\text{HCl}$ ,  $\text{CH}_4$ ,  $\text{NO}$  and  $\text{O}_2$ , the IR inactive molecule is \_\_\_\_\_.