KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Marks Scored:

Level : B.E./B.Pharm.
Year : III

Course : INAN 301
Semester : II/I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : 10 FEB 2025

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose and mark [X] in the most appropriate option from the given set of choices

1. In a 400 MHz ^{1}H NMR spectrometer, a proton resonated at 1560 Hz higher than that of tetramethylsilane. The chemical shift value of the proton is _____ppm approximately. (Chemical shift of tetramethylsilane is zero ppm)
   [ ] 0.2 [ ] 3.5 [ ] 4 [ ] 4.5

2. Absorption of radiation in the UV range attributable to $n \rightarrow \pi^*$ electronic transitions is characteristic of which of the following types of compounds?
   [ ] aromatic hydrocarbons
   [ ] unsaturated carbonyl compounds
   [ ] non conjugated polyenes
   [ ] conjugated polyenes

3. Which of the following statements regarding IR spectroscopy is wrong?
   [ ] Infrared radiation is higher in energy than UV radiation.
   [ ] Infrared spectra record the transmission of IR radiation.
   [ ] Molecular vibrations are due to periodic motions of atoms in molecules, and include bond stretching, torsional changes, and bond angle changes.
   [ ] Infrared spectra give information about bonding features and functional groups in molecules.

4. In Atomic Absorption Spectroscopy, chemical interferences due to low volatility can be corrected by_____.
   [ ] employing natural gas as the fuel and air as the oxidant.
   [ ] using protective agents like EDTA.
   [ ] using ionization suppressor like CsCl.
   [ ] Converting to complete combustion so that scattering effect is minimized.

5. Which of the following organic compound exhibits only one signal in the ^{1}H NMR spectrum?
   [ ] 1, 1-dichloropropane
   [ ] 2, 2-dichloropropane
   [ ] 1, 2-dichloropropane
   [ ] 1, 3-dichloropropane

6. The correct order for the basic features in mass spectroscopy is_____.
   [ ] acceleration, deflection, detection, ionization.
   [ ] ionization, acceleration, deflection, detection.
   [ ] acceleration, ionization, deflection, detection.
   [ ] acceleration, deflection, ionization, detection.

7. In mass spectroscopic studies involving McLafferty rearrangement, generally there is a loss of_____.
   [ ] oxonium ion
   [ ] ethyne
   [ ] methyl substituent
   [ ] ethene

8. In revers phase chromatography, the stationary phase is _____and mobile phase is_____.
   [ ] Liquid adsorbed on solid support, liquid
   [ ] non polar, polar
   [ ] polar, non polar
   [ ] solid, varying concentration of liquids

9. The column chromatography elutes two compounds A and B (adsorption of B>A). Which of the following is the correct statement?
   [ ] B will elute first with high R_f value
   [ ] B will elute first with low R_f value
   [ ] A will elute first with high R_f value
   [ ] A will elute first with low R_f value

10. Considering CH_3-CH_2-CH_2-Br, which one of the following statements about ^{13}C NMR spectroscopy is true?
   [ ] The peak of γ carbon will be at upfield with more δ value
   [ ] The peak of α carbon will be at upfield with less δ value
   [ ] The peak of γ carbon will be at downfield with less δ value
   [ ] The peak of α carbon will be at downfield with more δ value

Fill in the blanks by most appropriate VALUE or WORD.

11. The resolution for the substances A and B having retention time 10.5 min and 15 min, respectively is _____(Given, peak width for A is 1.0 and for B is 2.0 min).

12. Arsenic can be easily detected in atomic absorption spectroscopy by_____ _____technique.

13. Mass and frequency in a quartz crystal microbalance are related with the equation_____ _____.

14. Polar solvents in UV Vis spectroscopy causes λ_{max} to shift towards _____ _____wavelength and is called_____ shift.

15. Specific retention volume (V_g) in GC is the characteristic property of an individua solute that depends only on _____ _____.

16. Among visible, infrared, radio waves and ultra violet radiation of an electromagnetic spectrum, the correct sequence with increasing frequency is_____ _____.

17. In a reversed phase HPLC column, a solute was found to have retention time of 30.0 min, and the dead time min as 0.5 min; the retention factor k' will be_____.

18. Frequency in IR spectroscopy is directly proportional to_____ and inversely proportional to_____.

19. Amino acids are easily detected in thin layer chromatography (TLC) plates after applying _____as the visualization agents.

20. The general reaction that takes place inside the anion suppressor (ion exchange chromatography) can be represented as _____.

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10 FEB 2025

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Semester : II/I
F. M. : 55

SECTION "B"
[5 Q. × 3 = 15 marks]

Attempt *ANY FIVE* questions.

1. Define Beer Lambert law. If a compound absorbs at 275 nm (ε_{max}=8400 L mol^{-1}cm^{-1}), what is the concentration (mmol/L) required to observe an absorbance of 0.7 when the cell length is 1 cm?

2. What is a bias in analytical studies? What is the difference between absolute and relative bias? How instrumental bias can be corrected?

3. Write down the relation of plate height and thermotical plate count. How particle size inside the column affect the plate height and thus in the column efficiency?

4. Why thin layer chromatography is generally performed prior to column chromatography?

5. The selectivity coefficient for an ion-selective electrode for K^+ with respect to Na^+ is 0.048. Calculate the relative error in the determination of K^+ in a solution that has a K^+ concentration of 2.5×10^{-3} M if the Na^+ concentration is (a) 2.5×10^{-2} M (b) 2.5×10^{-4} M. Assume that S_{bl} for a series of blanks was approximately zero.

6. In mass spectrometry, what is the role of the ionization process and how does the choice of ionization method (i) Electron Impact Ionization (EI) (ii) Chemical Ionization (CI) influence the type of information obtained about the sample?

7. How can monochromatic light be obtained from a light source? How does filters contribute in this process?

SECTION "C"
[5 Q. × 5 = 25 marks]

Attempt *ANY FIVE* questions.

8. a. Why different types of radiation sources are used in IR spectroscopy? How many total modes of vibration can be obtained by CH_3OH and what and where will be the characteristic peak of this compound in IR spectroscopy? [3]
   b. What is the coupling constant J in NMR studies and what information does it provide in structure elucidation of the compound? [2]

9. a. Derive the equation to calculate the vibration frequency of a diatomic molecule. What information can be obtained from group frequency region of IR spectra? [3]
   b. What is flame less atomizer in atomic absorption spectroscopy and what are its advantages? [2]

P.T.O.

10. a. Retardation factor R_f is important parameter in chromatography. Elaborate the statement. What is the major advantage of performing two-way paper chromatography? [3]

b. Compare the species that can be separated by HPLC and GC. [2]

11. a. Differentiate between normal phase and reverse phase chromatography. Why is reversed phase needed? [3]

b. Differentiate between isocratic and gradient elution in GC. Give a brief account on thermal conductivity detector used in gas chromatography. [2]

12. a. Predict the proton magnetic resonance spectra of $(CH_3)_3\,C\text{-}CH_2\text{-}Cl$. Explain the spectra in terms of chemical shift, splitting and area of the peaks. [3]

b. C_6H_6 shows the λ_{max} at 204 nm and ε_{max} as 7900 where as $C_6H_5NH_2$ shows 230 nm and 8600. Explain this variation. What happens on this phenomenon when $C_6H_5NH_2$ is reacted with acid? [2]

13. a. With necessary chemical equations, explain the role of suppressor column in ion exchange chromatography. [3]

b. How does ionization affect chemical interference in atomic absorption spectroscopy? How can this interference be minimized? . [2]

14 a. Define selectivity factor (α) of two species eluting through a column. What message does its value give and why is it always greater than unity? How can it be calculated? [3]

b. What are isotopic peaks in mass spectrometry? In which factors do the mass to charge ratio of ions that reach the detector depend on? [2]

SECTION "D"

[2 Q. × 7.5 = 15 marks]

Attempt *ANY TWO* questions.

15. a. Draw the block diagram of HPLC and describe the various kinds of pumps used in HPLC. [4.5]

b. What is dynamic range of an instrument and how can you determine the concentration of unknown substance by using calibration curve method? [3]

16. a. What is mass resolution and how can it be calculated? Predict the mass spectrum of $CH_3\text{-}CH_2\text{-}CH_2\text{-}Br$ showing the fragmentation pattern. Also explain the spectrum. [4.5]

b. Describe the various process and steps that occur from introduction to detection in a mass spectrometer. [3]

17. a. What do you know about Kovats retention index? Give a brief note on fused silica open tubular column of GC. [3+1.5]

b. What is the separation mechanism in size exclusion chromatography? How does different sized molecules elute in this chromatographic technique? [1+2]