

J AMIA HAMDARD
Department of Chemistry
School of Chemical and Life Sciences (SCLS)
M. Sc. Chemistry, I Semester
End-Term Examination 2023

Paper Name: Analytical Chemistry
Time: 3 hours

Paper Code: MCHCC-104
Maximum Marks: 60

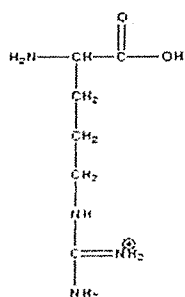
Note: This paper has 3 sections A, B, and C, Attempt all three sections; **Section A:** Answer *all* the questions; **Section B:** Answer *any 2* out of 4; **Section C:** Answer *all* the questions, each question has an *internal choice*

Abbreviations Used

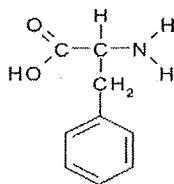
CLO- Course Learning Outcome, PLO- Program learning Outcome, BTL- Bloom Taxonomy Level: BT level 1-Remember; BT level 2-Understand; BT level 3-Apply; BT level 4-Analyse; BT level 5-Evaluate, BT level 6-Create

Q.No**BTL CLO PLO****SECTION A**Attempt ***all*** questions**(10*1.5= 15 Marks)**

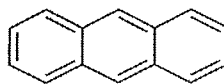
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|---|-----|-----|-----|
| A 1. What is the basis (principle) of chromatographic process? | 1/2 | 1-3 | 1-3 |
| A 2. What is chiral chromatography? | 1/2 | 1-3 | 1-3 |
| A 3. Arginine, phenylalanine, and anthracene are to be separated via reverse-phase liquid chromatography. Analyze the elution order: | 1/4 | 1-3 | 1-3 |



arginine



phenylalanine



anthracene

- | | | | |
|---|-----|-----|-----|
| A 4. What is meant by "planar chromatography"? List examples of such techniques. | 1/2 | 1-3 | 1-3 |
| A 5. The R _f of ibuprofen was found to be 0.40 when ethyl acetate was used as the development solvent. What effect would there be on the R _f of ibuprofen if acetone is used to develop the TLC plate? | 1/2 | 1-3 | 1-3 |
| A 6. What are nuclear reactions? Analyse how are nuclear reactions different from chemical reactions. | 2/4 | 2-3 | 2-3 |
| A 7. What are the essential components of an HPLC system | 3/4 | 3-4 | 3-4 |
| A 8. Write the formula for the simplified "van Deemter equation" (3 terms) and name the terms in the equation. | 1/2 | 1-3 | 1-3 |
| A 9. A biochemist analyzing triglycerides by normal phase HPLC wants to perform a gradient using the eluents hexane and methylene chloride. The % of which solvent should increase in the gradient run? | 1/2 | 1-3 | 1-3 |
| A 10. What is exclusion limit? | 1/2 | 1-3 | 1-3 |

SECTION B

Attempt any two out of the following four questions

(2*10=20 Marks)

- B 1.** a. What do you understand by the column efficiency, peak asymmetry factor, tailing factor, and resolution of a chromatographic peak? Explain how you analyse and calculate each of them. 3/4 3/4 3/4
- b. Various types of curves are obtained from thermogravimetric (TG) experiments. Analyze these different TG curves and provide suitable explanation for their interpretation? Discuss the interpretation of TGA curve of CaCO_3 and AgNO_3 .
- B 2.** a. What makes HPLC to be called as high performance. Describe briefly the principle and the modes of HPLC separation. Applying the modes of HPLC separation, how would you analyse a caffeine sample to check its purity and estimate its concentration? 3/4 3/5 3/5
- b. What are theoretical plates and what is their significance? Give the salient features and drawbacks of plate theory. 5/6 5/7 5/7
- B 3.** a. Chromatography band becomes broader as it moves down a column. Justify this statement by applying van Deemter's theory and also support your answer by drawing the van Deemter plot. 5/7 5/7 5/7
- b. A GC column was operated under the following conditions: Column: 1.10 m x 2.0 mm, packed with Chromosorb P; weight of stationary liquid added, 1.40 g; density of liquid, 1.02 g/mL; Flow rate: 25.3 mL min⁻¹; Temperature: Room-21.2°C; Column- 102.0°C. Retention times: air-18 s; methyl acetate- 1.98 min; methyl propionate-4.16 min; methyl n-butyrate- 7.93 min; Peak widths of esters at base: 0.19, 0.39, and 0.79, respectively.
- Calculate the following.
- the retention factor k for each component.
 - selectivity factor, for each adjacent pair of compounds.
 - the average number of theoretical plates and plate height for the column.
 - the resolution for each adjacent pair of compounds.
- B 4.** a. What are semiconductor detectors? Germanium and silicon are classified as either n-type or p-type according to the predominant type of impurity that they possess. Justify the statement while also highlighting the effect of impurities on pulse formation. 3/4 3/4 3/4
- b. Draw a labelled block diagram of the thermogravimetric analyser and briefly discuss its each component. Enumerate the advantages, limitations and applications of TGA.

SECTION C

Attempt **all** questions, each question has an **internal choice**

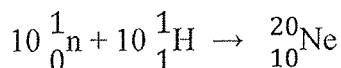
(5*5=25 Marks)

- C 1.** Explain the principle, process, advantages and applications of thin-layer chromatography. 4/5 4/7 4/7

OR

Consider the following nuclear reaction is:

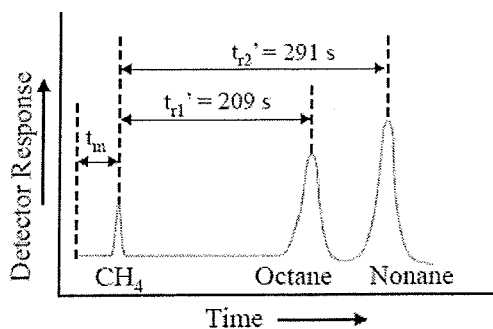
5 4/7 4/7



Calculate the mass defect and nuclear binding energy of $20\text{}^{10}_{10}\text{Ne}$

Given: Mass of $20\text{}^{10}_{10}\text{Ne}$ = 19.992397u, Mass of $1\text{}^1_1\text{H}$ = 1.007825u, Mass of $1\text{}^1_0\text{n}$ = 1.008665u.

- C 2.** Applying the knowledge of principles of chromatography, analyse the following chromatogram and calculate the relative retention and the capacity factor. 3/4 3/4 3/4



OR

A chromatographic analysis for the chlorinated pesticide Dieldrin gives a peak with a retention time of 8.68 min and a baseline width of 0.29 min. Calculate the number of theoretical plates. Given that the column is 2.0 m long, calculate the height of a theoretical plate in mm?

- C 3.** Differentiate between isothermal and programmed temperature GC? What criteria would you apply to select one of these two methods to analyze and evaluate a given sample by GC. 5/2 4/7 4/7

OR

Explain with suitable examples different types of ion exchange resins. What are the criteria for the selection of these resins in the analysis of samples by ion exchange chromatography? Discuss briefly the process of elution of the ion exchange column.

3/4 3/4 3/4

- C 4.** Explain with a suitable diagram the functioning of FID detector and highlight its application making it a universal detector in GC. 2/3 2/3 2/3

OR

Distinguish between split and splitless injection methods. Justify how a user will apply his knowledge to analyze and evaluate a given sample by these two injection methods.?

5/6 4/7 4/7

- C 5.** What is bonded phase chromatography? Describe the types of bonded phases. Discuss briefly the significance of end capping and double end capping process. 3/4 3/4 3/4

OR

Discuss the principle and instrumentation of Differential Scanning Calorimetry? How is DSC different from DTA. Highlight the applications of DSC.

3 3/4 3/4

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