

2025

**CHEMISTRY**

Paper : CHE0400404

**(Magnetic Resonance Spectroscopy and Analytical Techniques)**

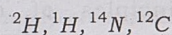
Full Marks : 45

Time : Two hours

**The figures in the margin indicate full marks for the questions.**

1. Answer the following questions as directed :  
1×5=5

(a) Which of the nuclei show magnetic properties for NMR spectroscopy ?



(b) State which of the following radiations is associated with NMR spectroscopy :  
X-ray, infrared,  $\gamma$ -ray, radiowave

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(c) Name the crystal system with characteristics  $a = b \neq c$ ;  $\alpha = \beta = 90^\circ$ ,  $\gamma = 120^\circ$ .

(d) Which is the commonly used adsorbent in column chromatography ?

$\text{NH}_4\text{OH}$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{CuSO}_4$ , Silica gel

(e) In mass spectrometry, the sample that has to be analyzed is bombarded with which of the following ?  
protons, electrons, neutrons,  $\alpha$ -particles

2. Answer **any five** questions : 2×5=10

(a) What are  $\alpha$ -cleavage and induce cleavage in mass spectroscopy ?

(b) What is the basic difference between the principles of conventional chromatography and HPLC ?

(c) Write *two* reasons for using TMS as reference in non-aqueous solvents in  $^1\text{H}$  NMR spectroscopy.

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(d) Explain spin-spin coupling in case of 1, 1-dibromoethane.

(e) What is  $R_f$  value ? During a chromatography experiment, a pigment moved 3.4 cm and the solvent had moved 4.8 cm. Calculate the  $R_f$  value.

(f) What is McLafferty rearrangement ?

(g) The edge length in  $\text{NaCl}$  crystal is  $5.63 \times 10^{-10} \text{ m}$ . Find the distance between (111) planes.

(h) How the molar conductance of strong electrolyte changes with dilution ?

(i) Write briefly about redox electrode.

(j) How the metal-amalgam electrode is set up ? How is it represented ?

3. Answer **any four** questions : 5×4=20

(a) What do you understand by adsorbent ? Give *two* classes of an adsorbent. Give examples of each class. 1+2+2=5

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(b) Name the different ionization techniques in mass spectrometry. Explain *any two* techniques. 2+3=5

(c) What do you mean by ionic doublets? Write briefly about asymmetry effect. 1+4=5

(d) What is metal-metal insoluble salt electrode? How this electrode is represented? Write the overall electrode reaction and electrode potential of metal-metal insoluble electrode. 1+1+3=5

(e) Write the principle of NMR spectroscopy and draw the block diagram of NMR spectrometer. 2+3=5

(f) The mass spectrum of 2-methylpentane shows two prominent peaks and  $m/z$  values of 71 and 43. Identify each species showing adequate fragmentation. Also identify the base peak. Distinguish between molecular ion peak and base peak in mass spectrometry. 2+1+2=5

(g) Draw a rough sketch of  $^1\text{H}$  NMR spectrum of 1-bromoethane and predict the chemical shift positions of the protons. Name *two* factors that affect chemical shift. 3+2=5

(h) Why are liquid  $\text{N}_2$  and  $\text{He}$  used in NMR spectrometers? Name *one* solvent used in NMR spectroscopy. Calculate the chemical shift in ppm unit for a proton that shifted to 270 Hz downfield from the TMS in a 100 MHz NMR spectrometer. 2+1+2=5

4. Answer **any one** question : 10×1=10

(a) (i) What are shielding and deshielding involved in NMR spectroscopy? 3

(ii) How many signals will be shown by  $\text{Br}_2\text{CHCH}_2\text{Br}$  in NMR spectroscopy? 3

(iii) How will you distinguish 1-propanol and 2-propanol using NMR spectroscopy? 2