

Total number of printed pages-7

1 (Sem-4) CHE 4

2025

CHEMISTRY

Paper : CHE0400404

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

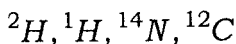
Full Marks : 45

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 spectrometry ?



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

(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?

NH_4OH , H_2SO_4 , $CuSO_4$, Silica gel

(e) In mass spectrometry, the sample that has to be analyzed is bombarded with which of the following?

protons, electrons, neutrons, α -particles

2. Answer **any five** questions : $2 \times 5 = 10$

(a) What are α -cleavage and induced 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 1H NMR spectroscopy.

(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 moved 4.8 cm. Calculate the R_f value.

(f) What is McLafferty rearrangement?

(g) The edge length in NaCl crystal is 5.63×10^{-10} 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 : $5 \times 4 = 20$

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

- (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 ^1H 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 N_2 and 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

(iv) Write the structure of the compound with molecular formula $C_3H_6Cl_2$ which exhibits only one signal in the 1H NMR spectrum.

2

(b) (i) Discuss the theory of electron spin resonance spectroscopy.

5

(ii) Taking example of hydrogen atoms, explain what is meant by hyperfine splitting in electron spin resonance spectroscopy ?

3

(iii) How many signals will be observed in the ESR spectrum of methyl radical ?

2

(c) (i) State Bragg's law and deduce the equation $n\lambda = 2d \sin \theta$

3

(ii) The parameters of an orthorhombic unit cell are $a = 50pm$, $b = 100pm$, $c = 150pm$. Determine the spacing between the (123) planes.

3

(iii) Calculate the Miller indices of crystal plane which cut through the crystal axes at $(2a, 3b, c)$ and (a, b, c) .

4

(d) (i) What is a concentration cell ? Write a short note on concentration cells without transference.

1+4=5

(ii) What is liquid junction potential ? Show that liquid junction potential depends upon the transference number of anions and cations.

1+4=5