2026
Chemistry
Paper : CH204
(Spectroscopy - II)

Full Marks : 60

Time : 3 hours

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

1. Answer ***any four*** of the following questions : 5×4=20

   a) Describe the basic principle of Nuclear Magnetic Resonance (NMR) phenomenon. 5

   b) What is Fourier Transform (FT) in NMR ? What is the advantage of FT mode of operation over that continuous wave (CW) mode ? 3+2=5

   c) Explain diamagnetic anisotropy taking the example of ring current effect. 5

   d) What is Nuclear Overhauser Effect (NOE) in NMR spectroscopy ? Discuss its physical origin and mechanism. 2+3=5

   e) What are the factors affecting chemical shift in NMR spectroscopy ? Discuss briefly. 5

   f) Define spin-spin coupling (*J*-coupling) in ^{1}H NMR. Explain the factors affecting the magnitude of coupling constant with suitable examples. Distinguish between geminal and vicinal coupling. 1+3+1=5

2. Answer ***any three*** of the following questions : 5×3=15

a) Explain zero-field splitting in ESR spectroscopy. Under what conditions is it observed ? 3+2=5

b) Define *g*-value in ESR and explain its significance. What is the value of g_e ? 4+1=5

c) How can z-elongated and z-compressed 6-coordinate Cu(II) complexes be distinguished using solid state EPR spectroscopy? [^{63}Cu (I=3/2)] 5

d) Explain Kramers degeneracy in ESR spectroscopy with suitable examples. Discuss the EPR signals expected for a Mn(II) complex ? 3+2=5

3. Answer ***any two*** of the following questions : 5×2=10

a) i) Write the differences between Spectroscopy and Spectrometry. 2

ii) How can mass spectrometry be used to distinguish between organic compounds substituted with one chlorine atom and one bromine atom ? 3

b) What is meant by molecular ion peak in mass spectrometry ? Discuss any one ionisation method used in mass spectrometry. 2+3=5

c) Explain the McLafferty rearrangement with mechanism. Predict the fragment ion masses formed in the mass spectrum of 4-*n*-butyltoluene due to this rearrangement. 3+2=5

4. Answer ***any four*** of the following questions : 2½×4=10

a) What is the basic difference between AB and AX Pople notations ?

b) What are shift reagents in NMR ? How do they help in resolving overlapping signals ? 1+1½=2½

c) Why solid state NMR spectra are broad ? How can you simplify a solid state NMR. 1+1½=2½

d) What is the pseudo contact shift observed in paramagnetic metal complexes ? 2½

e) Discuss peak broadening in NMR spectroscopy due to chemical exchange. 2½

f) Explain the Karplus relationship with the help of a diagram between $^{3}J_{HH}$ and dihedral angle. 2½

5. Answer ***any one*** of the following questions 5×1=5

a) What is the Mossbauer effect ? Explain the conditions necessary for recoil-free emission and absorption of γ-rays. How does temperature affect the Mossbauer spectrum ? 2+2+1=5

b) What is isomer shift in Mossbauer spectroscopy ? How can you differentiate between $FeSO_4$ and $FeCl_3$ with the help of Mossbauer spectroscopy ? 2+3=5

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