**DEPARTMENT OF CHEMISTRY**
**RANIRASHMONI GREEN UNIVERSITY**
**M.Sc. COURSE IN CHEMISTRY**
**SEMESTER III FINAL EXAMINATION: 2024**

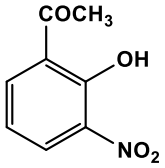
**Course ID: CHEM–C31**

**Full Marks: 40** **Time: 2hrs**

***Answer any ONE question from each UNIT in your own words with proper scientific justification.***

## Unit-1: IR and UV-Vis-NIR Spectral Study

**Q-1.**(a) Explain why the following compound shows two carbonyl and two OH stretching frequency.



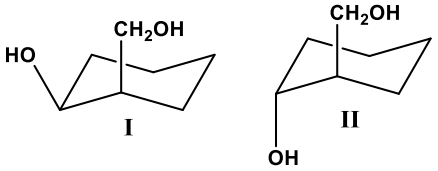

(b) Distinguish isomers of the compound having formula $Mn(CO)_3Cl_3$ by IR spectroscopy.

(c) Compare and explain the $\lambda_{max}$(n to σ*) for the following compounds$CH_3OH$, $CH_3Cl$ and $CH_3I$.

(d) Explain why molar absorbity of $K_2[CoCl_4]$ is more than $K_2[MnCl_4]$.

**[2+2+2+2 = 8]**

**Q-2.**(a) Predict and explain the vibrational frequency of OH group in the following isomers (I and II).




(b) Explain any two binding modes of nitrite ion by IR spectroscopy with suitable example.

(c) Define hyperchromic and hypochromic shift in UV spectroscopy with suitable example.

(d) Discuss the color intensity of the following complexes with proper reason:

(i) $[Fe(H_2O)_6]^{3+}$ (ii) $[MnBr_4]^{2-}$

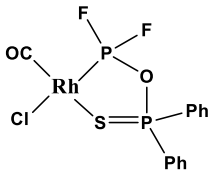
**[2+2+2+2 = 8]**

## Unit-2:NMR Spectral Study

**Q-3.** (a) Discuss ring whizzing in $^1H$ NMR with suitable example.

(b) Explain why outer protons appear in upfield and inner protons appear in downfield for [16] annulene.

(c) Sketch the respective NMR ($^{31}P$) spectrum of the following compound showing all reasonable couplings.

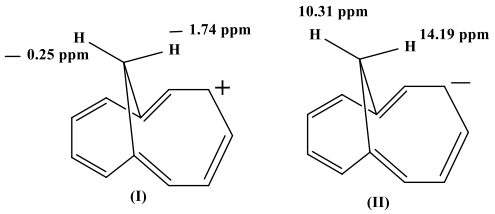



(d) Distinguish isomers of $Pt(PMe_3)_2BrCl$ by $^{195}Pt$ NMR showing all reasonable coupling.

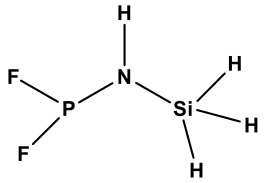
**[2+2+1.5+2.5 = 8]**

**Q-4.**(a)Discuss fluxionality in $^{1}H$ NMR with suitable example.

(b) Discuss the chemical shift of protons in NMR for following compounds (I and II).




(c) Sketch the respective NMR ($^{31}P$) spectrum of the following compound showing all reasonable couplings.



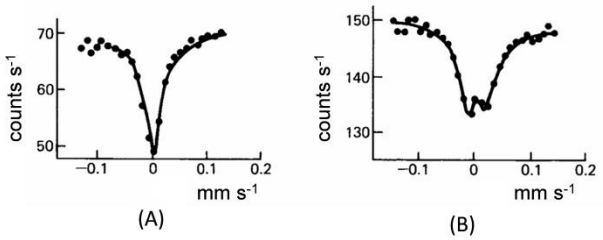

(d) Explain the signals of $^{11}B$, $^{10}B$, $^{1}H$ NMR for diborane compound.

**[2+2+1.5+2.5 = 8]**

**Unit-3: Mössbauer, Photoelectron and X-ray FluorescenceSpectral Study**

**Q-5.**(a) Draw a schematic energy-level diagram showing the decay process of radioactive $^{57}Co$ to $^{57}Fe$ in Mössbauer spectroscopy.

(b) One of the Mössbauer spectra below is of $K_3Fe(CN)_6$ and the other is of $K_4Fe(CN)_6$. Identify them and explain why?

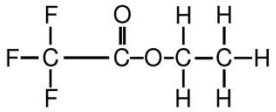



**[4+4 = 8]**

**Q-6.**(a) Briefly describe the basic principle of X-ray photo electron spectroscopy (XPS) showing the necessary energy-level diagram.

(b) What is the effect of using different X-ray sources on the binding-energy and kinetic-energy of electrons of a particular material in XPS?

(c) How many signal(s) do you expect in the XPS spectrum of **C 1s** in ethyl-trifiuoroacetate (**A**)? Predict the increasing order of their binding energies and explain your answer.




(A)

**[3+2+3 = 8]**

**Unit-4: EPR and Auger Electron Spectral Study**

**Q-7.** (a) Explain the basic principle of Auger Electron Spectroscopy (AES) with an energy diagram.

(b) Explain how can you resolve the spectral overlaps between Auger lines and Photoelectron lines?

(c) Write two important applications of AES. **[4+3+1 = 8]**

**Q-8.** (a) Explain why the EPR signal appears as broad?

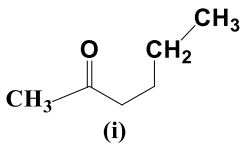
(b) Calculate the number of EPR lines in the following complexes: (i) $[Cu(NH_3)_4]^{2+}$&(ii) $[Ti(H_2O)]^{2+}$. Given $I_{Cu}$&$I_{Ti}$ = 3/2, $I_H$ = 1/2,$I_O$ = 0, $I_N$ = 1.

**[4+2+2 = 8]**

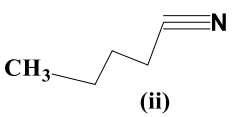
**Unit-5: Mass and CD-ORD- MCD Spectral Study**

**Q-9.**(a) Define metastable ion with suitable example.

(b) Comment on the typical fragmentation of the following compounds.



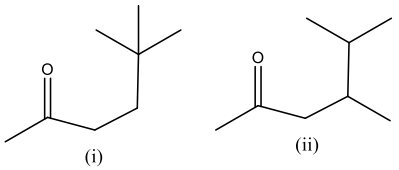

(i)




(ii)

(c) R(+) 3-methyl cyclohexanone exhibits positive Cotton effect. Apply the octant rule and predict preferred conformation. **[2+2+4 = 8]**

**Q-10.** (a) Distinguish the following compounds by mass spectrometry.



(i) (ii)

(b) Define circular birefringence and Cotton effect.

(c) Explain axial haloketone rule with suitable example. **[2+3+3 = 8]**