

Seat No. : \_\_\_\_\_

# ME-102

March-2025

B.Sc., Sem.-V

## CHE-304 : Chemistry (Analytical Spectroscopic Techniques)

Time : 2:30 Hours]

[Max. Marks : 70

સૂચના : જમણી બાજુના આંકડાઓ માર્ક્સ દર્શાવે છે.

1. નીચેનાના જવાબ લખો :

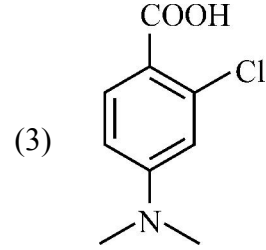
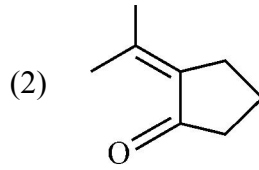
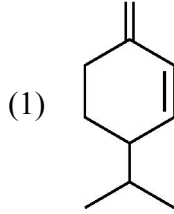
(i) ટૂંકનોંધ લખો : UV વર્ણપટ્ટમાં સંક્રાંતિઓ. 7

(ii) નોંધ લખો : ડાઈન પ્રણાલી માટે વુડવર્ડ-કિશરના નિયમો. 7

અથવા

1. (i)  $\lambda_{max}$  ને અસરકર્તા પરિબલો ચર્ચો. 7

(ii)  $\lambda_{max}$  ગણો : (ગમે તે બે). 7



2. નીચેનાના જવાબ લખો :

(i) IR વર્ણપટ્ટનો સિદ્ધાંત સમજાવો. 7

(ii) રામન વર્ણપટ્ટનો સિદ્ધાંત સમજાવો. 7

અથવા

2. (i) IR અને રામનને પ્રભેદિત કરો. 7

(ii) બંધકોણ અને સંકરણની IR વર્ણપટ્ટ પર અસરો ચર્ચો. 7

3. નીચેનાના જવાબ લખો :

(i) NMRમાં અવકાશીય અસર ચર્ચો. 7

(ii) NMRમાં પ્રોટોનના પ્રકારો ચર્ચો. 7

અથવા

3. (i) NMRમાં TMS સંદર્ભ સંયોજન તરીકે ઉપયોગી છે. – સમજાવો. 7

- (ii) નીચેના ડેટા પરથી અંધારણ શોધો : (કોઈપણ બે) : 7
- (a) M.F. : C<sub>9</sub>H<sub>11</sub>ON  
 UV :  $\lambda_{\max}$  235 nm, 336 nm.  
 IR: 2820(m), 2740 (doublet), 1645(s), 1600, 1567, 1528, 808, 720 cm<sup>-1</sup>.  
 NMR : Singlet  $\delta$  = 9.72 (1H), Singlet  $\delta$ =2.98 (6H),  
 Multiplet  $\delta$  = 6.65 (2H), Multiplet  $\delta$  = 7.7 (2H),
- (b) M.W. : 122  
 UV :  $\lambda_{\max}$  228 nm અને 272 nm.  
 IR : 3025-2528(Vb), 1680(s), 1602, 1580, 1451(s), 1285(s), 701 (s) cm<sup>-1</sup>.  
 NMR : Complex  $\delta$  = 7.6, 3H, Complex  $\delta$  = 8.2, 2H, Singlet  $\delta$  = 12.69, 1H
- (c) M.W.: 130 (બાષ્પશીલ સંયોજન). %C=73.8, %H= 13.8,  
 UV:  $\lambda_{\max}$  210 nm ઉપર પારદર્શી.  
 IR : 2960-285 l(m), 1342(w), 1075(s) cm<sup>-1</sup>.  
 NMR : Singlet  $\delta$  = 1.05

4. નીચેનાના જવાબ લખો : 7
- (i) બિયરનો નિયમ લખો. તેનું વિચલન અને મર્યાદાઓ ચર્ચો. 7
- (ii) ICPEs સમજાવો. 7

**અથવા**

4. (i) AASમાં હોલો કેથોડ લેમ્પનો ઉપયોગ સમજાવો. 7
- (ii) FESમાં માપન ત્રુટીઓ. 7

5. એક કે બે લીટીમાં જવાબ લખો : (ગમે તે સાત) 14
- (1) UVમાં R-બેન્ડ એટલે શું ?
- (2) ઓક્સોક્રોમ એટલે શું ?
- (3) વ્યાખ્યા કરો : વાદળી સ્થળાંતરણ.
- (4) એસીટામાઈડ અને ઈથાઈલ એમાઈન વચ્ચેનો IR આવૃત્તિનો એક ભેદ આપો.
- (5) IRમાં પેલેટ કેવી રીતે બનાવાય છે ?
- (6) IRમાં અંગુલી નિર્દેશ વિભાગ એટલે શું ?
- (7) વ્યાખ્યા કરો : ફ્લિપ્પિંગ
- (8) પાસ્કલનો ત્રિકોણ કયા સંબંધ માટે છે ?
- (9) પ્રોપેનોલના સમઘટકો લખો અને સક્રિયતાની સંખ્યા જણાવો.
- (10) લેમ્બર્ટનો નિયમ લખો.
- (11) વ્યાખ્યા કરો : આણુ અવશોષણતા.
- (12) હોલો કેથોડ લેમ્પમાં વપરાતા વાયુના નામ લખો.

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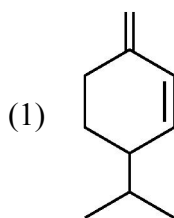
**Instruction** : Figure on R.H.S. indicates marks.

1. Write the following :

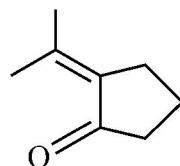
- (i) Write short note: Transitions in the UV spectroscopy. 7  
(ii) Write note : Woodward-fieser rules for diene system. 7

**OR**

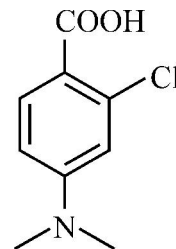
1. (i) Discuss factors affecting  $\lambda_{\max}$ . 7  
(ii) Calculate  $\lambda_{\max}$  : (Any two). 7



(2)



(3)



2. Write the following :

- (i) Write principle of IR spectra. 7  
(ii) Explain principle of the Raman spectroscopy. 7

**OR**

2. (i) Differentiate IR and Raman. 7  
(ii) Discuss effects of bond angle and hybridization on IR spectra. 7

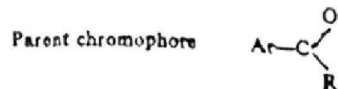
3. Write the following :

- (i) Discuss space effect in NMR. 7  
(ii) Discuss types of protons in NMR. 7

**OR**

3. (i) TMS is used as a reference compound in NMR-Explain. 7  
(ii) Deduce structure from the following data (Any **two**) : 7  
(a) M.F. :  $C_9H_{11}ON$   
UV :  $\lambda_{max}$  235 nm, 336 nm.  
IR: 2820(m), 2740 (doublet), 1645(s), 1600, 1567, 1528, 808, 720  $cm^{-1}$ .  
NMR : Singlet  $\delta = 9.72$  (1H), Singlet  $\delta=2.98$  (6H),  
Multiplet  $\delta = 6.65$  (2H), Multiplet  $\delta = 7.7$  (2H),  
(b) M.W. : 122  
UV :  $\lambda_{max}$ . 228 nm and 272 nm.  
IR : 3025-2528(Vb), 1680(s), 1602, 1580, 145 l(s), 1285(s), 701 (s)  $cm^{-1}$ .  
NMR : Complex  $\delta = 7.6$ , 3H, Complex  $\delta = 8.2$ , 2H, Singlet  $\delta = 12.69$ , 1H  
(c) M.W.: 130 (Volatile compound). %C=73.8, %H= 13.8,  
UV:  $\lambda_{max}$  Transparent above 210 nm.  
IR : 2960-285 l(m), 1342(w), 1075(s)  $cm^{-1}$ .  
NMR : Singlet  $\delta = 1.05$
4. Write the following :  
(i) Write Bear's law. Discuss its deviation and limitations. 7  
(ii) Explain ICPEs. 7  
**OR**
4. (i) Explain use of Hollow cathode lamp in AAS. 7  
(ii) Errors in the measurement of FES. 7
5. Answer in **one** or **two** lines : (any **seven**) 14  
(1) What is R-band in UV ?  
(2) What is auxochrome ?  
(3) Define : Blue shift.  
(4) Give one difference of IR frequency between acetamide and ethyl amine.  
(5) How pellet is prepared in IR ?  
(6) What is finger print region in IR ?  
(7) Define : Flipping.  
(8) Pascal's triangle is meant for which relation ?  
(9) Write isomers of Propanol and predict their number of signals.  
(10) Write Lambert's law.  
(11) Define : Molar absorptivity.  
(12) Write names of gases used in hollow cathode lamp.

*Empirical Rules for Benzoyl Derivative*



R = alkyl or ring residue	246 nm
R = H	250 nm
R = OH or O Alkyl	230 nm

Increments for each substituent :-

-alkyl or ring residue	O, m 3; p 10 nm
-OH, -OCH <sub>3</sub> , O Alkyl	O, m 7; p 25 nm
-O-	O 11; m 20; p 78 nm
-Cl	O, m 0 (zero); p 10 nm
-Br	O, m 2; p 15 nm
-NH <sub>2</sub>	O, m 13; p 58 nm
-NHCOCH <sub>3</sub>	O, m 20; p 45 nm
-NHCH <sub>3</sub>	p 73 nm
-N(CH <sub>3</sub> ) <sub>2</sub>	O, m 20; p 85 nm

*Infra-red Data*

Alkane	$\begin{matrix}   \\ -\text{C}-\text{H} \\   \\ -\text{C}-\text{C}- \\   \quad   \\ -\text{C}-\text{D} \end{matrix}$	2850-2960(s) 600-1500(w) ~2200(s)
Alkene	$\begin{matrix}   \\ =\text{C}-\text{H} \end{matrix}$	3010-3095(m) 1620-1680 (v)
Alkyne	$\begin{matrix} > \text{C}=\text{C} < \\ & \backslash \quad / \end{matrix}$	3200-3300(s)
Alkyne	$\equiv\text{C}-\text{H}$	2100-2260(v)
Aromatic	$\text{Ar}-\text{H}$	3010-3100(m) 690-900(s)
Aromatic ring	$\text{C}=\text{C}$	1500-1600(v)
Monomeric alcohol phenol	$-\text{O}-\text{H}$	3590-3650(v)
H-bonded alcohol phenol	$-\text{O}-\text{H}$	3200-3600(v)
Monomeric carboxylic acid	$-\text{O}-\text{H}$	3500-3650(m)
H-bonded mono carboxylic acid	$\begin{matrix}   \\ -\text{O}-\text{H} \\   \end{matrix}$	2500-300(v, b)
Amine, Amide	$-\text{N}-\text{H}$	3300-3500(m)
Amine, Amide	$\begin{matrix}   \\ -\text{C}=\text{N}- \\   \end{matrix}$	1180-1360(s)
Nitrile	$-\text{C}\equiv\text{N}$	2210-2280(s)
Alcohol, Ester, Carboxylic acid	$\begin{matrix}   \\ -\text{C}-\text{O}- \\   \end{matrix}$	1050-1300(s)
Aldehyde, Ketone, Carboxylic acid, Ester	$\begin{matrix} > \text{C}=\text{O} \\ \quad \quad   \end{matrix}$	1690-1760(s)
Nitro Compound	$-\text{NO}_2$	1500-1570(s)
	$-\text{CO}$	1300-1370(s)
Anhydride	$\begin{matrix} > \text{O} \\ \quad \quad \backslash \end{matrix}$	1850-1800(s)
	$-\text{CO}$	1790-1740(s)
Ether	$-\text{O}-$	1150-1070(s)

*Empirical Rules for Dienes*

	Homocannular (cisoid) $\lambda = 253 \text{ nm}$	Heterocannular (transoid) $\lambda = 214 \text{ nm}$
Parent		
Increments for double bond extending conjugation	30	30
alkyl subst. or ring residue	5	5
Exocyclic double bond	5	5
Polar groupings :-		
$-\text{OCOCH}_3$	0	0
$-\text{OR}$	6	6
$-\text{Cl}, -\text{Br}$	5	5
$-\text{NR}_2$	60	60

*Empirical Rules for Enones*



**Base Values**

6-membered ring or acyclic parent enone	= 215 nm
5-membered ring parent enone	= 202 nm
Acyclic Dienone	= 245 nm

**Increments for :-**

Double bond extending conjugation	30 nm
Alkyl group or ring residue	$\alpha$ 10 nm
	$\beta$ 12 nm
	$\gamma$ or higher 18 nm

**Polar groupings :-**

$-\text{OH}$	$\alpha$ 35; $\beta$ 30; $\delta$ 50	nm
$-\text{OCOCH}_3$	$\alpha, \beta, \delta$ 6	nm
$-\text{OCH}_3$	$\alpha$ 35; $\beta$ 30; $\gamma$ 17; $\delta$ 31	nm
$-\text{Cl}$	$\alpha$ 15; $\beta$ 12	nm
$-\text{Br}$	$\alpha$ 25; $\beta$ 30	nm
$-\text{NO}_2$	$\beta$ 95	nm
Exocyclic Double bond	5	nm
Homocyclic Diene Component	39	nm
Solvent correction	Variable	

EtOH  
 $\lambda_{\text{max(alc)}} = \text{Total}$

*N.M.R. Chemical Shifts*

Type of Proton	Chemical Shift ppm ( $\delta$ )	Type of Proton	Chemical Shift ppm ( $\delta$ )
Primary	$\text{RCH}_3$ 0.9	Alcohols	$\text{HC-OH}$ 3.4-4
Sec.	$\text{R}_2\text{CH}_2$ 1.3	Ethers	$\text{HC-OR}$ 3.3-4
Tert.	$\text{R}_3\text{CH}$ 1.5	Esters	$\text{RCOO-CH}$ 3.7-4.1
Vinyllic	$\text{C=C-H}$ 4.6-5.9	Esters	$\text{HC-COOR}$ 2-2.2
Acetylenic	$\text{C}\equiv\text{C-H}$ 2-3	Acids	$\text{HC-COOH}$ 3-2.6
Aromatic	$\text{Ar-H}$ 6-8.5	Carbonyl	$\text{HC-C=O}$ 2-2.7
Benzyllic	$\text{Ar-C-H}$ 2.2-3	Aldehydic	$\text{RCHO}$ 9-10
Allylic	$\text{C=C-CH}_2$ 1.7	Hydroxylic	$\text{R-OH}$ 1-5.5
Chloride	$\text{HC-Cl}$ 3-4	Phenolic	$\text{Ar-OH}$ 4-12
Bromides	$\text{HC-Br}$ 2.5-4	Enolic	$\text{C=C-OH}$ 15-17
Iodides	$\text{HC-I}$ 2-4	Carboxylic	$\text{R-COOH}$ 10.5-12
		Amino	$\text{R-NH}_2$ 1-5