

6 SEM TDC CHM M 7 (N/O)

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(May)

CHEMISTRY

(Major)

Course : 607

(Spectroscopy)

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

(New Course)

Full Marks : 48

Pass Marks : 14

Time : 2 hours

1. Choose the correct option : 1×5=5

(a) The radiation in the wavelength range
400–800 nm corresponds to

(i) ultraviolet

(ii) infrared

(iii) visible

(iv) far IR

(b) The value of extinction coefficient increases with

- (i) increase in conjugation
- (ii) addition of chromophore
- (iii) both of (i) and (ii)
- (iv) None of (i) and (ii)

(c) The molecule which is microwave active is

- (i) HCl
- (ii) CO₂
- (iii) H₂
- (iv) N₂

(d) The number of NMR signals formed by 2-chloropropene is

- (i) 2
- (ii) 3
- (iii) 1
- (iv) None

(e) In case same lines are obtained both in infrared and Raman spectra, then the molecule

(i) should be centrosymmetric

(ii) has no centre of symmetry

(iii) has high value of dipole moment

(iv) has low value of dipole moment

2. Answer any *five* of the following : $2 \times 5 = 10$

(a) Water is a good solvent for UV- and visible-spectroscopy but not for IR-spectroscopy. Explain.

(b) Explain Fermi resonance.

(c) Discuss about the interaction of electromagnetic radiation with a rotating molecule.

(d) Explain mutual exclusion principle with examples.

- (e) Describe Larmor frequency.
- (f) Cu^+ ion does not show ESR spectra but Cu^{2+} ion shows ESR spectra. Explain.

UNIT—I

3. (a) Discuss the effect of isotopic substitution on the rotational spectra of a diatomic molecule. 2½
- (b) The rotational spectrum of HF has lines 41.9 cm^{-1} apart. Calculate the bond length of H—F bond in HF. 2½

UNIT—II

4. (a) State and explain fundamental and overtone frequencies with mathematical expressions. 3

Or

Show that the frequency of the absorbed radiation in pure vibrational spectra is equal to the fundamental frequency of vibration ν_0 of the molecule. 3

- (b) Roughly sketch the fundamental vibrations of water molecule. 2
- (c) In the near IR spectrum of CO, there is an intense band at 2144 cm^{-1} . Calculate (i) the fundamental vibrational frequency of CO, (ii) the force constant and (iii) zero-point energy. 3

UNIT—III

5. (a) What are Stokes and anti-Stokes lines? Explain with anti-Stokes lines are weaker than that of Stokes lines. 2+2=4
- (b) Write the differences between Raman spectra and infrared spectra. 3

UNIT—IV

6. (a) Discuss various types of electronic transition with one example each. 4
- (b) Explain bathochromic shift with two examples. 2
- Or
- Write a short note on auxochrome. 2

UNIT—V

7. (a) Draw the high resolution NMR spectra of 1-chloropropane and 2-chloropropane. $1\frac{1}{2}+1\frac{1}{2}=3$

(b) What is chemical shift in NMR-spectroscopy? Mention two factors that affect chemical shift. $2+2=4$

Or

Discuss relaxation processes in NMR-spectroscopy. 4

(Old Course)

Full Marks : 48

Pass Marks : 19

Time : 3 hours

1. Choose the correct option : 1×5=5

(a) The radiation in the wavelength range 400–800 nm corresponds to

(i) ultraviolet

(ii) infrared

(iii) visible

(iv) far IR

(b) The value of extinction coefficient increases with

(i) increase in conjugation

(ii) addition of chromophore

(iii) both of (i) and (ii)

(iv) None of (i) and (ii)

- (c) The molecule which is microwave active is
- (i) HCl
 - (ii) CO₂
 - (iii) H₂
 - (iv) N₂
- (d) The number of NMR signals formed by 2-chloropropene is
- (i) 2
 - (ii) 3
 - (iii) 1
 - (iv) None
- (e) In case same lines are obtained both in infrared and Raman spectra, then the molecule
- (i) should be centrosymmetric
 - (ii) has no centre of symmetry
 - (iii) has high value of dipole moment
 - (iv) has low value of dipole moment

2. Answer any *five* of the following : 2×5=10

- (a) The nuclei like ¹²C and ¹⁶C do not exhibit NMR spectra. Explain.

- (b) Water is a good solvent for UV- and visible-spectroscopy but not for IR-spectroscopy. Explain.
- (c) Explain Fermi resonance with one example.
- (d) Discuss about the interaction of electromagnetic radiation with a rotating molecule.
- (e) Explain the principle of mutual exclusion.
- (f) Cu^+ ion does not show ESR spectra but Cu^{2+} ion shows ESR spectra. Explain.
- (g) Describe Larmor frequency.

UNIT—I

3. (a) Discuss the effect of isotopic substitution on the rotational spectra of a diatomic molecule. 2
- (b) The rotational spectrum of HF has lines 41.9 cm^{-1} apart. Calculate the bond length of H—F bond in HF. 2
- (c) State the reason why the microwave studies are done in gaseous state only. 1

UNIT—II

4. (a) Show that the frequency of the absorbed radiation in pure vibrational spectra is equal to the fundamental frequency of vibration ν_0 of the molecule. 3
- (b) In the near IR spectrum of CO, there is an intense band at 2144 cm^{-1} . Calculate (i) the fundamental vibrational frequency of CO, (ii) the force constant and (iii) zero-point energy. 3
- (c) Roughly sketch the fundamental vibrations of water molecule. Show how many of them are infrared active and Raman active. 2

UNIT—III

5. (a) What are Stokes and anti-Stokes lines in Raman spectroscopy? Why anti-Stokes lines are less intense than Stokes lines? 3
- (b) Discuss about the rotational Raman spectrum in linear molecule. 3
- (c) Write any one difference between Raman spectra and infrared spectra. 1

UNIT—IV

6. (a) Discuss various types of electronic transition with one example each. 3

(b) Write short notes on the following :
 $1\frac{1}{2}+1\frac{1}{2}=3$

(i) Bathochromic shift

(ii) Auxochrome

UNIT—V

7. (a) Discuss briefly the principle of ESR-spectroscopy. 3

Or

Discuss the relaxation processes in NMR-spectroscopy. 3

(b) Draw the high resolution NMR spectra of 1-chloropropane and 2-chloropropane. $1+1=2$

(c) What is chemical shift in NMR-spectroscopy? Mention one factor that affects chemical shift. 2
