Enrollment No._____

NAVRACHANA UNIVERSITY
a UGC recognized University

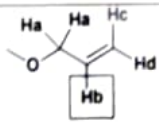
School: School of Science
Program/s: M.Sc. (Chemistry)
Year: 1st **Semester:** 1st
Examination: End Semester Examination
Examination year: December - 2022

Course Code: CH116 **Course Name:** **Spectroscopy**
Date: 06/12/2022 **Total Marks:** 40
Time: 11:30 am to 1:30 pm **Total Pages:** 2

Instructions:

- *Use of a calculator is permitted.*
- *Briefly justify the choice you make for multiple choice questions if 2 marks are assigned.*
- ** COs=Course Outcome mapping. # BTL=Bloom's Taxonomy Level mapping*

Q. No.	Details	Marks	COs*	BTL#
Q.1	**(A)** Which one of the following molecules doesn't exhibit a rotational spectrum. Please justify the choice you make **[Marks 2]** (i) H_2 (ii) CO (iii) HCl (iv) HBr **(B)** The infrared spectrum of HCl gas shows an absorption band centered at 2885cm^{-1}. The zero-point energy of HCl molecule under harmonic oscillator approximation is …….. Joules. **[Marks 2]** **(C)** The frequency of precession, the transition frequency and the Larmor frequency are different terms for the same frequency. True or false? **[Mark 1]** **(D)** When radiation energy is absorbed by a spin 1/2 nucleus in a magnetic field, what happens? **[Mark 1]** a) The precessional frequency of the nucleus increases b) The nucleus spins faster c) The angle of precession " flips " so that the magnetic moment of the nucleus opposes the applied field	**6**	CO1 CO2 CO3	BT1 BT2 BT3 BT4
Q.2	The J = 0 to J = 1 rotational transition for $^1H^{79}Br$ occurs at 500.72 GHz. Assuming the molecule to be a rigid rotor, the J = 3 to J = 4 transition occurs at (a) 50.1 cm^{-1} (b) 66.8 cm^{-1} (c) 16.7 cm^{-1} (d) 83.5 cm^{-1} Given 1 cm^{-1}= 30GHz.	**4**	CO1 CO2 CO3	BT1 BT2 BT3 BT4 BT5
Q.3	Draw the splitting Tree for H_b at δ = 6.07 (1H, m) $^3J_{BC}$ = 16.8 Hz, $^3J_{BD}$ = 10 Hz, $^3J_{BA}$ = 6.2 Hz.	**4**	CO2	BT1 BT2 BT3 BT44

				
Q.4	(a) Discuss the theory of ^1H NMR Spectroscopy and the condition of resonance. (b) Highlight the similarities and differences between NMR and EPR spectroscopy with appropriate equations and diagram.	3+3	CO3 CO4	BT1 BT2 BT3 BT4
Q.5	What factor(s) governs the intensity of spectral lines? [consider the intrinsic transition probability between the states are the same]. **OR** How can microwave spectroscopy be used to measure precise bond length(s) of a heteronuclear diatomic molecule?	5	CO1 CO2 CO3	BT1 BT2 BT3 BT4
Q.7	Both N_2O and NO_2 exhibit three different fundamental vibrational frequencies, and for the two molecules some modes are observed in both infra-red and the Raman. The bands in N_2O show only simple PR structure (no Q branches) while those in NO_2 show complex rotational structure. What information can be deduced about the structure of each molecule?	4	CO2 CO3	BT1 BT2 BT3 BT4
Q.8	State an expression for evaluating the wavenumbers of spectral lines exhibited by a Raman active, diatomic molecule exhibiting vibration-rotation spectra. State the selection rules for Raman scattering in these conditions. Illustrate the schematic diagram of rotation-vibration spectrum for a diatomic molecule having a fundamental frequency of $\overline{\nu_0}$ cm^{-1}	5	CO2 CO3	BT1 BT2 BT3 BT4
Q9	1. Sky looks blue because the sun light is subjected to _____. (a) Rayleigh scattering (b) Compton scattering (c) Both (d) None 2. The spectroscopic technique that can distinguish unambiguously between trans-1,2- dichloroethylene and cis-1,2-dichloroethylene without any numerical calculation is (a) Microwave spectroscopy (b) UV-Visible spectroscopy (c) X-ray photoelectron spectroscopy (d) γ-ray spectroscopy 3. The correct statement in the context of NMR spectroscopy is (a) static magnetic field is used to induce transition between the spin states (b) magnetization vector is perpendicular to the applied static magnetic field (c) the static magnetic field is used to create population difference between spin states (d) static magnetic field induces spin-spin coupling	3	CO1 CO2 CO3	BT1 BT2 BT3 BT4
Q10	What do you understand by molecular polarizability and polarizability ellipsoid? Illustrate the polarizability ellipsoids of the following molecules in presence of an electric field: a) SiH_4 b) CH_3Cl	3	CO2 CO3	BT1 BT2 BT3 BT4

**********End of Question Paper**********