

M. Sc. DEGREE END SEMESTER EXAMINATION - APRIL 2026**SEMESTER 2: CHEMISTRY/PHARMACEUTICAL CHEMISTRY****COURSE: 24P2CHET07/24P2CPHT07 - PHYSICAL CHEMISTRY II***(For Regular 2025 Admission and Improvement/Supplementary 2024 Admission)*

Time: Three Hours

Max. Weights: 30

PART A**Answer any 8 questions****Weight : 1**

1. Distinguish between collisional broadening and Doppler broadening. (CO1)
2. Define the term signal to noise ratio. What are the factors that affect signal to noise ratio? (CO1)
3. Discuss the selection rule in microwave spectroscopy. Which of the following molecules are microwave active? H_2 , NO, N_2O , CH_3Cl . (CO2)
4. The stretching vibrational frequency O-D is greater than O-H. True or false. Justify your answer. (CO2)
5. Bring out the difference between vibrational coarse structure and rotational fine structure of electronic spectrum. (CO2)
6. Define the term g -factor of a nucleus. Estimate the value of g -factor of a hydrogen nucleus operating at a magnetic field of 2.3487 T and a radio frequency of 100 MHz. (β_N for $^1H = 5.05 \times 10^{-27}$ J/T). (CO2)
7. Differentiate between field sweep and frequency sweep in NMR. Which is more favorable? (CO2)
8. The precessional frequency of ^{13}C nucleus is lower in comparison with 1H nucleus. Why? (CO2)
9. Discuss Nuclear Overhauser effect and list out its applications. (CO2)
10. What do you mean by McConnell equation. Explain its significance in EPR. (CO3)

(1 x 8 = 8)**PART B****Answer any 6 questions****Weights : 2**

11. The pure rotational spectrum of a molecule consists of equally spaced lines. Substantiate with suitable equations and transitions. Sketch the rotational energy levels and the spectrum of a diatomic molecule. (CO2)
12. Determine the ratio (N_J/N_0) for HI at (a) 300 K and (b) 1000 K (rotational quantum number $J = 5$ and $J = 0$, $I = 4.31 \times 10^{-47}$ kg m²) (CO2)
(c) Calculate the value of J_{max} at these two temperatures.

13. Show mathematically that the separation of the first Raman line from the Rayleigh line is $6B \text{ cm}^{-1}$, whereas the separation between successive lines is $4B \text{ cm}^{-1}$. (CO2)
14. Discuss the significance of Fortrat diagram in electronic spectroscopy. (CO2)
15. Explain the term magnetic anisotropy. Can chemical shift values be negative? Validate. (CO2)
16. (i) Differentiate between chemically equivalent and magnetically equivalent nuclei in NMR.
(ii) Chemical shift differences vary with the strength of the applied field, whereas coupling constants do not. Substantiate. (CO2)
17. Explain the terms (i) double resonance and (ii) HETCOR. (CO2)
18. Define the term isomer shift. Explain how Mossbauer spectroscopy can be used to identify the oxidation state of a metal ion. (CO3)
- (2 x 6 = 12)**

PART C

Answer any 2 questions

Weights: 5

19. (a) The equilibrium vibration frequency of the iodine molecule is 215 cm^{-1} , and the anharmonicity constant is 0.003. Calculate the intensity of the hot band relative to the fundamental band at 300 K.
(b) Deduce the mathematical expressions for fundamental absorption, first overtone, second overtone, and hot band. Estimate frequencies of these transitions if $\omega_e = 2990 \text{ cm}^{-1}$, $\chi_e = 0.0174$. (CO2)
20. Describe the classification of lasers. (CO2)
21. What are second order effects on NMR spectra. How they can be simplified? (CO2)
22. Briefly explain
(a) the applications of NQR Spectroscopy.
(b) factors affecting the (i) chemical shift in Mossbauer spectroscopy and (ii) g-values in EPR. (CO3)
- (5 x 2 = 10)**