Róll No..... Department of Physics & Photonics Science, NIT Hamirpur (HP) End Semester Examination, May, 2023

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Subject: Atomic and Molecular Spectroscopy (PH-221) Class: B. Tech. (Engineering Physics), 2nd Year Semester: 4th **Time: 3hrs**

Max. Marks: 50

Note: All questions are compulsory. Write answers to the questions in your own words. Q.1

(a) What are equivalent electrons? Discuss Wiswersser's rule with the help of an example. (2)

(b) Mention the procedure to determine the ground state term symbol. Determine the ground term symbol of Cobalt (Z=29). (3)

(c) Differentiate between continuous and discontinuous spectra. Explain the origin of band spectra and mention its important characteristics. (3)

Q.2 (a) Draw the Zeeman splitting of the ground state level 3 $^2S_{1/2}$ and excited state levels $3^{2}P_{1/2}$ and $3^{2}P_{3/2}$ of sodium. Also draw the transitions allowed by the appropriate selection

(b) The average spacing between the adjacent levels of CO molecule is 3.8626cm⁻¹. Calculate the bond length. Given that the isotopic masses of ¹²C and ¹⁶O are 0.012kg/mole and 0.016kg/mole, Avogadro's number is 6.022×10^{23} /mole, Planck's constant $h = 6.626 \times 10^{23}$ 10^{-34} /s. (3)

(c) Discuss Born – Oppenhiemer approximation briefly. (3)

Q.3 Explain the qualitative and quantitative intensity rules. Using quantitative rules determine the relative intensity of fundamental series of doublet character of Na spectrum. (4)

Q.4 Derive expression for the interaction energy in LS-coupling scheme. Discuss the splitting of energy levels in sp system due to LS interaction. (5)

Q.5 Discuss the origin of pure rotational spectra and mention its main features. Discuss the rigid rotator model of a diatomic molecule. (5)

Q.6 Explain Morse function and the Morse curve. Write the expression for energy and the vibrational term values for an anharmonic oscillator. Using various selection rules explain the origin of fundamental band, first overtone, second overtone and the hot bands. (5)

Q.7

(a) Explain Raman effect. What are the limitations of classical theory of Raman effect? (2) (b) Discuss the quantum theory of Raman effect. Explain various Raman transitions using the selection rules. Discuss rotational Raman spectra. (5)

Q.8 (a) What is Stark effect? Discuss its main features and types. Explain weak field stark effect. (3)

(b) Discuss fine structure and weak field Stark effect for H_{α} line of hydrogen atom. (4)