20P405 (Pages: 2) Name: ……..…...

Reg. No……..

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2022

(CBCSS-PG)

(Regular/Supplementary/Improvement)

CC19P PHY4 C12 - ATOMIC AND MOLECULAR SPECTROSCOPY

(Physics - Core Course)

(2019 Admission onwards)

Time: Three Hours Maximum: 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. What is Zeeman effect? Distinguish between normal and anomalous Zeeman effect.
2. Obtain an expression for rotational energy levels of a non-rigid diatomic molecule and schematically represent it.
3. What are hot bands? Why are they called so?
4. Explain Stimulated Raman Effect.
5. Explain mutual exclusion principle with examples.
6. Write a note on Déslandre's table.
7. What is meant by relaxation process? Explain spin- spin relaxation.
8. Discuss recoilless emission and absorption of gamma rays.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Explains the theory of anomalous Zeeman effect. Illustrate with diagrams of the Zeeman splitting of Sodium Yellow D lines.
10. Explain how the structure of XY_2 type and XY_3 type is determined using Raman and Infra-Red spectroscopy.
11. Discuss in detail the rotational fine structure of electronic vibrational spectra. Obtain equations for $\overline{\nu_P}$, $\overline{\nu_Q}$ and $\overline{\nu_R}$.
12. Explain the principle of ESR technique. Discuss the working of ESR spectrometer with the help of a schematic diagram.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. Consider two electrons, one in the 4*p* and the other in the 4*d* sub shell. Obtain the *L*, *S* and *J* values and the spectroscopic symbols for this two electron system.
14. The lines in the pure rotational spectrum of HCl are spaced as 20.8×10^2 per metre. Calculate the moment of inertia and the internuclear distance. Mass of proton $= 1.67 \times 10^{-27} kg$, Mass of Chlorine $= 58.5 \times 10^{-27} kg$.
15. How many revolutions per second does a Carbon monoxide molecule make when J = 4? The rotational constant of CO molecule is 1.9313 cm^{-1}.
16. With the exciting line 2536A, a Raman line for a sample is observed at 2612A. Calculate the Raman shift in cm^{-1}.
17. For $^1H^{35}Cl$, the rotational constant B_0 = 10.44 cm^{-1} and B_1 = 10.13 cm^{-1} for the V= 0 and 1 vibrational levels, respectively, and the separation of these vibrational levels, ω_0 is 2886.04 cm^{-1}. Calculate the wave numbers of the first two members of each of the O and S branches in Raman vibration-rotation spectrum.
18. The values of $\overline{\nu_e}$ and x_e for lower and upper states of CO are 2170.21 cm^{-1}, 0.0062 and 1515.61 cm^{-1}, 0.0114 respectively. The (0,0) transition is observed at 64746.55cm^{-1}. Calculate the energy difference of the two electronic states.
19. A proton magnetic resonance spectrometer operates at 300 MHz. Calculate the value of the magnetic field. $g_N = 5.585$ and $\mu_N = 5.05 \times 10^{-27} JT^{-1}$.

(4 × 3 = 12 Weightage)

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