19P405 (Pages: 2) Name: ……..…...

Reg. No……..

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2021

(CBCSS - PG)

CC19P PHY4 C12 - ATOMIC MOLECULAR SPECTROSCOPY

(Physics - Core Course)

(2019 Admission - Regular)

Time: Three Hours Maximum: 30 Weightage

SECTION A

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

1. Explain singlet and triplet states with examples.
2. Explain the L-S coupling scheme for the addition of angular momenta.
3. Elucidate the salient microwave spectral features of symmetric top molecule.
4. In the rotational fine structure of vibrational electronic spectra, the band head of the Q branch is always at J=-1/2, while that of the P or R branch may be anywhere. Comment.
5. Discuss Frank – Condon principle.
6. Explain hyper Raman effect.
7. Explain chemical shift with an example.
8. Describe the decay scheme of ^{119}Sn.

(8 x 1 = 8 Weightage)

SECTION B

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

9. Derive Bloch equations.
10. Explain with example Zeeman effect and Paschen Back effect in atoms.
11. With necessary energy level diagram discuss the rotational fine structure of vibrational band in a diatomic molecule.
12. With the help of a schematic diagram, describe the construction and working of a Raman spectrometer.

(2 x 5 = 10 Weightage)

SECTION C

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

13. The microwave spectrum of CN radical shows a series of lines spaced by a nearly constant value of 3.798 cm^{-1}. Compute the bond length of CN.
14. The equilibrium vibration frequency of the iodine molecule is 215 cm^{-1} and the anharmonicity constant $\chi_e = 0.003$. What is the intensity of the hot band $\upsilon = 1 \rightarrow \upsilon = 2$ relative to that of the fundamental, if the temperature is 300 K?

15. The Raman line associated with a vibrational mode which is both Raman and infrared active is found at 4,600 A^0 when excited by light of wavelength 4,358 A^0. Calculate the wavelength of the corresponding infrared band.
16. The zero point energy of the ground state of N_2 is 1176 cm^{-1} and that of its lowest excited state is 727 cm^{-1}. The energy difference between the minima of the potential energy curve is 50206 cm^{-1}. What is the energy of the (0, 0) transition? What is the corresponding wavelength?
17. Prove that in the electronic spectroscopy of a diatomic vibrator, the highest vibrational quantum number that can be reached is given by $\upsilon_{max} = \frac{1}{2\chi_e} - 1$ where notations have their usual meanings.
18. Draw the energy level diagram and transitions for the odd electron of the free radical in 1, 4-benzosemiquinone.

    (In the benzosemiquinone free radical ion, the odd electron can move throughout the molecule and interact with the nuclear moments of the four equivalent protons.)
19. A Mossbauer nucleus ^{57}Fe makes the transition from the excited state of energy 14.4 keV to ground state. What is the recoil energy?

(4 x 3 = 12 Weightage)

****