K – 4897

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021.

Physics

PH: 232 ATOMIC AND MOLECULAR SPECTROSCOPY

(2018 Admission onwards)

Time : 3 Hours   Max. Marks : 75

SECTION – A

Answer **any five** questions. Each question carries **3** marks.

I. (a) Write a note on L-S coupling and j-j coupling

(b) State the conditions for a vibration to be Raman active

(c) Explain Frank-Condon principle

(d) Write a note on continuous wave NMR spectrometer

(e) Explain the fine structure of ESR absorptions

(f) Write short note on Doppler shift in Mossbauer spectroscopy

(g) What are singlet and triplet states? Give examples.

(h) What is Larmour Precession?

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

Answer **all** questions. Each question carries **15** marks.

II. (A) Give the quantum theory of anomalous Zeeman Effect and obtain an expression for the Zeeman shift.

OR

(B) (a) Discuss the theory of rotation-vibration spectra of a diatomic molecule.

(b) What will be the effect of the presence of isotopes on the spectrum?

III. (A) (a) With a neat diagram explain the working of an NMR Spectrometer.

(b) Briefly explain how the Raman and IR spectra help to identify the structure of the molecules?

OR

(B) (a) What are reducible and irreducible representations?

(b) Explain the important rules regarding irreducible representations and their characters.

IV. (A) Explain resonance absorption and emission of gamma rays. Discuss the effect of magnetic field and crystal field in Mossbauer spectra.

OR

(B) Discuss structure determination using IR and Raman spectroscopy for molecules of the type XY_2, XY_3 and XV_4.

(3 × 15 = 45 Marks)

SECTION – C

Answer any **three** of the following questions. Each question caries **5** marks.

V.   (a)   The wavelength of the $H\alpha$ line for hydrogen is 656.28 nm. What is the wavelength of $H\alpha$ line for deuterium?

(b)   What is the average period of rotation of HCl molecule if it is in the J=1 state. The inter nuclear distance of HCl is 0.1274 nm. Given the mass of hydrogen and Chlorine atoms are 1.673 x 10^{-27} kg and 58.06 x 10^{-27} kg respectively.

(c)   The normal modes of vibration of CO_2 molecules are $\overline{V_1} = 1330 cm^{-1}$ $\overline{V_2} = 667 cm^{-1}$, $\overline{V_3} = 2349 cm^{-1}$. Evaluate the zero point energy of a CO_2 molecule.

(d)   If the bond length of H_2 is 0.07417 nm, what would be the positions of the first three rotational Raman lines in the spectrum? What is the effect of nuclear spin on the spectrum? ^1H=1.673 x 10^{-27} kg.

(e)   In the NMR spectrum of 14 N with I=1, how many spectral lines will be observed? Calculate the frequency required for the NMR line at an external field of 1.4T (g_N=0.403)

(f)   A Mossbauer nucleus 57Fe makes the transition from the excited state of energy 14.4 KeV to the ground state. What is its recoil velocity?

(3 $\times$ 5 = 15 Marks)

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