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WT—251—2024

FACULTY OF SCIENCE

M.Sc. (First Year) (First Semester) EXAMINATION

NOVEMBER/DECEMBER, 2024

PHYSICS

Paper-PHY-103

(Atomic and Molecular Physics)

(Tuesday, 17-12-2024) **Time : 10.00 a.m. to 1.00 p.m.**

Time—3 *Hours* *Maximum Marks*—75

N.B. :— (*i*) *All* questions are compulsory.

(*ii*) Figures to the right indicate full marks.

(*iii*) Use of calculator is allowed.

(*iv*) Atomic masses (in kg) :

$^{1}H = 1.673 \times 10^{-27}$

$^{35}Cl = 58.06 \times 10^{-27}$

$^{37}Cl = 61.38 \times 10^{-27}$

$h = 6.626 \times 10^{-34}$ J-sec

$c = 2.998 \times 10^{8}$ m/sec

1. Discuss in detail, normal Zeeman effect. Derive an expression for interaction energy. Show the Zeeman transitions between 2*s* and 2*p* states. 15

P.T.O.

Or

(*a*) What are the term symbols for the *pp* non-equivalent electrons ? 8

(*b*) Describe the spectrum of hydrogen atom. Show the schematic representation of the Lyman series. Calculate the convergenic limit for Lyman series. 7

2. Discuss the spectrum of diatomic rotor. Explain the effect of isotopic substitution on the spectrum of rigid rotor. 15

Or

(*a*) Discuss the spectrum of linear polyatomic molecule with the help of linear triatomic molecule (OCS). 8

(*b*) The rotational constant for $H^{35}Cl$ is observed to be 10.5909 cm^{-1}. What is the value of B for $H^{37}Cl$. 7

3. What is the effect of failure of Born-Oppenheimer approximation on the spectrum of diatomic vibrating rotator ? 15

Or

(*a*) Discuss the techniques and instrumentation for IR spectrometer. 8

(*b*) How many normal modes of vibration one possible for the following molecules :

HBr, SO_2, BCl_3, CH_4 ? 7

4. What is Raman effect ? Discuss the Raman activity of vibration with the help of H_2O and CO_2 molecules. 15

Or

(*a*) What is the relevance of nature of polarized light to Raman spectroscopy. Discuss with suitable example. 8

(*b*) Discuss the pure rotational spectrum of linear molecules. 7

5. Write short notes on *three* of the following : 15

(*a*) Stark effect

(*b*) Intensities of spectral lines in rotational spectrum

(*c*) Harmonic oscillator

(*d*) Rule of mutual exclusion.