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NY—251—2023

FACULTY OF SCIENCE

M.Sc. (First Semester) EXAMINATION

NOVEMBER/DECEMBER, 2023

(New/CBCS Pattern)

PHYSICS

Paper-PHY-103

(Atomic and Molecular Physics)

(Tuesday, 12-12-2023)

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) :

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

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

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

$$h = 6.626 \times 10^{-34} \text{ J-s.}$$

1. What do you mean by equivalent electrons ? Find out the terms for p^2 electrons.

15

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Or

- (a) Explain the concept of compound doublet with reference to hydrogen atom. Show the compound doublet spectrum as a result of transitions in the hydrogen atom. 8
- (b) The term symbol for a particular atomic state is quoted as $^4D_{5/2}$. What are the values of L, S & J for this state? 7
2. Discuss the spectrum of a non-rigid rotator. What is the reason for non-rigidity and its consequences? 15

Or

- (a) Draw a schematic diagram of a microwave spectrometer and discuss various components involved therein. 8
- (b) HCl has a B value of 10.593 cm^{-1} and a centrifugal distortion constant D of $5.3 \times 10^{-4} \text{ cm}^{-1}$. Estimate the vibrational frequency and force constant of the molecule. 7
3. Discuss, in detail, the spectrum of diatomic-vibrating rotator when Born-Oppenheimer approximation holds good. 15

Or

- (a) How many normal modes of vibration are possible for the following molecules :
HBr, O₂, OCS, SO₂, BCl₃, CH₄, CH₃I & C₆H₆. 8
- (b) How the analysis is carried out by IR techniques? 7

4. How to decide whether various vibrational modes of a particular molecule will be Raman Active or in-active ? Discuss with the help of asymmetric top and linear triatomic molecules. 15

Or

- (a) Explain the term polarizability ellipsoid. Discuss the classical theory of Raman effect. 8
- (b) With which type of spectroscopy would one observe the pure rotation spectrum of H_2 ? If the bond length of H_2 is 0.07417 nm, what would be the spacing of the lines in the spectrum ? 7
5. Write short notes on any *three* of the following : 15
- (a) Building up principle
- (b) Types of molecules
- (c) Progressions and sequences in electronic spectra
- (d) Pure rotational Raman spectra.