

**238201**

May, 2019

M.Sc. SEMESTER II

Atomic and Molecular Physics (PHL201)

Time : 3 Hours]

[Max. Marks : 75

*Instructions :*

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

**PART-A**

1. (a) What is meant by space quantization. (1.5)  
(b) Define space-lattice relaxation time. (1.5)  
(c) Find Lande's g factor for  $2P_{3/2}$ . (1.5)  
(d) Differentiate dissociation and pre dissociation energy. (1.5)  
(e) How many peaks would you expect in NMR spectra of propane. (1.5)  
(f) What is Lande Interval Rule? (1.5)

- (g) How Raman spectra explain the structure of molecule. (1.5)
- (h) What is Stark effect? (1.5)
- (i) What is chemical shift? (1.5)
- (j) The exciting line is  $4358 \text{ \AA}$  and Stokes line is at  $4458 \text{ \AA}$ . Find the wavelength of anti-stokes line. (1.5)

### PART-B

2. (a) What is Anomalous Zeeman effect? Discuss the Zeeman pattern of the resonance ( $D_1$ ,  $D_2$ ) lines of sodium? (10)
- (b) Calculate the possible orientations of the total angular momentum vector corresponding to  $j = 3/2$  with respect to a magnetic field along the  $z$  axis. (5)
3. (a) How does the spin-orbit interaction when combined with the relativity correction, explain the hydrogen fine structure? (10)
- (b) Explain the intensity alternation in the Rotational Raman Spectra of  $H_2$  molecule with special reference to nuclear statistics. (5)
4. (a) Discuss the principle and significance of Stern-Gerlach Experiment. (10)
- (b) Explain the intensity distribution in absorption bands from Franck-Condon principle. (5)

5. (a) Determine the electron configuration and term types for the lowest configuration of  $H_2^+$  using co-relation diagram. (5)
- (b) "The molecular wave function can be written as a product of electronic and nuclear wave functions." Elucidate this statement. (10)
6. (a) What is spin-spin coupling in NMR spectroscopy & how it affects the peaks present in spectrum? Explain with example? (10)
- (b) What is the difference between NMR and ESR? (5)
7. Discuss rotational fine structure of electronic vibrational transition. Discuss the condition under which the band heads are degraded towards violet or red. (15)