

2022
M.Sc.
Third Semester
 CORE – 10
PHYSICS
Course Code: MPHC 3.21
 (Atomic & Molecular Spectroscopy)

Total Mark: 70

Pass Mark: 28

Time: 3 hours

Answer five questions, taking one from each unit.

UNIT-I

1. (a) In case of Sommerfeld model of atom, corresponding to $n = 1$, $n = 2$ and $n = 3$, what are the possible values of n_ϕ ? Illustrate the possible orbits with diagram. 3
- (b) Obtain the expression of total energy of a single electron in Sommerfeld atomic model in absence of relativistic correction. 8
- (c) Discuss how fine structure lines are produced in He^+ ? 3
2. (a) Obtain the expression of energy in Sommerfeld atomic model after introducing Sommerfeld relativistic correction. 10
- (b) State and discuss Ritz combination principle. 4

UNIT-II

3. (a) Discuss the variation method of chemical bonding. 9
- (b) What is an MO wave function? Describe LCAO-MO wave functions. 5
4. (a) Discuss the MO treatment of hydrogen molecule ion and show that symmetric orbitals form a stable state. 10
- (b) Describe quantum theory of Raman effect. 4

UNIT-III

5. (a) What is electronic spectra of a molecule? Describe the salient features of molecular electronic spectra. Explain the formation of electronic spectrum from electron transition in a molecule. 1+4+6 = 11
- (b) In the CO molecule, the wave number difference between the successive absorption lines in the pure rotational spectrum is 384 m^{-1} . Calculate the moment of inertia of the molecule and the equilibrium bond length of the molecule. Masses of the C^{12} and O^{16} atoms are respectively $1.99 \times 10^{-26} \text{ kg}$ and $2.66 \times 10^{-26} \text{ kg}$. 3
6. (a) State and explain Frank-Condon principle. 4
- (b) Discuss vibrational spectra of diatomic molecule. 4
- (c) Describe vibrating diatomic molecule as anharmonic oscillator. 6

UNIT-IV

7. (a) Describe the relaxation mechanisms in NMR spectroscopy. 6
- (b) Explain chemical shift in NMR spectroscopy. 6
- (c) What is nuclear magnetic moment? Express it mathematically. 2
8. (a) Explain how fine structure is obtained in ESR spectroscopy. 4
- (b) What is electron nuclear double resonance? Describe double resonance in ESR spectroscopy. 5
- (c) What is ESR spectroscopy? Explain how does electron spin interact with magnetic field? 5

UNIT-V

9. (a) Explain the detection process of NQR spectroscopy. 5
- (b) Calculate the frequencies of transition and energies associated with the transition for a nuclei having spin $I = \frac{3}{2}$. 4
- (c) Describe CW oscillator with proper block diagram. 4

10. (a) Discuss magnetic hyperfine interaction in Mössbauer spectroscopy. 6
- (b) Describe X-ray photoelectron spectroscopy. 5
- (c) Calculate the energy and frequency of transition associated with the transition for a nuclei having spin $I=1$. 3
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