

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc
BRANCH: CHEMISTRY

SEMESTER: III
SESSION: MO/2023

SUBJECT: CH215 PHYSICAL CHEMISTRY III

TIME: 3 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
 2. Attempt all questions.
 3. The missing data, if any, may be assumed suitably.
 4. Before attempting the question paper, be sure that you have got the correct question paper.
 5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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Q.1(a)	Obtain the commutator of the operators of the square of the orbital angular momentum and any one of its components.	[5]	1	2
Q.1(b)	Analyze the possibility of having simultaneous eigenfunctions of those operators and the implications of the uncertainty principle therein.	[5]	1	3
Q.2(a)	State the variational principle and discuss the quantization of energy and orbital angular momentum of hydrogen-like systems.	[5]	2	1
Q.2(b)	Show that the Slater determinants obey both Pauli exclusion principle and Pauli antisymmetry principle.	[5]	2	2
Q.3(a)	Draw and explain the potential energy curve of H ₂ molecule.	[5]	3	1
Q.3(b)	Discuss the drawbacks of the molecular orbital theory and the valence bond theory. How can those be eradicated?	[5]	3	2
Q.4(a)	Explain the origin of Stokes, anti-Stokes and Rayleigh lines from the classical theory in Raman Spectroscopy.	[5]	4	1
Q.4(b)	The IR spectrum of HCl shows three lines at 2886, 5668 and 8347 cm ⁻¹ . Determine the anharmonicity constant and frequency of fundamental vibration in HCl molecule.	[5]	4	3
Q.5(a)	How does nuclear spin quantum number govern the NMR spectrum? What will be the Larmor precessional frequency of protons under 4.7 T magnetic field if it precesses at 60 MHz under 1.4 T?	[5]	5	2
Q.5(b)	What is chemical shift? What is TMS and why it is used while recording ¹ H NMR of unknown compound?	[5]	5	2

:::23/11/2023:::E