

M.Sc. 1st Semester Examination, 2023**CHEMISTRY**

PAPER—CEM-101

*Full Marks : 50**Time : 2 hours**The figures in the right hand margin indicate marks**Candidates are required to give their answers in their own words as far as practicable***GROUP – A**Answer any **four** questions from the following :

2 × 4

1. If ψ is a eigen function of an operator, \hat{A} with eigen value ' a ', then show that ψ is also an eigen function of $e^{\hat{A}}$ with eigen value e^a .

2. Spatial part of the ground state wavefunction of He atom is $1S(1)1S(2)$. Write down the spin component of the above wave function.
3. Define a Grand Canonical Ensemble.
4. Write down the conditions at which the Fermi-Dirac distribution reduces to the Boltzmann distribution.
5. Give an example of each of the (i) Symmetric top and (ii) asymmetric top molecules.
6. Evaluate the commutator, $[\hat{p}_x, [\hat{x}, \hat{p}_x^2]]$.

GROUP – B

Answer any **four** questions from the following :

4 × 4

7. Write down the polar form of \hat{L}_z operator.
Deduce the normalized wavefunction of \hat{L}_z

1 + 3

8. For a particle in a box problem ($x = 0$ to L), evaluate $\langle x^3 \rangle$ as $x \rightarrow \infty$. 4
9. Show that $\beta = 1/kT$, (where the symbols indicate their usual meaning) 4
10. How would you measure the activity of a volatile solute for practical system? 4
11. The rotational constant for $H^{35}Cl$ is observed to be 10.5909 cm^{-1} . What are the values of B for $H^{37}Cl$ and $D^{35}Cl$? 4
12. State Virial theorem. For a conservative system, deduce the following relation,

$$\left\langle q_i \left(\frac{\partial v}{\partial q_i} \right) \right\rangle = 2T$$

(Symbols have their usual significances)

1 + 3

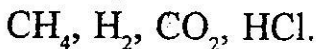
GROUP – C

Answer any two questions from the following :

8 × 2

13. Wavefunctions for a rigid rotator are represented by the Spherical Harmonics functions, $Y_l^m(\theta, \phi)$; where ' l ' is the Azimuthal quantum number and ' m ' is the magnetic quantum number. Show that $-l \leq m \leq l$. 8
14. Derive the Sackur-Tetrode equation for molar entropy of translational motion of a particle. What is the best composition of a mixture of a ternary system ? 7 + 1
15. Derive an expression for the thermodynamic probability distribution of particles described by symmetric wave function and arrive at the appropriate quantum statistical distribution law. 8

16. What are the different advantages of Fourier transformation technology ? What are hot bands ? State (with justification) among the following molecules, whose rotational constant cannot be determined by spectroscopic method :



2 + 2 + 4

[Internal Assessment — 10 Marks]
